**3GPP TSG-RAN WG1 #104-e R1-21xxxxx**

**eMeeting, Jan 25 – Feb 05, 2021**

**Source: Moderator (Ericsson)**

**Title: Summary of Email discussion [104-e-NR-DSS-01]**

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

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

# 1 Introduction

This document summarizes the discussions for email thread [104-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 [1-21] submitted for RAN1#104-e

### 2.1.1 Search Space and DCI format handling

Following aspects were discussed related to Search Space and DCI format handling when CCS from sSCell to PCell/PSCell is configured

1. DCI formats 0\_1,1\_1,0\_2,1\_2 on USS for scheduling PCell/PSCell PDSCH/PUSCH
	* Alt 1 – [4],[17],[18]
	* Alt 2 – [1],[2],[3],[5],[6],[8],[9],[10],[11],[12],[13],[14],[15],[16],[19],[20]
		+ Alt 2-1 – [3],[6],[10],[13], [15],[19]
		+ Alt 2-2 – [5],[7],[9],[12],[14],[20]
		+ Alt 2-3 – [11?],
		+ Alt 2-4 – [5],[12],[15],[20]
		+ Other – modified 2-2 [see 8], modified 2-4 [see 8]
2. DCI formats 0\_0 and 1\_0 on CSS for scheduling PCell/PSCell PDSCH/PUSCH
	* only on PCell/PSCell as in Rel15/16– [1],[2],[3],[4],[5],[6],[9],[11],[12],[13],[15],[17],[19]
3. DCI formats 0\_0 and 1\_0 on USS for scheduling PCell/PSCell PDSCH/PUSCH
	* only on PCell/PSCell as in Rel15/16 – [1],[2],[3],[6],[9],[11],[12],[13],[15],[17],[19]
	* not allowed on PCell/PSCell – [4]
	* follows for non-fallback handling – [5]
4. DCI format 2-5
	* Type 3 CSS
		+ Follows Rel16 handling – [1],[2],[4],[5],[8],[10?],[14],[15],[17],[20]
	* USS
		+ Follows Rel16 handling – [4],[5],[8],[10?],[14],[15],[17]
		+ Check further – [2]
5. DCI format 2-6
	* Follows Rel16 handling – [1],[2],[4],[9],[10],[14],[17]
	* Can be sent also on sSCell – [3],[5],[8],[15],[20]
6. CIF handling, hashing function – [6],[9],[18]
7. DCI formats 0\_1,1\_1 with SCell dormancy indication can be monitored on the sSCell – [3]
8. PDCCH in SS set provided by recoverySearchSpaceId can be monitored on the sSCell – [3]
9. Independent config of (PeriodicityAndOffset, SymbolsWithinSlot, and duration) for sSCell 🡪 PCell/PSCell scheduling and PCell/PSCell 🡪 PCell/PSCell scheduling – [18]
10. Separate config of UL and DL DCI formats – [19]

### 2.1.2 Scheduling framework

Following aspects were discussed related to scheduling framework when CCS from sSCell to PCell/PSCell is configured

1. sSCell activation/deactivation/dormancy
	* Supported -- [1],[4?],[5?],[8],[10],[12?],[15?],[19]
	* FFS – [11?]
2. Out of order scheduling between a) unicast PCell/PSCell PUSCH/PDSCH scheduled by PDCCH on PCell/PSCell and b) unicast PCell/PSCell PUSCH/PDSCH scheduled by PDCCH on sSCell is not supported
	* [3],[6],[9],[13],[18],[19]
3. Simultaneous tx/rx of a unicast PCell/PSCell PUSCH/PDSCH scheduled from PCell/PSCell and a unicast PCell/PSCell PUSCH/PDSCH scheduled from sSCell is not supported
	* [9],[13],[18],[19]
4. PDCCH for initial transmission and retransmission can be on different cells for same TB -- [3]
5. Dynamic activation/activation/switching of sSCell 🡪 PCell/PSCell scheduling
	* Support – [1], [8?],[12],[13],[16],[21]
		+ Based on activation/deactivation/dormancy of sSCell – [8?],[12]
		+ BWP switching – [13],
		+ Search space set group switching – [12],[16]
	* Not support – [5]

