3GPP TSG RAN WG1 Meeting #100-Bis-e R1-200XXXX

**April 20th – April 30th , 2020**

Agenda Item: 7.2.7.2

Source: MediaTek Inc.

Title: Summary#2 for Procedure of Cross-Slot Scheduling Power Saving Techniques

Document for: Discussion and Decision

# Introduction

In this contribution, there summarize the email discussions for the agenda item, procedure of cross-slot scheduling power saving techniques. In particular, the following sections are devoted for

* Section 2 (preparation phase): T-doc summary and candidate issues for email discussion
* Section 3 (discussion phase): Views and results on the selected issues for email discussion

# T-doc summary and candidate issues for email discussion

In this section, companies’ views are categorized and summarized in the following sub-sections:

1. Remaining issue #1 related to cross-BWP scheduling
2. Remaining issue #2 related to cross-BWP scheduling
3. Other remaining issues
4. Suggested threads for email discussion

where the last sub-section is for further discussion and decision for formal email discussion.

## Remaining issue #1 for cross-BWP scheduling

In RAN1#100-e [1], there is no consensus in specifying UE behaviors related to cross-BWP scheduling. To move forward, there are two issues in the end of Section 3.2 of [2] for further discussion in this meeting. In this sub-section, companies’ views for issue #1, i.e., whether and how to apply the currently active minimum scheduling offset restriction in the case of cross-BWP scheduling, are first summarized, and proposal(s) for moving forward will suggested for further discussion.

In Table 1, companies’ views for issue #1 are summarized. The content of issue #1 and the list of supporting companies are also provided below:

|  |
| --- |
| Issue #1: Whether and how to apply the currently active minimum scheduling offset restriction in the case of cross-BWP scheduling   1. **Alt 1: Agree**; TP is needed to clarify how K0min/K2min of source BWP is applied to target BWP of cross-BWP scheduling    * Supporting companies (11): Apple, CMCC, DoCoMo, Ericsson, LG, Nokia, Qualcomm, Samsung, Sony, Spreadtrum, VIVO 2. **Alt 2: Disagree**; TP to clarify the applied K0min/K2min only for an active BWP, not covering cross-BWP case    * Supporting companies (4): : CMCC, MediaTek, OPPO, ZTE 3. **Alt 3: Disagree**; but agree that there should be additional factor(s) for cross-BWP scheduling restriction (in addition to Rel-15 BWP switch delay). Further discuss the factor(s) (e.g. based on the currently active application delay, etc).    * Supporting companies (4): Huawei, HiSilicon, Intel, CATT |

From the above summary, Alt 1 has majority view. On the other hand, the total number of companies of disagreement is also not small. Since Alt 1 still need to specify how K0min/K2min of source BWP is applied to target BWP, one possibility is to consider application delay that is also based on K0min of source BWP and is regarded applicable to all cases. Since for UL BWP switch case, application delay can be different from scaled K2min, companies can first discuss what is the critical factor to ensure UE power saving and then finalize how K0min/K2min of source BWP is applied for scheduling offset selection of cross-BWP scheduling.

Consequently, the following are suggested for further email discussion:

Proposal 1: For cross-BWP scheduling, K0min/K2min of source BWP is applied to restrict the selection of the scheduling offset. Further consolidate the details based on companies’ views on Question 1.

Question 1: For the cross-BWP scheduling that triggers active UL BWP change, if application delay is different from scaled K2min, what factor(s) should be considered for the selection of scheduling offset K2?

