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

**e-Meeting, April 20th – 30th, 2020**

**Agenda Item: 7.2.2.1.2**

**Source: Moderator (Lenovo)**

**Title: Email discussion/approval on processing time for switching and default SS group, including BWP switching (NR-U DL Signals and Channels)**

**Document for: Discussion, Decision**

# Scope and issues based on company submissions

According to the guidance by RAN1 (vice-)chairman, this email discussion is to be finalised by 24 April; if necessary, followed by endorsing the corresponding TPs by 30 April.

## Processing time for SS set group switching

### Huawei (R1-2001532)

The processing time for UE blind detect and parse DCI takes most of processing time required by the UE to switch search space set group. Similar capability defined for UE to response SPS PDSCH release can be taken as a baseline considering similar processing pipeline. According to section 10.2 of TS38.213 v16.1.0

A UE is expected to provide HARQ-ACK information in response to a SPS PDSCH release after  symbols from the last symbol of a PDCCH providing the SPS PDSCH release. If *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for the serving cell with the PDCCH providing the SPS PDSCH release,  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 SPS PDSCH release and the SCS configuration of a PUCCH carrying the HARQ-ACK information in response to a SPS PDSCH release.

For UE with HARQ capability 2, P =5 symbols for 15 kHz SCS, P=5.5 symbols for 30 kHz SCS and P=11 for 60 kHz SCS. For UE with HARQ capability 1, P =10 for 15 kHz SCS, P ==12 for 30 kHz SCS and P=22 for 60 kHz.

***Proposal 6: The processing time required by the UE for performing search space switching should be same as that of SPS PDSCH release. The corresponding text proposal is in TP#2 in appendix.***

### ZTE (R1-2001703)

Compared with that of SPS PDSCH release, the overall UE processing time required to perform SSS switching is more similar to the processing time of cross carrier scheduling, since both SSS switching and cross carrier scheduling are related to two DL channels reception. Thus, we suggest to reuse the processing time of cross carrier scheduling for P.

**Proposal 2: Reuse the processing time values of cross-carrier scheduling in Clause 5.5 in TS 38.214 for the processing time “P” of SSS group switching. Adopt the TP#2 to reflect the change in TS 38.213.**

---------------------------------------------- < Start of text proposal #2 for 38.213 [2]> -------------------------------------------

10.4 Search space set switching

A UE can be provided a group index for a respective search space set by *searchSpaceGroupIdList-r16* for PDCCH monitoring on a serving cell. If the UE is not provided *searchSpaceGroupIdList-r16* for a search space set, the following procedures are not applicable for PDCCH monitoring according to the search space set.

If a UE is provided *searchSpaceSwitchingGroupList-r16*, indicating one or more groups of serving cells, the following procedures apply to all serving cells within each group; otherwise, the following procedures apply only to a serving cell for which the UE is provided *searchSpaceGroupIdList-r16*.

A UE can be provided, by *searchSpaceSwitchingTimer-r16*, a timer value. The UE decrements the timer value by one after each slot in the active DL BWP of the serving cell where the UE monitors PDCCH for detection of DCI format 2\_0.

If a UE is provided by *SearchSpaceSwitchTrigger-r16* a location of a search space set switching field for a serving cell in a DCI format 2\_0, as described in Clause 11.1.1, and detects the DCI format 2\_0 in a slot

- if the UE is not monitoring PDCCH according to search space sets with group index 0, the UE starts monitoring PDCCH according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, on the serving cell at a first slot that is at least P symbols as described in Table 10.4-1 after the last symbol of the PDCCH with the DCI format 2\_0, if a value of the search space set switching field is 0

- if the UE is not monitoring PDCCH according to search space sets with group index 1, the UE monitors PDCCH according to search space sets with group index 1, and stops monitoring PDCCH according to search space sets with group index 0, on the serving cell at a first slot that is at least P symbols after the last symbol of the PDCCH with the DCI format 2\_0, and the UE sets the timer value to the value provided by *searchSpaceSwitchingTimer-r16*, if a value of the search space set switching field is 1

< Unchanged parts are omitted >

- if the UE monitors PDCCH on a serving cell according to search space sets with group index 1, the UE starts monitoring PDCCH on the serving cell according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, on the serving cell at the beginning of the first slot that is at least P symbols after a slot where the timer expires or, if the UE is provided a search space set to monitor PDCCH for detecting a DCI format 2\_0, after a last symbol of a remaining channel occupancy duration for the serving cell that is indicated by DCI format 2\_0

Table 10.4-1: P as a function of the subcarrier spacing of the PDCCH

|  |  |
| --- | --- |
| ***µPDCCH*** | **P [symbols]** |
| 0 | 4 |
| 1 | 5 |
| 2 | 10 |

-------------------------------------------------- < End of text proposal #2> ----------------------------------------------------

### MediaTek (R1-2001902)



**Figure 1. Example of search space set group switching**

In RAN1#99 meeting, it was agreed that the switching between two groups should happen at “the next applicable slot” after the corresponding event, where “the next applicable slot” is the first slot that is at least P symbols after the last symbol of the corresponding event, as shown in Figure 1, and P should not be less than the processing time required by UE for performing search space set group switching. In [1], the processing times in Table 5.5-1 of 38.214 [2] are reused for the processing times for search space set switching. However, clearly, the values are not reasonable since they only consider the UE required processing time for decoding the message from DCI and ignores the UE required processing time for performing PDCCH monitoring switching. According to the UE required processing time for both decoding the message from DCI and performing PDCCH monitoring switching, we propose the values of P in different numerologies in Table 1.

