Performance Evaluation of DL Open Loop MIMO Schemes

Document Number: IEEE C80216m-08_824

Date Submitted: 2008-07-10

Source:

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Re: IEEE 802.16m-08/024 - Call for Comments on DL MIMO SDD text

Purpose: For discussion and approval by TGm for 802.16m SDD

Introduction

- This contribution compares several open loop schemes for a 4 tx system with single codeword (SCW)
- Schemes compared are:
  - Rate 1:
    - STTD with and without antenna hopping (WiMAX matrix A)
    - SM/CDD (cyclic delay diversity)
    - rate 1 phase shift diversity (PSD) [1]
    - rate 1 PSD with precoder rotation (RPSD) [2]
  - Rate 2:
    - Double STTD with and without antenna hopping (WiMAX matrix B)
    - rate 2 SM with antenna hopping (SM/AH)
    - rate 2 PSD
    - rate 2 PSD with precoder rotation (RPSD)

[1] IEEE C802.16m-08/426, An Open-loop MIMO Scheme based on Phase Shift Diversity, 2008-05-05, LGE.
[2] IEEE C802.17mDL_MIMO-08/008, Draft 3: SDD Text on Downlink MIMO Schemes, 2008-06-20, DL MIMO Rapporteur Grouop Chairs

Simulation Parameters

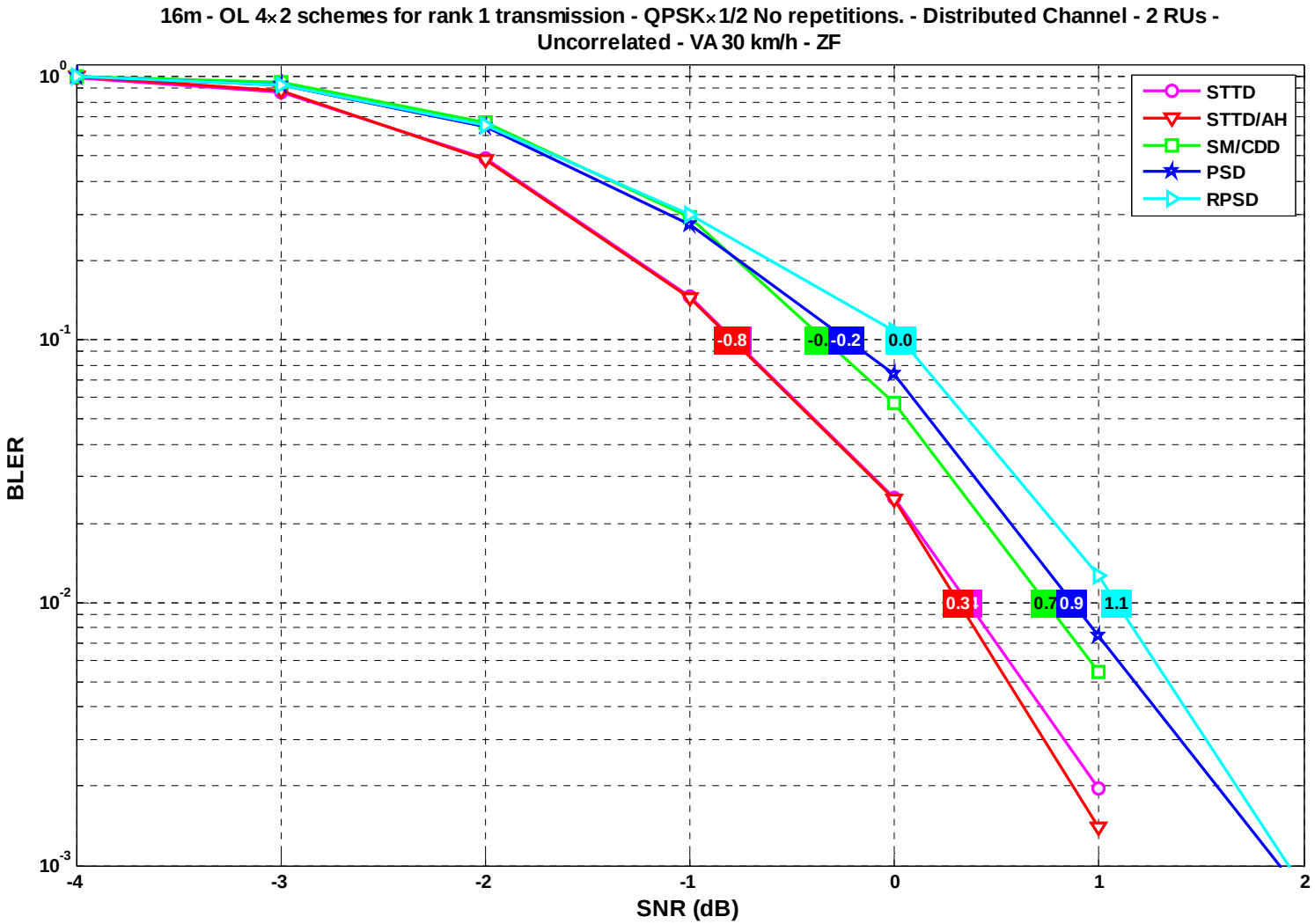
- **Channelization**
  - 2 RUs (18 x 6)
  - tone-based distributed
- **Antenna**
  - 4 Tx, 2 Rx
  - uncorrelated
  - 0 dB receive power imbalance
- **Fading channel**
  - PB 3 km/h, VA 30 km/h
  - Carrier frequency 2.5 GHz
  - Ideal channel estimation
- **Detector**
  - MMSE
  - ZF
  - MLD
  - Sphere decoder (SD) as a sub-set MLD (64 is maximum number of candidates, radius is $4N_0$ [3])

[3] Nikopour, H., etc., "*Parallel soft spherical detection for coded MIMO systems,*" WCNC 2006, vol. 3, pp.1776-1781, 2006.