* **Example case: UL BWP switch with BWP switch delay of 6 slots, K2min of 6 slots, and K0min of 8 slots. Assume no numerology change after BWP switch, should K2 be larger than 6 slots (K2min) or 8 slots (application delay based on K0min)?**

Table 1: Companies' views on “whether and how to apply the currently active minimum scheduling offset restriction in the case of cross-BWP scheduling”

|  |  |
| --- | --- |
| Company name | Alt 1/2/3 |
| Suggested TP/proposal(s) or supporting reasons |
| Huawei, HiSilicon [3] | Alt 3 (Jointly consider BWP switch delay and application delay) |
| ---------------- Unchanged parts are omitted (Section 5.1.2.1 of TS 38.214-g10) ----------------  When the UE configured with [minimumSchedulingOffset] in an active DL BWP it applies a minimum scheduling offset restriction indicated by the ['Minimum applicable scheduling offset indicator'] field in DCI format 0\_1 or 1\_1. When the UE configured with [minimumSchedulingOffset] in active DL BWP and it has not received ['Minimum applicable scheduling offset indicator'] field in DCI format 0\_1 or 1\_1, UE shall apply a minimum scheduling offset restriction indicated based on ['Minimum applicable scheduling offset indicator'] value '0'. When the minimum scheduling offset restriction is applied the UE is not expected to be scheduled with a DCI in slot n to receive a PDSCH scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI with K0 smaller than the applicable minimum scheduling offset restriction K0min. The minimum scheduling offset restriction is not applied when PDSCH transmission is scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI in common search space associated with CORESET0 and default PDSCH time domain resource allocation is used or when PDSCH transmission is scheduled with SI-RNTI or RA-RNTI. The application delay of the change of the minimum scheduling offset restriction is determined in Clause 5.3.1.  A UE does not expect to detect a DCI format 1\_1 indicating respectively an active DL BWP change with the corresponding time domain resource assignment field providing a slot offset value for a PDSCH reception that is smaller than an application delay of the change of the minimum scheduling offset restriction if a minimum scheduling offset restriction indicated by the DCI format 1\_1.  ---------------------------------- Unchanged parts are omitted ---------------------------------- |
| ZTE [4] | Alt 2 (Proposal 1: The currently active minimum scheduling offset restriction is not applied to cross-BWP scheduling.) |
|  |
| VIVO [5] | Alt 1 |
| Observation 1: If UE reports capability of Type-1 BWP switch delay, the BWP delay may be smaller than the active minimum scheduling offset especially for FR2, and there is concern that UE cannot save power effectively when currently active minimum scheduling offset restriction does not apply in the case of cross-BWP scheduling. If UE reports capability of Type-2 BWP switch delay, most likely there is no issue.  Observation 2: Regarding whether to apply the currently active minimum scheduling offset restriction in the case of cross-BWP scheduling or not, it is a tradeoff between UE power saving and performance of BWP switch.  Proposal 1: For Issue #1: whether and how to apply the currently active minimum scheduling offset restriction in the case of cross-BWP scheduling, the final choice should make sure that UE can save power by cross-slot scheduling enhancement in both same-BWP scheduling and cross-BWP scheduling. Before the concern is fully solved, we slightly prefer Alt 1. |
| OPPO [6] | Alt 2 |
| “In summary, it has to be take care by UE processing and UE should make sure it applies all the new setting after any BWP switching.” |
| Sony [7] | Alt 1 |
| Observation 1: A TP is needed to clarify how K0min/K2min of source BWP is applied to target BWP of cross-BWP scheduling.  Proposal 1: For indicating the scheduling offset in cross-BWP scheduling, the scheduling offset should be no smaller than max (A,C), where A and C are:  A. BWP switch delay  C. Active minimum scheduling offset in the active DL BWP before the BWP switch |
| MediaTek [8] | Alt 2 (Disagree. TP to clarify the applied K0min/K2min only for an active BWP, not covering cross-BWP case, is given as follows) |
| -------------- Unchanged parts are omitted (Section 5.3.1 of TS 38.214-g10) -----------  When the UE is scheduled with DCI format 0\_1 or 1\_1 with a ['Minimum applicable scheduling offset indicator']field, it shall determine the *K*0min and *K*2min values to be applied, while the previously applied *K*0min and *K*2min values are applied for the same active BWP until the new values take effect after application delay. Change of applied minimum scheduling offset restriction indication carried by DCI in slot *n*, shall be applied in slot *n*+*X* of the scheduling cell. The UE does not expect to be scheduled with DCI format 0\_1 or 1\_1 with ['Minimum applicable scheduling offset indicator'] field indicating another change to the applied *K0min* or *K2min* for the same active BWP before slot *n+X* of the scheduling cell.  ---------------------------------- Unchanged parts are omitted ---------------------------------- |