**Proposal 1: Adopt Table 1 for values of P in TS 38.213 clause 11.5.2.**

Table 1. UE processing time P for search space set group switching

|  |  |
| --- | --- |
| cid:image005.png@01D5E1B7.F332DFC0 | Values of P [symbols] |
| 0 | 8 |
| 1 | 10 |
| 2 | 18 |

###  Ericsson (R1-2002029)

In the previous meeting it was agreed that the values for P1 and P2, the processing times for explicit and implicit search space switching between groups respectively, are equal ‎[1].

Agreement:

For processing times for search space switching, P1 and P2 have the same value.

However the exact values were not agreed and need to be discussed. We note that Section 5.5 of TS38.214 provides the minimum times that are required for a UE to receive PDCCH on one carrier with one numerology and receive PDSCH scheduled by the PDCCH on a different carrier with a different numerology. These times take into account the processing time of a PDCCH and the time needed in an implementation to receive PDSCH. We assume that preparation to receive PDCCH in another search space on the same carrier should be achievable in a time less than or equal to that taken to receive a PDSCH on another carrier. Therefore, we propose that we can use these same times for the purpose of search space switching and provide a corresponding text proposal.

1. The processing times in Table 5.5-1 of 38.214 can be reused for the processing times for search space set switching. Specifically, the values in the table can provide the minimum number of symbols required from the end of the PDCCH indicating the search space set switch to the start of the slot where the search space set is switched.

**----- Start TP for Section 10.4 of 38.213 -----**

10.4 Search space set switching

If a UE is not provided *SearchSpaceSwitchingTrigger-r16* for a serving cell,

- if the UE detects a DCI format by monitoring PDCCH according to a search space set with group index 0, the UE starts monitoring PDCCH according to search space sets with group index 1, and stops monitoring PDCCH according to search space sets with group index 0, on the serving cell at a first slot that is at least P symbols after the last symbol of the PDCCH with the DCI format, the UE sets the timer value to the value provided by *searchSpaceSwitchingTimer-r16* if the UE detects a DCI format by monitoring PDCCH in any search space set

- if the UE monitors PDCCH on a serving cell according to search space sets with group index 1, the UE starts monitoring PDCCH on the serving cell according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, on the serving cell at the beginning of the first slot that is at least P symbols after a slot where the timer expires or, if the UE is provided a search space set to monitor PDCCH for detecting a DCI format 2\_0, after a last symbol of a remaining channel occupancy duration for the serving cell that is indicated by DCI format 2\_0

Values of P is derived from Table 10.4-1 based on the PDCCH subcarrier spacing

Table 10.4-1: P as a function of the subcarrier spacing of the scheduling PDCCH

|  |  |
| --- | --- |
| ***µPDCCH*** | **P [symbols]** |
| 0 | 4 |
| 1 | 5 |
| 2 | 10 |
| 3 | 14 |

**------ End TP ----------**

###  Samsung (R1-2002115)

In Release 15, a processing time for UE required to provide HARQ-ACK information in response to a SPS PDSCH release is defined in TS38.213 as follows.

|  |
| --- |
| A UE is expected to provide HARQ-ACK information in response to a SPS PDSCH release after  symbols from the last symbol of a PDCCH providing the SPS PDSCH release. If *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for the serving cell with the PDCCH providing the SPS PDSCH release,  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 SPS PDSCH release and the SCS configuration of a PUCCH carrying the HARQ-ACK information in response to a SPS PDSCH release. |

Since the overall UE processing time required to perform search space set switching is similar to the above case, the same processing time can be applied to search space set switching.

