

R1-051429



3GPP TSG-RAN1 Meeting #43

Seoul, Korea, 7-11, November, 2005

Agenda Item: 8.4

Source: Nortel

Title: Link-to-System Mapping for 2x2 SM Mode with MLD Receiver

Document for: Discussion



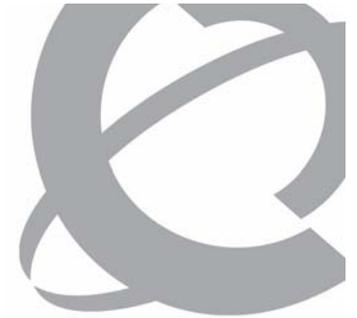
>THIS IS **THE WAY**

Link-to-System Mapping for 2x2 SM Mode with MLD Receiver

Nortel

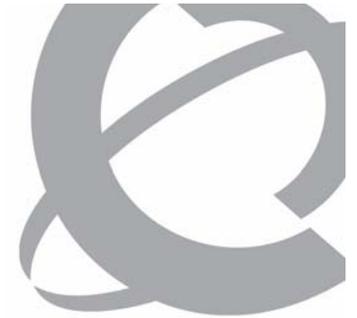
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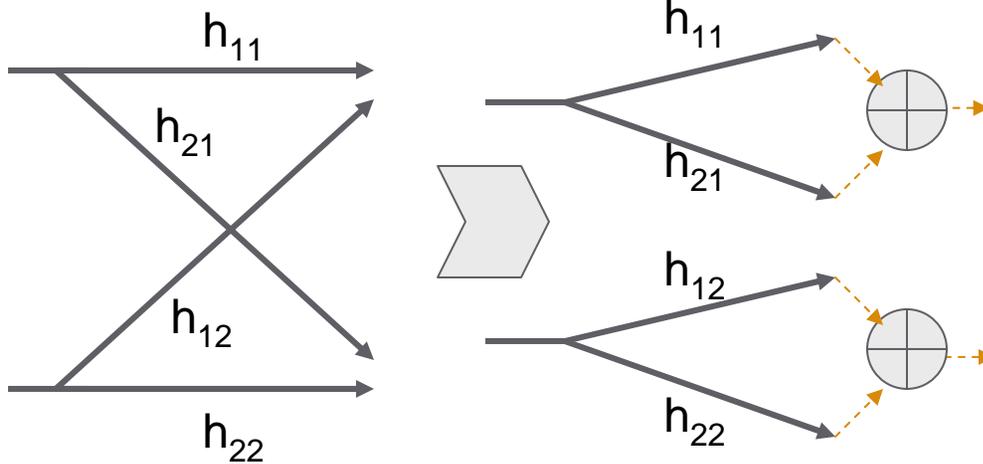
Background and Introduction

- > For 2x2 DL MIMO the mode adaptation enables the optimization of the sector throughput and coverage
 - The mode adaptation criterion is discussed in contribution R1-051424
 - However, when SM modes is selected, not every MIMO channel matrix is good for spatial multiplexing transmission
 - Since the eigen-value of the channel matrix may quite unbalanced, hence leads to the throughput loss, especially the MMSE receiver is used.
 - On the other hand, in the multi-user scheduling case, when several UE are preferred to transmit SM mode, the possibility for a particular UE has a balanced eigen mode becomes significantly higher.
 - Therefore the principle for the scheduling of the SM mode UE is to avoid bad channel user and schedule the user with good channel
 - The ideal 2x2 MIMO channel for scheduling is when the 2x2 MIMO channel can be perfectly decomposed into two 1x2 SIMO channels
 - We use this condition as perfect layer separation (PLS) for the system lever simulation
 - We use MLD as practical receiver
- > In this contribution we present the link level results of the performance difference for the MLD receiver and PLS



