**3GPP TSG RAN WG1 #102e R1-2006712**

**e-Meeting, August 17th – 28th, 2020**

**Source: Moderator (NTT DOCOMO, INC.)**

**Title:** **Summary on UE features for MR-DC/CA**

**Agenda Item:** **7.2.11**

**Document for:** **Discussion and Decision**

1. Introduction

This contribution summarizes the discussions and proposals in AI 7.2.11 regarding UE features for MR-DC/CA enhancement.

Based on the discussions summarized in Section 2, following is one of the suggested email discussions/approvals for AI 7.2.11.

**FL proposal of email discussion/approval:**

**Email discussion/approval on UE features for MR-DC/CA (17th – 20th August)**

* **Whether and how to define FG 18-4b.**
* **Whether and how to define FG 18-5c/5d, including values of X, reporting type, applicable PDCCH monitoring capability and corresponding potential further separate capability**
* **Whether to add “different only” as candidate value for FG18-5a/6a**
* **Whether/how to add candidate values for FG18-7**
* **Whether to modify “DL DCI” to “unicast DL DCI” in FG18-9 FG name**
* **Whether the note “This FG is for synchronous EN-DC” is kept or removed for FG18-2a/2b/3/3a/3b**
* **Whether/how to modify the prerequisite FG of FG18-3a/3b**

Companies are encouraged to check above FL proposal and to provide feedback if any in below.

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| Company | Comment |
| MTK | Thanks for the well-organized summary. We think the topics FL proposed should be discussed in this meeting. |
| Apple | We are supportive of the FL proposal |
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1. Discussion on NR Rel-16 UE features for MR-DC/CA
   1. FG18-4/[18-4b]

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| 18. MR-DC/CA enhancement | 18-4 | SCell dormancy indication within active time | Support for SCell dormancy indication sent within the active time on PCell with DCI format 0\_1/1\_1 | 6-5 | Yes | N/A |  | Per BC | N/A | N/A | N/A | One dormant BWP and one non-dormant BWP is supported per carrier  More than one non-dormant BWP per carrier is supported only if UE feature 6-3/6-4 is also supported | Optional with capability signalling |
| 18. MR-DC/CA enhancement | [18-4b] | [Support of SCell dormancy indication without data scheduling within active time] | [Support of SCell dormancy indication without data scheduling within active time] | TBD | Yes | N/A |  | FFS [Per UE or Per BC] | No | [Yes or N/A] | N/A |  | Optional with capability signaling |

Following proposals are made in contributions.

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| [2] | From UE implementation point of view, the main difference resides in the HARQ-ACK feedback of the different dormancy indication mechanisms, i.e., one mechanism is to follow the legacy PDSCH feedback and another mechanism is to follow the dedicated HARQ-ACK for dormancy indication PDCCH. However, it seems this implementation difference doesn’t require a separate UE feature. Furthermore, from NR community perspective, this can also promote the development of UE power saving.  ***Proposal 12****: Delete FG18-4b and make it as a component of FG18-4.*  If companies cannot converge on deleting FG 18-4b or keeping FG 18-4b, another way could be to define a default power saving mechanism if UE indicates support of UE power saving mechanism.  ***Proposal 13****: Define a default dormancy indication mechanism if companies cannot converge on deleting FG 18-4b or keeping FG 18-4b.*   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 18. MR-DC/CA enhancement | 18-4 | SCell dormancy indication within active time | Component#1: Support for SCell dormancy indication sent within the active time on PCell with DCI format 0\_1/1\_1  Component#2: Support of SCell dormancy indication without data scheduling within active time | 6-5 | Yes | N/A |  | Per BC | N/A | N/A | N/A | One dormant BWP and one non-dormant BWP is supported per carrier  More than one non-dormant BWP per carrier is supported only if UE feature 6-3/6-4 is also supported | Optional with capability signalling  {Component#1,  both components} | |
| [4] | Our preference is below, as there seems minor implementation additions/extra complexity needed for these two cases, especially if there can be an extra X symbols relaxed for the BWP switching for dormancy operation.   * **The FG 18-4b is removed with the following assumption:**   + The N value in 38.213 10.3 can be relaxed by [X] (X> 0) symbols for each subcarrier spacing, depending on further discussion in RAN1 and/or RAN4 replying LS in the next meeting.   + This does not preclude the possibility that DCI format 0\_1 and/or 1\_1 carrying dormancy indication field is expected only in the first 3 symbols of a slot, to be further discussed in the next RAN1 meeting together with consideration of RAN4 replying LS. |
| [5] | For the SCell dormancy indication, FG [18-4b] treats it separately for the case that the trigger is DCI format 1\_1 without scheduled PDSCH, i.e. Case 2. In fact, Case 1 or Case 2 are only differentiated by whether a PDSCH or PUSCH is scheduled or not. All other SCell dormancy operations are common to both cases, except for some concern on HARQ-ACK feedback. Though the most simplified way to let gNB implementation guarantee the feedback delay, it is also fine to relax the UE processing time defined for SPS PDSCH release for several symbols. Further, a benefit of supporting both cases is to allow a full flexibility for the gNB to control the SCell dormancy behaviors. Therefore, we slightly prefer following Alt. 1 from moderator in email discussion [101-e-Post-NR-UE-Features-13].  **Proposal 19: we are supportive on latest Alt 1 from modorator in [101-e-Post-NR-UE-Features-13], i.e. the FG 18-4b is removed with the following assumption:**   * + **The N value in 38.213 10.3 can be relaxed by [X] (X> 0) symbols for each subcarrier spacing, depending on further discussion in RAN1 and/or RAN4 replying LS in the next meeting.**   + **This does not preclude the possibility that DCI format 0\_1 and/or 1\_1 carrying dormancy indication field is expected only in the first 3 symbols of a slot, to be further discussed in the next RAN1 meeting together with consideration of RAN4 replying LS.** |
| [6] | For the FG 18-4b, following alternatives are considered:  **Alt.1**   * **The FG 18-4b is removed with the following assumption:**   + The N value in 38.213 10.3 can be relaxed by [X] (X> 0) symbols for each subcarrier spacing, depending on further discussion in RAN1 and/or RAN4 replying LS in the next meeting.   + This does not preclude the possibility that DCI format 0\_1 and/or 1\_1 carrying dormancy indication field is expected only in the first 3 symbols of a slot, to be further discussed in the next RAN1 meeting together with consideration of RAN4 replying LS.   **Alt.2**   * **The FG 18-4b is kept with the following assumption:**   + No relaxation on N value in 38.213 10.3 from RAN1 perspective; further requirement could be defined as RAN4 capability if deemed necessary   + No restriction on the possible location of DCI format 0\_1 and 1\_1 carrying dormancy indication field in a slot   We prefer to keep 18-4b. HARQ-ACK feedback requirements are different – for example, 18-4 may not result to less latency than the current MAC-based activation/deactivation while 18-4b does. The attributes and motivates for 18-4 and 18-4b are identifiably different and therefore they should be separate FGs. Therefore it is preferred to keep the 18-4b.  ***Proposal 1*:** *The FG 18-4b is kept.* |
| [8] | * We prefer that this FG is removed and the support of SCell dormancy indication without data scheduling is covered by FG18-4. Once SCell dormancy functionality is introduced at NW, NW would like to utilize the indication with scheduling and indication without scheduling for UE supporting FG18-4 according to the presence/absence of scheduling data for the UE. At least we would like to avoid having three types of UEs supporting dormancy indication with active time, 1) UE supporting only 18-4, 2) UE supporting only 18-4b, 3) UE supporting both 18-4/4b, in NW to avoid complex operation. |
| [9] | Since this FG has a dependency on RAN1 and RAN4 discussions on the interruption time caused by SCell dormancy DCI and reception timing of the DCI. It would be better if decision on this FG is postponed. We agree with the FL proposal to wait for more conclusions to be made in RAN1 and RAN4. It is also understood if there is still no conclusion from RAN1 and RAN4 on the related issues before deadline of this FG, a decision can be made in UE feature discussions.  If it is decided that FG 18-4b is kept, a few points can be clarified  **Proposal: If FG 18-4b is kept**   * **Clarify FG 18-4 is applicable to SCell dormancy indication with data scheduling within active time** * **Type of FG 18-4b is “Per BC”** |
| [10] | Separate FG for ‘Support of SCell dormancy indication without data scheduling within active time’ should not be introduced. Whether to use dormancy indication with or without data scheduling depends on the CA use case (i.e., #CCs, intra or inter-band CA etc.), and it is more efficient to handle these cases if UE supporting dormancy supports both cases. It is not also efficient if different UEs supporting dormancy support only one of the two cases.   1. FG 18-4b is not introduced. |