- **Modulation and coding**
  - 16-QAM or QPSKx1/2
  - without repetition
  - Rate ½ duo-binary turbo code
  - 1 or 2 layers
  - single codeword

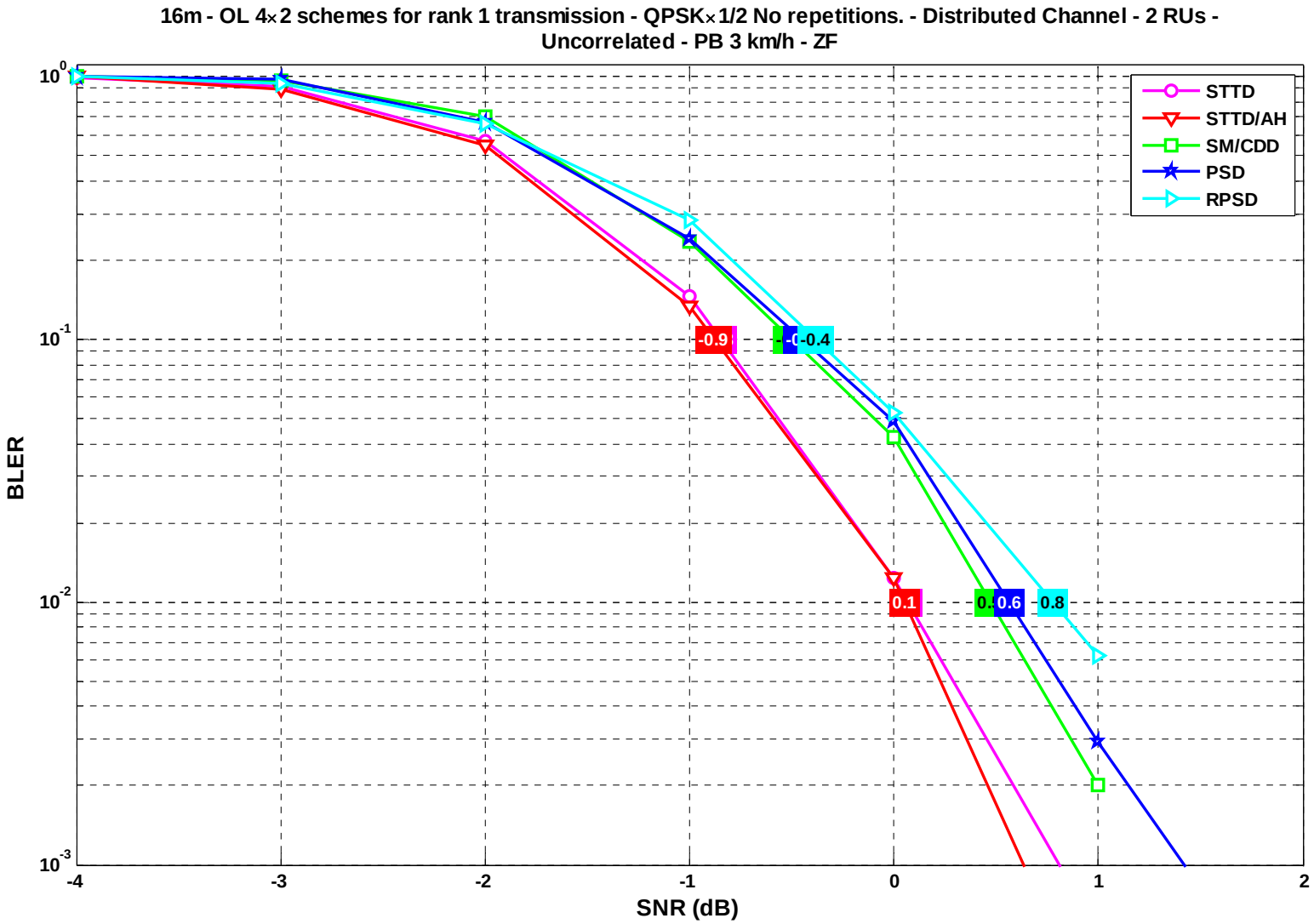
Link Level Performance Comparison for Rate 1

Comparing OL Schemes with ZF Receiver (QPSK, Veh-A 30 km/h)



STTD/AH has the overall best performance. PSD and RPSD are inferior to other transmit diversity schemes, and with added complexity due to unitary precoder and phase shift precoder computation.

Comparing OL Schemes with ZF Receiver (QPSK, PB 3 km/h)



