Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Corrections to STC transmission.
Date Submitted	July 07, 2004
Source(s)	Atul Salvekar, Ph.D. mailto:atul.a.salvekar@intel.com Baraa Al-Dabagh mailto:baraa.al.dabagh@intel.com Hassan Yaghoobi, Ph.D. mailto:hassan.yaghoobi@intel.com Intel Corporation CHP3-105 350 East Plumeria Dr. San Jose, CA 95134
Re:	Supporting document for recirculation ballot #14b.
Abstract	In P802.16 REVd/D5 [1], an STC Preamble is only mandatory if there is an STC allocation in the frame. However, in order to get accurate maintenance values, for example power, an STC preamble should occur in a preceding frame. In order to alleviate the situation, it is recommended that if there is an STC allocation in frame K and there is no STC allocation in the preceding frame, K-1, then the BS must transmit an STC preamble as the last allocation in the preceding frame, i.e frame K-1. A second recommended item is to adjust the STC FCH so that it mirrors the FCH in normal transmission. This resolves the problem in the current standard that the MAP cannot necessarily be parsed in STC mode. This issue becomes even more severe in mobile situations where the channel variations can occur more rapidly. The modifications are to be made with respect to P802.16e/D3[2].
Purpose	Adoption
Notice	
Release	
Patent Policy and Procedures	

incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Corrections to STC transmission

1. Introduction

In 802.16Revd/D5 [1], the STC Downlink frame structure includes a STC DL preamble. By utilizing the transmitted STC preamble in the same frame, it may be difficult to perform channel estimation for data reception and at the same time optimize other system parameters, for example operating power setpoint for the STC receiver. This mirrors the situation in normal transmission.

It has been noted that this is better suited to the 802.16 corrigenda, but this issue becomes more severe in highly mobile environment since the channel variations occur more quickly. For this reason we propose sending an extra STC preamble in the preceding frame as described in Section 2. In addition to the DL preamble, because of the way the frame structure is defined, it turns out that it is difficult to parse the STC MAP if it exists. Therefore, we propose a new STC FCH, which is the same format as the FCH in normal transmission.

As an example, consider the case of two rayleigh fading paths with equal average power. If P_1 is the instantaneous power of path 1 and P_2 is the instantaneous power of path 2, then the Figure 1 shows the distribution of the power of P_1 vs. (P_1+P_2).