**Discussion point#1**

* **Whether and how to define FG 18-4b.**
  1. FG18-5/5b/[5c]/[5d]

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| 18. MR-DC/CA enhancement | 18-5 | DL cross-carrier scheduling with different SCS | 1. The UE supports DL cross carrier scheduling for the different numerologies with carrier indicator field (CIF) in DL carrier aggregation where numerologies for the scheduling cell and scheduled cell are different  Candidate value set for component 1: {Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both} | 6-5 | Yes | N/A |  | Per BC | N/A | N/A | N/A | crossCarrierScheduling-OtherSCS | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-5b | UL cross-carrier scheduling with different SCS | 1. The UE supports UL cross carrier scheduling for the different numerologies with carrier indicator field (CIF) in UL carrier aggregation where numerologies for the scheduling cell and scheduled cell are different  Candidate value set for component 1: {Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both} | 6-6 | Yes | N/A |  | Per BC | N/A | N/A | N/A | crossCarrierScheduling-OtherSCS | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-5c | Processing up to X unicast DCI scheduling for DL per scheduled CC | Processing up to X unicast DCI scheduling for DL per scheduled CC   * + X is based on pair of (scheduling CC SCS, scheduled CC SCS):     - X=[4] for (15,120), (15,60), (30,120),     - X=[2] for (15,30), (30,60), (60,120 kHz),     - X applies per span in a slot of scheduling CC     - FFS: additional value X |  |  |  |  |  |  |  |  | FFS: Modify the note to “[In case UE supports 3-5b, the limits apply for each span for FDD scheduling cell and TDD scheduling cell.]”  FFS: which PDCCH monitoring related capabilities this FG applies to  FFS: detailed design of this FG |  |
| 18. MR-DC/CA enhancement | 18-5d | Processing up to X unicast DCI scheduling for UL per scheduled CC | Processing up to X unicast DCI scheduling for UL per scheduled CC   * + X is based on pair of (scheduling CC SCS, scheduled CC SCS):     - X=[4] for (15,120), (15,60), (30,120),     - X=[2] for (15,30), (30,60), (60,120 kHz),     - X applies per span in a slot of scheduling CC     - FFS: additional value X |  |  |  |  |  |  |  |  | FFS: Modify the note to “[In case UE supports 3-5b, the limits apply for each span for FDD scheduling cell and TDD scheduling cell.]”  FFS: which PDCCH monitoring related capabilities this FG applies to  FFS: detailed design of this FG |  |

Following proposals are made in contributions.

