

Structure of SU and MU-MIMO codebooks

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Bruno Clerckx, David Mazzaresse,
Jerry Pi, Hokyu Choi, Heewon Kang
Samsung Electronics

E-mail: bruno.clerckx@samsung.com, d.mazzaresse@samsung.com

Venue:

RE: Call for comments on DL MIMO SDD text (IEEE C80216m-08_657r2)

Base Contribution:

IEEE C80216m-08_851

Purpose:

Adoption of the proposed text for the 802.16m SDD.

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Background

- SDD text currently states

“The desired properties of the codebook are:

- Good performance in uncorrelated, correlated, and dual-polarized channels
- Low feedback and signaling overhead
- Low computational complexity
- Low memory requirement
- Low PAPR / Power balanced

The following codebook are being considered:

- DFT-based codebook
- 16e codebook”

Overall performance in SU-MIMO

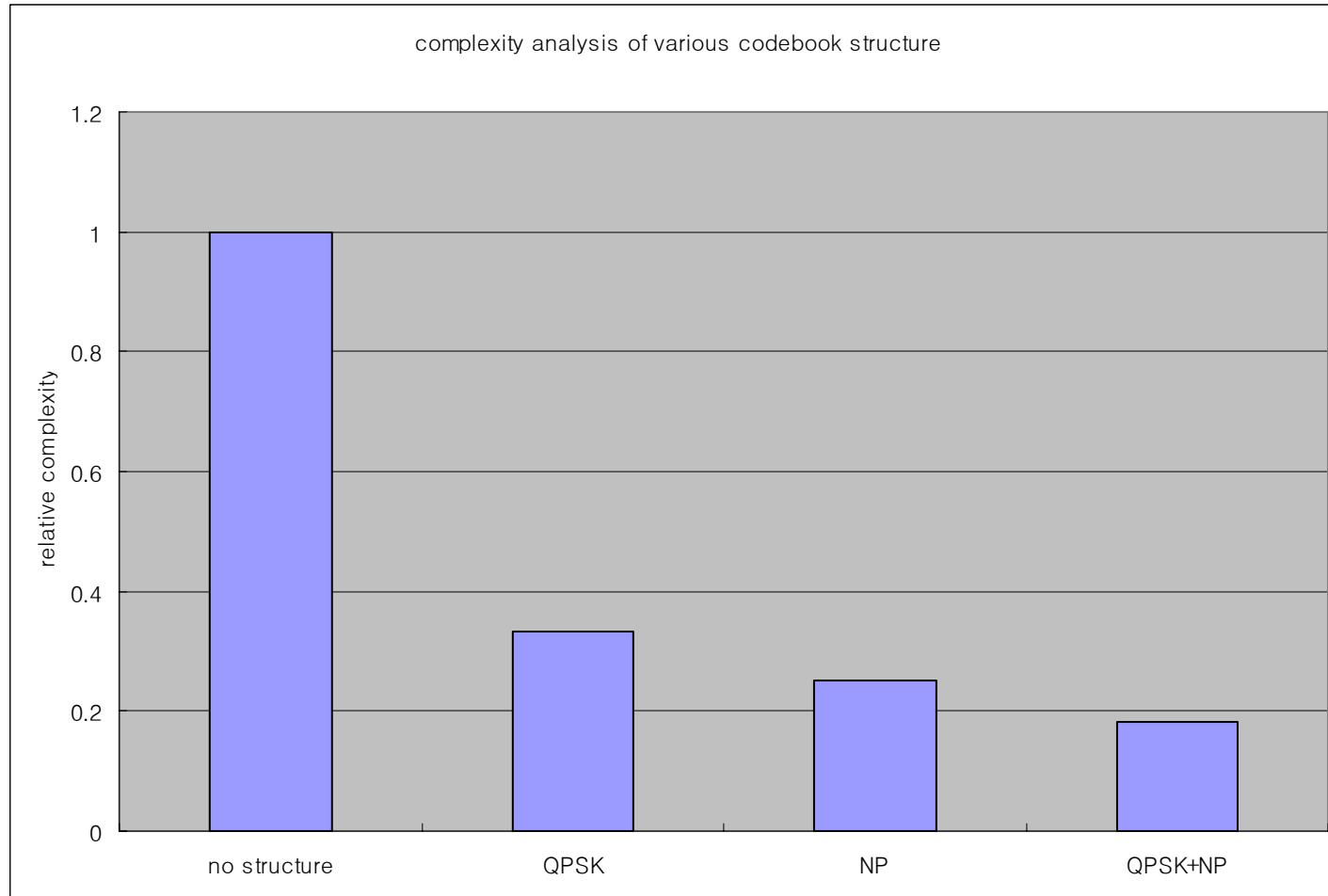
Scenario	Comparison	Remark
2x2	10 dB: 16e > DFT-based by 3% (uncorr.) 16e = DFT-based (corr.) 0 dB: 16e > DFT-based by 0.5% (uncorr.) 16e < DFT-based by 2% (corr.)	16e: 3 bits DFT-based: 3 bits
4x2	10 dB: 16e > DFT-based by 4% (uncorr.) 16e = DFT-based (corr.) 16e < DFT-based by 3.5% (dual-polarized) 0 dB: 16e = DFT-based (uncorr.) 16e < DFT-based by 5.5% (corr.)	16e: 6 bits DFT-based: 4 bits
4x4	16e > DFT-based by 3% (uncorr) 16e < DFT-based by 5% (dual-pol)	16e: 6 bits DFT-based: 4 bits
Overall performance	16e 6-bits \approx DFT-based 4-bits	Lower overhead for DFT-based codebook

