

Uplink MIMO Schemes for IEEE 802.16m

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Call for Contributions on IEEE 802.16m-08/003 System Description Document (SDD)

Topic: Uplink MIMO schemes

Base Contribution:

IEEE C80216m-08_534

Purpose:

Discussion and approval

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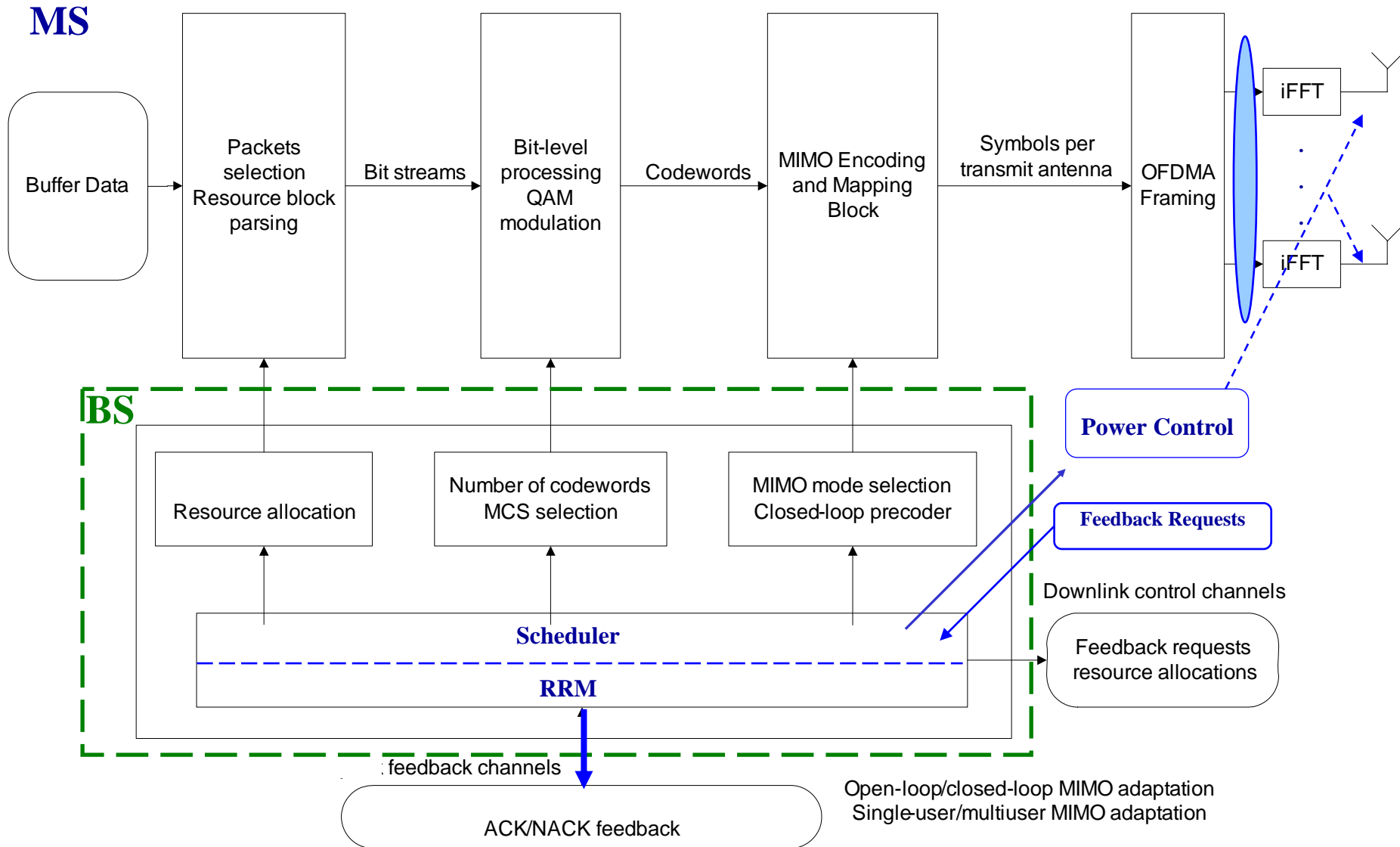
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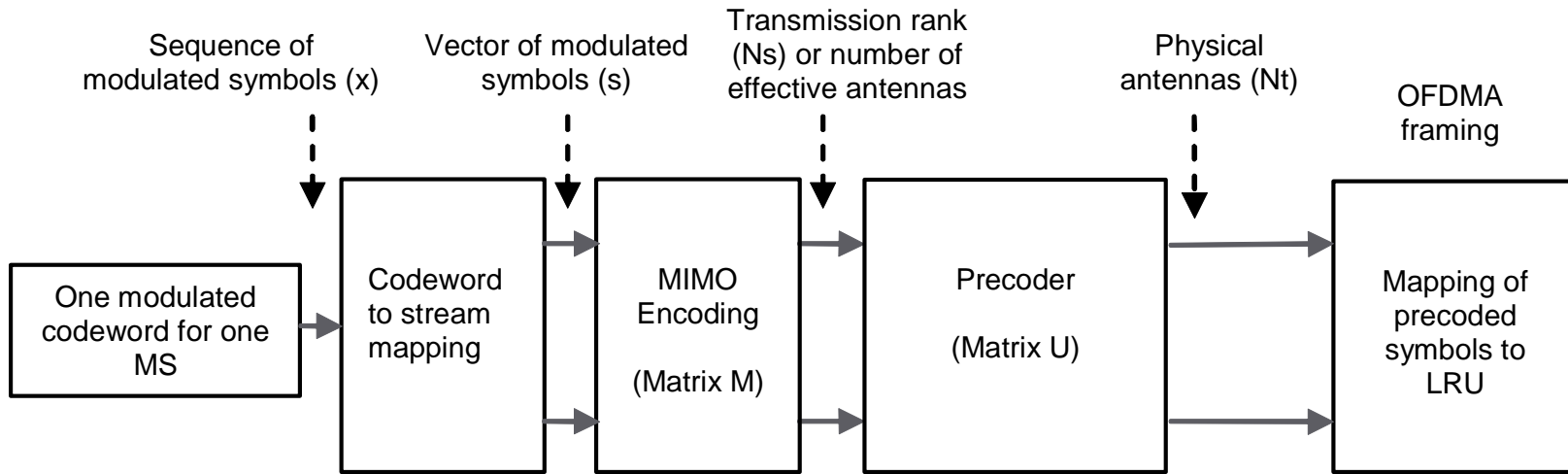
Proposed Scope of Uplink MIMO