***Proposal 1: Adopt following TP for TS38.213 to define processing time for search space set switching.***

|  |
| --- |
| 10.4 Search space set switchingA UE can be provided a group index for a respective search space set by *searchSpaceGroupIdList-r16* for PDCCH monitoring on a serving cell indicated by *searchSpaceSwitchingGroup-r16*. If the UE is not provided *searchSpaceGroupIdList-r16* for a search space set, or for PDCCH monitoring on a serving cell that is not indicated by *searchSpaceSwitchingGroup-r16*, the following procedures are not applicable for PDCCH monitoring according to the search space set.A UE can be provided, by *searchSpaceSwitchingTimer-r16*, a timer value. The UE decrements the timer value by one after each slot in the active DL BWP of the serving cell where the UE monitors PDCCH for detection of DCI format 2\_0.If a UE is provided by *SearchSpaceSwitchTrigger-r16* a location of a search space set switching field for a serving cell in a DCI format 2\_0, as described in Clause 11.1.1, and detects DCI format 2\_0 in a slot- if the UE is not monitoring PDCCH according to search space sets with group index 0, the UE starts monitoring PDCCH according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, on the serving cell at a first slot that is at least N symbols after the slot in the active DL BWP of the serving cell, where N is defined in Clause 10.2, if a value of the search space set switching field is 0- if the UE is not monitoring PDCCH according to search space sets with group index 1, the UE monitors PDCCH according to search space sets with group index 1, and stops monitoring PDCCH according to search space sets with group index 0, on the serving cell at a first slot that is at least N symbols after the slot in the active DL BWP of the serving cell, where N is defined in Clause 10.2, and the UE sets the timer value to the value provided by *searchSpaceSwitchingTimer-r16*, if a value of the search space set switching field is 1- if the UE monitors PDCCH on a serving cell according to search space sets with group index 1, the UE starts monitoring PDCCH on the serving cell according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, on the serving cell at the beginning of the first slot that is at least N symbols after a slot where the timer expires, where N is defined in Clause 10.2 or after a last slot of a remaining channel occupancy duration for the serving cell that is indicated by DCI format 2\_0If a UE is not provided *SearchSpaceSwitchTrigger-r16* for a serving cell,- if the UE detects a DCI format by monitoring PDCCH according to a search space set with group index 0 in a slot, the UE starts monitoring PDCCH according to search space sets with group index 1, and stops monitoring PDCCH according to search space sets with group index 0, on the serving cell at a first slot that is at least N symbols after the slot in the active DL BWP of a serving cell, where N is defined in Clause 10.2, the UE sets the timer value to the value provided by *searchSpaceSwitchingTimer-r16* if the UE detects a DCI format by monitoring PDCCH in any search space set- if the UE monitors PDCCH on a serving cell according to search space sets with group index 1, the UE starts monitoring PDCCH on the serving cell according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, on the serving cell at the beginning of the first slot that is at least N symbols after a slot where the timer expires, where N is defined in Clause 10.2 or, if the UE is provided a search space set to monitor PDCCH for detecting a DCI format 2\_0, after a last slot of a remaining channel occupancy duration for the serving cell that is indicated by DCI format 2\_0 |

###  Apple (R1-2002320)

In general, at least two sequential steps are involved in the search space group switching operation, one is PDCCH decoding (either DCI format 2\_0 or a scheduling DCI format in Group 0) and the other is intra-UE communication. Correspondingly, the value of processing time P should provide sufficient margin for these two sequential steps even in the worst cases. For example, in case of *SearchSpaceSwitchTrigger-r16* is not configured for a given UE and a DCI format is detected in the last PDCCH monitoring occasion close to the end of slot n, the earliest slot that UE can switch to Group-1 based on the detected scheduling DCI maybe slot n+3, taking into account both PDCCH processing time and lead time to configure the switched group. We therefore propose P = 25 symbols for both 15kHz and 30kHz SCS. If DCI format 2\_0 is received at the first three symbol of slot n, this value also provides the benefit of enabling SSSG switch at the start of slot n+2 to better serve the power saving purpose. For the case of 60kHz, P1/P2=53 symbols is preferable based on similar rationale.

**Proposal 1: The processing time for search space sets group switching is defined as follows:**

* *P = 25 symbols for 15kHz and 30kHz SCS.*
* *P = 53 symbols for 60kHz SCS*

Another aspect with regard to search space set switching is how to interpret P value when different numerologies are configured for different DL CCs in a CC group e.g. one is 15kHz and the other is 30kHz SCS.

There are two different alternatives for SSSG operation as follows:

* Alt.1: The smallest numerology across CCs within a CC group is used to determine a common P value and the first slot of switching for all CCs within a CC-group.
* Alt.2: P values and the first slot for switching are determined independently on a per CC basis based on the DL SCS configured for each CC.



FIG.1 provides one example of SSSG switching assuming 15kHz SCS on CC#1 and 30khz SCS on CC2. It is our view that Alt.1 is a simpler and cleaner solution, which operates the SSSG switching mechanism on a per CC group basis by referring to a group-specific switching point and is well-aligned aligned with the motivation and definition of CC group switching. Although Alt.2 achieves more faster SSSG switching for CC(s) with larger SCS e.g. CC1 in FIG.1, it results in different switching instances for different serving cells in a CC group if different numerologies are configured for them. More specifically, if the intended UE behaviour is Alt.2 i.e. triggering different switching points for different CCs even in a same group, it is then questionable about the need of CCs grouping since the same UE behaviour can be achieved even without introducing any group configuration. Note that, for the case of different numerologies for different CCs, the processing time budget for SSSG switching becomes more complicated due to PDCCH decoding time and intra-UE communication time have to be determined separately based on SCS configured for the CC where DCI format is transmitted (i.e. CC0 in FIG.1) and a different SCS configured for the other CC where SSS switching occurs (e.g. CC1 in FIG.1). As one consequence, additional standard/implementation/testing efforts are needed to define new switching latency $P^{'}$ accounting for the difference between the same and different numerologies across CCs within a CC group. Based on the analysis above, Alt.1 is preferable for us to enable SSSG switching for the case when different numerologies are used on different CCs within a same CG.

