Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>	
Title	**Uplink Sounding for Antenna Selection at Mobile Station**	
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Re:	Response to IEEE 802.16m-08/024 Call for Contributions on Project 802.16m System Description Document (SDD) (i.e., ***uplink MIMO schemes***).	
Abstract	This contribution proposes to use uplink sounding to facilitate antenna selection at mobile station for 802.16m system description document (SDD).	
Purpose	To adopt the scheme of using uplink sounding for antenna selection at mobile station proposed herein into IEEE 802.16m system description document (SDD).	
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Uplink Sounding for Antenna Selection at Mobile Station

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1 Overview

Antenna selection is a technique in which only a subset of available antenna elements is used for the transmission/reception of data; the subset can change according to channel conditions and interference situation. It has been demonstrated in [1] and the references contained therein that antenna selection can effectively reduce hardware complexity/cost, while retaining most of the benefits of large antenna arrays (e.g., diversity).

To conduct antenna selection, mobile station needs to estimate the channel for downlink and uplink. This contribution proposes to use the uplink sounding zone, which has already been specified in the current IEEE 802.16e standard, to facilitate channel estimation for antenna selection at mobile station.

In the following, channel estimation for antenna selection will be exemplified in section 2.1, and the legacy uplink sounding scheme defined in IEEE 802.16e will be briefly explained in section 2.2. The proposed scheme of using uplink sounding to estimate the channel for antenna selection is then introduced and discussed in section 2.3. The proposed text change is finally provided in section 0.

2 Uplink Sounding for MS Antenna Selection

2.1 Channel estimation for antenna selection

Figure 1 illustrates the principle and operation of uplink antenna selection at a mobile station, and the channel estimation needed to enable such antenna selection. More specifically, suppose an MS has 1 RF chain and 2 antennas. Thus, in order to choose the best antenna at the MS for uplink transmission, the BS can estimate the channel between its antenna(s) and the two antennas at the MS. Based upon this channel estimation, the BS then decides which antenna MS should use for uplink transmission, and further instructs the MS for antenna switch accordingly.

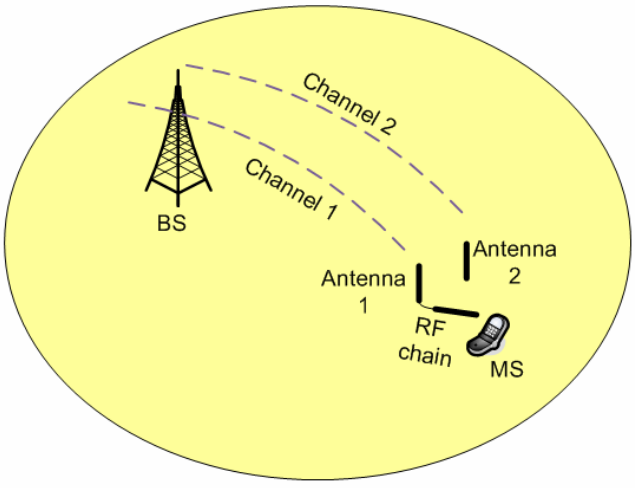

Figure 1: Channel estimation for antenna selection at mobile station.

2.2 Legacy uplink sounding

IEEE 802.16e has defined an uplink sounding zone, which is used by the BS to sound channel between itself and the MSs. The channel state information (CSI) obtained thereby for uplink can even be used for downlink transmission in a TDD system, when channel reciprocity can be assumed.

