**3GPP TSG-RAN WG1 #103-e R1-20xxxxx**

**eMeeting, Oct 26th – Nov 13th, 2020**

**Source: Moderator (Ericsson)**

**Title: Summary of Email discussion [103-e-NR-DSS-01]**

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

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

# 1 Introduction

This document summarizes the discussions for email thread [103-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#103-e

1. **Search Space and DCI format handling when CCS from an SCell (sSCell) to PCell/PSCell is configured**
	* Type 0/0A/1/2 CSS sets for any associated DCI formats
		+ monitored only on PCell/PSCell – [1],[2],[4],[6],[7],[10],[11],[13],[14]
	* DCI formats 0\_0 and 1\_0 for scheduling PDSCH/PUSCH on PCell/PSCell in any associated SS set
		+ monitored only on PCell/PSCell – [2],[3],[7],[10],[14],[16]
	* DCI formats 0\_1,1\_1,0\_2,1\_2 for scheduling PDSCH/PUSCH on PCell/PSCell in USS set(s)
		+ Not monitored on PCell/PSCell and can be monitored only on sScell – [2],[3],[6?],[8],[11?],[19]
		+ Can be monitored on both PCell/PSCell and the sSCell – [1],[7],[13],[14],[15],[16],[17?],[18]
		+ Study further – [4],[5],[10]
	* DCI formats 2\_0, 2\_1, 2\_2, 2\_3, 2\_4 in Type 3 CSS set and DCI format 2\_5
		+ monitored on PCell/PSCell/sSell according to existing specifications – [1?],[2],[4],[6],[10],[18]
		+ applicable to PCell/PSCell even when monitored on PCell/PSCell in some cases – [14]
	* DCI format 2\_6 in type 3 CSS set
		+ Monitored only on PCell/PSCell – [10]
		+ Can be monitored on sSCell – [1],[6],
	* DCI formats 0\_1,1\_1 with SCell dormancy indication
		+ Monitored only on PCell/PSCell –
		+ Can be monitored on the sSCell – [1]
	* SS set overbooking and associated UE procedures
		+ Applied only for PCell – [1],[6],[19]
		+ Applied considering both PCell and sSCell – [14?]
2. **Scheduling framework when CCS from an SCell (sSCell) to PCell/PSCell is configured**
	* Activation/deactivation of sSCell
		+ Discussed in [2],[4],[6],[7],[9],[18]
	* Dormancy/non-dormancy for sSCell
		+ Discussed in [2],[4],[18]
	* No out of order scheduling between a) PDSCH/PUSCH on PCell/PSCell scheduled by PDCCH on PCell/PSCell and b) PDSCH/PUSCH on PCell/PSCell scheduled by PDCCH on sSCell
		+ Discussed in [1],[18],[19]
	* No simultaneous rx/tx of unicast PDSCH/PUSCH on PCell/PSCell scheduled from PCell/PSCell and unicast PDSCH/PUSCH on PCell/PSCell scheduled from sSCell
		+ Discussed in [18],[19]
	* Simultaneous rx of PDCCH on sSCell used for scheduling PCell/PCell and PDCCH for self-scheduling on PCell/PSCell
		+ Discussed in [5]
	* PDCCH for initial transmission and retransmission can be on different cells for same TB
		+ Discussed in [1],[5]
3. **BD/CCE limit handling when CCS from an SCell (sSCell) to PCell/PSCell is configured**
	* Use multi-TRP for BD/CCE handling as starting point – [1]
	* PCell is counted as a scheduled cell for both the PCell and sSCell – [6]
	* BD/CCE limits are counted over both scheduling cells (PCell and SCell) and determined for scheduled PCell, overbooking is allowed [14]
	* Both PCell self-scheduling and SCell to PCell are considered – [18]
	* Per-scheduling-CC limit is determined as (per-CC BD or CCE limit) – (max of the number of BDs or CCEs at a slot across all the slots on the PCell/PSCell) – [19]
	* Study further – [2],[10],[11],[13],
4. **Other aspects**
	* Further details on CCS configuration
		+ *CrossCarrierSchedulingConfig* details – [2],[3],[10].[11]
	* Dynamic switching of PDCCH candidates/SS sets/SS groups between PCell/PSCell and sSCell – [13],[14],[15],[17]
	* Further details on search space handling
		+ UE is not configured with complete USS in P(S)cell for self-scheduling/only parts of USS are moved – [2],[10]
		+ Light SS linking – [2]
		+ SS set linking between PCell/PSCell and sSCell by using same index – [4],[10]
		+ Use n\_CI for SS hashing – [19]
		+ Independent config. of parameters related to PDCCH monitoring occasions on sSCell for scheduling PCell/PSCell and for scheduling sSCell – [19]
		+ Configuration of individual DCI format(s) (e.g. only DCI format 0-1, only DCI format 1-1) – [18]
		+ CIF = 0 used for sSCell or PCell? – [11],[19]
	* sSCell can schedule dynamic and CG PDSCH/PUSCH – [2]
	* Multi/single-TRP operation should remain independent on the PCell and the SCell – [6]
	* Is SCell scheduling PCell configured per UE, per BWP or per SS? – [11]
	* Reuse Rel16 preparation time between sSCell PDCCH and PCell/PSCell PDSCH/PUSCH – [19]
	* Clarify whether PCell and/or sSCell can be unlicensed cell(s) – [16]
	* Clarify allowed #UL DCI and #DL DCI combination – [16]
	* DCI size alignment clarifications – [12]
	* Impact of BWP change on sScell on Scell to Pcell scheduling – [6]
	* SCell to PCell/PSCell scheduling has no impact on PUCCH – [6],[14]
	* Clarify that one sSCell per CG can be configured (in case wording in previous agreement is not clear) – [9]
	* BFR operations/mechanism for the sSCell should be studied – [9]