| LG [9] | Alt 1 |
| Proposal 1: In cross-BWP scheduling, the scheduling offset is not smaller than Max (BWP switch delay, active minimum scheduling offset of the scheduling BWP) or (BWP switching delay + active minimum scheduling offset of the scheduling BWP).  Proposal 2: Regarding the issue #1, Alt 1 is supported (i.e., TP is needed to clarify how K0min/K2min of source BWP is applied to target BWP of cross-BWP scheduling). |
| Intel [10] | Alt 3 |
| **Proposal 3: For adaptation to the indicated minimum applicable K0 value(s) in the switched BWP triggered by the 1-bit indication of a DCI format 1-1 in a serving cell, application delay X in slot(s) for Alt 3 in the numerology of the target BWP is given by**   * **X = max(Y, ceiling(Z\*2^μscheduled/2^μscheduling)) in the numerology of the target BWP**   + **Z is determined by the SCS of the active DL BWP or the scheduling BWP in the serving cell and takes value of 1/1/2/2 slot(s) for DL SCS of 15/30/60/120 KHz, respectively**     - **μscheudling and μscheudled are the SCS indices for the scheduling and the scheduled BWP, respectively.**   + **Y is the configured value if one value is RRC configured for the minimum applicable value of K0 in the scheduled BWP; The lowest-indexed RRC configured value if two values are RRC configured for the minimum applicable value of K0 in the scheduled BWP** |
| CATT [11] | Alt 3 |
| Proposal 1: Our view is alternative 3 to have no specification change. It is the gNB implementation issue to ensure that the indicating scheduling offset in the cross-slot scheduling during the BWP switching should be greater than BWP switching delay indicated by UE capability and the 1-bit indicated minimum scheduling offset in the active BWP before BWP switching. |
| Samsung [12] | New |
| Proposal 1: The minimum applicable value, Kmin, is applied to both source BWP and target BWP.  Proposal 2: For an inactive BWP, if there is no valid entry after applying the Kmin value, the UE does not expect to receive a BWP indicator to switch the inactive BWP.  Proposal 3: A UE does not expect to detect a DCI format 1\_1/0\_1 indicating BWP change with the corresponding TDRA field providing a slot offset value for a PDSCH/PUSCH that is smaller than X + Tbwp where X is an application delay for cross-slot scheduling and Tbwp is a delay required by the UE for an active BWP change. |
| CMCC [13] | Alt 1 / Alt 2 |
| Proposal 1. Alt 1 or Alt 2 can be considered in issue #1: Whether and how to apply the currently active minimum scheduling offset restriction in the case of cross-BWP scheduling.  Proposal 2. Max(A, C) can be used as the scheduling offset restriction in cross-BWP scheduling if Alt 1 in issue #1 is agreed. |
| Nokia [14] | Alt 1 |
| Proposal 6: The scheduling slot offset restriction when BWP switch is indicated by DCI is set as the maximum of the BWP switch delay and the applied minimumSchedulingOffset of the source BWP in absolute time. |
| Spreadtrum [15] | Alt 1 |
| Proposal 1: Apply the minimum scheduling offset restriction to all configured BWPs in cross-BWP scheduling, and the scheduling offset should be no less than . |
| Apple [16] | Alt 1 |
| To allow for predictability on K0/K2 in the target BWP, the values of K0min/K2min in the target BWP should initially be derived from those of the source BWP and a it should be clarified how K0min/K2min of source BWP is applied to target BWP of cross-BWP scheduling.  Proposal 1: Clarify how K0min/K2min of source BWP is applied to target BWP of cross-BWP scheduling |
| InterDigital [17] | N/A |
|  |
| Ericsson [18] | Alt 1 |
| Therefore, in summary, as discussed in 100-e, the PDCCH to PDSCH/PUSCH gap should be no smaller than maximum value between the BWP-switch delay (A) and the minimumSchedulingOffset of the source BWP (C). A numerology conversation (i.e. C translated to absolute time) can be done for the case of the SCS between the source and target BWP is different.  Proposal 3: For the case of cross-BWP scheduling, the scheduling offset is not smaller than max (A, C). |
| DoCoMo [19] | Alt 1 |
| **Proposal 1:**   * **The applied scheduling restriction for DCI indicating cross-BWP scheduling is**   + **BWP switching delay, or**   + **max(BWP switching delay, active minimum scheduling offset in the active BWP before the BWP switch)**     - **SCS conversion for target BWP is needed for active minimum scheduling offset in the active BWP before the BWP switch.** |
| Qualcomm [20] | Alt 1 |
| Proposal 1: For indicating the scheduling offset in cross-BWP scheduling, the scheduling offset should be no smaller than the maximum of following factors:  • BWP switch delay  • Active minimum scheduling offset in the active DL BWP before the BWP switch (assuming numerology conversion for the target BWP if needed)  Observation 1: If Proposal 1 is adopted for determining scheduling offset in cross-BWP scheduling, there is no or little impact on the current Rel-16 specification.  Observation 2: The current Rel-16 specification for the minimum scheduling offset operation is generic and does not discern same-BWP scheduling and cross-BWP scheduling scenarios. |

