**3GPP TSG RAN WG1 #101 R1-2005108**

**e-Meeting, May 25th – June 5th, 2020**

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

**Title:** **Summary on [101-e-Post-NR-UE-Features-04]**

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

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

1. Introduction

This contribution summarizes the following email discussion/approval regarding UE features for MR-DC/CA enhancements.

[101-e-Post-NR-UE-Features-04]  Email discussion/approval for remaining issues on UE features for MR-DC/CA, till 6/10 – Hiroki (DCM)

* Whether/how to define FG[18-4b]
* Whether/how to define component 2 of FG18-5/5b or alternative new FGs
1. Discussion on whether/how to define FG[18-4b]

## 2.1 Summary on the discussion in RAN1#101-e [11]

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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****( 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 | 18-4 | 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 |  | FFS [Per UE or Per BC] | No | [Yes or N/A] | N/A |  | Optional with capability signalling |
| 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 | 6-5 and [19-1] | Yes | N/A |  | FFS [Per UE or Per BC] | No | [Yes or N/A] | N/A |  | Optional with capability signalling |
| [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 |

* **Necessity of FG18-4b**
	+ **FG is removed: [4], [7], [8], [10]**
	+ **FG is kept (and clarify FG18-4 is “with data scheduling”): [3], [5], [9]**
* **Reporting type of FG18-4/4a/[4b]**
	+ **Per BC: [3], [5], [8], [9]**
	+ **Per UE: [3], [10]**
* **xDD/FRx differentiation for FG18-4/4a/[4b]**
	+ **with FR1/FR2 differentiation: [10]**
* **Note for FG18-4/4a/[4b]**
	+ **Add notes “One dormant BWP and one non-dormant BWP is supported per carrier”, “DCI-based Scell dormancy indication is supported” and “More than one non-dormant BWP per carrier is supported only if UE feature 6-3/6-4 is also supported.”: [9]**

Above remaining issues and proposals are identified based on following feedbacks provided in contributions for the RAN1#101-e meeting.

|  |  |
| --- | --- |
| [3] | For FG 18-4, two Cases of Scell dormancy indication are supported when the indication is sent within DRX Active Time.* Case 1 Scell dormancy indication:
	+ DCI format 0\_1 and 1\_1 with additional bit field “Scell dormancy indication” are used.
	+ Case 1 DCI can still schedule PDSCH/PUSCH, and the timeline for HARQ-ACK information feedback is the same as N1 in Rel-15.
	+ 1 bit in “Scell dormancy indication” indicates Scell dormancy/non-dormancy for a group of Scells.
* Case 2 Scell dormancy indication:
	+ DCI format 1\_1 with some repurposed bit fields is used.
	+ Case 2 DCI cannot schedule PDSCH but UE still needs to report HARQ-ACK information. Its HARQ-ACK report timeline is tighter than in Case 1. (working assumption: timeline is the same as in HARQ-ACK information report for SPS PDSCH release).
	+ 1 bit of Scell dormancy indication indicates Scell dormancy/non-dormancy for a Scell.

Because of many differences between Case 1 and Case 2 Scell dormancy indication, it is more reasonable to have separated FGs for them. We suggest the following revisions:**Proposal 1:*** **FG 18-4: Scell dormancy indication within active time with data scheduling**
	+ **Support for Scell dormancy indication sent within the active time on Pcell with DCI format 0\_1/1\_1 scheduling PUSCH/PDSCH**
* **Keep FG 18-4b: Scell dormancy indication without data scheduling within active time**
	+ **Support for Scell dormancy indication sent within the active time on Pcell via DCI format 1\_1 without PDSCH scheduling**

**Proposal 5: For FG 18-4/4a, Type to be per BC or per UE.** |
| [4] | FG 18-4 is for Scell dormancy switching inside active time that is triggered by a DCI format with scheduled PDSCH or PUSCH, i.e. Case 1. On the other hand, FG [18-4b] is 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. In this sense, it does not introduce any further complexity by supporting both Case 1 and Case 2 as a whole. Further, a benefit of supporting both cases is to allow a full flexibility for the gNB to control the Scell dormancy behaviors. Therefore, we prefer to remove FG [18-4b] and merge it as a second bullet in 18-4. The extended FG 18-4 will cover both Case 1 and Case 2. **Proposal 1: for Scell dormancy,** * **Remove FG [18-4b];**
* **Extend FG 18-4 for both Case 1 and Case 2.**
 |
| [5] | **FG 18-4 through 18-6a**We support “per band combination” and FR1/FR2 differentiation.**FG 18-4a:** Support for Scell dormancy indication sent outside the active time on Pcell with DCI format 2\_6Remove 19-1 as a prerequisite. There is no direct relevance between skipping DRX cycles on Pcell and switching BWPs on Scells. Further, UE functionalities for/during Scell dormancy are different that UE functionalities when starting/not starting *drxOnDurationTimer* on Pcell. This is why FG 19-1 and FG 18-4a are separate FGs anyway.**FG 18-4b:** Support of Scell dormancy indication without data scheduling within active timeKeep. UE requirements are different than for 18-4 for processing of the DCIs and for HARQ-ACK feedback. The network requirements for supporting Scell dormancy for UEs under either FG 18-4 or FG 18-4b are a non-issue as they are same as for supporting any other UE-specific function. Further, since Scell dormancy is primarily for the UE benefit (not for the network benefit), having FG 18-4b is practically entirely driven from the UE implementation (a network can always choose to support none/either/both of FG 18-4 and FG 18-4b without any impact on system performance or the network). Clarify that FG 18-4 is for the case of both PDSCH scheduling and Scell dormancy indication. |
| [7] | * 18-4a
	+ Confirm 19-1 as prerequisite for this FG (in addition to 6-5).
		- Dormancy indication outside active time cannot be supported unless UE also supports detection of DCI format 2\_6 with CRC scrambling by PS-RNTI which is a component of 19-1
* [18-4b]
	+ We are not OK with introducing separate FG 18-4b.
		- 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.
 |
| [8] | At the last meeting, it was discussed that whether or not to introduce a separate FG for support of Scell dormancy indication without data scheduling within active time, but there was no consensus achieved at the last meeting. Our preference is to not introduce the 18-4b as separate FG and to cover Scell dormancy indication with and without data scheduling within active time by FG18-4. It seems complex and restrictive for NW if a UE supporting only one of them and another UE supporting only another one co-exist in the same cell.**Proposal 1: [18-4b] for support of Scell dormancy indication without data scheduling within active time is not introduced.**Regarding the reporting type of FG18-4/4a, per BC would be acceptable to majority companies according to discussions so far.**Proposal 2: Reporting type of 18-4/4a is per BC.**For prerequisite feature groups of 18-4a, we think 19-1 is necessary and hence bracket should be removed.**Proposal 3: 19-1 is one of prerequisite feature groups of 18-4a.** |
| [9] | FG18-4/4a/4b* We support to have ‘Per band combination’ type. ‘Per UE’ type does not allow the differentitation between licensed and unlicensed. It is unlikely that the feature would be introduced at the same time for licensed and unlicensed, while IODT differentiation is necessary. Besides, most of the current MR-DC/CA FGs already have the per BC granularity.
* We support to keep FG 18-4b. In the meanwhile, it should be clarified that once FG 18-4b is added, FG 18-4 will only cover the Case 1 DCI within active time that both includes Scell dormancy indication and schedules data.
* We propose to add the following three bullets to notes of FG 18-4/4a/4b to further clarify these FGs.
	+ One dormant BWP and one non-dormant BWP is supported per carrier
	+ DCI-based Scell dormancy indication is supported
	+ More than one non-dormant BWP per carrier is supported only if UE feature 6-3/6-4 is also supported.
 |
| [10] | **18-4/4a/4b*** 18-4/4a should be per UE, dormancy does not relate to RF implementation. While the battery saving gains may relate to RF and thus to band combinations, the BB power saving should be there regardless.
* 18-4/4a we would prefer no FR1/FR2 differentiation, but if that is needed to compromise and not have this per BC, we’d be willing to accept FRx differentiation.
* 18-4b: No need to separate this from 18-4, FG 18-4b should be deleted.
 |