Scope of Support	Method of Support
Support of Robust MIMO on Traffic Channels	Uplink Single-User Open-Loop MIMO
Support of High Uplink User Throughput	Uplink Single-User Open-Loop MIMO Uplink Single-User Closed-Loop MIMO
Support of High Uplink Sector Throughput	Uplink Collaborative Multi-User MIMO (CSM) for fixed and nomadic users
Flexible MIMO Feedback	Index of MCS Level, Tx Antenna, Codebook, LDC modes
Flexible MIMO channel estimation	UL Channel Sounding DL midamble (with reciprocity in TDD)

UL-MIMO Transmitter Architecture



UL-MIMO Processing



Definitions

- CSM-MU
 - CSM means Multi-user Scenario, without restriction on each MS's MIMO mode and number of transmit antennas
- LDC
 - Linear Dispersion Code
 - Cf contribution IEEE C80216m-08/535 for details

Uplink MIMO Modes

MS Transmit antennas (N)	Transmission Scheme	Rank	Precoder
1	OL SIMO (SU)	1	No Precoder
2	OL MIMO (SU)	1 to 2	Fixed Precoder
1,2	OL CSM* MIMO (MU)	1 to 2	Fixed Precoder
2	CL Precoding (SU,CSM-MU)	1 to 2	Adaptive Precoder

