Performance evaluation of Codebooks Proposed for IEEE 802.16m

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Topic: request for details

Base Contribution:

IEEE C80216m-08_1285r1

Purpose:

Discussion and approval

Notice:

Release:

Patent Policy:

Introduction

- A DFT-based codebook has been proposed in C80216m-MIMO-08_063, C80216m-08_851r1, C80216m-08_1187.
- Performance evaluation was provided in comparison to other proposed codebook with link-level simulations.
- A detailed complexity analysis and a review of important codebook properties was also provided in C80216m-08_1187.

- This contribution provides the performance evaluation with system-level simulations, considering updated proposals from Session #57 in Kobe.

Performance evaluation

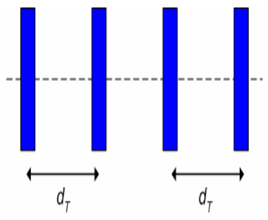
- Codebook (CB) candidates for MU-MIMO with ZFBF
  - 16e CB (6 bits): optimized for uncorrelated channel
  - Pure DFT CB (6 bits): optimized for correlated channel
  - DFT-based CB (4 bits): robust compromise in different scenarios
  - DFT-based CB (6 bits): robust compromise in different scenarios
  - Transformed DFT-based CB (4 bits): optimized for correlated channel
  - Transformed DFT-based CB (6 bits): optimized for correlated channel
  - Transformed 16e CB (6 bits): optimized for correlated channel

- References
  - Transformed codebook: C80216m-08_1182r3
  - DFT-based CB (4 bits): C80216m-08_1187

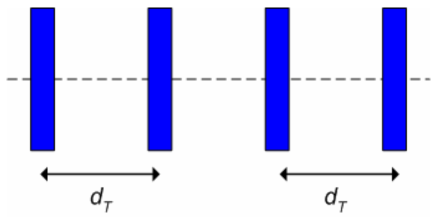
BS Antenna Array Configurations

- System Level Simulations Environment
  - 19 Cell – 3 sector, Freq. reuse = 1
  - 4x2 MU-MIMO, 16 active users, 3 km/h
  - Rank adaptation (up to 4 scheduled users), HARQ-on
  - CQI calculated based on interference power
  - 3 types of Antenna Configurations (Ped B, 8 degrees AS)
  - Dual polarized arrays are an important deployment scenario to be simulated later

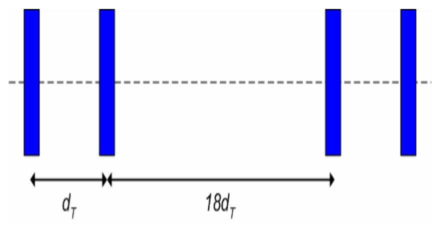
ULA (0.5λ)



ULA (10λ)



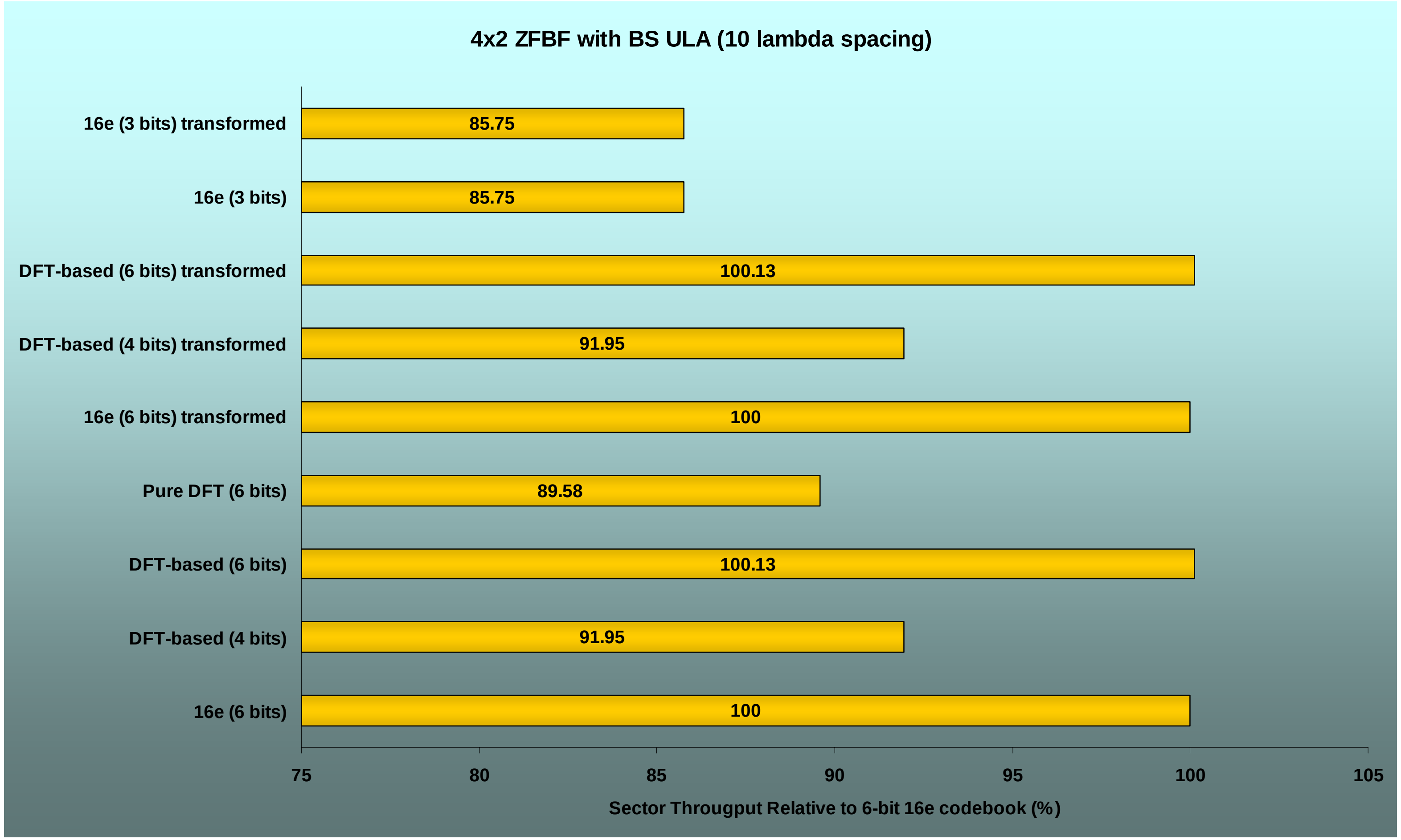
SLA (0.5λ+10λ)
(Split Linear Array)



