3GPP TSG RAN#101
Bangalore, September 11-15, 2023

RP-232021

Scope of MIMO enhancements in Rel-19

Agenda: 8A.2.2
Source: Samsung
Document for : Discussion and decision

Overview

- Scope of Rel-19 MIMO Evolution: consideration and moving forward
- Recap of enhancement areas proposed in RWS-230207 (Samsung) and prioritization
- Other potentially beneficial enhancement areas

Rel-19 MIMO scope: consideration and moving forward

- Prioritization based on commercial needs while maintaining future-proof mindset (cf. guidance from RAN Chair):
  - Facilitate later-stage enhancement in, e.g. Rel-20 NR, especially for new areas
- Highly focused (specific and limited) objective description for each area
  - Avoid/minimize scope ambiguity and expansion during WI phase (reasonably well-executed in Rel-17/18)
  - Build on legacy spec/features as much as possible
- Avoid overlap with other potential Rel-19 WIs
  - Examples: NES, Mobility, AI/ML, coverage enhancement
  - Focus on MIMO-specific core features (tools)

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Recap - Rel-19 MIMO enhancement areas in RWS-230207

Driving factors: high network capacity via expanded M-TRP deployment, outage-free low overhead/latency FR2 operation for mobile, ultra-high UL data rate and coverage for FWA/CPE

MIMO enhancement areas proposed in [RWS-230207] (Samsung)

- {M-TRP} UE-assisted inter-TRP calibration measurement and reporting to circumvent impairments due to non-ideal backhaul and synchronization – both for TDD and FDD, targeting FR1
- {M-TRP} Extending Rel-18 Type-II CJT codebook for high/medium-speed with UE-side prediction – targeting FR1
- {FR2} UE-initiated/event-based beam reporting and switching – targeting FR2, based on Rel-17/18 unified TCI (*)
- {FR2} Predictive beam indication and reporting – targeting FR2, based on Rel-17/18 unified TCI (*)
- {UL FWA} High-resolution and frequency-selective UL precoding – targeting FR1 and FWA/CPE use case
- Miscellaneous: 2TA support for S-DCI M-TRP, UL-based BFR – targeting FR2

(*) Also discussed in, e.g. Rel-18 AI/ML SI and/or Rel-18 Mobility

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Multi-TRP enhancement

UE-assisted inter-TRP calibration reporting:

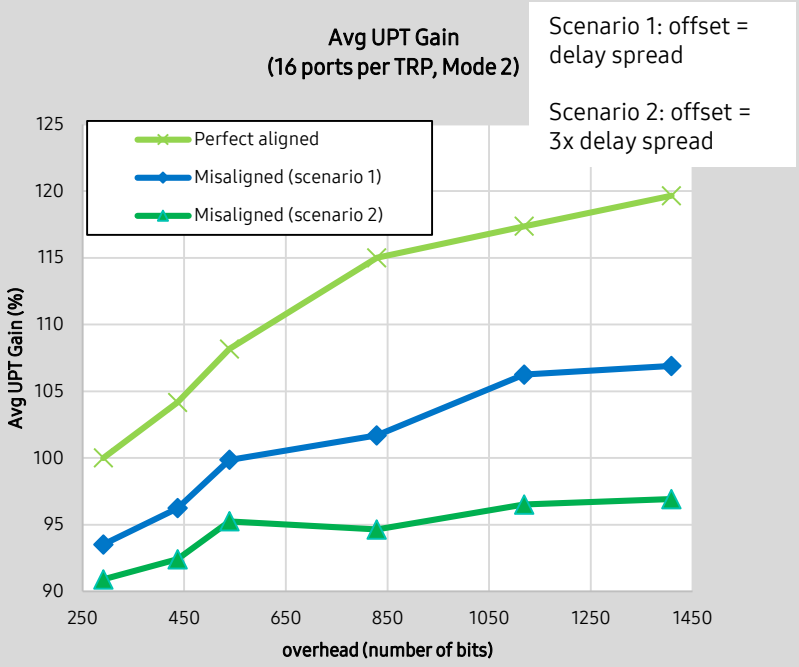
- Rel-18 Type-II CJT, 2-QCL, and SRS interference avoidance signify a first-step toward ultra-high performance CJT (cooperative) network
- To limit the scope, Rel-18 targets intra-site CJT ("ideal" sync and backhaul), restricting applicable deployment scenarios
  - Impairments such as inter-TRP phase/delay and frequency offsets are present especially for inter-site M-TRP, causing large throughput degradation
  - Implementation-based inter-TRP calibration is challenging due to limited knowledge at NW side
- If designed as a standalone report based on legacy CSI-RS, its objective is specific and limited

