

[RAN1 led] Study on Next Generation CSI

[SI]

Motivation

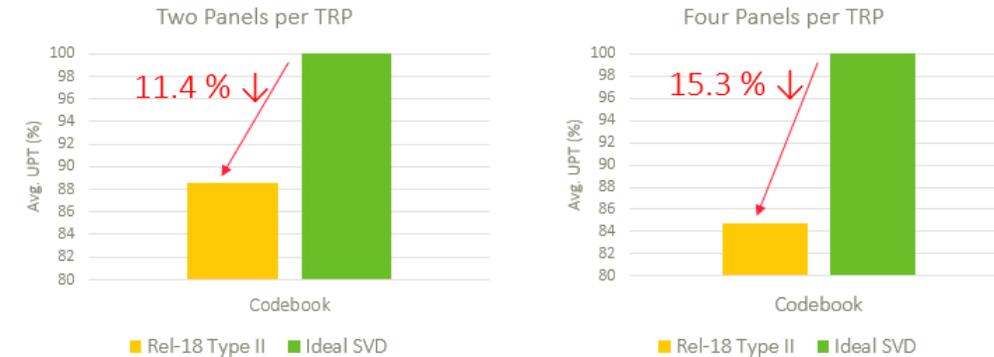
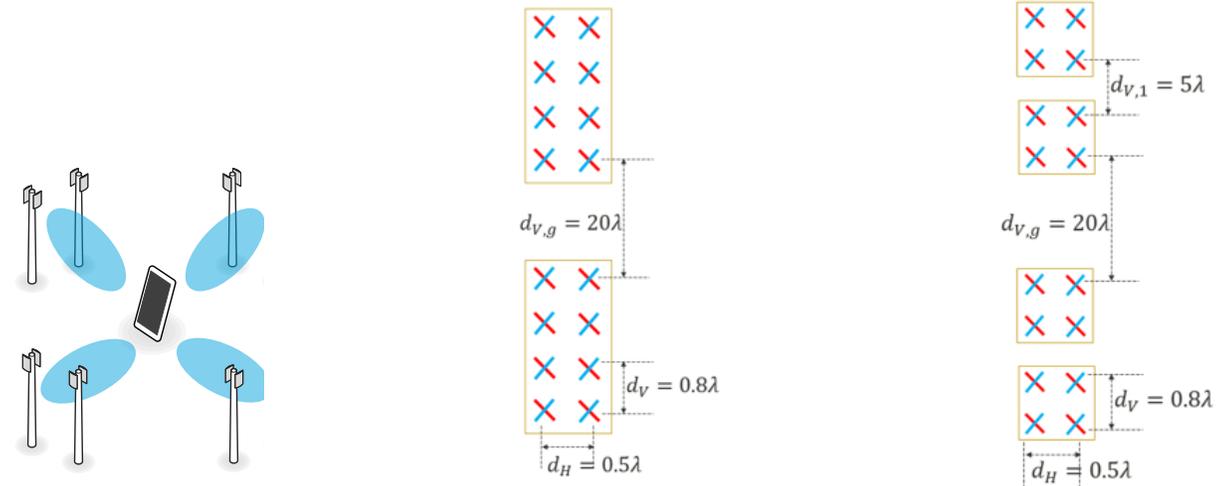
[1/3]

- Historically
 - CSI feedback from UE is in the form of precoder (PMI)
 - Compression over space (Rel-15), frequency(Rel-16), and time (Rel-18) domain
 - Does not support interference suppression in MU scenario well
 - Uniformly spaced antenna elements have been assumed in CSI codebook
- New CSI framework to address the following issues
 - Compression efficiency when # of effective paths getting smaller than # of Tx ports e.g., in upper Mid-band
 - Precoder not smooth across frequency subbands and time domain
 - Stronger channel sparsity in higher frequency bands
 - Uniformly spaced antenna elements assumption does not hold in real deployments e.g., massive MIMO scenarios, such as co-site multi-panel Tx and mTRP
 - High-resolution channel acquisition in sensing and positioning applications
 - Ranging, motion, positioning etc.
- STUDY: unified framework for scenario-dependent CSI feedback
 - Alternative basis for channel information compression
 - CSI itself is adaptive to scenarios