## 2.1 Proposals for discussion

Below are some proposals for discussion

### Proposal 1

* 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

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

|  |  |  |
| --- | --- | --- |
| **Company Name** | **support/not support** | **Comments (Proposal 1)** |
| Intel | support | Type0/0A/1/2 CSS sets are necessary for UE with single cell operation on ‘PCell’. Specifically, they are used before a CA UE enters CA mode. It is possible ‘SCell’ has its own Type0/0A/1/2 CSS sets, since ‘SCell’ can be PCell for some other UEs. However, this is not related to ‘SCell scheduling PCell’ under current scope of WI. |
| Qualcomm | Support |  |
| CATT | Support |  |
| vivo | support | Type0/0A/1/2 CSS sets remains on PCell/PSCell as NR Rel-15/16 |
| Nokia | Support | This approach is aligned to the current specifications and limit the specification change needs. |
| InterDigital | Support |  |
| Samsung | Support | This is the main usage of scheduling combination (a) from RAN1#102e (“self-scheduling on PCell/PSCell is allowed”) |
| ZTE | Support | We are generally fine with the proposal. Just to make it clear, we propose to clarify that Type 0/0A/2 CSS is only allowed in PCell while Type 1 CSS is allowed in both PCell and PSCell. Thus, we propose the following.Proposal 1* When CCS from an SCell (sSCell) to PCell/PSCell is configured,
* UE monitors Type 0/0A/2 CSS sets (for the DCI formats associated with those SS sets) only on the PCell and not on the sSCell
* UE monitors Type 1 CSS sets (for the DCI formats associated with those SS sets) only on the PCell/PSCell and not on the sSCell
 |
| LG | Support | Agree with ZTE’s proposal for more clarity. |
| DOCOMO | Support |  |
| Apple | Support |  |

### Proposal 2

* When CCS from an SCell (sSCell) to PCell/PSCell is configured, UE monitors DCI formats 0\_0 and 1\_0 for scheduling PDSCH/PUSCH on PCell/PSCell (in any associated SS set(s)) only on the PCell/PSCell and not on the sSCell

