RP-212991

3GPP TSG RAN #94e
Electronic Meeting, December 6 - 17, 2021
Agenda Item: 8A.1
Source: Apple

On Rel-18 MIMO Enhancement

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Background

- In RP-212701, the following objectives are proposed from the moderator for NR Rel-18 MIMO enhancement
  - Extend specification support in the following areas [RAN1]
    - Enhancements on DL MIMO:
      - Study, and if justified, specify CSI enhancement in high/medium velocities for exploiting time-domain correlation/Doppler-domain information, including potential enhancement to feedback-based CSI acquisition mechanisms for DL precoding
      - Specify extension of Rel-17 Unified TCI framework, e.g.,
        - for indication of multiple DL and UL TCI states (e.g., M>1 and/or N>1) for multi-TRP schemes
        - for multi-TRP, it includes multi-TRP schemes supported in Rel-16/Rel-17
      - Specify to support larger number of orthogonal DMRS ports
      - Study, and if justified, specify enhancements on CSI acquisition for Coherent-JT for both FDD and TDD targeting FR1
      - Study, and if justified, specify overhead and/or Latency reduction with UE-initiated beam management/beam acquisition procedures
    - Enhancements on UL MIMO:
      - Study, and if justified, specify at least UL DMRS, SRS to enable 6 and 8 Tx UL operation to support [up to 4 layers per UE] in the UL targeting CPE/ FWA/vehicle/Industrial devices
      - Study, and if needed, specify features to facilitate simultaneous multi-panel UL transmission for higher UL throughput/reliability
      - Study, and if justified, specify panel-specific[/beam-specific] timing/power control for UL multi-TRP/panel scenario
      - Study, and if justified, specify frequency-selective precoding targeting devices with equal or more than 4 Tx
      - Study, and if justified, specify 2 CW for equal or more than 2 layers in uplink
  - Specify higher layer support of enhancements listed above [RAN2]
  - Specify core requirements associated with the items specified by RAN1 [RAN4]

Discussion | Our General View

- High level views on the scope of Rel-18 NR MIMO enhancement
  - Further downscope of Rel-18 NR MIMO enhancement is definitely needed
  - Minimize or control the number of objectives with “Study, and if justified, specify”
  - At least 3 TU is needed for Rel-18 NR MIMO enhancement.

- The following objectives are of high priority in our view
  - Specify extension of Rel-17 Unified TCI framework
  - Overhead and/or Latency reduction for UE-initiated beam management/beam acquisition procedures
  - CSI enhancement in high/medium velocities for exploiting time-domain correlation/Doppler-domain Info.

- The following objectives have high concern from us and should be downscoped
  - Simultaneous multi-panel UL transmission
  - Panel-specific timing for UL multi-TRP/panel scenario

Discussion | Our General View

	Objective	Our view (ranking)
Enhancements on DL MIMO	Study, and if justified, specify CSI enhancement in high/medium velocities for exploiting time-domain correlation/ Doppler-domain information, including potential enhancement to feedback-based CSI acquisition mechanisms for DL precoding	High priority
	Specify extension of Rel-17 Unified TCI framework, e.g., ▪ for indication of multiple DL and UL TCI states (e.g., M>1 and/or N>1) for multi-TRP schemes ▪ for multi-TRP, it includes multi-TRP schemes supported in Rel-16/Rel-17	High priority
	Specify to support larger number of orthogonal DMRS ports	Medium priority
	Study, and if justified, specify enhancements on CSI acquisition for Coherent-JT for both FDD and TDD targeting FR1	Medium priority
	Study, and if justified, specify overhead and/or Latency reduction with UE-initiated beam management/beam acquisition procedures	High priority
Enhancements on UL MIMO	Study, and if justified, specify at least UL DMRS, SRS to enable 6 and 8 Tx UL operation to support [up to 4 layers per UE] in the UL targeting CPE/ FWA/vehicle/Industrial devices	Medium priority
	Study, and if needed, specify features to facilitate simultaneous multi-panel UL transmission for higher UL throughput/ reliability	Low priority (Downscoped)
	Study, and if justified, specify panel-specific[/beam-specific] timing/power control for UL multi-TRP/panel scenario	Low priority (Downscoped)
	Study, and if justified, specify frequency-selective precoding targeting devices with equal or more than 4 Tx	Medium priority
	Study, and if justified, specify 2 CW for equal or more than 2 layers in uplink	Medium priority

