3GPP TSG RAN #101
Bangalore, India, Sept. 11th – 15th, 2023
Agenda Item: 9.3.1.2
Document for: Discussion

RP-232090

Discussion on the supported scenarios for Rel-18 MCE

NTT DOCOMO, INC.

Introduction

- For Rel-18 Multi-carrier UL Tx switching scheme, both RAN1 and RAN4 have been discussing following points.
  - **Issue 1: Whether each of following scenarios is supported in Rel-18 UL Tx switching or not**
    - » {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}
      - – If supported, whether this scenario is applicable to switched UL only or both switched UL and dual UL
    - » Dual UL in 3 or 4 bands including SUL (i.e., {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s), or {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band})
      - – Case 1: simultaneous transmission between NUL and NUL
      - – Case 2: simultaneous transmission between SUL and non-corresponding NUL
      - – Case 3: simultaneous transmission between SUL and SUL
  - **Issue 2: Where/how to capture the supported scenarios/restrictions with 3 or 4 bands including SUL**
    - » Where/how the supported scenarios/restrictions based on the outcome of Issue 1 discussion are captured in specifications, e.g., RAN1 spec (TS38.214) and/or RAN2 spec (TS38.306/331) and/or RAN4 spec (TS38.101-1)

- For Rel-18 Multi-cell PUSCH/PDSCH scheduling via single DCI, RAN1 has been discussing following point
  - **Issue 3: Whether DCI format 0_3/1_3 can request/schedule transmission on SUL carrier (without UL/SUL indicator) or not**

- Based on the above situation in RAN1/4, it has been difficult to endorse RAN1/4 CRs.
- **We propose to discuss and resolve above three issues at RAN#101.**

Issue 1: supported scenarios for Rel-18 UL Tx switching

Background

- At the RAN#96, target scenarios for Rel-18 UL Tx switching were discussed and the proposal in RP-221880 was agreed without changes, where concerned scenarios were captured as below.

> ●~~Other~~ Further check additional **scenarios** ~~as below can be discussed~~ **in** ~~RAN4#104e and~~ **RAN#97e**, e.g.,
> - **{SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}**
> - **Simultaneous transmission across 2 bands in {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s) (excluding simultaneous transmission between SUL and corresponding NUL)**

- At the RAN#97-e, concerned scenarios were discussed as summarized in RP-222672, but there was no conclusion regarding the scenarios.
- At the RAN#98-e, new WID on NR CA band combo with dual SUL bands was approved in RP-223553.
- At the RAN#99, whether simultaneous configuration of two cells with SUL is allowed or not was discussed due to different understanding on Note 2 in RP-223553, and following was agreed in RP-230810.

> Task RAN4 to assess the additional, if any, RAN4 specification impact and UE implementation impact for a UE configured with two serving cells, each with SUL; report to RAN#100 with the goal of striving for potential normative work supporting the case where a UE is configured with two serving cells, each with SUL
>
> E.g., whether back-to-back transmissions between two SUL carriers and back-to-back transmissions between SUL carrier and non-corresponding NUL carrier could be supported without any switching period, or
>
> E.g., whether it is only feasible to support such configuration in the UL Tx switching framework with UE capability based switching period
>
> Example band combinations are referred to in RP-223553 (RP-230719)
>
> Further check the status in RAN#100

- At the RAN#100, RAN4 CR in R4-2310270 was not approved and corresponding discussion was postponed to RAN#101

Issue 1: supported scenarios for Rel-18 UL Tx switching

- **Discussion**
  - Regarding the scenario with dual SUL, there is a clear operator's demand as shown in RP-223553, and RAN4 agreed that "For a UE configured with two serving cells, each with SUL, UL Tx switching between two SUL carriers and between SUL carrier and non-corresponding NUL carrier can be supported with UL Tx switching framework without additional RAN4 spec impact and UE implementation issue". Therefore, the scenario ({SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}) should be supported at least for the case of switched UL in Rel-18.
  - Regarding the dual UL support for the scenario with SUL(s), simultaneous transmission between SUL and SUL or non-corresponding NUL has not been studied/supported in previous releases as well as in Rel-18. We think that the study on such simultaneous transmission between SUL and SUL or non-corresponding NUL is necessary before supporting it.
  - On the other hand, simultaneous transmission between NUL and NUL in the scenario with SUL(s) can be supported. In Rel-18 UL Tx switching, switched UL or dual UL can be reported/configured per band pair, and hence supporting dual UL for specific band pair only can be handled.