Sector Throughput of ZFBF in DL 4x2

ULA with 10 wavelengths spacing

(reference: 6-bit 16e codebook)



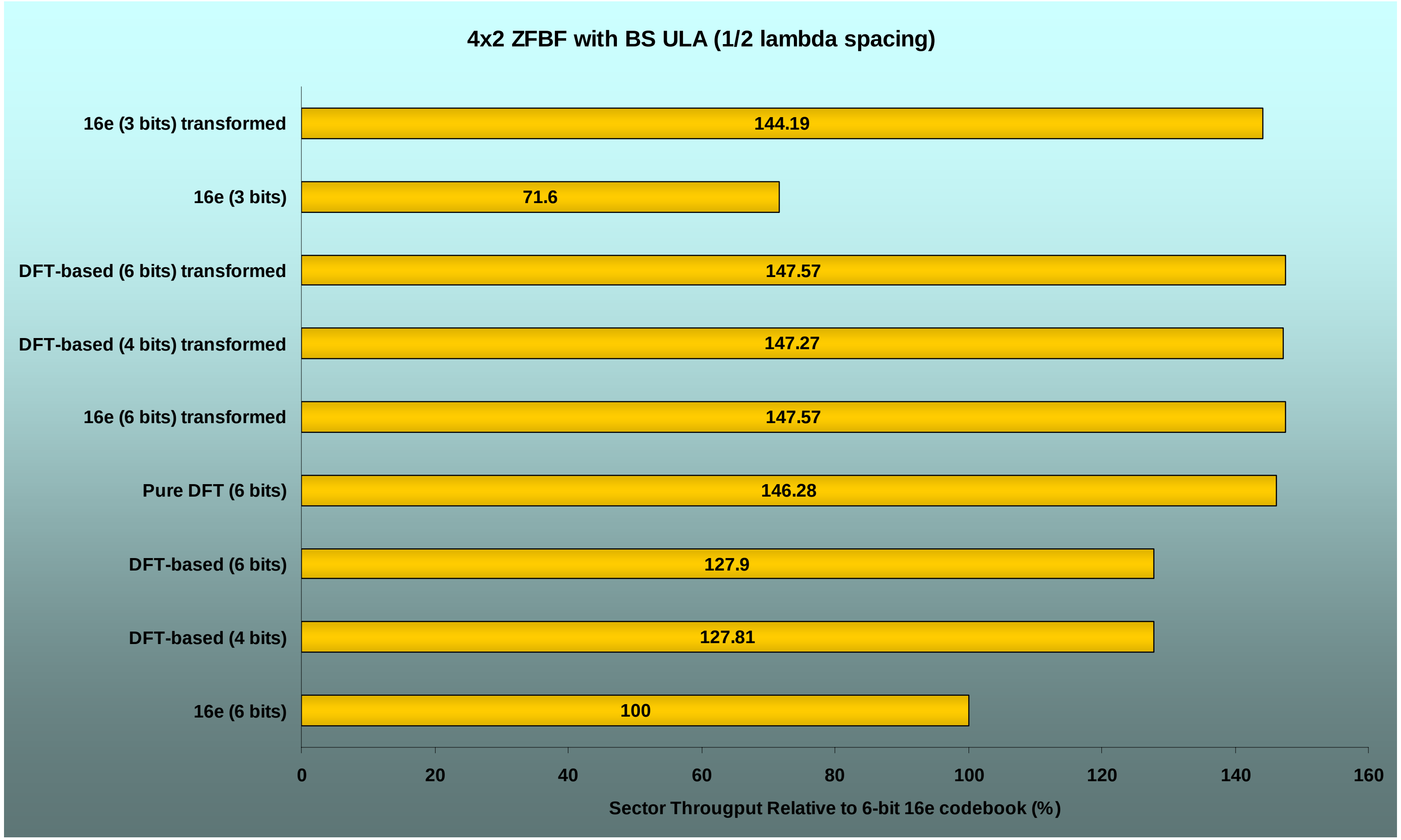
6-bit DFT-based codebook shows similar performance as the 6-bit 16e codebook