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| [3] | In the latest RAN1 UE feature list [1], the following UE capabilities structure for DL/UL cross carrier scheduling is applied:    It can be seen that the enhanced DCI processing capability (component 2 highlighted in yellow) is still in bracket and not stable yet. Since FG 18-5 and FG 18-5b are basic features for cross-carrier scheduling, and with the late state in Rel-16, we do not think the enhanced DCI processing capability should be included inside the basic features.  **Proposal 5: Remove Component 2 from FG 18-5 and FG 18-5b.** |
| [4] | We don’t think further modification or additional values of X is needed, since it is already a separate FG. Both two FGs can be per BC reported and N/A for XDD/FRX differentiation, as optional capabilities. |
| [5] | In cross-carrier scheduling, if the scheduling cell has a lower SCS than the scheduled cell, it is necessary to increase the number of PDCCHs that schedules PDSCHs for the scheduling flexibility [2]. In FG 18-5 or 18-5b, the component 2) is regarding increased number of processed PDCCH per span. If the Component 2 in FG18-5/5b is removed, UE doesn’t have a capability to handle multiple DCIs at a same PDCCH MO with corresponding HARQ-ACK in same codebook. It basically reverts the agreement which we made in MR-DC session on the enhanced HARQ-ACK codebook generation. Therefore, we prefer to keep component 2 for FG 18-5/5b or its equivalent as a UE capability. We are fine with latest proposal from moderator.  **Proposal 20: we are supportive to latest proposal from moderator in [101-e-Post-NR-UE-Features-13], i.e.**   * **A new FG for “Processing up to X unicast DCI scheduling for DL per scheduled CC” is added in UE features list for MR-DC/CA**   + **X is based on pair of (scheduling CC SCS, scheduled CC SCS):**     - **X=[4] for (15,120), (15,60), (30,120),**     - **X=[2] for (15,30), (30,60), (60,120 kHz),**     - **X applies per span in a slot of scheduling CC**     - **FFS: additional value X**   + **Component 2 description and following note in FG18-5 is moved to this FG**     - **FFS: Modify the note to “[In case UE supports 3-5b, the limits apply for each span for FDD scheduling cell and TDD scheduling cell.]”**     - **FFS: which PDCCH monitoring related capabilities this FG applies to**   + **FFS: detailed design of this FG** * **A new FG for “Processing up to X unicast DCI scheduling for UL per scheduled CC” is added in UE features list for MR-DC/CA**   + **X is based on pair of (scheduling CC SCS, scheduled CC SCS):**     - **X=[4] for (15,120), (15,60), (30,120),**     - **X=[2] for (15,30), (30,60), (60,120 kHz),**     - **X applies per span in a slot of scheduling CC**     - **FFS: additional value X**   + **Component 2 description in FG18-5b is moved to this FG**     - **FFS: Modify the note to “[In case UE supports 3-5b, the limits apply for each span for FDD scheduling cell and TDD scheduling cell.]”**     - **FFS: which PDCCH monitoring related capabilities this FG applies to**   + **FFS: detailed design of this FG** |
| [9] | Regarding the new FG 18-5c and FG 18-5d which used to be the component 2 of FG 18-5/5b, we do not think they are needed. The current FG 3-5b is already enough for lower SCS carrier scheduling higher SCS carrier case. There is no need to define the new FGs with vast impact to cross-carrier scheduling feature given unclear additional benefit.  **Proposal: Remove component 2 from FG 18-5/5b. Do not define new FG 18-5c/5d.** |
| [10] | The following was agreed in the email discussion [101-e-Post-NR-UE-Features-13]:   * *A new FG (18-5c) for “Processing up to X unicast DCI scheduling for DL per scheduled CC” is added in UE features list for MR-DC/CA*   + *X is based on pair of (scheduling CC SCS, scheduled CC SCS):*     - *X=[4] for (15,120), (15,60), (30,120),*     - *X=[2] for (15,30), (30,60), (60,120 kHz),*     - *X applies per span in a slot of scheduling CC*     - *FFS: additional value X*   + *Component 2 description and following note in FG18-5 is moved to this FG*     - *FFS: Modify the note to “[In case UE supports 3-5b, the limits apply for each span for FDD scheduling cell and TDD scheduling cell.]”*     - *FFS: which PDCCH monitoring related capabilities this FG applies to*   + *FFS: detailed design of this FG* * *A new FG (18-5d) for “Processing up to X unicast DCI scheduling for UL per scheduled CC” is added in UE features list for MR-DC/CA*   + *X is based on pair of (scheduling CC SCS, scheduled CC SCS):*     - *X=[4] for (15,120), (15,60), (30,120),*     - *X=[2] for (15,30), (30,60), (60,120 kHz),*     - *X applies per span in a slot of scheduling CC*     - *FFS: additional value X*   + *Component 2 description in FG18-5b is moved to this FG*     - *FFS: Modify the note to “[In case UE supports 3-5b, the limits apply for each span for FDD scheduling cell and TDD scheduling cell.]”*     - *FFS: which PDCCH monitoring related capabilities this FG applies to*   + *FFS: detailed design of this FG*   The FFS parts and the square brackets need to be resolved. Regarding the values of X, at least the values listed in square brackets should be confirmed. We are also OK to introduce additional value of X in which case UE must explicitly indicate the X value supported.  For the PDCCH monitoring capability, the FG should apply at least to the basic 3-1 capability. We are also okay to apply the limits to 3-5b, in which case the limits apply for each span for the FDD scheduling cell and TDD scheduling cell, but this might need a separate indication from the UE.   1. For FGs 18-5c and 18-5d, at least the values of X in square brackets are supported. 2. For FGs 18-5c and 18-5d, the FGs are applicable to at least the basic PDCCH monitoring capability 3-1. 3. For FGs 18-5c and 18-5d, a UE can separately indicate if FG is applicable to PDCCH monitoring capability 3-5b, in which case the limits apply for each span for the FDD scheduling cell and TDD scheduling cell. |

**Discussion point#2**

* + **Whether and how to define FG 18-5c/5d, including values of X, reporting type, applicable PDCCH monitoring capability and corresponding potential further separate capability**
  1. FG18-5a/6a

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| 18. MR-DC/CA enhancement | 18-5a | Default QCL assumption for cross-carrier scheduling | Indicates whether the UE can be configured with enabledDefaultBeamForCCS for default QCL assumption for cross-carrier scheduling for same/different numerologies   * Candidate values are {same only, both}   + When “both” is reported, the UE supports this feature for same SCS and for different SCS combination(s) (low-to-high, high-to-low or both) reported for 18-5 | one of {6-10, 18-5} | Yes | N/A |  | Per BC | N/A | N/A | N/A |  | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-6a | Default QCL assumption for cross-carrier A-CSI-RS triggering | Indicates whether the UE can be configured with enabledDefaultBeamForCCS for default QCL assumption for cross-carrier A-CSI-RS triggering for same/different numerologies   * Candidate values are {same only, both}   + When “both” is reported, the UE supports this feature for same SCS and for different SCS combination(s) (low-to-high, high-to-low or both) reported for 18-6 | 6-5 | Yes | N/A |  | Per BC | N/A | N/A | N/A |  | Optional with capability signalling |

Following proposals are made in contributions.

