3GPP TSG RAN Meeting #66
Maui, USA, 8 – 11 December, 2014

RP-141917

Document for: Discussion
Agenda Item: 14.1.1

Motivation for a study on enhancements for multiuser transmission in R13

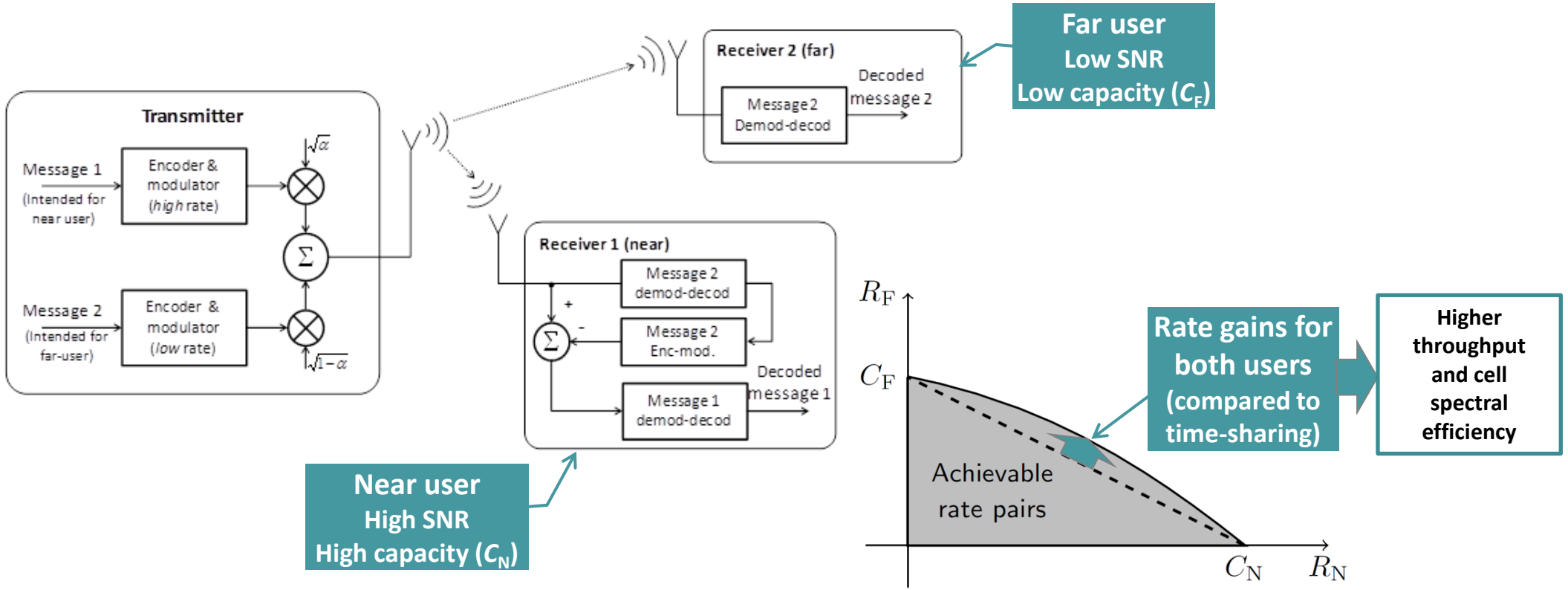
Huawei, HiSilicon

www.huawei.com

Motivation

- Small number of antennas at BS in most exiting systems e.g. 2 or 4 transmit antennas, especially for low frequency bands below 2.1GHz due to antenna size
- Most UEs only have 2 receiver antennas
- Issues of MU-MIMO with small number of antenna ports (2 or 4) in the exiting systems
  - Due to the limited CSI feedback in FDD and low-resolution beam, pairing-UE will introduce non-negligible inter-user interference, which will degrade the gain of MU-MIMO even negative gain may be obtained.
  - Power-level MA is not utilized in the traditional MU-MIMO, e.g. multi-user large-scale fading difference
  - MU-MIMO capacity improvement cannot only rely on the complicated receiver (e.g. SIC), due to UE power consumption and detection latency
- The advantages of using superposition coding to enhance multiple user access are:
  - Increased number of users served on the available time-frequency-space resources
  - Increased aggregate throughput on the available time-frequency-space resources