DL SM Mode MIMO Scheduling

> For a [2Tx, 2Rx] MIMO channel, UE compute the MIMO channel metric



> Node-B selects the MIMO UE with two orthogonal layers

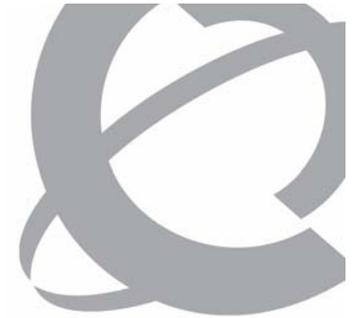
$$\min \left\| \begin{bmatrix} h_{11} & h_{21} \end{bmatrix} \begin{bmatrix} h_{12}^* \\ h_{22}^* \end{bmatrix} \right\| \sim 0$$

> UE computes the metric

$$\max \left\{ \frac{\det(H^H H)}{\text{trace}(H^H H)} \right\}$$

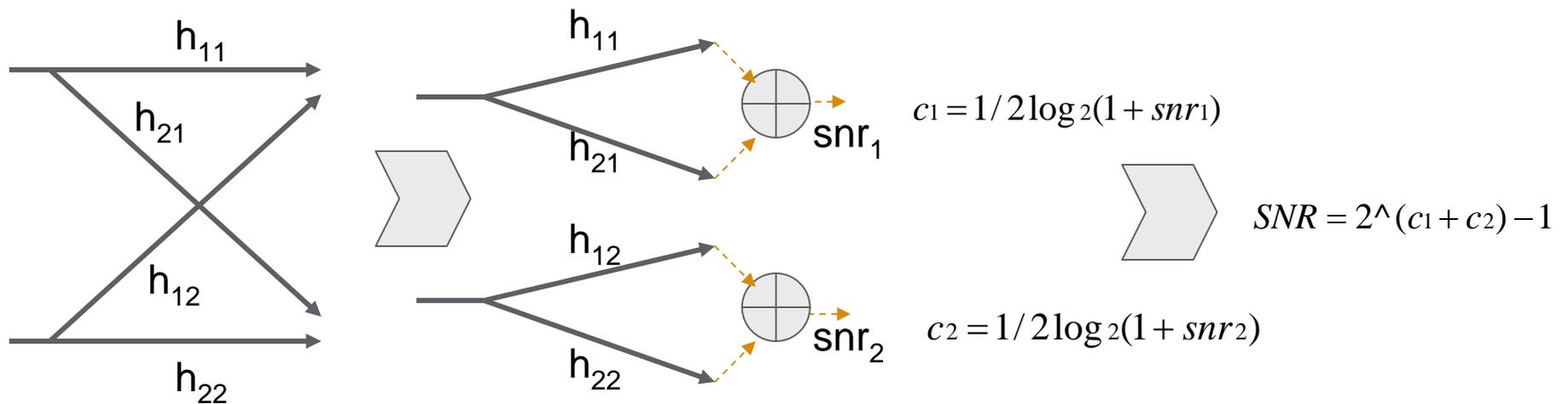
> The MIMO system is decomposed into two layers, with channel attenuation factors being

$$\beta_1 \sqrt{|h_{11}|^2 + |h_{21}|^2} \quad \text{and} \quad \beta_2 \sqrt{|h_{12}|^2 + |h_{22}|^2}$$



Link to System Level Mapping

> For a [2Tx, 2Rx] MIMO channel,



> If the MIMO channel can be decomposed into two orthogonal layers

$$\min \left\| \begin{bmatrix} h_{11} & h_{21} \\ h_{12}^* & h_{22}^* \end{bmatrix} \right\| = 0$$

> In the system level we call this perfect layer separation (PLS)



