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| **Agenda Item:** | **8.4** |
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| **Document for:** | **Discussion** |



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>THIS IS **THE WAY**

# UL Virtual MIMO Scheduling

Nortel

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# Background and Introduction

> The UL virtual MIMO (V-MIMO) allows two UEs with single transmit antenna operate on the same sub-channel

- This allows to mitigate the dimensionality limitation of the orthogonal system (OFDM like)
- It allows to increase the UL capacity and user throughput

> However, the Node-B is required to schedule and assign two UEs onto a sub-channel in the pair-wise fashion

- The orthogonal transmission pilot of two V-MIMO UEs facilitate the channel estimation
- On the other hand, the Node-B needs to schedule a UE either to perform basic SIMO transmission or to pair with other UE to perform V-MIMO transmission

> We propose V-MIMO scheduling algorithm for OFDMA UL

- The same principle is applicable to SC-FDMA UL


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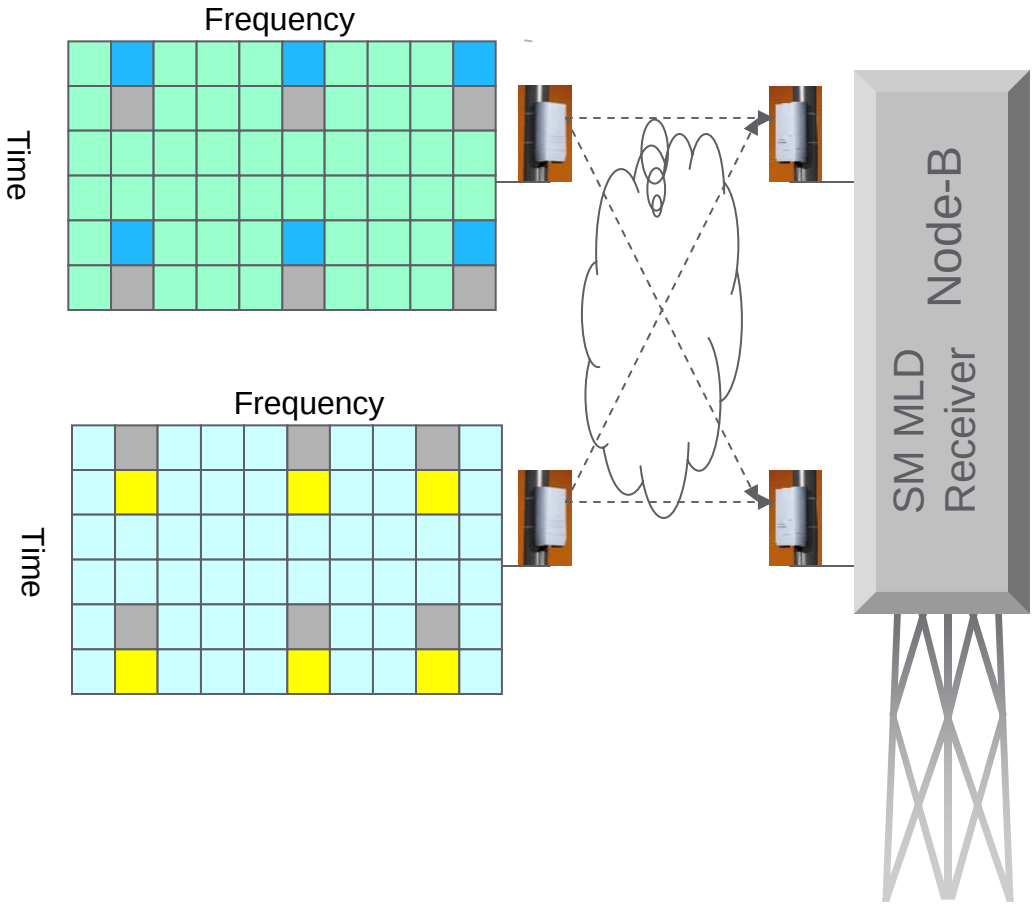
# V-MIMO UE Pairing Approach




> Method-1: Random Pairing
- Assign any UE pairing
- Flexible and support higher mobility speed
- No need sounding support

> Method-2: Orthogonal Pairing
- Assign pair of UE meet orthogonal criterion
- Achieve best throughput
- Need sounding support
- Support lower mobility speed
  - E.g., 30km/h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# DL Random Pairing Scheduling Algorithm

> The Node-B measures the CIR of each UE

> For the UE with lower CIR, Node-B assign the sub-channel for one UE only

- Use SIMO to improve the coverage

> For the UE with higher CIR, Node-B assign the sub-channel for first V-MIMO UE and randomly pick the second V-MIMO UE with orthogonal pilot w.r.t. the first V-MIMO UE

- Use V-MIMO to improve the throughput

> The Node-B uses spatial multiplexing receiver to separate two V-MIMO UEs

> The random paring scheduling allows the flexibility of the UE sub-channel assignment without the need of full band CIR information


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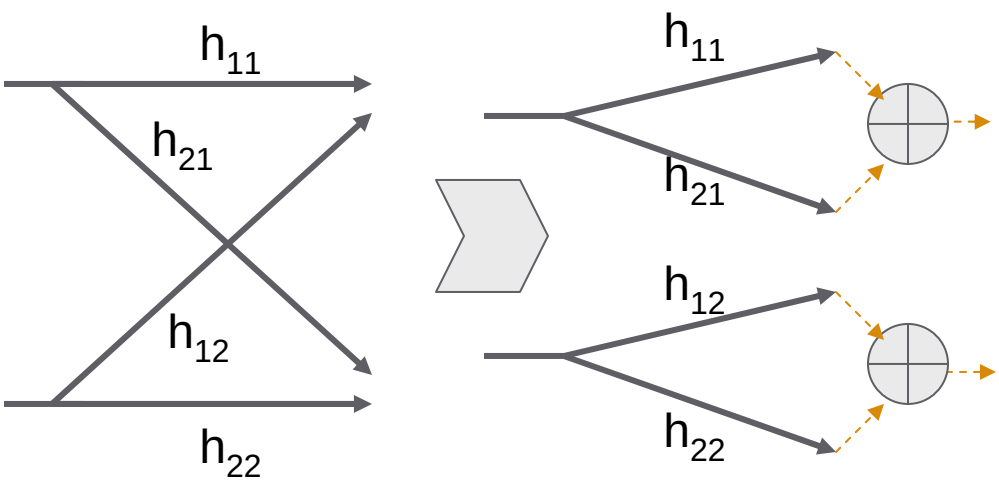
# DL Orthogonal Pairing Scheduling Algorithm

> For a [2Tx, 2Rx] MIMO channel, Node-B computes the MIMO channel metric

> Node-B selects the V-MIMO UEs with two orthogonal layers




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

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

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



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# Summary

> For 1x2 V-MIMO in the UL, several scheduling algorithms can be applied

- For low CQI UE, the 1x2 SIMO mode is assigned to a sub-channel
- For high CQI UE with high mobile speed or the without full band CQI information
  - Random pairing scheduling can be applied
- For high CQI UE with low mobile speed and full band CQI information
  - Orthogonal pairing scheduling can be applied, i.e. the two paired V-MIMO UEs satisfy

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

  - Channel sounding (such as out-band pilot) can be designed to enable sub-band scheduling in the UL


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