## Remaining issue #2 for cross-BWP scheduling

In Table 2, companies’ views for issue #2 are summarized. The content of issue #2 and the list of supporting companies are also provided below:

|  |  |
| --- | --- |
| Issue #2: Whether and how to decide the applied minimum scheduling offset restriction for the slots after BWP switch and before the application delay is ended   1. **Alt 1**: Scaled K0min/K2min from source BWP: There may reuse the TP for issue #1 if the proposal is agreed    * Supporting companies (3): Apple, CMCC, Sony 2. **Alt 2**: The indicated K0min/K2min in target BWP: This is effectively to say only BWP switch delay is considered even when the application delay is longer. TP may be needed to clarify it.    * Supporting companies (7): CMCC, Ericsson, Intel, Nokia, OPPO, Spreadtrum, ZTE 3. **Alt 3**: The lowest-indexed RRC configuration of target BWP (some company think it belongs to the following agreement): TP needed for specifying the UE behavior  |  | | --- | | Agreements (RAN1 #98b):For an activated BWP without the 1-bit indication received in DCI for adapting the minimum applicable value of K0 (K2) for the BWP when there are one or two RRC configured values for the BWP, e.g., due to BWP switching triggered by BWP timer expiration, etc., the value applied for the BWP before the 1-bit indication is received within the BWP is determined by   * Option 2: The configured value if one value is RRC configured; The lowest-indexed RRC configured value if two values are RRC configured |  * + Supporting companies (2): DoCoMo, Intel  1. **Alt 4**: UE implementation (some companies think it is corner case that network can avoid): A conclusion can be decided independent from issue #1 and no TP needed.    * Supporting companies (5): CATT, Huawei, HiSilicon, MediaTek, Qualcomm, VIVO 2. **No issue by ensuring K0/K2 of cross-BWP scheduling always no smaller than application delay**    * Supporting companies (2): Samsung, LG |

By the above, Alt 2 has the highest number of supporting companies, and Alt 4 also has similar supporting company number. Since Alt 2, Alt 4 and the last item become the same if K0/K2 of cross-BWP scheduling can be always be no smaller than application delay, the way forward for this issue will depend on how K0min/K2min of source BWP is applied as per the discussions on Proposal 1 and Question 1. Therefore, the following proposal is suggested:

Proposal 2: The indicated K0min/K2min of target BWP is applied after BWP switch. Specify the TP, if necessary, based on the outcome of Proposal 1.

