Document for: Discussion
Agenda Item: 10.1.1

Motivation for Rel-14 work on CSI and CQI enhancements for MIMO

Huawei, HiSilicon

Recall of FDD/TDD MIMO in LTE

FDD

Rel-8: TM4 for 2Tx

Baseline

Rel-8 TM5 for MU

No gain over 2Tx

Rel-10: TM9 for 4Tx/8TX

4TX:10% avg. SE gain

Rel-12: Double Codebook 4Tx, CQI report mode: PUSCH3-2

4Tx: Marginal SE gain
Approx 15% UPT gain (only for high load) over Rel-10 4Tx

TM7/8/9 TDD (non-CB)

25~30% SE gain over FDD 4Tx/8Tx

TDD 4Tx/8Tx (including MU BF) show good performance in commercial network

TDD

Rel-14

MIMO enhancement

FDD/TDD converged here (Around 40% SE gain for FDD; 10% SE gain for "ideal" TDD assuming multiple UL PA)

Views on proposed MIMO topics
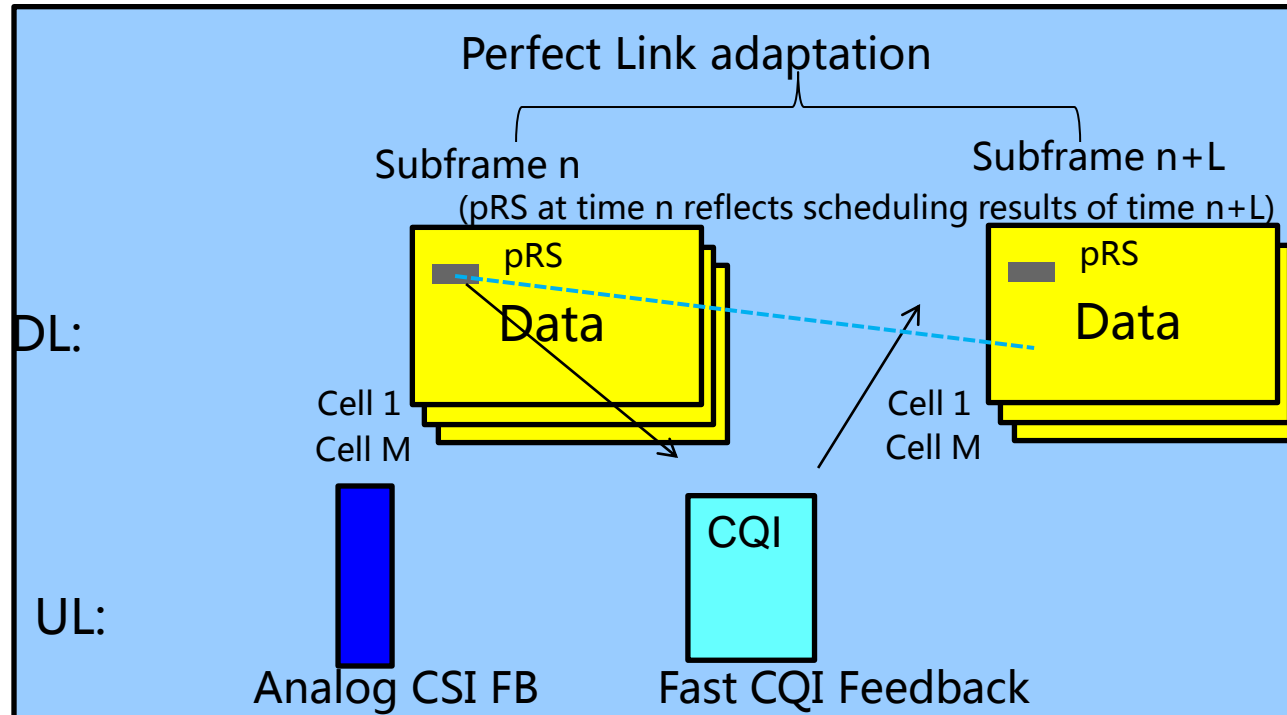
MIMO topics