Based on above, following FL proposals are made.

**FL proposal 1:**

* **FG[18-4b] is removed from the UE features list for MR-DC/CA**

Companies are encouraged to check above FL proposals and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposals:

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | We support the FL proposal. |
| Ericsson | Support the FL proposal. |
| Samsung | Do not support the FL proposal |
| Huawei, HiSi | OK with FL proposal |
| Nokia, NSB | We support the FL proposal |
| MTK | We prefer to keep the feature. This can be discussed after the HARQ timing for Case 2 dormancy finished in Scell dormancy agenda. |
| Moderator (NTT DOCOMO) | Although there are larger number of companies (4 vs 2) prefer to remove the FG18-4b, we can wait for the outcome of discussion in Scell dormancy agenda if everyone is also fine. |
| Ericsson2 | We are not OK with introducing FG [18-4b]. We don’t see the need to wait for outcome of maintenance session.  |
| MTK2 | Given the stalled situation in maintenance session, we can accept to remove FG [18-4b] if the current working assumption of N value in **38.213 10.3** can be relaxed by 5 symbols for each subcarrier spacing.Current working assumption in **38.213 10.3**:**A UE is expected to provide HARQ-ACK information in response to a DCI format 1-1 indicating SCell dormancy without scheduling PDSCH after N symbols from the last symbol of a PDCCH providing the SCell dormancy without scheduling PDSCH**. **If *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for the serving cell with the PDCCH providing the DCI format 1-1 indicating SCell dormancy without scheduling PDSCH, [] for , [] for , and []  for , otherwise, [] for , [] for , [] for , and [] for , wherein  corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH providing the DCI format 1-1 indicating SCell dormancy without scheduling PDSCH and the SCS configuration of a PUCCH carrying the HARQ-ACK information in response to a DCI format 1-1 indicating SCell dormancy without scheduling PDSCH.** |
| Qualcomm 06/03 | We were not very keen on this FG. However, given some current situation in SCell dormancy discussion, we strongly request this new FG is maintained.In the mean while, component of FG 18-4 should be updated to only cover Case 1 dormancy indication DCI without data scheduling

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| 18-4 | Scell dormancy indication within active time | Support for Scell dormancy indication together with data scheduling in the same DCI sent within the active time on Pcell with DCI format 0\_1/1\_1  |

 We will explain the reason in the following.In SCell dormancy discussion, there is a debate on whether a restriction is agreeable that DCI format 0\_1 and 1\_1 carrying dormancy indication field is expected only in the first 3 symbols of a slot.Our preference is this restriction should be agreed because the legacy DCI-based BWP switching has the same restriction according to the following spec text in TS 38.213:* *A UE expects to detect a DCI format 0\_1 indicating active UL BWP change, or a DCI format 1\_1 indicating active DL BWP change, only if a corresponding PDCCH is received within the first 3 symbols of a slot.*

Since SCell dormancy transition is also based on BWP switch framework, we see the restriction as a UE friendly design for SCell dormancy indication DCI.However, this restriction is not agreeable to some companies. Therefore, there is a risk for UE implmenation if the UE supports SCell dormancy indication DCI within DRX active time but is configured with SCell dormancy indication DCI after the first 3 symbols of a slot. Without any further change, the T 38.213 spec text implies that * For dormancy indication carried by DCI format 1\_1, the DCI is only expected within the first 3 symbols.
* For dormancy indication carried by DCI format 0\_1, there is no such a restriction.

The DCI format 0\_1 behvaior without restriction is definitely not preferred by UE implementation. Case 1 dormancy indication DCI with data scheduling can use both DCI format 0\_1 and 1\_1, but Case2 doramncy indication DCI without data scheduling can only use DCI format 1\_1.Given this, a UE may support FG 18-4b but not FG 18-4 (with modifications as shown above). By this means, the UE can avoid supporting some new behvaior that was not defined for legacy DCI-based BWP switch for monitoring Scell dormancy indication DCI formt 0\_1.Based on this, we think FG 18-4b has to be kept. |
| Apple  | We prefer to keep this FG.  |
| Nokia, NSB | Given the conclusion in maintenance session that there is no difference in processing timeline with respect to interuptions during BWP switch on Scell for this case and hence this FG is not needed. |
| Ericsson3 | We are not OK with introducing FG [18-4b]. Regarding above comments, the issues can be discussed as part of spec clarifications and there is no need to have a separate FG for it.  |

## 2.2 Discussion in email discussion after RAN1#101-e

Based on the discussion on FG[18-4b] in [101-e-NR-UEFeatures-MRDCCA-01], concerns from some companies can be solved by either introducing FG18-4b separately from FG18-4 or updating/clarifying specifications without introducing FG18-4b.