- **Proposal**
  - **The scenario {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band} is supported in Rel-18 UL Tx switching framework (no back-to-back transmission), with following restrictions.**
    - » **For the band pair between NUL and NUL, "switched UL" or "dual UL" can be reported/configured.**
    - » **For any other band pair including SUL, only "switched UL" can be reported/configured in Rel-18.**
  - **The same restrictions are applied to the scenarios {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s).**

Issue 2: how to capture the supported scenarios/restrictions

- **Background**
  - In RAN1 specification TS38.214 section 6.1.6 on UL Tx switching, there are three sub-sections i.e., 6.1.6.1 for ENDC case, 6.1.6.2 for CA case and 6.1.6.3 for SUL case in Rel-16/17.
  - For Rel-18 TS38.214, the new sub-sub-section 6.1.6.2.2 for UL Tx switching with 3 or 4 UL bands is to be introduced according to the latest draft CR from editor (which was discussed in post-RAN1#113 email discussion but not endorsed due to Issue 1).
  - Due to Issue 1, RAN4 CR in R4-2310270 was not approved at RAN#100.
  - As proposed for Issue 1, if supported scenarios and restrictions are clarified by RAN, next issue is where/how to capture such supported scenarios and restrictions in the specifications, e.g., whether it should be in RAN4 spec, RAN1 spec or RAN2 spec (such as RRC/UE capability signaling)

- **Discussion**
  - In latest CRs for TS38.214 and TS38.101-1, there is no description about the proposed restriction for Issue 1 such as "**dual UL is not appliable to any band pair including SUL band**", and there is no restriction on dual SUL bands.
  - We think either one of following alternatives (or both) can be selected.
    - » Alt.1: clarify the restriction according to the Issue 1 discussion in **TS38.101-1 e.g., section 5.5C "Configurations for SUL"**
    - » Alt.2: clarify the restriction according to the Issue 1 discussion in **TS38.306/331 i.e., UE capability/RRC signaling on switchedUL/dualUL**

- **Proposal**
  - **RAN should provide guidance on where/how to capture the restrictions (if any) according to Issue 1 discussion.**

Issue 3: whether DCI format 0_3/1_3 can request Tx on SUL carrier

NTT docomo

- **Background**
  - At the RAN#99, it was agreed that UL/SUL indicator field is excluded from a DCI format 0_X.
  - RAN1 has been discussing whether DCI format 0_3/1_3 can request/schedule UL transmissions on SUL carrier(s)
    - » Some company argued that "SUL can be semi-statically configured and used without switching, therefore DCI 0_3 can still be used for scheduling PUSCH on SUL, without UL/SUL indicator".
      - – *UL/SUL indicator – **0 bit for** UEs not configured with supplementaryUplink in ServingCellConfig in the cell or **UEs configured with supplementaryUplink in ServingCellConfig in the cell but only one carrier in the cell is configured for PUSCH transmission**;*
    - » RAN1 has also been discussing the bit size per cell in the row of the joint SRS request configuration table
      - – Alt.1: BIT STRING(SIZE(x)), where x=3 for a cell configured with SUL and x=2 for a cell configured without SUL
      - – Alt.2: BIT STRING(SIZE(2))
- **Discussion**
  - UL CA band combination including one or two serving cells each with SUL is possible in Rel-18 (as in Issue 1).
  - Although legacy DCI with UL/SUL indicator can be used to dynamically select SUL or NUL for UL transmission, MC-DCI can also be used to schedule/request UL transmissions on set of cells including cell(s) with SUL.
    - » Due to no UL/SUL indicator field in MC-DCI, **pre-defined rule and/or semi-static configuration** to determine which carrier is scheduled/requested for UL transmission by MC-DCI is necessary for cell(s) with SUL.
    - » SRS request can be 2 or 3 bits according to SUL configuration for each serving cell as in legacy DCIs.
  - **However, as proposed for Issue 1, simultaneous transmission between SUL and SUL or NUL should not be expected.**
- **Proposal**
  - **RAN should provide guidance on whether DCI format 0_3/1_3 can request UL transmissions on cell(s) with SUL.**

Appendix 1:

- RAN#96 (RP-221880)

conclusion: proposal is agreed (without changes)

Proposal:
RAN provides following guidance to RAN1/2/4.
•If Rel-18 UL Tx switching is supported,
- **●RAN1/2/4 shall ~~work~~ focus on defining necessary mechanisms and requirements for UL Tx switching across 3 or 4 different bands ~~at least for following scenarios during Rel-18 timeframe~~in Q3 2022**
  - **➢Inter-band UL-CA Option 1 (i.e., switched UL) and Option 2 (i.e., dual UL) without SUL band**
  - **➢Inter-band UL CA Option 1 (i.e., switched UL) for {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s)**
    - **✧UL CA framework where UL CA is performed between NULs according to current RAN4 specifications should not be changed**
    - **✧Note: switching across any band in this scenario is not precluded**
  - **➢Intra-band two contiguous aggregated carriers within one non-SUL band out of 3 or 4 bands**
- **~~●Other~~ Further check additional scenarios ~~as below can be discussed~~ in ~~RAN4#104e and~~ RAN#97e, e.g.,**
  - **➢{SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}**
  - **➢Simultaneous transmission across 2 bands in {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s) (excluding simultaneous transmission between SUL and corresponding NUL)**
- **●Mechanisms/requirements should not introduce restrictions on what were already supported in current specifications for UL Tx switching**

Appendix 2:

- RAN#98-e (RP-223553)

RP-223515 **New WID: NR CA band combinations with dual SUL bands in Rel-18**

Type: WID new *For:* *Approval*
Source: CMCC

(Replaces RP-223075)

Discussion:

result of discussion [98e-08-R18-RAN4-SpectrumRelated]

conclusion: revised during Fri GTW to update Note 2 and to replace SUL_n79A-n98A by SUL_n79A-n95A for combo CA_SUL_n41A-n83A_SUL_n79A-n95A in the Excel list

Decision: The document was **revised to RP-223553**.