Link-to-System Mapping Methodology

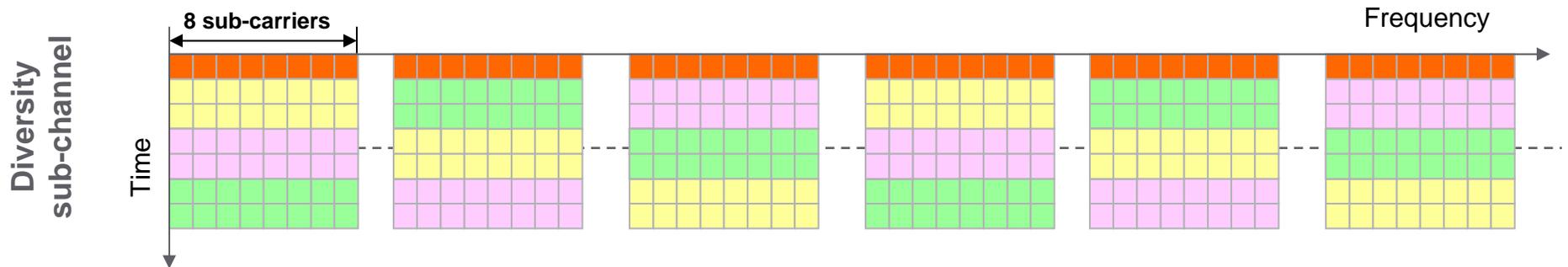
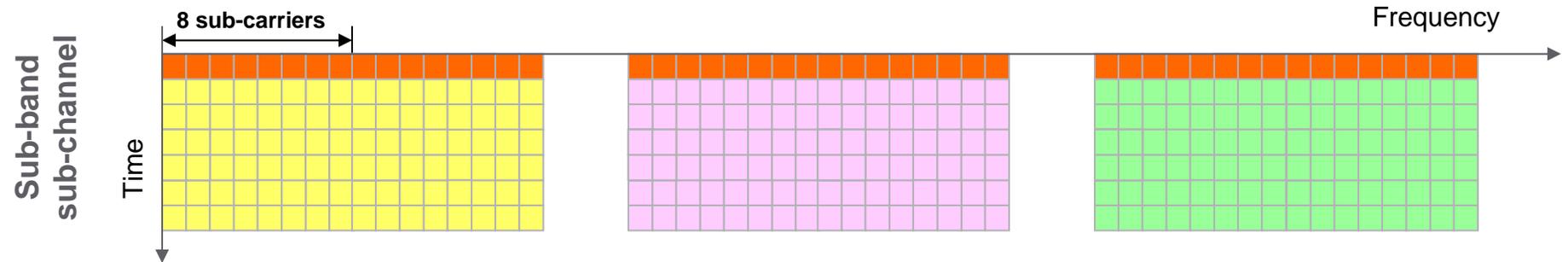
- > In the system level simulation when the SM is selected for a 2x2 MIMO user, the UE computes the layer separation metric

$$\max \left\{ \frac{\det(H^H H)}{\text{trace}(H^H H)} \right\}$$

- > The UE satisfying the metric is selected for scheduling, and the PLS is performed at system level simulation.
- > Since the practical MLD 2x2 SM receiver is used, we need add the penalty after the PLS is performed before mapping the MCS to select a coding modulation
- > In this contribution we present such penalty calibration for both types DL sub-channels
 - sub-band and diversity sub-channels



Sub-channel Structure and Scheduling Metric



> For diversity sub-channel we use metric

$$\max \left\{ \sum \log \left[\det \left(I + H^* H / \sigma^2 \right) \right] \right\}$$