Overall performance in MU-MIMO

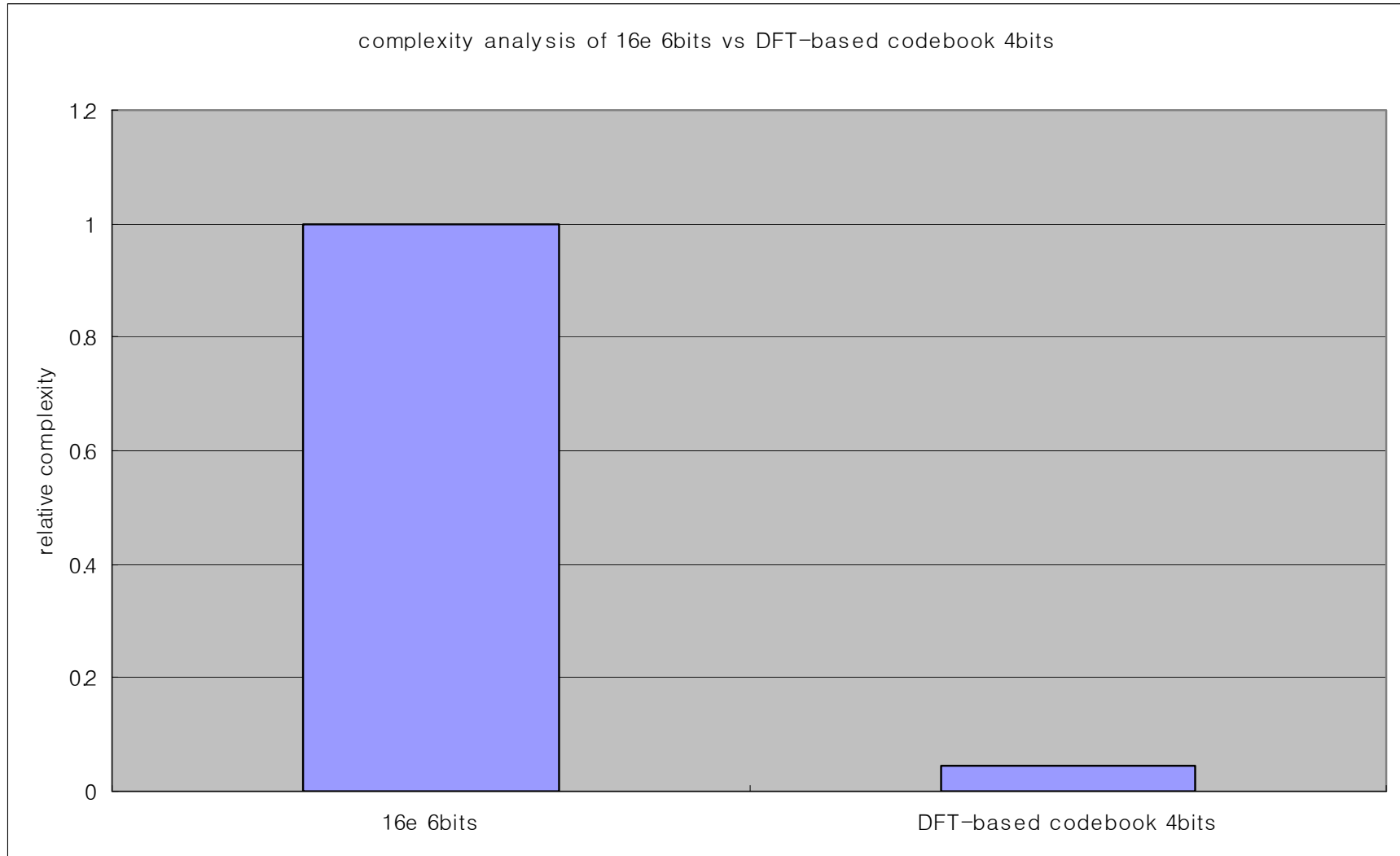
Scenario	Comparison	Remark
2x2 Unitary precoding	16e < DFT-based by 2.5% (uncorr) 16e < DFT-based by 16% (corr)	16e: 2 bits DFT-based: 2 bits
4x2 Unitary precoding	16e < DFT-based by 150% (corr)	16e: 3 bits DFT-based: 3 bits
4x4 ZFBB	16e < DFT-based by 5% (uncorr) 16e < DFT-based by 110% (corr)	16e: 6 bits DFT-based: 4 bits
Overall performance	16e << DFT-based	For any overhead

