

3GPP RAN Rel-19 Workshop

RWS-230183

June 15th-16th, 2023, Taipei, Taiwan

Agenda Item: 5

NR MIMO

Qualcomm Incorporated

NR MIMO Evolution

RAN1/RAN2/RAN4 | Rel-19 WI

Description

- MIMO is likely to keep evolving in Rel-19 in the area of beam mgmt., mTRP, UL MIMO, modulation and reference signals
- Enhancing link adaptation is a major opportunity for spectral efficiency improvement

Objectives

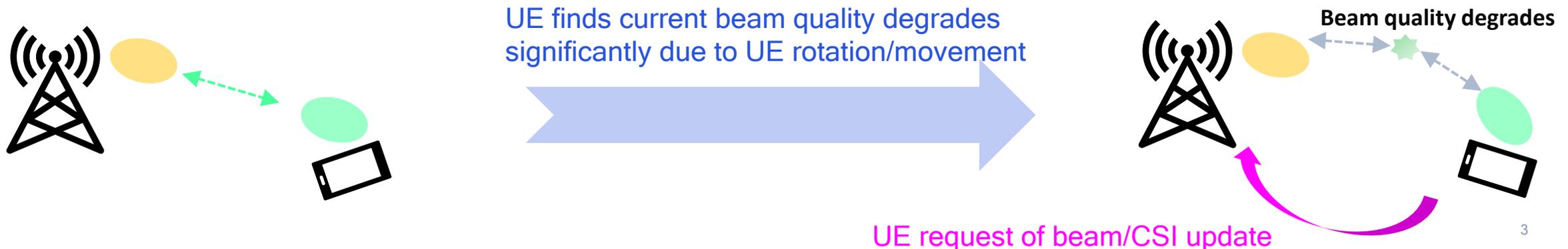
- Beam mgmt. enhancements
 - Group-based L1-SINR report and beam selection to reflect cross-beam interference per beam pairs;
 - UE initiated beam/CSF update
- PTRS rate matching for mDCI mTRP
- Modulation and reference signal enhancements
 - Introduce new MCSs for 1K QAM for UL
- Link adaptation enhancements
 - Quantify the gains associated with coding rate adaptation using rate-less coding and HARQ combining
 - Specify Soft NACK feedback (gap to capacity) for optimizing the number of re-transmissions
 - Specify new RVs to allow fine grained re-transmissions

Related topics

- Rel-15/-16/-17/-18 MIMO WI

UE Initiated BM/CSI Update

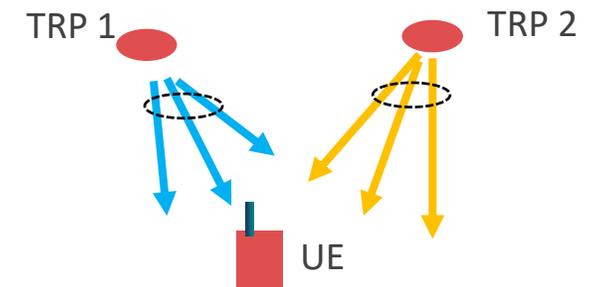
- **Motivation:** In existing CSI framework, beam/CSI report is fully managed by gNB. However, gNB may not know the beam and corresponding channel has changed significantly for timely beam refinement and CSI update
 - E.g. gNB may not know that link quality, UE position, speed, orientation has changed significantly, and hence corresponding beam quality degrades significantly since last beam refinement
- **Proposal:** UE initiated BM/CSI update via event-triggered request or report
 - For event-triggered request, to reduce beam measurement overhead & latency, UE may dynamically request BM/CSI update when the best gNB or UE beam and corresponding CSI are likely to change
 - For example, if UE finds current beam quality degrades significantly, e.g. via PDSCH DMRS, the UE can request beam/CSI measurement for gNB beam update, UE beam refinement, and/or corresponding CSI update
 - The request can be sent via one or multiple UCI bits, e.g. together with A/N info, or via MAC-CE
 - For event-triggered report, UE only sends beam report under triggering condition, e.g. best gNB beam changes