Long-term correlation-based transformation provides no gain in uncorrelated channels

Sector Throughput of ZFBF in DL 4x2

ULA with 1/2 wavelength spacing

(reference: 6-bit 16e codebook)

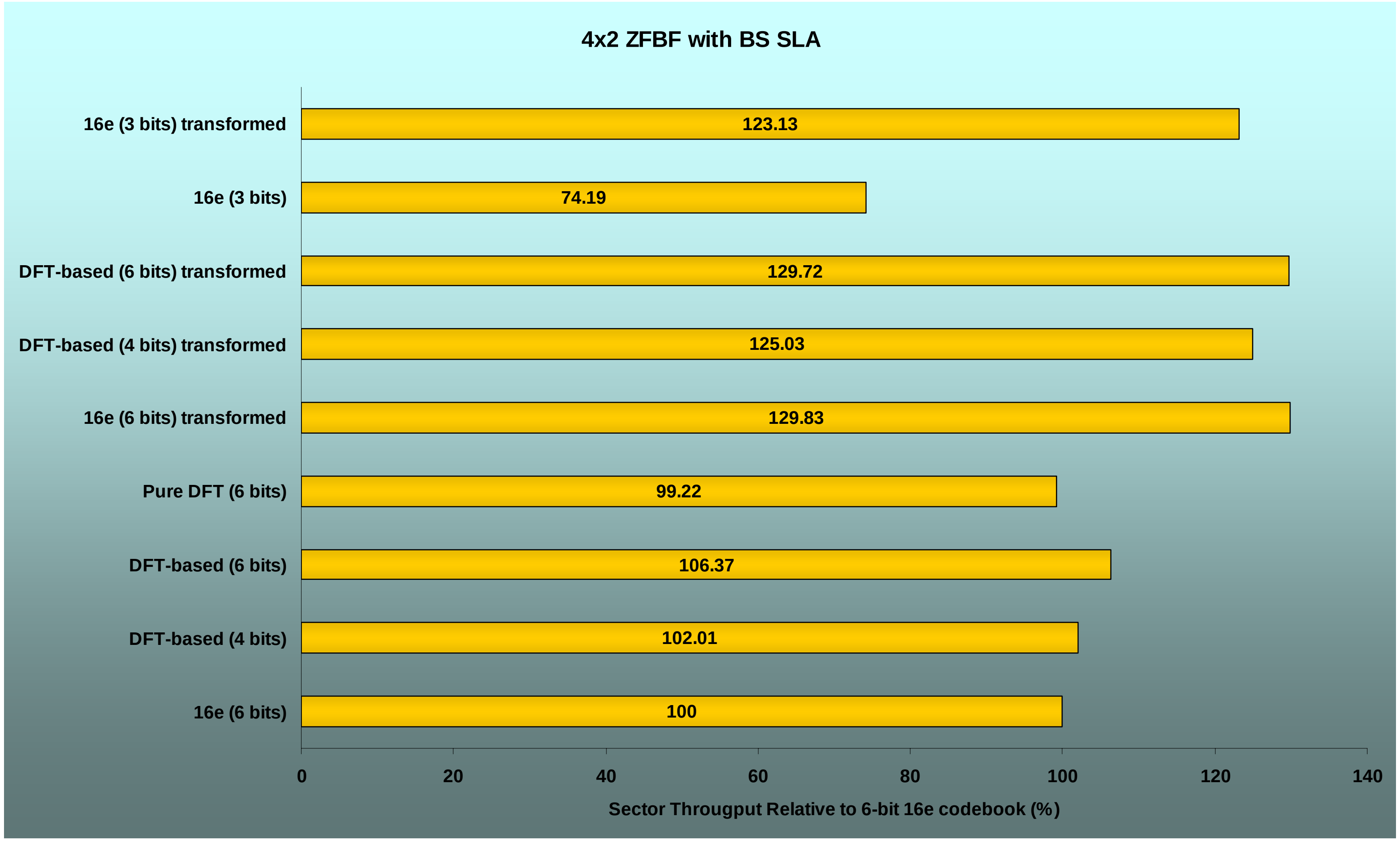


Transformed 4bit DFT–based codebook achieves same performance as the Transformed 6-bit 16e codebook and Transformed 6bit DFT–based codebook

Sector Throughput of ZFBF in DL 4x2

Split Linear Array

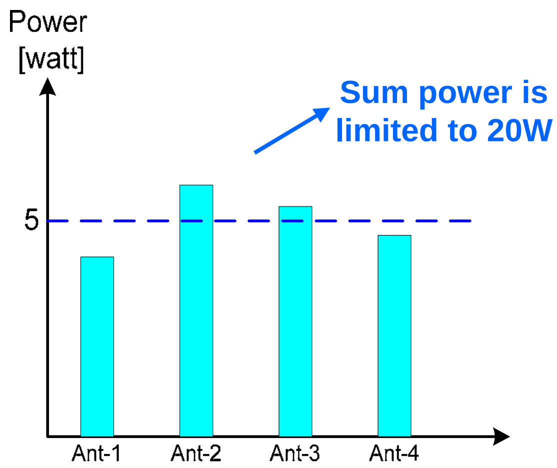
(reference: 6-bit 16e codebook)



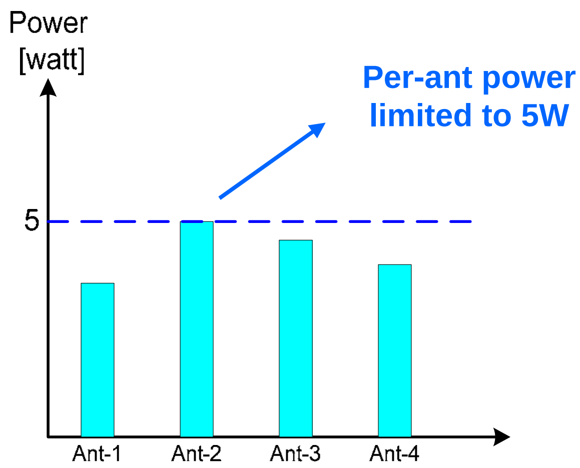
Same trend as in correlated channels

Power fluctuation effect between antennas

- Constant modulus property
  - Definition: Every elements of codebook vector has same magnitude
  - Good for per-antenna peak power limit
  - DFT-based codebooks have a constant modulus property, while 16e-based do not