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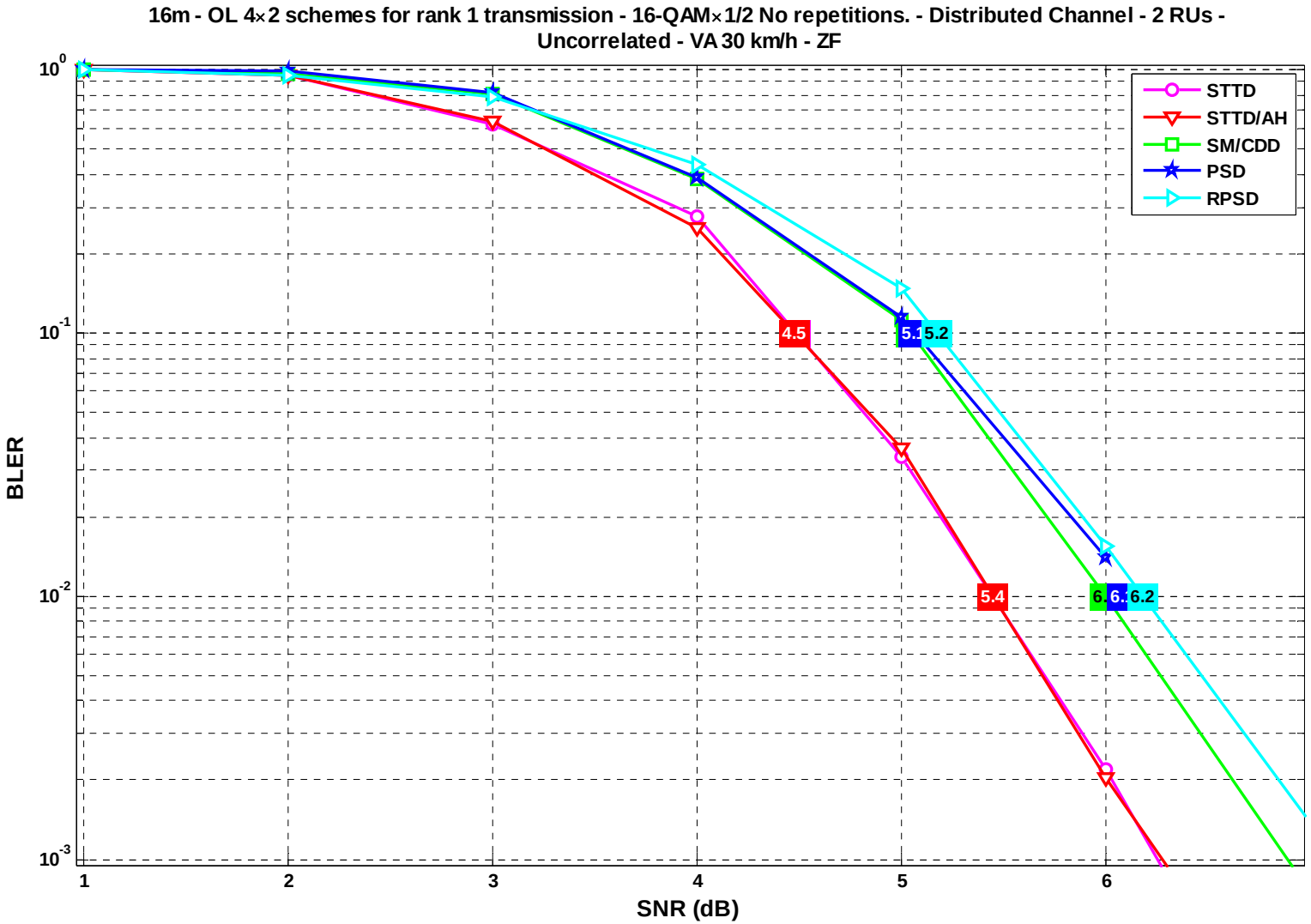
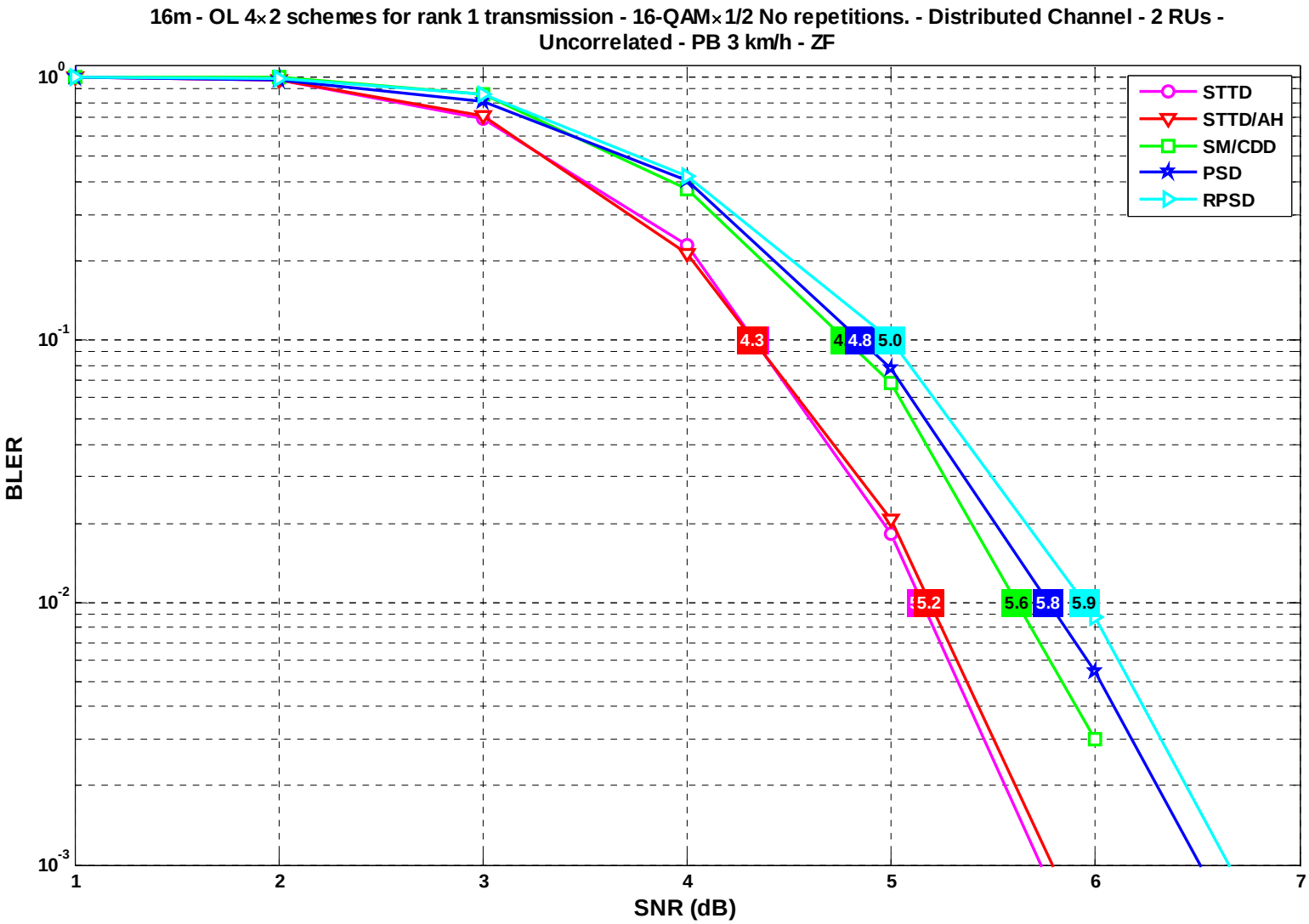
Comparing OL Schemes with ZF Receiver (16-QAM, Veh-A 30 km/h)



STTD/AH and STTD have the overall best performance. PSD and RPSD are inferior to other transmit diversity schemes, and with added complexity due to unitary precoder and phase shift precoder computation.