L1-SINR Based Beam Group Report

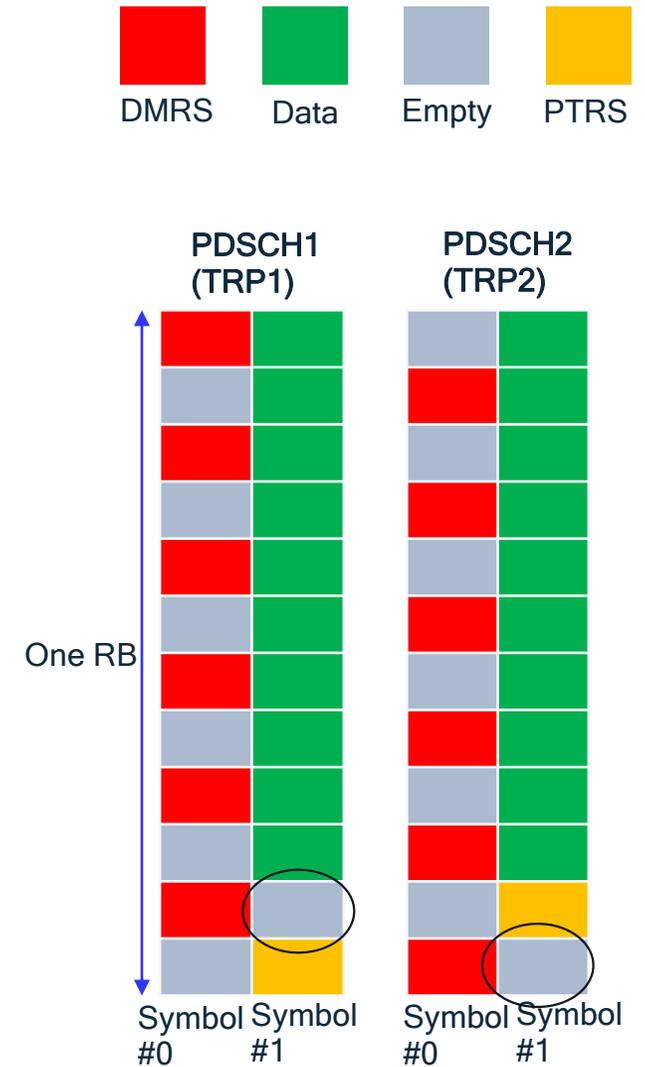
- **Motivation:** In R17 group-based beam report, the reported metric only considers L1-RSRP, which does not reflect the cross-beam interference per beam pair
 - As shown in R1-2202125, L1-SINR based beam group selection can achieve substantial UE throughput gain over L1-RSRP based beam group selection.
 - 5%ile gain: 51.9%
 - 50%ile gain: 56.7%
 - 95%ile gain: 11.3%
- **Proposal:** L1-SINR based beam group report
 - The beam group selection is based on L1-SINR, which can also be reported. gNB configures CMR+IMR to measure L1-SINR, which captures cross-beam interference
 - Same as legacy L1-RSRP based beam group report, the exact reported beam group(s) should still be up to UE

	5% Percentile - L1-RSRP	5% Percentile - L1-SINR	50% Percentile - L1-RSRP	50% Percentile - L1-SINR	95% Percentile - L1-RSRP	95% Percentile - L1-SINR
UE Tput (Mbps)	2.3853	3.6236	10.2755	16.1090	24.5854	27.3659
UE Tput Gain [%]	NA	51.9%	NA	56.7%	NA	11.3%