Therefore, although it was already discussed in [101-e-NR-LTE\_NR\_DC\_CA-ScellDormancy], we can check whether following specification updates/clarifications are acceptable or not.

|  |  |
| --- | --- |
| MTK2 | Given the stalled situation in maintenance session, we can accept to remove FG [18-4b] if the current working assumption of N value in **38.213 10.3** can be relaxed by 5 symbols for each subcarrier spacing.Current working assumption in **38.213 10.3**:**A UE is expected to provide HARQ-ACK information in response to a DCI format 1-1 indicating SCell dormancy without scheduling PDSCH after N symbols from the last symbol of a PDCCH providing the SCell dormancy without scheduling PDSCH**. **If *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for the serving cell with the PDCCH providing the DCI format 1-1 indicating SCell dormancy without scheduling PDSCH, [] for , [] for , and []  for , otherwise, [] for , [] for , [] for , and [] for , wherein  corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH providing the DCI format 1-1 indicating SCell dormancy without scheduling PDSCH and the SCS configuration of a PUCCH carrying the HARQ-ACK information in response to a DCI format 1-1 indicating SCell dormancy without scheduling PDSCH.** |

|  |  |
| --- | --- |
| Qualcomm 06/03 | ~In SCell dormancy discussion, there is a debate on whether a restriction is agreeable that DCI format 0\_1 and 1\_1 carrying dormancy indication field is expected only in the first 3 symbols of a slot.Our preference is this restriction should be agreed because the legacy DCI-based BWP switching has the same restriction according to the following spec text in TS 38.213:* *A UE expects to detect a DCI format 0\_1 indicating active UL BWP change, or a DCI format 1\_1 indicating active DL BWP change, only if a corresponding PDCCH is received within the first 3 symbols of a slot.*

Since SCell dormancy transition is also based on BWP switch framework, we see the restriction as a UE friendly design for SCell dormancy indication DCI.However, this restriction is not agreeable to some companies. Therefore, there is a risk for UE implmenation if the UE supports SCell dormancy indication DCI within DRX active time but is configured with SCell dormancy indication DCI after the first 3 symbols of a slot. Without any further change, the T 38.213 spec text implies that * For dormancy indication carried by DCI format 1\_1, the DCI is only expected within the first 3 symbols.
* For dormancy indication carried by DCI format 0\_1, there is no such a restriction.

The DCI format 0\_1 behvaior without restriction is definitely not preferred by UE implementation. Case 1 dormancy indication DCI with data scheduling can use both DCI format 0\_1 and 1\_1, but Case2 doramncy indication DCI without data scheduling can only use DCI format 1\_1.Given this, a UE may support FG 18-4b but not FG 18-4 (with modifications as shown above). By this means, the UE can avoid supporting some new behvaior that was not defined for legacy DCI-based BWP switch for monitoring Scell dormancy indication DCI formt 0\_1.~ |

**Proposal 1:**

* **The current working assumption of N value in 38.213 10.3 can be relaxed by 5 symbols for each subcarrier spacing**
* **DCI format 0\_1 and 1\_1 carrying dormancy indication field is expected only in the first 3 symbols of a slot**
* **FG18-4b is removed from the UE features list for MR-DC/CA**

Companies are encouraged to check above proposal and to provide feedback if any in below. If you cannot accept the proposal, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposals:

|  |  |
| --- | --- |
| Company | Comment |
| Nokia | 1st bullet: The N value is discussed in maintenance and the understanding of the maintenance session is that these may still be discussed in August. We don’t see the need to tie this to the FG discussion and don’t find it prudent to modify the maintenance working assumptions under features. The issue of Pcell interruptions due to Scell BWP switching applies with or without PDSCH. The working assumption timeline for the case of “no PDSCH” has no connection to BWP switch timeline with PDSCH in Rel-15, because BWP switching happens on Scell, while HARQ-ACK/PDSCH is scheduled on Pcell. 🡺 Such relaxation not in scope of features2nd bullet: We don’t see the system need for the restriction, but it it helps to agree removal of the fg 18-4b, we would be fine to agree to the restriction with the condition that 18-4b is removed.3rd bullet: The 18-4b is adding to the feature fragmentation and should only be included if there is a strong motivation to do so. In addition, the case “with PDSCH” case has the same issue, where PDSCH and HARQ-ACK can be both scheduled on Pcell during BWP switching on Scell(s), so the FG18-4b does not elimitate the stated issue 🡺 support removing the FG. |
| Samsung | 1st bullet: Can skip for reasons mentioned by Nokia2nd bullet: No need. Rel-15 specs already capture that a UE expects to detect a DCI format indicating BWP switching in the first 3 symbols of a slot3rd bullet: Keep 18-4b. Agree with the other UE vendors for same reasons. As mentioned by Mediatek, 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 the motivates for 18-4 and 18-4b are identifiably different and therefore they should be separate FGs.  |
| Ericsson | Overall – we prefer to remove FG [18-4b]. If no consensus to remove, it can be kept it in square brackets. The FG discussion has wider scope and should not be linked to the the CR issues that are already being actively discussed in maintainence seesion.Below is our understanding on maintainence issues raised in first two bullets (provided mainly as background)Issue related to first bullet – The issue and the approach proposed by MTK (i.e., increase processing time by 5symbols) were discussed in maintainence session without any conclusion due to differeing views among companies. From E// perspective, we are open to the principle in MTK proposal. However, it needs to be explicitly clarified that the solution applies for all cases, including those with/without interruption and there would be no further relaxations discussed for Case 2 HARQ timeline in this context.Inssue related to second bullet – Current RAN1 conclusion on this as follows. From E// perspective, it needs to be discussed for both DCI 1\_1 and 0\_1 whether to introduce restriction per below RAN1 conclusion. The point raised by QC (i.e., for SCell dormancy indication, there is no restriction for DCI 0\_1 while there is a restriction for DCI 1\_1) was never agreed in RAN1. The assumption that this is somehow ‘current status’ is based on some companies interpretation of current spec text (written for Rel15 BWP indicator filed) and there is no consensus that such interpretation is correct.**Conclusion** (from RAN1#100bis-e)* + - *For at least DCI format 2\_6, there is no restriction that the DCI format with SCell dormancy indication is received only in the first 3 symbols of a slot*
			* *Note: No TP required*
			* *Note: If any restriction is introduced for DCI 2\_6 in UE power savings WI, whether/not it applies also for DCI format 2\_6 with SCell dormancy indication can be discussed further.*
		- *Discuss further whether to introduce restriction for DCI format 0\_1,1\_1*
 |
| Apple | Bullet 1: We are okay for the relaxation, Bullet 2: We support this proposal, or we clarify that the current specification already specifies this restriction. Bullet 3: We support to keep FG18-4b |
| Qualcomm | For bullet 1: we prefer to have timeline relaxation for Case 2 SCell dormancy DCI and HARQ-ACK, but the specific relaxation should be further discussed in SCell dormancy session. For bullet 2: we have supported this in SCell dormancy session. We think it is a natural extension of legacy scheduling DCI triggered BWP switch for the UE to at least optionally maintain the restriction for SCell dormancy indication DCI triggered BWP switch. Without any further change, the current TS 38.213 spec text implies that * For dormancy indication carried by DCI format 1\_1, the DCI is only expected within the first 3 symbols.
* For dormancy indication carried by DCI format 0\_1, there is no such a restriction.

For bullet 3: keeping FG 18-4b would be ideal given timeline relaxation and restriction above are not agreeable to some companies. |
| MTK | Bullet 1: Same view with QC. The specific relaxation could be further discussed in SCell dormancy session of next RAN1 meeting.Bullet 2: We support this proposal. Since the BWP frame work is adopted for SCell dormancy, applying the same rule for DCI based BWP switching as Rel-15 is straightforward. Bullet 3: We support to keep FG18-4b as the reasons explained by QC. |
| Moderator (NTT DOCOMO) | Based on the above feedbacks, followings are my observations.* Bullet 1 does not need to be discussed here, and should be discussed in SCell dormancy session in next meeting.
* Bullet 2 is supported by Apple, Qualcomm and MediaTek, while not supported by Samsung, Nokia (ok if FG18-4b is removed)
* Bullet 3 is supported by Nokia, Ericsson, while not supported by Samsung, Apple, Qualcomm, MediaTek unless both bullet 1 and bullet 2 are confirmed.