Comparing OL Schemes with ZF Receiver (16-QAM, PB 3 km/h)



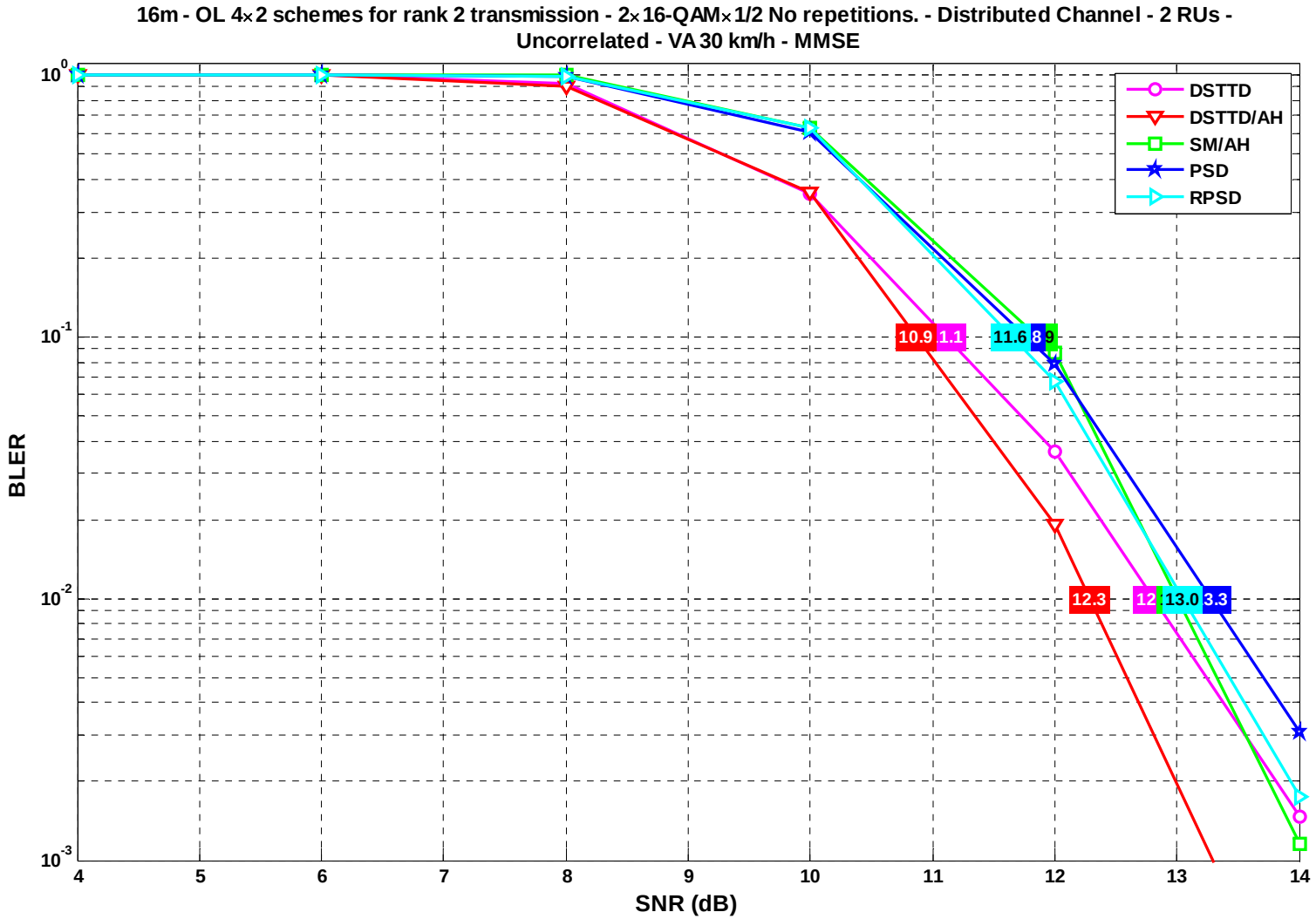
STTD/AH and STTD have the overall best performance. PSD and RPSD are inferior to other transmit diversity schemes, and with added complexity due to unitary precoder and phase shift precoder computation.

Overall Summary of Comparison of OL Schemes for Rate 1

- STTD/AH has the overall best performance and lower complexity
- Recommendation: STTD/AH