Superposition coding with near and far UE

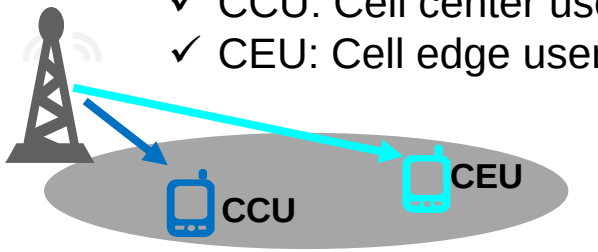


- Superposition coding can provide more capacity comparing to OFDMA

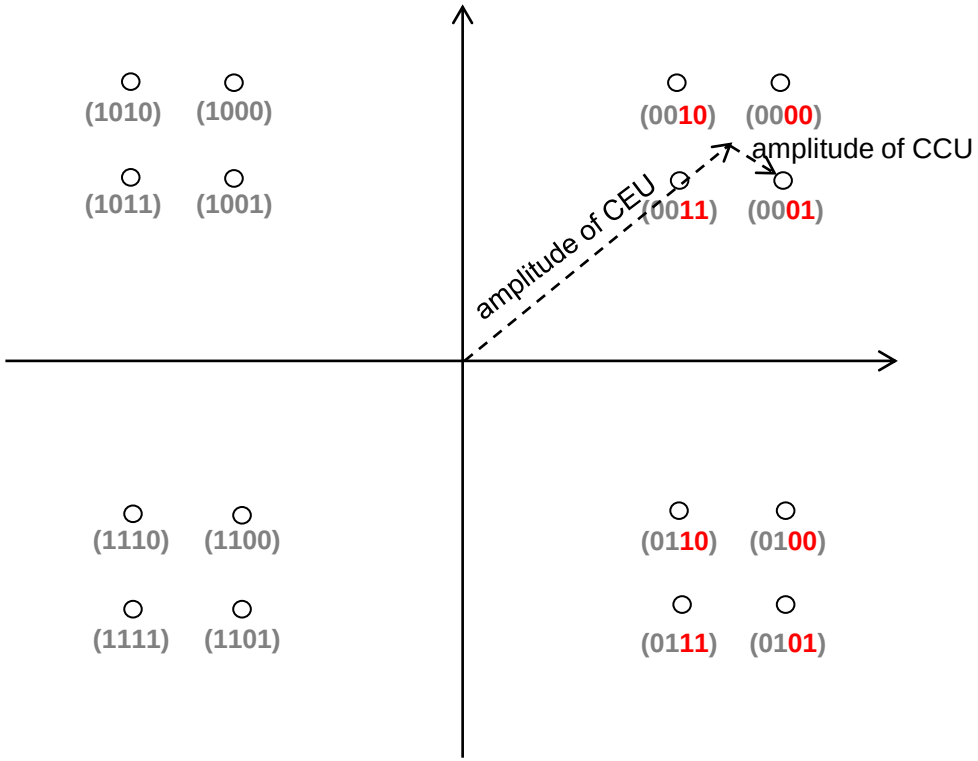
Possible solutions

- **Solution 1:** Linear superposition coding (usually called Non-Orthogonal Multiple Access, NOMA)
  - User multiplexing in the power domain
  - Based on linear superposition of coded modulated signals
  - Non-Orthogonal for far user and near user
- **Solution 2** Non-linear superposition coding (also called Semi-Orthogonal Multiple Access, SOMA)
  - User multiplexing on the bit-label domain of constellation symbols obtained by weighted superposition of conventional modulations. Gray mapping of bit labels to symbols.
  - Semi-Orthogonal for near user and non-orthogonal for far user.
- **Solution 3** Rate-Adaptive Constellation Expansion Multiple Access (RA-CEMA**)**
  - User multiplexing at the codeword level. Not based on linear superposition.
  - Based on rate-adaptive multiplexing of codewords.