### 2.1.3 BD/CCE limit, overbooking, DCI size, #unicast DCIs per slot/span

Following aspects were discussed related to BD/CCE limit, overbooking, DCI size, #unicast DCIs per slot/span when CCS from sSCell to PCell/PSCell is configured

1. Separate BD/CCE limits for sSCell 🡪 PCell/PSCell scheduling and PCell/PSCell 🡪 PCell/PSCell scheduling – [1],[2],[9]
2. Overbooking handling
	* Consider only PCell/PSCell – [3],[9],[18]
	* Consider both sSCell and PCell/PSCell – [1],[5],[10],[15]
3. number of DL and UL unicast DCI formats in a span – [11],[17],[18]
4. DCI size handling – [9],[13],
5. Count PCell as one cell for BD/CCE limit handling with CA – [1]
6. Use lower SCS of two scheduling cells as reference SCS when computing BD/CCE limits – [18]
7. CA limits not exceeded for # BDs/CCEs across PCell/PSCell and sSCell – [18]
8. BDs/CCEs limit for sSCell 🡪 PCell/PSCell scheduling <= {per-cell limits} – {maximum of the numbers of BDs/CCEs for PDCCH on the PCell/PSCell across all the slots} – [18]
9. Separate BDfactorR if the SCS of sSCell and PCell/PSCell are different -- [3]

### 2.1.4 Other aspects

1. RRC configuration details for CCS from sSCell to PCell/PSCell (CrossCarrierSchedulingConfig details) -- [1],[4],[5],[7],[9],
2. Search space ID linking – [1],[5],
3. Fallback SCell for sSCell in case sSCell is unavailable – [8]
4. SCell to PCell/PSCell scheduling has no impact on PUCCH or PUSCH/SRS for non-CA – [8]
5. Whether to enable SCell scheduling PCell transmission can be configured per search space set – [6]
6. Whether sSCell can be unlicensed band? – [6]
7. BFR on sSCell – [21]

Below are some proposals for discussion

## 2.2 Proposals

### Proposal 1

* 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 total BD/CCE budget across PCell/PSCell, sSCell and other SCells shall not exceed existing CA/DC limits

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

|  |  |  |
| --- | --- | --- |
| **Company Name** | **support/not support** | **Comments (Proposal 1)** |
| Moderator notes |  | The proposal corresponds to Alt-2 from the RAN1#103-e discussion and is based on company inputs to RAN1#104-e as summarized in section 2.1.1 (item 1) above |
| Samsung | Not support | No need to create new proposals. The agreed alternatives can be narrowed down, such as to exclude Alt. 1 and probably Alt. 2-3, and then focus on the remaining agreed Alt 2-1/2-2/2-4.  |
| ZTE | Support | We are supportive of this proposal. From our perspective, it won’t increase the UE implantation complexity as long as the BD/CCE budget is kept the same. Anyway, UE needs to monitor DCIs on both PCell (at least for CSS) and SCell. Besides, we would like to add an FFS point to say how to guarantee that the total BD/CCE budget across PCell/PSCell, sSCell and other SCells is not exceed existing CA/DC limits.Proposal 1* 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 total BD/CCE budget across PCell/PSCell, sSCell and other SCells shall not exceed existing CA/DC limits
		- FFS how to guarantee the budget limits.
 |
| Qualcomm | Not support | We support Alt.1.The fundamental principle of cross-carrier scheduling is “a scheduling cell is semi-statically configured for a scheduled cell”. Cross-carrier scheduling from sSCell to PCell/PSCell is basically not an exceptional. The reason that we have agreed to keep CSS sets on the PCell/PSCell when the cross-carrier scheduling from sSCell to PCell/PSCell is configured is that the CSS sets are essential for the PCell/PSCell. USS sets are not especially if fallback operation is supported by Type3-CSS set on the PCell/PSCell. With Alt.1, the UE complexity is already increased due to support of two scheduling cells (possibly with different SCSs, different duplex modes, and/or licensed/unlicensed differentiation) for the PCell/PSCell, and the proposal 1 (or Alt.2) would further increase the complexity depending on the actual solution to be adopted, e.g., PDCCH overbooking, span-by-span BD/CCE sharing across scheduling cells for the same scheduled cell, etc. Looking at Alt.2, there are a lot of sub-alternatives which are actually quite different. Hence, they should not be treated as “Alt.2 group”, and each solution should be sufficiently clear before the narrow down. |
| Apple | Do not support | Non-fallback DCI monitoring dynamical toggling, or simultaneous operation between SpCell and sSCell makes it so flexible that it is even more flexible than other SCell as scheduled cell. This is way beyond the scope of DSS. If we need to enhance CCS, we need a separate agenda and WI. Also, we already support RRC based switching, there is no need for other design such as MAC-CE or even DCI. |
| OPPO | Support the main bullet.  | Regarding to the sub-bullet, it is not clear to us what the “existing limit” is and what this sub-bullet intends to contribute. To our understanding, the existing spec supports following CA setup: P(S)Cell has self-scheduling only and one SCell-A schedules itself and another SCell-B. Now what RAN1 does is to change SCell-B to P(S)Cell or to add the P(S)Cell to the scheduled cell list of SCell-A. The total BD/CCE budget over “P(S)Cell + SCell-A” does not seem to change fundamentally.  |
| Spreadtrum | Support the main bullet. | For sub-bullet, we would like to clarify:1. Does the “total BD/CCE budget across PCell/PSCell, sSCell and other SCells” means CA limits and carrier limits do not exceed existing limits？Such as for non-overlapped CCEs.
2. Regarding BD/CCE budget:
	1. For sSCell, its BD/CCE budget means the self-scheduled PDCCH candidates and its non-overlapping CCEs.
	2. For other SCells, its BD/CCE budget means the self-scheduled or cross-scheduled PDCCH candidates and its non-overlapping CCEs
	3. For PCell/PSCell, its BD/CCE budget include both BDs and non-overlapped CCEs on PCell and sSCell.