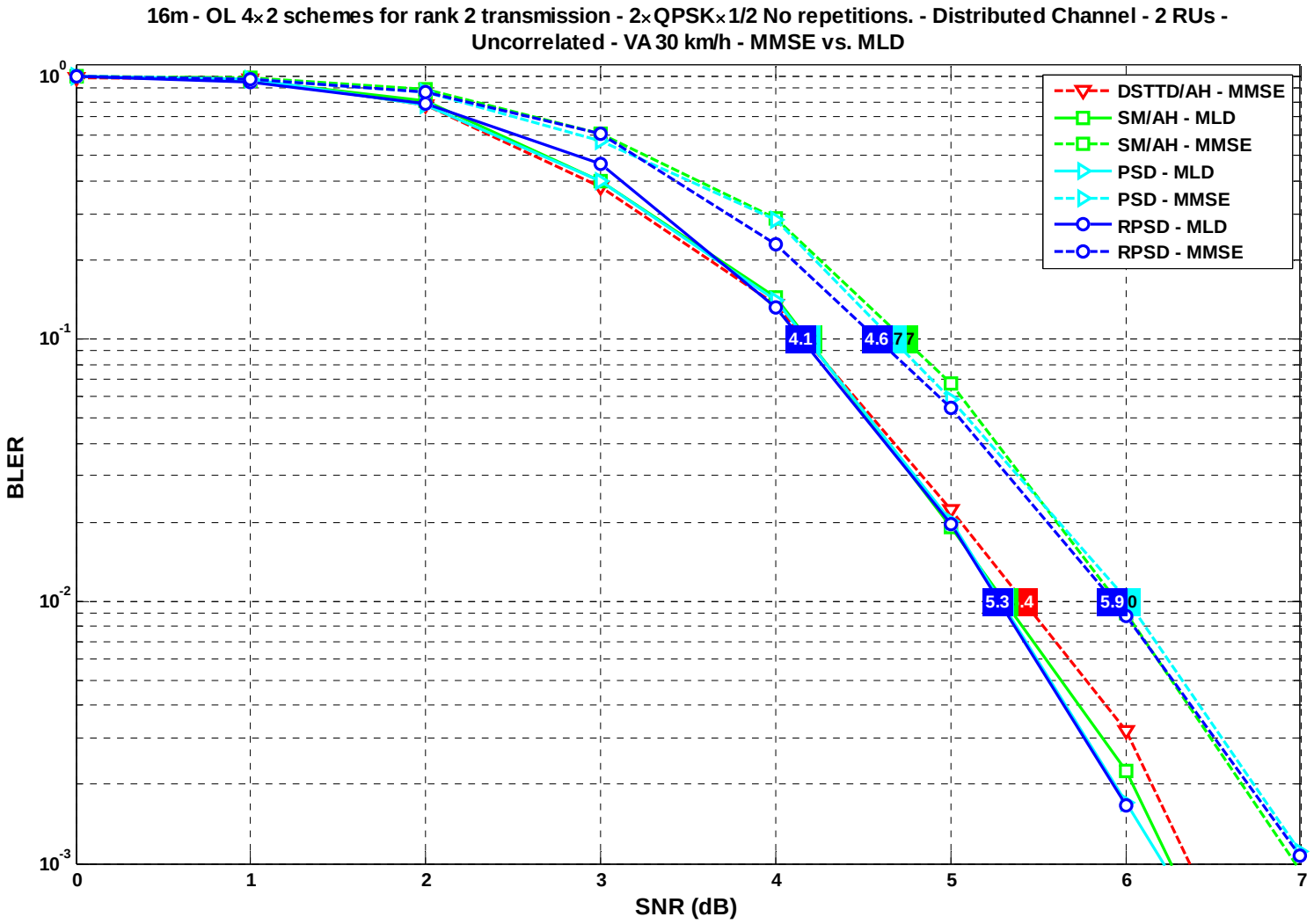
Link Level Performance Comparison for Rate 2

Comparing OL Schemes with MMSE Receiver (16-QAM, Veh-A)



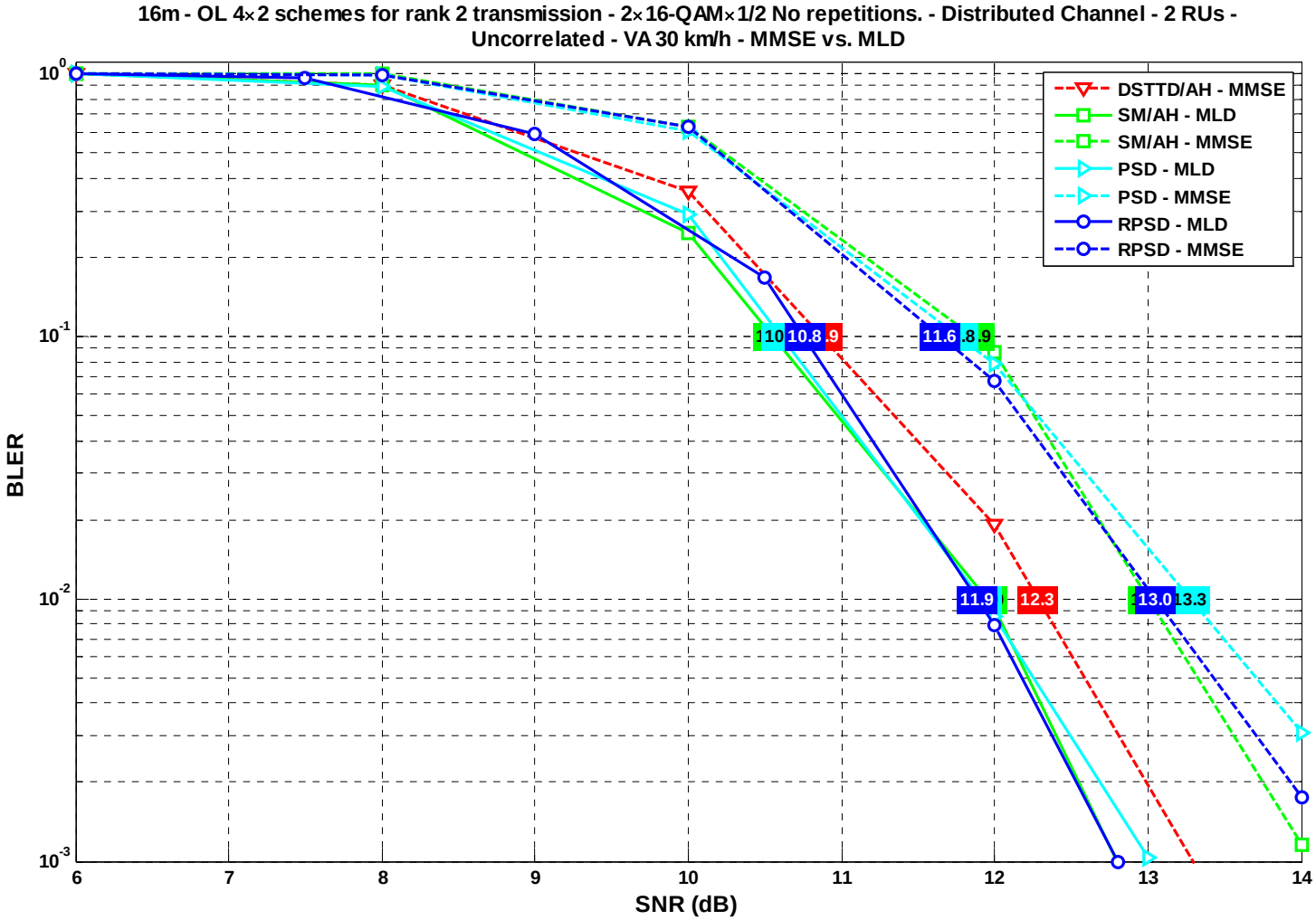
DSTTD/AH has the overall best performance. For reduced receiver complexity, SM/AH is the best candidate compared to PSD and RPSD.