Since at least bullet 1 needs further discussion in maintenance agenda in next meeting, it seems not possible to agree on the proposal 1 now. |

1. Discussion on whether/how to define component 2 of FG18-5/5b or alternative new FGs

## 3.1 Summary on the discussion in RAN1#101-e [11]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | 18-5 | 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

{Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both}[2. 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 | 6-5 and one of {6-9, 6-9a} | Yes | N/A |  | FFS[Per UE or Per band and per BC or Per FS] | N/A | [Yes or N/A] | N/A | crossCarrierScheduling-OtherSCS 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. | 6-10 and 18-5 | Yes | N/A |  | FFS[Per UE or Per band and per BC or Per band] | N/A | [Yes or N/A] | N/A |  | Optional with capability signalling |
| 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

{Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both}[2. 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 | 6-6 and one of {6-9, 6-9a} | Yes | N/A |  | FFS[Per UE or Per band and per BC or Per FS] | N/A | [Yes or N/A] | N/A | crossCarrierScheduling-OtherSCS 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 |
| [18-5c] | [DL cross-carrier scheduling with different SCS and PDSCH processing capability 2] | [DL cross-carrier scheduling with different SCS and PDSCH processing capability 2] | 18-5a TBD | Yes | N/A |  | FFS[Per UE or Per band and per BC or Per FS] | N/A | [Yes or N/A] | N/A |  | [Optional with capability signaling] |
| [18-5d] | [UL cross-carrier scheduling with different SCS and PUSCH processing capability 2] | [UL cross-carrier scheduling with different SCS and PUSCH processing capability 2] | 18-5bTBD | Yes | N/A |  | FFS[Per UE or Per band and per BC or Per FS] | N/A | [Yes or N/A] | N/A |  | [Optional with capability signaling] |

* **Necessity of FG18-5c/5d**
	+ **FGs are kept: [3], [5], [9], [10]**
	+ **FFS: [7]**
* **Potential new FGs**
	+ **A new FG for “support of the DCI format 1\_2 for cross-carrier scheduling” is introduced: [3]**
	+ **Separate FGs for component 2 of FG18-5/5b: [5]**
	+ **New FGs for “DL cross-carrier scheduling with same SCS and PDSCH processing capability 2” and for “UL cross-carrier scheduling with same SCS and PUSCH processing capability 2”: [9]**
* **Components of FG18-5/5b**
	+ **Component 2 is kept: [4], [7], [8], [10]**
	+ **Component 2 is removed (as well as notes): [3], [5], [9]**
* **Others**
	+ **Clarify whether/how to cover additional cases of SCS combinations + capability 1/2 support if the UE only supports capability 2 on one of the scheduling and scheduled carriers: [9]**

Above remaining issues and proposals are identified based on following feedbacks provided in contributions for the RAN1#101-e meeting.

|  |  |
| --- | --- |
| [3] | For cross-carrier scheduling/ACSI-RS triggering, according to GTW session of DC/CA UE features in RAN1 #100-bis-e, companies agreed that UE capabilities 18-5a/18-6a for default QCL assumption should apply to both same/different numerologies. Hence, it would be better to add add “for same/different numerologies” to FG 18-5a and FG 18-6a for clarification.**Proposal 2: Add “for same/different numerologies” to FG 18-5a and FG 18-6a for clarification (according to previous companies consensus during GTW session of DC/CA UE features in RAN1 #100-bis-e).**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). The value of X should be deleted since RAN1 never achieved consensus to set this X values for basic features. We are open to introduce components 2 of both 18-5/5b as separate ifferen, say as 18-5e and 18-5f.**Proposal 3: Delete the descriptions related to value of X (component 2) in FG 18-5 and FG 18-5b.** **Proposal 6: For FG 18-5/5a/5b/6/6a, Type to be per band and per BC.**For [18-5c] and [18-5d], these are cross-carrier counterpart for the same-carrier features:* FG 5-5a – UE PDSCH processing capability #2
* FG 5-5b – UE PDSCH processing capability #2 with scheduling limitation for 30kHz-SCS
* FG 5-5c – UE PUSCH processing capability #2