- Enhance Non-precoded CSI-RS up to 32 ports, and associated codebook design

- Enhancement on CSI reporting for higher resolution CSI feedback including enhancement on interference measurement to support efficient multi-user transmissions

- Beamformed CSI-RS with improved efficiency

- Uplink DMRS enhancement to support more orthogonal partial overlapped DMRS

- SRS enhancement including 4/8 antennas switching and multi-shot transmission by one trigger

HW' View

- Beamformed CSI-RS approach yields similar performance as full port while allowing low UE complexity.
  Up to 32 antenna port CSI-RS and codebooks also takes out of a lot of time units in RAN1 (Rank 5~8 codebooks of Rel-13 are still not completed for up to 16 ports)

- Higher resolution scheme such as analog CSI feedback provides more accurate channel information for TDD and FDD
  NZP CSI-RS for both channel and interference measurement reflects the perfect CQI in MU scenario

- UE specific CSI-RS consume too much CSI-RS resource. More efficient beamformed CSI-RS transmission mechanism should be specified.

- More paired UEs in uplink gains more spectrum efficiency. DMRS design to support more partial overlapped UEs will release the scheduling limitation on eNB side

- The remaining issue of 4 antenna switch including periodic and periodic transmission should be further discussed in Rel.14.
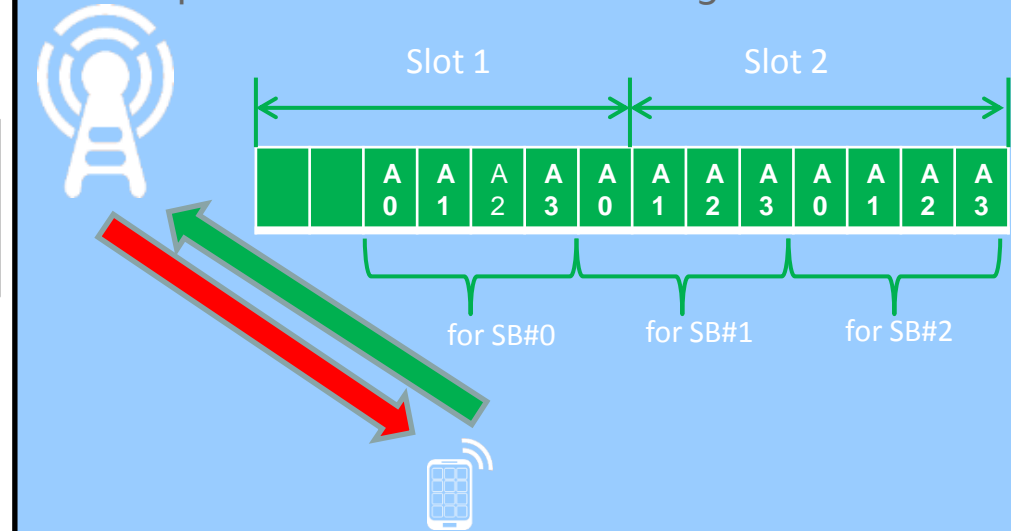
Enhancement on MIMO: overview