Comparing OL Schemes, MMSE vs. MLD Receiver (QPSK, Veh-A)



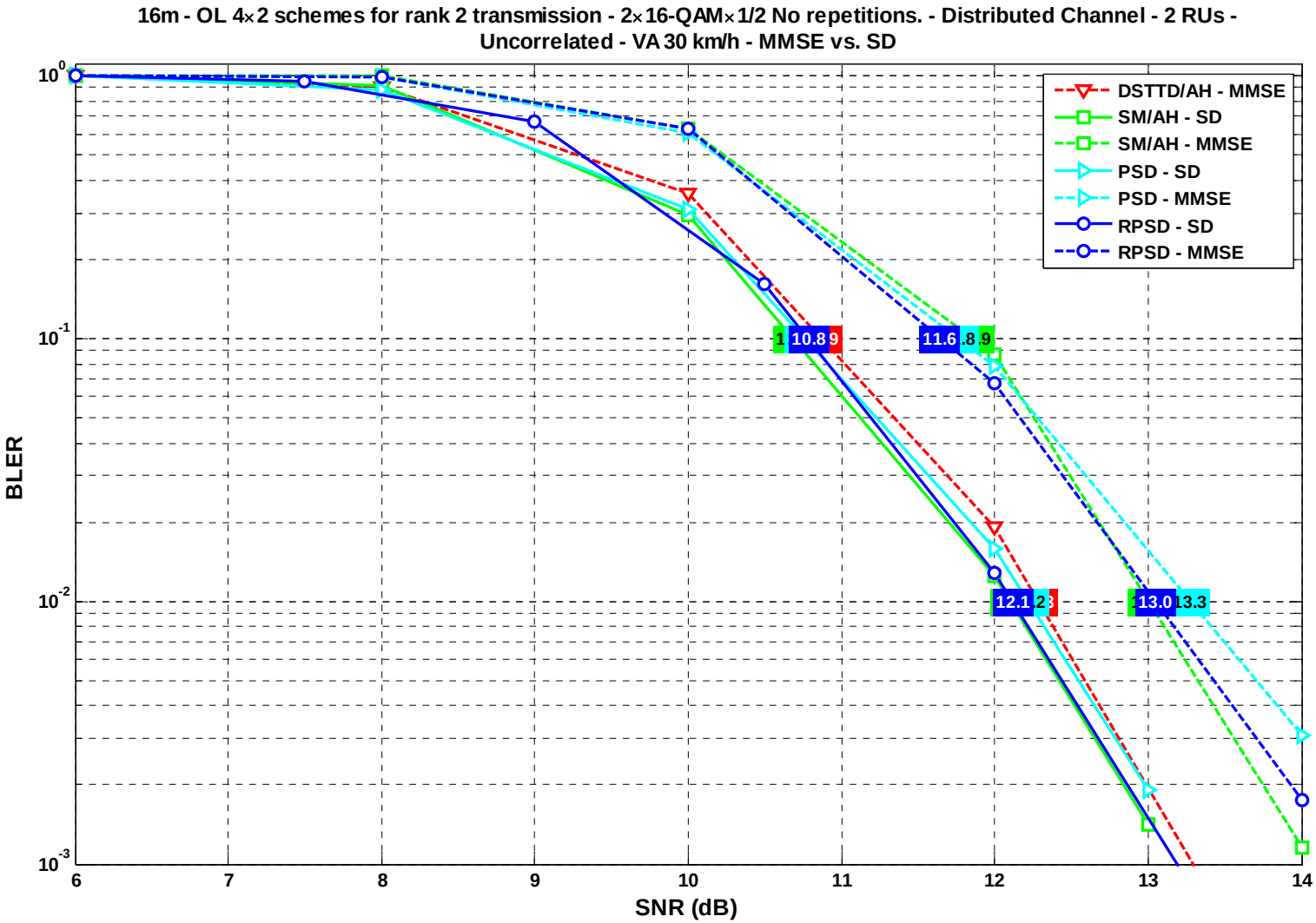
With full MLD receiver, SM/AH, PSD, RPSD have similar performance and are slightly better than DSTTD/AH with MMSE receiver.

Comparing OL Schemes, MMSE vs. MLD Receiver (16-QAM, Veh-A)