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| [3] | In the latest RAN1 UE feature list [1], the candidate values for FG 18-5a and FG 18-6a are still FFS:    We thus have the following proposal:  **Proposal 7: For FG 18-5a and FG 18-6a, the candidate value should be {same numerology, different numerology, both}.** |
| [5] | In an alternative proposal of candidate values, i.e. {scheduling cell SCS = scheduled cell SCS, scheduling cell SCS < scheduled cell SCS, scheduling cell SCS > scheduled cell SCS}, FG18-5a/6a applies to only one of, but not both of ‘scheduling cell SCS < scheduled cell SCS’ and ‘scheduling cell SCS > scheduled cell SCS’. Such a limitation is not preferred. On the other hand, with the note in the sub-bullet, FG18-5a/6a has the aligned capability as FG18-5/6.  **Proposal 21: we supportive to updated proposal 3 from moderator in [101-e-Post-NR-UE-Features-13]:**   * **Candidate values for FG18-5a/6a are {same only, both}**   + **When “both” is reported for FG18-5a/6a, the UE supports this feature for same SCS and for different SCS combination(s) (low-to-high, high-to-low or both) reported for 18-5/18-6** |
| [9] | Regarding the default QCL FGs, we support Alt. 2. “different only” in Alt. 1 or corresponding combinations of different SCSs in Alt. 2 should be kept to allow a Rel-16 UE to follow Rel-15 behavior for cross-carrier scheduling with same SCS (i.e., no default QCL assumption) but support default QCL for the Rel-16 cross-carrier scheduling with different SCS.  **Proposal: For FG 18-5a/6a, support Alt. 2. “different only” or corresponding combinations of different SCSs should be kept.** |

**Discussion point#3**

* **Whether to add “different only” as candidate value for FG18-5a/6a**
  1. FG18-7

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| 18. MR-DC/CA enhancement | 18-7 | CA with non-aligned frame boundaries | CA with non-aligned frame boundaries for inter-band CA | 6-5 for DL CA with non-aligned frame boundaries for inter-band CA  6-6 for UL CA with non-aligned frame boundaries for inter-band CA | Yes | N/A |  | Per BC | N/A | N/A | N/A | Defines whether the UE supports carrier aggregation operation where the frame boundaries of the Pcell and the Scell are not aligned, while the slot boundaries are. | Optional with capability signalling |

Following proposals are made in contributions.

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| [3] | In the latest RAN1 UE feature list [1], the following UE capabilities structure for unaligned CA is applied:    It should be noted that many important parameters (say SMTC window, measurement gap) are defined on the timeline of PCell. To avoid the SCell slot slit, we suggest to add the following candidate values to FG 18-7 that UE can report:   * **PCell/PSCell** lowest SCS among all the configured SCSs in DL/UL *SCS-SpecificCarrierList* in *ServingCellConfig* **<=** **SCell** lowest SCS among all the configured SCSs in DL/UL *SCS-SpecificCarrierList* in *ServingCellConfig* * **PCell/PSCell** lowest SCS among all the configured SCSs in DL/UL *SCS-SpecificCarrierList* in *ServingCellConfig* **>** **SCell** lowest SCS among all the configured SCSs in DL/UL *SCS-SpecificCarrierList* in *ServingCellConfig* * both     **Figure 1: SCell slot slit when PCell SCS > SCell SCS**  **Proposal 8: To avoid the SCell slot slit issue while many important parameters (say SMTC window, measurement gap) are defined on the timeline of PCell, add the following candidate values to FG 18-7 that UE can report:**   * **PCell/PSCell lowest SCS among all the configured SCSs in DL/UL *SCS-SpecificCarrierList* in *ServingCellConfig* <= SCell lowest SCS among all the configured SCSs in DL/UL *SCS-SpecificCarrierList* in *ServingCellConfig*** * **PCell/PSCell lowest SCS among all the configured SCSs in DL/UL *SCS-SpecificCarrierList* in *ServingCellConfig* > SCell lowest SCS among all the configured SCSs in DL/UL *SCS-SpecificCarrierList* in *ServingCellConfig*** * **both** |

**Discussion point#4**

* **Whether/how to add candidate values for FG18-7**
  1. FG18-9

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| 18. MR-DC/CA enhancement | 18-9 | Type2 HARQ-ACK codebook for >1 DL DCIs in same Monitoring Occasion | For HARQ-ACK type 2 codebook: Usage of the PDSCH starting time in addition to the existing MO and Cell index to order the HARQ-ACK feedback | 3-1 | Yes | N/A |  | Per UE | No | No | N/A | Note: The UE capability is introduced with following assumption:  ·Specification reflects that UE behavior is modified only for UEs supporting this capability.  ·UE behavior of a UE supporting this capability is different from UE behavior of a UE not supporting this capability only for following case:  ·Type-2 HARQ-ACK codebook when HARQ-ACK feedback in a codebook corresponds to more than one DL DCI for same scheduled cell in a MO of a scheduling cell. | Optional with capability signalling |

Following proposals are made in contributions.