- New MIMO CSI/CQI feedback framework: FDD MIMO and TDD MIMO performance convergence
  - CSI acquisition: analog feedback for improved CSI resolution
  - CQI enhancement: CQI measurement reference signal based on pre-scheduling and aligned between cells, the CQI measurement is the same as the channel quality when data transmission occurs
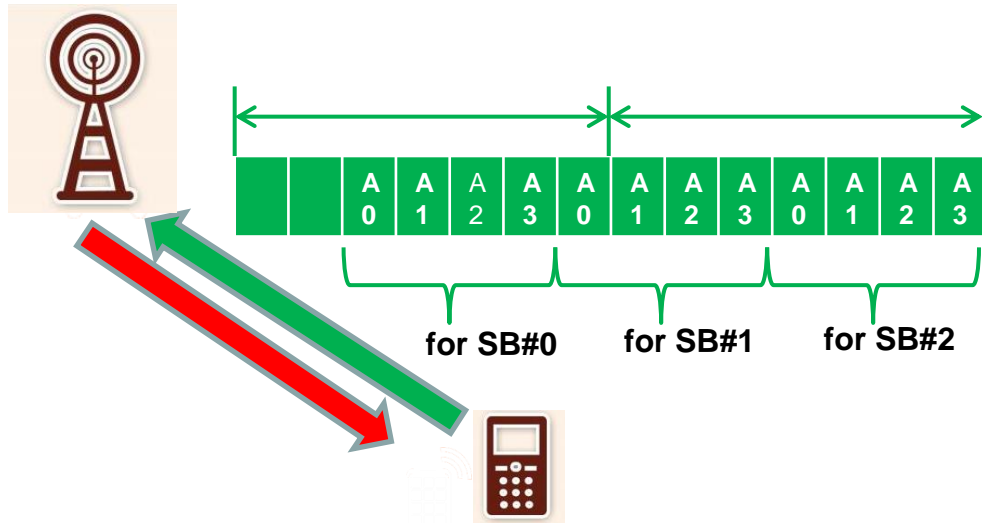   - Interference Measurement on NZP CSI-RS
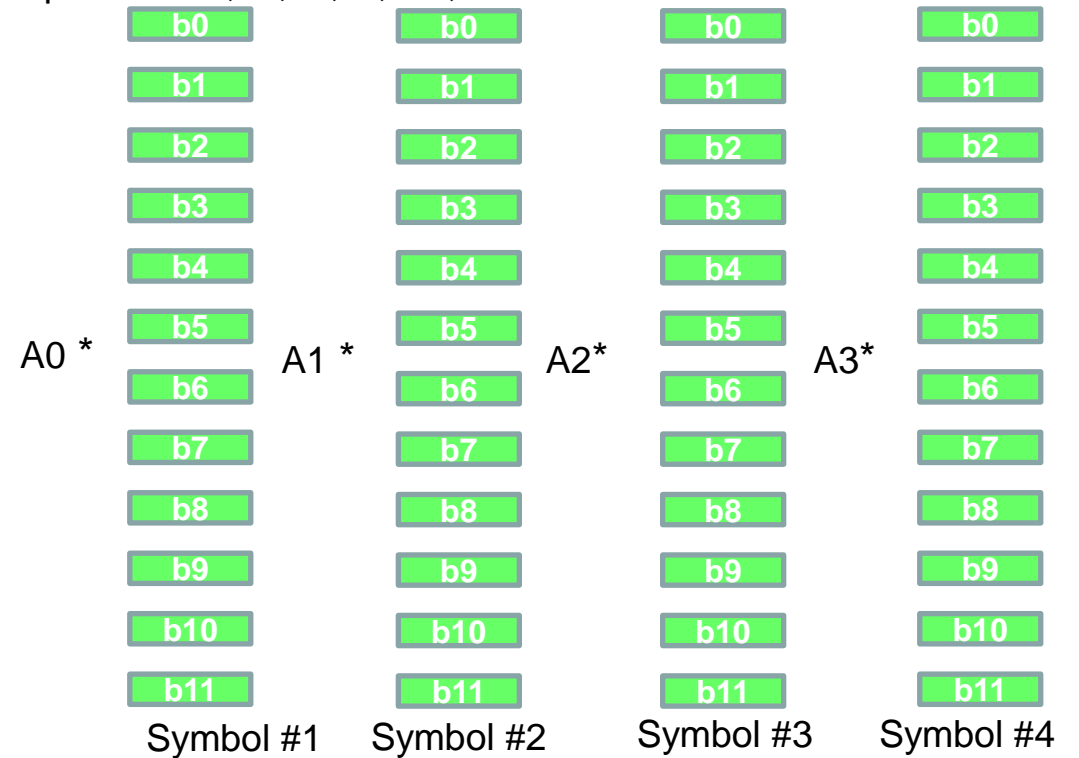   - Faster CQI feedback