**Proposal 2:**

* *For the case of different numerologies on CCs within a CC group, the smallest numerology across CCs within a CC group is used to determine a common P value and the first slot of switching for all CCs within a CC-group to support SSSG switching.*
* *TP1 implement the Alt.1.*

[FL Note: TP1 is available in R1-2002320]

### Qualcomm (R1-2002528)

For search space set switching, it was agreed in RAN1 #100e that the P1 and P2 values should be the same. The common value is P. However, the value itself is not yet decided. Consider this P value is a common value for all cases, included ones with the heaviest PDCCH computation load under maximum carrier aggregation, a conservative value to handle the worst case is needed. Our calculation shows P=25 symbols for 15KHz/30KHz/60KHz is possible.

**Proposal : For search space group switching, the P value is defined to be 25 symbols for both** $μ=0, 1,$ **and 2.**

## Default search space group

### Huawei (R1-2001532)

After UE is configured with SS set group by *searchSpaceGroupIdList-r16* or UE switches to another active DL BWP configured with *searchSpaceGroupIdList-r16*, it is not clear whether UE should start monitor PDCCH in SS set group #0 or PDCCH in SS set group #1. The motivation to introduce SS set group switch from group #0 to group#1 is to reduce PDCCH BD when UE is able to identify an ongoing DL COT. After search space is just configured or BWP switch, the DL COT Structure information is usually unknown and UE should assume SS set group#0 at that time.

***Proposal 4: UE should monitor PDCCH in SS set group#0 after UE is configured with SS set group by searchSpaceGroupIdList-r16 or UE switches to another active DL BWP configured with searchSpaceGroupIdList-r16. The corresponding text proposal is in TP#2 in appendix.***

### vivo (R1-2001650)

From the above agreement, UE could be configured with two separate search space (SS) group but only one SS group is active in a certain time duration. The details on implicit or explicit switching condition are also provided in the above agreement. However, which group should be monitored immediately after RRC configuration on SS, or switching to another cell or BWP, DRX on and etc. So, there is need to define a default search space set group to serve the above purpose.

**Proposal 1: One default SS group (i.e. search space sets with group index 0) should be specified for UE to perform PDCCH monitoring after RRC configuration on SS, switching to another BWP or cell, from DRX off to DRX on.**

**Proposal 2: RAN1 adopt the following TP1 on section 10.4 of TS 38.213.**

------------------------------------------- Start TP1 for Section 10.4 of TS 38.213 --------------------------------------

A UE can be provided a group index for a respective search space set by searchSpaceGroupIdList-r16 for PDCCH monitoring on a serving cell indicated by searchSpaceSwitchingGroup-r16. If the UE is not provided searchSpaceGroupIdList-r16 for a search space set, or for PDCCH monitoring on a serving cell that is not indicated by searchSpaceSwitchingGroup-r16, the following procedures are not applicable for PDCCH monitoring according to the search space set.

In default, search space sets with group index 0 will be monitored immediately after receiving RRC configuration on search space sets, switching to another BWP or cell, switching from DRX off to DRX on.

--------------------------------------------- End TP1 for Section 10.4 of TS 38.213 --------------------------------------

### OPPO (R1-2001757)

If UE is indicated to switch active DL BWP, how to monitor PDCCH according to the configured search space set should be defined.

For PDCCH monitoring according to a serving cell, if UE is monitoring PDCCH according to search space group 0 before the BWP switching, the UE shall keep monitoring PDCCH according to search space group 0 on the target BWP after BWP switching. If UE is monitoring PDCCH according to search space group 1 before the BWP switching, and the BWP switching time is shorter than the configured timer or COT duration, the UE shall monitor PDCCH in search space group 1 on the target BWP after BWP switching, otherwise, the UE shall monitor PDCCH in search space group 0 on the target BWP after BWP switching.

For PDCCH monitoring according to a serving cell group, the PDCCH monitoring behavior on the target BWP after BWP switching shall follow the same behavior as other cell in the same cell group.

***Proposal 5:*** *Adopt TP2 into section 10.4 of TS 38.213 to define PDCCH monitoring behavior in BWP switching case.*

------------------------------------TP2: Start of TP 38.213 section 10.4 ---------------------------------------------

10.4 Search space set switching

A UE can be provided a group index for a respective search space set by *searchSpaceGroupIdList-r16* for PDCCH monitoring on a serving cell. If the UE is not provided *searchSpaceGroupIdList-r16* for a search space set, the following procedures are not applicable for PDCCH monitoring according to the search space set.

If a UE is provided *searchSpaceSwitchingGroupList-r16*, indicating one or more groups of serving cells, the following procedures apply to all serving cells within each group; otherwise, the following procedures apply only to a serving cell for which the UE is provided *searchSpaceGroupIdList-r16*.

A UE can be provided, by *searchSpaceSwitchingTimer-r16*, a timer value. The UE decrements the timer value by one after each slot in the active DL BWP of the serving cell where the UE monitors PDCCH for detection of DCI format 2\_0.

For search space set switching applied to a serving cell, if UE is monitoring PDCCH according to search space sets with group index 1 before BWP switching and if the BWP switching time is shorter than configured timer or indicated COT duration, the UE shall monitor PDCCH according to search space sets with group index 1 on the target BWP, otherwise, the UE shall monitor PDCCH according to search space sets with group index 0 on the target BWP. For search space set switching applied to a serving cell group, the PDCCH monitoring behavior on the target BWP after BWP switching shall follow the same behavior as other cell in the same cell group.

<Unchanged parts are omitted>

----------------------------------------End of TP 38.213 section 10.4 ---------------------------------------------

### Panasonic (R1-2002054)

In 38.213 Clause 10.4, search space set switching is specified. However, the switching behaviour is described by assuming that UE has already monitored one of the groups of search space sets. It is undefined which search space set group UE should start with right after *searchSpaceSwitchingGroupList-r16* is provided to UE. Therefore, we propose to specify a default group. In the current description of 38.213, search space sets with group index 0 should be understood as a default group, because when the time configured by *searchSpaceSwitchingTimer-r16* expires or outside COT, search space sets with group index 0 will be monitored. Therefore, we propose to use group 0 as a default group right after RRC configuration for search space set switching. The text proposal to 38.213 is the following:

Text Proposal for Search space set group after RRC configuration to TS 38.211 in Rel-16:

|  |
| --- |
| 10.4 Search space set switchingA UE can be provided a group index for a respective search space set by *searchSpaceGroupIdList-r16* for PDCCH monitoring on a serving cell. If the UE is not provided *searchSpaceGroupIdList-r16* for a search space set, the following procedures are not applicable for PDCCH monitoring according to the search space set.If a UE is provided *searchSpaceSwitchingGroupList-r16*, indicating one or more groups of serving cells, the following procedures apply to all serving cells within each group; otherwise, the following procedures apply only to a serving cell for which the UE is provided *searchSpaceGroupIdList-r16*.If the UE is provided a group index by *searchSpaceGroupIdList-r16* for PDCCH monitoring on a serving cell, and if the UE has not started to monitor PDCCH according to either search space sets with group index 0 or search space sets with group index 1, the UE starts monitoring PDCCH according to search space sets with group index 0 and does not monitor PDCCH according to search space sets with group index 1 on the serving cell.… |

### Sharp (R1-2002381)

Issue #2: PDCCH monitoring behaviour right after RRC configuration for search space set switching

The agreement on search space set group switching from RAN1#99 [1] is well reflected into the current specification of TS38.213. On the other hand, there is a missing case. The current switching behaviour is defined by assuming that UE monitors either PDCCH according to search space sets with group index 0 or PDCCH according to search space sets with group index 1 at a given time. However, the current Spec does not specify which group index is assumed for PDCCH monitoring right after RRC configuration for search space set switching. Considering the group index 0 was assumed as fallback state during RAN1#99 discussions, we propose that, if the UE has not started to monitor PDCCH according to either search space sets with group index 0 or search space sets with group index 1, the UE starts monitoring PDCCH according to search space sets with group index 0 and does not monitor PDCCH according to search space sets with group index 1 on the serving cell.

**Proposal 2:**

* **TS38.213 to capture that an initial search space set group after RRC configuration is group #0.**
	+ **Adopt the following Text proposal #2.**

