**Project**  
IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>

**Title**  
TDD Subband Diversity

**Date Submitted**  
2002-07-02

**Source(s)**  
Phil Kelly  
BeamReach Networks  
755 N. Mathilda Ave  
Sunnyvale, CA 94086  
Voice: 408-869-8706  
Fax: 408-869-8701  
mailto:pkelly@beamreacchnetworks.com

**Re:**  
Call for contributions, IEEE 802.16-02/28, 28 May 2002, regarding document IEEE P802.16a/D4-2002

**Abstract**  
Proposal is to add an additional section on TDD subband frequency diversity to the OFDMA PHY section.

**Purpose**  
Make the normative changes in the proposal.

**Notice**  
This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

**Release**  
The contributor grants a free, irrevocable license to the IEEE to incorporate text contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE’s name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE’s sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.

**Patent Policy and Procedures**  
The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures (Version 1.0) <http://ieee802.org/16/ipr/patents/policy.html>, including the statement “IEEE standards may include the known use of patent(s), including patent applications, if there is technical justification in the opinion of the standards-developing committee and provided the IEEE receives assurance from the patent holder that it will license applicants under reasonable terms and conditions for the purpose of implementing the standard.”

Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:r.b.marks@ieee.org> as early as possible, in written or electronic form, of any patents (granted or under application) that may cover technology that is under consideration by or has been approved by IEEE 802.16. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.
TDD Subband Diversity
Phil Kelly
BeamReach Networks

Introduction
This proposal is to add an additional section on TDD subband frequency diversity to the OFDMA PHY section. As a result, Section 8.3.3.8.2 is added, Sections 8.3.3.8.1-3 are renumbered, and the heading for Section 8.3.3.8 is modified to reflect these changes. There is no change to any content within existing sections on Alamouti Space-Time Coding. (The proposal is generic, and can be included in the other PHY sections if desired.)

Background
Some frequency diversity is achieved by allocating data to tones within a subchannel. However, for very short delay channels with strong multipath, a multipath fade may stretch across an entire subband or significant portion of it. The motivation for the additional section is to permit the use of TDD subband frequency diversity to achieve greater link reliability.

For most frequency allocations, a frequency band is composed of lower and upper subbands. Because the frequency separation between these subbands is typically much greater than the coherence bandwidth, subchannels in different subbands are likely to have uncorrelated multipath fading. Hence, a flat fade affecting a subchannel in one subband will, with high probability, not occur in the other subband. For four nines of availability, the reduction in fade margin can be on the order of 20 dB. To exploit diversity across subbands, we propose that the same data be transmitted on a subchannel in the lower subband and a sub-channel in the upper subband. If knowledge of the channel is available, a water pouring power allocation scheme can be used to achieve optimal performance.

Proposed Changes
The text below reflects these changes and provides the additional normative text.

8.3.3.8 Transmit Diversity: Alamouti’s Space-Time Coding
8.3.3.8.1 Transmit Diversity: Alamouti’s Space-Time Coding
no change in content
8.3.3.8.1.2 MISO channel estimation and synchronization
no change in content
8.3.3.8.1.3 Alamouti STC Encoding
no change in content
8.3.3.8.1.4 Alamouti STC Decoding
no change in content
8.3.3.8.2 TDD Subband Diversity

The frequency allocation in TDD systems is logically divided into lower and upper subbands. Frequency diversity across subbands can be used on the downlink and/or uplink. At the transmitter, the same data is transmitted on nominally two sub-channels. Complex weights may be applied to exploit any available channel information. In particular, power can be allocated to the sub-channels so as to achieve a water-pouring power allocation scheme.

Decoding can be based on a variety of algorithms, such as selection diversity or diversity combining techniques, and requires no special coordination between the transmitter and receiver except to know that subband frequency diversity at the transmitter is being used.