

Design Considerations of Pilot Structures for Downlink MIMO Transmission

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Purpose:

Propose to be discussed and adopted by TGm for the use in Project 802.16m SDD

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Design Considerations

- Design of pilot pattern should meet following two properties

1. Minimally satisfy pilot spacing constraints derived from 2-D sampling theorem

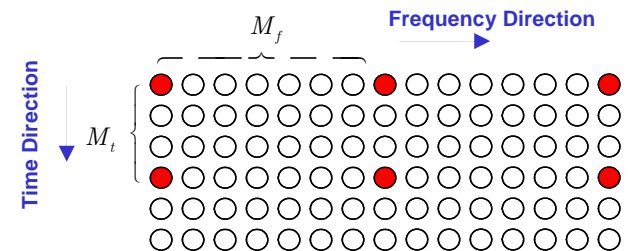
- ▶ Guarantee that MS can reconstruct channels at data tones, but with least pilot overhead

$$M_t \leq \frac{1}{2f_d T_s} \quad M_f \leq \frac{1}{2\tau_{\max} \Delta f}$$

2. Channel extrapolation is avoided as far as possible

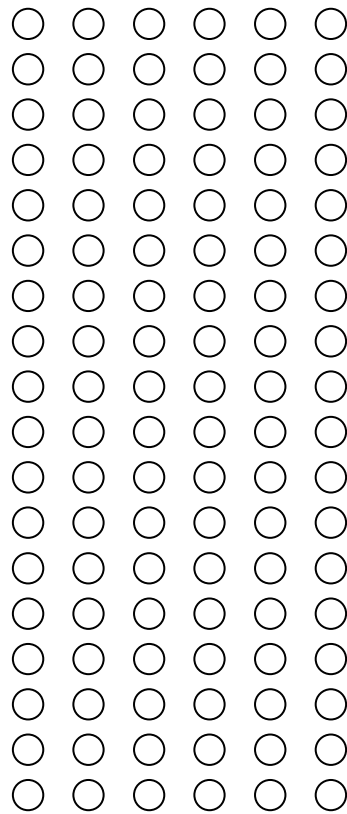
$$MSE_{\text{interpolation}} \leq MSE_{\text{extrapolation}}$$

- ▶ Pilot tones frame most of data tones



Pilot Structure Examples

- Resource block for our example
 - ◆ 18 subcarriers over 6 OFDM symbols



- Design parameters

- ◆ $T_s = 102.82 \mu s$ $\Delta f = 10.94 kHz$

- ◆ According to 802.16m EVM document, delay spread in general does not exceed $5 \mu s$

- ▶ τ_{\max} is set to be $\tau_{\max} = 5 \mu s$ without loss of generality

- ◆ 802.16m supports mobility velocity up to 350 Km/h

- ▶ $f_d = 810$ Hz under 2.5 GHz carrier frequency

- ◆ Constraints on M_t and M_f

$$M_t \leq 6$$

$$M_f \leq 9$$

- 2-TX-antenna downlink MIMO transmission

- ◆ Satisfy pilot spacing constraints $M_t \leq 6$ $M_f \leq 9$

- ◆ Pilot tones frame most of data tones

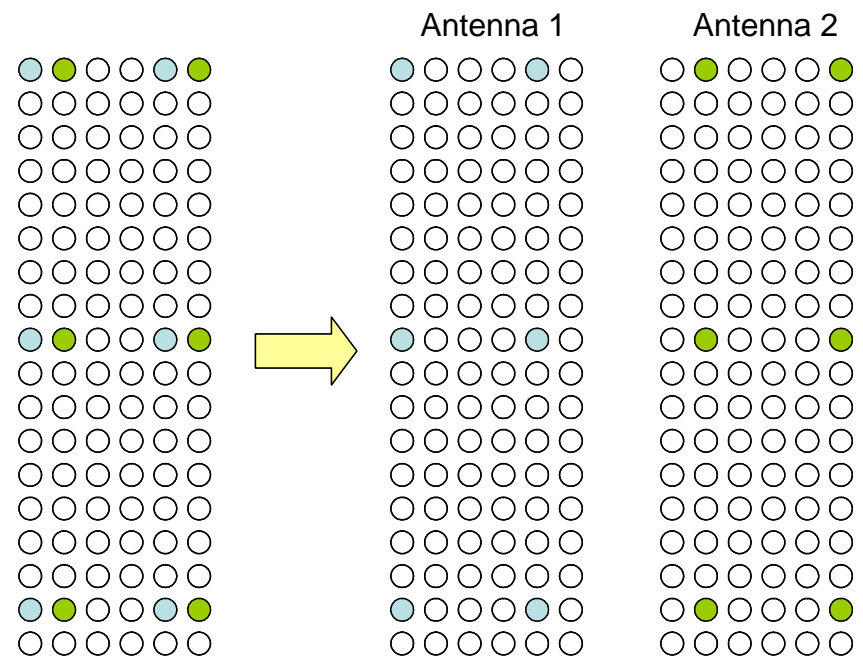
- ▶ As possible as we can to avoid extrapolation