"Analog" CSI for eMIMO

- **UE measure CSI-RS and acquire unquantized CSI (e.g. eigen-vectors)**
- **UE report quantized CQI and RI with respect to the unquantized (analog) CSI**
- **Unquantized CSI is "analog" modulated on new uplink RS (e.g. aRS) and transmitted by UE**
- **eNB detects/decodes quantized CQI and RI**
- **eNB measures aRS and acquires the analog CSI**

Transmitter (UE):
ZC sequence : b0,b1,b2,…,b11, modulated in 12 subcarriers of a RB

A0 *   A1 *   A2*   A3*

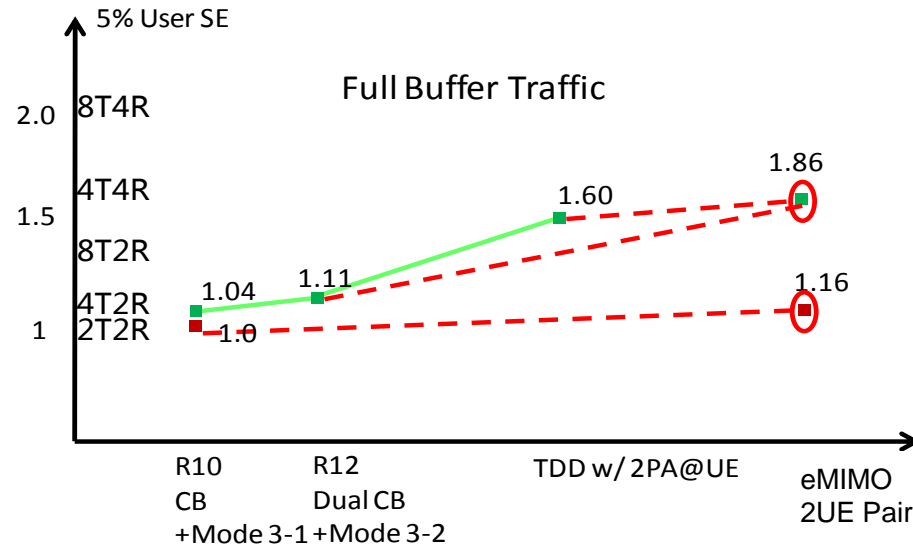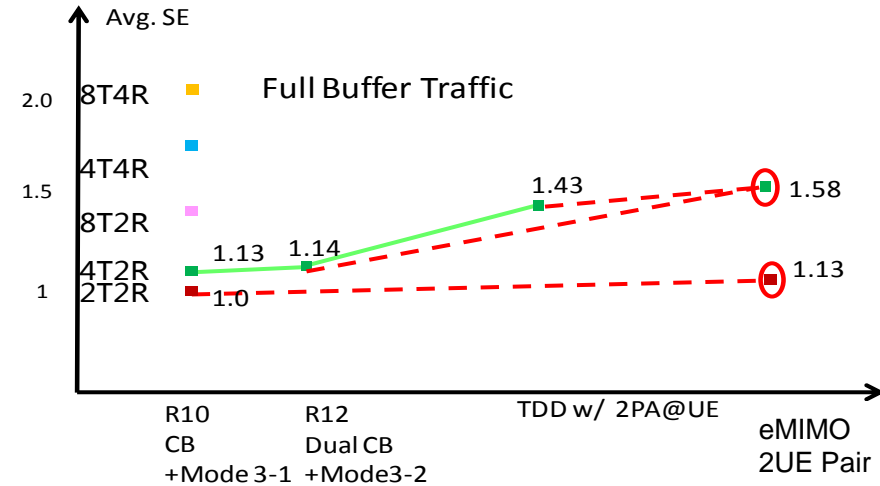Symbol #1   Symbol #2   Symbol #3   Symbol #4

