**3GPP TSG RAN WG1 #100bis-e R1-20xxxxx**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on Email discussion [100b-e-NR-UEFeatures-MRDCCA-02]

Agenda Item: 7.2.11.10

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

# **Introduction**

This contribution summarizes the following email discussion in AI 7.2.11.10 regarding UE features for MR-DC/CA.

[100b-e-NR-UEFeatures-MRDCCA-02] Email discussion/approval on feature group structure for cross-carrier operation with different SCS (20th-24th April) – Hiroki (DCM)

* Confirm that FG[18-5a] for “Default QCL assumption for cross-carrier scheduling” is kept (i.e., remove bracket)
  + It is clarified that FG18-5a is only for same SCS
* Discuss whether new FG for “UL CA with mixed numerologies” is added or not
* Discuss whether new FG for “Cross-carrier scheduling with different SCS for URLLC” is added or not
* Discuss whether FG[18-6a] for “Default QCL assumption for cross-carrier A-CSI-RS triggering” is kept (i.e., remove bracket) or removed (i.e., added in 18-6)
* Discuss whether new FG for “Cross-carrier A-CSI-RS triggering with different SCS for URLLC” is added or not
* Confirm to keep FG18-5/6

# **18-5/[18-5a]: Cross-carrier scheduling with different SCS**

In [1], FG18-5 and [18-5a] are captured as below.

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| 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**  **(the ‘type’ definition from UE features should be based on the granularity of 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 | 18-5 | Cross-carrier scheduling with different SCS | 1) The UE supports 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  [2) Processing up to X unicast DCI scheduling (DL and UL) per scheduled CC ]  [3 Default QCL assumption for cross-carrier scheduling with different SCS] |  |  | N/A |  | Per band combination | No | No |  | crossCarrierScheduling-OtherSCS    1) {Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both}  [2) ]  X is based on pair of (scheduling CC SCS, scheduled CC SCS):  [4] for (15,120), (15,60), (30,120),  [2] for (15,30), (30,60), (60,120 kHz),  Note: This applies also to the case where there is a single span in the slot for the scheduling CC.  In case UE supports 3-5b, the limits apply for each span for FDD scheduling cell and TDD scheduling cell. | Optional with capability signalling |
| [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 with same SCS. |  |  |  |  | Per band combination |  |  |  | FFS if this is needed or if it should cover also component 3 of 18-5 | Optional with capability signalling |