Total power limitation



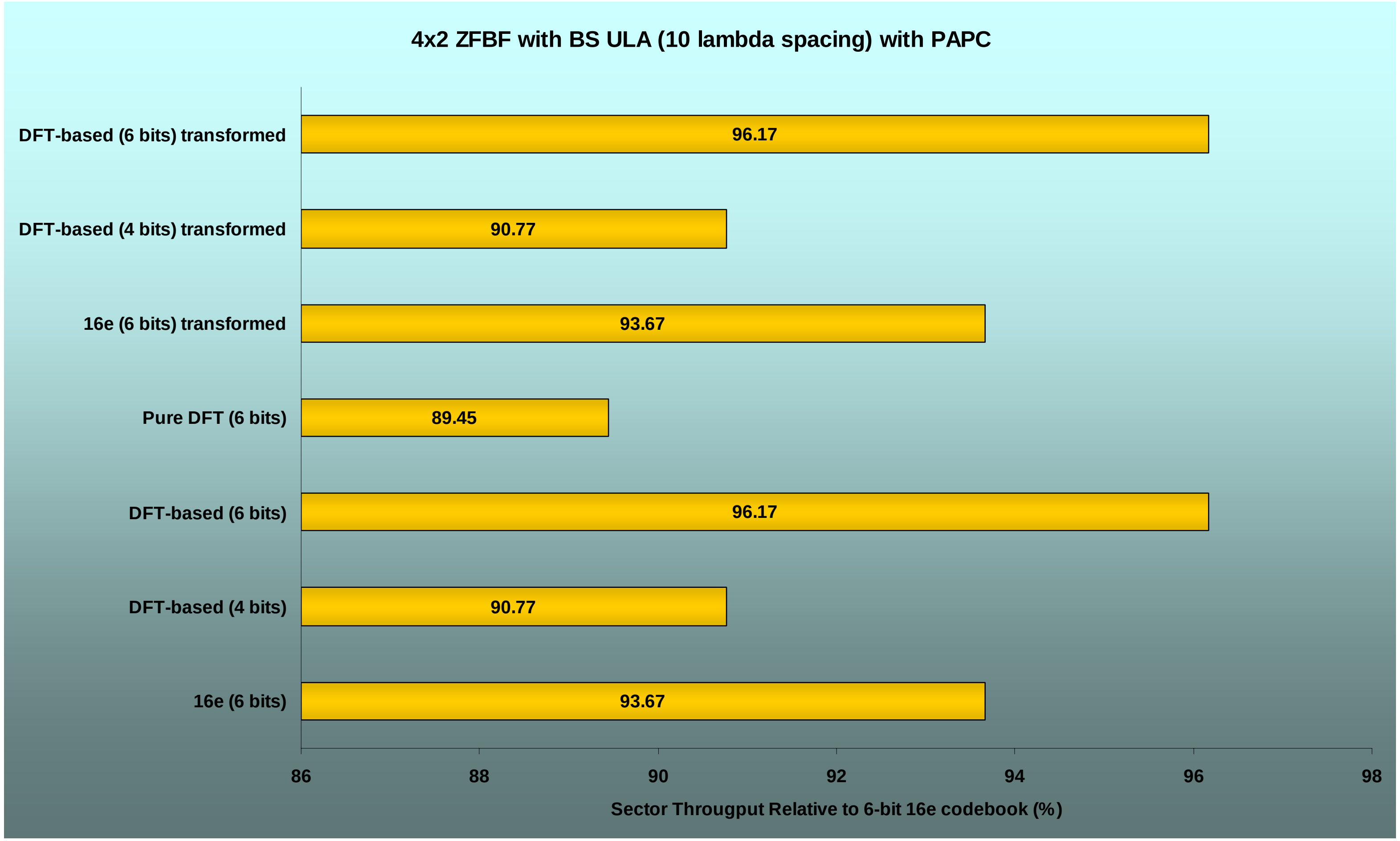
Per-ant. Peak power limitation

Power adjustment frame by frame

Sector Throughput of ZFBF in DL 4x2

ULA with 10 wavelengths spacing and per Antenna Peak Power Limitation

(reference: 6-bit 16e codebook without power limitation)