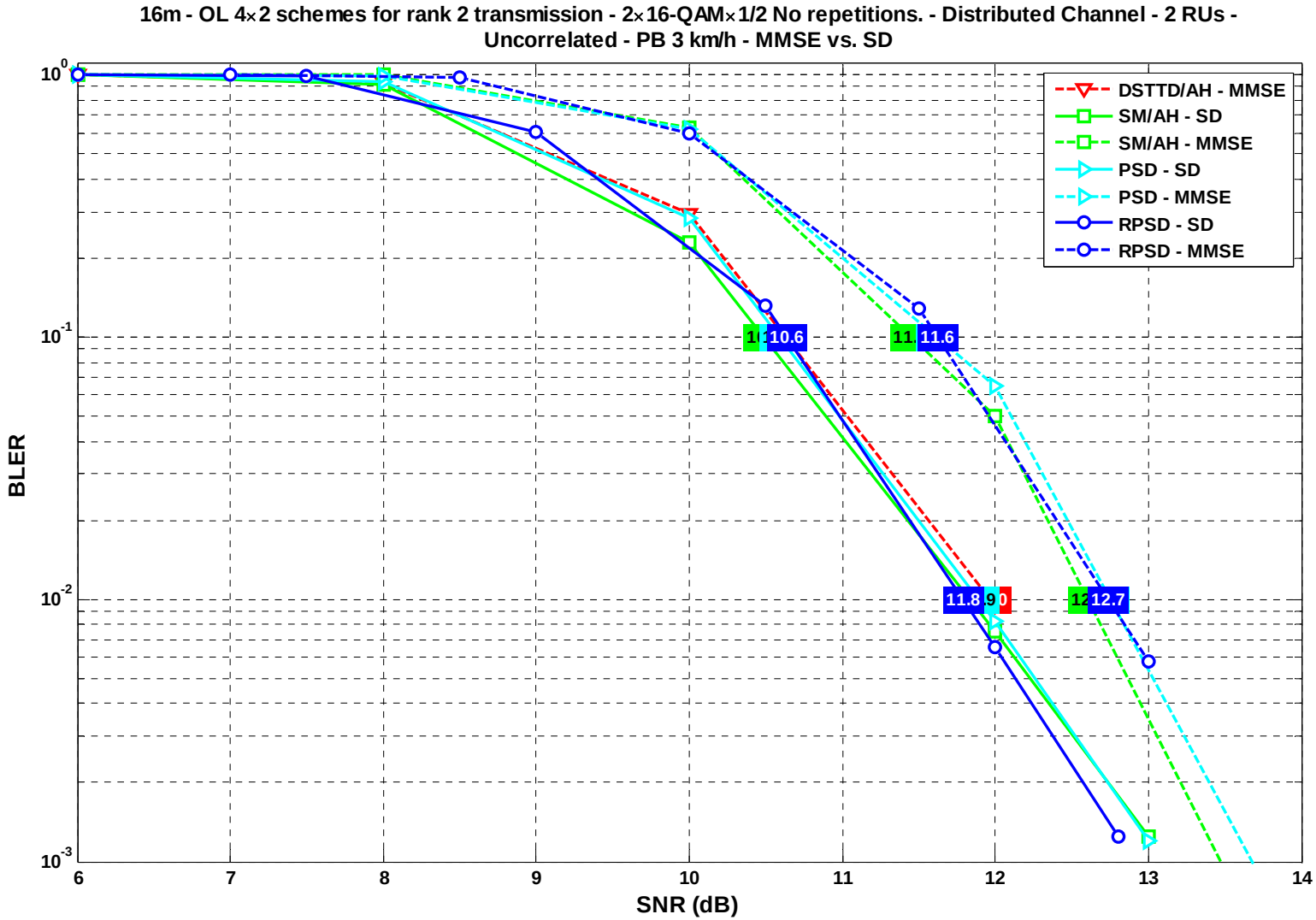
With full MLD receiver, SM/AH, PSD, RPSD have similar performance and are about 0.4dB better than DSTTD/AH with MMSE receiver.

Comparing OL Schemes, MMSE vs. SD Receiver (16-QAM, Veh-A)



With sphere decoder receiver, SM/AH and RPSD have similar performance and are slightly better than PSD and slightly better than DSTTD/AH with MMSE receiver.

Comparing OL Schemes, MMSE vs. SD Receiver (16-QAM, PB)



With sphere decoder receiver, SM/AH, PSD and RPSD have similar performance and are slightly better than DSTTD/AH with MMSE receiver.

Overall Summary of Comparison of OL Schemes for Rate 2

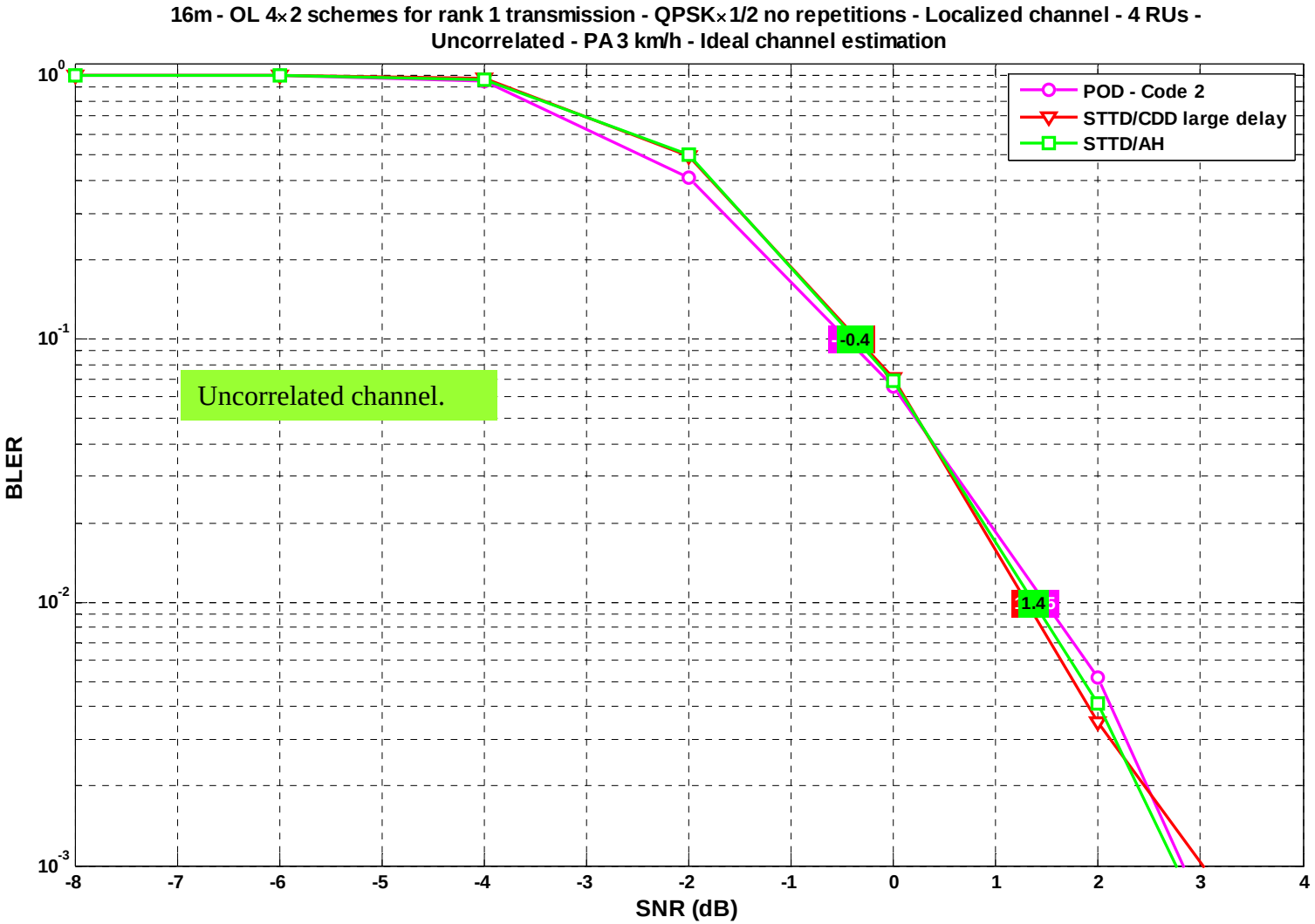
SM schemes	Overall Performance with sub-MLD	Overall performance with MMSE	Needs unitary precoder?	Needs phase shift precoder?
DSTTD/AH	N/A	best (at the expense of similar complexity as other schemes with sub-MLD)	no	no
DSTTD	N/A	better (at the expense of similar complexity as other schemes with sub-MLD)	no	no
SM/AH	best	good	no	no
RPSD	best	good	yes	yes
PSD	better	worse	yes	yes