Table 2: Companies’ views on “whether and how to decide the applied minimum scheduling offset restriction for the slots after BWP switch and before the application delay is ended”

|  |  |
| --- | --- |
| Company name | Alt 1/2/3/4 |
| Suggested TP/proposal(s) or supporting reasons |
| Huawei, HiSilicon [3] | Alt4 |
| Proposal 3: Adopt the Alt.4 to leave the issue as UE implementation. |
| ZTE [4] | Alt 2 |
| Proposal 3: It is preferred that the minimum value indicated for the target BWP is applied right after UE finishes BWP switch |
| VIVO [5] | Alt 4 |
| Proposal 2: For Issue #2: Whether and how to decide the applied minimum scheduling offset restriction for the slots after BWP switch and before the application delay is ended, Alt 4 is preferred to minimize the spec impact. |
| OPPO [6] | Alt 2 |
| “In summary, it has to be take care by UE processing and UE should make sure it applies all the new setting after any BWP switching.” |
| Sony [7] | Alt 1 |
| Proposal 2: For the slots after BWP switch and before the application delay is ended, the applied minimum scheduling offset restriction should be: Alt 1: Scaled K0min/K2min from source BWP. |
| MediaTek [8] | Alt 4 (UE implementation and such cases can be avoided via gNodeB configuration. The following conclusion can be captured and no TP needed.) |
| Suggested conclusion  The scheduling offset restriction is not specified for the slot(s) after BWP switch and before the application delay is ended. For network, the ambiguity slot(s) can be avoided by confining the configured scheduling offset restrictions no larger than UE reported BWP switch delay. No RAN1 specification impact is needed. |
| LG [9] | No issue by ensuring BWP switch is ended ono earlier than application delay |
| Proposal 1: In cross-BWP scheduling, the scheduling offset is not smaller than Max (BWP switch delay, active minimum scheduling offset of the scheduling BWP) or (BWP switching delay + active minimum scheduling offset of the scheduling BWP).  Regarding issue #1 raised by a FL, in order to support both power saving techniques (i.e., PDCCH processing relaxation and extension of sleep duration) and maximize power saving gain by cross-slot scheduling, our proposal is that the minimum applicable K0/K2 of source BWP should be maintained until termination of BWP switching. If this proposal is agreed, there is no problem on issue #2. |
| Intel [10] | Alt2/Alt3 |
| Observation 1: PDCCH processing relaxation timeline is limited by BWP switching delay if UE supports cross-BWP scheduling.  Observation 2: Alt 1 poses artificial restriction on TDRA table configuration across all BWPs, forcing gNB to have correlated TDRA design for the BWPs.  Observation 3: Alt 4 causes uncertainty in scheduling after BWP switching forcing the UE to not operate in cross-slot scheduling mode.  Proposal 1: Select between Alt 2 or Alt 3 for application of minimum scheduling offset restriction in target BWP. |
| CATT [11] | Alt 4 |
| Proposal 2: Alternative 4 is the solution. The feature interaction between cross-slot scheduling and BWP switching is an implementation issue and no specification change. |
| Samsung [12] | No issue by ensuring BWP switch is ended ono earlier than application delay |
| Proposal 3: A UE does not expect to detect a DCI format 1\_1/0\_1 indicating BWP change with the corresponding TDRA field providing a slot offset value for a PDSCH/PUSCH that is smaller than X + Tbwp where X is an application delay for cross-slot scheduling and Tbwp is a delay required by the UE for an active BWP change.  If we consider proposal 3 that always ensures scheduling offset for cross-BWP scheduling larger than both Tbwp and X, the issue #2 never happens. |
| CMCC [13] | Alt 1 / Alt 2 |
| * Case 1. Keep the current application delay unchanged If the application delay cannot be revised, we think the combination of Alt 1 in issue #1 and Alt 1 in issue #2 is a better solution for scheduling offset restriction determination in case of cross-BWP switching. That is, the scheduling offset in the cross-BWP scheduling DCI should be no smaller than max(A,C). * Case 2. Take the BWP switch delay as the upper bound of application delay in case of cross-BWP switch:  If the application delay can be revised as no longer than BWP switch delay, we think the combination of Alt 2 in issue #1 and Alt 2 in issue #2 can be considered. That is, the scheduling offset in the cross-BWP scheduling DCI should be not smaller than A.   Proposal 3. If keeping the current application delay unchanged, the scheduling offset in the cross-BWP scheduling DCI should be not smaller than max(A,C), i.e., max(BWP switch delay, minimum scheduling offset in the source BWP before the BWP switch).  Proposal 4. If taking the BWP switch delay as the upper bound of application delay in case of cross-BWP switch, the scheduling offset in the cross-BWP scheduling DCI should be not smaller than A only (i.e., BWP switch delay). |
| Nokia [14] | [Alt 2] |
| Proposal 5: In case of cross-slot scheduling offset restriction and BWP switch, the scheduling slot offset restriction applies only to the scheduling of the target BWP (indicated by the DCI). |
| Spreadtrum [15] | Alt 2 |
| Proposal 2: The application delay of the change of minimum applicable K0/K2 is same as the BWP switch delay in cross-BWP scheduling. |
| Apple [16] | Alt 1 |
| Proposal 2: The target BWP should use a scaled K0min/K2min from source BWP for the slots after BWP switch and before the application delay is ended. |
| InterDigital [17] | N/A |
| Ericsson [18] | Alt 2 |
| Proposal 4: For the case of cross-BWP scheduling, the indicated minK0 value in DCI 1-1/0-1 of the target BWP is applied after BWP switching. |
| DoCoMo [19] | Alt 3 |
| Proposal 2:  For the slots after BWP switch and before the application delay is ended in cross-BWP scheduling when there are one or two RRC configured values for the target BWP, the value applied for the target BWP is determined by the configured value if one value is RRC configured; The lowest-indexed RRC configured value if two values are RRC configured. |
| Qualcomm [20] | Alt 4 |
| Proposal 2: It is up to UE implementation whether and how to decide the applied minimum scheduling offset restriction for the slots after BWP switch and before the end of application delay |