Views on DL MIMO enhancement

Discussion | Views on CSI Enhancement Exploiting TD Correlation

- Our views on the following objective
  - *Study, and if justified, specify CSI enhancement in high/medium velocities for exploiting time-domain correlation/Doppler-domain information, including potential enhancement to feedback-based CSI acquisition mechanisms for DL precoding*

- We support this objective with high priority
  - In Rel-15, the DL MIMO codebook exploits the channel spatial correlation
  - In Rel-16/17, the DL MIMO codebook enhancement exploits the channel frequency domain correlation
  - It is nature to enhance the DL MIMO codebook exploiting the channel time domain correlation

Discussion | Views on Extension of Rel-17 Unified TCI Framework

- Our views on the following objective
  - *Specify extension of Rel-17 Unified TCI framework, e.g., for indication of multiple DL and UL TCI states (e.g., M>1 and/or N>1) for multi-TRP schemes, for multi-TRP, it includes multi-TRP schemes supported in Rel-16/ Rel-17*

- We support this objective with high priority
  - It is important to note that In Rel-17, the following working assumption was achieved:

> Working Assumption
> The UE is not expected to be configured with Rel-15/Rel-16 TCI/SpatialRelationInfo if the UE is configured with Rel-17 TCI in any CC in a band.
> - The CC list for Rel-16 multi-CC beam indication should not contain any CC configured with Rel-17 TCI

  - Currently all mTRP operation is designed based on Rel-16 TCI/SpatialRelationInfo framework, but the Rel-17 inter-cell BM is designed based on R17 unified TCI framework. With the Rel-17 working assumption, both mTRP and inter-cell BM cannot be enabled in a band
  - Therefore, we should at least consider to extend Rel-17 unified TCI framework for multi-TRP and/or support inter-cell BM based on Rel-16 TCI/SpatialRelationInfo framework.

Discussion | Views on Larger number of DMRS ports

- Our views on the following objective
  - *Specify to support larger number of orthogonal DMRS ports*

- We view this objective as medium priority
  - Our understanding is that this does not increase the maximum number of MIMO layers supported on DL (i.e., 4 for MU-MIMO and 8 for SU-MIMO) per UE.
  - The main objective is to improve MU-MIMO performance from NW perspective
  - In our view, this is secondary concern while the first concern is how to improve UE MU-MIMMO detection performance.

Discussion | Views on CSI for Coherent-JT

- Our views on the following objective
  - *Study, and if justified, specify enhancements on CSI acquisition for Coherent-JT for both FDD and TDD targeting*

- We view this objective as medium priority
  - Coherent-JT can be supported largely based on the current specification in a transparent way, if there is true ideal back-haul between different TRPs
  - The scope of the objective needs to be further clarification, for example
    - Whether it is extension of Multi-Panel CSI codebook, or CSI codebook enhancement to address certain NW back-haul concern, or something else
  - It should not be high priority since even the NCJT mTRP is not ready to be deployed in the field

Discussion | Views on Overhead and/or Latency Reduction

- Our views on the following objective
  - *Study, and if justified, specify overhead and/or Latency reduction with UE-initiated beam management/beam acquisition procedures*