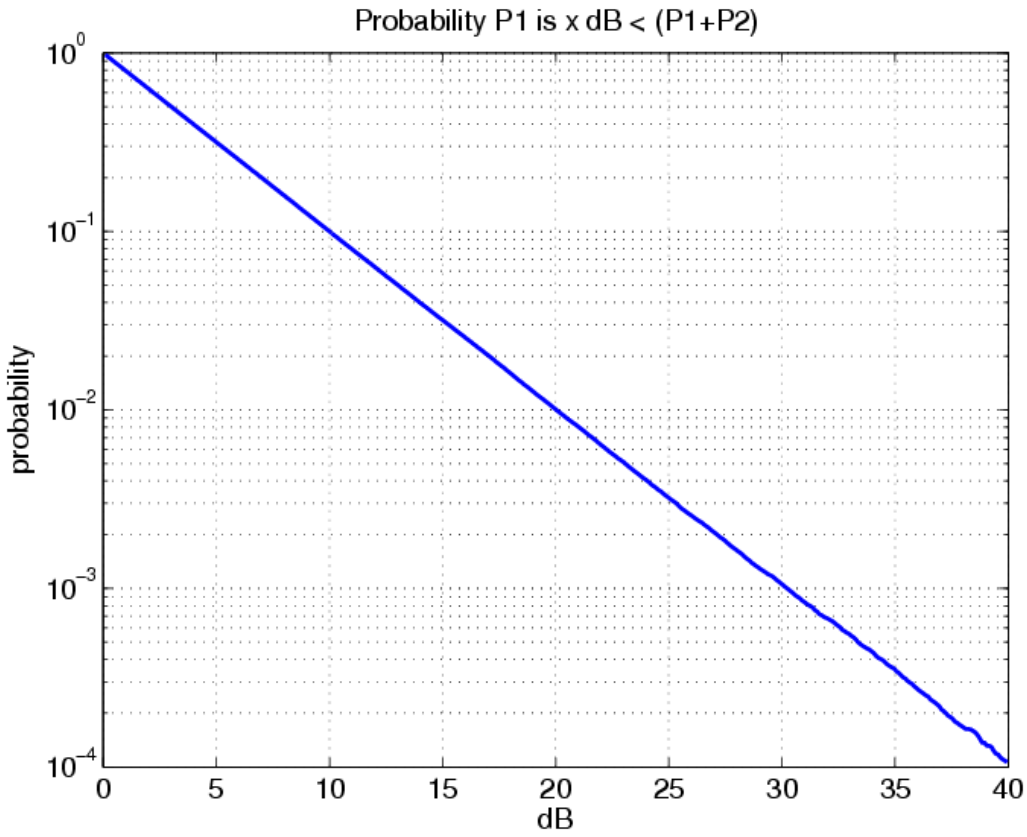


Figure 2: The probability that x dB greater than P1 is less than (P1+P2)

There is a very interesting mathematical fact that this probability can be shown to exactly equal $10^{-x/10}$. This is shown in the following derivation:

$$P(P_{1dB} + x_{dB} < P_{2dB}) = \int_0^\infty P\left(P_1 = Z, P_1 + P_2 < Z * 10^{x/10}\right) dZ$$

$$= \int_0^\infty P\left(P_1 = Z, P_2 < Z(10^{x/10} - 1)\right) dZ$$

$$= \int_0^\infty \frac{1}{2} e^{-Z/2} (e^{-(10^{x/10}-1)Z} - 1) dZ$$

$$= \int_0^\infty \frac{1}{2} (e^{-(10^{x/10})Z/2} - e^{-Z/2}) dZ$$

$$= 10^{-x/10}$$

The contribution is organized as follows. In Section 2, describes the requisite changes to the 802.16e/D3 text for the DL preamble [2]. Section 3 describes the change to the STC MAP. Sections 4 and 5 are conclusions and references.

2. STC Preamble

Suppose that during non-STC portions of the frame, the BS transmits on antenna 1. The SS sets operating values based on the DL preamble. Once STC enabled transmission begins, both antenna 1 and antenna 2 transmit, which may make these operating values faulty. This can result in incorrect decoding of the data. For instance the power from a single antenna could be over 20 dB less that that of a second antenna for uncorrelated Rayleigh Fading Channels. In this case, instability can exist as expressed in Figure 1.

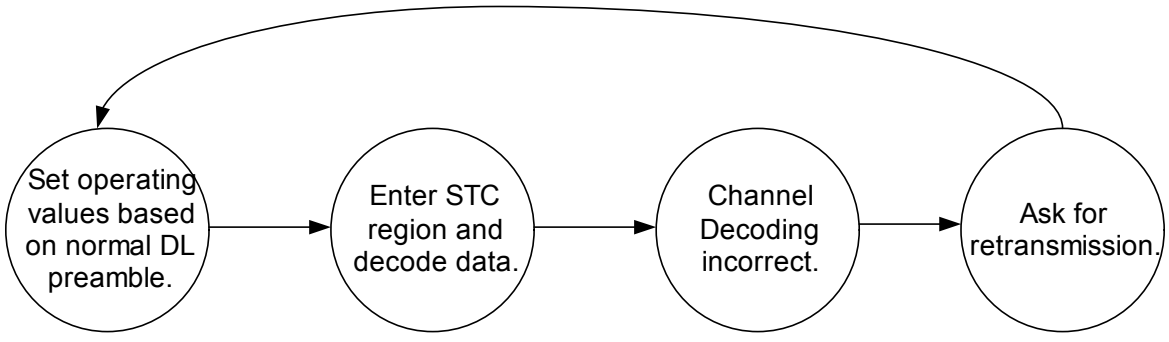


Figure 1: Instability caused by using a single STC preamble for STC data transmission.