CSM means Multi-user Scenario, w/o restricting each user's MIMO mode

Uplink Open-Loop MIMO Schemes

- **Transmission of Uplink Traffic Channels**
 - Fixed Precoder + LDC Schemes
 - LDC embeds legacy matrices A,B
 - cf. contribution IEEE C80216m-08/535 (Unifying Framework)
- **Transmission of Uplink Control Channels**
 - Baseline is still 1 Tx only at MS
 - Fixed precoder enables the use of multiple antennas for uplink control channels
 - If target is 2 Tx @ MS
 - STTD support is FFS on UL control channels
 - One effective antenna diversity scheme is supported

Closed-Loop Precoding

- **TDD with UL/DL channel Reciprocity**
 - Channel estimation on DL midamble
 - Precoding: vendor-dependent, transparent at BS
- **FDD/TDD**
 - Feedback: Uplink Sounding
 - DL control (in DL MAP)
 - index of precoder in a Codebook
 - Index of MIMO mode/LDC Matrices (can be seen as codebooks)
- **Precoding Codebook size**
 - Reuse the DFT-based DL precoding codebook (or a subset)
 - For simplicity, robustness and to ensure transmit power balance at MS
- **LDC Codebook size**
 - Maximum 4 layers ($Q=4$) for sake of implementation feasibility

Uplink MU MIMO Support (16e CSM = Collaborative Spatial Multiplexing)

MS # Tx antennas	CSM Feature
1	2 to 4 MS
2	2 MS with LDC at MS
2	2 to 4 MS with precoding at MS (1 beam)

Mode and Link Adaptation Information

Feedback Information	Features
Full Channel State Information at BS	BS measure channel from uplink sounding
Index of uplink precoder from codebook (*)	Codebook Search/Selection required @ BS DL MAP signaling to MS
Index of LDC/MIMO mode (*)	Optimal MIMO mode search required @ BS DL MAP signaling to MS
MCS Level	Optimal MCS level search @ BS DL MAP signaling to MS

* Supported feature can be acknowledged based on capability exchange between BS and MS (i.e. terminal class)

Uplink Control Structures

Uplink Control Channel	Properties
Uplink Sounding Symbol	An Uplink sounding OFDM symbol is supported.