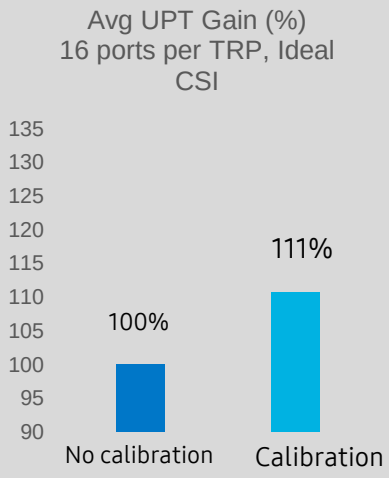
→ Rel-19 MIMO priority: High

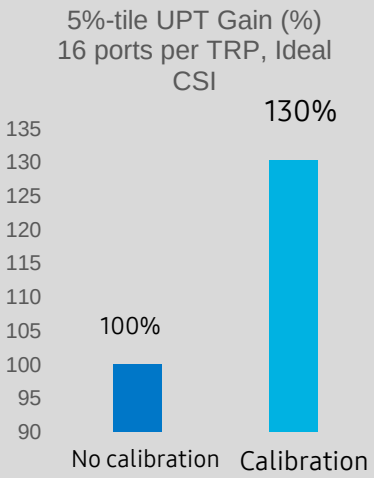
Type-II CJT extension to high/medium speed for FR1:

- While this is potentially beneficial, unless inter-TRP calibration issue is addressed, its benefit is quite limited

→ Rel-19 MIMO priority: Low







Multi-beam (FR2) enhancement

UE-initiated/event-based beam management based on unified TCI:

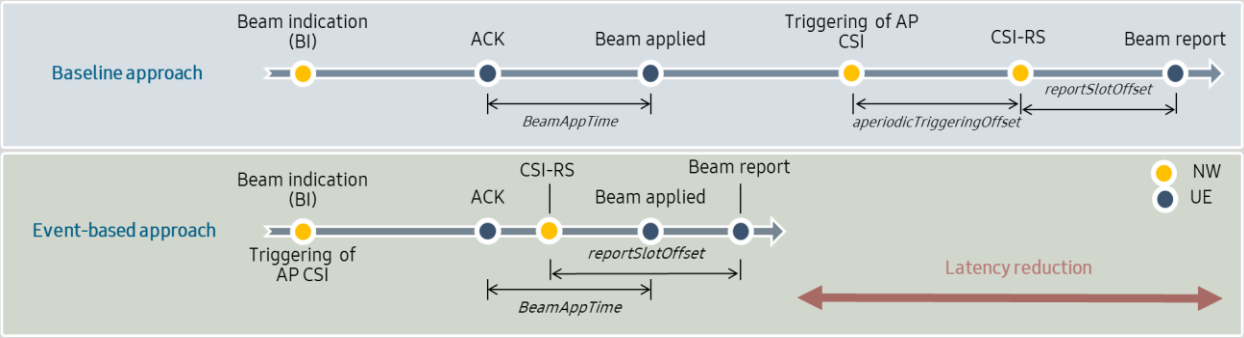
- Circumventing impediment against FR2 deployment in mobile and outdoor cellular amounts to reduction in latency, overhead, **and** outage, as well as improving network coverage
- As UE possesses more knowledge than network, UE-initiated/event-based approach can offer a way forward
- MIMO-specific core features comprise UL signaling content and container design (considering the event-driven nature, future-proof container for later extension), allowing specific and limited objective for this new enhancement area
  - Precise event definition is use-case-dependent and modular, can be left to other WI(s) and/or later release(s)