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

|  |  |  |
| --- | --- | --- |
| **Company Name** | **support/not support** | **Comments (Proposal 2)** |
| Intel | Support  | We are considering two sources of DCI 0\_0/1\_0 on PCell/PSCell:1. a DCI format in CSS, which has same DCI size as DCI 0\_0/1\_0 can be used for unicast scheduling
2. a USS containing only DCI 0\_0/1\_0 may be configured on PCell
 |
| Qualcomm | Not support | We do not see the need of supporting a USS set on the PCell/PSCell when the UE is configured to monitor USS set(s) on the SCell for cross-carrier scheduling from the SCell to the PCell/PSCell. Therefore, we propose the following.* When CCS from an SCell (sSCell) to PCell/PSCell is configured, UE monitors DCI formats 0\_0 and 1\_0 for scheduling PDSCH/PUSCH on PCell/PSCell (in ~~any associated~~ CSS set(s)) only on the PCell/PSCell and not on the sSCell
 |
| CATT | Not support | We support Qualcomm’s update.The motivation of supporting a USS on the scheduled P(s)Cell is far from being justified. The intention of supporting CCS from Scell to PCell is to offload the PDCCH overhead on the scheduled PCell. If a USS can be configured on the PCell for self-scheduling, there is no reason to further configure CCS from SCell to PCell. |
| vivo |  | We understand the key point of this proposal is not to allow DCI 0\_0 and 1\_0 from sScell to PCell/PSCell scheduling. If this is the correct understanding, we support it; otherwise we agree with QC’s update. |
| Nokia  | Support | DCI formats 0\_0/1\_0 do not carry the CIF field, there is no need to monitor them in the scheduling SCell for cross-carrier scheduling. In other words, DCI formats 0\_0/1\_0 are monitored for self-scheduling in PCell in CSS and USS, and for self-scheduling in the SCell in the USS.  |
| InterDigital | Support | We think that USS on PCell is needed when the SCell quality drops. |
| Samsung |  | For CSS, support (UE anyway monitors non-Type3 CSS on PCell).For USS, consider together with P4. Suggest to resolve P4 first. |
| ZTE | Support | Our understanding is that the legacy UE behaviors of DCI format 0-0 and DCI format 1-0 are the same as before. Thus, DCI format 0-0 and DCI format 1-0 in both CSS and USS should still be kept in PCell.Regarding Qualcomm’s comment above, fallback DCI on PCell/PSCell should be used to schedule PDSCH/PUSCH in case fallback scheduling is needed. Because there are many restrictions only using fallback DCI with C-RNTI in CSS (For example, only aggregation level 4/8/16 can be used for Type 0/0A/2 CSS; Type 1 CSS can be only used if the UE has not been provided a Type 3 CSS or a USS and the UE has received a C-RNTI; Type 3 CSS can be used if this optional search space is configured and only configured on PCell.) From network vendor’s perspective, we see the need to kept fallback DCIs in USS in PCell/PSCell. |
| LG | Need discussion | We think that USS associated with fallback DCI may need to be monitored on at least one of P(S)Cell and SCell, with consideration of potential PDCCH blocking/congestion in UE-common CSS resources in case of scheduling fallback DCI. |
| DOCOMO |  | We have similar view as Samsung. |
| Apple | In principle support | We think the fall back DCI is only monitored in SpCell |

### Proposal 3

* When CCS from an SCell (sSCell) to PCell/PSCell is configured, UE monitors DCI formats 2\_0, 2\_1, 2\_2, 2\_3, 2\_4 in Type 3 CSS set configured on PCell/PSCell/sSell, and applicability of the information in the DCI formats is as per Rel15/Rel6 framework