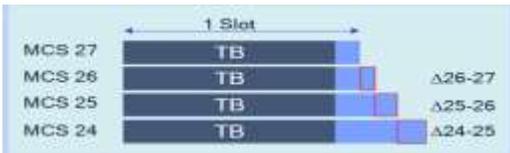
PTRS rate matching for mDCI mTRP

- **Motivation:** For two overlapping PDSCHs in mDCI based mTRP:
 - Rel-16 already ensures no collision among: DMRS-DMRS, DMRS-data, and data-DMRS
 - However, PTRS of one PDSCH overlaps with data of another PDSCH
 - This may degrade the performance in FR2 especially for higher MCS: The need for clean PTRS becomes important to match the performance of DMRS channel estimation
 - Indicating rate matching pattern for PTRS (of another overlapping PDSCH) can address the issue at the cost of signaling overhead
 - Trade-off between flexibility and signaling overhead can be considered
 - For ideal backhaul, there is no issue at the network side for indicating such info. For non-ideal backhaul, TRPs can coordinate semi-statically (similar to Rel-16 restrictions on DMRS-DMRS and DMRS-data collision)
- **Proposal:** Specify enhancements to enable data REs of one PDSCH to be rate matched around PTRS of another PDSCH for mDCI based mTRP at least for fully-overlapping PDSCHs



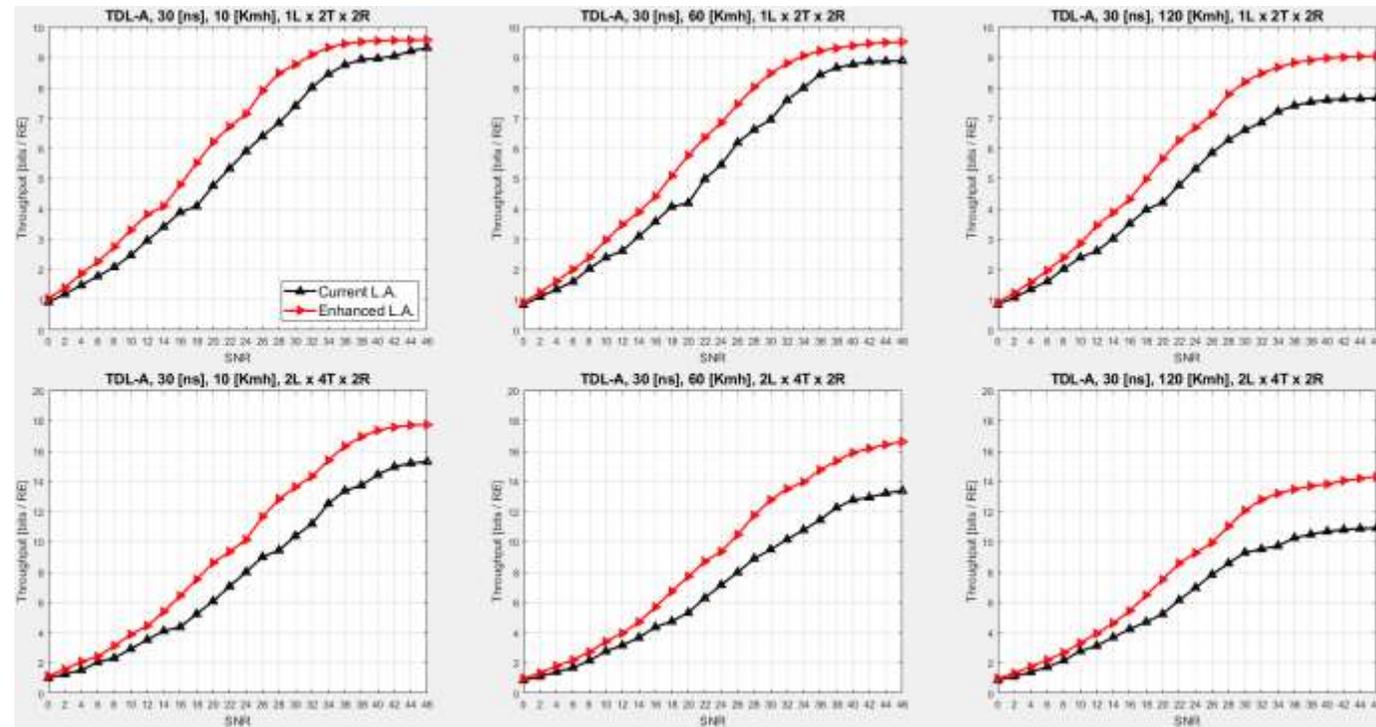
Link Adaptation - Coding rate adaptation enhancements