→ Rel-19 MIMO priority: Medium/high

Predictive beam management based on unified TCI:

- While this is potentially beneficial, there is high likelihood of overlap with Rel-19 AI/ML and can be addressed there

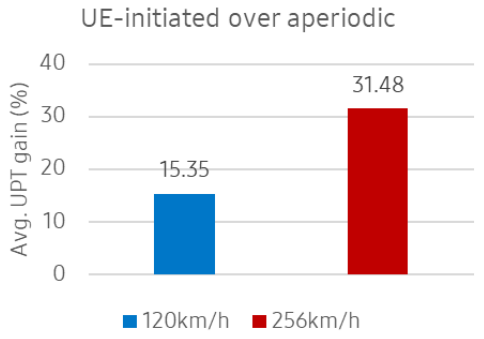
→ Rel-19 MIMO priority: Low



Evaluation results

Parameters	Values
SCS	120 kHz
BW	100 MHz
Number of PRBs	66
Distance between RRHs	200 m
UE Speed	120, 256 km/h
Number of beams per RRH	64
Number of active UEs	1024

High-speed train



Further enhanced UL for FWA/CPE

FWA/CPE is a key use-case in 5G and constitutes 40% of traffic of 5G in 2028, with 70% usage indoor

UL sub-band codebook-based precoding for FDD FR1:

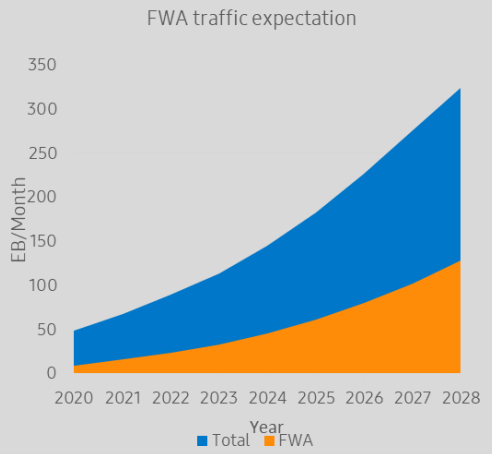
- Sub-band precoding can offer large throughput and coverage gain
- Its objective can be specific and limited if focusing on DL control signaling design based on legacy codebooks and extension of legacy DCI design(s), e.g. two-part DCI used in SL/V2X