Description of solution 1 (NOMA)



- ✓ CCU: Cell center user
- ✓ CEU: Cell edge user



Different bits allocated to different users

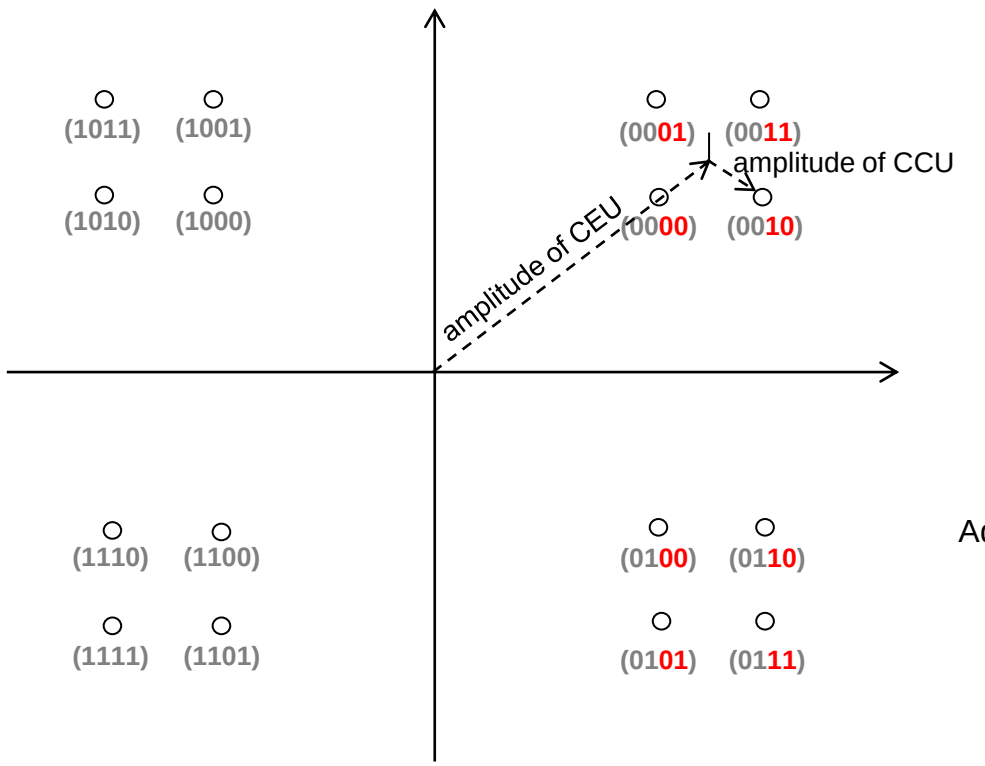
b0 b1 → CEU

b2 b3 → CCU

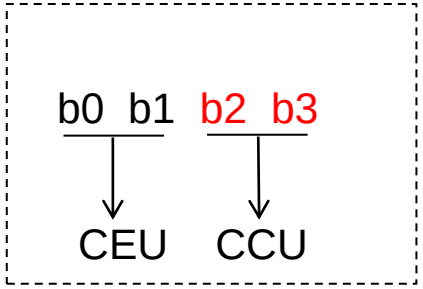
Adjacent points are not Gray-mapped

The transmitted signal is obtained by amplitude-weighted superposition of conventional modulations.

Description of solution 2 (SOMA)



