IEEE P802.22 Wireless RANs

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| Comment Resolution: Text for Section 13.2.3.2 (Spatial Multiplexing using 4 Antennas) |
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Abstract

This document partially addresses CID#20, CID#172 referent the MIMO section of 802.22b standard. More specifically, it provides text to section 13.2.3.2 on Spatial Multiplexing using 4 antennas considered in 802.22b standard.

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**Comments:**

CID#20

Section 13.2.3 is left as TBD.

CID#172

There is no description in "13.2.3 Spatial Multiplexing".

**Resolution:**

13.2.3.2 Spatial Multiplexing using 4 Antennas

Previous sections have described spatial multiplexing with 2 Tx and 2 Rx antennas. This section illustrate the same technique, however, for 4 Tx and 4 Rx antennas.

Consider a 4x4 wireless communications system. The channel gains between the ith transmit antenna and the jth receive antenna *hj,i* is represented by the MIMO channel matrix

***H*** =

Similarly to the 2x2 case, let all antennas be spaced at least half-wave length from each other from where four symbols *s1*, *s2*, *s3*, *s4*, taken from the arbitrary complex constellation *C* are simultaneously transmitted. The transmitted symbols vector is ***s*** *=* [*s1 s2 s3 s4*]*T* and the noise at the receive antennas is ***w*** = [*w1 w2 w3 w4*]*T* with the received signals also given by ***y*** *=* ***Hs + w****.*

Spatial Multiplexing Signal Detection:

Linear zero-forcing (ZF) method yields the estimated symbols ***s* + *(HHH)-1HHw***due to **,** where ***Z = (HHH)-1HH***, where **H** represents Hermitian operator.

Similarly to the 2x2 case, improved bit-error-rate (BER) and packet-error-rate (PER) performance can be obtained through OSIC technique. Here we detail the OSIC technique applied to a 4x4 SM-MIMO system. The symbol, from a parallel stream, which is estimated first, is then subtracted from the originally received signal yielding a reduced interference signal. This reduced interference signal is used in the following stage of the OSIC detection where another symbol will be estimated and then subtracted from the signal in order to further reduce interference. This procedure is repeated until all symbols are estimated as shown in Fig. 1.

Again considering column norm-based order, ||***H:,1***||, ||***H:,2***||, ||***H:,3***|| and||***H:,4***||, and for illustrations purposes, considering that ||***H:,1***|| > ||***H:,2***|| > ||***H:,3***|| >||***H:,4***||, the symbols are estimated in the following order:

The first symbol *s1* is estimated by the 1th row of ***Z****,*

 **y**,  **(1)**

yielding

,  **(2)**

which is then mapped to the possible transmitted symbol from the constellation *C* with the closest Euclidian distance to it.

Generating the reduced interference (provided that ) signal,

.  **(3)**

A new MIMO matrix is constructed by deleting the 1st column, i.e.,

,

with  ***= (H)-1H***.

Then, is estimated by

**. (4)**

Again, a further reduced interference signal (provided that ) is generated by

,  **(5)**

along with

 and ***= (H)-1H***.

Estimation of follows,

**. (6)**

Finally, the last reduced interference signal (provided that ) is generated by

,  **(7)**

along with

 and  ***= (H)-1H***.

The last estimation follows,

**. (8)**

Note that precoder-based spatial multiplexing could be employed by exploiting the channel reciprocity inherent to TDD systems. This is due to the fact that both the down-link (DL) and the up-link (UL) of TDD systems operate in the same frequency however in different time-slots and thus are highly correlated. The channel state information (CSI) can be obtained by the Tx side during (UL) transmissions.

Once CSI is known, the Tx transmits the , where ***W*** is the NtxNs precoding matrix with Nt referring to the number of transmit antennas and Ns to the number of streams. For instance, for the 4x4 SM-MIMO with zero-forcing considered above, **W = αH-1**,

 , (9)

due to Tx power constraints and where *Tr* represents the trace of

After dividing the received signal **α,**  it then becomes

 **(10)**

or

 **(11)**