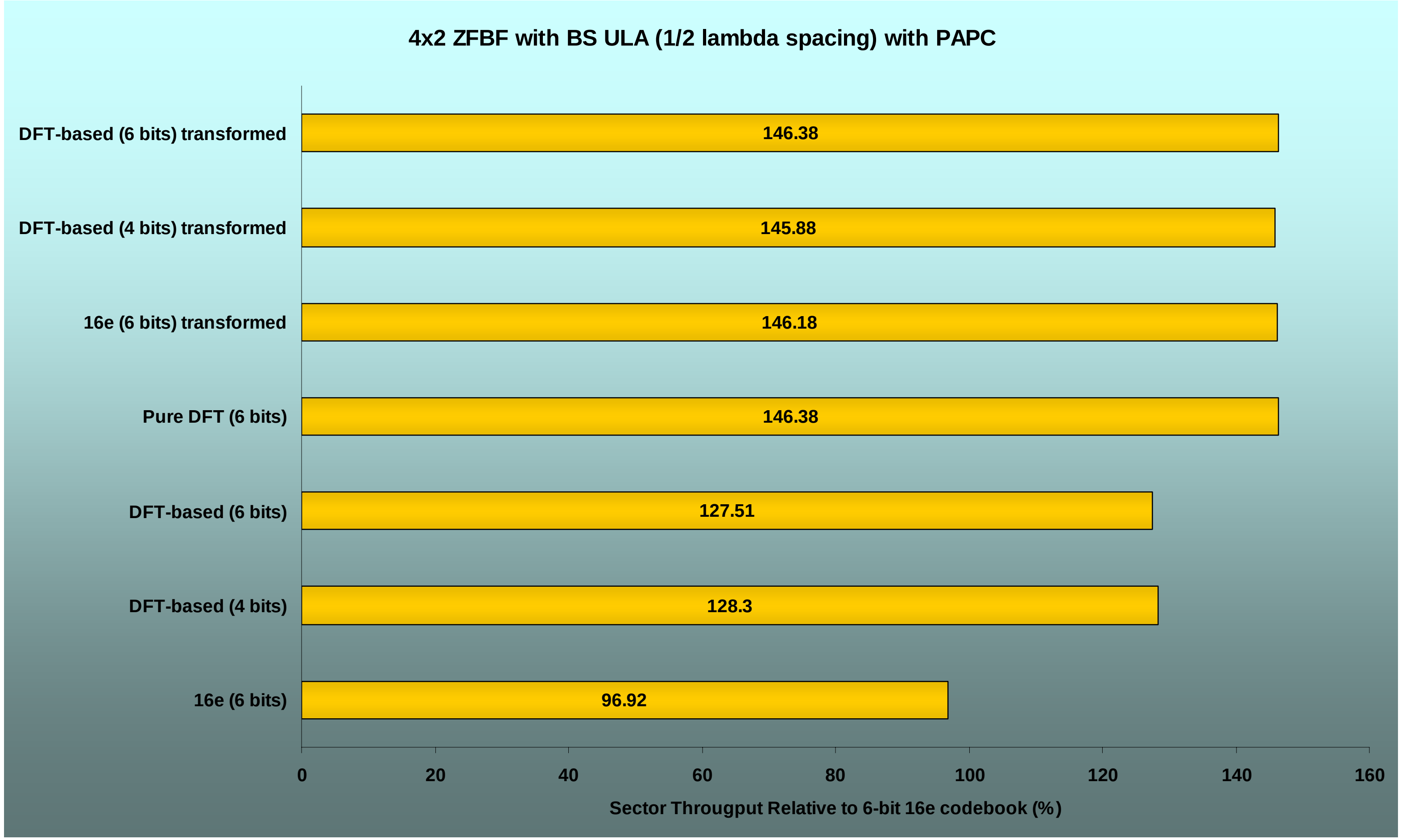


6-bit DFT-based codebook provides the best performance

Sector Throughput of ZFBF in DL 4x2

ULA with 1/2 wavelength spacing and per Antenna Peak Power Limitation

(reference: 6-bit 16e codebook without power limitation)