Following views are provided in a contribution for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [2] | ZTE Corporation | According to RAN1#98bis meeting, UE vendors may have the concern that too many unicast DCIs are placed within one monitoring occasion if one scheduling cell cross-carrier schedules a large number of scheduled cells. In this case, the maximum number of unicast DCIs in one scheduling slot/span across all scheduled cells can be defined.  ***Proposal 1:***  *Increase the number of valid DCIs in a PDCCH monitoring occasion to at least 4;*  *Define the maximum number of unicast DCIs in one scheduling slot/span across all scheduled cells.*  The current Rel-15 DAI counting mechanism assumes that only up to one unicast DL DCI is in each monitoring occasion for each scheduled cell, which doesn’t cover the case that more than one unicast DL DCI is received for the same scheduled cell. More than one unicast DL DCI for one scheduled cell is a typical case for cross-carrier scheduling with smaller SCS for the scheduling cell. For example, the scheduling cell is of 15 KHz SCS and the scheduled cell is of 120 KHz SCS, where one 15 KHz slot equals to 8 120 KHz slots. For full flexibility, up to 8 unicast DCIs may need to be transmitted within one MO. Thus, the new DAI counting order shall also take this case into account. For PDSCHs scheduled from the same MO for the same scheduled cell, the PDSCH starting time can be used for DAI counting. Combined with the Rel-15 DAI counting order, the new DAI counting order can be summarized as below:   1. First in ascending order of PDSCH starting time; 2. Second in ascending order of serving cell index; 3. Third in ascending order of MO index.   ***Proposal 2****: If the maximum number of unicast DCIs per MO is increased, the PDSCH starting time in addition to the existing MO and Cell index is introduced to order the HARQ-ACK feedback.*    **Figure 2.** DAI count order if more than one DCI is received within one MO. |
| [3] | MediaTek Inc. | For FG 18-5: Cross-carrier scheduling with different SCS, it is sufficient to reuse the Rel. 16 FG 3-5b PDCCH monitoring to have multiple DCIs in one slot of the scheduling cell with lower SCS than the scheduled cell. This has the benefit of avoiding introducing additional impact to the spec (e.g., new design for HARQ-ACK codebook). We think the value of X is not needed. Besices, it is recommended to add ‘Per band’ to support the feature for CA within certain bands or not.  **Proposal 3: RAN1 agree to reuse the Rel. 16 FG 3-5b PDCCH monitoring to have multiple DCIs in one slot of the scheduling cell with lower SCS than the scheduled cell. Delete the descriptions related to value X. Add ‘Per band’ to FG 18-5 to support the feature for CA within certain bands or not.**  For FG [18-5a]: Default QCL assumption for cross-carrier scheduling with same SCS, we support to keep this capability for better UE implementation flexibility.  **Proposal 4: Keep “18-5a Default QCL assumption for cross-carrier scheduling with same SCS” in current RAN1 UE feature table.**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 18-5 | Cross-carrier scheduling with different SCS | 1) The UE supports 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  [2 Default QCL assumption for cross-carrier scheduling with different SCS] |  |  | N/A |  | Per band combination | No | No |  | crossCarrierScheduling-OtherSCS    1) {Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both} | Optional with capability signalling | | 18-5a | Default QCL assumption for cross-carrier scheduling with same SCS | Indicates whether the UE can be configured with *enabledDefaultBeamForCCS* for default QCL assumption for cross-carrier scheduling with same SCS. | 6-10 |  |  |  | Per band combination |  |  |  |  | Optional with capability signalling | |
| [4] | Intel Corporation | FG 18-5 component 2): it is not clear which interpretation is correct.   * Interpretation #1: X DL DCI + X UL DCI, i.e. gNB can transmit up to 2X DCI per scheduled cell * Interpretation #2: totally X DCIs, i.e. gNB can transmit up to X DCI per scheduled cell   As discussed in [2], the main motivation for X>1 is for the case that the scheduling cell has a SCS shorter than scheduled cell. For better scheduling flexibility on the scheduled cell, the number of PDCCH detections needs to be increased. Another limitation is the maximum number of DL DCIs that schedule PDSCH on a same cell. If the maximum number is more than 4, it is not enough to rely on C-DAI as additional dimension in HARQ-ACK bit ordering for Type1 HARQ-ACK codebook. Some alternative options were proposed in early meetings. However, it is not likely to converge on any option. Therefore, we prefer to define . The current value of X in [1] is OK.  FG 18-5a: it could be a separate feature since all 3 components in FG 18-1 are related to cross-carrier scheduling with different SCS.  **Proposal 4: for *Cross-carrier scheduling with different numerology,***   * **FG 18-5 component 2): it is not clear which interpretation is correct.**   + **Interpretation #1: X DL DCI + X UL DCI, i.e. gNB can transmit up to 2X DCI per scheduled cell**   + **Interpretation #2: totally X DCIs, i.e. gNB can transmit up to X DCI per scheduled cell** * **To confirm that**   + **X=4 for (15,120), (15,60), (30,120),**   + **X=2 for (15,30), (30,60), (60,120 kHz**), * **FG 18-5a can be separate feature** |
| [5] | Ericsson | * Propose to add new FG 18-5b for UL CA with mixed numerologies   + The feature for cross-carrier scheduling with mixed numerology for uplink carrier aggregation is missing since 18-5 describes only DL CA. Introduce a new feature 18-5b for supporting UL CA, mirroring 18-5 with following changes:     - * Change DL CA to UL CA in component 1)       * Delete component 3) * FG 18-5   + Regarding component 2     - We propose to confirm the text in square brackets around component 2. For improved scheduling flexibility (e.g. contiguous scheduling) and efficient operation, especially in case of low SCS scheduling high SCS, it is desirable to allow increasing number of DCIs within a span.   + Regarding component 3     - Propose to confirm the text in square brackets as default beam for different SCS case does not need separate capability. * FG 18-5a   + Prefer to define this capability only for same SCS as different SCS can be handled by 18-5. |
| [6] | Nokia, Nokia Shanghai Bell | **18-5:**   * Component 2: support the proposal where the X is based on the scheduling/scheduled carrier SCS combination as currently written in the table. The proposed values for X are reasonable. The component should be clarified that the X is defined per span. * Component 3: This should be included as a basic component as always supported when UE indicates support for 18-5   **18-5a:** OK to have this new FG. Add pre-requisite 6-10 Cross carrier scheduling for the same numerology |
| [7] | Qualcomm Incorporated | On FG 18-5, we propose to add ‘Per band’ to selectively support the feature for CA within certain bands.  On component 2 of FG 18-5, based on early RAN1 discussions, we observed that it is sufficient to use the Rel. 16 FG 3-5b PDCCH monitoring to have multiple DCIs in one slot of the scheduling cell with a lower SCS than the scheduled cell. There are discussions on whether a UE should support all components in an FG if the UE supports any. At least for FG 18-5, we think the UE should not be required to automatically support component 2 because the UE reports to support cross-carrier scheduling with different SCS as described by component 1.  On component 3 of FG 18-5, similar to component 2, we would like to clarify whether a UE must support all components in an FG if the UE supports any.  On FG 18-5a, we support to include this FG in the UE features. It can be further discussed whether 18-5a and 18-5 compnent 3 can be merged together. If they are merged together, compnent 3 of FG 18-5 is added to FG 18-5a, but not the other way round.  ~  We can calrify more on our proposals. The intent is not to differentiate UE behaviours between DCI formats 0\_1/1\_1 and DCI formats 0\_2/1\_2 but to differentiate UE behaviours between eURLLC and eMBB. It is not clear to us how eURLLC benefits from the feature. It is also too restrictive if a UE must support cross-carrier scheduling with different SCS for both or neither of eMBB and eURLLC simultaneously. In the updated proposals below, DCI formats are removed from the “components” field.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 18-5 | Cross-carrier scheduling with different SCS | | 1) The UE supports 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  [2] Processing up to X unicast DCI scheduling (DL and UL) per scheduled CC ]  [3 Default QCL assumption for cross-carrier scheduling with different SCS] |  |  | N/A |  | Per band and per band combination | No | No |  | crossCarrierScheduling-OtherSCS    1) {Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both}  [2] ]  X is based on pair of (scheduling CC SCS, scheduled CC SCS):  [4] for (15,120), (15,60), (30,120),  [2] for (15,30), (30,60), (60,120 kHz),  Note: This applies also to the case where there is a single span in the slot for the scheduling CC.  In case UE supports 3-5b, the limits apply for each span for FDD scheduling cell and TDD scheduling cell. | Optional with capability signalling | | [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 with same SCS. | |  |  |  |  | Per band and per band combination |  |  |  | FFS if this is needed or if it should cover also component 3 of 18-5 | Optional with capability signalling | | 18-5b | Cross-carrier scheduling with different SCS for URLLC | The UE supports cross-carrier scheduling with different SCS for URLLC | |  | Yes | N/A |  | Per band and per band combination | No | No |  | 1) {Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both} | Optional with capability signalling | |

