

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

Source: ZTE, Sanechips

Agenda: 5

RWS-230290

ZTE

Tomorrow never waits

Views on Rel-19 MIMO evolution



Overview — MIMO

Items	Details
TRP-side MIMO calibration in CJT	Enabling inter/intra-site CJT well: UE assisted Doppler(phase-offset)/Delay-domain calibration for <u>CJT</u> in both <u>TDD</u> and <u>FDD</u>
UL-MIMO Enhancement	<p>#1 <u>UL-only TRP</u> operation for UL UPT improvement, deployment cost and energy saving</p> <ul style="list-style-type: none">• UL power control and TA for enabling UL-only TRP, and UL beam management• High-resolution precoding in multi-TRP coherent joint reception
	<p>#2 Left-over from R18 <u>STxMP</u></p> <ul style="list-style-type: none">• PUCCH+PUCCH/PUSCH in SDM, involving UCI multiplexing;• Enabled by asymmetric panel architecture.
CSI in MU-MIMO	DL precoding and CQI refinement for assisting <u>NW-level payload-dependent rank adaptation</u> in MU-MIMO (from 1-layer to 4-layer): <ul style="list-style-type: none">• Dynamic update for rank restriction in a CSI report for both Type-I and eType-II codebook• Full-rank information (e.g., eigenvalue per layers) via eType-II codebook refinement
RS	Middle & high-speed UEs in TDD MU-MIMO: Indication of <u>SRS</u> phase-consistency for assisting gNB-side CSI prediction, like time-domain bundling
Multi-beam	Extension of dynamic beam (unified TCI) update to <u>periodic/semi-persistent (P/SP)</u> transmission occasion in both DL and UL, considering, from the perspective of gNB side, <u>cell-specific/pre-determined beam switching pattern</u> in time-domain. <ul style="list-style-type: none">• e.g., extension of applicable scope of unified TCI to P/SP-CSI-RS, P/SP-SRS and scheduling request (SR)) (via additionally providing time-domain offset, etc.)

TRP-side MIMO calibration in CJT

• Motivation

- Different delay offset(s) for each TRP (due to different propagation delay for respective TRPs).
 - For instance, in 30KHz SCS, even with 2 RBs as in a subband, max diff. in propagation distance is only 417 m.
- Different Doppler/phase offset(s) (frequency-sync bias) for each TRP (due to TRP-in-sync and UE mobility)
 - For instance, when freq. sync error is 0.025ppm per TRP, Doppler shift/freq-sync bias may be up to 65 Hz for a TRP (2.6GHz), and then, for 5 ms (a typical periodicity of CSI report), ~120 degree phase-error may be experienced.
- Via delay-offset/Doppler-offset calibration, significant performance gains (e.g., ~3.6% and ~15.6% in avg. UPT, respectively) may be obtained.

• Potential WID objectives (for both TDD and FDD)

- Standalone report for delay offset and Doppler/phase offset (UE-assisted)
 - For refining Rel-18 CJT-CSI/CQI, introduce a new hypothesis of TRP-specific pre-compensation (i.e., via measuring normal CMR(s) but assuming TRP-specific pre-compensation for PDSCH reception)
 - Besides, unified TCI/QCL extension for additionally supporting QCL-TypeA + QCL-TypeB (representing TRP-specific delay-domain pre-compensation).

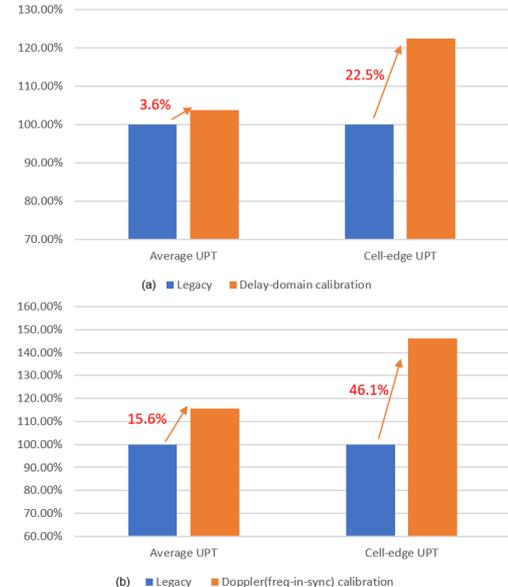
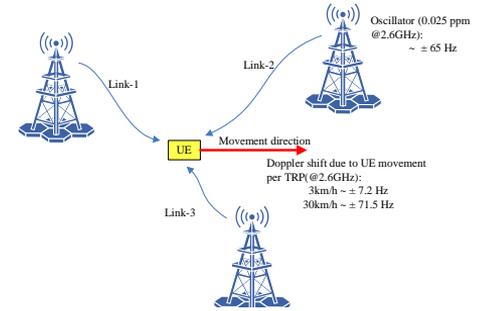