Motivation

Alternative basis for non-uniform antenna scenario

- DFT basis not efficient for synthesizing precoder if antennas placed non-uniformly
 - Study alternative basis other than DFT basis
 - Target for non-uniformly spaced panels or distributed TRPs (>4)
 - The basis can be UE-specific.
 - Looking for efficient way or codebook structure to signal basis
 - Example: eigenvector as new SD basis
 - Minimized overhead from linear combination coefficients
 - However, high overhead basis feedback due to lack of structure
 - Merit
 - Better compression efficiency due to UE-specific basis
 - Adaptive to different scenarios

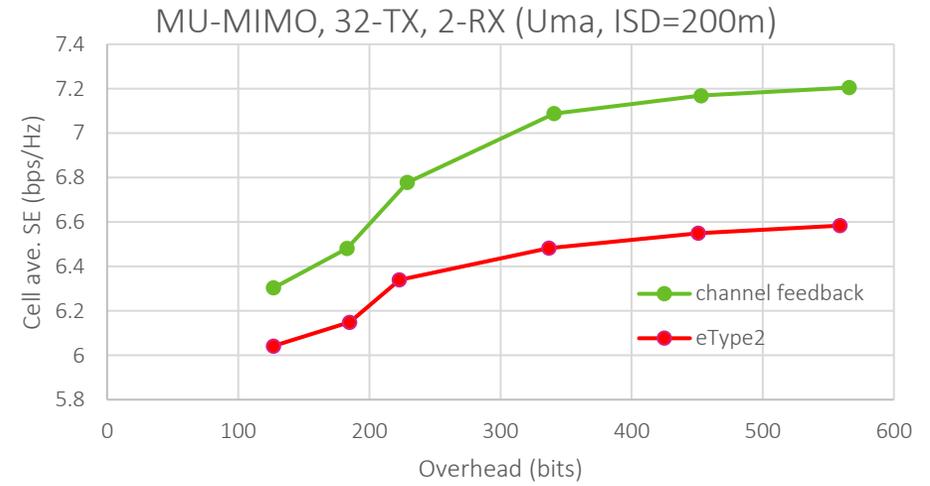
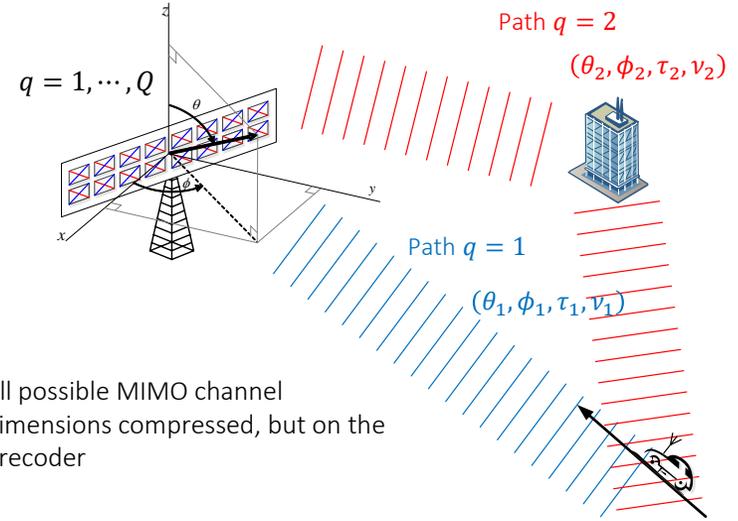


Impact of non-uniform antenna spacing on Rel-18 C-JT codebook performance

Motivation

Direct channel feedback

- Non-orthogonal basis parametrization in various domains
 - Strong multipath components are parameterized for feedback
- Merit
 - Better compression efficiency over eType-II
 - Early results show 5%~10% over eType-II in MU-MIMO
 - Still large room for improvement
 - Enable CSI interpolation/extrapolation in time/frequency/spatial domains
 - Straightforward exploitation of channel sparsity
 - Flexible TRP selection in mTRP C-JT without additional UE complexity
 - Pilot/feedback overhead not in direct proportion to the gNB array size
 - Other usage such as sensing and positioning



Proposal

SA/CT Dependency: No

Study new CSI tailored to scenarios and operating environment

- **Facilitating network densification (ultra-dense with low-cost TRPs i.e. w/ fewer antenna ports)**
- **Enabling massive MIMO without proportionally scaling up CSI acquisition overhead**

Objective I: Study and evaluate alternative basis other than DFT basis for spatial/frequency/time domain compression [RAN1]

- Study, evaluate, and identify candidate basis, and applicable scenarios with following assumption
 - mTRP scenario with maximum number of cooperating TRP larger than 4
 - multi-panel scenario
- Study signaling/compression method for feeding back the identified candidate basis

Objective II: Study and evaluate direct feedback of parameterized MIMO channel [RAN1]

- The study includes the following scenarios
 - Baseline evaluation to consider a feedback mechanism not compliant with NR Type-II based codebook parameter sets
 - Advanced evaluation to consider a feedback mechanism compliant with NR Type-II based codebook parameter sets
 - Evaluation scenario to include both SU-/MU-MIMO cases
- The Study includes the following aspects
 - Compression/signaling method in various domains, including spatial/delay/Doppler/receiver antenna domains
 - Pilot/reporting overhead
 - Identify use cases for utilizing fed back parameters from all or a subset of compression domains, including DL power control across spatial layers

Expected TU

| | 2024 | | | | | | | | | | | | 2025 [Calendar TBC at the time of writing] | | | | | | | | | | | | 2026 | | |
|------------|------------|-----|-----|------------|-----|-----|------------|-----|-----|------------|-----|-----|--|-----|-----|------------|-----|-----|------------|-----|-----|------------|-----|-----|------------|-----|-----|
| | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Q1 | | |
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar |
| RAN | 103 | | | 104 | | | 105 | | | 106 | | | 107 | | | 108 | | | 109 | | | 110 | | | 111 | | |
| R1 | 115b | 116 | | 116b | 117 | | | 118 | | 118b | 119 | | 119b | 120 | | 120b | 121 | | | 122 | | 122b | 123 | | 123b | 124 | |
| R2 | 124b | 125 | | 125b | 126 | | | 127 | | 127b | 128 | | 128b | 129 | | 129b | 130 | | | 131 | | 131b | 132 | | | | |
| R3 | 122b | 123 | | 123b | 124 | | | 125 | | 125b | 126 | | 126b | 127 | | 127b | 128 | | | 129 | | 129b | 130 | | | | |
| R4 | 109b | 110 | | 110b | 111 | | | 112 | | 112b | 113 | | 113b | 114 | | 114b | 115 | | | 116 | | 116b | 117 | | 117b | 118 | |
| R1 | | 1 | | 1 | 1 | | | 1 | | 1 | 1 | | | 1 | | 1 | 1 | | | | | | | | | | |
| R2 | | | | N/A | N/A | | | N/A | | N/A | N/A | | | N/A | | N/A | N/A | | | N/A | | | | | | | |
| R3 | | | | N/A | N/A | | | N/A | | N/A | N/A | | | N/A | | N/A | N/A | | | N/A | | | | | | | |
| R4 RD | | | | N/A | N/A | | | N/A | | N/A | N/A | | | N/A | | N/A | N/A | | | N/A | | | | | | | |
| R4 RF | | | | N/A | N/A | | | N/A | | N/A | N/A | | | N/A | | N/A | N/A | | | N/A | | | | | | | |

Study TU
Feature TU



Thank you!