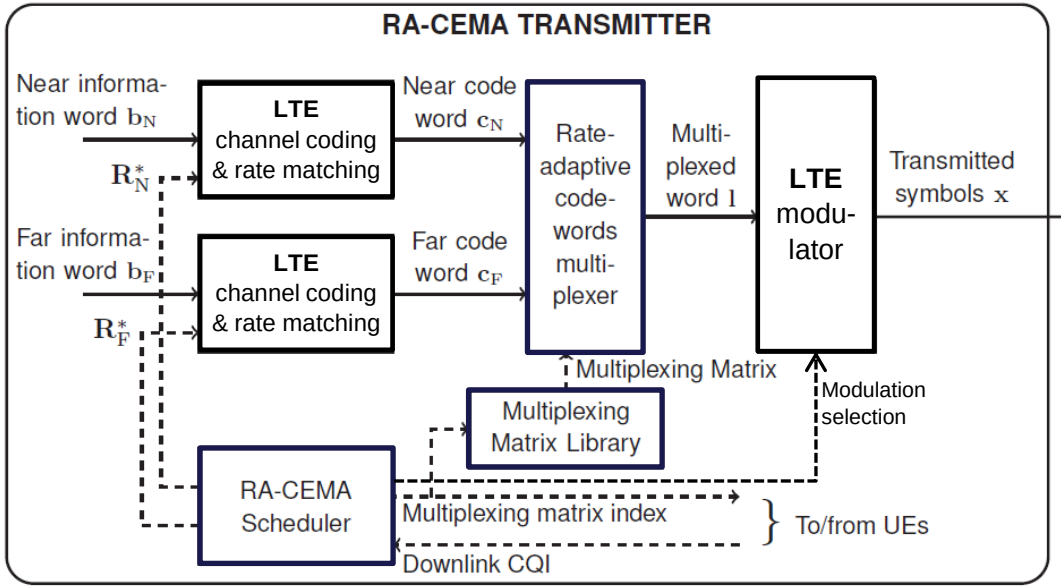
Different bits allocated to different users

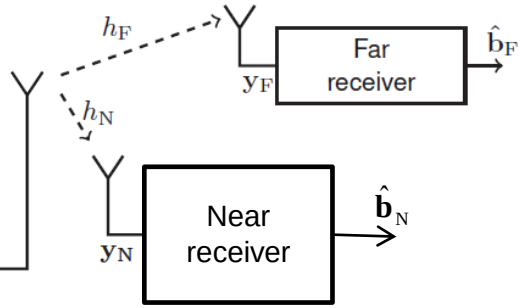


Adjacent points are Gray-mapped

- The same constellation symbols as in solution 1, but Gray mapping of bits to the constellation symbols.

Description of solution 3 (RA-CEMA)



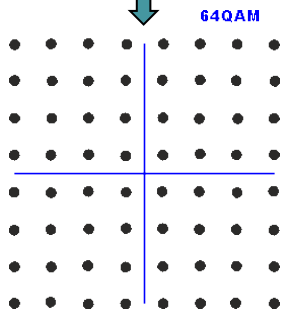


Multiplexing matrix is used to indicate how to map the near and far code words onto the constellation bit labels of the multiplexed word.

Example of multiplexing matrix:

columns = # available REs

$$M = \begin{bmatrix} F & \dots & F & F & \dots & F \\ F & \dots & F & F & \dots & F \\ F & \dots & F & N & \dots & N \\ N & \dots & N & N & \dots & N \\ N & \dots & N & N & \dots & N \\ N & \dots & N & N & \dots & N \end{bmatrix}$$



Codewords are multiplexed on constellation labels.

F: label bits assigned to the **far UE**

N: label bits assigned to the **near UE**

Each column is used to select a modulation symbol

Preliminary evaluation of the solutions

- Based on the outcome of the system simulation,, the system performance gain of solution 1/2 over SU-MIMO is about 12% for cell average and 20% cell edge respectively
- The simulation assumptions
  - Antenna configuration is 2x2 MIMO scenarios
  - The scenario is 3GPP Case-1
  - MMSE for far UE, ideal SIC for near UE
  - Traffic model is full buffer

Evaluation criteria

- DL Multi-user access system performance
  - Cell average and Cell edge user throughput
- DL Multi-user scheduling flexibility
  - Power allocation
  - UEs Pairing strategy (whether legacy UE can be paired)
  - Simple signaling
- Rx complexity
  - Whether CSI need to be enhanced
  - Whether baseline receiver(e.g. soft de-mapping) can be used
- Required signaling overhead
- Tx requirements (EVM)

Objectives

- Identify the candidate solutions for multi-user transmission schemes
- Evaluate the identified solutions including
  - System performance
  - Rx complexity
  - Scheduling flexibility
  - Signalling overhead
  - Tx requirements
- Identify the necessary standards effort for the candidate solutions, e.g.
  - Joint Tx/Rx optimization
  - CSI feedback
  - Network signalling
  - EVM specification