> For sub-band sub-channel we use metric

$$\max \left\{ \frac{\det(H^H H)}{\text{trace}(H^H H)} \right\}$$



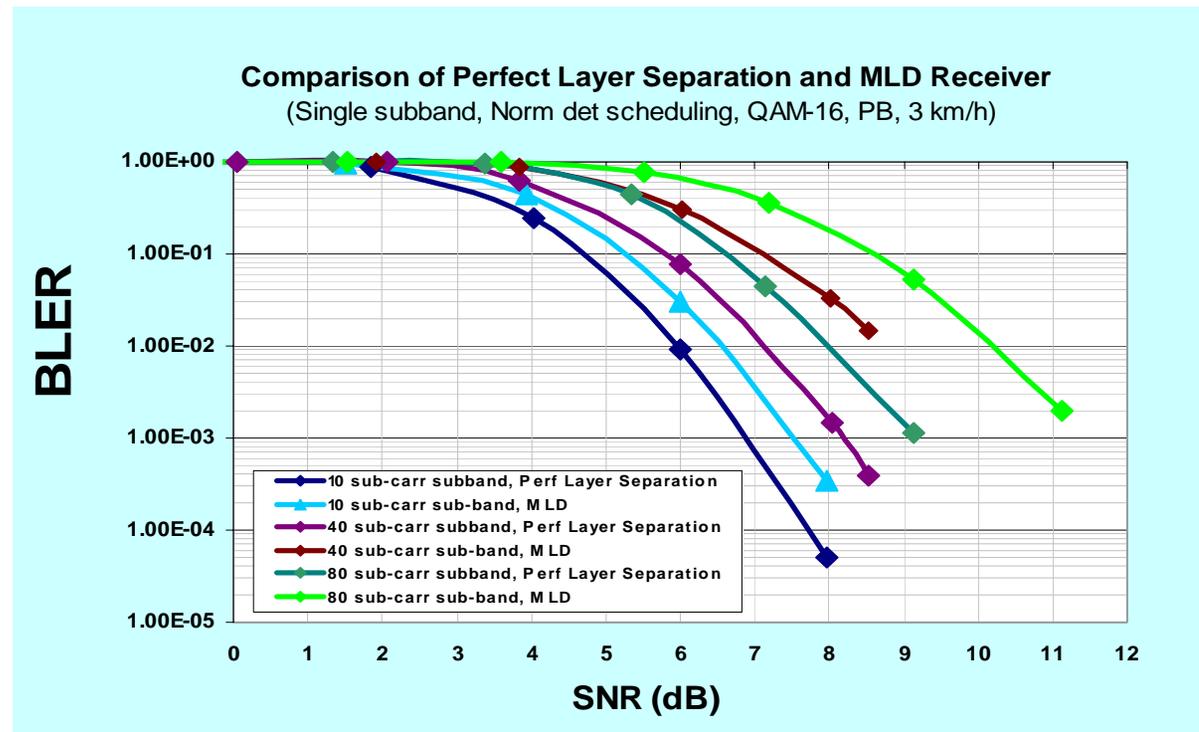
The Impact of Sub-channelization Structure

- > The sub-band based sub-channelization enables the accurate orthogonal layer separation scheduling, since in one sub-channel the sub-carriers are correlated
 - This can achieve best performance for low speed UE
- > For the diversity sub-channel which consists of several discrete sub-bands distributed over the entire band, the sub-carriers are most uncorrelated, this makes the orthogonal layer separation scheduling difficult
 - The MLD receiver is assumed to perform close the PLS operation and this will server as lower bound the SM system level performance



Simulation Results – (1)