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

|  |  |  |
| --- | --- | --- |
| **Company Name** | **support/not support** | **Comments (Proposal 3)** |
| Intel | Support | Our understanding is the support of DCI formats 2\_0, 2\_1, 2\_2, 2\_3, 2\_4 on a SCell is already supported in Rel-15. Therefore, it can be used on sSCell |
| Qualcomm | Need a clarification | It is better to clarify that a UE monitors DCI formats 2\_0, 2\_1, 2\_2, 2\_3, 2\_4 in Type 3 CSS set configured on either of PCell/PSCell or sSell. |
| CATT | Support |  |
| vivo | Need updates | It seems 2\_5 introduced in NR Rel-16 is missed in the proposal. Besides, 2\_6 is already supported in PCell/PSCell and whether to extend to sScell can be FFS. Combined with QC’s update, we suggest the proposal updated below:* When CCS from an SCell (sSCell) to PCell/PSCell is configured, UE monitors DCI formats 2\_0, 2\_1, 2\_2, 2\_3, 2\_4, 2\_5 in Type 3 CSS set configured on either of PCell/PSCell or sSell and 2\_6 in PCell/PSCell, and applicability of the information in the DCI formats is as per Rel15/Rel6 framework
* FFS: whether/how to support DCI 2\_6 in sScell
 |
| Nokia  | Support | It is desirable to have at least the CSS type 3 for power control of the PCell configurable in the SCell (DCI format 2\_2/2\_3) so that all the normal operations of an ongoing connection can be handled via the SCell. We see no obvious reasons why any of the DCI format, search space or PCell related limitations would need to be revisited.  |
| InterDigital | Support |  |
| Samsung | Need clarification | What additional to Rel-16 is to be agreed? Is this for DCI format 2\_6? |
| ZTE | Support | Two comments,1. It seems DCI format 2\_5 can also be included in the above proposal.2. Similar comment as Qualcomm. We prefer not to use “either …. or” here, as it seems that these DCI formats are not precluded to be configured on both PCell/PSCell and sSCell.Proposal 3When CCS from an SCell (sSCell) to PCell/PSCell is configured, UE monitors DCI formats 2\_0, 2\_1, 2\_2, 2\_3, 2\_4 or 2\_5 in Type 3 CSS set configured on PCell/PSCell or/sSell, and applicability of the information in the DCI formats is as per Rel15/Rel6 framework |
| LG | Support | Also fine with vivo’s update. |
| DOCOMO | Support |  |
| Apple | Need discussion | We also have 2\_5 and 2\_6. Also similar concern as Qualcomm |

### Discussion point 4

* For USS handling, below options should be further discussed
	+ Option 1
		- When CCS from an SCell (sSCell) to PCell/PSCell is configured, regarding DCI formats 0\_1,1\_1,0\_2,1\_2 that schedule PDSCH/PUSCH on PCell/PSCell, UE does not monitor them on PCell/PSCell USS set(s), and monitors them only on the sSCell USS set(s)
	+ Option 2
		- When CCS from an SCell (sSCell) to PCell/PSCell is configured, regarding DCI formats 0\_1,1\_1,0\_2,1\_2 that schedule PDSCH/PUSCH on PCell/PSCell, UE can monitor them on both PCell/PSCell USS set(s) and sSCell USS set(s)

Companies are requested to indicate their view about the above options in the Table below. If companies prefer to study further, please indicate FFS and the aspects to be considered.

|  |  |  |
| --- | --- | --- |
| **Company Name** | **Preferred option**  | **Comments (Discussion point 4)** |
| Intel | Option 2 | We prefer to allow the flexibility to configure a USS on PCell/PSCell or sSCell. By this way, operator can select a most proper configuration based for a deployment. Configuration of a USS on PCell/PSCell or sSCell could be per BWP. In fact, it is possible that the NR BW and LTE BW are only partially overlapped. In this case, it is possible that, a first BWP is overlapped with LTE hence coordination is needed, while a second BWP is not overlapped with LTE. For the latter case, it is preferable to allow USS configured on PCell. Even for the overlap case, it doesn’t mean that PCell cannot transmit PDCCH. In fact, UE anyway needs to monitor DCI 0\_0/1\_0 and DCI 2\_x on PCell. Therefore, it doesn’t introduce new behavior to monitor a USS on PCell. The choice of configuration of a USS or not on PCell can be left to implementation.  |
| Qualcomm | Option 1 | So far, for a given scheduled cell, there was only one scheduling cell that is configured by higher-layer signalling semi-statically. We do not think we need to change this principle. The reason why a UE configured with cross-carrier scheduling from an SCell to the PCell/PSCell has to monitor PDCCH on the PCell/PSCell is because of UE-common functions and fallback operation using CSS set(s). This does not mean we should enable USS on the PCell/PSCell.Allowing USS on the PCell/PSCell will cause further trouble if the subcarrier-spacings are different between PDCCH on the PCell/PSCell and PDCCH on the scheduling SCell. |
| CATT | Option 1 | We don’t see the necessity of supporting USS configuration on the scheduled P(S)Cell.The case here is similar to the current cross carrier scheduling scheme in some regard, wherein UE only monitoring USS on the scheduling cell. gNB has the freedom to configure the combination of scheduling cell and scheduled cell, and any proper search space on the scheduling cell. The flexibility is already fully respected from the current mechanism.As we commented on proposal 2, it doesn’t make sense to configure USS on the scheduled cell considering it can already been scheduled by a USS on the scheduling cell. It will cause more efforts of monitoring PDCCH on different cells in vain. |
| Vivo  | Option 1 | In our view, there is no use case to monitor USS simultaneously from Pcell/PScell and sScell. It makes the handling of DCI size budget, BD/CCE budget more complicated. |
| Nokia  | Option 2 | When cross carrier scheduling from SCell to PCell, (for formats 0\_1,1\_1,0\_2,1\_2) UE monitors USS on scheduling SCell. UE can be configured to monitor USS on PCell as well. We do not see a need to have any restriction on the PCell USS. It can be left to the implementation to configure USS on SCell and/or PCell. This also serves as a fall-back for the case when UE runs out of coverage on SCell. In situations when scheduling cell fall-back happens, gNB may switch SearchSpace group and within 2ms move the majority of USS PDCCH candidates from Scell to Pcell. R16 SS group switching feature may be used for this purpose. |
| InterDigital | Option 2 | Having USS only on SCell can create reliability issue for downlink control channels that schedule PCell. For example, the radio link quality of SCell can drop while the PCell radio link quality is still good. In that case, the UE cannot be scheduled on PCell using USS and RRC reconfiguration is needed to configure USS on PCell. |
| Samsung | Discuss further | We understand the concerns for complexity of option 2. However, if the PCell is viewed as another scheduled cell for the scheduling sSCell, Rel-16 can be directly re-used. Although the per-cell limits on BDs/CCEs may not apply (resulting total of BDs/CCEs can be larger), we don’t think that is a problem because it does not affect UE complexity. Otherwise, if the per cell limits on BDs/CCEs need to be kept, option 1 is of course simpler. But then there is no ‘D’ in DSS. At least, if option 1 is selected, self/cross-carrier scheduling should be BWP-specific, not cell-specific.  |
| ZTE | Option2 | Option 1 may be simpler while Option 2 can offer higher flexibility for network implementation. Both alternatives are feasible, more studies are needed for these two alternatives. Since USS with corresponding DCI formats are configured by RRC, Option 2 supports dynamic switching of the PDCCH for PCell scheduling. When the UE is close to gNB, the scheduling PDCCH is transmitted on sSCell. When the UE moves to cell edge area, the PDCCH carrying non-fallback DCI can reside in PCell (usually low frequency and better for coverage) to guarantee the performance. While if Option 1 is supported, this switching will rely on RRC reconfiguration which is not flexible. |
| LG | Option 2 |  |
| DOCOMO | Discuss further | In the current specifications, scheduling cell for a serving cell is semi-statistically configured by *schedulingCellInfo*. Therefore, when PDCCH capacity of P(S)Cell becomes sufficient and NW would like to change from cross-carrier scheduling to self-carrier scheduling for the P(S)Cell, RRC reconfiguration is necessary. Option2 doesn’t have the concern. On the other hand, if option1 is selected, we may need to consider enhancement to address the above point (e.g. dynamic switching of scheduling cell for P(S)Cell). |
| Apple | Option 1 | When SCell is configured to schedule PCell, the main purpose is to schedule non-fallback DCI. Then we should maintain the same Rel-15 principle as much as possible, i.e. only one scheduling cell can schedule a scheduled cell. The reason we agree simultaneous PCell self-scheduling is due to the fall back and support of initial acquisition etc. |

