MIMO Evolution in Rel-19

Taipei, 15th – 16th June, 2023

Agenda item: 5

Source: Nokia, Nokia Shanghai Bell

 © 2023 Nokia

Overview

Motivations and key proposals for MIMO evolution work Rel-19

- MIMO technologies are at the heart of many NR operations, in particular regarding beam management
- 3GPP has enhanced MIMO over the last few releases, including a renewal and extension of the beam management framework to address new scenarios, including multiple TRPs and joint transmission
- It is important to ensure the renewed framework is complete, so that it is a solid baseline for any future enhancements
- At the same time, the overall scope of MIMO work in Rel-19 needs to be constrained, and any new areas to be considered based on clear market needs

In Rel-19 the key areas for MIMO enhancements are:

- Beam management: UE assisted operation, dynamic TCI state updates
- Multi-TRP enhancements: simultaneous UL transmissions (Rel-18 leftover)
- CSI enhancements for joint transmission (type II CSI)
- CSI enhancement for higher rank operation in FR2
- Enhancements for SRS-based CSI-acquisition

© 2023 Nokia

Beam management / Multi-Beam operation

UE-centric operation

UE initiated/assisted Beam Management (BM)

- In some cases, UE may have better view on which beam should be selected than what can be revealed in L1-RSRP reporting
- gNB could allow some flexibility in the beam or beam pair link selection by allowing UE to select among a given set
- UE may also be enabled to trigger the beam change/reporting
- **Reduces latency and potentially UL overhead compared to existing procedures, which is particularly relevant in highly dynamic channels, such as in FR2**

Dynamic TCI state update for periodic CSI-RS

- Periodic CSI-RS is the main time and frequency tracking source signal of the NR system
- In addition, typically, periodic CSI-RSs are used for BM measurements and CSI acquisition
- However, only RRC-based beam switching is currently allowed, which is therefore relatively slow
- **System operation would be enhanced significantly if more dynamic beam switching is supported for periodic CSI-RS, e.g., MAC based**

© 2023 Nokia

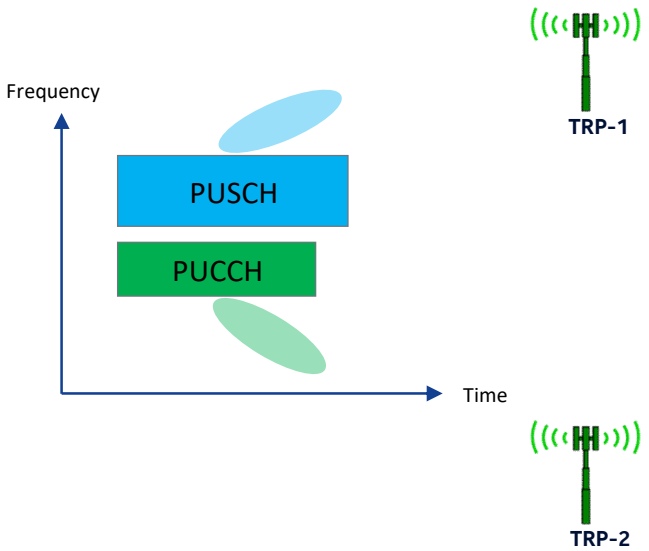
Enhanced multi-TRP operation

Simultaneous UL transmissions of PUCCH and PUSCH – Rel-18 leftover

Simultaneous UL transmissions from multiple panels (STxMP) of PUCCH and PUSCH

- The scope of the Rel-18 simultaneous UL transmissions objective for multi-TRP was restricted to simultaneous transmission of two PUCCHs or two PUSCHs, meaning that simultaneous UL transmissions of PUCCH and PUSCH is not possible.
- Avoiding overlap between PUSCH and PUCCH may not be feasible in practice, especially under Multi-DCI mode.
- Therefore, **to unleash full potential of the simultaneous UL transmissions feature, simultaneous transmissions of PUCCH and PUSCH can be adopted/enabled in Rel-19**.

- Example of STxMP of PUCCH and PUSCH:



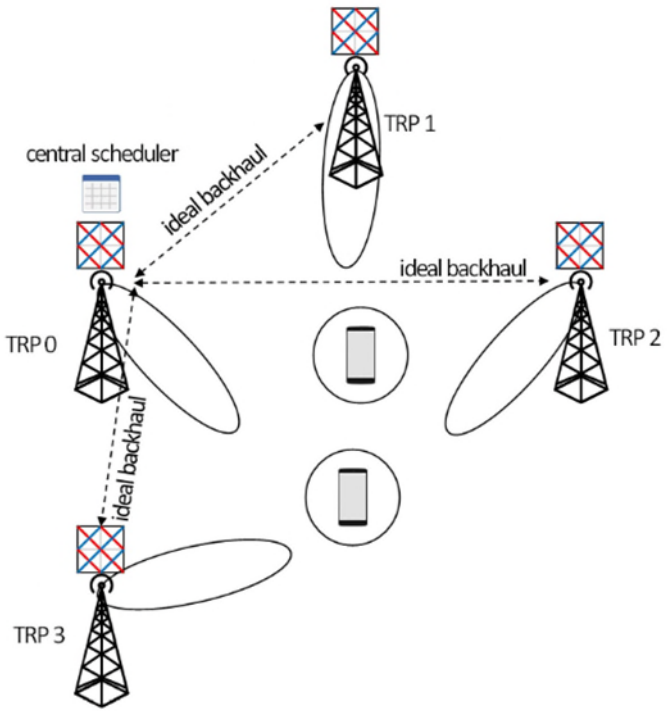
© 2023 Nokia

CSI acquisition framework

Extension of Type II CSI

Extend Type II CSI to support Rank 8:

- **Motivation:** improve CJT performance with low-to-moderate traffic levels where the higher rank per UE can significantly improve performance.
- Rel-18 extends Type II CSI to support CJT with up to rank 4 per UE
- In Rel-19 **extend Type II for CJT to support up to rank 8 per UE for 8RX UEs, e.g. supporting up to rank 4 on each panel** → increase spatial multiplexing capabilities for CJT



© 2023 Nokia

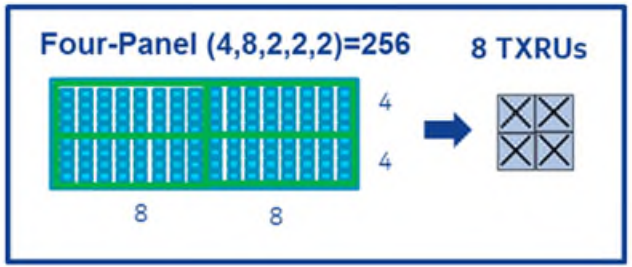
CSI acquisition framework

Improving FR2 spectral efficiency with higher rank operation

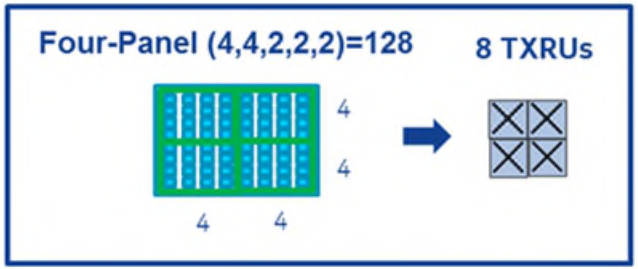
- **Motivation**: Leveraging hybrid array structures at both gNB and UE can enable higher rank operation in FR2. E.g.:
  - Multi-panel gNB: 8-port TX, 8-port Rx
  - Multi-panel UE: 8-port Tx, 8-port Rx
- System level simulations at 30GHz with 8TX-8RX operation show benefits (R1-1703154):
  - Uplink: ~20% improvement
  - Downlink: ~60% improvement

- **Objective**: Study enhancements / optimizations to efficiently support higher rank SU-MIMO operation that can be enabled with multi-panel / hybrid array implementations at gNB and UE.

- **gNB array**: uniform panel array configured with four sub-panels:



- **UE array**: uniform panel array configured with four sub-panels:



© 2023 Nokia

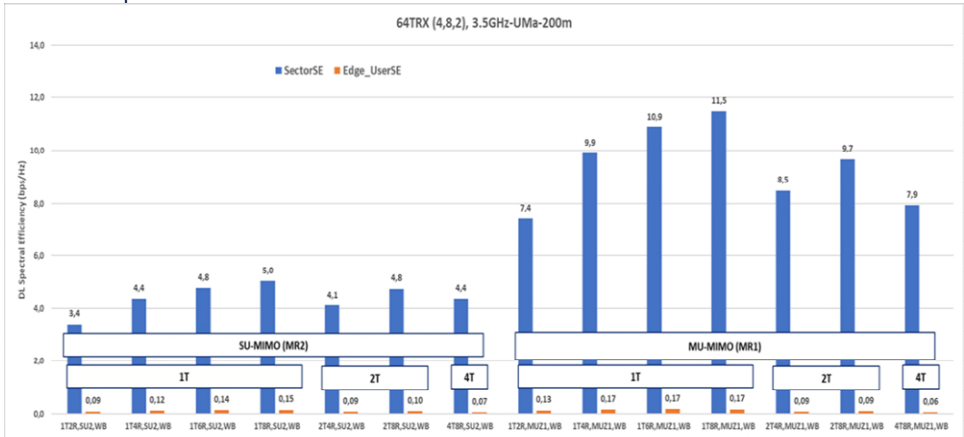
Latency and overhead reduction for SRS-based CSI-acquisition

Gap-less SRS switching

- Typically, it would be beneficial to use 1T8R antenna switching configuration to increase DL throughput
  - See Figure, which **does not take into account latency and overhead increase**
- However, due to use of guard periods with antenna switching, the **UL SRS resource overhead and latency may increase drastically** (e.g. 1T4R → 3 guard periods required or **1T8R →7 guard periods required**), thus compromising the potential gains
- To reduce latency and overhead related to antenna switching, new antenna switching configurations could be specified (e.g. 1T8R for 4/8TX UEs) **with reduced amount of guard periods or even without any guard periods**
- This should be feasible for UEs capable of transmitting and receiving simultaneously with, e.g. 4/8TX and 4/8RX

Benefits of such an approach include:

- Reduced number of scheduling restrictions and interruptions per UE
- Higher UL SRS resource utilization
- Improved SRS-based CSI acquisition latency and reduced overhead while maintaining higher quality SRS-based CSI acquisition



© 2023 Nokia

Summary

Beam Management / Multi Beam Operation:

- Dynamic TCI state updates for periodic CSI-RS: MAC-CE rather than RRC-configured TRS and CSI-RS: better for dynamic channels
- UE initiated/assisted Beam Management
- Autonomous UL beam management

→ Improving latency and streamlining the beam management framework

Multi-TRP enhancements:

- Simultaneous UL transmissions of PUCCH and PUSCH

→ Improving latency and flexibility for UL transmissions for M-TRP

CSI Acquisition Framework

- FR1: Study extending Type II CSI to up to Rank 8 operation
- FR2: Study efficient support of higher rank operation at FR2 by leveraging hybrid array structures at gNB and UE (e.g., 4 or 8-port). (R1-1703154)

→ Improving system performance in FR1 and FR2

Reference Signals

- SRS: Gap-less operation for antenna-switched UEs.

→ Improving SRS-based CSI-acquisition latency & quality

© 2023 Nokia

NOKIA