Thus, we suggest that in the case that there is STC encoded traffic in a specific frame, K, without STC encoded data traffic on the previous frame, K-1, the preceding BS DL subframe, K-1, shall contain an STC zone, in which the STC zone consists of only an STC preamble without FCH-STC. The SS will be able to determine that there is no FCH-STC by determining that the STC preamble is at the end of a frame. This is expressed in for TDD transmission in Figure 2. SF refers to subframe in the figure below.

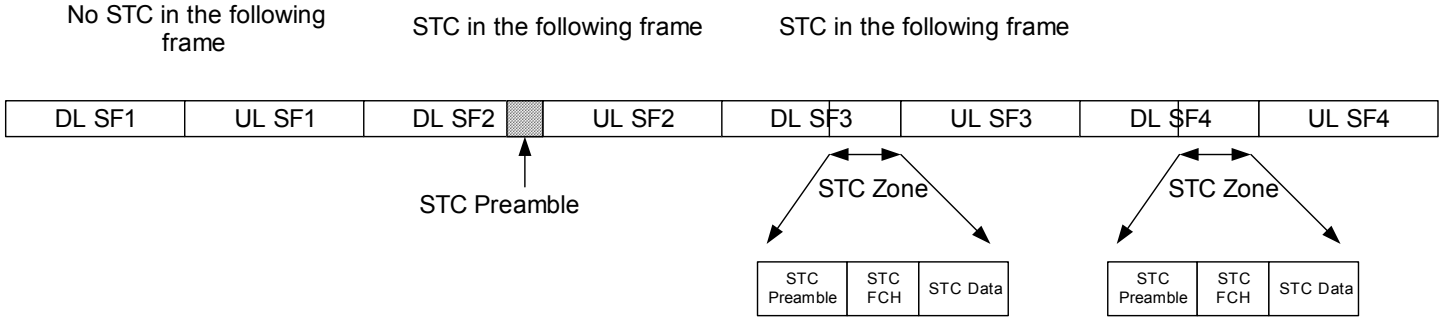


Figure 2: New STC Frame structure in TDD

Proposed Text Changes:

In section 8.3.5.1, pg. 62 of 802.16e/D3

[Add the following text to section 8.3.5.1 as indicated by the surrounding text:]

The STC zone starts from a preamble and an STC encoded FCH-STC burst, which is one symbol with the same payload format as specified in Table 239. The FCH-STC burst is transmitted at BPSK rate ½. It is followed by one or several STC encoded PHY bursts. The first burst in the STC zone may contain a DL-MAP applicable only to the STC zone. If DL-MAP is present, it shall be the first MAC PDU in the payload of the burst.