Complexity of CQI calculation

Constrained alphabet and nested property significantly reduce CQI calculation complexity

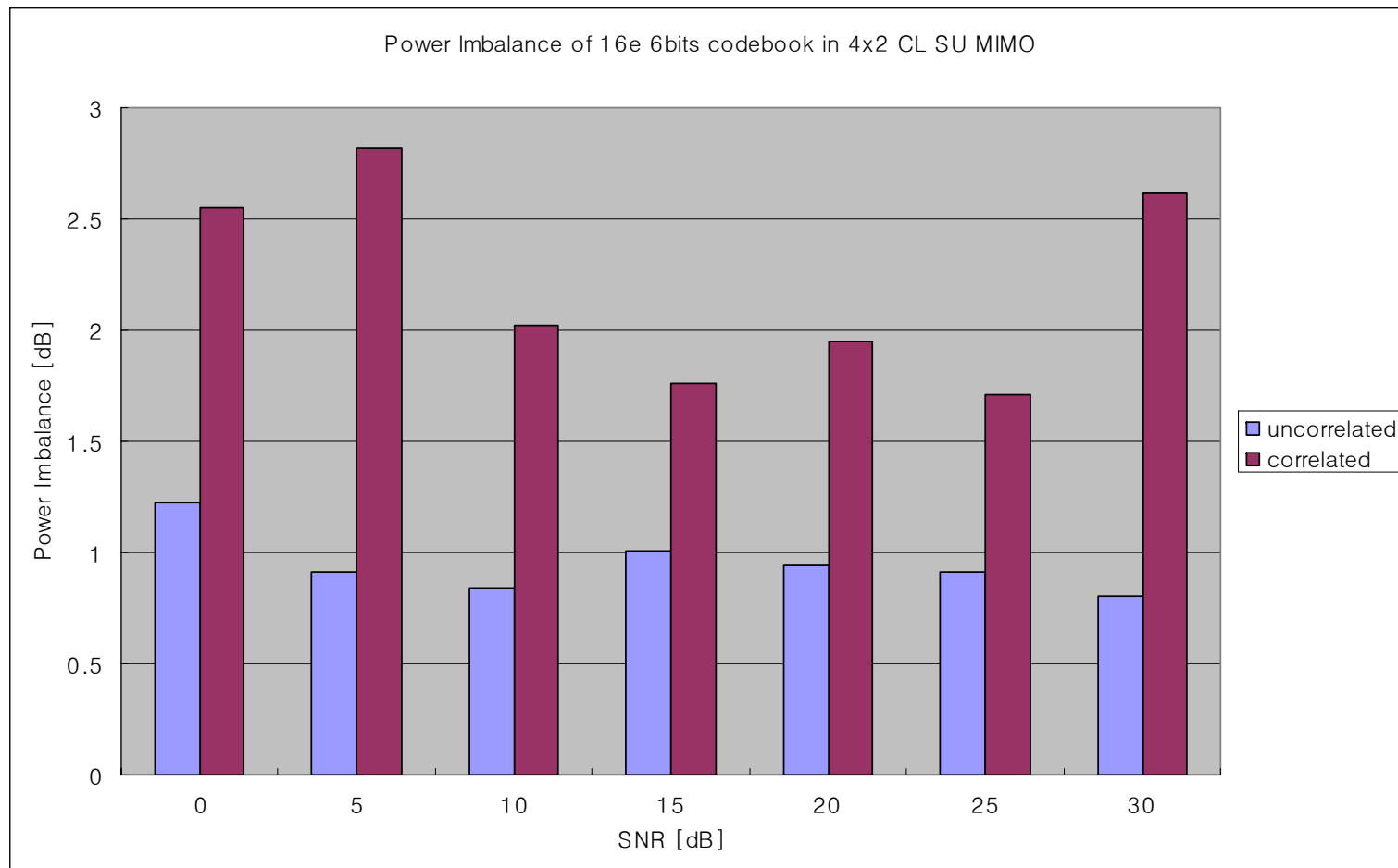


Complexity of 16e 6bits vs. DFT 4bits



Power Amplifier Imbalance

- **DFT-based codebook is constant modulus**
- 16e creates non negligible imbalance



Rank overriding

- *Definition 2*: A codebook has the **nested property for rank overriding** when for each pre-coder matrix in a certain rank $(2,3,\dots,\min\{nt,nr\})$, there exists at least one corresponding column subset in all the codebooks of the lower ranks.
- **Satisfied by DFT-based codebook**
- **Not satisfied by 16e codebook**

Conclusion

- In SU-MIMO,
 - 16e codebook and DFT-based codebook have similar performance
 - a slight advantage for 16e codebook in uncorrelated
 - slight advantages of DFT-based codebook for correlated and dual-polarized scenarios.
- In MU-MIMO, DFT-based codebook very significantly outperforms 16e codebook.
- The overhead is lower for a DFT-based codebook compared to 16e codebook.
- The complexity of CQI calculation with DFT-based codebook is significantly lower
- DFT is constant modulus
- DFT enables rank-overriding

Text proposal

11.x.2.1.2. Closed-loop SU-MIMO

11.x.2.1.2.1. Precoding technique

In FDD and TDD systems, unitary codebook based precoding shall be supported.

[To add to current text]

The desired properties of the codebook are:

- Good performance in uncorrelated, correlated, and dual-polarized channels
- Low feedback and signaling overhead
- Low computational complexity
- Low memory requirement
- Low PAPR / Power balanced

A codebook composed of a combination of DFT-based matrices and precoding matrices optimized for cross-polarized channels is supported

11.x.2.2. Multi-user MIMO

11.x.2.2.3.2. CSI feedback

Channel state information feedback may be employed for MU-MIMO. Codebook-based feedback is supported in both FDD and TDD. Sounding-based feedback is supported in TDD.

The codebook is composed of a subset of the unitary matrices defined in the SU-MIMO codebook.

[To add to current text: The MU MIMO codebook is composed of unitary DFT-based matrices.]