### Proposal 5

* When CCS from an SCell (sSCell) to PCell/PSCell is configured, CA activation/deactivation of the sSCell is supported

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

|  |  |  |
| --- | --- | --- |
| **Company Name** | **support/not support** | **Comments (Proposal 5)** |
| Intel |  | We are fine with the proposal. However, it seems the proposal is not as basic as the other 4 proposals. It is fine to leave this issue for further study.  |
| Qualcomm |  | Agree with Intel. |
| CATT |  | Share similar views with Intel. |
| vivo |  | Agree with Intel. In addition, dormancy behavior of sSCell should also be discussed for future study. |
| Nokia | Support | We agree with Vivo. |
| InterDigital |  | We agree with Intel  |
| Samsung |  | Support in principle. This also relates to P4 and having self/cross-carrier scheduling be BWP specific (e.g. when sSCell moves to dormant, PCell becomes self-carrier scheduled) – can discuss together with P4.In addition, above proposals 1 ~ 4 require corresponding updates with this proposal 5, e.g.:Proposals 1 ~ 4: “When CCS from an SCell (sSCell) to PCell/PSCell is ~~configured~~ activated, ….” |
| ZTE | Support | We are ok with the proposal and we are also fine to either clarify it in this meeting or in the future meeting. |
| LG |  | Agree with vivo. |
| DOCOMO |  | We agree with Intel. |
| Apple | Need discussion | First of all, it is related to whether non-fallback DCI is only monitored on sSCell which is our preferred solution. In that case, if NW uses MAC-CE to deactivate the sSCell, UE cannot receive non-fallback DCI scheduled data on PCell, i.e., UE can only be scheduled by fallback DCI. This is partly like to deactivate the PCell.  |

# 3 Conclusions

TBD

# 4 References

1. R1-2007579 Discussion on SCell PDCCH scheduling P(S)Cell PDSCH or PUSCH Huawei, HiSilicon
2. R1-2007695 Discussion on Scell scheduling Pcell vivo
3. R1-2007839 Disucssion on cross-carrier scheduling from Scell to Pcell CATT
4. R1-2008062 Discussion on cross-carrier scheduling from SCell to Pcell LG Electronics
5. R1-2008110 Discussion on cross-carrier scheduling from SCell to Pcell Spreadtrum Communications
6. R1-2008195 Cross carrier scheduling from SCell to Pcell Samsung
7. R1-2008284 Discussion on cross-carrier scheduling from Scell to Pcell OPPO
8. R1-2008451 Views on Rel-17 DSS SCell scheduling PCell Apple
9. R1-2008695 Discussion on cross-carrier scheduling from SCell to PCell ASUSTeK
10. R1-2008830 Discussion on Cross-Carrier Scheduling from SCell to PCell ZTE
11. R1-2009003 On SCell scheduling PCell transmissions Intel Corporation
12. R1-2009023 Cross-carrier scheduling from SCell to Pcell ETRI
13. R1-2009040 Discussion on Cross-carrier scheduling from SCell to Pcell Xiaomi
14. R1-2009046 Cross-carrier scheduling from SCell to Pcell Nokia, Nokia Shanghai Bell
15. R1-2009085 Search space monitoring to support SCell scheduling PCell InterDigital, Inc.
16. R1-2009110 Cross-carrier scheduling (from Scell to Pcell) Lenovo, Motorola Mobility
17. R1-2009195 Discussion on cross-carrier scheduling enhancements for NR DSS NTT DOCOMO, INC.
18. R1-2009206 Enhanced cross-carrier scheduling for DSS Ericsson
19. R1-2009277 Views on cross-carrier scheduling from an SCell to the PCell/PSCell Qualcomm Incorporated

# 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