Based on above, following points need to be discussed for FG18-5/[5a].

* Confirm to keep FG18-5
* Confirm that FG[18-5a] for “Default QCL assumption for cross-carrier scheduling” is kept (i.e., remove bracket)
  + It is clarified that FG18-5a is only for same SCS
* Whether new FG for “UL CA with mixed numerologies” is added or not
* Whether new FG for “Cross-carrier scheduling with different SCS for URLLC” is added or not

## 2.1 Discussion 1

|  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 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**  **(the ‘type’ definition from UE features should be based on the granularity of 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 |
| 18-5 | Cross-carrier scheduling with different SCS | 1) The UE supports 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  [2) Processing up to X unicast DCI scheduling (DL and UL) per scheduled CC ]  [3 Default QCL assumption for cross-carrier scheduling with different SCS] |  |  | N/A |  | Per band combination | No | No |  | crossCarrierScheduling-OtherSCS    1) {Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both}  [2) ]  X is based on pair of (scheduling CC SCS, scheduled CC SCS):  [4] for (15,120), (15,60), (30,120),  [2] for (15,30), (30,60), (60,120 kHz),  Note: This applies also to the case where there is a single span in the slot for the scheduling CC.  In case UE supports 3-5b, the limits apply for each span for FDD scheduling cell and TDD scheduling cell. | Optional with capability signalling |