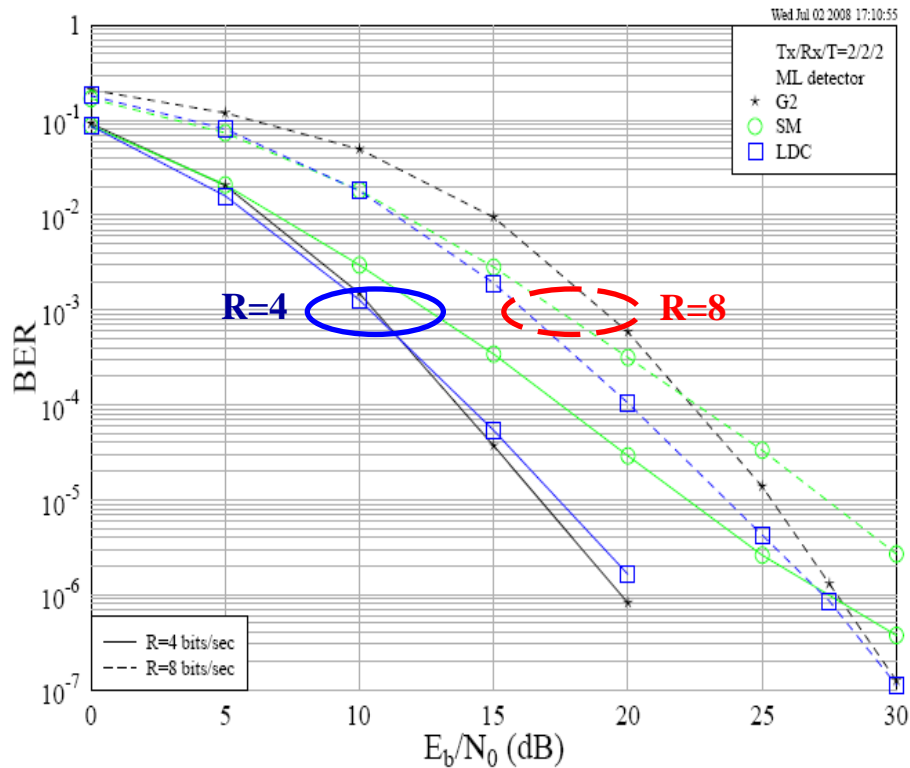
Downlink Control Structures

Downlink Control Channel	Properties
Downlink midamble	In TDD with channel reciprocity To obtain UL channel estimate at MS
DL MAP	Precoder index, LDC encoding matrix index, MCS level

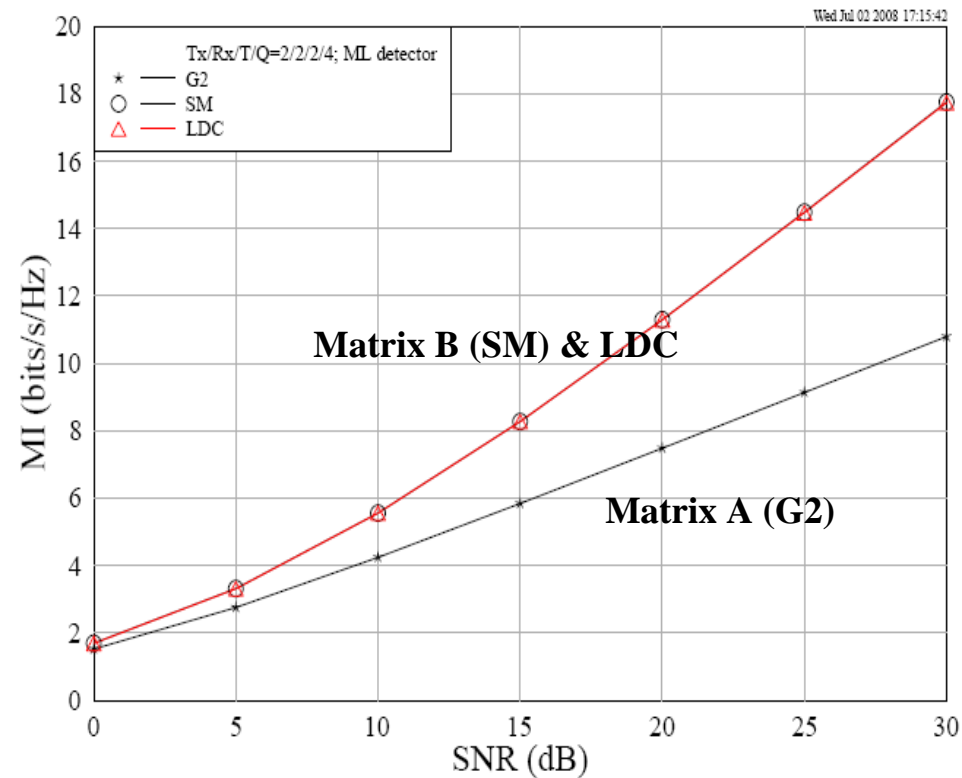
Key Simulations Results (1/3)

- **LDC advantages w.r.t. legacy UL MIMO (A,B)**
 - Unified Framework
 - Multiplexing-Diversity Trade-off