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| [3] | In the latest RAN1 UE feature list [1], a new UE feature FG 18-9 “**Type2 HARQ-ACK codebook for >1 DL DCIs in same Monitoring Occasion**” is defined in RAN1 #101e [2] as shown below:    To our understanding, in the feature group description, the “**DL DCI**” should be modified to be “**unicast DL DCI**”.  During RAN1 online email discussion in RAN1 #101e, the original FL proposal is:   * **Feature lead proposal: introduce a resolution based on option 1:**   + If the maximum number of unicast DCIs per MO per scheduled cell is increased to larger than one, the PDSCH starting time in addition to the existing MO and Cell index is introduced to order the HARQ-ACK feedback.   + Introduce separate UE capability as being discussed under the UE feature session   After a lengthy discussion, the “unicast” is lost due to no reason. Thus, the DCI mentioned in FG 18-9 here should be “unicast” DCI.  **Proposal 6: In FG 18-9 “Type2 HARQ-ACK codebook for >1 DL DCIs in same Monitoring Occasion”, Modify “DL DCI” to be “unicast DL DCI” for clarification.** |

**Discussion point#5**

* **Whether to modify “DL DCI” to “unicast DL DCI” in FG18-9 FG name**
  1. FG18-2a/2b/3/3a/3b

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| 18. MR-DC/CA enhancement | 18-2a | Enhanced single UL TX operation for FDD Pcell EN-DC | TDM restriction to LTE FDD Pcell in EN-DC for single UL-Transmission associated functionality when tdm-patternConfig-r16 is configured  1) DL-reference UL/DL configuration defined for LTE-FDD-SCell in LTE-TDD-FDD CA with LTE-TDD-PCell  2) PRACH transmission in non- designated UL subframes given by the DL-reference configuration (only for type 1 UE)  3) LTE UL transmissions scheduled/triggered by a DCI in any UL subframe not limited to the reference TDM pattern (only for type 1 UE)  4) the UE does not transmit on SCG in FR1 when the UE has overlapped transmission on a subframe on the MCG if the conditions in TS38.213 Section 7.6.1 are satisfied | 6-13 | Yes | N/A |  | Per band combination | Applicable to in FDD-LTE -NR EN-DC | Applicable to FR1 only |  | Enhancement to the R15 capability tdm-Pattern  [This FG is for synchronous EN-DC] | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-2b | Support of HARQ-offset for SUO case1 in EN-DC with LTE TDD PCell for type 1 UE | Support of HARQ-offset for SUO case1 in EN-DC with LTE TDD PCell for type 1 UE | 18-2 | Yes | N/A |  | Per band combination | N/A | N/A | N/A | [This FG is for synchronous EN-DC] | Optional with capability signaling |
| 18. MR-DC/CA enhancement | 18-3 | Dual Tx transmission for EN-DC with FDD PCell(TDM pattern for dual Tx UE) | TDM restriction to LTE FDD PCell in EN-DC for dual UL Tx operation when tdm-patternConfig-r16 is configured  1) DL-reference UL/DL configuration defined for LTE-FDD-SCell in LTE-TDD-FDD CA with LTE-TDD-PCell  2) PRACH transmission in non- designated UL subframes given by the DL-reference configuration (only for type 1 UE)  3) LTE UL transmissions scheduled/triggered by a DCI in any UL subframe not limited to the reference TDM pattern (only for type 1 UE) | 6-13, EN-DC | Yes | N/A |  | Per band combination | Applicable to EN-DC with LTE FDD PCell only | Applicable to FR1 only |  | Extension of the R15 capability tdm-Pattern to a dual Tx UE  [This FG is for synchronous EN-DC] | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-3a | Semi-statically configured LTE UL transmissions in all UL subframes not limited to tdm-pattern in case of FDD PCell | UE configured with tdm-patternConfig-r16 can be semi-statically configured with LTE UL transmissions in all UL subframes not limited to the reference tdm-pattern (only for type 1 UE) in case of FDD PCell | 18-2a | Yes | N/A |  | Per UE | Applicable to EN-DC only | Applicable to FR1 only |  | [This FG is for synchronous EN-DC] | Optional with capability signaling |
| 18. MR-DC/CA enhancement | 18-3b | Semi-statically configured LTE UL transmissions in all UL subframes not limited to tdm-pattern in case of TDD PCell | UE configured with tdm-patternConfig-r16 can be semi-statically configured with LTE UL transmissions in all UL subframes not limited to the reference tdm-pattern (only for type 1 UE) in case of TDD PCell | One of {18-2, 18-3} | Yes | N/A |  | Per UE | Applicable to EN-DC only | Applicable to FR1 only |  | [This FG is for synchronous EN-DC] | Optional with capability signaling |

