**3GPP TSG-RAN WG1 #106-e R1-21xxxxx**

**eMeeting, Aug 16 – 27, 2021**

**Source: Moderator (Ericsson)**

**Title: Summary of Email discussion [106-e-NR-DSS-01]**

**Agenda item:** **8.13.1**

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

# 1 Introduction

This document summarizes the discussions for email thread [106-e-NR-DSS-01] under agenda item 8.13.1 on Cross-carrier scheduling (from SCell to PCell) for the Rel17 WI on NR Dynamic spectrum sharing (DSS).

# 2. Discussion

## 2.1 Moderator Summary

Below is a short moderator summary based on tdocs [1-19] submitted for RAN1#106-e

### 2.1.1 PDCCH monitoring and BD/CCE limit handling

Following aspects were discussed related to PDCCH monitoring and BD/CCE limit handling when CCS from sSCell to PCell/PSCell is configured

1. BD/CCE limit handling for Type B UE (related to Discussion point 4v3 from RAN1#105e)
   * [based on Option A/C]
     + [1] (C), [2],[3],[7],[8] (A),[10]?,[11],[12],[18] (C),[19], [4](2nd /3rd preference), [14](different SCS)
   * [based on Option B]
     + [4],[5],[6],[9],[13],[14] (same SCS),
   * When determining or
     + (p-p) counted once, (s-p) is not counted (i.e., similar to Rel16)
       - [4],[7],[8]?,[11],[12]?,[19]
     + (p-p) counted once, (s-p) is counted one additional time assuming SCS of sSCell
       - [6],[10]?,[19], [5] (if s1, s2 below not provided)?,
     + (p-p) counted by applying scaling factor s1, (s-p) is counted additionally assuming SCS of sSCell by applying scaling factor s2
       - [1],[4],[5]?,[6],[10]? ,[12]
   * scaling factors
     + RRC – [1],[2],[3]?,[4]?,[5],[6]?,[7]?,[8],[11],[12],[14]?,[19]
     + a fixed factor, value can be agreed during the discussions – [13]
     + values of scaling factors determined dynamically by the UE based on the configured number of PDCCH candidates on sSCell scheduling PCell – [15]
   * Clarification on overbooking
     + Consider only PCell candidates – [12] (scaled)
     + Consider both PCell and sSCell candidates if Option B – [4]
     + Wait for Option A/C vs. Option B discussion – [5]
   * Do not support P(S)Cell SCS > sSCell SCS – [7],[8]
   * For (s-p) monitoring on sSCell use single span of (first) 3 consecutive OFDM symbols of a P(S)Cell slot – [8]
   * Wideband CORESET simplification – [8]
   * “Consider to apply Rel-15/16 BD/CCE limit for a slot where any CORESETs are not assigned on one of P(S)Cell and sSCell” – [10]
2. Additional Clarifications for Type A UE
   * [slot/symbol] in RAN1#105e agreement
     + per slot (of P(S)Cell) overlap is avoided – [5],[8],[12]
     + overlapping search space condition is evaluated on a symbol basis – [13]
   * Type 0/0A/1/2/CSS handling
     + No restriction on configuration
       - [4],[8] (but UE does expect to not decode CS/MCS/C-RNTI on 0/0A/1/2/CSS), [12] (but UE drops overlapping sSCell slots when collision?), [19]
     + Configured such that overlap with sSCell USS monitoring is avoided
       - [1],[2],[5]
   * USS handling
     + Supports non-fallback DCI format on PCell – [4],[14]
   * BD/CCE handling
     + “Based on the PCell parameters if candidates are configured on PCell; Based on the sSCell parameters if candidates are configured on sSCell” – [1]
     + Option B – [2]
     + “based on Rel-16 PDCCH monitoring” – [5] ; “there is no spec impact on BD/CCE handling” – [12]
     + Same as Type B UE -- [8],[14],[19]
   * Handling when sSCell is deactivated
     + monitor USS/non-fallback DCI formats on P(S)Cell– [1],[3],[9],[13] (also dormant, sSCell RLF), [14],[19]
     + FFS: -- [10]
3. DCI format 2\_5
   * follows Rel16 – [4],[10],[16],[18]
4. DCI format 2\_6
   * Follows Rel16 handling – [4],[10],[12],[16],[18]
   * Can be sent also on sSCell – [2]
5. Impact on DCI size budgets – [3],[11],[16],
6. Impact on #DL and UL unicast DCI per monitoring occasion/span – [4],[6],[12],[16]
7. SCell to PCell scheduling for unaligned CA
   * Supported – [9],[14],
8. SCell to PCell scheduling for multicast
   * Supported -- [5],[14],
   * FFS – [3],[9]
9. Separate config of UL and DL DCI formats – [19]

### 2.1.2 Configuration details for CCS from sSCell to P(S)Cell

1. Use CIF for PCell non-fallback DCI when sSCell is configured – [4],[8]
2. Search space linking configuration for CCS
   * Use SS linking as in Rel16
     + [2],[4],[6],[7],[9],[14],[18]
   * Use SS linking but PeriodicityAndOffset, SymbolsWithinSlot, and duration can be configured on linked PCell SS
     + [4](also OK), [6],[8],[12],[17],
   * Separate search space config for sSCell to PCell scheduling and sSCell self-scheduling
     + [3],[5],
3. SCell to PCell scheduling configured per USS set
   * [9],[10]
4. RRC configuration details for CCS from sSCell to PCell/PSCell (How to indicate using CrossCarrierSchedulingConfig) – [2]