Figure 1 UPT for CJT in (a) inter-site; (b) 0.025ppm per TRP

UL-MIMO enhancement: UL-only TRP (1)

• Background

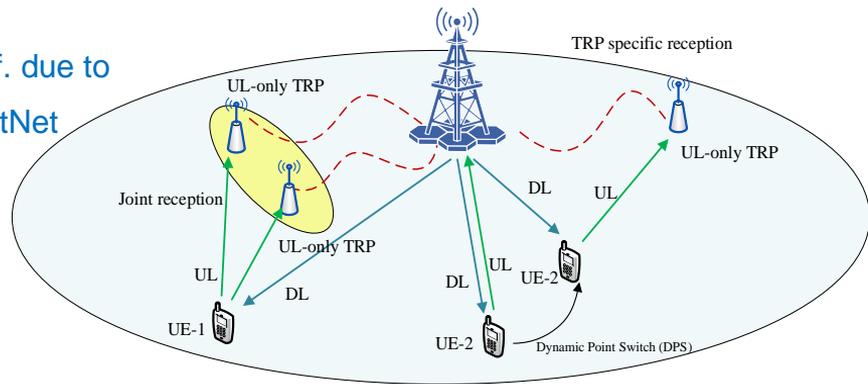
- DL/UL-link decoupling with the objective of maximizing perf. due to different DL/UL-coverage ranges for macro BS and micro in HetNet
- UL UPT improv. via deploying low-cost UL-only TRPs.
- NW energy saving via powering off DL links of some TRPs

• Scenarios

- UL-TX scheme (MU-MIMO, SU-MIMO):
 - a) TRP-specific (e.g., DPS);
 - b) TRP joint reception, e.g., non-coherent joint reception (NCJR) and coherent joint reception (CJR);

• Potential WID objectives

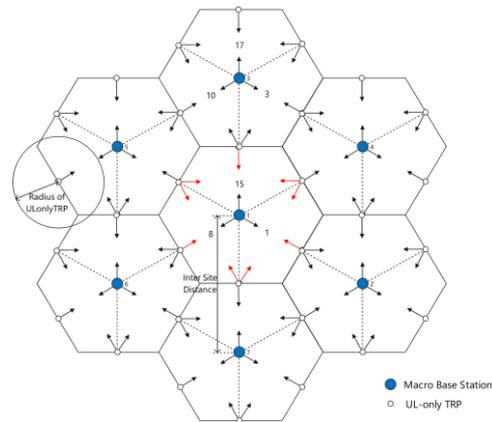
- Basic features for enabling UL-only TRP architecture (due to different DL-UL sites):
 - UL power control, and TA for UL-only TRP (e.g., PL-RS, TPC command, and PRACH or SRS based TA meas.)
 - UL beam management (e.g., SRS for beam management)
- Advanced features for UL-distributed MIMO
 - High-resolution precoding (e.g., $\geq 4\text{Tx}$) in multi-TRP coherent joint reception
 - Dynamic switching between Tx schemes (e.g., from NCJR/CJR to sTRP/DPS), e.g., signaling design.



UL-MIMO enhancement: UL-only TRP (2)

Comprehensive evaluation in SLS

- Evaluation assumption (Layout as shown in the right):
 - 7 macro base stations, 3 sections per macro and 3 UL-only TRPs per section
- Transmission modes to be evaluated:



a) Scheme-1: Dynamic Uplink-Point Selection (DuPS)

- Best uplink-point from macro BS and UL-only TRPs is determined with objective of maximizing UL-UPT/UL-RSRP.
- Based on the following SLS results, it can be observed that, the proposed scheme can bring +24.5% and +216.5% average UPT gain in $ISD = 200m$ and $ISD = 500m$, respectively.