- ◆ Pilot density: 0.11111

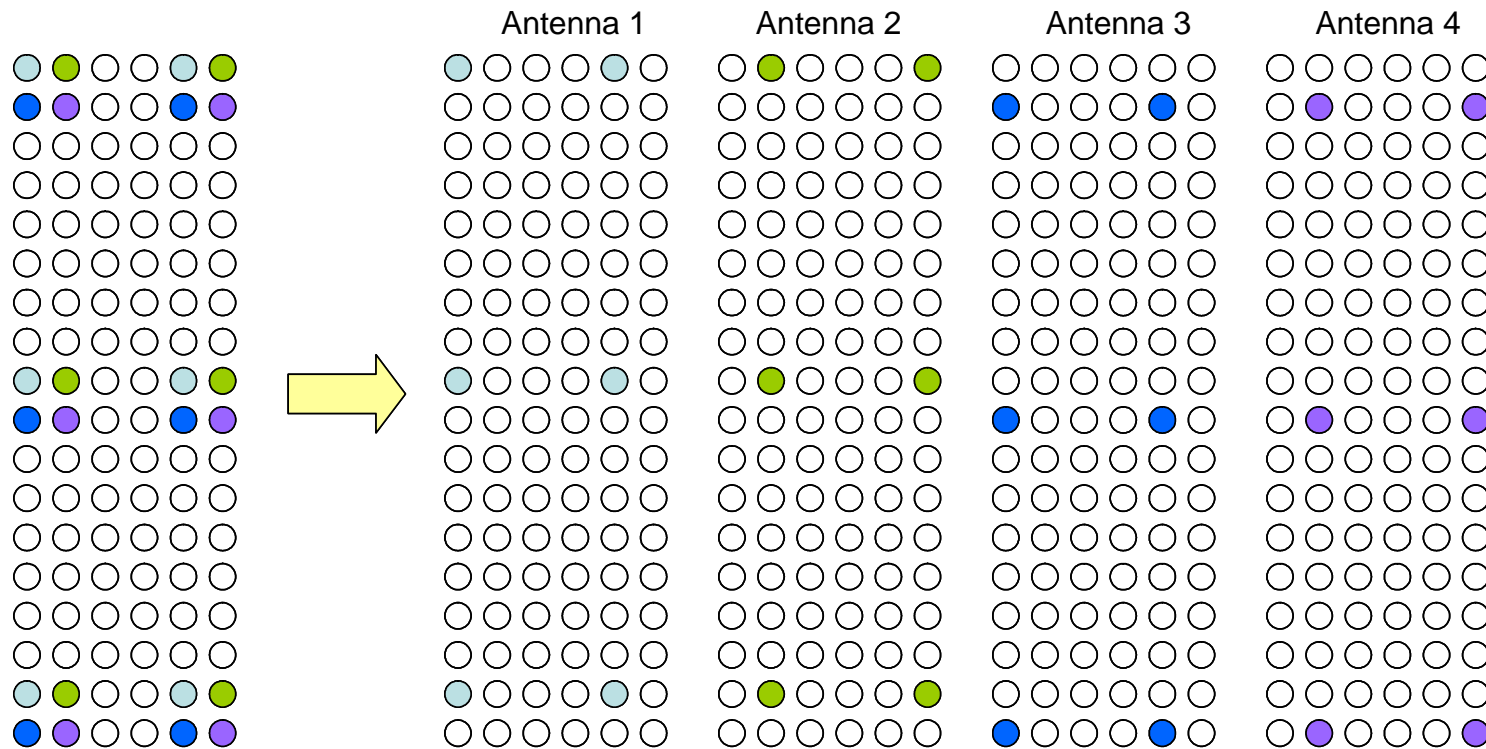
- ▶ More spectrally efficient than STC PUSC (with pilot density 0.14286)