### 2.1.3 Remaining details on scheduling framework

1. Dynamic activation/activation of sSCell to P(S)Cell scheduling – [4],[18]
2. simultaneous replacement of a deactivated/dormant sSCell by a new sSCell, or DCI/MAC CE based indication of sSCell – [5]
3. Dormancy for sSCell?
   * Supported – [2], [4], [14,[17]
   * FFS – [6]

### 2.1.4 Other aspects

1. TP to 38.300 – [19]
2. SCell to PCell/PSCell scheduling has no impact on PUCCH or PUSCH/SRS for non-CA – [13]
3. Whether sSCell can be unlicensed band? – [6]
4. BFR on sSCell – [2]

Below are some proposals for discussion

## 2.2 Proposals

### Proposal 1

* At least for Type B UE, when the UE is configured for CCS from sSCell to P(S)Cell and when P(S)Cell SCS () is less than or equal to sSCell SCS ()
  + On P(S)Cell (for self-scheduling)
    - UE is not required to monitor more than PDCCH BD candidates per P(S)Cell slot
  + On sSCell (for cross-carrier scheduling to P(S)Cell)
    - UE is not required to monitor more than PDCCH BD candidates per sSCell slot
    - UE is additionally not required to monitor more than PDCCH BD candidates per P(S)Cell slot
  + and are based on RRC configuration and at least cases of are supported
  + FFS the following
    - Distribution of PDCCH BD candidates between multiple sSCell slots overlapping a P(S)Cell slot including whether the above additional BD limitation is defined per sSCell slot or per P(S)Cell slot.
      * Discuss further using following alternatives as starting point (other alternatives/further refinement of alternatives not precluded)
        + Alt1

The additional BD limitation is per sSCell slot with further limitation that UE is not required to monitor more than PDCCH BD candidates per sSCell slot

* + - * + Alt 2

The additional BD limitation is per P(S)Cell slot and no further restrictions

* + - * + Alt 3

The additional BD limitation is per P(S)SCell slot with below further limitation

All search space configurations monitored on sSCell for cross-carrier scheduling to P(S)Cell are within a single span of 3 consecutive OFDM symbols within a duration spanning P(S)Cell slot

* + - Whether/how the definition of or is modified compared to Rel16 when UE is configured with CCS from sSCell to P(S)Cell
    - Whether separate and are configured by RRC or if and only is configured

Companies are requested to indicate their view about the above proposal in the Table below

|  |  |
| --- | --- |
| **Company Name** | **Comments (Proposal 1)** |
| Moderator notes | Continuation of discussion from previous meeting. Considering the inputs for this meeting (summarized in point 1 in section 2.1.1) and considering the discussion in previous two meetings, the proposal is based on [Option A/C]. |
| Apple | In general, we are fine with the proposal |
| Samsung | 1. Option A/C would be acceptable provided that the UE complexity regarding Option B is first substantiated and not just mentioned. For example, is the suggested complexity of Option B larger than (or comparable to) the complexity for performing overbooking per slot? What exactly makes Option B complex? 2. What is the reason for allowing ? 3. The WID does not restrict DSS to only eMBB but the proposal focuses on slot-based PDCCH monitoring. 4. It should be clarified that the condition/sub-bullet “on P(S)Cell (for self-scheduling)” as well as the first condition/sub-bullet “on sSCell (for cross-carrier scheduling to P(S)Cell” are from Rel-16.   For the FFS, OK with Alt. 2 - Alt. 3 can be part of UE features discussion. |
| Qualcomm | We are OK with the proposal. Clarifying details under the FFS can be the next step but let us explain why we propose Alt.3; Case 2 PDCCH monitoring (PDCCH monitoring periodicity smaller than a slot) is not the scenario for DSS, and we do not think it is reasonable either to mandate this to all Rel-17 DSS UEs, or to define another (sets of) optional UE capability signalling for the case 2. With Alt.3, BD budget split across sSCell slots within a P(S)Cell slot duration can be concluded. |
| Spreadtrum | We support the proposal.  Option A/C is hard division, while Option B is soft division. When the configured CC number is larger than UE capability, it calculates the BD/CCE limit per same numerology, which is soft division among the cells with same SCS. But the BD/CCE limits of P(S)Cell are fixed to and . That means when checking whether there is overbooking on P(S)Cell, the configurations of BDs/CCEs on the other SCells with same SCS do not considered. It is easier. Similarly, can provide static values of BD/CCE limits of P(S)Cell. It is easier when the overbooking and dropping on P(S)Cell is implemented due to no consideration of the BDs/CCEs on SCells. However, if Option B is applied, the BDs/CCEs on sSCell vary every slot. There BD/CCE limits change every slot. It is more complex compared with Option A/C. |
| LG Electronics | We do not support Proposal 1. In our view, how to define or should be discussed first, since it can determine BD/CCE limit per each cell/SCS and does not require an issue on how to re-distribute BD/CCE limit for different SCS case (as in FFS). After deciding how to define or , we can discuss whether additional adjustment for is needed or not. |
| vivo | We are general OK with the idea to have semi-static BD/CCE budget for Type B UEs. But there is some confusing part for me. It seems that the proposal has no intention to down-select between option A and C. However, the proposal includes both restriction per sScell slot and P(S)cell slot for sScell scheduling P(S)Cell part. From current proposal, the following is exact restriction details for Alt 1:   * Alt. 1 (corresponding to Option C): On sSCell (for cross-carrier scheduling to P(S)Cell)   + - UE is not required to monitor more than PDCCH BD candidates per sSCell slot     - UE is additionally not required to monitor more than PDCCH BD candidates per P(S)Cell slot     - UE is not required to monitor more than PDCCH BD candidates per sSCell slot   In my understanding, Option C is quite simple and it doesn’t need to have BD/CCE restriction per P(S)cell slot, which is provided below:   * Alt. 1 (corresponding to Option C): On sSCell (for cross-carrier scheduling to P(S)Cell)   + - UE is not required to monitor more than PDCCH BD candidates per sSCell slot   This needs to be clarified that the proposal is aligned with previous agreement. |
| Huawei, HiSilicon | 1. is the total BD limit per slot for the scheduling cells with SCS configuration. UE is not required to monitor more than BDs per slot for all the scheduling cells with SCS configuration including the PCell. If there is no other scheduling cell with SCS configuration and no other limit are considered, UE can monitor BDs on PCell. So on P(S)Cell (for self-scheduling), we suggest to modify the limit to 2. andcan be used for definition of and respectively. 3. On sSCell (for cross-carrier scheduling to P(S)Cell), we suggest to modify the two limits to one limit defined on per sSCell slot: |