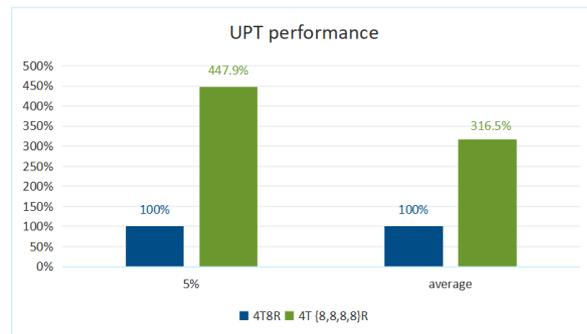
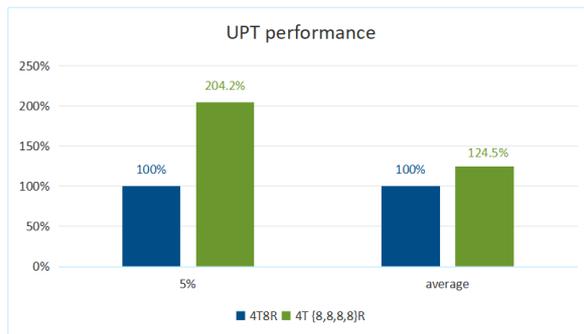
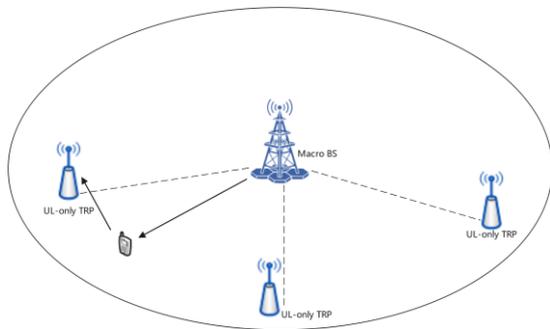


Figure 1 Dynamic uplink-point selection (DuPS) in SU-MIMO: (a) Diagram of proposed mechanism; (b) UPT in $ISD=200m$; (c) UPT in $ISD=500m$.

UL-MIMO enhancement: UL-only TRP (3)

Comprehensive evaluation in SLS

- Transmission modes to be evaluated (cont):
 - Scheme-2: Joint Reception across Multiple Points (JR_xMP)
 - UL-only TRPs are regarded as additional distributed antenna(s) for BS, and then coherent joint reception is preformed.
 - Based on the following SLS results, it can be observed that, the proposed scheme can bring +73.6% and +170.9% average UPT gain in ISD = 200m and ISD = 500m, respectively.
- Observation:** Via introducing UL-only TRP(s)/UL-distributed-MIMO, 'Dynamic Uplink-Point Selection' (DuPS) and 'Joint Reception across Multiple Points' (JR_xMP) both bring significant average/cell-edge UPT gains but may have respective suitable scenarios.
 - DuPS is suitable for Tx-power-limited scenario (e.g., large ISD), and, on the contrary, for interference-limited scenarios of UDN or small ISD, JR_xMP obtains more dominant gain due to coherent transmission and active interference mitigation.

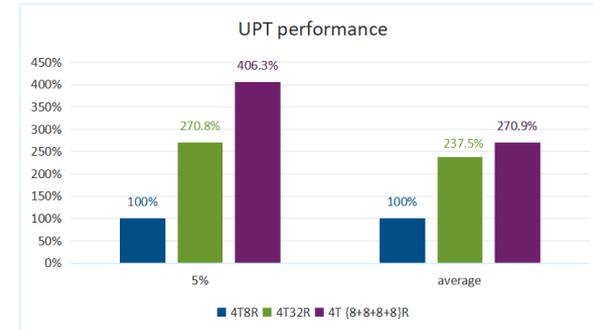
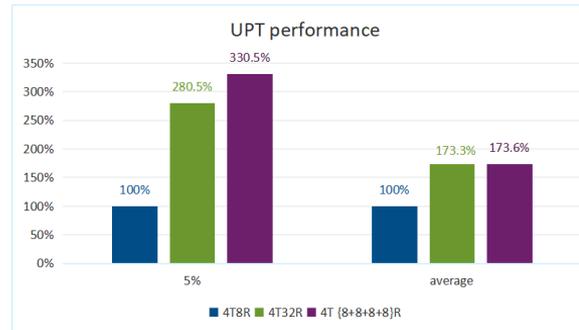
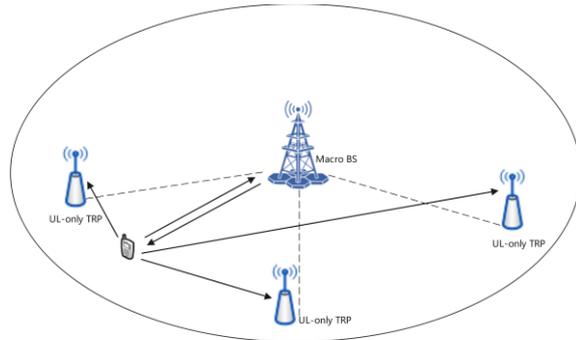
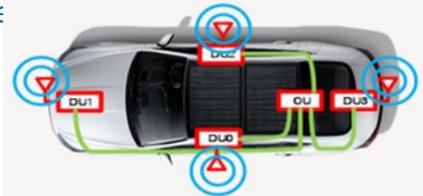