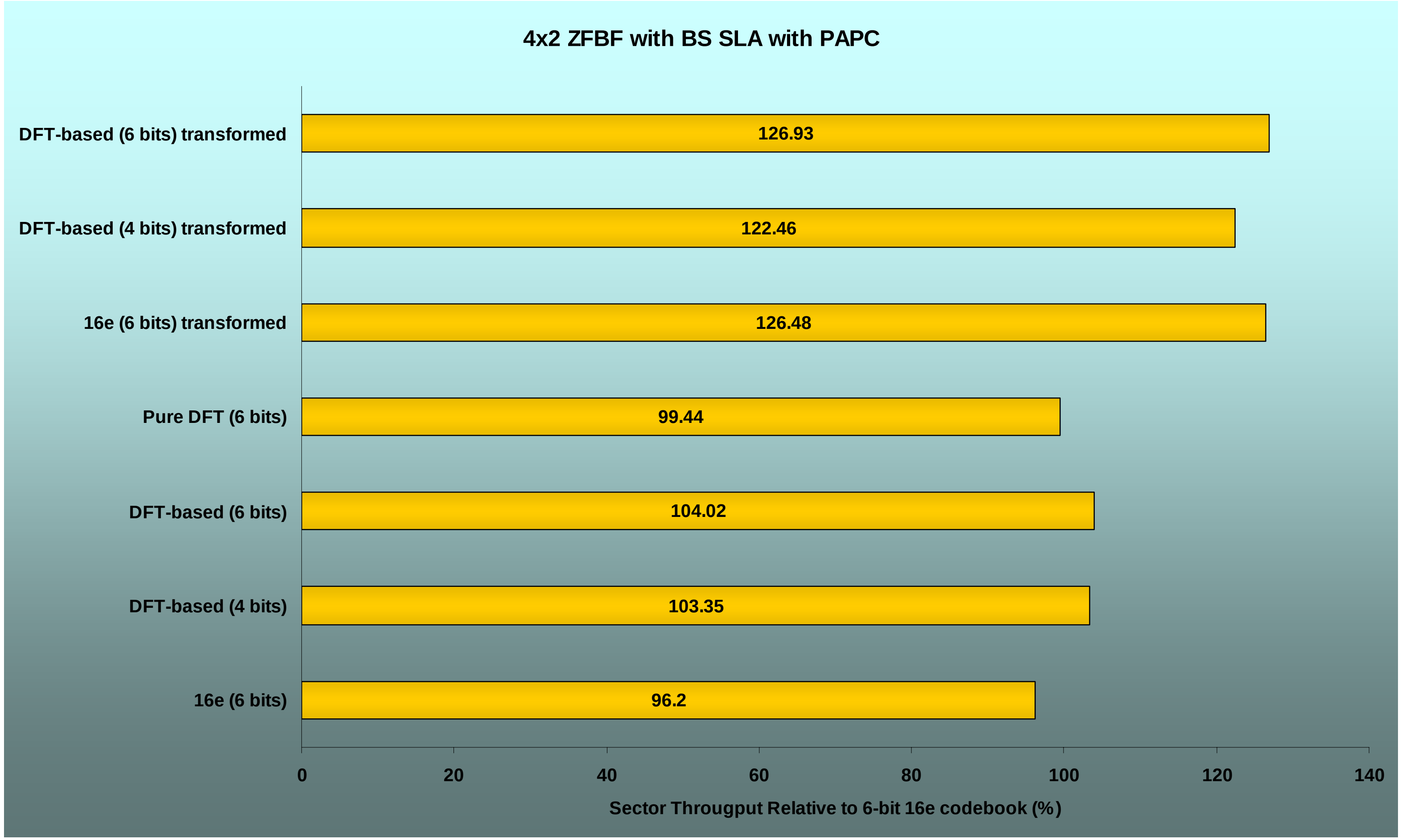


Transformed 6-bit DFT-based codebook provides the best performance

Sector Throughput of ZFBF in DL 4x2

SLA with per Antenna Peak Power Limitation

(reference: 6-bit 16e codebook without power limitation)



Same trend as in correlated channels

Conclusions

- 6-bit DFT-based codebook offers the most robust performance in all channels among all non-transformed codebooks.

- Transformed 6-bit DFT-based codebook offers the best performance in all channels.

- We recommend that 802.16m considers a 4-bit DFT-based codebook as standard codebook, relying on further improvements of differential feedback mode.

Proposed SDD Text Changes

Page 83 line 2

- Replace "For codebook based precoding, the codebook will be a .16e-based and/or DFT-based codebook."
- By "For codebook based precoding, the codebook is a DFT-based codebook."

- Page 83 line 40
- Replace "The standardized codebook will be a .16e-based and/or DFT-based codebook"
- By "The standardized codebook is a DFT-based codebook"

Appendix
Rank 1 vectors of the 6-bit DFT-based Codebook

0.5000	0.5000	0.5000	0.5000
0.3260 + 0.6774i	0.3254 + 0.1709i	0.3254 + 0.1709i	-0.0250 + 0.4051i
0.1499 + 0.0347i	0.5009 + 0.3071i	0.1505 + 0.5412i	0.1505 + 0.5412i
0.0918 + 0.3270i	0.1311 + 0.6387i	0.2473 + 0.0541i	0.4815 + 0.4045i
0.5000	-0.5000	0.5000	-0.5000
0.0918 + 0.3270i	-0.1311 - 0.6387i	0.2473 + 0.0541i	-0.4815 - 0.4045i
0.3841 + 0.3851i	0.0056 - 0.3076i	0.2285 + 0.6580i	-0.3448 - 0.0735i