Following proposals are made in contributions.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [4] | **18-2a/2b/3/3a**  We feel “This FG is for synchronous EN-DC” should be removed. According to the agreements below, all Rel-15 UE behaviors at LTE side are inherited.   |  | | --- | | * + Agreements: * For the single-Tx case, for FDD LTE Pcell,   + All uplink subframes can be scheduled for LTE for type 1 Ues     - In which case, NR transmission is dropped for when the LTE and NR transmissions collide     - Note: there is no change of UL scheduling timing for LTE compared to R15 single-Tx with LTE FDD Pcell   + Agreements: * For the dual-Tx case, for FDD LTE Pcell,   + All uplink subframes can be scheduled for LTE at least for type 1 Ues     - Note: there is no change of UL scheduling timing for LTE compared to R15 single-Tx with LTE FDD Pcell   + Agreements: * R15 specification on “DL HARQ timing for FDD Scell for LTE TDD-FDD CA with TDD Pcell, applied to FDD Pcell” (i.e., case1 HARQ timing in single UL), is applied to EN-DC UE capable of dual UL Tx in EN-DC with LTE FDD Pcell to mitigate DL de-sensing due to Harmonics, at least including: * UE behavior specified in 36.213 and 36.212 * FFS: all uplink subframes can be scheduled for LTE |   If such restriction is introduced, it will cause non-backwards compatibility to Rel-15 UE behaviors, i.e. the prerequisite FG 6-13. Regarding the concern raised on potential increase of UE complexity for asynchronous operation, we are afraid that it is not true because it has been agreed that all Rel-16 EN-DC UEs will support dynamic power sharing with NR dropping for both asynchronous and synchronous EN-DC. The LTE TDM pattern has no change to the basic UE behavior but only restricting available LTE PUCCH subframes and introducing corresponding DL HARQ timing, regardless it is asynchronous or synchronous between LTE link and NR link. The potential burden to the UE implementation only exists for the dynamic power sharing between LTE and NR modem instead of introducing TDM pattern. In conclusion, the note “this FG is for synchronous EN-DC” of FG 18-2a/2b/3/3a should be removed.  **Proposal DCA-1: Make modifications for the following UE feature groups as in Table:**   * **For FG 18-2a/2b/3/3a, delete the “This FG is for synchronous EN-DC” in the note column.**   **18-3a/3b**  Note that in the agreement above the FG 18-3 is introduced for the indication of dual Tx transmission for EN-DC with **FDD** PCell, and the FG 18-3b in introduced to indicate the capability of Semi-statically configured LTE UL transmissions in all UL subframes not limited to tdm-pattern in case of **TDD** PCell. Thus, FG 18-3 should be the prerequisite FG of FG 18-3a instead of FG 18-3b.  **Proposal DCA-2: Make modifications for the following UE feature groups as in Table:**   * **Change the FG 18-3 as the prerequisite FG of FG 18-3a instead of FG 18-3b.**   **Table. Update and revise the feature group 18-2a/2b/3/3a/3b**   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Type** | **Need of FDD/TDD differentiation** | **Need of FR1/FR2 differentiation** | **Note** | **Mandatory/Optional** | | 18-2a | Enhanced single UL TX operation for FDD Pcell EN-DC | TDM restriction to LTE FDD Pcell in EN-DC for single UL-Transmission associated functionality when tdm-patternConfig-r16 is configured  1) DL-reference UL/DL configuration defined for LTE-FDD-SCell in LTE-TDD-FDD CA with LTE-TDD-PCell  2) PRACH transmission in non- designated UL subframes given by the DL-reference configuration (only for type 1 UE)  3) LTE UL transmissions scheduled/triggered by a DCI in any UL subframe not limited to the reference TDM pattern (only for type 1 UE)  4) the UE does not transmit on SCG in FR1 when the UE has overlapped transmission on a subframe on the MCG if the conditions in TS38.213 Section 7.6.1 are satisfied | 6-13 | Per BC | Applicable to in FDD-LTE -NR EN-DC | Applicable to FR1 only | Extension of the R15 capability tdm-Pattern to TDD PCell | Optional with capability signaling | | 18-2b | Support of HARQ-offset for SUO case1 in EN-DC with LTE TDD PCell for type 1 UE | Support of HARQ-offset for SUO case1 in EN-DC with LTE TDD PCell for type 1 UE | 18-2 | Per BC | N/A | N/A |  | Optional with capability signaling | | 18-3 | Dual Tx transmission for EN-DC with FDD PCell(TDM pattern for dual Tx UE) | TDM restriction to LTE FDD PCell in EN-DC for dual UL Tx operation when tdm-patternConfig-r16 is configured  1) DL-reference UL/DL configuration defined for LTE-FDD-SCell in LTE-TDD-FDD CA with LTE-TDD-PCell  2) PRACH transmission in non- designated UL subframes given by the DL-reference configuration (only for type 1 UE)  3) LTE UL transmissions scheduled/triggered by a DCI in any UL subframe not limited to the reference TDM pattern (only for type 1 UE) | 6-13, EN-DC | Per BC | Applicable to EN-DC with LTE FDD PCell only | Applicable to FR1 only | Extension of the R15 capability tdm-Pattern to a dual Tx UE | Optional with capability signalling | | 18-3a | Semi-statically configured LTE UL transmissions in all UL subframes not limited to tdm-pattern in case of FDD PCell | UE configured with tdm-patternConfig-r16 can be semi-statically configured with LTE UL transmissions in all UL subframes not limited to the reference tdm-pattern (only for type 1 UE) in case of FDD PCell | 18-2a, 18-3 | Per UE | Applicable to EN-DC only | Applicable to FR1 only |  | Optional with capability signaling | | 18-3b | Semi-statically configured LTE UL transmissions in all UL subframes not limited to tdm-pattern in case of TDD PCell | UE configured with tdm-patternConfig-r16 can be semi-statically configured with LTE UL transmissions in all UL subframes not limited to the reference tdm-pattern (only for type 1 UE) in case of TDD PCell | 18-2 | Per UE | Applicable to EN-DC only | Applicable to FR1 only |  | Optional with capability signaling | |
| [6] | For FG18-2a/2b/3/3a/3b, a remaining issue is whether each of them is for synchronous EN-DC. As provided during UE feature email discussion [3], our view is to remove the note “[This FG is for synchronous EN-DC]” from FG18-2a/2b/3/3a because it was not specified even for the single TX UL operation in Rel-15 and similar approach can be applied for Rel-16.  ***Proposal 2:*** *The note “[This FG is for synchronous EN-DC]” is removed from FG18-2a/2b/3/3a/3b.* |
| [7] | * **Note “[This FG is for synchronous EN-DC]” for FG18-2a/2b/3/3a:** It should be clear from the descriptions that the corresponding FGs apply for synchronous case only, irrespective of having the note included or not. From that point of view we are fine either way as long as that is the common understanding in RAN1. |
| [9] | As We and MediaTek commented, EN-DC with TDM switched operation does not work if SN does not know the timing of MN. We have not seen any reasonable answer on this concern. We believe it is inpractical to include asynchronous EN-DC operation as the scenario of TDM operation using *tdm-PatternConfig-r16* while it causes a huge burden to the UE implementation/testability.  Note that “[This FG is for synchronous EN-DC]” in the row for FG18-3b has been missed in the email discussion [101-e-Post-NR-UE-Features-13]. However, we believe it should also be resolved together with the same thing for FG18-2a/2b/3/3a.  Proposal: The note “[This FG is for synchronous EN-DC]” is kept for FG18-2a/2b/3/3a/3b with removing the square bracket. |

**Discussion point#6**

* **Whether the note “This FG is for synchronous EN-DC” is kept or removed for FG18-2a/2b/3/3a/3b**

**Discussion point#7**

* **Whether/how to modify the prerequisite FG of FG18-3a/3b**

Reference

[1] R1-2006462 Updated RAN1 UE features list for Rel-16 NR Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2005423 Discussion on NR Rel-16 UE Features ZTE

[3] R1-2005781 Views on Rel-16 UE features MediaTek Inc.

[4] R1-2005814 Remaining details of Rel-16 NR UE features Huawei, HiSilicon

[5] R1-2005857 Rel-16 UE feature Intel Corporation

[6] R1-2006124 Remaining issues on NR Rel-16 UE features Samsung

[7] R1-2006677 Remaining aspects of Rel-16 UE features Nokia, Nokia Shanghai Bell

[8] R1-2006703 Discussion on NR Rel-16 UE features NTT DOCOMO, INC.