|  |
| --- |
| **Text proposal #2**--------- beginning of text proposal for TS 38.213 **<omitted>**10.4 Search space set switchingA UE can be provided a group index for a respective search space set by *searchSpaceGroupIdList-r16* for PDCCH monitoring on a serving cell. If the UE is not provided *searchSpaceGroupIdList-r16* for a search space set, the following procedures are not applicable for PDCCH monitoring according to the search space set.If a UE is provided *searchSpaceSwitchingGroupList-r16*, indicating one or more groups of serving cells, the following procedures apply to all serving cells within each group; otherwise, the following procedures apply only to a serving cell for which the UE is provided *searchSpaceGroupIdList-r16*.A UE can be provided, by *searchSpaceSwitchingTimer-r16*, a timer value. The UE decrements the timer value by one after each slot in the active DL BWP of the serving cell where the UE monitors PDCCH for detection of DCI format 2\_0.If the UE is provided a group index by *searchSpaceGroupIdList-r16* for PDCCH monitoring on a serving cell, and if the UE has not started to monitor PDCCH according to either search space sets with group index 0 or search space sets with group index 1, the UE starts monitoring PDCCH according to search space sets with group index 0 and does not monitor PDCCH according to search space sets with group index 1 on the serving cell.If a UE is provided by *SearchSpaceSwitchTrigger-r16* a location of a search space set switching field for a serving cell in a DCI format 2\_0, as described in Clause 11.1.1, and detects DCI format 2\_0 in a slot- if the UE is not monitoring PDCCH according to search space sets with group index 0, the UE starts monitoring PDCCH according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, on the serving cell at a first slot that is at least P symbols after the last symbol of the PDCCH with the DCI format 2\_0, if a value of the search space set switching field is 0- if the UE is not monitoring PDCCH according to search space sets with group index 1, the UE monitors PDCCH according to search space sets with group index 1, and stops monitoring PDCCH according to search space sets with group index 0, on the serving cell at a first slot that is at least P symbols after the last symbol of the PDCCH with the DCI format 2\_0, and the UE sets the timer value to the value provided by *searchSpaceSwitchingTimer-r16*, if a value of the search space set switching field is 1- if the UE monitors PDCCH on a serving cell according to search space sets with group index 1, the UE starts monitoring PDCCH on the serving cell according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, on the serving cell at the beginning of the first slot that is at least P symbols after a slot where the timer expires or after a last symbol of a remaining channel occupancy duration for the serving cell that is indicated by DCI format 2\_0If a UE is not provided *SearchSpaceSwitchTrigger-r16* for a serving cell,- if the UE detects a DCI format by monitoring PDCCH according to a search space set with group index 0, the UE starts monitoring PDCCH according to search space sets with group index 1, and stops monitoring PDCCH according to search space sets with group index 0, on the serving cell at a first slot that is at least P symbols after the last symbol of the PDCCH with the DCI format, the UE sets the timer value to the value provided by *searchSpaceSwitchingTimer-r16* if the UE detects a DCI format by monitoring PDCCH in any search space set- if the UE monitors PDCCH on a serving cell according to search space sets with group index 1, the UE starts monitoring PDCCH on the serving cell according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, on the serving cell at the beginning of the first slot that is at least P symbols after a slot where the timer expires or, if the UE is provided a search space set to monitor PDCCH for detecting a DCI format 2\_0, after a last symbol of a remaining channel occupancy duration for the serving cell that is indicated by DCI format 2\_0**<omitted>** |

# Discussion

Companies are invited to comment on the questions below.

## Processing time for SS set group switching

Agreement (RAN1#100-e):

For processing times for search space switching, P1 and P2 have the same value.

**Q1: What processing time P1=P2 should be adopted?**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Please provide your views on the processing time for switching to a different SS set group. It is suggested to include a short table for easier overview, e.g.:

|  |  |
| --- | --- |
| µPDCCH | Value of P1=P2 [symbols] |
| 0 | x |
| 1 | y |
| 2 | z |

 |
| **Company** | **Comment** |
| MediaTek | Reuse Cap.1 processing time for responding DL SPS release for SCS = 15, 30, and 60 kHz. Reuse processing time for X-carrier scheduling is not reasonable since it only considers the latency for decoding DCI without preparing time for switching PDCCH monitoring.

|  |  |
| --- | --- |
| µ | Value of P [symbols] |
| 0 | 10 |
| 1 | 12 |
| 2 | 22 |

Note that µ corresponds to the smallest SCS configuration between the SCS configuration of the triggering event (e.g., PDCCH with the detected DCI format 2\_0) and the SCS configuration of the serving cell(s) applying the procedure for search space set group switching. |
| Huawei,HiSilicon | We propose same values as SPS PDSCH releasing in Rel 15, i.e.For UE capability#1, x=10, y=12, z =22for UE capability#2, x = 5, y =5.5, z=11 |
| Nokia, NSB | Preferably as small as possible, having one value for up to N cells and other value for >N cells could be an option, if it helps to reduce the value of P1=P2. |
| ZTE, Sanechips | Reuse the processing time values of cross-carrier scheduling in Clause 5.5 in TS 38.214Table 10.4-1: P as a function of the subcarrier spacing of the PDCCH

|  |  |
| --- | --- |
| ***µPDCCH*** | **P [symbols]** |
| 0 | 4 |
| 1 | 5 |
| 2 | 10 |

 |
| Samsung | Reuse the processing time for SPS PDSCH release, e.g., for UE capability #1,

|  |  |
| --- | --- |
| µ | Value of P [symbols] |
| 0 | 10 |
| 1 | 12 |
| 2 | 22 |

 |
| Qualcomm | Consider the number setting needs to consider the worst case CA, we propose number 25 for all cases

|  |  |
| --- | --- |
| µ | Value of P [symbols] |
| 0 | 25 |
| 1 | 25 |
| 2 | 25 |

 |
| OPPO | Reuse SPS PDSCH release processing time |
| Sharp | Agree with MediaTek that reusing Cap.1 processing time for responding DL SPS release is reasonable, i.e. x=10, y=12, z =22.  |
| vivo | The length of processing time depends on what needs to do when SS set group switching. It may include two parts: PDCCH decoding and PDCCH monitoring change. For PDCCH decoding, SPS release time could be a reference. For PDCCH monitoring change, the time may be different according to different UE implementation/use case. For NRU case, it is preferred that the processing time is preferably as small as possible. But for other case such as power saving, UE may only need to keep part of hardware closed to save power while monitoring one SS group. In this case, the processing time for SS group switching is better to be large to accommodate the hardware adjustment. So we propose to define two sets of processing time for different UE capability/implementation.