**The proposal is to confirm that FG18-5 “Cross-carrier scheduling with different SCS” is kept.**

**Companies are encouraged to provide views if there is a concern or comment on the proposal.**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | OK to keep the FG.  [Updated] We see a real problem with removing component 2, as it significantly impacts the relevance of the feature. The scheduling carrier becomes essentially dedicated to scheduling-only, and that is far from ideal condition to operate the network. On component 3, if it is moved to 18-5a, then the FG needs to be mandatory for FR2 if FG 18-5 is supported. |
| ZTE | We support keeping this FG. |
| Samsung | OK to keep the FG. |
| Qualcomm | Support to keep FG 18-5 “Cross-carrier scheduling with different SCS”.  We assume UE can independently support each individual component of FG 18-5. If not, we propose to move additional components other than component 1 out of FG 18-5 to define separate capabilities.  [Updated] We support FL’s proposal on this FG. There is no need to have component 2 given FG 3-5b is sufficient for the new cross-carrier scheduling with different SCS feature in Rel-16.  We also support FL’s proposal to combine component 3 of FG 18 to FG 18-5a for the purpose to separate component 3 from component 1.  It is not acceptable to make either capability mandatory. |
| Ericsson | OK to keep the FG.  [Updated] We prefer to keep component 2 in the FG for same reasons as mentioned by Nokia. |
| Intel | OK to keep the FG. |
| MTK | We support to keep the FG 18-5 **with only the first component**. Component 3 can be combined with FG 18-5a.  For Component 2, we think defining the value of X is not needed since FG 3-5b can be reused to define UE’s unicast DCI processing capability. However, we can accept to define separate capability out of FG 18-5 for component 2 if some companies deem necessary. |
| Huawei | OK to keep the FG together with the brackets.  We further suggest to update “DL carrier” to “DL/UL carrier” and combine 18-5a into component 3. |
| Apple | We agree that component 3 is merged with 18-5a  We prefer to have a separate FG for component 2 for PDCCH monitoring related capability and we also prefer to discuss whether FG3-5b can be reused.  We also assume this is for processing capability #1, i.e. eMBB for PDSCH/PUSCH  Overall, we have concern that the current FG discussion is not flexible enough for UE capability reporting, for cross carrier scheduling, we need to consider 3 dimensions   * PDSCH, PUSCH, [AP-CSI] * For PDSCH, PUSCH, the processing capability #1 and processing capability #2 * The SCS relation between DCI and triggered PDSCH/PUSCH/AP-CSI-RS, =, >, <   We suggest to reuse Rel-15 abandoned FG6-10a which covers both PDSCH and PUSCH, but we prefer to clarify that it only applies to PDSCH/PUSCH with processing capability #1.  FG 3-5b is span based PDCCH monitoring in Rel-15, the corresponding capability *pdcch-MonitoringAnyOccasionsWithSpanGap* is signalled per “FS”, i.e. per band per BC. For crossing carrier scheduling, there is a scheduling cell and there is a scheduled cell. Given an example, CC in band A with 15kHz can schedule two cells at the same time (1) itself (2) another CC in band B with 120kHz SCS. How can we differentiate the 2 scenarios by the per FS capability in case it is BC of Band A + Band B and *pdcch-MonitoringAnyOccasionsWithSpanGap signalled for Band A.* We also need to know that there are new span based PDCCH monitoring being discussed in Rel-16, UE does not have to even support span based PDCCH monitoring, therefore, we don’t think we can reuse 3-5b, instead, a new FG should be used.  For component 1, we prefer to be able to independently indicate the support {[SCSPDCCH = SCSPDSCH], SCSPDCCH < SCSPDSCH, SCSPDCCH > SCSPDSCH} based on the existing agreement, and FR1 ⬄ FR2 issues |

**FL proposal:**

* FG18-5 is kept with component 1 only.
  + Note that component 3 is merged with 18-5a
  + Note that component 2 is not necessary and FG3-5b is reused

**Updated FL proposal:**

* FG18-5 is kept for DL cross-carrier scheduling with different SCS

## 2.2 Discussion 2

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| 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**  **(the ‘type’ definition from UE features should be based on the granularity of 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 |
| [18-5a] | Default QCL assumption for cross-carrier scheduling | Indicates whether the UE can be configured with *enabledDefaultBeamForCCS* for default QCL assumption for cross-carrier scheduling with same SCS. |  |  |  |  | Per band combination |  |  |  | FFS if this is needed or if it should cover also component 3 of 18-5 | Optional with capability signalling |

**The proposal is to confirm that FG[18-5a] for “Default QCL assumption for cross-carrier scheduling” is kept (i.e., remove bracket).**