Figure 1 Joint reception across multiple points (JR_xMP) in SU-MIMO: (a) Diagram of proposed mechanism; (b) UPT in ISD=200m; (c) UPT in ISD=500m.

UL-MIMO enhancement: R18 left-over and onwards

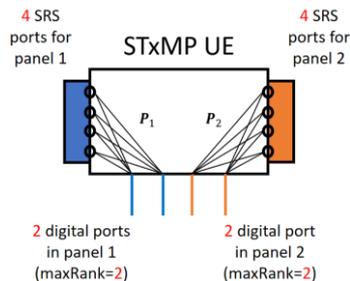
• STxMP UL

- Left-over: PUCCH + PUCCH/PUSCH in STxMP M-DCI based mTRP
 - Individual UCI procedure for each TRPs, involving TRP-specific UCI multiplexing
- Supposed to complete elaborate types for CPE/FWA/vehicle/industrial devices.
 - Enabled by asymmetric panel capability (€ ϵ panel).

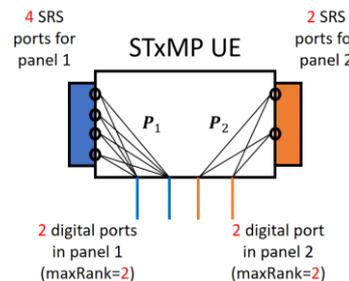


@ New 5GAA White Paper on Vehicular-DAS, 2 Dec. 2022

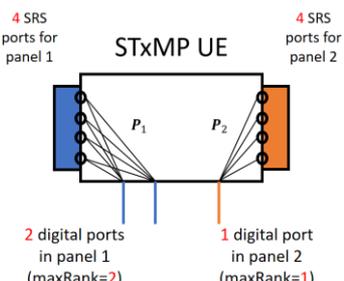
SDM: symmetric antenna ports and symmetric digital ports



SDM: asymmetric antenna ports but symmetric digital ports



SDM: symmetric antenna ports but asymmetric digital ports



Rel-18 (Already supported)

Rel-19 Enh.

Rel-19 Enh.

antenna ports / digital ports	Symmetric	Asymmetric
Symmetric	Rel-18 STxMP (Already supported)	Rel-19 (Baby step)
Asymmetric	Rel-19 (Baby step)	Rel-19 (Next step)

• 8-Tx UL

- Left-over: Unclear (Rel-18 8-Tx progress seems fine for now)

CSI enh.: DL precoding and CQI refinement for assisting NW-level payload-dependent rank adaptation in MU-MIMO

• Motivation

- In MU-MIMO, due to dynamic variation of NW traffic payload in total, CSI enhancement for assisting CQI/MCS and rank adaptation (from 1 layer to 4) in MU-MIMO becomes urgent to meet market demand.
- In addition, DL precoding should be refined according to scheduled UE(s) using SLNR or zero-forcing approach, and additional information of receiver side information/full-rank information in CSI report (for post-CQI/MCS determination) becomes essential for improving performance.

• Potential WID objectives

- DL precoding and CQI refinement for assisting NW-level traffic-payload-dependent rank adaptation in MU-MIMO (from 1-layer to 4-layer) for both CJT and sTRP:
 - Example-1: Dynamic update of rank restriction in CSI report for both Type-I and eType-II codebook (also applied to 64T or 128T (if enhanced), besides for legacy, e.g., 8/16/32T);
 - Example-2: Full-rank information (e.g., eigenvalue per layer, or wideband-Rxx) via eType-II codebook refinement.