- **Motivation:** Current coding rate adaptation perform far from optimal and far from the channel capacity
 - An enhanced coding approach can closely track the channel capacity, even for highly mobile terminals, achieving significant gains over current scheme
- **Proposal:** Enhanced LA based-on rate-less coding through HARQ combining
 - Method
 - Start from overestimated MCS
 - Reduce rate by multiple re-Tx until successful decoding
 - Utilizing Soft NACK for optimizing re-Tx size & latency



- Significant gains over current scheme

	With interleaver	w/o interleaver
1L, 10 [Km/h]	6	5.5
1L, 60 [Km/h]	6	5
1L, 120 [Km/h]	8	6.5-7
2L, 10 [Km/h]	7.25	6.5
2L, 60 [Km/h]	15	13.5-14
2L, 120 [Km/h]	Inf	Inf



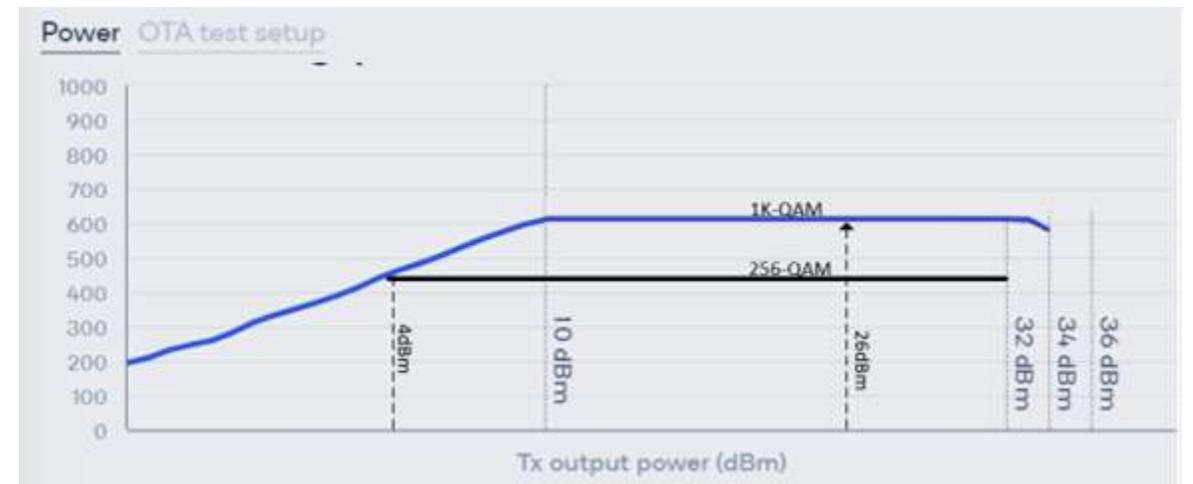
So... Performance gains [dB], @ 70% maximal throughput

1K-QAM for UL

- **Motivation:**
 - Increases spectral efficiency
 - Latest 5G field trial indicated high usage of 256QAM
 - Statistics - for UL
 - Implies good probability of usage of 1K-QAM
- **Proposal:** introduce 1K-QAM for UL

5G Modulation Usage Statistics, Feb 2023 - Global			
Waveform	Modulation scheme	Record Count	Usage
CP-OFDM	QPSK	23230178	22%
CP-OFDM	16_QAM	14022098	13%
CP-OFDM	64_QAM	32882800	31%
CP-OFDM	256_QAM	36917292	34%

Measured Modulation scheme usage Feb 2023





Thank you

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