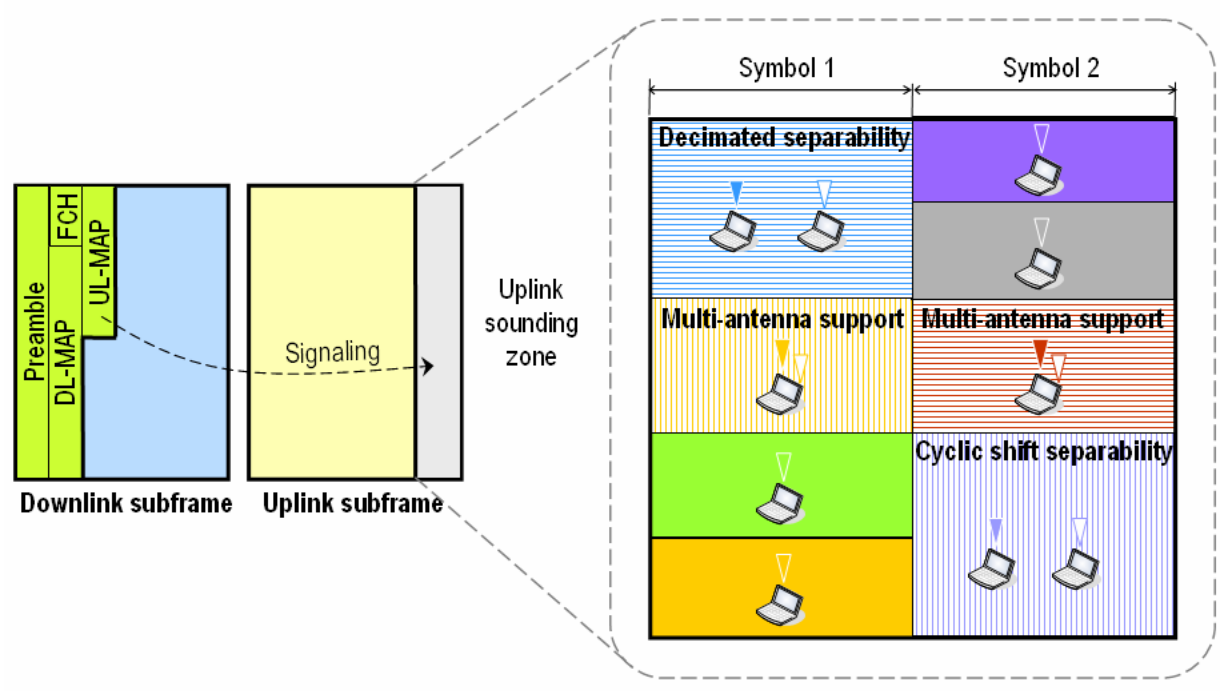

Figure 2: Uplink sounding defined in IEEE 802.16e.

Error! Reference source not found. provides an illustration of how uplink sounding defined in IEEE 802.16e works. One or multiple OFDMA symbols at the very end of an uplink subframe can form an uplink sounding zone, during which one or multiple MSs transmit specific signal waveforms to the BS for channel sounding

purpose. In order to enable multiple MSs to sound the channel using only one OFDMA symbol, MS *multiplexing* is needed.

Two types of carrier allocations are defined:

- Type A: non-distributed subcarrier allocation
- Type B: distributed subcarrier allocation

Type A carrier allocation supports MS multiplexing by the means of either *decimated separability* or *cyclic shift separability*, while Type B carrier allocation does not support MS multiplexing at all.

2.3 Proposed uplink sounding scheme for antenna selection

Per the discussion in section 2.1 and 2.2, it is evident that current IEEE 802.16e uplink sounding can be easily extended to facilitate channel estimation for mobile station antenna selection.

A BS can use the legacy PAPR_Reduction_Safety_and_Sounding_Zone_Allocation_IE() (UIUC code 13) in an UL-MAP_IE() to indicate the location of an uplink sounding zone. Then, the BS can send an updated UL_Sounding_Command_IE() to the MS, directing the MS to transmit the legacy sounding signal waveform using different subsets of candidate antennas at different OFDMA symbols within the sounding zone. Note that the UL_Sounding_Command_IE() *only* needs to be slightly modified (i.e., insertion of a new field) to enable the above operation. The entire legacy uplink sounding mechanism is *completely reused*, and all of its benefits are thus *fully inherited*.