## Other remaining issues

In Table 3, the summarize companies’ views on other remaining issues to be addressed. Due to limited email capacity, the following two categories are highlighted:

1. Exception handling:
   * New exceptional cases relating to BFR (MediaTek, Nokia), C/CS/MCS-RNTI monitored in CSS type 3 if default TDRA table is applied (CMCC, Ericsson, [OPPO]), MsgB-RNTI (MediaTek, ZTE), SP-CSI-RNTI (Huawei, HiSilicon)
   * Error handling, including
     + UE falls back to lowest applicable value for Kmin when the UE detects an invalid entry in TDRA table by DCI format 0\_0 or 1\_0 (DoCoMo, MediaTek, Samsung, VIVO)
     + UE is not expected to receive at the same monitoring occasion DCI format 1-1 and format 0-1 with different 1-bit indications (MediaTek, VIVO)
2. Application delay:
   * uPDSCH 🡪 u\_DL\_active\_BWP: Huawei, HiSilicon, MediaTek
   * Y: Based on scheduled cell (working assumption; Nokia), based on scheduling cell (Huawei, HiSilicon, ZTE), , New formula (Samsung)
   * K0min = 0 if no configuration: Qualcomm, CATT
   * Numerology conversion with active BWP change: MediaTek, Qualcomm

Since application delay related issues are basically clarification, the category of exception handling is suggested for the email discussion in this meeting:

Proposal 3: Include issues related to exception handling in the email discussion for the maintenance of Rel-16 cross-slot scheduling power saving techniques.

Table 3: Companies’ views on other remaining issue(s) for cross-slot scheduling power saving