**Also, it can be clarified that FG18-5a is only for same SCS.**

**Companies are encouraged to provide views if there is a concern or comment on the proposal.**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | ~~We agree with the proposals from the moderator.~~  [Updated] If confirmed, then the FG needs to be mandatory for FR2 if FG 18-5 is supported. |
| ZTE | We are supportive of the FL proposal. |
| Samsung | Agree with the FL proposal |
| Qualcomm | We support to keep FG 18-5a “Default QCL assumption for cross-carrier scheduling”. Regarding whether it is same or different SCS, we prefer to use one capability to cover both cases. This has a dependency on [100b-e-NR-UEFeatures-MRDCCA-05] for component 3 of FG 18-5. For that, if component 3 of FG 18-5 can be combined with FG 18-5a, then “same SCS” can be removed from FG 18-5a.  [Updated] We support FL’s proposal to remove “same SCS” in FG 18-5a.  Mandatory capability is not acceptable to us. |
| Ericsson | ~~Agree with FL proposal.~~  [Updated]Agree with Nokia comment that if confirmed, then this FG should be mandatory for FR2 if FG 18-5 is supported. |
| Intel | We are supportive of the FL proposal. |
| MTK | We support to keep FG 18-5a “Default QCL assumption for cross-carrier scheduling”.  According to the current newest 38.214 CR (R1-2001443) 5.1.5 Antenna ports quasi co-location:  **“**When the UE is configured with CORESET associated with a search space set for cross-carrier scheduling and the UE is not configured with [*enableDefaultBeamForCCS*], the UE expects *tci-PresentInDCI* is set as 'enabled' or *tci-PresentInDCI-ForFormat1\_2* is configured for the CORESET, and if one or more of the TCI states configured for the serving cell scheduled by the search space set contains 'QCL-TypeD', the UE expects the time offset between the reception of the detected PDCCH in the search space set and the corresponding PDSCH is larger than or equal to the threshold *timeDurationForQCL.****”***  It can be seen that *enableDefaultBeamForCCS* controls whether there is default beam behavior in cross-carrier scheduling for both same/different numerology. Hence, component 3 of FG 18-5 can be combined with FG 18-5a, and “same SCS” can be removed from FG 18-5a.  [Updated] We support FL’s proposal. We also think Rel-16 features are supposed to be optional unless for very special reason. |
| Huawei | Can be combined into 18-5. We understand 18-5 is for different SCS while there is no technical need for this minor difference to set one additional UE capability bit. |
| Apple | We support FL proposal |

**FL proposal:**

* FG18-5a is kept (with removing bracket and “same SCS”).

**Updated FL proposal:**

* FG18-5a is kept for Default QCL assumption for cross-carrier scheduling.

## 2.3 Discussion 3

**Companies are encouraged to provide views on whether new FG for “UL CA with mixed numerologies” is added or not.**

**Adding the new FG supported by:**

**Objected by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | ~~No need for new FG, instead confirm component 3 in FG18-5.~~  [Updated] It is OK to introduce the FG, but then 18-5 should be renamed to apply only for DL. |
| ZTE | If the component 3 of FG18-5 is confirmed, then this new FG is not needed. |
| Samsung | No need for new FG. |
| Qualcomm | The proposal text is related to UL CA but companies also commented on component 3 in FG 18-5 probably because the table is for FG 18-5a.  We assume the discussion here is still for UL CA.  For this capability, it should be clarified first whether FG 18-5 has covered UL CA with mixed numerologies. |
| Ericsson | The correct proposal text for this discussion 3 is to introduce a new FG for “UL CA with mixed numerologies” but the comments seem to be regarding [18-5a].  In our understanding, the revisions from post 100-e RAN1 meeting added the restriction of “DL carrier aggregation” in component (1) of 18-5, implying UL carrier aggregation is not covered in 18-5.  We support introducing new FG for UL CA. |
| Intel | Agree with QC. If UL CA is not covered by FG 18-5, there should be a separate capability for UL CA with mixed numerologies. |
| MTK | Same view as Ericsson. We support introducing this new FG for UL CA. |
| Huawei, HiSi | No need for separate FG for ULCA but that can be part of 18-5. R15 UE capability for same SCS 6-10 does not differentiate DL or UL cross-carrier scheduling as well. Also, in RAN1 discussion of the below, there seems to be common understanding that UL and DL differentiation is not desirable. |
| Apple | We support FL proposal.  However, there is an important FG missing, i.e. cross carrier scheduling of PUSCH for PUSCH processing capability #1, #2. It can be merged together with FG18-5 and FG18-5b, however, we prefer separate FG. |

