**3GPP TSG RAN Meeting #109 RP-2xxxxx**

**Beijing, China, Sep. 15-18, 2025**

**Agenda Item:**  **9.6.1.6**

**Source: Lenovo**

**Title:** **Summary for WI: Multi-carrier enhancements for NR Phase 3**

**WI code(s): NR\_MC\_enh2**

**leading WG: RAN1**

**Release: Rel-19**

### 1 Introduction

Multi-carrier operation is very important for 5G commercial networks by aggregating various spectrum resources for providing high data rate and low latency communication.

Due to quite limited TU for Rel-18 multi-carrier enhancements, some important use cases were excluded from Rel-18, e.g., different SCSs among co-scheduled cells, different carrier types among co-scheduled cells. Co-scheduled carriers with different SCSs have high commercial needs for operators, e.g., 3.5GHz TDD + Sub-3GHz FDD, FR1 + FR2, etc.

Furthermore, two new DCI formats were introduced in Rel-18, DCI format 0\_3 and 1\_3. Each DCI format 0\_3 or 1\_3 can schedule up to 4 cells with limitation of a single PUSCH or PDSCH per scheduled cell. In Rel-17, for FR2 with high SCS, multi-PDSCH/PUSCH scheduling was introduced, i.e., up to 8 PUSCHs or PDSCHs on a single serving cell can be scheduled by a single DCI format 0\_1 or 1\_1, in order to save UE power consumption and reduce PDCCH overhead. Hence, it is straightforward to combine multi-cell scheduling and multi-PDSCH/PUSCH scheduling in Rel-19 to fully exploit the gain of power saving and PDCCH overhead reduction so that one DCI format 0\_3 or 1\_3 can schedule multiple cells with one or multiple PUSCHs/PDSCHs per scheduled cell. This is especially useful when scheduling cell in FR1 with a lower SCS schedules multiple cells in FR2 with higher SCS.

The WI introduced two enhancements for multi-carrier operation, one enhancement was to use a single DCI to schedule multiple cells with different subcarrier spacing values or carrier types, and another enhancement was to use a single DCI to schedule multiple cells with multiple PDSCH/PUSCH transmissions on each cell. And two enhancements were not mutually exclusive.

### 2 Description

The key functionalities introduced in this WI is multi-cell PDSCH/PUSCH scheduling with a single DCI, including scheduling of different SCS/carrier types and one or multiple PUSCHs/PDSCHs per scheduled cell as shown in Figure 1. In Rel.18 MC enhancement, same SCS/carrier types (licensed/unlicensed, FR1/FR2/FR2-2) among co-scheduled cells, and single PDSCH/PUSCH scheduled per scheduled cell were supported. In Rel.19 MC enhancement, same or different SCS/carrier types among co-scheduled cells and one or more PDSCH/PUSCH scheduled per scheduled cell were specified. Single-cell multi-PUSCH/PDSCH scheduling and multi-cell multi-PUSCH/PDSCH scheduling on the same or different cells within a same PUCCH group are not expected to be configured to UE simultaneously.

The existing DCI formats 1\_3 and 0\_3 are enhanced and optimized to support multi-cell PDSCH/PUSCH scheduling with up to 8 PUSCH/PDSCH for a scheduled cell by a single DCI with DCI payload size restriction (i.e. less than 140 bits). For some fields in DCI format 1\_3/0\_3, a single indication is commonly applied to all scheduled PUSCHs/PDSCHs and co-scheduled cell(s) so that the payload size could be compact while some other fields have separate indication for each PDSCH/PUSCH, e.g., for NDI/RV field, the number of bit for each block of the corresponding cell is equal to the maximum number of schedulable PUSCHs/PDSCHs by the DCI, and placed according to an ascending order of a serving cell index.

To support HARQ-ACK information feedback for multi-cell scheduling with multiple PDSCHs per scheduled cell by DCI format 1\_3, Type-1 HARQ-ACK codebook was reused without enhancement, Type-2 HARQ-ACK codebook generation is enhanced (e.g., for the second sub-codebook, the number of HARQ-ACK information bits is generated based on all the configured cell set(s) in the PUCCH group for the UE). Furthermore, time-domain HARQ-ACK bundling configured per cell is supported.



Figure 1 Rel.19 MC Enhancement Illustration

### 3 References

[1] RP-242904 Revised WID: Multi-carrier enhancements for NR Phase 3

[2] [R1-2504988](file:///C%3A%5CMyMeetings%5CTSGR1_121-Malta%5CDocs%5CR1-2504988.zip) Introduction of Rel-19 Multi-carrier enhancements (TS38.212)

[3] [R1-2504972](file:///C%3A%5CMyMeetings%5CTSGR1_121-Malta%5CDocs%5CR1-2504972.zip) Introduction of multi-carrier enhancements for NR Phase 3 (TS38.213)

[4] [R1-2504995](file:///C%3A%5CMyMeetings%5CTSGR1_121-Malta%5CDocs%5CR1-2504995.zip) Introduction of Multi-carrier enhancements for NR Phase 3 (TS38.214)

[5] R2-2506252 Stage 2 CR for Rel-19 Multi-carrier enhancements (TS38.300)

[6] R2-2506253 Introduction of Rel-19 Multi-carrier enhancements (TS38.331)