0.3260 + 0.6774i	-0.3254 - 0.1709i	0.3254 + 0.1709i	0.0250 - 0.4051i
-0.5000	-0.5000	0.5000	0.5000
-0.0918 - 0.3270i	-0.2473 - 0.0541i	0.1311 + 0.6387i	0.4815 + 0.4045i
-0.0337 - 0.6193i	-0.4621 - 0.5019i	0.2280 + 0.1515i	0.2280 + 0.1515i
-0.4422 - 0.0928i	-0.2479 - 0.5606i	0.2479 + 0.5606i	0.0137 + 0.2102i
-0.5000	0.5000	0.5000	-0.5000
-0.4422 - 0.0928i	0.2479 + 0.5606i	0.2479 + 0.5606i	-0.0137 - 0.2102i
-0.3841 - 0.3851i	-0.0056 + 0.3076i	0.3448 + 0.0735i	-0.2285 - 0.6580i
-0.0918 - 0.3270i	0.2473 + 0.0541i	0.1311 + 0.6387i	-0.4815 - 0.4045i
0.5000	0 + 0.5000i	0.5000	0 + 0.5000i
0.3841 + 0.3851i	-0.3076 - 0.0056i	0.3448 + 0.0735i	-0.6580 + 0.2285i
0.0918 + 0.3270i	-0.0541 + 0.2473i	0.1311 + 0.6387i	-0.4045 + 0.4815i
0.0337 + 0.6193i	-0.5019 + 0.4621i	0.2280 + 0.1515i	-0.1515 + 0.2280i
0.5000	0 - 0.5000i	0.5000	0 - 0.5000i
0.0337 + 0.6193i	0.5019 - 0.4621i	0.2280 + 0.1515i	0.1515 - 0.2280i
0.4422 + 0.0928i	0.5606 - 0.2479i	0.2479 + 0.5606i	0.2102 - 0.0137i
0.3841 + 0.3851i	0.3076 + 0.0056i	0.3448 + 0.0735i	0.6580 - 0.2285i
-0.5000	0 - 0.5000i	0.5000	0 + 0.5000i
-0.3841 - 0.3851i	0.3076 + 0.0056i	0.2285 + 0.6580i	-0.0735 + 0.3448i
-0.3260 - 0.6774i	0.1709 - 0.3254i	0.3254 + 0.1709i	-0.4051 - 0.0250i
-0.1499 - 0.0347i	0.3071 - 0.5009i	0.1505 + 0.5412i	-0.5412 + 0.1505i
-0.5000	0 + 0.5000i	0.5000	0 - 0.5000i
-0.1499 - 0.0347i	-0.3071 + 0.5009i	0.1505 + 0.5412i	0.5412 - 0.1505i
-0.0918 - 0.3270i	-0.6387 + 0.1311i	0.2473 + 0.0541i	0.4045 - 0.4815i
-0.3841 - 0.3851i	-0.3076 - 0.0056i	0.2285 + 0.6580i	0.0735 - 0.3448i