LDC, Uncor_Rayleigh



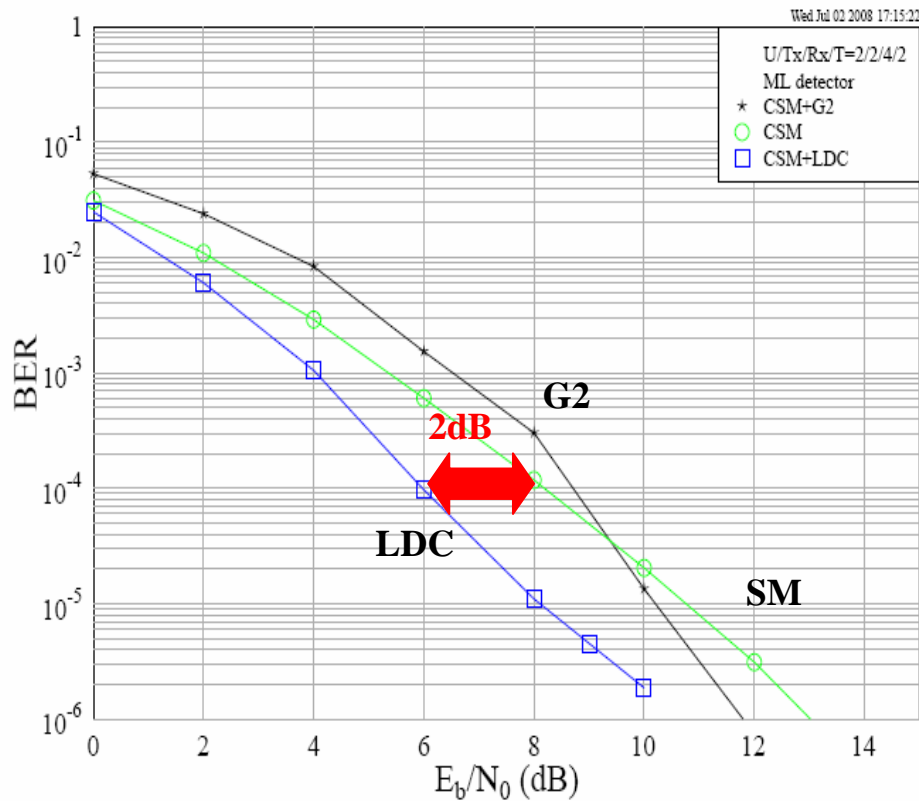
LDC, Uncor_Rayleigh, R=4 bits/sec



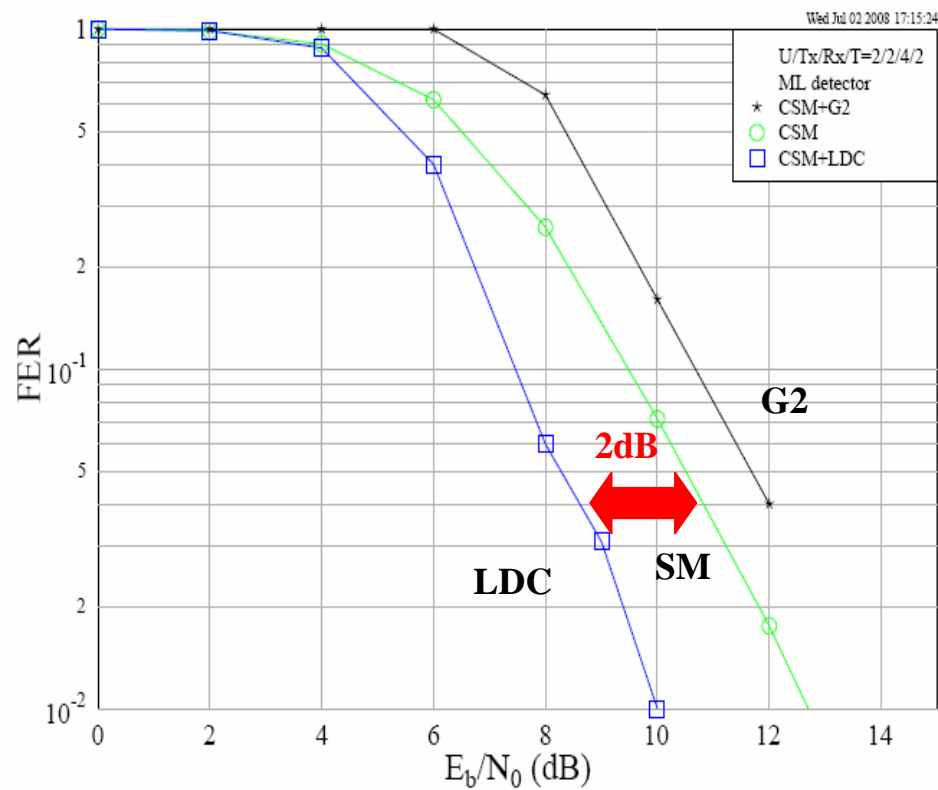
Key Simulations Results (2/3)