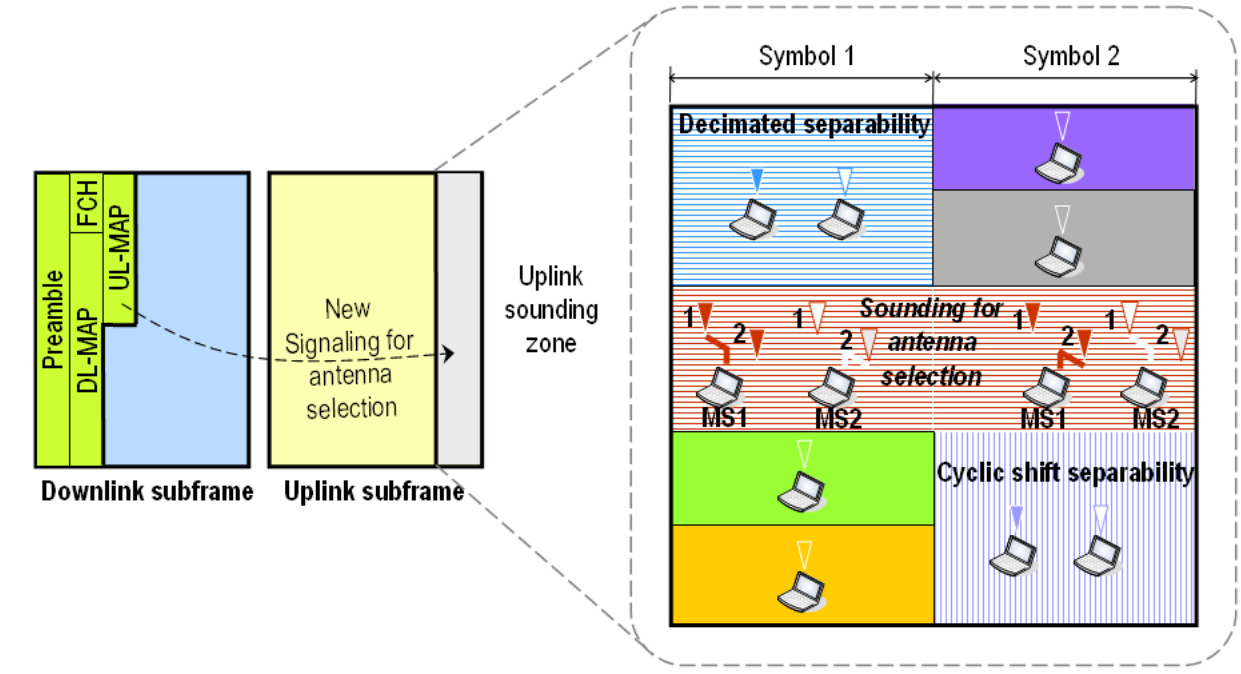

Figure 3: Using uplink sounding to estimate channel for antenna selection.

Figure 3 demonstrates the uplink sounding process for antenna selection. Suppose two MSs, namely MS1 and MS2, support antenna selection. Each of these MSs has one RF chain and 2 transmit antennas. These two MSs can be multiplexed into a set of OFDMA subchannels for uplink sounding over two symbols shown in Figure 3. In symbol 1, MS1 and MS2 are instructed by the BS to use antenna 1 and antenna 2, respectively, to transmit uplink sounding signal waveform. Per the instruction contained in UL_AS_Sounding_Command_IE(), both

MSs switch from one subset of candidate antennas to another subset during the cyclic prefix (CP) period of symbol 2, so that unnecessary interruption to sounding signal transmission is minimized. Thus, MS1 and MS2 can use antenna 2 and antenna 1, respectively, to transmit uplink sounding signal waveform during symbol 2. At the end of this sounding process, the BS can compare the channel quality associated with each of the two transmit antennas for both MS1 and MS2, and decide which antenna should be used by each MS for subsequent uplink transmission.

3 Proposed Text Change

8.4 WirelessMAN-OFDMA PHY

8.4.6.2.7.1 Channel sounding

[Change the format of UL Sounding Command IE in Table 486 as follows]

Table 486—UL Sounding Command IE format

Syntax	Size (bit)	Notes
UL_Sounding_Command_IE() {	-	-
Extended-2 UIUC	4	UL_Sounding_Command_IE() = 0x04
…	…	…
Power boost	1	0 = no power boost 1 = power boost
Multi-antenna flag	1	0 = MS sounds first antenna only 1 = MS sounds all antenna
…	…	…
Periodicity	3	0b000 = Single command, not periodic, or ter-minate periodicity. Otherwise, repeat sound-ing once per r frames, where r = 2(n–1), where n is the decimal equivalent of the periodicity field.
Number of AS sounding symbols	*3*	*Number of OFDMA symbols immediately following the UL sounding symbol in this sounding zone that will be used for the sounding for uplink antenna selection*
…	…	…
}		

[Insert following statement at the end of subclause 8.4.6.2.7.1]
The "Multi-antenna flag" and "number of AS sounding symbols" field can be used together to signal the uplink channel sounding for antenna selection. If "Multi-antenna flag" is set to 1 and the value of "number of AS sounding symbols" field is greater than 1, the MS that supports antenna selection is then implicitly instructed by the BS to switch from one candidate antenna subset to another in the cyclic prefix duration of each subsequent OFDMA symbol, and use the new candidate antenna subset to transmit the uplink sounding signal waveform in each subsequent OFDMA symbol, until it completes all the AS sounding symbols indicated by the field of "Number of AS sounding symbols".

4 Reference

[1] Z. Tao, A. F. Molisch, P. V. Orlik, J. Zhang, C. Nie, T. Wang, T. Kuze, “Antenna Selection at the Mobile Station”, IEEE C802.16m-08/170r1, Orlando, FL March 2008