[9] R1-2006788 Discussion on NR Rel-16 UE features Qualcomm Incorporated

[10] R1-2006874 Remaining details of Rel-16 NR UE features Ericsson

Appendix: UE features list for MR-DC/CA in [1]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **( 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 18. MR-DC/CA enhancement | 18-1 | Basic UL power sharing for DC | Semi-static power sharing mode1 between MCG and SCG cells of same FR for NR dual connectivity. |  | Yes | N/A |  | Per BC | N/A | N/A | N/A | Absence means intra-FR DC is not supported. | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-1a | Semi-static UL power sharing mode 2 for DC | Semi-static power sharing mode 2 between MCG and SCG cells of same FR for NR dual connectivity. | 18-1 | Yes | N/A |  | Per BC | N/A | N/A | N/A | Semi-static power sharing mode 2 between MCG and SCG cells of same FR is applicable only for synchronous NR dual connectivity | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-1b | Dynamic UL power sharing for DC | Dynamic power sharing between MCG and SCG cells of same FR for NR dual connectivity.   1. T\_offset | 18-1 | Yes | N/A |  | Per BC | N/A | N/A | N/A | 1) {short, long} | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-4 | SCell dormancy indication within active time | Support for SCell dormancy indication sent within the active time on PCell with DCI format 0\_1/1\_1 | 6-5 | Yes | N/A |  | Per BC | N/A | N/A | N/A | One dormant BWP and one non-dormant BWP is supported per carrier  More than one non-dormant BWP per carrier is supported only if UE feature 6-3/6-4 is also supported | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-4a | SCell dormancy indication outside active time | Support for SCell dormancy indication sent outside the active time on PCell with DCI format 2\_6 | 19-1 | Yes | N/A |  | Per BC | N/A | N/A | N/A | One dormant BWP and one non-dormant BWP is supported per carrier  More than one non-dormant BWP per carrier is supported only if UE feature 6-3/6-4 is also supported | Optional with capability signalling |
| 18. MR-DC/CA enhancement | [18-4b] | [Support of SCell dormancy indication without data scheduling within active time] | [Support of SCell dormancy indication without data scheduling within active time] | TBD | Yes | N/A |  | FFS [Per UE or Per BC] | No | [Yes or N/A] | N/A |  | Optional with capability signaling |
| 18. MR-DC/CA enhancement | 18-5 | DL cross-carrier scheduling with different SCS | 1. The UE supports DL cross carrier scheduling for the different numerologies with carrier indicator field (CIF) in DL carrier aggregation where numerologies for the scheduling cell and scheduled cell are different  Candidate value set for component 1: {Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both} | 6-5 | Yes | N/A |  | Per BC | N/A | N/A | N/A | crossCarrierScheduling-OtherSCS | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-5a | Default QCL assumption for cross-carrier scheduling | Indicates whether the UE can be configured with enabledDefaultBeamForCCS for default QCL assumption for cross-carrier scheduling for same/different numerologies   * Candidate values are {same only, both}   + When “both” is reported, the UE supports this feature for same SCS and for different SCS combination(s) (low-to-high, high-to-low or both) reported for 18-5 | one of {6-10, 18-5} | Yes | N/A |  | Per BC | N/A | N/A | N/A |  | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-5b | UL cross-carrier scheduling with different SCS | 1. The UE supports UL cross carrier scheduling for the different numerologies with carrier indicator field (CIF) in UL carrier aggregation where numerologies for the scheduling cell and scheduled cell are different  Candidate value set for component 1: {Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both} | 6-6 | Yes | N/A |  | Per BC | N/A | N/A | N/A | crossCarrierScheduling-OtherSCS | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-5c | Processing up to X unicast DCI scheduling for DL per scheduled CC | Processing up to X unicast DCI scheduling for DL per scheduled CC   * + X is based on pair of (scheduling CC SCS, scheduled CC SCS):     - X=[4] for (15,120), (15,60), (30,120),     - X=[2] for (15,30), (30,60), (60,120 kHz),     - X applies per span in a slot of scheduling CC     - FFS: additional value X |  |  |  |  |  |  |  |  | FFS: Modify the note to “[In case UE supports 3-5b, the limits apply for each span for FDD scheduling cell and TDD scheduling cell.]”  FFS: which PDCCH monitoring related capabilities this FG applies to  FFS: detailed design of this FG |  |
| 18. MR-DC/CA enhancement | 18-5d | Processing up to X unicast DCI scheduling for UL per scheduled CC | Processing up to X unicast DCI scheduling for UL per scheduled CC   * + X is based on pair of (scheduling CC SCS, scheduled CC SCS):     - X=[4] for (15,120), (15,60), (30,120),     - X=[2] for (15,30), (30,60), (60,120 kHz),     - X applies per span in a slot of scheduling CC     - FFS: additional value X |  |  |  |  |  |  |  |  | FFS: Modify the note to “[In case UE supports 3-5b, the limits apply for each span for FDD scheduling cell and TDD scheduling cell.]”  FFS: which PDCCH monitoring related capabilities this FG applies to  FFS: detailed design of this FG |  |