0.5000	0.5000	0.5000	-0.5000
0.0337 + 0.6193i	0.2280 + 0.1515i	0.2280 + 0.1515i	-0.4621 - 0.5019i
0.0918 + 0.3270i	0.4815 + 0.4045i	0.1311 + 0.6387i	-0.2473 - 0.0541i
0.3841 + 0.3851i	0.2285 + 0.6580i	0.3448 + 0.0735i	0.0056 - 0.3076i
0.5000	0 + 0.5000i	-0.5000	0 + 0.5000i
0.4422 + 0.0928i	-0.2102 + 0.0137i	-0.2479 - 0.5606i	-0.5606 + 0.2479i
0.0337 + 0.6193i	-0.1515 + 0.2280i	-0.2280 - 0.1515i	-0.5019 + 0.4621i
0.0918 + 0.3270i	-0.4045 + 0.4815i	-0.1311 - 0.6387i	-0.0541 + 0.2473i
0.5000	-0.5000	0.5000	0.5000
0.3841 + 0.3851i	-0.2285 - 0.6580i	0.3448 + 0.0735i	-0.0056 + 0.3076i
0.4422 + 0.0928i	-0.0137 - 0.2102i	0.2479 + 0.5606i	0.2479 + 0.5606i
0.0337 + 0.6193i	-0.2280 - 0.1515i	0.2280 + 0.1515i	0.4621 + 0.5019i
0.5000	0 - 0.5000i	-0.5000	0 - 0.5000i
0.0918 + 0.3270i	0.4045 - 0.4815i	-0.1311 - 0.6387i	0.0541 - 0.2473i
0.3841 + 0.3851i	0.6580 - 0.2285i	-0.3448 - 0.0735i	0.3076 + 0.0056i
0.4422 + 0.0928i	0.2102 - 0.0137i	-0.2479 - 0.5606i	0.5606 - 0.2479i
0.5000	0.3536 + 0.3536i	0 + 0.5000i	-0.3536 + 0.3536i
0.3841 + 0.3851i	0.0022 + 0.1690i	-0.3076 - 0.0056i	-0.7536 - 0.1140i
-0.1560 + 0.4926i	0.0837 + 0.4175i	-0.4597 + 0.3989i	-0.4175 + 0.0837i
0.3841 + 0.3851i	-0.1140 + 0.7536i	-0.3076 - 0.0056i	-0.1690 + 0.0022i
0.5000	-0.3536 + 0.3536i	0 - 0.5000i	0.3536 + 0.3536i
0.3396 + 0.1614i	-0.3400 - 0.3060i	0.3493 - 0.5641i	-0.3060 + 0.3400i
0.3841 + 0.3851i	-0.1690 + 0.0022i	0.3076 + 0.0056i	-0.1140 + 0.7536i
-0.1560 + 0.4926i	-0.4175 + 0.0837i	0.4597 - 0.3989i	0.0837 + 0.4175i
0.5000	-0.3536 - 0.3536i	0 + 0.5000i	0.3536 - 0.3536i
0.3841 + 0.3851i	0.1140 - 0.7536i	-0.3076 - 0.0056i	0.1690 - 0.0022i
0.3396 + 0.1614i	0.3060 - 0.3400i	-0.3493 + 0.5641i	0.3400 + 0.3060i
0.3841 + 0.3851i	-0.0022 - 0.1690i	-0.3076 - 0.0056i	0.7536 + 0.1140i
0.5000	0.3536 - 0.3536i	0 - 0.5000i	-0.3536 - 0.3536i
-0.1560 + 0.4926i	0.4175 - 0.0837i	0.4597 - 0.3989i	-0.0837 - 0.4175i
0.3841 + 0.3851i	0.7536 + 0.1140i	0.3076 + 0.0056i	-0.0022 - 0.1690i
0.3396 + 0.1614i	0.3400 + 0.3060i	0.3493 - 0.5641i	0.3060 - 0.3400i