**FL proposal:**

* A new FG (18-5b) for support of UL CA with mixed numerologies is introduced

**FL proposal:**

* A new FG (18-5b) for support of UL CA with mixed numerologies is included with bracket

## 2.4 Discussion 4

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| 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**  **(the ‘type’ definition from UE features should be based on the granularity of 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 |
| 18-5b | Cross-carrier scheduling with different SCS for URLLC | The UE supports cross-carrier scheduling with different SCS for URLLC |  | Yes | N/A |  | Per band and per band combination | No | No |  | 1) {Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both} | Optional with capability signalling |

**Companies are encouraged to provide views on whether new FG for “Cross-carrier scheduling with different SCS for URLLC” is added or not.**

**Adding the new FG supported by:**

**Objected by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | The need and scope of the proposed component is unclear, so we cannot support it. |
| ZTE | RAN1 didn’t introduce cross-carrier scheduling capability for URLLC in Rel-15. We fail to see the motivation to introduce this FG in Rel-16. |
| Samsung | Agree with ZTE. No need for the new FG. |
| Qualcomm | We propose to define different capabilities for eMBB and eURLLC for cross-carrier scheduling with different numerologies as explained in our contribution proposal above. |
| Ericsson | Not support as more clarifications are needed on the components.  It is unclear what URLLC means from a spec functionality perspective - the component should describe the functionality that a UE supports rather than a specific service use case. |
| Intel | We think differentiating eMBB and URLLC is not needed |
| MTK | We support to add this new FG to define different capabilities for eMBB and eURLLC. We also agree with Ericsson that the FG description needs to be more specific. For example, change the component to be   * The UE supports cross-carrier scheduling with different SCS for ~~URLLC~~DCI formats 0\_2 and 1\_2 |
| Huawei, HiSi | The proposal is not clear on exactly what is aimed for when mentioning uRLLC, whether it is some specific FGs in uRLLC session or else how. |
| Apple | We support to keep it, but we may need two FG, one for PDSCH, one for PUSCH, corresponding to PDSCH processing capability #2 and PUSCH processing capability #2 |

**FL proposal:**

* A new FG for support of Cross-carrier scheduling with different SCS for URLLC is not introduced

# **18-6/[18-6a]: Cross-carrier A-CSI RS triggering with different SCS**

In [1], FG18-6 and [18-6a] are captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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**  **(the ‘type’ definition from UE features should be based on the granularity of 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 | 18-6 | Cross-carrier A-CSI RS triggering with different SCS | Cross-carrier A-CSI RS triggering with different SCS | 2-33 |  | N/A |  | Per band combination | No | No |  | 1) {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} . | Optional with capability signalling |
| [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. |  |  |  |  | Per band combination |  |  |  | FFS if this is needed | Optional with capability signalling |

Following views are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [3] | MediaTek Inc. | For FG [18-6a]: Default QCL assumption for cross-carrier A-CSI-RS triggering, we support to keep this capability for better UE implementation flexibility.  **Proposal 5: Keep “18-6a Default QCL assumption for cross-carrier A-CSI-RS triggering” in current RAN1 UE feature table.**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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. |  |  |  |  | Per band combination |  |  |  |  | Optional with capability signalling | |
| [6] | Nokia, Nokia Shanghai Bell | **18-6a**: This should be made a mandatory component of 18.6. No need for a separate capability |
| [7] | Qualcomm Incorporated | One FG 18-6   * We propose to update feature type same as FG 18-5. * Minor changes were made by adding “cell” and replaing a “-” with space for the second A-CSI RS to keep wording consistency.   On FG 18-6a, we propose to remove the FFS.  ~  We can calrify more on our proposals. The intent is not to differentiate UE behaviours between DCI formats 0\_1/1\_1 and DCI formats 0\_2/1\_2 but to differentiate UE behaviours between eURLLC and eMBB. It is not clear to us how eURLLC benefits from the feature. It is also too restrictive if a UE must support cross-carrier scheduling with different SCS for both or neither of eMBB and eURLLC simultaneously. In the updated proposals below, DCI formats are removed from the “components” field.   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 18-6 | Cross-carrier A-CSI RS triggering with different SCS | Cross-carrier A-CSI RS triggering with different SCS | 2-33 |  | N/A |  | Per band and per combination | No | No |  | 1) {PDCCH cell of lower SCS and A-CSI RS cell of higher SCS, PDCCH cell of higher SCS and A-CSI RS cell of lower SCS, both} . | Optional with capability signalling | | [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. |  |  |  |  | Per band and per combination |  |  |  | FFS if this is needed | Optional with capability signalling | | 18-6b | Cross-carrier A-CSI RS triggering with different SCS for URLLC | The UE supports cross-carrier A-CSI RS triggering with different SCS for URLLC |  | Yes | N/A |  | Per band and per band combination | No | No |  | 1) {PDCCH cell of lower SCS and A-CSI RS cell of higher SCS, PDCCH cell of higher SCS and A-CSI-RS cell of lower SCS, both}. | Optional with capability signalling | |