### Discussion Point 2

* Companies are requested to provide their view on following
  + If Type-0/0A/1/2-CSS sets are to be configured such that overlap with USS sets on sSCell (i.e., the USS sets used for SCell to P(S)Cell scheduling) is avoided
    - What (if any) simplification is expected for UE operation/implementation for SCell to PCell scheduling (i.e., in terms of BD/CCE handling etc.)
    - What (if any) impact is expected on SI scheduling, paging, RACH etc. related procedures?

Companies are requested to indicate their view in the Table below

|  |  |
| --- | --- |
| **Company Name** | **Comments (Discussion Point 2)** |
| Moderator notes | Considering the inputs for this meeting (summarized in point 2 in section 2.1.1), additional discussion to improve companies mutual understanding could be beneficial. Please provide your input (including potential examples, any additional issues etc.) to help converge the understanding of UE/system impact. |
| Apple | Our understanding is that the proposal is to make UE PDCCH monitoring purely TDM between SpCell and sSCell which also simplifies the BD/CCE discussion.  This may provide limited benefit in terms of UE implementation. But when SpCell and sSCell have different SCS, the benefit could be further limited. To take advantage of this to simplify UE implementation or operation, UE needs to toggle between two CCs with the same PDCCH monitoring engine potentially based on per slot basis, which is not supported by the current UE. But anyway, the DSS enhanmcent will impact UE PDCCH monitoring implementation, very likely, if UE supports this feature.  We also think this will limit the NW schedules flexibility for the procedures that are broadcasted |
| Samsung | The simplification is that a Rel-16 UE can support CCS based only on a capability to be scheduled on the PCell from an SCell which is readily available for a Rel-16 UE supporting cross-carrier scheduling. There are no other requirements.  DSS is for RRC connected UEs. There is no impact to legacy UEs, or to initial access, or to SI scheduling/paging/RAR, or to any configurations from *PDCCH-ConfigCommon* provided by SIB1. *PDCCH-ConfigCommon* is also provided by UE-dedicated signalling. A UE can be configured a BWP other than the initial BWP and corresponding non-Type3 CSS sets via *BWP-DownlinkCommon*. Any required monitoring of non-Type-3 CSS sets in RRC connected can be easily provided without any practical restrictions just by considering the UL slots of the TDD sSCell (see [5]). |
| Qualcomm | Broadcast and unicast can be parallelly processed even in Rel-15. Compared to the benefit achieved by the Point 2 above from UE complexity point of view, having this would cause more burden to the network side. With the restriction, when a network wants to configure Rel-17 DSS cross-carrier scheduling for a couple of UEs in the cell, the network has to make sure that broadcast PDCCH (provided to all UEs in the cell) is configured such that it is not overlapped with the unicast PDCCH on sSCell for these couple of Rel-17 DSS UEs. |
| Spreadtrum | This proposal brings large network configuration restrictions for search space monitoring, with reducing the complexity of PDCCH monitoring and BD/CCE counting at UE side. |
| LG Electronics | We think that any restriction for Type0/0A/1/2 CSS set configuration is not needed even for Type A UE and the restriction may affect network scheduling perspective. If Type A UE is incapable of PDCCH monitoring both on Pcell and sScell, it can be considered for the UE to monitor only one of either C-RNTI DCI in Type0/0A/1/2 CSS set on Pcell or DCI in USS set on sScell. |
| vivo | In our understanding, there is no need to distribute BD/CCE budget in multiple cells for scheduling one cell if further restriction on CSS. In the other hand, we also think it may limit network configuration to avoid the overlapping. |
| Huawei, HiSilicon | If Type-0/0A/1/2-CSS sets are to be configured such that overlap with USS sets on sSCell for Type A UE, the impacts on BD/CCE limit handling and UE implementation introduced by Type A UE are similar to the impacts introduced by Type B UE. |

### Proposal 3

* For Type A UE, when sSCell is deactivated, monitoring of non-fallback DCI formats on P(S)Cell is supported.