- ▶ But has better BER performance

- ◆ Suitable for randomized resource allocation



- 4-TX-antenna downlink MIMO transmission

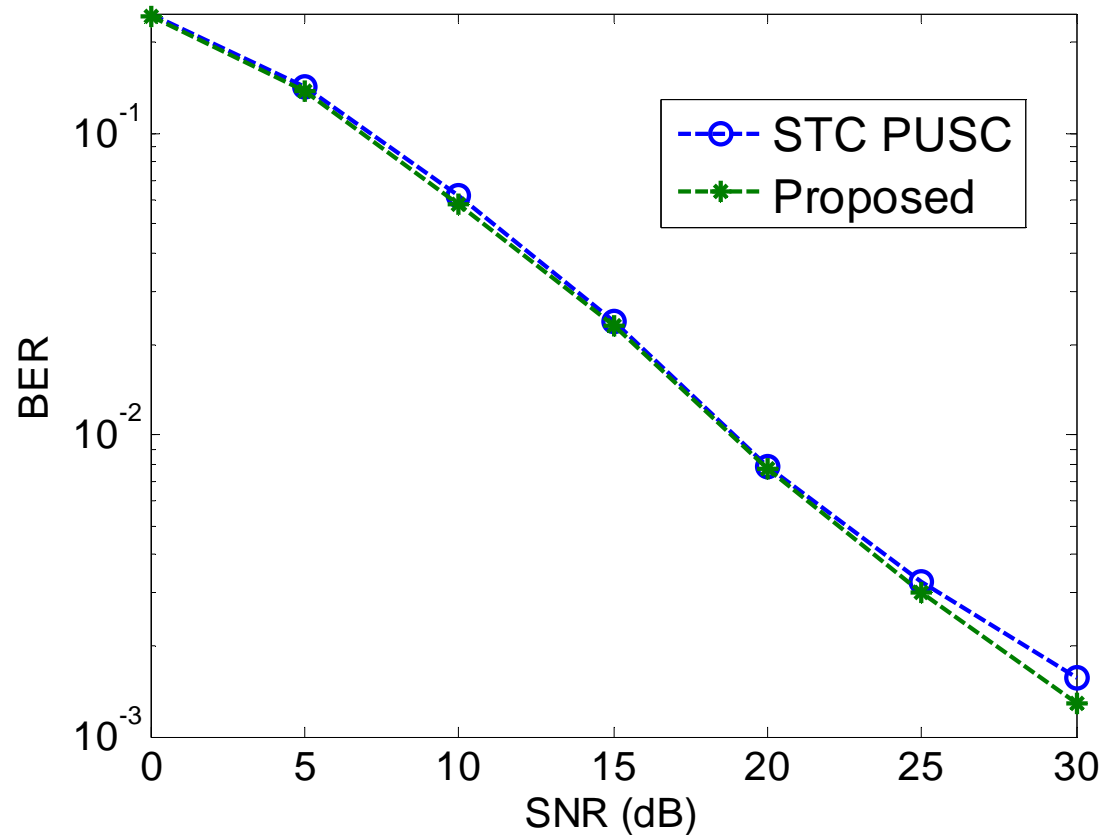


Simulation Results

- Compare proposed example with STC PUSC (adopted in baseline system)
- System parameters
 - ◆ 2-by-2 MIMO system with Matrix B (MMSE detector)
 - ◆ FFT size = 512, 24 OFDM symbols
 - ◆ QPSK modulation
 - ◆ $\tau_{\max} = 2.51 \text{ } \mu\text{s}$ (ITU vehicular A channel model)
 - ◆ $f_d = 250 \text{ Hz}$ (120 km/h vehicle speed)
 - ◆ Channel characteristics follow Jakes' model
 - ◆ Two 1-D linear interpolations
 - ▶ Time-direction interpolation first, and then frequency-direction one
 - ▶ Linear extrapolation is used at those data tones which are not in between pilot tones

- BER performance

- ◆ Results justify, under the design considerations, proposed pilot pattern outperforms traditional PUSC, although with lower pilot density



Conclusion

- Two design considerations should be taken into account when designing pilot pattern
 - ◆ 2-D sampling theorem should be minimally satisfied
 - ◆ Pilot allocations should be designed to avoid channel extrapolation as possible as we can
- Our design considerations can be extended to other resource block designs