Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Evaluation of the Space Time Code Proposal (reply to comment 459)**
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Re:	IEEE 802.16e D3 Draft
Abstract	Evaluation of the Space Time Code Proposal
Purpose	The evaluation of the 4x1 STC code performances is presented in this contribution. The proposed 4x1 STC code drastically increase the decoding complexity by 9~17 times to achieve the same performance for QPSK modulation, such a complexity increase is exponentially high for higher order modulation (for 16QAM it requires to de-map 256QAM for 64QAM it requires to de-map 4096QAM) and any possible performance advantage due to the full diversity is diminished. Therefore there is no justification for changing the currently defined IEEE802.16-2004 4x1 code.
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Evaluation of the Space Time Code Proposal (Reply to comment 459)

1 Performance

The rational of the proposed 4x1 STC is that it achieves full rate and full diversity and therefore better performance. Even though the IEEE802.16-2004 4x1 code is not a full diversity matrix (diversity order of 2), the additional diversity is achieved by exploiting the built-in time-frequency diversity with sub-channel permutation, bit-interleaver and FEC decoding.

From Figure 1 we can see the proposed code does have the diversity advantage over the existing IEEE802.16-2004 4x1 code in the *raw bit error rate*. Figure 2 shows the CTC coded QPSK Rate=1/2 bit error rate at decoder output.

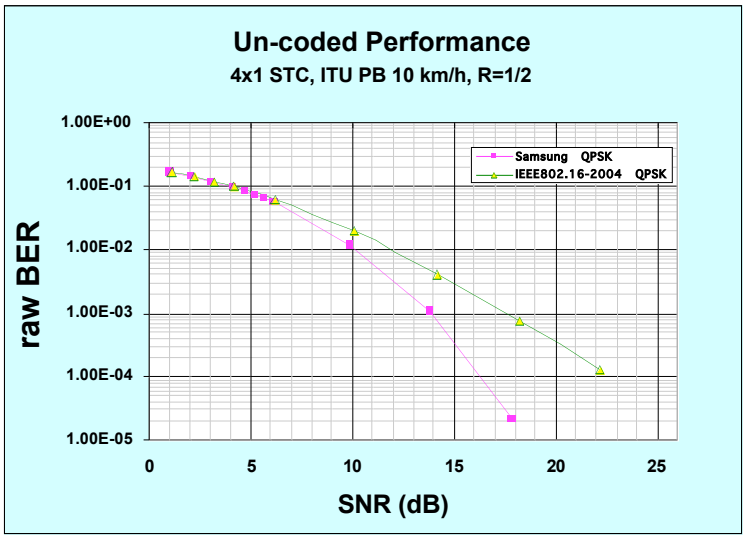

Figure 1 Raw Bit Error Rate Performance

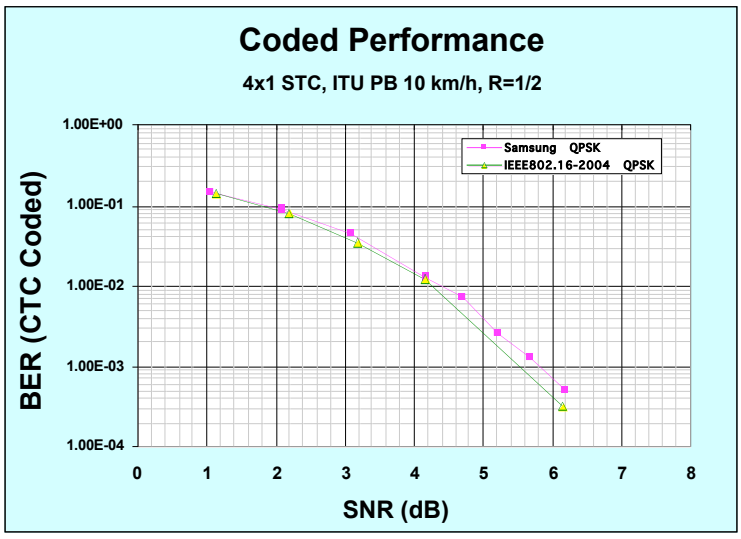

Figure 2 Coded Bit Error Rate Performance

Clearly, with the FEC coding, the performance the proposed STC code is the same as the IEEE802.16 4x1 code (see Figure 2). Therefore, based on performance alone, there is no justification for changing the current spec.

2 Complexity

The decoding for the IEEE802.16-2004 STC code is a straightforward Alamouti decoding and QAM de-mapping. For the proposed new codes, *additional complexity* is introduced by pre-coding and the significant complexity addition is the de-mapping of 16 constellations. Table-1 listed the computational complexity comparison.

Table 1 Decoding Complexity Comparisons

	Complexity (per sub-carrier)
IEEE802.16-2004	8M+4A+4m
Samsung	72M+68A+4m+32COMP+64LUT

Where

- M is complex multiplication,
- A is the complex addition
- m is the real multiplication,
- COMP is the real value comparison operation and
- LUT is the table look up

The complexity of proposed STC has more than 9~17 times computations than the IEEE802.16-2004 4x1 code.

3 Summary

The proposed code drastically increase the decoding complexity by 9~17 times to achieve the same performance for QPSK modulation, such a complexity increase is exponentially high for higher order modulation (for 16QAM it requires to de-map 256QAM for 64QAM it requires to de-map 4096QAM) and any possible performance advantage due to the full diversity is diminished. Therefore there is no justification for changing the currently defined IEEE802.16-2004 4x1 code.