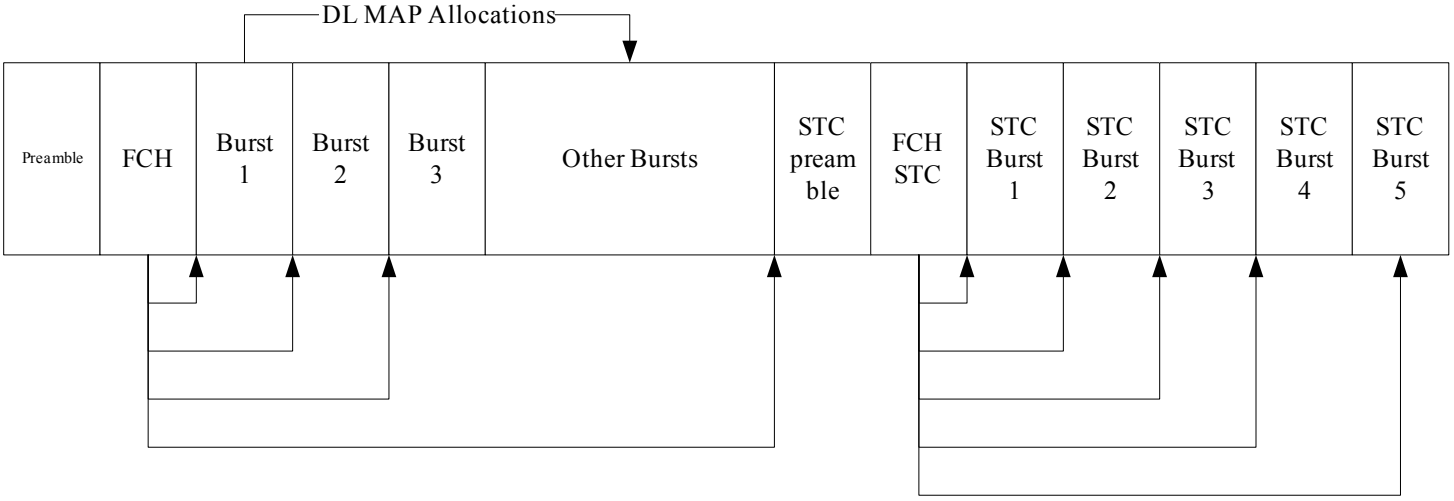
In the case that there is STC encoded traffic in a specific frame, K, without STC encoded data traffic on the previous frame, K-1, the preceding BS DL subframe, K-1, shall contain an STC zone, in which the STC zone consists of only an STC preamble without FCH-STC. The SS will be able to determine that there is no FCH-STC by determining that the STC preamble is at the end of a frame.

The DL sub-frame may optionally contain a DL subchannelization zone as described in 8.3.5.3 PMP-DL subchannelization Zone.

With the OFDM PHY, a PHY burst, either a downlink PHY burst or an uplink PHY burst, consists of an integer number of OFDM symbols, carrying UL-MAP IE format...

3. STC FCH

Since a downlink map may be sent in both the normal and STC section of a frame there can be a confusion on where should the STC allocation shall be spelled out. Thus we propose that the following be adopted: The FCH STC shall be changed in format to look like the normal FCH DLFP IEs with the restriction that there cannot be another STC region. The following figure illustrates that.



Proposed text changes

[Section 8.3.5.1]

The STC zone starts from a preamble and an STC encoded FCH-STC burst, which is one symbol with the same payload format as specified in Table ~~239~~ XXX. The FCH-STC burst is transmitted at BPSK rate ½. It is followed by one or several STC encoded PHY bursts. The first burst in the STC zone may contain a DL-MAP applicable only to the STC zone. If DL-MAP is present, it shall be the first MAC PDU in the payload of the burst. **The DL map if sent in Burst 1 of the normal frame shall not describe any allocations in the STC region.**

Table XXX

Syntax	Size	Notes
STC_DL_Frame_Prefix_Format() {		
for (n=0; n < 5; n++) {	4 bits	
Rate_ID/ DIUC		For all IEs this field is DIUC that defines the burst profile of the corresponding burst.
Preamble present	1 bit	If '1', preamble is placed before the burst.
Length	11 bits	Number of OFDM symbols in the burst.
}		
HCS	8 bits	An 8-bit Header Check Sequence; calculated as specified in Table 5

4. Conclusions:

To build a robust 802.16 system with Alamouti Transmission, it is important to ensure that mechanisms exist to allow for reception in even the most pathological cases. We have proposed changes to the standard that solve two issues. We have proposed that an STC preamble to be present in the prior frame in the case that there is an STC allocation in the current one and we also propose adjusting the STC FCH to resolve ambiguity in the STC MAP elements.

References:

[1] IEEE P802.16-REVd/D5-2004 Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems
[2] IEEE P802.16-REVe/D3-2004 Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands