

**3GPP TSG RAN Rel-19 workshop
Taipei, June 15-16, 2023**

RWS-230057

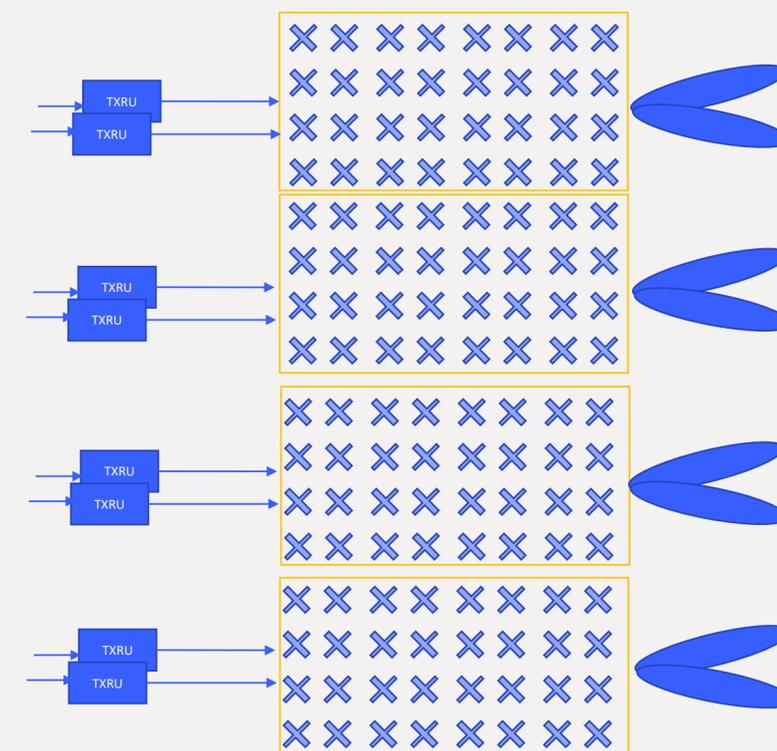
Agenda Item: 5
Source: vivo
Title: Views on further MIMO enhancements in Rel-19
Document for: Discussion

- **Enhanced Massive MIMO**
- Enhanced multi-TRP/cell
- Enhanced CSI prediction
- Enhanced UL transmission

Enhanced Massive MIMO

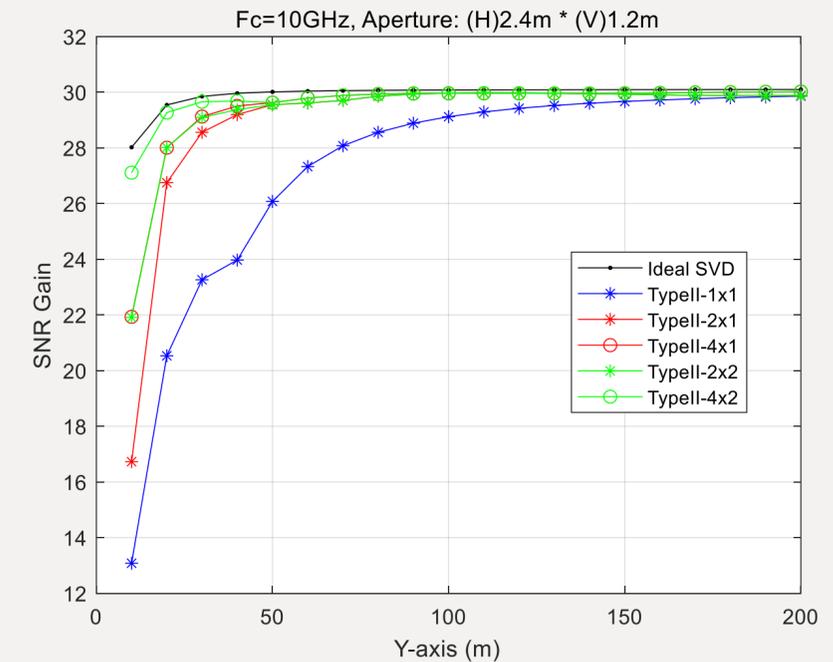
Motivation

- As the global penetration of 5G networks increases, data consumption steadily grows, further enhancement of Massive MIMO technology becomes inevitable
- With increased demand of data volume, massive MIMO deployment in higher spectrum can alleviate operators' need
 - Large antenna array can tackle coverage in higher frequency band, however narrower beams could lead to excessive overhead
 - Efficient operation of massive array based MIMO system is crucial
 - Relatively large antenna array compared to operating wavelength (λ) could cause near-field effect
 - Simple extension of current CSI framework could cause large overhead and latency in beam based operation
 - Advancement in antenna technologies, supporting various antenna structures of large massive antenna array, e.g. fully connected, analog/digital hybrid, multi-panel design etc.

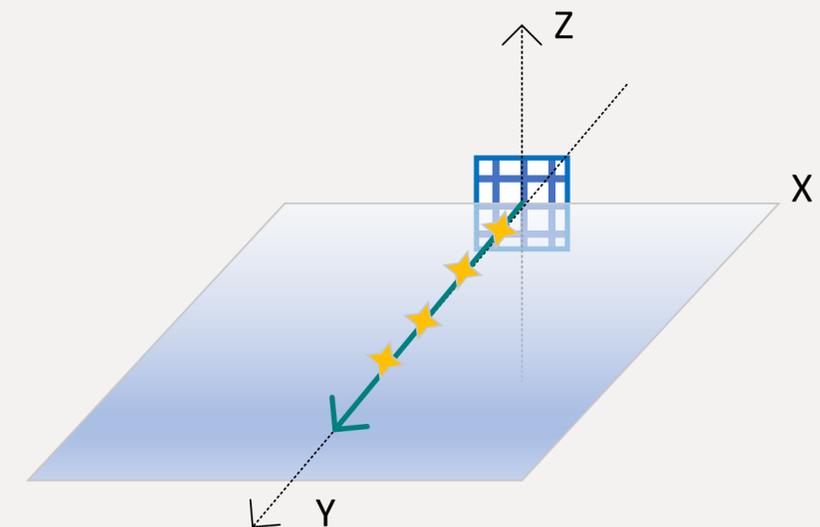


Enhanced Massive MIMO

- Study channel model for frequency range above FR1 considering both planar and spherical waves
- Study potential solutions including CSI enhancement, BM enhancement for enhanced massive antenna array deployment
 - Antenna elements are divided into multiple sub-groups forming multiple logical panels for both planar and spherical wave transmission
 - Simultaneous beam sweeping from multiple logical panels, potential BM enhancement
 - CSI feedback enhancement for multiple logical panels
 - Consider potential solutions for future proof designs including spherical wave transmission



Number of two dimensional sub-panels: {1, 2, 4, 8}



CONTENT

- Enhanced Massive MIMO
- **Enhanced multi-TRP/cell**
- Enhanced CSI prediction
- Enhanced UL transmission

Enhanced multi-TRP/cell

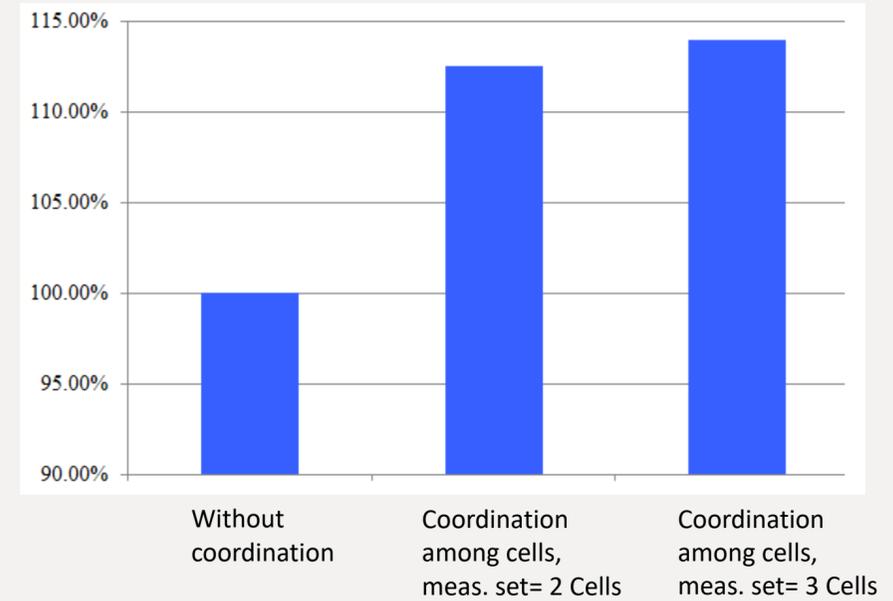
Motivation

- Multi TRP based network operation is supported in NR
 - Rel-15 supports DPS by implementation
 - Rel-16 supports SDCl and MDCl based multi TRP operation for PDSCH
 - Rel-17 supports further enhancement of multi TRP including inter-cell operation, beam indication from non-serving cell, NCJT CSI feedback, TRP-specific BFR
 - Rel-18 supports CJT CSI feedback, unified TCl extension for MTRP, also supports L1/L2 signaling based cell switching
- Various multi-TRP schemes are independently configured with independent UE capabilities, hence network cannot exploit the UE capability to full extent, for example:
 - NCJT is supported for Type I codebook only
 - CSI feedback is not optimal for SFN, FDM, TDM schemes
 - CJT cluster is smaller which leads to frequent RRC reconfiguration
 - Inter-cell CSI reporting is not supported
 - Inter-cell SRS transmission is not supported
- In dense deployment, inter-cell interference could become a problem

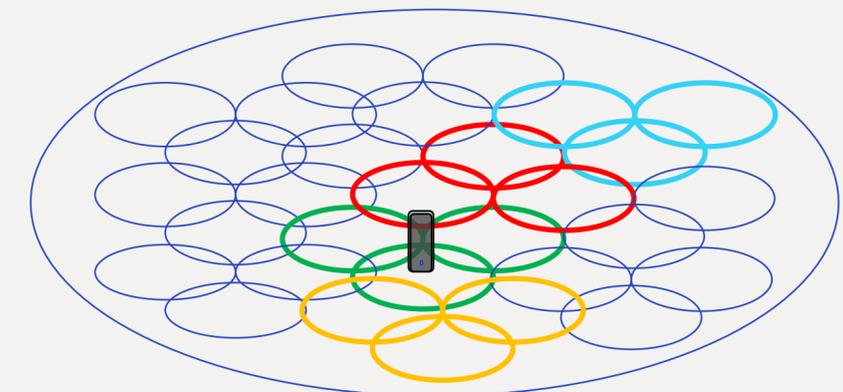
Enhanced multi-TRP/cell

- Enhancement for inter-cell operation
 - Study CSI reporting for candidate cell(s) including relevant RAN2 enhancement, multi TRP with LTM
 - Study techniques for interference management/coordination including potential enhancement on interference measurement for PDSCH demodulation and CSI feedback
 - Inter-cell SRS configuration/transmission
- Support of large scale distributed MIMO deployment
 - Study codebook extension for NCJT, i.e., Type II-based codebook for NCJT
 - Study CSI feedback supporting combined NCJT hypothesis and CJT hypothesis
 - Taking NCJT/CJT framework as basis, study more dynamic RS configuration, scheduling, interference mitigation etc

Cell mean SE comparison of different size of measurement set for interference management, InH, 16T2R, max rank = 2, measurement set =2/3 Cells, cell selection by UE for PMI reporting



UE reports CSI for NCJT hypothesis and CJT hypothesis



- CJT cluster
- CJT cluster
- CJT cluster
- CJT cluster

CONTENT

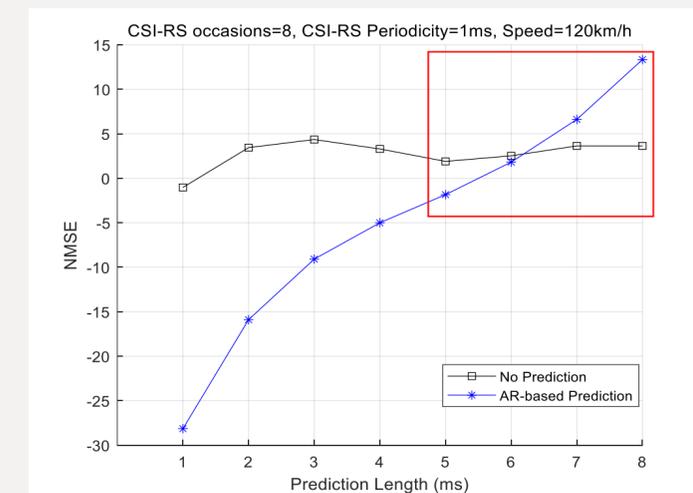
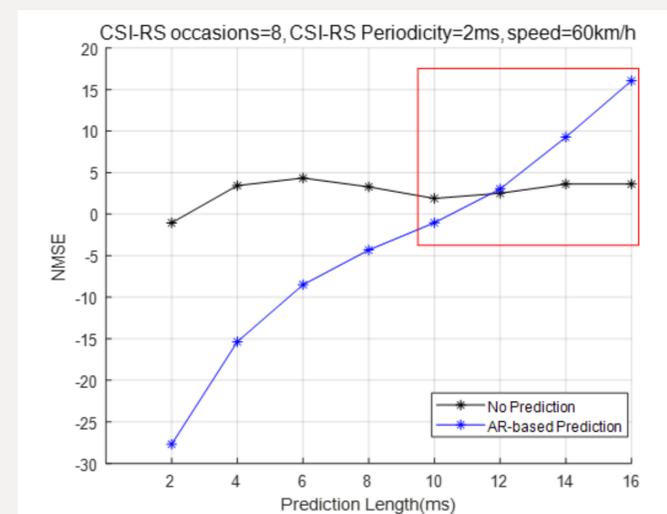
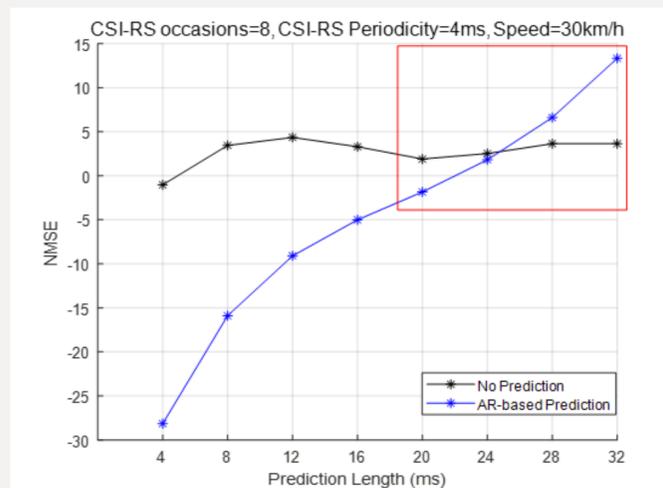
- Enhanced Massive MIMO
- Enhanced multi-TRP/cell
- **Enhanced CSI prediction**
- Enhanced UL transmission

Enhanced CSI prediction

Motivation

Background

- **Issue 1):** UE-side CSI prediction based on pure PMI reporting is being specified in Rel-18, thus further gNB-side CSI prediction enhancement for SRS based DL CSI acquisition can be considered in TDD scenario in Rel-19
- **Issue 2):** Performance of UE-side CSI prediction depends on many aspects (e.g., UE speed, channel time-variation, UE algorithm, etc.). Prediction performance/reliability varies dynamically along with these aspects.
- **Issue 3):** Rel-18 supports basic features of CSI prediction with reasonable performance for moderate speed, e.g., 30km/h. However, performance degrades significantly for higher UE speed (see the three figures below)

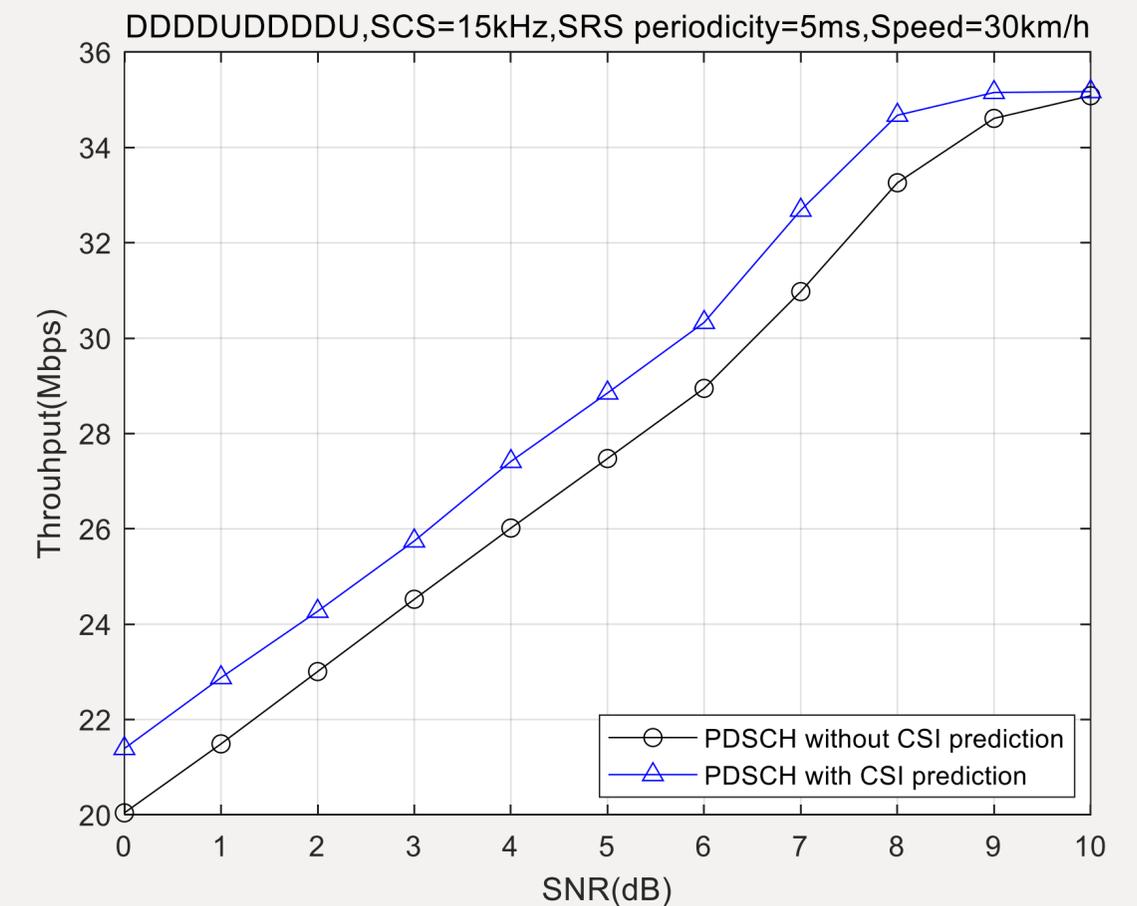


Simulation results for Rel-18 Type II Doppler under 30, 60 and 120 km/h

Enhanced CSI prediction

Potential enhancement

- **Issue 1):** gNB-side CSI prediction for reciprocity based DL precoding in TDD scenario
 - Symbol-level CSI prediction based on SRS repetition
 - Enhancement on SRS, e.g., SRS capacity enhancement and/or overhead reduction
 - Doppler information reported for multiple paths to assist CSI prediction for DL precoding
- **Issue 2):** Performance monitoring for UE-side CSI prediction to ensure the reliability
 - UE reporting of performance metrics to enable gNB monitoring of the prediction performance
- **Issue 3):** UE-side CSI prediction enhancement for higher UE speed, e.g., up to 120km/h
 - Enhanced CSI-RS and/or CSI configurations to capture larger Doppler spread



Simulation results for CSI prediction based on SRS

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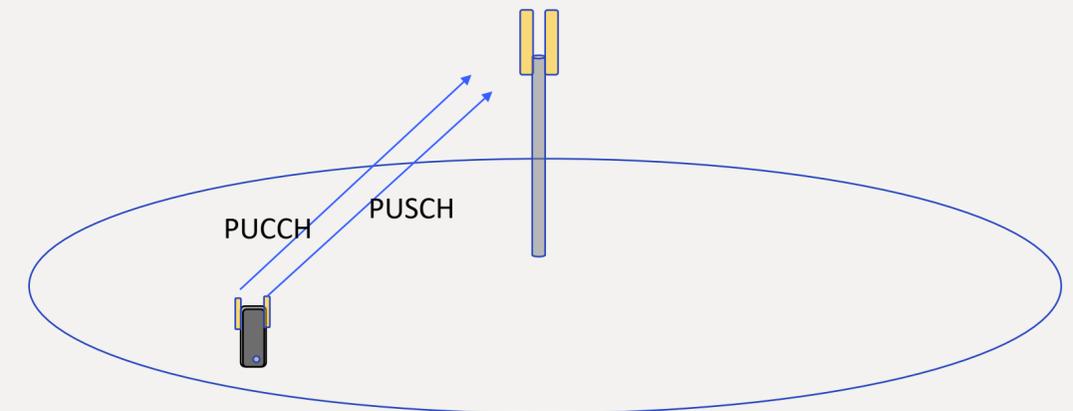
Enhanced UL transmission

Motivation

- UL performance has always been the bottleneck in network deployment
- Exploiting UE PAs can bring benefits not only in terms of coverage but also cell-edge throughput
 - LTE supports up to 4 layers transmission in uplink
 - RAN4 requirement on MPR is at least 2dB larger for CP-OFDM than for DFT-s-OFDM waveform, UE PA efficiency is better with DFT-s-OFDM waveform
- Dynamic antenna switching in UL is beneficial to tackle dynamic changes in the channel including blockage, fast fading etc.
- Rel-18 supports simultaneous UL transmission for PUSCH+PUSCH and PUCCH+PUCCH, however simultaneous transmission of PUCCH and PUSCH is not support

Enhanced UL transmission

- Support of rank>1 for DFT-s-OFDM waveform
 - e.g. for non-coherent codebook based transmission
- Closed loop PUSCH antenna selection for UL Codebook based operation
 - e.g. for UE with more Rx antenna and 1TX chain support configuring more SRS resources in a set for usage "codebook"
- Support UL performance enhancement for high speed scenario, e.g. (semi-) open loop precoding, time/frequency domain precoder cycling
- Support of PUCCH+PUSCH simultaneous transmission (for multi Tx UE)
- Study, if needed specify, potential enhancement on interference measurement for PUSCH demodulation



UE simultaneously transmits PUSCH and PUCCH from different antennas