Above all, we suggest to achieve a common understanding of BD/CCE budget for PCell/PSCell, sSCell and other SCells, and then detailed limits can be studied. |

### Proposal 2

* 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
* When CCS from sSCell to PCell/PSCell is configured, UE monitors ‘DCI formats 0\_0 and 1\_0 in USS that schedule PDSCH/PUSCH on PCell/PSCell’ 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)** |
| Moderator notes |  | The proposal is based on company inputs to RAN1#104-e as summarized in section 2.1.1 (items 2,3) above |
| Samsung | Support as conclusion | There is no need for an agreement as the behavior is default due to the absence of CIF in DCI formats 0\_0/1\_0 (and nothing else is defined). OK with a conclusion. |
| ZTE | Support | We support this proposal for the following reasons.1. There is no CIF field in fallback DCI.2. If USS can NOT be configured on PCell, then only CSS can be used schedule PCell’s PDSCH/PUSCH from PCell, which is too restrictive. 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. |
| Qualcomm | Support (1st bullet)Not support (2nd bullet) | Type-3 CSS set on the PCell/PSCell can schedule unicast data in case fallback operation is necessary. We do not see the need of the second bullet unless the need and the complexity increase are justified. |
| Apple | Support  |  |
| OPPO | Support | We would like to comment that for the 2nd bullet, it is still possible for sSCell to have DCI 0\_0 and 1\_0 in USS that self-schedules PDSCH/PUSCH on sSCell.  |
| Spreadtrum | Support |  |

### Proposal 3 (for conclusion)

* When CCS from an SCell (sSCell) to PCell/PSCell is configured,
	+ DCI format 2\_5 handling for Type 3 CSS is same as in Rel16
	+ DCI format 2\_5 handling for USS set(s) is same as in Rel16

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 |  | The proposal is based on company inputs to RAN1#104-e as summarized in section 2.1.1 (item 4) above |
| Samsung | Support | DCI 2\_6 needs to also be addressed |
| ZTE | Support | Also support to clarify DCI 2-6. |
| Qualcomm |  | The decision should be on top of the outcomes from proposal 1 and proposal 2. Suggest deferring the decision for now as this is not the main scenario to be targeted. |
| Apple | Support |  |
| OPPO | Support |  |
| Spreadtrum | Support |  |