Companies are requested to indicate their view about the above proposal in the Table below

|  |  |  |
| --- | --- | --- |
| **Company Name** | **Support/Not support** | **Comments (Proposal 3)** |
| Moderator notes |  | Continuation of discussion on related FFS point in agreement from previous meeting. Company views summarized in last sub-bullet of point 2 in section 2.1.1 |
| Apple |  | The scope of this agreement is not very clear. The support can be achieved by RRC reconfiguration of PDCCH monitoring of P(S)Cell anyway. |
| Samsung | Not support | sSCell deactivation (or dormancy) typically means that there is no more data for the UE. It would then be counter-productive for the UE to monitor non-fallback DCI on the PCell. Any new data arrival can be addressed by DCI format 2\_6 for dormancy, or by MAC CE for deactivation, of the sSCell. If DSS is to be disabled, that can be done by RRC configuration including for search space sets on the P(S)Cell.  Also, depending on the resolution of the FFS “whether or not a UE monitors PDCCH on the P(S)Cell and the sSCell in a same slot”, a purpose/value for having Type A UEs may become redundant. |
| Qualcomm | Not support | We have agreed to support Type A and Type B UEs. In both cases the UE can monitor non-fallback DCI formats on the P(S)Cell. Therefore, the proposal is no longer essential. |
| LG Electronics |  | Need clarification. The proposal can be understood such that when sScell is deactivated, all USS sets that schedule Pcell but are configured to be monitored on sScell are moved to Pcell as if cross-carrier scheduling (from sScell to Pcell) is not configured. Is that correct understanding? |
| vivo |  | The details of the proposal is not clear. Non-fallback DCI in which search space? |
| Huawei, HiSilicon | Support | And perhaps same applies for TypeB UE. |

### Proposal 4

* When CCS from sSCell to P(S)Cell is configured for a UE
  + at least the number of PDCCH monitoring candidates monitored on sSCell (for scheduling P(S)Cell) is indicated to the UE using the SS set linking approach as in Rel16
  + FFS: If any modifications to Rel16 approach are introduced for *monitoringSlotPeriodicityAndOffset, monitoringSymbolsWithinSlot, duration* for the PDCCH monitoring candidates monitored on sSCell (for scheduling P(S)Cell)

Companies are requested to indicate their view about the above proposal in the Table below

|  |  |  |
| --- | --- | --- |
| **Company Name** | **Support/Not support** | **Comments (Proposal 4)** |
| Moderator notes |  | Issue discussed in previous two meetings. Many companies prefer to (at least partly) reuse the Rel16 SS linking framework (summarized in point 2 in section 2.1.2) |
| Apple |  | We are fine with the proposal |
| Samsung |  | The value of this proposal is unclear. The main question should be whether to de-link search space set configurations for the scheduling cell and scheduled cells as was intended in Rel-15 by RAN1. That would be desirable because the hack implemented by RAN2 due to ASN.1 freeze requires several limitations. It would be unfortunate to not have a clean solution now and have to defer this to a later release (if ever). |
| Qualcomm | Support | We do not prefer to have multiple versions of cross-carrier scheduling configurations such as SSID-linked version in Rel-15/16 and SSID-unlinked version in Rel-17. The necessary change for Rel-17 cross-carrier scheduling from sSCell to P(S)Cell should be minimal, and this should not impact on the general framework of cross-carrier scheduling. |
| Spreadtrum | Support |  |
| LG Electronics |  | We are fine with the proposal and prefer to reuse the linkage between scheduling cell and scheduled cell as in Rel-15 by removing the second FFS bullet. |
| vivo |  | Support in general. However, the linkage rule may need to be adjusted a bit since there will be SS configuration for self-scheduling and cross-carrier scheduling simultaneously. If purely follow current rule that “search spaces with the same *searchSpaceId* in a scheduled cell and a scheduling cell are linked to each other”, UE shouldn’t expect the same SS ID for P(S)cell self-scheduling and sScell self-scheduling. |

### Discussion Point 5

* Companies are requested to provide their view on below proposed draft TP for 38.300 (for endorsement from RAN1 perspective)

----------------------------------------- start TP1 for 38.300 v.xyz -------------------------------------------

10.8 Cross Carrier Scheduling

Cross-carrier scheduling with the Carrier Indicator Field (CIF) allows the PDCCH of a serving cell to schedule resources on another serving cell but with the following restrictions:

- ~~Cross-carrier scheduling does not apply to PCell i.e~~. When cross-carrier scheduling from an SCell to PCell is not configured, PCell is always scheduled via its PDCCH;

- When cross-carrier scheduling from an SCell to PCell is configured, PCell’s PDSCH and PUSCH can be scheduled via PDCCH on the PCell and via PDCCH on the SCell, and PDCCH on PCell cannot schedule PDSCH and PUSCH on any other cell. Only one SCell can be configured to be used for cross-carrier scheduling to PCell;

- When an SCell is configured with a PDCCH, that cell's PDSCH and PUSCH are always scheduled by the PDCCH on this SCell;

- When an SCell is not configured with a PDCCH, that SCell's PDSCH and PUSCH are always scheduled by a PDCCH on another serving cell;

- The scheduling PDCCH and the scheduled PDSCH/PUSCH can use the same or different numerologies.

--------------------------------------------------- end TP1 -----------------------------------------------

Companies are requested to indicate their view in the Table below

|  |  |
| --- | --- |
| **Company Name** | **Comments (Discussion Point 5)** |
| Moderator notes | Updates to Stage 2 spec are needed to reflect the RAN1 agreements made so far. Intention of discussion is to 1) converge on RAN1 endorsed text reflecting the RAN1 agreements in relevant part of 38.300, and 2) send LS to RAN2 with the endorsed text and list of related RAN1 agreements.  Note 1: Discussion on RRC impact is expected after RAN1#106e.  Note 2 – per RP-211580, RAN2 plan for DSS handling is “***DSS*** *– Expected to be treated from November meeting, if LS from R1 is received by R2 then. …*”). |
| Apple | We are fine with the TP |
| Samsung | It is generally fine except for “PCell’s PDSCH and PUSCH can be scheduled via PDCCH on the PCell and via PDCCH on the SCell” – the second ‘and’ should be ‘or’ as a PDSCH/PUSCH is not scheduled by both the PCell and the sSCell. |
| Qualcomm | We are OK with the TP. |
| vivo | We are fine with the TP |
| Huawei, HiSilicon | The below can be just removed.  *~~Cross-carrier scheduling does not apply to PCell i.e~~. When cross-carrier scheduling from an SCell to PCell is not configured, PCell is always scheduled via its PDCCH;*  A minor:  Only one SCell can be configured to be used for cross-carrier scheduling ~~to~~ PCell; |

### Proposal 6

* When CCS from sSCell to P(S)Cell is configured, dormant BWP operation for sSCell is supported at least for Type B UE

Companies are requested to indicate their view about the above proposal in the Table below

|  |  |  |
| --- | --- | --- |
| **Company Name** | **Support/Not support** | **Comments (Proposal 6)** |
| Moderator notes |  | This was discussed in earlier meetings, and in RAN1#104e, it was confirmed that activation/deactivation of sSCell is supported with dormancy support left for further discussion. This discussion can be resumed now given RAN1#105e agreements on PDCCH monitoring. |
| Apple |  | We are fine with this proposal |
| Samsung | Support | It is useful for adjusting to varying traffic for a UE – same reasons as in Rel-16. |
| Qualcomm |  | We are OK with the proposal. |
| Spreadtrum | Support |  |
| LG Electronics |  | We are fine with the proposal and the same handling with the case of sScell deactivation is preferred.  However, we need clarification why dormant BWP operation may not be supported for Type A UE. |
| vivo | Support | We are OK with the proposal |

# 3 Conclusions

TBD

# 4 References

1. R1-2106472 Discussion on SCell PDCCH scheduling P(S)Cell PDSCH or PUSCH Huawei, HiSilicon
2. R1-2106627 Discussion on Scell scheduling Pcell vivo
3. R1-2106721 Discussion on cross-carrier scheduling from SCell to Pcell Spreadtrum Communications
4. R1-2106749 Discussion on Cross-Carrier Scheduling from SCell to PCell ZTE
5. R1-2106915 Cross-carrier scheduling from SCell to PCell Samsung
6. R1-2107187 Cross-carrier scheduling (from Scell to Pcell) Lenovo, Motorola Mobility
7. R1-2107277 Discussion on cross-carrier scheduling from Scell to Pcell OPPO
8. R1-2107372 Cross-carrier scheduling from an SCell to the PCell/PSCell Qualcomm Incorporated
9. R1-2107428 Discussion on cross-carrier scheduling from SCell to Pcell CMCC
10. R1-2107460 Discussion on cross-carrier scheduling from SCell to Pcell LG Electronics
11. R1-2107483 Cross-carrier scheduling from SCell to PCell ETRI
12. R1-2107499 On Cross-Carrier Scheduling from sSCell to P(S)Cell MediaTek Inc.
13. R1-2107526 On cross-carrier scheduling from SCell to Pcell Nokia, Nokia Shanghai Bell
14. R1-2107614 On SCell scheduling PCell transmissions Intel Corporation
15. R1-2107641 PCell and sSCell scheduling Pcell InterDigital, Inc.
16. R1-2107766 Views on Rel-17 DSS SCell scheduling PCell Apple
17. R1-2107884 Discussion on cross-carrier scheduling enhancements for NR DSS NTT DOCOMO, INC.
18. R1-2107903 Discussion on Cross-carrier scheduling from SCell to PCell Xiaomi
19. R1-2108004 Enhanced cross-carrier scheduling for DSS Ericsson

# 5 Annex A – Agreements from previous meetings

## Agreements from RAN1#102-e

Agreements:

* Following scheduling combinations are allowed/not allowed when cross-carrier scheduling from an SCell to PCell/PSCell is configured  
  1. self-scheduling on PCell/PSCell is allowed
  2. cross-carrier scheduling from PCell/PSCell to another SCell is not allowed
  3. self-scheduling on the ‘SCell used for scheduling PCell/PSCell’ is allowed
  4. cross-carrier scheduling from the ‘SCell used for scheduling PCell/PSCell’ to another serving cell is allowed
  5. cross-carrier scheduling from another serving cell to the ‘SCell used for scheduling PCell/PSCell’ is not allowed
* FFS: Search space and DCI format handling for the allowed cases above

Agreements:

* Configuring 2 or more Scells to schedule the PCell/PSCell is not allowed

## Agreements from RAN1#103-e

**Conclusion**

* When CCS from sSCell to PCell/PSCell is configured, the configuration of Type 3 CSS set for DCI formats 2\_0, 2\_1, 2\_2, 2\_3, 2\_4 and applicability of the information in the DCI formats are the same as in Rel-15/Rel-16
  + FFS: DCI format 2\_5 and DCI Format 2\_6 handling
* Note: The SCell configured with CCS to Pcell/PSCell is referred to as ‘sSCell’

**Conclusion**

* When the PCell/PSCell and sSCell use different numerologies, the PDSCH reception preparation time between the PDCCH on the sSCell and the PDSCH on the PCell/PSCell is applied (i.e., as specified in TS38.214 Section 5.5).

Agreements:

* When CCS from an SCell (sSCell) to PCell/PSCell is configured, UE monitors Type 0/0A/1/2 CSS sets (for the DCI formats associated with those SS sets) only on the PCell/PSCell and not on the sSCell
  + Note: UE monitors Type 0/0A/2 CSS only on PCell while Type 1 CSS can be monitored on PCell/PSCell

Agreements:

* Discuss in RAN1#104-e how to handle ‘DCI formats 0\_1,1\_1,0\_2,1\_2 scheduling PDSCH/PUSCH on PCell/PSCell’ from USS set(s), when CCS from sSCell to PCell/PSCell is configured.. Below alternatives can be considered in the discussion (other alternatives are not precluded)
* ~~Below alternatives can be considered in the discussion (other alternatives are not precluded)~~
  + Alt 1: ~~When CCS from sSCell to PCell/PSCell is configured,~~ UE cannot be configured to monitor DCI formats 0\_1,1\_1,0\_2,1\_2 on PCell/PSCell USS set(s), and can be configured to monitor them only on the sSCell USS set(s)
  + Alt 2: ~~When CCS from sSCell to PCell/PSCell is configured,~~ UE can be configured to monitor DCI formats 0\_1/1\_1/0\_2/1\_2 on PCell/PSCell USS set(s), and/or on sSCell USS set(s). The PDCCH monitoring is based on following alternatives (other alternatives are not precluded)
    - Alt 2-1:
      * UE can monitor DCI formats 0\_1,1\_1,0\_2,1\_2 on both PCell USS set(s) and sSCell USS sets simultaneously
        + ~~FFS activation/deactivation of scheduling from sSCell to PCell/PSCell~~
    - Alt 2-2:
      * Dynamic switching of PDCCH monitoring of DCI formats 0\_1,1\_1,0\_2,1\_2 between monitoring on PCell/PSCell USS sets and monitoring on sSCell USS sets is supported
        + FFS: Details of switching mechanism (~~e.g. based on SS group switching, based on BWP switching,…~~)
      * UE does not monitor DCI formats 0\_1,1\_1,0\_2,1\_2 on both PCell USS set(s) and sSCell USS sets simultaneously
    - Alt 2-3:
      * UE does not monitor the same DCI format on both PCell USS set(s) and sSCell USS sets simultaneously. UE can monitor some DCI formats on sSCell USS sets and other DCI formats on PCell/PSCell USS sets simultaneously
    - Alt 2-4:
      * The USS set(s) on PSCell/PCell and the USS set(s) on sSCell are configured such that UE does not monitor DCI formats 0\_1,1\_1,0\_2,1\_2 on both PCell USS set(s) and sSCell USS set(s) simultaneously
* FFS following aspects
  + Impact of sSCell activation/deactivation and sSCell dormancy
  + Impact on BD/CCE limit handling ~~including considering PDCCH monitoring on CSS sets and PDCCH monitoring of ‘DCI formats 0\_0, 1\_0 scheduling PUSCH/PDSCH on PCell/PSCell’~~
  + Whether PDCCH overbooking on sSCell is supported or not supported and impact (if any) on overbooking handling on PCell/PSCell
  + Impact from different numerologies between PDCCH on the PCell/PSCell and that on the sSCell
  + Whether or not to have mechanism for activation/deactivation of scheduling from sSCell to PCell/PSCell
  + USS configuration details (e.g. handling of USS type (self-scheduling, cross carrier scheduling) for a ~~configured~~ USS set configured for scheduling of ~~in~~ PCell/PSCell)

## Agreements from RAN1#104-e

**Agreement**

When CCS from sSCell to PCell/PSCell is configured,

* Out of order scheduling is not allowed between a) PDSCH on PCell/PSCell scheduled by PDCCH on PCell/PSCell and b) PDSCH on PCell/PSCell scheduled by PDCCH on sSCell
* Out of order scheduling is not allowed between a) PUSCH on PCell/PSCell scheduled by PDCCH on PCell/PSCell and b) PUSCH on PCell/PSCell scheduled by PDCCH on sSCell

FFS: Whether this agreement requires RAN1 specification impact.

**Agreement**

When CCS from sSCell to PCell/PSCell is configured,

* Simultaneous reception of a) unicast PDSCH on PCell/PSCell scheduled from PCell/PSCell and b) unicast PDSCH on PCell/PSCell scheduled from sSCell is not allowed
* Simultaneous transmission of a) PUSCH on PCell/PSCell scheduled from PCell/PSCell and b) PUSCH on PCell/PSCell scheduled from sSCell is not allowed
* Note: Simultaneous implies full/partial time overlapping

FFS: Whether this agreement requires RAN1 specification impact.

**Agreement**

* When CCS from sSCell to PCell/PSCell is configured, CA activation/deactivation operation for the sSCell is supported

**Working Assumption**

* When CCS from sSCell to PCell/PSCell is configured, UE can be configured to monitor DCI formats 0\_1/1\_1/0\_2/1\_2 that schedule PDSCH/PUSCH on PCell/PSCell on PCell/PSCell USS set(s), and/or on sSCell USS set(s)
* The WA to be confirmed after agreements are made on PDCCH BD/CCE handling and PDCCH overbooking handling for CCS from sSCell to PCell/PSCell
* Specs also allow UEs supporting functionality of only Alt-1. Capability signaling details, if any, can be handled during the UE capability discussion for Rel17
* FFS: Whether the UE can monitor PDCCH from both cells in the same slot.

**Agreement**

* When CCS from sSCell to PCell/PSCell is configured, UE monitors ‘DCI formats 0\_0 and 1\_0 in CSS that schedule PDSCH/PUSCH on PCell/PSCell’ only on the PCell/PSCell and not on the sSCell

## Agreements from RAN1#104b-e

**Agreement**

* When CCS from sSCell to PCell/PSCell is configured
  + CIF=0 used for sSCell self-scheduling, and CIF for sSCell to PCell cross-carrier scheduling is explicitly configured using RRC signalling

**Agreement**

PDCCH overbooking on sSCell USS set(s) is not allowed

Following was captured in RAN1 Chairman notes

**For RAN1#105-e, companies are encouraged to consider:**

* Further discuss PDCCH monitoring and BD/CCE limit handling in RAN1#105e considering below BD/CCE limit handling options
  + Option A
    - At least when P(S)Cell SCS is not higher than sSCell SCS, PDCCH monitoring candidates on P(S)Cell and/or sSCell are configured such that max of (x1(m1)+x2(m1))+max of y(m2) corresponding to any P(S)Cell slots m1 and m2 is less than or equal to Z1
    - At least the case of Z1 = 44 is supported for P(S)Cell SCS 15kHz
      * FFS if Z1 larger than above can also be supported based on UE capability (e.g. similar to *BDFactorR* in Rel16)
    - FFS signalling details on how the limit Z1 is realized, e.g.
      * RRC configured BD limit/scaling factor-based limit for max(x1(m)+x2(m))
      * Separate RRC configured BD limits/scaling factor-based limits for max(x1(m)+x2(m)) and max(y(m))
      * separate BdfactorR for P(S)Cell and sSCell
      * SS configuration-based BD limit for max(x1(m)+x2(m)) and max(y(m))
      * RRC configured BD limit/scaling factor-based limit for max(x1(m)+x2(m))+ max(y(m))
      * Counting ‘sSCell-to-P(S)Cell’ scheduling as an additional scheduling cell with numerology given by sSCell numerology in determining the BD/CCE limits
    - FFS reference SCS to use when P(S)Cell has higher SCS than sSCell (if supported)
    - For sSCell scheduling P(S)Cell, the UE is not required to monitor on the active DL BWP with SCS configuration of the sSCell more than PDCCH candidates per slot of sSCell.
      * FFS how limit is computed and applied when CCS from sSCell to P(S)Cell is configured
  + Option B
    - At least when P(S)Cell SCS is not higher than sSCell SCS, For P(S)Cell slot m, PDCCH monitoring candidates on P(S)Cell and/or sSCell are configured such that x1(m)+x2(m)+y(m) is less than or equal to BD limit Z2
    - At least the case of Z2 = 44 is supported for P(S)Cell SCS 15kHz
      * FFS if Z2 larger than above can also be supported based on UE capability (e.g. similar to *BDFactorR* in Rel16)
    - max of (x1(m1)+x2(m1)) + max of y(m2) corresponding to any P(S)Cell slots m1 and m2 ~~can~~ is allowed to be larger than BD limit Z2
    - FFS signalling details on how the limit Z2 is realized
    - FFS reference SCS to use when P(S)Cell has higher SCS than sSCell (if supported)
    - For sSCell scheduling P(S)Cell, the UE is not required to monitor on the active DL BWP with SCS configuration of the sSCell more than PDCCH candidates per slot of sSCell.
      * FFS how limit is computed and applied when CCS from sSCell to P(S)Cell is configured
  + Option C
    - PDCCH monitoring candidates on P(S)Cell are configured such that max of (x1(m1)+x2(m1)) is less than or equal to Z3
      * Z3 is derived by the PDCCH monitoring capability of PCell
    - PDCCH monitoring candidates on sSCell are configured such that max of y(m2) is less than or equal to Z4
      * Z4 is derived by the PDCCH monitoring capability of sSCell
    - FFS details to define Z3 and Z4, e.g.
      * Separate RRC configured BD limits/scaling factor-based limits for max(x1(m)+x2(m)) and max(y(m))
    - For sSCell scheduling P(S)Cell, the UE is not required to monitor on the active DL BWP with SCS configuration of the sSCell more than Z4 PDCCH candidates per slot of sSCell
  + Note
    - x1(m) is #BDs for PDCCH CSS(s) candidates monitored on P(S)Cell slot m
    - x2(m) is #BDs for PDCCH USS(s) candidates monitored on P(S)Cell slot m
    - y(m) is #BDs for PDCCH USS(s) candidates monitored on sSCell in all sSCell slot(s) that overlap slot m of P(S)Cell
    - USS(s) => USS(s) that can schedule PDSCH/PUSCH on P(S)Cell)

## Agreements from RAN1#105-e

**Agreement**

Two types of UEs (Type A and Type B) can support CCS from sSCell to P(S)Cell

* For Type A UE
  + At least following search space sets on P(S)Cell and search space sets on sSCell are configured so that the UE does not monitor them in overlapping [slot/symbol] of P(S)Cell and sSCell
    - search space sets on P(S)Cell
      * USS sets for DCI formats 0\_1,1\_1,0\_2,1\_2 (if supported for Type A UE)
      * USS sets for DCI formats 0\_0,1\_0
      * Type3-CSS set(s) for DCI formats 1\_0/0\_0 with C-RNTI/CS-RNTI/MCS-C-RNTI
    - search space sets on sSCell
      * USS set(s) for scheduling P(S)Cell
  + FFS: BD/CCE handling
* For Type B UE
  + Following search space sets on P(S)Cell and search space sets on sSCell can be configured so that the UE monitors them in overlapping [slot/symbol] of P(S)Cell and sSCell
    - search space sets on P(S)Cell
      * USS sets for DCI formats 0\_0,1\_0
      * Type3-CSS set(s) for DCI formats 1\_0/0\_0 with C-RNTI/CS-RNTI/MCS-C-RNTI
    - search space sets on sSCell
      * USS set(s) for scheduling P(S)Cell
  + For handling ‘USS sets for scheduling P(S)Cell’ on P(S)Cell and/or on sSCell for DCI formats 0\_1,1\_1,0\_2,1\_2
    - Alt 2-1 is adopted
  + There is no restriction on Type-0/0A/1/2-CSS sets configurations
  + FFS: BD/CCE handling
* For Type A and/or Type B UE
  + FFS: switching to ‘normal’ PDCCH monitoring on P(S)Cell when sSCell is deactivated
* FFS: Whether Type A is specified or is Type-B with restrictions (as part of UE features discussion)
* FFS: Whether the UE can be configured with unaligned CA
* FFS: Whether the above applies for multicast PDSCH

**Discuss further in RAN1#106-e:**

* For at least Type B UE, downselect from one of the BD/CCE limit handling options below
  + [based on Option A/C] When UE is configured for CCS from sSCell to P(S)Cell and when P(S)Cell SCS () is less than or equal to sSCell SCS ()
    - On P(S)Cell (for self-scheduling)
      * UE is not required to monitor more than PDCCH BD candidates per P(S)Cell slot
      * UE is not required to monitor more than
        + Alt1

PDCCH BD candidates per P(S)Cell slot

* + - * + Alt2

PDCCH BD candidates per P(S)Cell slot

* + - On sSCell (for cross-carrier scheduling to P(S)Cell)
      * UE is not required to monitor more than PDCCH BD candidates per slot of sSCell
      * UE is not required to monitor more than
        + Alt1

PDCCH BD candidates per P(S)Cell slot

* + - * + Alt2:

PDCCH BD candidates per P(S)Cell slot

* + - At least case of is supported.
      * FFS case of
      * FFS multi-TRP case
    - FFS following
      * Selection between Alt1 vs. Alt2 above
      * Whether separate and are configured by RRC or if and only is configured
      * How the PDCCH BD candidates are distributed between multiple sSCell slots overlapping a P(S)Cell slot when and whether the BD limits for sSCell are specified per sSCell slot or per P(S)Cell slot
  + [based on Option B] When UE is configured for CCS from sSCell to P(S)Cell and when when P(S)Cell SCS () is less than or equal to sSCell SCS ()
    - On P(S)Cell (for self-scheduling)
      * UE is not required to monitor more than PDCCH BD candidates per slot of P(S)Cell
    - On sSCell (for cross-carrier scheduling to P(S)Cell)
      * UE is not required to monitor more than PDCCH BD candidates per slot of sSCell
    - Considering both PDCCH BD candidates for P(S)Cell self-scheduling on P(S)Cell and PDCCH BD candidates for sSCell to P(S)SCell cross-carrier scheduling on sSCell
      * UE is not required to monitor more than
        + Alt 1

PDCCH BD candidates per P(S)Cell slot

* + - * + Alt 2

PDCCH BD candidates per P(S)Cell slot

* + - FFS: selection between Alt-1 and Alt-2
  + FFS: whether/how the definition of or is modified compared to Rel16 when UE is configured with CCS from sSCell to P(S)Cell