NOTE 2: No simultaneous uplink transmission on the two SUL bands according to Table 1.

RP-223553 **New WID: NR CA band combinations with dual SUL bands in Rel-18**

Type: WID new *For:* *Approval*
Source: CMCC

(Replaces RP-223515)

Discussion:

conclusion: RP-223553 is approved with the understanding that

- non-PC3 aspects will be removed from this WI and shifted into WI HPUE_FR1_TDD_NR_CADC_SUL_R18 at RAN #99;
- RAN4 will not work on non-PC3 aspects of WI RP-223553 in Q1/23)

Decision: The document was **approved**.

NOTE 2: No simultaneous uplink configuration on the two SUL bands according to Table 1.

Appendix 3:

RAN#99 (RP-230810)

- UL/SUL indicator field is excluded from a DCI format 0_X.
- Task RAN4 to assess the additional, if any, RAN4 specification impact and UE implementation impact for a UE configured with two serving cells, each with SUL; report to RAN#100 with the goal of striving for potential normative work supporting the case where a UE is configured with two serving cells, each with SUL
  - E.g., whether back-to-back transmissions between two SUL carriers and back-to-back transmissions between SUL carrier and non-corresponding NUL carrier could be supported without any switching period, or
  - E.g., whether it is only feasible to support such configuration in the UL Tx switching framework with UE capability based switching period
  - Example band combinations are referred to in RP-223553 (RP-230719)
  - Further check the status in RAN#100

RAN#100

conclusion: discussion is postponed to RAN #101 where we will decide, CR R4-2310270 of RP-231389 is postponed

- RP-230848 (R4-2310394): LS on support of UE configured with two serving cells, each with SUL

- For a UE configured with two serving cells, each with SUL, UL Tx switching between two SUL carriers and between SUL carrier and non-corresponding NUL carrier can be supported with UL Tx switching framework. Time mask requirements for switching across three or four uplink bands can be applied. No RAN4 specification impact is observed. No UE implementation issue is observed.
- For a UE configured with two serving cells, each with SUL, back to back transmission between two SUL carriers and back-to back transmission between SUL carrier and non-corresponding NUL carrier without any switching period can be supported by some UE implementations but enabling such feature will require RAN4 work.

Appendix 4:

- R4-2310270: TS38.101-1 CR

5.5C Configurations for SUL

The configuration tables for SUL describe Bandwidth Combination Sets. Bandwidth Combination Set 4 and 5 contains all possible defined channel bandwidths for each band in the combination. The fact that BCS4 and BCS5 contains all channel bandwidths for each band does not alter if a bandwidth is mandatory or optional for a given band. Bandwidths that are identified as optional in Table 5.3.5-1 for a given release are still optional for UEs that support BCS4 or BCS5. , where the bandwidths the UE supports for each band, the maximum bandwidth and/or minimum bandwidth for the band in the band combination are indicated in the UE capabilities. Note that the minimum bandwidth is indicated only in BCS5 and BCS5 shall not be indicated together with BCS4 for a SUL configuration. For SUL band combinations including FR1 intra-band CA and with BCS4 or BCS5, the Bandwidth Combination Sets for the FR1 intra-band CA are BCS4 or BCS5.

For the NR SUL band configurations with inter-band CA in sub-clause 5.5C, when the capability [*BandCombination-UplinkTxSwitch-r18*] is present, three or four bands can be configured in the uplink with simultaneous uplink transmission on up to two bands, and the corresponding requirements for SUL band configurations with inter-band CA and with uplink assigned to one or two bands shall apply. For each uplink band pair in the NR SUL band configurations with inter-band CA, according to the capability [*uplinkTxSwitching-OptionSupport*],

- if *switchedUL* is supported, uplink transmission on any one band of the band pair in the band combination shall be supported according to the scheduling commands, and the corresponding requirements for SUL band configuration with inter-band CA and with uplink assigned to one band on band X or band Y apply;
- if *dualUL* is supported, simultaneous uplink transmission on the two NR UL bands from the band pair for which *dualUL* is declared in the band combination shall be supported according to the scheduling commands, and the corresponding requirements for SUL band configuration with inter-band CA and with uplink CA between the two uplink bands apply.