|  |  |  |
| --- | --- | --- |
| µ | Value of P [symbols]UE capability 1 | Value of P [symbols]UE capability 2 |
| 0 | 10 | 25 |
| 1 | 12 | 25 |
| 2 | 22 | 50 |

 |
| Apple | The following was proposed from our implementation perspective.

|  |  |
| --- | --- |
| µ | Value of P [symbols] |
| 0 | 25 |
| 1 | 25 |
| 2 | 53 |

To explain a bit on the components of this value. These values come from two sequential steps, first is decoding the PDCCH (DCI format 2\_0 or implicit DCI format in SSSG0) and then followed by some intra-UE communication to apply the new PDCCH monitoring setting of the SSSG that UE switched to. The values can be quite varied depending on the implementation details for CA case. Considering this particular issue is mainly determined by the implementation structure and very limited space to compromise (same situation as we discussed processing time N1/N2 in Rel-15), similar thought as vivo, we are thinking one possible way forward to move forward by defining two capabilities for each numerology, one is smaller value and the other is larger value. UE can indicate which of two it supports.  |
| Spreadtrum | The processing time of SPS PDSCH release for UE capability #1 can be reused. |
| Ericsson | As explained in our contribution, the minimum times that are required for a UE to receive PDCCH on one carrier with one numerology and receive PDSCH scheduled by the PDCCH on a different carrier with a different numerology (in section 5.5 of 38.214 ) are similar to SSS groups switching scenarios. However, we can discuss this further to address concern of UE vendors.

|  |  |
| --- | --- |
| ***µPDCCH*** | **P [symbols]** |
| 0 | 4 |
| 1 | 5 |
| 2 | 10 |

 |

**Q2: Which numerology is taken as reference if switching to/from different BWPs/cells?**

|  |
| --- |
| Apple lists the following alternatives (for different cells):* Alt.1: The smallest numerology across CCs within a CC group is used to determine a common P value and the first slot of switching for all CCs within a CC-group.
* Alt.2: P values and the first slot for switching are determined independently on a per CC basis based on the DL SCS configured for each CC.

A screenshot of a cell phone  Description automatically generated**Proposal 2:** *For the case of different numerologies on CCs within a CC group, the smallest numerology across CCs within a CC group is used to determine a common P value and the first slot of switching for all CCs within a CC-group to support SSSG switching.*Please provide your view on the issue and Apple's proposal. |
| **Company** | **Comment** |
| MediaTek | Support Alt1 in principle. We should also consider that the detected DCI 2\_0 triggering the switching behavior may not come from the CC group. Thus, the P and the first slot of switching should be determined based the CC with smallest SCS configuration across the CCs within a same CC group and, if any, the CC providing DCI 2\_0 triggering switching. |
| Huawei, HiSilicon | Alt 1 is preferred due to aligned switch point. |
| Nokia, NSB | Alt.1 sounds reasonable to us, but “smallest numerology” should be replace “smallest SCS” |
| LG Electronics | Support Apple’s proposal, to align switching points between cells (having different numerologies) within a group of cells for SS set group switching, which makes UE implementation simple. |
| ZTE, Sanechips | Support Alt-1 |
| Samsung | Support Alt 1 |
| Qualcomm | Support Alt 1 |
| OPPO | Support Alt 1 |
| Sharp | OK with the direction of Alt 1. However, as numerologies are not per-CC but per-BWP, more clarification is necessary – Does the smallest numerology mean the smallest one among configured BWPs within a CC group, among active BWPs within the CC group, or anything else? |
| vivo | May need more clarification. Based on my understanding on the proposal, it aims to define a common P duration value in configured cell group to achieve aligned switching point. However, it seems not enough by having a common P duration only. For example, P will also apply to implicit switching case. If PDCCH is transmitted in different time point in CC0 and CC1, it will also result in separate switching point as the figure below shows:Agree that the switching between CCs in configured cell group should be aligned since this is why to introduce the cell group. However, the alignment could be done like this: Each CC in the cell group apply the switching criterion independently and the monitoring SS set is switched at the time point as long as SS set group needs to be switched in at least one cell in the cell group. Following this, the switching time point in CC0 is in the middle of slot n+1 in your Alt.2 example. |
| NTT DOCOMO | Support Alt.1 |
| Apple  | Alt.1. We are also supportive to implement the suggestion from MTK.Regarding the Vivo comment, referring to FIG above, the switching on CC1 should be aligned and happen on the same time as on CC0 since the implicit triggering comes earlier on CC0 and CC0/CC1 is grouped together.  |
| Spreadtrum | Support Alt 1 |
| Ericsson | We area generally ok with the Alt1. However, probably some changes with the wording are needed when capturing in the specification e.g. using SCS instead of numerology  |
| vivo | Thanks apple for further clarification. So the implicit triggering still applies as I mentioned. The misalignment in Alt. 2 is due to that the switching time should be slot boundary which may not be the same for different SCS. In this sense, defining the reference slot boundary for SS set group switching is enough to align the switching and there is no need to have a common P duration. In your example on Alt. 2 with different P duration, the switching can also be aligned if defining the same slot for SSSG switching? |