Based on above, following points need to be discussed for FG18-6/[6a].

* Confirm to keep FG18-6
* Whether FG[18-6a] for “Default QCL assumption for cross-carrier A-CSI-RS triggering” is kept (i.e., remove bracket) or removed (i.e., added in 18-6)
* Whether new FG for “Cross-carrier A-CSI-RS triggering with different SCS for URLLC” is added or not

## 3.1 Discussion 5

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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**  **(the ‘type’ definition from UE features should be based on the granularity of 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 |
| 18-6 | Cross-carrier A-CSI RS triggering with different SCS | Cross-carrier A-CSI RS triggering with different SCS | 2-33 |  | N/A |  | Per band combination | No | No |  | 1) {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} . | Optional with capability signalling |

**The proposal is to confirm that FG18-6 “Cross-carrier A-CSI RS triggering with different SCS” is kept.**

**Companies are encouraged to provide views if there is a concern or comment on the proposal.**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | OK to keep FG18-6. |
| ZTE | We are fine to keep FG18-6 and [18-6a] could be one component of FG18-6. |
| Samsung | OK to keep the FG. |
| Qualcomm | Support to keep FG18-6 “Cross-carrier A-CSI RS triggering with different SCS” |
| Ericsson | OK to keep. |
| Intel | OK to keep FG18-6. |
| MTK | OK to keep FG18-6. |
| Huawei, HiSi | OK. |
| Apple | We support FL proposal, but need to separate 3 possible SCS relationship between AP-CSI-RS and DCI |

**FL proposal:**

* FG18-6 is kept.

## 3.2 Discussion 6

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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**  **(the ‘type’ definition from UE features should be based on the granularity of 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 |
| [18-6a] | 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. |  |  |  |  | Per band combination |  |  |  | FFS if this is needed | Optional with capability signalling |

**Companies are encouraged to provide views on whether FG[18-6a] for “Default QCL assumption for cross-carrier A-CSI-RS triggering” is kept (i.e., remove bracket) or removed (i.e., added in 18-6).**

**Keeping the FG[18-6a] (removing bracket) supported by:**

**Objected (i.e., support removing FG[18-6a]) by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | Remove the FG and add it as a component of 18-6.  [Updated] If kept as separate component then it needs to be mandatory in FR2 for UE supporting FG 18-6. |
| ZTE | Similar as cross-carrier scheduling, we prefer to make [18-6a] a component of 18-6. |
| Samsung | We prefer to remove FG 18-6a. |
| Qualcomm | We support to keep FG 18-6a for “Default QCL assumption for cross-carrier A-CSI-RS triggering” as a counterpart to the CCS capability for default QCL.  In the Rel-16 cross-carrier A-CSI-RS CR discussion, we raised an issue that the Rel-16 default QCL agreement for cross-carrier A-CSI-RS was not captured in spec for same numerology case. We prefer to both capture the agreement and keep FG 18-6a.  We would like to ask whether UE can separately report the support for each individual component of an FG. If not, please keep FG 18-6a as a separate capability outside FG 18-6.  [Updated] We support FL’s proposal.  A mandatory capability is not acceptable to us. |
| Ericsson | Remove separate FG and add as a component under 18-6.  [Updated]Agree with Nokia comment that if confirmed, then this FG should be mandatory for FR2 if FG 18-6 is supported. |
| Intel | I may miss something, but did we have an agreement that *enabledDefaultBeamForCCS* also applies to A-CSI RS triggering? If so, we may adopt similar structure as 18-5 and 18-5a. If not, we may make 18-6a a component of 18-6, which means default QCL for A-CSI RS is mandated under 18-6 |
| MTK | We support to keep FG 18-6a. As we mentioned in Discussion 2, in current 38.214 CR (R1-2001443) 5.1.5, *enableDefaultBeamForCCS* controls whether there is default beam behavior in cross-carrier scheduling for both same/different numerology. Hence, we suggest to keep FG 18-6a to align the behavior with FG 18-5a.  [Updated] We support FL’s proposal. We also think Rel-16 features are supposed to be optional unless for very special reason. |
| Huawei, HiSi | Can be part of 18-6 as similarly proposed handling on 18-5a to 18-5. |
| Apple | Support FL proposal |