for SB#0   for SB#1   for SB#2

Receiver (eNB):
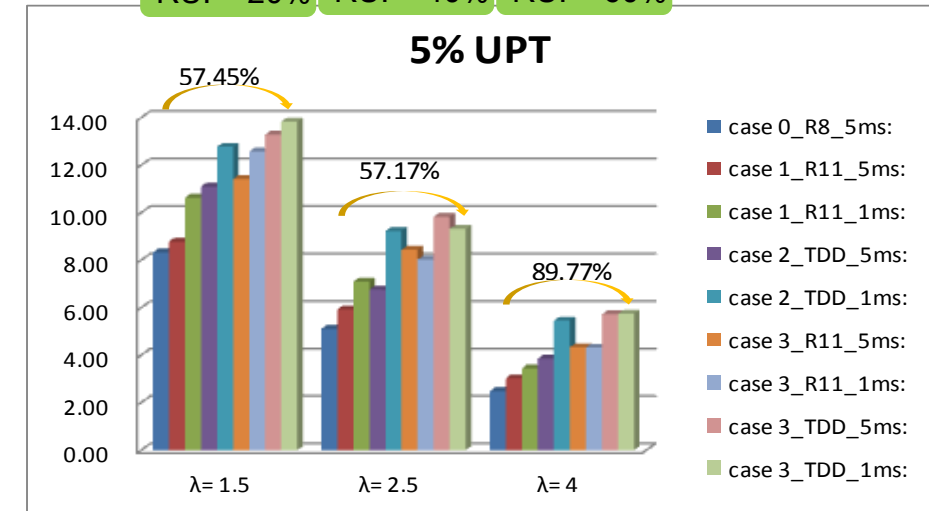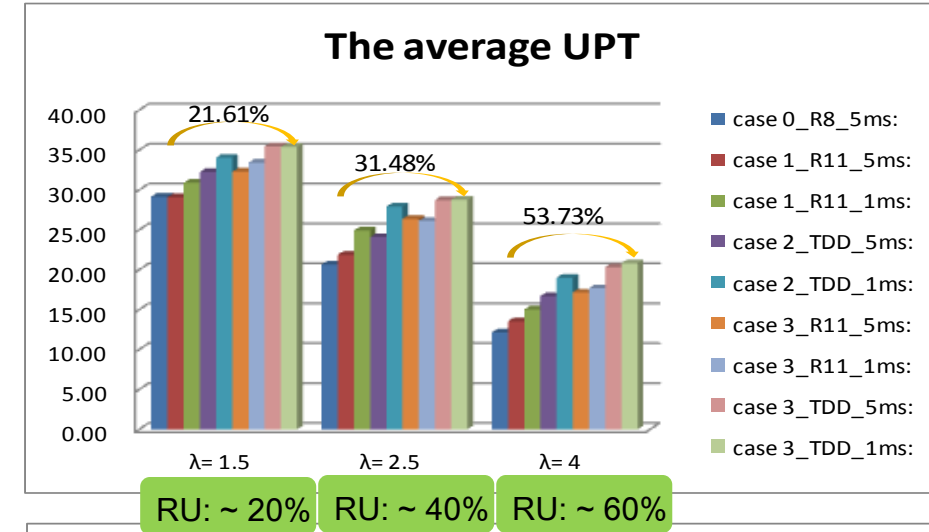① Channel estimation based on symbol 1
② Do the channel equalization for symbol 2/3/4
   −assuming channel is flat in the subframe
③ Estimate A2/A1, A3/A1, A4/A1

eMIMO performance evaluation

Full Buffer Traffic and Spectrum Efficiency:
4T eMIMO enhance 60% Avg. SE over 2T2R, 40% over 4T2R

Burst Traffic and UPT:
4T eMIMO enhance 20%~50% avg. UPT and 50%~90% 5% UPT

Conclusions

- **MIMO system performance is limited by inaccurate CSI measurement and feedback**

- **Key advanced technologies for MIMO enhancement should include**

  - Analog CSI feedback to improve precoding matrix feedback accuracy

  - CQI measured on pre-scheduled CSI-RS reflects the real channel quality experienced by PDSCH

  - Faster CQI feedback

- **Approve a WI for Rel-14 containing these objectives**