Since 5-5a/b/c are all applicable to FR1 only, we think [18-5c] and [18-5d] should also be applicable to FR1 only.**Proposal 7: FG [18-5c] and [18-5d] should be applicable to FR1 only.****Proposal 8: Introduce separate UE capability to indicate the support of the DCI format 1\_2 for cross-carrier scheduling (FG 18-5e).** |
| [4] | 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. The proposed value of X is also fine. **Proposal 2: for Cross-carrier scheduling with different numerology, agreed on component 2 of FG 18-5/18-5b.**  |
| [5] | **FG 18-4 through 18-6a**We support “per band combination” and FR1/FR2 differentiation.**FG 18-5 through 18-5d**Keep 18-5c and 18-5d. Support removing component 2 from 18-5 and 18-5b as it is not required.Support introducing corresponding separate features for component 2 as it is beneficial for self-schediling from the scheduling cell. |
| [7] | * 18-5 and 18-5b
	+ 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.
		- There were some comments on which kind of monitoring capability this applies to – our view is that this should generally apply at least to the capabilities defined based on Rel-15, but if there is an overlap with ongoing eURLLC features under development, such aspects can be described/discussed separately.
* [18-5c], [18-5d]
	+ Current UE cap2 feature is only for the case of self-scheduling. These FGs propose to extend UE cap2 to CA with different numerology but more information is needed about related component descriptions and associated spec impact due to introduction of these FGs. We prefer to keep these in square brackets until further and enough details are provided and make decision whether to include or not.
 |
| [8] | At the last meeting, it was discussed that whether or not to introduce separate FGs ([18-5c/5d]) for support of DL/UL different numerology CCS with processing capability 2, but there was no consensus achieved at the last meeting. Although there are Rel-15 capabilities 5-5a (PDSCH processing capability 2), 5-5b (PDSCH processing capability 2 with scheduling limitation for 30kHz SCS) and 5-5c (PUSCH processing capability 2), it may be possible to define 18-5c/5d as combination between CCS with different SCS and PDSCH (PUSCH) processing capability 2 may require extra complexity/test for UE. On the other hand, there are already too many FGs in Rel-16 and it is good if the number of additional FGs is as minimized as possible. So, if RAN1 agree to define 18-5c/5d, we prefer to not have any further separation on these FGs. **Proposal 4: If 18-5c and 18-5d are introduced, no more new FG is added for support of CCS with processing capability 2.**Regarding the component 2 of 18-5/5b, whether it should be kept as component of 18-5/5b or it should be separate FG needs to be discussed. Although there is a concern from UE/chip vendors to keep it as component of 18-5/5b, we think that it is preferable to keep component 2 in 18-5/5b in order to make basic capability for CCS with different SCS useful. **Proposal 5: The component 2 of 18-5 and 18-5b is kept (i.e., bracket is removed).**Regarding the reporting type for 18-5/5a/5b/[5c]/[5d], per BC would be acceptable to majority companies according to discussions so far.**Proposal 6: Reporting type of 18-5/5a/5b/[5c]/[5d] is per BC.** |
| [9] | FG18-5/5a/5b/5c/5d* Type: Per band and per BC
* Support to keep FG 18-5c and 5d. Additional features are needed.
	+ It was concluded in RAN1# 100bis-e in [100b-e-NR-UEFeatures-MRDCCA-02] that capability 2 for CCS with same SCS should be discussed in other agendas. However, after checking all Rel-16 related UE feature discussions, we do not see these FGs fit in any other agenda than MR-DC/CA enhancement. Therefore, we propose to discuss the following two FGs in this session
		- [FG18-5e for DL cross-carrier scheduling with same SCS and PDSCH processing capability 2]
		- [FG18-5f for UL cross-carrier scheduling with same SCS and PUSCH processing capability 2]
	+ Besides, there are additional cases of SCS combinations + capability 1/2 support if the UE only supports capability 2 on one of the scheduling and scheduled carriers at least for the following cases. More discussions are needed to cover different cases,
		- For DL cross-carrier scheduling with ifferent SCS, only the scheduling or scheduled carrier support processing capability 2
		- For UL cross-carrier scheduling with different SCS, only the scheduling or scheduled carrier support processing capability 2
		- For DL cross-carrier scheduling with same SCS, only the scheduling or scheduled carrier support processing capability 2
		- For UL cross-carrier scheduling with same SCS, only the scheduling or scheduled carrier support processing capability 2
* Remove componenent 2 from FG 18-5 and FG 18-5b. PDCCH processing and cross-carrier scheduling are two complicated features. For PDCCH processing capability, several FGs have been already defined. It would be necessary to clarify how the counterparts of the existing PDCCH processing related FGs are treated within the CCS with different SCSs framework. It is hard to bundle these two complicated functions together within the same FGs.
	+ The “notes” was added when component 2 was added. Given compoenent 2 is FFS (as highlighted in yellow), the “notes” should be highlighted as FFS
* For FG 18-5a, the current pre-requisite FG is 6-10 and 18-5 corresponding to CCS with same SCS and different SCS, respectively. The “and” should be “or”.
* For FG 18-5/5b, there is no need to have 6-9, /6-9a as the prerequisite FGs.
 |
| [10] | **18-5/5a/5b/5c/5d*** 18-5/5b: Support keeping component 2 as it now stands. Should be per UE as the cross-carrier ability is a BB feature not RF feature. Could consider making the capability multi-level as “intra-FR1, Intra-FR2, cross-FR” as a compromise, but should avoid unnecessary per BC or per FS signalling
* 18-5a: should be per UE, FRx differentiation
* 18-5c/5d: OK to keep these, same comment on applicability as for 5/5b.
 |

**FL proposal 3:**

* **No additional FG related to cross-carrier scheduling (18-5x other than 18-5/5a/5b/5c/5d) is added to the UE features list for MR-DC/CA enhancements**
	+ **Component 2 of FG18-5/5b are kept**

Companies are encouraged to check above FL proposals and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposals:

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | We support the FL proposal. |
| Ericsson | Support the FL proposal. |
| Qualcomm | Regarding “**No additional FG related to cross-carrier scheduling (18-5x other than 18-5/5a/5b/5c/5d) is added…**”, besides cases covered by FG 5c/5d, there are cases.Our understanding is with current FGs following the latest FL proposal, UE is not required to support the following cases.* For DL cross-carrier scheduling with same SCS, both the scheduling and scheduled carriers support processing capability 2
* For UL cross-carrier scheduling with same SCS, both the scheduling and scheduled carriers support processing capability 2
* For DL cross-carrier scheduling with same SCS, only the scheduling carrier supports processing capability 2
* For UL cross-carrier scheduling with same SCS, only the scheduling carrier supports processing capability 2
* For DL cross-carrier scheduling with same SCS, only the scheduled carrier supports processing capability 2
* For UL cross-carrier scheduling with same SCS, only the scheduled carrier supports processing capability 2
* For DL cross-carrier scheduling with different SCS, only the scheduling carrier supports processing capability 2
* For UL cross-carrier scheduling with different SCS, only the scheduling carrier supports processing capability 2
* For DL cross-carrier scheduling with different SCS, only the scheduled carrier supports processing capability 2
* For UL cross-carrier scheduling with different SCS, only the scheduled carrier supports processing capability 2

Regarding “**Component 2 of FG18-5/5b are kept**”, we object this for two reasons* Component 2 is very challenging for UE implementation. As we have been arguing throughout the entire RAN1 MR-DC enhancement discussion, it is not realistic to assume a UE can support such an increased number of DCIs per span. Given that companies think there should be no corresponding new FGs for component 2, we propose to remove it.
* Combining PDCCH features with cross-carrier scheduling with different SCS features is not good in the sense that each of these two is already very complicated. It is hard to believe that component 2 can well reflect PDCCH capabilities defined under PDCCH FGs (i.e., 3-x). Having said this, it would be problematic to assume that we can properly define new FGs for component 2 in current situation. Then, component 2 should be removed.
 |
| Samsung | Support the FL proposal. |
| Huawei, HiSi | OK with FL proposal |
| Nokia, NSB | We support the FL proposal |

Based on the discussion in Wednesday GTW session, following updated FL proposals are made.

**Updated FL proposal 3:**

* **No additional FG related to cross-carrier scheduling (18-5x other than 18-5/5a/5b/5c/5d) is added to the UE features list for MR-DC/CA enhancements**
	+ **Component 2 of FG18-5/5b are kept**
	+ **UE is not required to support following cases**
		- **For DL cross-carrier scheduling with same SCS, both the scheduling and scheduled carriers support processing capability 2**
		- **For UL cross-carrier scheduling with same SCS, both the scheduling and scheduled carriers support processing capability 2**
		- **For DL cross-carrier scheduling with same SCS, only the scheduling carrier supports processing capability 2**
		- **For UL cross-carrier scheduling with same SCS, only the scheduling carrier supports processing capability 2**
		- **For DL cross-carrier scheduling with same SCS, only the scheduled carrier supports processing capability 2**
		- **For UL cross-carrier scheduling with same SCS, only the scheduled carrier supports processing capability 2**
		- **For DL cross-carrier scheduling with different SCS, only the scheduling carrier supports processing capability 2**
		- **For UL cross-carrier scheduling with different SCS, only the scheduling carrier supports processing capability 2**
		- **For DL cross-carrier scheduling with different SCS, only the scheduled carrier supports processing capability 2**
		- **For UL cross-carrier scheduling with different SCS, only the scheduled carrier supports processing capability 2**

Companies are encouraged to check above FL proposals and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposals:

|  |  |
| --- | --- |
| Company | Comment |
| Ericsson | The list of cases that UE is not required to support needs more discussion, especially given FL proposal 2 above.We are OK to support together the main bullet and subbullet on keeping component 2. We are also OK with making component 2 a separate FG. Given this, we prefer component 2 discussion together with whether additional FG is needed. |
| Qualcomm | For component 2, we cannot accept for two reasons* First, it is not possible for UE to support this increased number of DCIs per span from the begning of deployment of the cross-carrier scheduling with different SCS feature. As we have been explaining in the regular MR-DC discussion, there is no schedulability problem with using FG 3-5b for the typical scheduling cell SCS = 30kHz and scheduled cell SCS = 120kHz case. The cross-carrier scheduling feature is chanllenging and component 2 makes it way more challenging. Optimization such as component 2 should be deferred to the future if necessary.
* Second, various PDCCH capaiblities are defined which shows that PDCCH monitoring is complicated. It is hard to use a single component 2 to well mirror extising PDCCH capaiblities. For that we think either we remove component 2 or we may have to extensively discuss many possible cases that mirror existing PDCCH capaiblities. Again, the purpose is hopefully by doing this, UE can have enough flexibility to choose to support the whole feature package in an increamental way in deployment and pontentially choose to not support some extremely chanllenging sub-feature.
 |
| Apple | * Component 2 of FG18-5/5b should be removed. This becomes a conditional mandatory feature, X can not be a single value.
* We prefer to limit both the scheduling cell and scheduled cell in FR1, but as we indicated above, with all the lengthy discuson, our first preference is to remove FG18-5c/5d.
 |
| MTK | * We can not accept Componenet 2 of FG18-5/5b as the same reason with QC.
* We also prefer to remove FG18-5c/5d since there seems no consensus on how to properly introduce this feature.
 |
| Moderator (NTT DOCOMO) | Based on the feedbacks, component 2 of FG18-5/5b should be removed and making them as separate FGs seems acceptable.Therefore, following is updated proposal.* 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
	+ 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
	+ FFS: detailed design of this FG
 |
| Moderator (NTT DOCOMO) | Based on further feedbacks over emails, FL proposal 3 is updated as below. |

**Updated FL proposal 3:**

* **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**
	+ **Component 2 description in FG18-5 is moved to this FG**
	+ **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**
	+ **Component 2 description in FG18-5b is moved to this FG**
	+ **FFS: detailed design of this FG**

Companies are encouraged to check above FL proposals and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposals:

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | We think for FL proposal 3, necessity of the new FGs still needs to be further discussed.Regarding the applicability to FG 3-5b, it is unnecessary for the following reasons:* Our view has been that using FG 3-5b is sufficient to support one slot scheduling multiple slots for the case of a lower SCS PDCCH scheduling a higher SCS PDSCH or PUSCH, at least for the typical SCS=30kHz scheduling SCS=120kHz case. In Rel-16 MRDC discussion, some argument against our view was by using FG 3-5b, network will waste more resource for PDCCH transmission in multiple spans per slot that otherwise can be used for data transmission (we do not agree with this based on the following sub-bullet), and hence network prefers to use a single span with increased number of DCIs per span. Then as a substitute of FG 3-5b, there is no need to apply the new FGs to each span of FG 3-5b.
	+ Regarding the waste of resource due to FG 3-5b, we think there is no such an issue. The total amount of time/frequency resource is determined by the number of data channels to be scheduled and hence the number of PDCCHs to be transmitting. Using a single span per slot or multiple spans per slot does not change this. In the case of using FG 3-5b, network can configure narrower BW CORESET for the spans to maintain the same amount of control resource. Because of this, we still believe the new FGs are not needed. Necessity of the new FGs is not clear for Rel-16.
 |
| Moderator (NTT DOCOMO) | Based on above feedback, updated FL proposal is to remove component 2 from FG18-5/5b without introducing new FGs. |
| Moderator (NTT DOCOMO) | Based on the discussion in GTW session, we should continue the discussion based on Alt.1 and Alt.2 below. I’d like to ask companies to consider possible compromise otherwise we cannot conclude this topic. |
| Qualcomm | We understand the intention of the proposal for component 2 which now is agreed to be made a separate FG. We do not have a strong view to object such an approach epescially if the FG is optional now. However, the current Alt. 1 has some major issues as we mentioned in the meeting. Under current situation, Alt.2 seems the only thing we can accept. We hope proponents of Alt.1 can take our comments into account to improve Alt.1 if Alt. 1 type of solution is considered critical. We summarize the issues and our views as follows* FG 3-5b and multiple DCIs in a span are considered two candidate solutions in Rel-16 MR-DC discussions. Our view is FG 3-5b is sufficient for one slot of lower SCS scheduling multiple slots of higher SCS (e.g., the typical 30kHz scheduling 120kHz). If companies think FG 3-5b is not good and want to propose to increase the number of DCIs in a span for one slot scheduling multiple slots, our understanding is this increase of DCI number should not be applied to each span of FG 3-5b. The reason is simple: FG 3-5b can provide enough DCIs. The combined solution of FG 3-5 and increasing DCI number in a span more or less indicates that increasing number of DCI is not needed if FG 3-5b is available. For this reason, we think Alt. 1 is not acceptable at least because it has “In case UE supports 3-5b, the limits apply for each span for FDD scheduling cell and TDD scheduling cell”
* Many PDCCH monitoring related FGs have been defined including 3-1, 3-1’, 3-2, 3-3, 3-5, 3-5a and 3-5b. Our view is at least 3-5b should not be involved in Alt. 1. Then whether and how to define increased number of DCIs in a span for the other FGs needs to be discussed. Right now, there is no such proposal or conclusion yet. Without careful design, a conclusion made now may cause significant CR efforts for the feature to really work. We should think about whether such a risk is worthwhile.
* If FG 3-5b is used for one slot scheduling multiple slots based on PDCCH monitoring in multiple spans, narrower bandwidth CORESET can be configured such that the total amount of time and frequency resource for PDCCH monitoring is fixed regardless of the number of spans. By this means, the remaining resource can still be used by data channels and hence ther is no blockage of PDSCH or PUSCH.

In summary, we understand the principle of Alt. 1 type of solution, i.e., increasing the number of DCIs in a span. However, there are many important details missing for this proposal. We see a high risk of significant CR efforts to make this proposal really work if a conclusion is made now without design details. Having said this, only Alt.2 is acceptable in current situation. |
| Ericsson2 | We suggest following updates to FL proposal 3 Alt 1, considering comments so far, including from Qualcomm. Hopefully, this is now acceptable. Updated Alt 1: * **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**
	+ **When all search space configurations are within a single span of 3 consecutive OFDM symbols in a slot, the number of DL DCIs in the span for each pair of (scheduling CC SCS, scheduled CC SCS) is no larger than X**
		- **X=4 for (15,120), (15,60), (30,120),**
		- **X=2 for (15,30), (30,60), (60,120 kHz)**
* **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**
	+ **When all search space configurations are within a single span of 3 consecutive OFDM symbols in a slot, the number of UL DCIs in the span for each pair of (scheduling CC SCS, scheduled CC SCS) is no larger than X**
		- **X=4 for (15,120), (15,60), (30,120),**
		- **X=2 for (15,30), (30,60), (60,120 kHz)**
 |
| Qualcomm 06/03 | Thanks Ericsson for updating the Alt. 1 proposal. However, there are still critical problems not addressed by the updated proposal.First, on the following condition in updated Alt 1 in “Ericsson2”* **When all search space configurations are within a single span of 3 consecutive OFDM symbols in a slot**

This may require UE to dynamincally switch between monitoring up to X DCIs per span if one slot is configured with a single span and monitoring a legacy number of DCIs per span if multiple spans are configured by the network if the UE supports multiple spans per slot. It should be clarified that the condition is a UE capability dependent condition but not a PDCCH configuration dependent condition. Besides, Rel-15 PDCCH span includes both the 2 symbol and 3 symbol span cases. If the condition has “**a single span of 3 consecutive OFDM symbols**” as in the updated Alt.1, network can still assume number of DCIs per span can be increased to X if the span size is 2-symbol. This is not acceptable.The current number of X has a single value. To make the FG workable for different UEs, more candidate values should be added, e.g., 2 for (15kHz, 120kHz). Also, the value and SCS pair relationship should be restructured sucth that for each (scheduling CC SCS, scheduled CC SCS) pair, a set of X values are defined as candidates.A major issue with the current proposal leads to this question: should the cross-carrier scheduling with different SCS PDCCH capability mirror Rel-15 PDCCH capabilities (i.e.., FG 3-1/3-1’/3-2/3-5/3-5a/3-5b)? Idealy, yes. It is clear now FG 3-5b is not involved in the CCS with different SCS feature for Rel-16. Then how about the other ones? The remaining PDCCH capabilities (i.e., FG 3-3/3-4) are also indirectly interacting CCS with different SCS feature. Should we look into them or just ignore it with unknwon risks?A minor change to make is to clarify this is an optional feature. |
| Apple | We cannot agree on Alt.1 in FL proposal 3 and the updated Alt 1 from Ericsson2.In Rel-15, the maximum number of unicast DCI is designed per monitoring occasion(s) (witin the same span) for each PDCCH monitoring capability, such as 3-1, 3-5a, 3-5b* Alt 1, the maximum number of unicast DCI is different for different PDCCH minoting capability, which is different between different FGs. We cannot agree on a generic X relaxation
* Updated Alt 1, it does not solve the problem either, since again for each PDCCH minotring occasion, the maximum number of unicast DCI depends on the UE reported PDCCH minotring capability, for example as one of FG3-1/5a/5b, it is not a function of search space configuration. The UE capability cannot change based on the UE configuration.
 |
| Ericsson3 | We made some more updates based on the comments. This is applicable based on 3-1. The capability is supported under certain configuration conditions as described in the component.Considering the discussions in maintenance session we also updated the component to include more than one unicast DCI in a MO in square brackets. Other option is to have a separate FG for multiple DCI per MO (as proposed by Nokia). Further Updated Alt 1: * **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**
	+ **When all search space configurations are within a single span of [2 or] 3 consecutive OFDM symbols in a slot, the number of DL DCIs in the span for each pair of (scheduling CC SCS, scheduled CC SCS) is no larger than X, [with more than one unicast DL DCI for a scheduled CC in a same PDCCH monitoring occasion,] and one span per slot with gap of 14 OFDM symbols between start of any two spans**
		- **UE can report one value of X from candidate values per each pair of scheduling CCS, scheduled CC SCS)**
		- **Candidates values:**
			* **{2,4} for (15 kHz,120 kHz),**
			* **{2,4} for (30 kHz,120 kHz),**
			* **{2,4} for (60 kHz, 120 kHz),**
			* **{2,4} for (15 kHz,60 kHz),**
			* **{2,4} for (30 kHz,60 kHz),**
			* **{2,4} for (15 kHz,30 kHz)**
	+ **Type: [Per UE]**
	+ **FDD/TDD differentiation: Yes**
	+ **FR1/FR2 differentiation: Yes**
	+ **Optional with capability signalling**
* **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**
	+ **When all search space configurations are within a single span of [2 or] 3 consecutive OFDM symbols in a slot, the number of UL DCIs in the span for each pair of (scheduling CC SCS, scheduled CC SCS) is no larger than X, [with more than one unicast UL DCI for a scheduled CC in a same PDCCH monitoring occasion,] and one span per slot with gap of 14 OFDM symbols between start of any two spans**
		- **UE can report one value of X from candidate values per each pair of scheduling CCS, scheduled CC SCS)**
		- **Candidates values:**
			* **{2,4} for (15 kHz,120 kHz),**
			* **{2,4} for (30 kHz,120 kHz),**
			* **{2,4} for (60 kHz, 120 kHz),**
			* **{2,4} for (15 kHz,60 kHz),**
			* **{2,4} for (30 kHz,60 kHz),**
			* **{2,4} for (15 kHz,30 kHz)**
	+ **Type: [Per UE]**
	+ **FDD/TDD differentiation: Yes**
	+ **FR1/FR2 differentiation: Yes**
	+ **Optional with capability signalling**
 |
|  |  |

**Updated FL proposal 3:**

**Alt.1**

* **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**
	+ **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: 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**
	+ **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: detailed design of this FG**

**Alt.2**

* **Component 2 in FG18-5/5b is removed**
	+ **FFS: Modify the note to “In case UE supports 3-5b, the limits do not apply for each span for FDD scheduling cell and TDD scheduling cell” for FG18-5/5b**

## 3.2 Discussion in email discussion after RAN1#101-e

Based on the discussion on potential new FGs in [101-e-NR-UEFeatures-MRDCCA-01] as well as in [101-e-NR-LTE\_NR\_DC\_CA-X-CC\_scheduling], it seems that the discussion outcome from [101-e-NR-LTE\_NR\_DC\_CA-X-CC\_scheduling] should be reflected here.

Therefore, **FL proposal is to wait for the discussion outcome of [101-e-NR-LTE\_NR\_DC\_CA-X-CC\_scheduling] and to discuss necessary details after the discussion in [101-e-NR-LTE\_NR\_DC\_CA-X-CC\_scheduling] is concluded**.

Companies are encouraged to check above proposal and to provide feedback if any in below. If you cannot accept the proposal, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposals:

|  |  |
| --- | --- |
| Company | Comment |
| Nokia | The current discussion in X-CC\_Scheduling is only loosely related, but it may have some implications to thie feature discussion thread. Believe we can proceed discussion on this one.Our view is Alt.1 or else the UE has no way of indicating improved PDCCH procedding capability. |
| Samsung | Alt. 1 – otherwise, UE cannot indicate support for reception of multiple DCIs at a same PDCCH MO with corresponding HARQ-ACK in same codebook. |
| Ericsson | On the relation to current discussion in X-CC\_Scheduling, we have similar view as Nokia, i.e. we can proceed with discussion on this. We prefer Alt 1 - otherwise UE cannot indicate improved PDCCH processing capability.  |
| Apple | Prefer Alt 2.* Current Rel-15 already provodes fine enough PDCCH monioting related capability, (1) FG3-1 (2) FG3-1’ (3) FG3-2 (4) FG3-5a (5) FG3-5b, (7, 3) (6) FG3-5b, (7, 3) and (4,3) (7) FG3-5b, (7, 3) and (4,3) and (2, 2). In terms of the number of unicast DCIs UE can decode per span, FG3-5b can support 2 DCI unicast DCI and 1 UL unicast DCI, or 1 DCI unicast DCI and 2 UL unicast DCI. It is not obvious that we need a new PDCCH monitoring capability
* We do not see the direct impact of gNB since there is no requirement for gNB to configure a certain span. UE is allowed to indicate its advanced PDCCH monitoring capability, to give gNB more flexibility in terms of the scheduling the resource configuration. gNB has full freedom to configure the number of spans etc., subject to UE capability. The fundenmental issue is that, we think all the advance PDCCH monitoring capabilities allowed in Rel-15 provides UE with enough granularity and allows full functionality of CCS with different SCS.
* We do not see why this is directly related to the reception of multiple DCIs at a same PDCCH MO with corresponding HARQ-ACK in same codebook since it is the same issue for FG3-5b at as well.
 |
| Qualcomm | We prefer Alt 2 and the FFS under Alt 2 should be also removed, for the following reasons* Existing mechanism including FG 3-5a/5b is good enough to provide one slot of lower SCS scheduling multiple slots of higher SCS. It is unnecessary to define a new mechanism to achieve the same goal
* FG 3-5a/b does not have the resource limitation problem due to distributed PDCCH transmission if network does not configure the full bandwidth of the BWP for PDCCH. This is in full control of network
* Even though UE reports the support of FG 3-5a/5b, network still has the full control of configuring a single span in some slots and multiple spans in other slots. This is another reason using FG 3-5a/5b does not cause schedulability issue although the second bullet above can already guarantee it.
* Defining a UE feature unnecessary for the current release has unpredictable impact to the future when a real critical use case emerges in the future. It should be avoided to introduce the new feature.
* Component 2 or a new FG as replacement of component 2 is at most an optimization rather than a critical solution. There is no need to introduce an optimization for Release 16. Besides, we do not think component 2 cannot be even considered as an optimization because of its obvious implementation challenges to UEs.
 |
| MTK | We prefer Alt. 2 and remove the FFS with same reason as Apple and Qualcomm. Furthermore, it should be noted that RAN2 has agreed recently that:* For NR UE capabilities in R1/4 feature list:
	+ To skip the UE feature group entry if the FFS is in any column other than mandatory/optional column for any component in that feature group

Thus, RAN1 should try to avoid FFS in a FG or the whole UE feature group may be skipped. |
| Moderator (NTT DOCOMO) | Based on the above feedbacks, still Alt.1 (supported by Nokia, Samsung, Ericsson) vs Alt.2 (supported by Apple, Qualcomm, MediaTek) is controversial and there seems no suggestion for compromise between two alternatives. Therefore, it seems not possible to agree on either alternative now.However, since the discussion is whether the improved PDCCH processing capability as component 2 of FG18-5/5b should be supported in Rel-16 or not and it seems reasonable argument that it is anyway implementation change to UE and hence should be optional for UE, can we try to remove component 2 from the FG18-5/5b and add Alt.1 FGs with brackets and yellow highlights for further discussion? It seems clear that keeping component 2 in FG18-5/5b is not acceptable and we are not going to discuss such alternative. |

### **Proposal 2:**

* **Component 2 in FG18-5/5b is removed**
* **Add following new FGs with bracket and yellow highlight in UE features list for MR-DC/CA**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [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] | 18-5 | Yes | N/A |  | TBD | TBD | TBD | TBD | [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 |
| [18-5d] | [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] | 18-5b | Yes | N/A |  | TBD | TBD | TBD | TBD | [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 |

In addition, it is pointed by MediaTek that following updates for FG18-5a seems necessary. Therefore, one more proposal is added as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Due to the reason that UE may only support 6-10 (same SCS) or only support 18-5 (different SCS), or support both 6-10 and 18-5, some suggested text revision for FG 18-5a is shown below (**in red**):

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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{Scheduling cell of lower SCS and scheduled cell of higher SCS, Scheduling cell of higher SCS and scheduled cell of lower SCS, both}[2. 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  | 6-5 | Yes | N/A |   | Per BC | N/A | N/A | N/A | crossCarrierScheduling-OtherSCS 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 for same**~~/~~ or** different numerologies**{same only, different only, both}** | one of {6-10, 18-5} | Yes | N/A |   | Per BC | N/A | N/A | N/A |   | Optional with capability signalling |

 |

### **Proposal 3:**

* **Component description of 18-5a is updated as below**
	+ **Indicates whether the UE can be configured with enabledDefaultBeamForCCS for default QCL assumption for cross-carrier scheduling for same or different numerologies**
		- **Candidate values: {same only, different only, both}**

Companies are encouraged to check above proposal and to provide feedback if any in below. If you cannot accept the proposal, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposals:

|  |  |
| --- | --- |
| Company | Comment |
|  |  |
|  |  |
|  |  |

1. Conclusion

TBD

Reference

[1] R1-2003202 Summary on email discussion [100b-e-NR-UEFeatures-Remaining] MR-DC/CA enhancement Moderator (NTT DOCOMO, INC.)

[2] R1-2003335 Discussion on UE feature for MR-DC ZTE

[3] R1-2003677 Views on Rel-16 UE features for MR-DC/CA MediaTek Inc.

[4] R1-2003760 UE feature for MR-DC Intel Corporation

[5] R1-2003901 UE features for MR-DC/CA Samsung

[6] R1-2004144 Rel-16 UE features for MR-DC/CA Huawei, HiSilicon

[7] R1-2004369 Discussion on UE features for MR-DC Ericsson

[8] R1-2004409 Discussion on UE features for MR-DC/CA enhancement NTT DOCOMO, INC.

[9] R1-2004478 Discussion on UE features for MR-DC/CA Qualcomm Incorporated

[10] R1-2004568 On UE features for MR-DC/CA Nokia, Nokia Shanghai Bell

[11] R1-2004823 Summary on [101-e-NR-UEFeatures-MRDCCA-01] Moderator (NTT DOCOMO, INC.)