## Default Search Space Set Group

**Q3: Which is the default search space set group used, and what are the conditions for its use?**

|  |
| --- |
| Submitted contributions suggested one or more of the following conditions:* After UE is configured with SS set group by *searchSpaceGroupIdList-r16*
* After UE switches to another active DL BWP configured with *searchSpaceGroupIdList-r16*
* After switching to another BWP or cell
* Transition from DRX off to DRX on
* For BWP switching, depends whether the BWP switching time is shorter than configured timer or indicated COT duration
 |
| **Company** | **Comment** |
| MediaTek | Agree to define a default group (e.g., group 0) at least for right after RRC (re)configuration and DL BWP switching. |
| Huawei, HiSilicon | UE assume Group#0 at least after UE is configured with SS set group by *searchSpaceGroupIdList-r16* or UE switches to another active DL BWP configured with *searchSpaceGroupIdList-r16*. |
| Nokia, NSB | After UE’s BWP is activated (RRC or DCI-based or timer based), UE monitors SS sets in Group #1 if at least one SS set is configured with a group on the BWP. DRX is independent from SS-set monitoring switching in R16.  |
| LG Electronics | It could be beneficial to define default group index in order to avoid mismatch on monitoring search space between gNB and UE. However, we need to discuss what happens if default group is not defined. For example, if timer is configured, this sort of mismatch can be figured out after timer expires. For another example, if type3-PDCCH CSS set is configured with both groups 0 and 1, gNB can manage search space set switching behavior for the UE. |
| ZTE, Sanechips | Support to define a default group, e.g., group 0 after UE is configured with SS set group by *searchSpaceGroupIdList-r16* or After UE switches to another active DL BWP configured with searchSpaceGroupIdList-r16 |
| Samsung | Define a default group at least for cases after RRC configuration and BWP switching. |
| Qualcomm | We are fine using group 0 as default, but for the case of DL BWP switching, we do not see a need to switch to default group after the DL BWP switching. For the case gNB wants the UE to switch BWP in a gNB COT, we believe the UE should stay in group 1, unless it is explicitly switched by gNB or timer expires or COT ends |
| OPPO | Default group can be group 0 only if there are two groups are configured in active DL BWP. For DL BWP switching, it should follow normal mechanism, i.e. checking COT end or timer expiration. |
| Sharp | Agree to define a default group (i.e. group 0) for right after RRC reconfiguration. However, we are wondering if the default group needs to apply to the other cases (BWP switching and DRX), because apparently the switching behaviors in the current Spec can work in those cases. |
| vivo | Support to define a default group as we propose. It seems most companies are OK to define a default SS set group (i.e. group 0) for cases after RRC configuration/reconfiguration. For BWP switching, UE will stop PDCCH monitoring in the BWP switching time. It is not normal switching between SS set group 0/1. The question becomes when PDCCH monitoring recovers in new BWP, which SS set group should be monitored? Besides, it is similar situation for DRX case. In our view, using a default group in these cases will make it simple. |
| NTT DOCOMO | Agree to define a default group (i.e. group 0) for after RRC (re)configuration. We don’t see the necessity of default group for other cases. |
| Panasonic | We support to define group 0 as the default group and UE to monitor the default group in the following cases:* Right after RRC configuration of search space set group by *searchSpaceGroupIdList-r16*.
* After a gap of no PDCCH monitoring, for example, due to BWP switching and DRX off period. The reason is that during such gap of no PDCCH monitoring, UE could miss the updated COT duration information (e.g. gNB decides to extend the COT by sending new DCI 2\_0 but UE is not monitoring PDCCH). If the default group is not defined for such cases, the mismatch problem can only be solved until the timer expires. Depending on the configured timer value, this might not solve the issue. Further, it is unclear in current spec whether timer value is reduced during DRX off.
 |
| Apple | We are supportive to define a default SSSG monitoring at least for BWP switching procedure and RRC reconfiguration of SSSGs. More precisely, we think SSSG0 is nature choice.  |
| Spreadtrum | We support to define a default group (e.g. group 0) for after RRC (re)configuration. For other cases, the UE should follow normal behavior, such as checking gNB indication or if the timer expires. |
| Ericsson | We agree with defining group 0 as the default search space set group. |