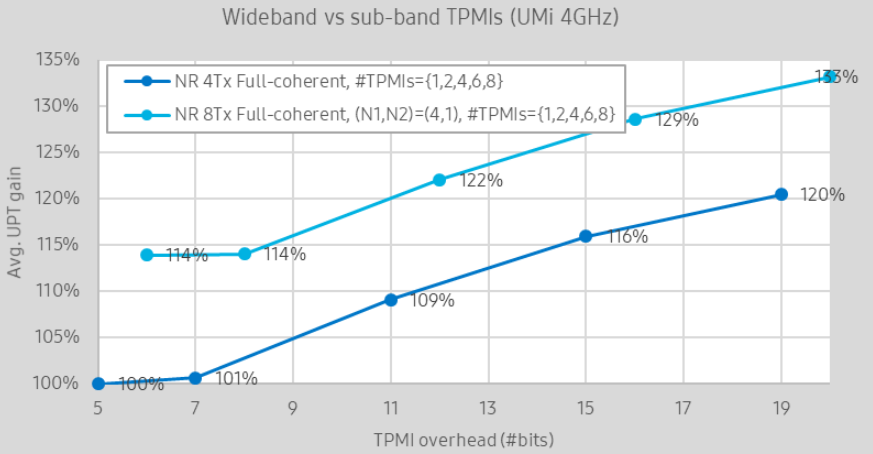
→ Rel-19 MIMO priority: Medium/high

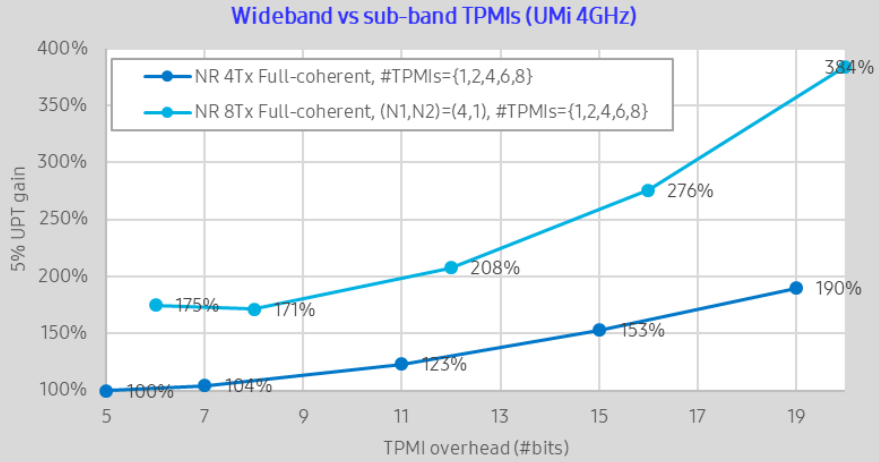
UL high-resolution precoding for TDD FR1:

- Performance analogous to Type-II DL codebook can be achieved in UL by exploiting DL/UL reciprocity, with the same payload as wideband TPMI
- However, whether UE-side DL/UL reciprocity is feasible (even for CPE) remains unclear

→ Rel-19 MIMO priority: Low







Other potentially beneficial enhancement areas for Rel-19 MIMO

The following areas could potentially benefit commercial networks with specific and limited objectives

CSI enhancement for FR1 with >32 ports:

- While 6-7GHz regime (C-band, utilizing larger antenna arrays) is primarily designated for TDD, large throughput loss can be observed when SRS-based CSI acquisition isn't feasible as the network falls back to 32-port PMI-based approach
- Such issue can be addressed by specifying Type-I/II codebook and/or CRI-based CSI for 64 and 128 ports
- Its objective can be specific and limited if legacy CSI-RS resources (32 ports per resource, up to 4 resources) are assumed

Reduced-complexity 6/8RX UEs for >4 layers DL MIMO reception:

- Main impediment to >4 layers for DL MIMO remains on the UE processing capability and supporting >4 RX antennas
- Partitioning RX array with 'partially coherent' reception may alleviate such issue, including CSI acquisition refinement
- Its objective can be specific and limited if legacy codebooks and layer mapping are reused

S-TRP DL/M-TRP UL ("UL-only TRP") for UL coverage enhancement:

- While separate DL/UL TCI is included in unified TCI, "UL-only TRP" introduces next-level asymmetry at the network side
- Potential enhancement comprises refinement on pathloss measurement and PC for SRS, TA, and cross-TRP beam indication
- Its objective can be specific and limited if TA enhancement is limited to supporting S-DCI 2TA based on legacy PRACH

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Conclusion – Rel-19 MIMO scope

Principle: commercial needs with future-proof mindset, highly focused (specific and limited) objectives, "zero" overlap with other potential Rel-19 WIs

From RWS-230207:

- High priority: UE-assisted M-TRP calibration (stand-alone) reporting based on legacy CSI-RS
- Medium/high priority:
  - UL container/medium for UE-initiated/event-driven beam management based on legacy contents
  - DL control signaling for UL sub-band precoding based on legacy UL codebooks

Other potentially beneficial areas:

- CSI enhancements for >32 ports FR1 utilizing legacy CSI-RS resources
- Reduced-complexity 6/8RX UEs for >4 layers DL MIMO reception utilizing legacy codebooks and layer mapping
- S-TRP DL/M-TRP UL ("UL-only TRP") for UL coverage enhancement utilizing legacy PRACH

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