**FL proposal:**

* FG18-6a is kept (with removing bracket).

## 3.3 Discussion 7

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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**  **(the ‘type’ definition from UE features should be based on the granularity of 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 |
| 18-6b | Cross-carrier A-CSI RS triggering with different SCS for URLLC | The UE supports cross-carrier A-CSI RS triggering with different SCS for URLLC |  | Yes | N/A |  | Per band and per band combination | No | No |  | 1) {PDCCH cell of lower SCS and A-CSI RS cell of higher SCS, PDCCH cell of higher SCS and A-CSI-RS cell of lower SCS, both}. | Optional with capability signalling |

**Companies are encouraged to provide views on whether new FG for “Cross-carrier A-CSI-RS triggering with different SCS for URLLC” is added or not.**

**Adding the new FG supported by:**

**Objected by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | The need and scope of the proposed component is unclear, so we cannot support it. |
| ZTE | We fail to see the motivation of this new FG. |
| Samsung | No need for new FG. |
| Qualcomm | We propose to define different capabilities for eMBB and eURLLC for cross-carrier A-CSI-RS trigger with different numerologies as explained in our contribution proposal above. |
| Ericsson | Like our comment for 18-5b, Not support 18-6b as more clarifications are needed on the component. It is unclear what URLLC means from a spec functionality perspective - the component should describe the functionality that a UE supports rather than a specific service use case. |
| Intel | We think differentiating eMBB and URLLC is not needed |
| MTK | We support to add this new FG to define different capabilities for eMBB and eURLLC. We also agree with Ericsson that the FG description needs to be more specific. For example, change the component to be   * The UE supports cross-carrier A-CSI RS triggering with different SCS for ~~URLLC~~DCI formats 0\_2 and 1\_2 |
| Huawei, HiSi | Similar comment as that for 18-5b |
| Apple | We support to keep this FG. Low latency CSI reporting is defined in Table 5.4-1 in Clause 5.4 38.214. |

**FL proposal:**

* A new FG for support of Cross-carrier A-CSI-RS triggering with different SCS for URLLC is not introduced

# **Conclusion**

**Updated FL proposal:**

* Following FGs are included in the UE features list for MR-DC/CA enhancements
  + FG18-5 for DL cross-carrier scheduling with different SCS
  + FG18-5a for Default QCL assumption for cross-carrier scheduling
  + [FG18-5b for UL cross-carrier scheduling with different SCS]
  + [FG18-5c for DL cross-carrier scheduling with different SCS and PDSCH processing capability 2]
  + [FG18-5d for UL cross-carrier scheduling with different SCS and PUSCH processing capability 2]
  + FG18-6 for cross-carrier A-CSI-RS triggering with different SCS
  + FG18-6a for Default QCL assumption for cross-carrier A-CSI-RS triggering

TBD

# **References**

[1] R1-2001484 RAN1 UE features list for Rel-16 NR after RAN1#100-E Moderator (AT&T, NTT DOCOMO, INC.)

[2] R1-2001631 Discussion on UE feature for MR-DC CA ZTE

[3] R1-2001833 Views on Rel-16 UE features for MR-DC/CA MediaTek Inc.

[4] R1-2002024 UE feature for MR-DC Intel Corporation

[5] R1-2002426 Discussion on UE features for MR-DC Ericsson

[6] R1-2002477 On UE features for MR-DC/CA Nokia, Nokia Shanghai Bell

[7] R1-2002571 Discussion on UE features for MR-DC/CA Qualcomm Incorporated

[8] R1-2002595 Rel-16 UE features for MR-DC/CA Huawei, HiSilicon