| 18. MR-DC/CA enhancement | 18-6 | Cross-carrier A-CSI RS triggering with different SCS | Cross-carrier A-CSI RS triggering with different SCS  Candidate value set: {PDCCH cell of lower SCS and A-CSI RS cell of higher SCS, PDCCH cell of higher SCS and A-CSI-RS of lower SCS, both} | 2-33 and 6-5 | Yes | N/A |  | Per BC | N/A | N/A | N/A |  | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-6a | Default QCL assumption for cross-carrier A-CSI-RS triggering | Indicates whether the UE can be configured with enabledDefaultBeamForCCS for default QCL assumption for cross-carrier A-CSI-RS triggering for same/different numerologies   * Candidate values are {same only, both}   + When “both” is reported, the UE supports this feature for same SCS and for different SCS combination(s) (low-to-high, high-to-low or both) reported for 18-6 | 6-5 | Yes | N/A |  | Per BC | N/A | N/A | N/A |  | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-7 | CA with non-aligned frame boundaries | CA with non-aligned frame boundaries for inter-band CA | 6-5 for DL CA with non-aligned frame boundaries for inter-band CA  6-6 for UL CA with non-aligned frame boundaries for inter-band CA | Yes | N/A |  | Per BC | N/A | N/A | N/A | Defines whether the UE supports carrier aggregation operation where the frame boundaries of the Pcell and the Scell are not aligned, while the slot boundaries are. | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-8 | HARQ-ACK codebook type and HARQ-ACK spatial bundling configuration per PUCCH group | HARQ-ACK codebook type and HARQ-ACK spatial bundling configuration per PUCCH group | 6-7 | Yes | N/A |  | Per UE | No | No | N/A | Support HARQ-ACK codebook type and HARQ-ACK spatial bundling configuration per PUCCH group.  Rel-15 had this per cell group | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-9 | Type2 HARQ-ACK codebook for >1 DL DCIs in same Monitoring Occasion | For HARQ-ACK type 2 codebook: Usage of the PDSCH starting time in addition to the existing MO and Cell index to order the HARQ-ACK feedback | 3-1 | Yes | N/A |  | Per UE | No | No | N/A | Note: The UE capability is introduced with following assumption:  ·Specification reflects that UE behavior is modified only for UEs supporting this capability.  ·UE behavior of a UE supporting this capability is different from UE behavior of a UE not supporting this capability only for following case:  ·Type-2 HARQ-ACK codebook when HARQ-ACK feedback in a codebook corresponds to more than one DL DCI for same scheduled cell in a MO of a scheduling cell. | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-2 | Single UL TX operation for TDD PCell in EN-DC | TDM restriction to LTE TDD PCell in EN-DC for single UL-Transmission associated functionality when tdm-patternConfig-r16 is configured  1) TDD UL/DL configuration#2, #4, #5 configured as DL-reference UL/DL configuration  2) PRACH transmission in non- designated UL subframes given by the DL-reference configuration (only for type 1 UE)  3) LTE UL transmissions scheduled/triggered by a DCI in any UL subframe not limited to the reference TDM pattern (only for type 1 UE)  4) the UE does not transmit on SCG in FR1 when the UE has overlapped transmission on a subframe on the MCG if the conditions in TS38.213 Section 7.6.1 are satisfied | EN-DC | Yes | N/A |  | Per band combination | Applicable to TDD-TDD EN-DC only | Applicable to FR1 only |  | Extension of the R15 capability tdm-Pattern to TDD PCell  This FG is for synchronous EN-DC | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-2a | Enhanced single UL TX operation for FDD Pcell EN-DC | TDM restriction to LTE FDD Pcell in EN-DC for single UL-Transmission associated functionality when tdm-patternConfig-r16 is configured  1) DL-reference UL/DL configuration defined for LTE-FDD-SCell in LTE-TDD-FDD CA with LTE-TDD-PCell  2) PRACH transmission in non- designated UL subframes given by the DL-reference configuration (only for type 1 UE)  3) LTE UL transmissions scheduled/triggered by a DCI in any UL subframe not limited to the reference TDM pattern (only for type 1 UE)  4) the UE does not transmit on SCG in FR1 when the UE has overlapped transmission on a subframe on the MCG if the conditions in TS38.213 Section 7.6.1 are satisfied | 6-13 | Yes | N/A |  | Per band combination | Applicable to in FDD-LTE -NR EN-DC | Applicable to FR1 only |  | Enhancement to the R15 capability tdm-Pattern  [This FG is for synchronous EN-DC] | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-2b | Support of HARQ-offset for SUO case1 in EN-DC with LTE TDD PCell for type 1 UE | Support of HARQ-offset for SUO case1 in EN-DC with LTE TDD PCell for type 1 UE | 18-2 | Yes | N/A |  | Per band combination | N/A | N/A | N/A | [This FG is for synchronous EN-DC] | Optional with capability signaling |
| 18. MR-DC/CA enhancement | 18-3 | Dual Tx transmission for EN-DC with FDD PCell(TDM pattern for dual Tx UE) | TDM restriction to LTE FDD PCell in EN-DC for dual UL Tx operation when tdm-patternConfig-r16 is configured  1) DL-reference UL/DL configuration defined for LTE-FDD-SCell in LTE-TDD-FDD CA with LTE-TDD-PCell  2) PRACH transmission in non- designated UL subframes given by the DL-reference configuration (only for type 1 UE)  3) LTE UL transmissions scheduled/triggered by a DCI in any UL subframe not limited to the reference TDM pattern (only for type 1 UE) | 6-13, EN-DC | Yes | N/A |  | Per band combination | Applicable to EN-DC with LTE FDD PCell only | Applicable to FR1 only |  | Extension of the R15 capability tdm-Pattern to a dual Tx UE  [This FG is for synchronous EN-DC] | Optional with capability signalling |
| 18. MR-DC/CA enhancement | 18-3a | Semi-statically configured LTE UL transmissions in all UL subframes not limited to tdm-pattern in case of FDD PCell | UE configured with tdm-patternConfig-r16 can be semi-statically configured with LTE UL transmissions in all UL subframes not limited to the reference tdm-pattern (only for type 1 UE) in case of FDD PCell | 18-2a | Yes | N/A |  | Per UE | Applicable to EN-DC only | Applicable to FR1 only |  | [This FG is for synchronous EN-DC] | Optional with capability signaling |
| 18. MR-DC/CA enhancement | 18-3b | Semi-statically configured LTE UL transmissions in all UL subframes not limited to tdm-pattern in case of TDD PCell | UE configured with tdm-patternConfig-r16 can be semi-statically configured with LTE UL transmissions in all UL subframes not limited to the reference tdm-pattern (only for type 1 UE) in case of TDD PCell | One of {18-2, 18-3} | Yes | N/A |  | Per UE | Applicable to EN-DC only | Applicable to FR1 only |  | [This FG is for synchronous EN-DC] | Optional with capability signaling |