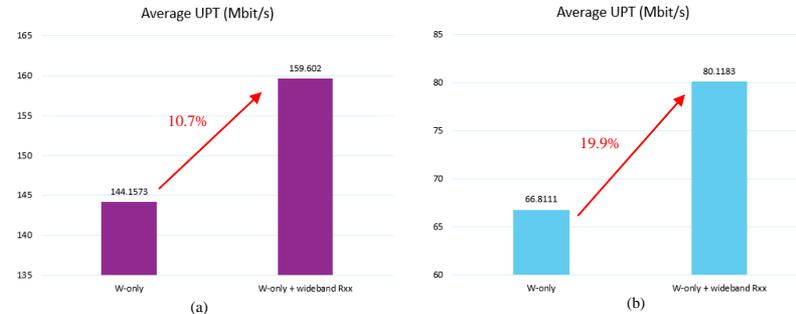


Figure 1 SLS for additional information report of receiver side information (i.e., full rank information/wideband Rxx) under: (a) RU~30% and (b) RU~80%

RS enhancement

- **SRS enh. for middle & high-speed in TDD MU-MIMO**
 - **Motivation**
 - From real-field test data, UE SRS phase inconsistency seriously impact DL-CSI prediction accuracy for MU-MIMO in gNB-side.
 - Wiener-filter prediction results in real-field is shown in the right
 - **Potential WID objectives**
 - Indication of SRS phase-consistency for assisting gNB-side CSI prediction, like SRS time-domain bundling

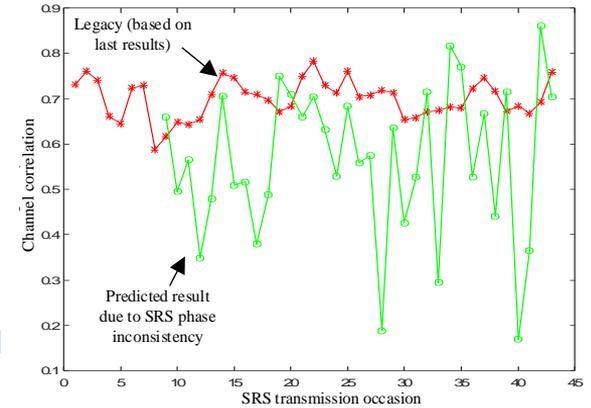


Figure 1 CSI prediction in TDD based on SRS from real field

Multi-beam enhancement (1)

- **Left-over from R17/18 unified TCI: Extension of dynamic beam update to P/SP transmission**

- **Motivation**

- For DL/UL-CSI/CQI derivation in real-field NW, P/SP-CSI-RS/SRS for CSI, compared with AP, is widely used but, unfortunately, precluded in the applicable scope of unified TCI framework.
- Extension of dynamic beam (unified TCI) update to P/SP-CSI-RS, P/SP-SRS and scheduling request (SR)) is urgent, considering, from the perspective of gNB side, cell-specific/pre-determined beam switching pattern in time-domain.

- **Potential WID objectives**

- Extension of applicable scope of unified TCI to periodic/semi-persistent (P/SP) transmission occasion in both DL and UL transmission occasion
 - Example: providing additional information (e.g., time-domain offset, etc) in unified TCI state(s), besides for QCL/spatial filtering assumption

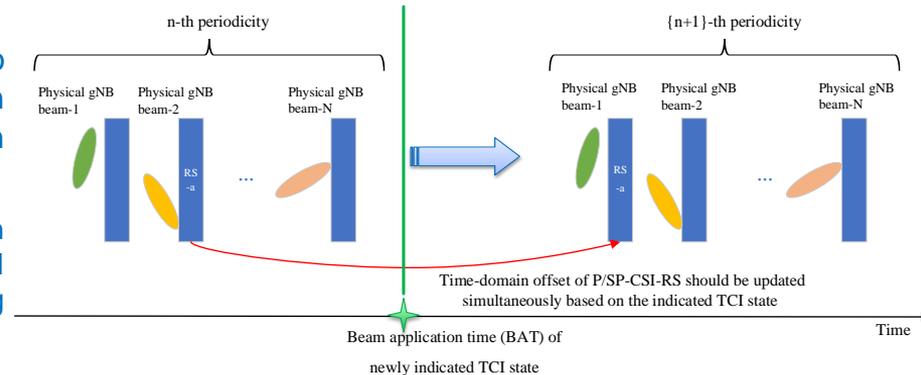


Figure 1 Updating time-domain offset of P/SP-CSI-RS based on the indicated TCI state

Multi-beam enhancement (2)

- **Left-over from Rel-17: UE-initiated beam management and advanced tracking**
 - **Motivation:** UE-initiated beam report and indication is mainly to reduce beam switching latency, but, once having temporal-domain beam prediction as proposed in AI-BM, its essentiality becomes questionable.
 - **Suggestion:** Deprioritized, or to be merged with AI-BM enh. in Rel-19

Thanks



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