- **Issue related to the precoder of PSD and RPSD**
  - precoders increase complexity of the transmitter.
  - precoder increases complexity of the receiver to build the equivalent channel as pilots are not dedicated.

Recommendations for SDD

- 11.x.2.1.1.1 Transmit diversity
  - 2Tx antennas, rate 1: STBC/SFBC
  - 4Tx antennas, rate 1: STTD/AH
- 11.x.2.1.1.2 Spatial Multiplexing
  - 2Tx antennas, rate 2: rate 2 SM
  - 4Tx antenna rate 2: rate 2 SM with antenna hopping
  - 4Tx antenna rate 3: rate 3 SM with antenna hopping
  - 4Tx antenna rate 4: rate 4 SM

Comparison of STTD/AH, STTD/CDD and STTD/2D-POD



The parameters used for POD and CDD are as suggested in [4]. All three schemes have similar performance. STTD/AH has lower complexity since per RU or per tone phase shift is not needed.

[4] Email from Kiran Kuchi, CeWIT, on the DL MIMO Rapporteur Group reflector, July 3, 2008.

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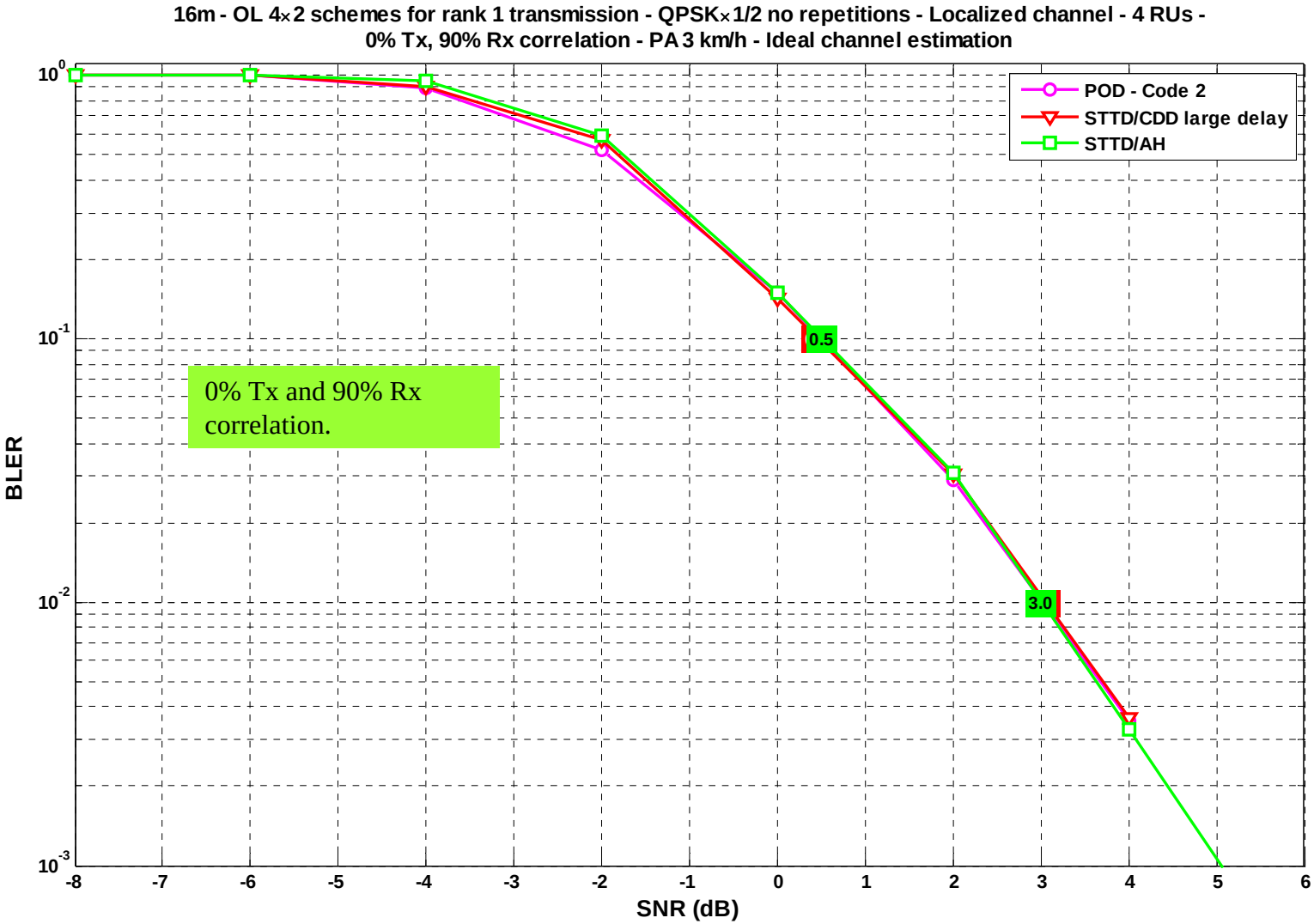

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[5] Email from Kiran Kuchi, CeWIT, on the DL MIMO Rapporteur Group reflector, July 5, 2008.