### Proposal 4

* 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

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 |  | The proposal is based on company inputs to RAN1#104-e as summarized in section 2.1.2 (item 2) above and RAN1#103-e discussion related to this topic |
| Samsung | Support | It would be good to not revisit this and conclude that the current text is 38.214 for OoO related to HARQ-ACK is reused for PDSCH/PUSCH. |
| ZTE | Support |  |
| Qualcomm | Support |  |
| Apple  | Support |  |
| OPPO | Support |  |
| Spreadtrum | Support |  |

### Proposal 5

* 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

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 |  | The proposal is based on company inputs to RAN1#104-e as summarized in section 2.1.2 (item 3) above and RAN1#103-e discussion related to this topic |
| Samsung | Support as conclusion | That can be treated as an error case. Rel-16 specifications not allowing simultaneous PDSCH receptions or PUSCH transmissions are sufficient.  |
| ZTE | Support |  |
| Qualcomm | Support |  |
| Apple  | Support |  |
| OPPO | Support |  |
| Spreadtrum | Support |  |

### Proposal 6

* When CCS from sSCell to PCell/PSCell is configured, CA activation/deactivation/dormancy operation for 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 4)** |
| Moderator Notes |  | The proposal is based on company inputs to RAN1#104-e as summarized in section 2.1.2 (item 1) above and RAN1#103-e discussion related to this topic |
| Samsung | Support |  |
| ZTE | Support | The main motivation of this WI is to improve the PDCCH capability. It is better to minimize the specification impact. |
| Qualcomm |  | CA activation/deactivation does not require any RAN1 impact and can be supported.SCell dormancy may or may not require RAN1 spec impact depending on the solution we will adopt in proposal 1, which should be discussed first.  |
| Apple | Need further discussion | If sSCell carries non-fall back DCI to schedule SpCell, which may be the cell that provide the basic communication with highest reliability and coverage, for example due to the low band operation, it may not be good to deactivate or dormant the sSCell  |
| OPPO | Need more info and study | We would like to review/compare the solutions in case sSCell is deactivated or in dormancy before agreeing the proposal.  |
| Spreadtrum | Support |  |

# 3 Conclusions

TBD

# 4 References

1. R1-2100110 Discussion on Cross-Carrier Scheduling from SCell to PCell ZTE
2. R1-2100186 Discussion on cross-carrier scheduling from Scell to Pcell OPPO
3. R1-2100193 Discussion on SCell PDCCH scheduling P(S)Cell PDSCH or PUSCH Huawei, HiSilicon
4. R1-2100358 Discussion on cross-carrier scheduling from Scell to Pcell CATT
5. R1-2100473 Discussion on Scell scheduling Pcell vivo
6. R1-2100677 On SCell scheduling PCell transmissions Intel Corporation
7. R1-2100694 Discussion on cross carrier scheduling for NR DSS NEC
8. R1-2100719 Om cross-carrier scheduling from SCell to Pcell Nokia, Nokia Shanghai Bell
9. R1-2100794 Discussion on cross-carrier scheduling from SCell to PCell Spreadtrum Communications
10. R1-2100885 Discussion on cross-carrier scheduling from SCell to Pcell LG Electronics
11. R1-2100992 Cross-carrier scheduling (from Scell to Pcell) Lenovo, Motorola Mobility
12. R1-2101066 Discussion on cross-carrier scheduling from SCell to Pcell CMCC
13. R1-2101088 Cross-carrier scheduling from SCell to Pcell ETRI
14. R1-2101100 Discussion on Cross-carrier scheduling from SCell to PCell Xiaomi
15. R1-2101237 Cross-carrier scheduling from SCell to PCell Samsung
16. R1-2101292 USS monitoring in sSCell and PCell InterDigital, Inc.
17. R1-2101362 Views on Rel-17 DSS SCell scheduling PCell Apple
18. R1-2101490 Cross-carrier scheduling from an SCell to the PCell/PSCell Qualcomm Incorporated
19. R1-2101561 Enhanced cross-carrier scheduling for DSS Ericsson
20. R1-2101632 Discussion on cross-carrier scheduling enhancements for NR DSS NTT DOCOMO, INC.
21. R1-2101655 Discussion on cross-carrier scheduling from Scell to Pcell ASUSTeK

# 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)