- We support this objective with high priority
  - Even though, certain overhead reduction enhancement has been introduced in both Rel-16 (e.g., MAC-CE enhancement) and Rel-17 (e.g., unified TCI framework), the delay for beam switching is not actually reduced
    - The beam tracking latency is still high, e.g., UE may need to measure the same SSB multiple times for beam tracking/refinement etc., which can lead to latency on the order of hundred of ms
  - In addition, there is no enhancement on beam reporting overhead reduction in Rel-17
    - Currently, there is no mechanism for network to identify the whether and when to trigger a beam report
    - UE has to measure a number of beam measurement RS, which not only takes too much overhead, but also increases UE's power consumption
  - We should consider to further reduce the overhead and latency reduction for beam management, focusing on
    - Mechanism to reduce TCI activation delay (UE beam tracking delay)
    - Mechanism to reduce beam reporting overhead

Views on UL MIMO enhancement

Discussion | Views on >4Tx UL operation

- Our views on the following objective
  - *Study, and if justified, specify at least UL DMRS, SRS to enable 6 and 8 Tx UL operation to support [up to 4 layers per UE] in the UL targeting CPE/ FWA/vehicle/Industrial devices*

- We view this objective as medium priority
  - From our perspective, the devices that support more than 4 PA in a CC should not be the focus of NR Rel-18 enhancement.
  - Furthermore, the scope of this objective can be very TU consuming especially if we need to consider codebook based PUSCH operation

Discussion | Views on Simultaneous multi-panel UL Tx

- Our views on the following objective
  - *Study, and if needed, specify features to facilitate simultaneous multi-panel UL transmission for higher UL throughput/reliability*

- We view this objective as low priority and should be downscoped
  - First of all, fast panel switching is not fully supported in Rel-17
    - Rel-17 only agreed some mechanism for UE to report the UE capability on the panels as well as a panel type info report for a beam. With the reported panel type info, only BWP switching can be used to accommodate the new UE capability for the new panel
    - There is no time for Rel-17 to finalize the design for fast panel switching, e.g., to configure multiple SRS resource sets with set selection.
  - Second but more important, simultaneous multi-panel transmission can cause excessive UE power consumption and thermal dissipation and should not be considered for Rel-18
  - Rel-18 should continue to finalize the details to support UE initiated fast panel selection, simultaneous multi-panel transmission can be de-prioritized

Discussion | Views on Panel-Specific TA/PC

- Our views on the following objective
  - *Study, and if justified, specify panel-specific[/beam-specific] timing/power control for UL multi-TRP/panel scenario*

- We view this objective as low priority and should be downscoped
  - First of all, panel specific power control is partly supported in Rel-17.
    - The typical deployment is to map each panel to different TRP, and per TRP power control is supported in Rel-17 as part of mTRP enhancement
  - Second but more important, panel-specific TA shouldn't be part of Rel-18
    - From UE perspective, the distance between two panels dose not warrant panel-specific TA
    - From NW perspective, asynchronous mTRP shouldn't be considered for Rel-18
      - Ever since LTE COMP, the mTRP with synchronous assumption is not deployed, asynchronous mTRP will provide even worse performance
      - Asynchronous mTRP is not realistic for commercial device to support, neither for FR1 nor for FR2

Discussion | Views on Frequency Selective UL Precoding

- Our views on the following objective
  - *Study, and if justified, specify frequency-selective precoding targeting devices with equal or more than 4 Tx*

- We view this objective as medium priority
  - For uplink frequency selective precoding, some results in Rel-15 showed some performance benefit for >= 4Tx case
    - The simulation in Rel-15 is also based on coherent transmission
    - No performance benefit is observed for non-coherent transmission
  - The scope of this objective needs to be clarified, it should only consider coherent codebook based PUSCH operation The 4 Tx UE is not the focus of NR deployment

Discussion | Views on 2 CW for >2 UL Layers

- Our views on the following objective
  - *Study, and if justified, specify 2 CW for equal or more than 2 layers in uplink*

- We view this objective as medium priority
  - We do acknowledge that NR design of mapping up to 4 layer MIMO to single CW does suffer performance issue since the SINR of each layer can vary largely in the field

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