- LDC within the Collaborative SM (Multi-user)**

LDC, PedA3, $R_s=8$ bits/sec

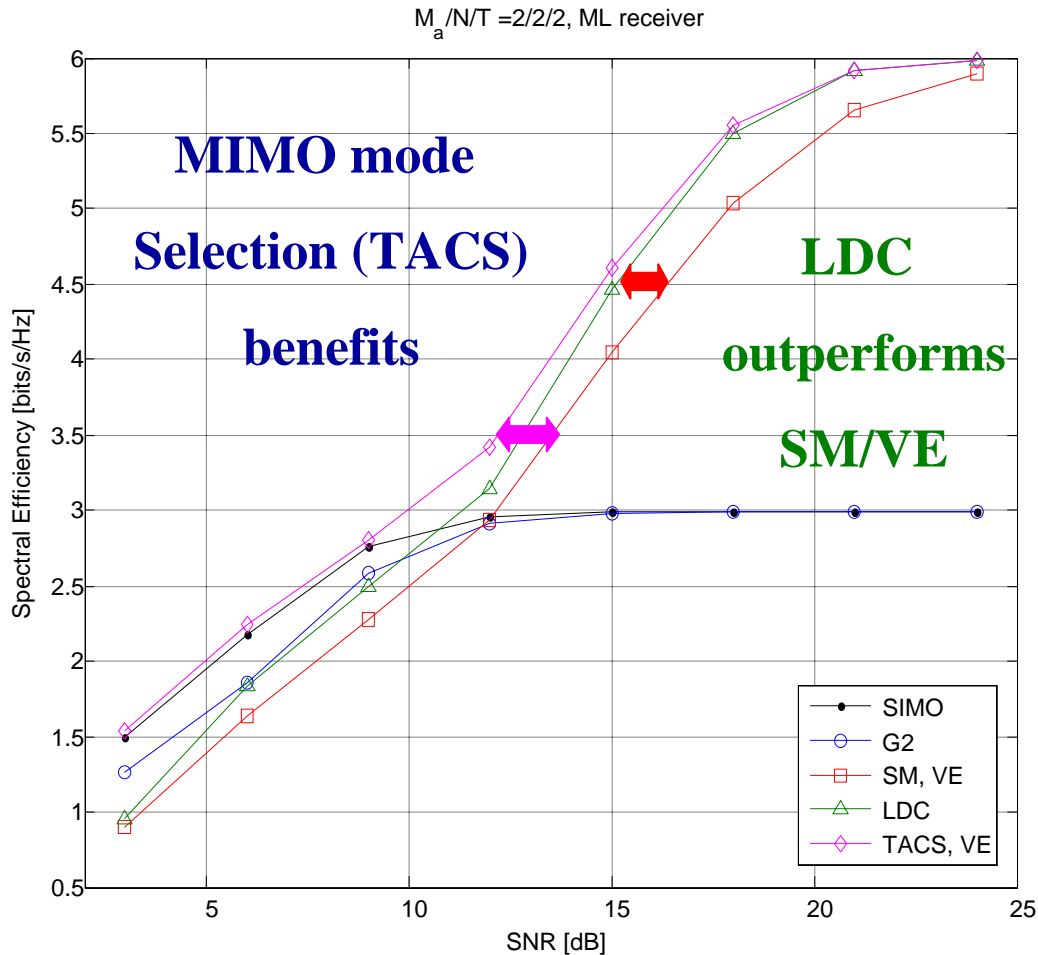


LDC, PedA3, $R_s=8$ bits/sec



Key Simulations Results (3/3)

- **Spatial Adaptation**
 - MIMO mode / LDC Selection
 - Link Adaptation (MCS Level)



Proposed SDD text

- **Cf baseline contribution IEEE C80216m-08/534**