> Single sub-band case

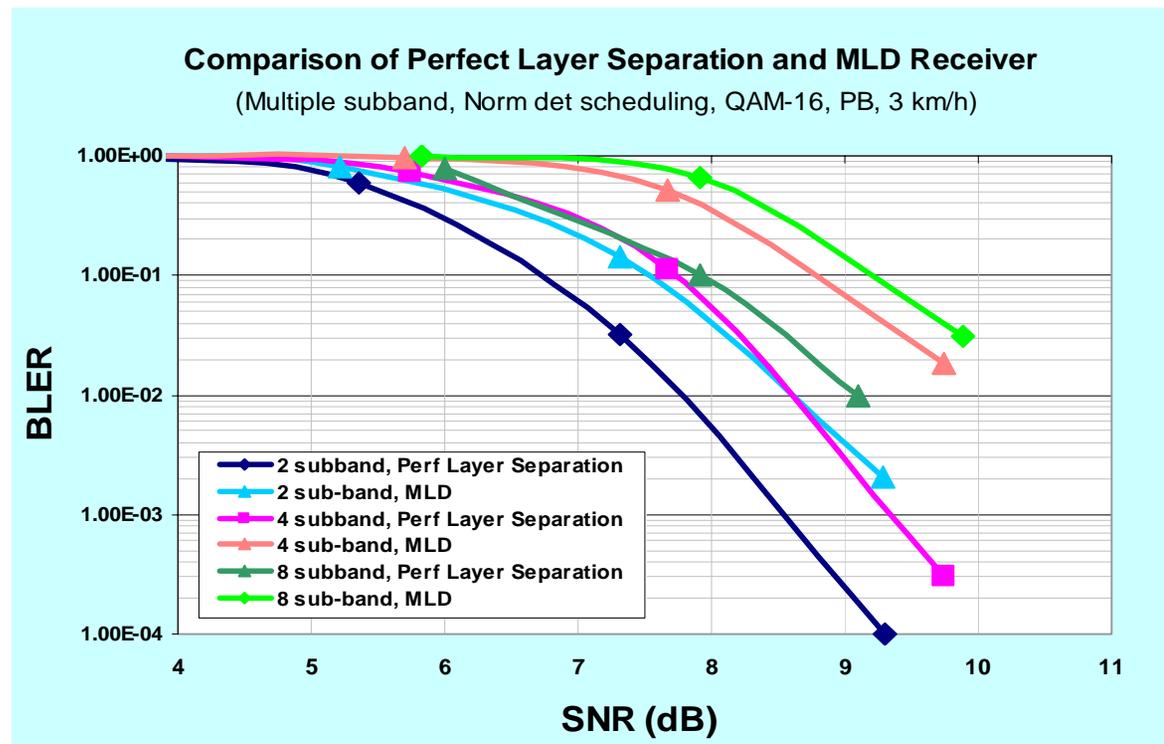


> As we can see that the loss of MLD receiver against the PLS is small for the single sub-band case.

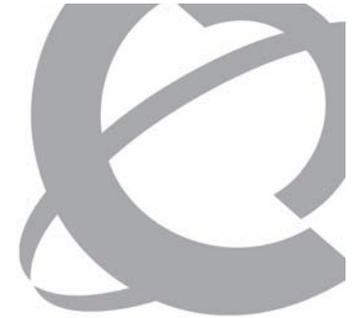


Simulation Results – (2)

> Multiple sub-band diversity sub-channel case



> As we can see that the loss of MLD receiver against the PLS diversity sub-channel is higher than single sub-band case



Summary of the Loss

> 2x2 SM-MLD decoder performance loss (in dB) against PLS for diversity sub-channel is listed in the table

Case No	MCS		Loss (PA, 3km)	Loss (PB, 3km)	Loss (VA, 30 km)
0	QPSK	r = 1/3	0.6	1	1
1	QPSK	r = 1/2	0.6	1	1
2	QPSK	r = 2/3	0.6	1	1
3	QPSK	r = 3/4	0.6	1	1
4	QPSK	r = 4/5	0.6	1	1
5	16QAM	r = 1/2	1	1.8	1.5
6	16QAM	r = 2/3	1	1.8	1.5
7	16QAM	r = 3/4	1	1.8	1.5
8	16QAM	r = 4/5	1	1.8	1.5

> We can use this table as penalty for the PLS link-to-system mapping in the system level simulation.



Discussions and Summary

- > In this contribution we present the link level results of the performance difference for the MLD receiver and PLS
 - We quantify the PLS scheduling penalty when the practical MLD receiver is employed
 - The Link-to-system mapping method is proposed
- > The scheduling criteria and two types of sub-channels; namely the sub-band sub-channel and diversity sub-channel are discussed