|  |  |
| --- | --- |
| Company name | Remaining issue(s) and suggested proposal(s)/TP |
| Huawei, HiSilicon [3] | 1. Proposal 2: In case of cross-carrier scheduling, the scheduling offset K0 or K2 indicated by the scheduling DCI should be restricted by the currently active K0min or K2min of the active BWP in the scheduling cell. 2. Proposal 4: Adopt the following Text Proposal to change the subscript of µPDSCH and modify the related description accordingly.  |  | | --- | | --------- Unchanged parts are omitted (Section 5.3.1 of TS 38.214-g10) --------  When the UE is scheduled with DCI format 0\_1 or 1\_1 with a [‘Minimum applicable scheduling offset indicator’]field, it shall determine the *K*0min and *K*2min values to be applied, while the previously applied *K*0min and *K*2min values are applied until the new values take effect after application delay. Change of applied minimum scheduling offset restriction indication carried by DCI in slot *n*, shall be applied in slot *n*+*X* of the scheduling cell.  When the DCI format 0\_1 or 1\_1 with [‘Minimum applicable scheduling offset indicator’**]** field indicating a change to the applied *K*0min or *K*2min is contained within the first three symbols of the slot, the value of application delay *X* is determined by, where *K*0minOld is the currently applied *K*0min value of the active DL BWP in the scheduled cell, *Zµ* is determined by the subcarrier spacing of the active DL BWP in the scheduling cell, and given in Table 5.3.1-1, *µ*PDCCH is the sub-carrier spacing configuration for PDCCH and *µ*active DL BWPis the sub-carrier spacing configuration for the active DL BWP in the scheduled cell.  -------------------------------- Unchanged parts are omitted ---------------------------- |      1. Proposal 5: Adopt the following Text Proposal to capture that the minimum scheduling offset K2min is applicable on DCI with CRC scrambled by SP-CSI-RNTI.  |  | | --- | | -------- Unchanged parts are omitted (Section 5.1.2.1 of TS 38.214-g10) ----------  When the UE configured with [*minimumSchedulingOffset*] in active UL BWP it applies a minimum scheduling offset restriction indicated by the [‘Minimum applicable scheduling offset indicator’] field in DCI format 0\_1 or 1\_1. When the UE configured with [*minimumSchedulingOffset*] in active UL BWP and it has not received [‘Minimum applicable scheduling offset indicator’] field in DCI format 0\_1 or 1\_1, the UE shall apply a minimum scheduling offset restriction indicated based on [‘Minimum applicable scheduling offset indicator’] value ‘0’. When the *minimum scheduling offset restriction* is applied the UE is not expected to be scheduled with a DCI in slot *n* to transmit a PUSCH scheduled with C-RNTI, CS-RNTI, MCS-C-RNTI or SP-CSI-RNTI with *K*2 smaller than the applicable minimum scheduling offset restriction *K*2min in slot *n*. The minimum scheduling restriction is not applied when PUSCH transmission is scheduled by RAR UL grant for RACH procedure, or when PUSCH is scheduled with TC-RNTI. The application delay of the change of the minimum scheduling offset restriction is determined in Section 5.3.1.  ---------------------------------- Unchanged parts are omitted ----------------------------- | |
| ZTE [4] | 1. Proposal 4: The K0min is not applied when PDSCH transmission is scheduled by DCI with MsgB-RNTI in type 1 common search space. Adopt the following text proposal.  |  | | --- | | ------------------------Text Proposal for 38.214 g10 clause 5.1.2.1-------------------  When the UE configured with [minimumSchedulingOffset] in an active DL BWP it applies a minimum scheduling offset restriction indicated by the [‘Minimum applicable scheduling offset indicator’] field in DCI format 0\_1 or 1\_1. When the UE configured with [minimumSchedulingOffset] in active DL BWP and it has not received [‘Minimum applicable scheduling offset indicator’] field in DCI format 0\_1 or 1\_1, UE shall apply a minimum scheduling offset restriction indicated based on [‘Minimum applicable scheduling offset indicator’] value ‘0’. When the minimum scheduling offset restriction is applied the UE is not expected to be scheduled with a DCI in slot n to receive a PDSCH scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI with K0 smaller than the applicable minimum scheduling offset restriction K0min. The minimum scheduling offset restriction is not applied when PDSCH transmission is scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI in common search space associated with CORESET0 and default PDSCH time domain resource allocation is used or when PDSCH transmission is scheduled with SI-RNTI or, RA-RNTI or MsgB-RNTI. The application delay of the change of the minimum scheduling offset restriction is determined in Section 5.3.1.  ------------------------------------ Unchanged parts are omitted -------------------------------- |      1. Application delay for cross-carrier scheduling case  |  | | --- | | ------------------------------- Text Proposal for 38.214 g10 clause -----------------------------  When the UE is scheduled with DCI format 0\_1 or 1\_1 with a ['Minimum applicable scheduling offset indicator']field, it shall determine the *K*0min and *K*2min values to be applied, while the previously applied *K*0min and *K*2min values are applied until the new values take effect after application delay. Change of applied minimum scheduling offset restriction indication carried by DCI in slot *n*, shall be applied in slot *n*+*X* of the scheduling cell.  For cross-carrier scheduling, if the slot definition of the scheduling cell is changed due to active BWP switch across different numerologies, the application delay should be converted to the slot definition corresponding to the new BWP’s numerology according to  before it is applied. µBWP,new and µBWP,old are the sub-carrier spacing configurations for the original BWP and new BWP,in the scheduling cell respectively.  The UE does not expect to be scheduled with DCI format 0\_1 or 1\_1 with ['Minimum applicable scheduling offset indicator'] field indicating another change to the applied *K0min* or *K2min* for the same active BWP before slot *n+X* of the scheduling cell.  ------------------------------------ Unchanged parts are omitted -------------------------------- |      1. Clarifications in TS 38.212  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | ------------------ Text Proposal for 38.212 g10 clause 7.3.1.1.2 and 7.3.1.2.2 ---------------  - Minimum applicable scheduling offset indicator – 0 or 1 bit  - 0 bit if higher layer parameter *minimumSchedulingOffset* is not configured;  - 1 bit if higher layer parameter *minimumSchedulingOffset* is configured. The 1 bit indication is used to determine the minimum scheduling offset restriction K0min for the active DL BWP and the minimum scheduling offset restriction K2min for the active UL BWP according to Table 7.3.1.1.2-33. If the minimum scheduling offset restriction K0min is indicated, the minimum applicable value of the aperiodic CSI-RS triggering offset for an active DL BWP shall be the same as the minimum scheduling offset restriction K0min.  ----------------- Text Proposal for 38.212 g10 clause 7.3.1.1.2 and 7.3.1.2.2 ----------------  ---------------------- Text Proposal for 38.212 g10 clause 7.3.1.1.2 ------------------------  Table 7.3.1.1.2-33: Joint indication of minimum scheduling offset restriction K0min/K2min   |  |  |  | | --- | --- | --- | | Bit field mapped to index | Minimum scheduling offset restriction K0min  for the active DL BWP, if *minimumSchedulingOffset* is configured for the DL BWP | Minimum scheduling offset restriction K2min  for the active UL BWP, if *minimumSchedulingOffset* is configured for the UL BWP | | 0 | The first value configured by *minimumSchedulingOffset* for the active DL BWP | The first value configured by *minimumSchedulingOffset* for the active UL BWP | | 1 | The second value configured by *minimumSchedulingOffset* for the active DL BWP if the second value is configured; 0 otherwise | The second value configured by *minimumSchedulingOffset* for the active UL BWP if the second value is configured; 0 otherwise |   ---------------------- Text Proposal for 38.212 g10 clause 7.3.1.1.2 ------------------------ | |
| VIVO [5] | 1. Proposal 3: UE applies lowest indexed minimum scheduling offset when the UE detects an invalid entry in TDRA table at least in fallback DCI.      1. Proposal 4: UE is not expected to receive at the same monitoring occasion DCI format 1-1 and format 0-1 with different 1-bit indications. 2. Proposal 5: Upon detecting PDCCH WUS indicating UE to wake up in the upcoming DRX OnDuration, UE automatically switch to same-slot scheduling in the upcoming DRX OnDuration. This mechanism can be switched on/off by network. 3. Proposal 6: If PDCCH WUS for CDRX is not configured, upon UE receives new transmission in DRX OnDuration, UE automatically switch to same-slot scheduling. This mechanism can be switched on/off by network. |
| OPPO [6] | 1. “we propose to exclude all DCI by RNTI applied with a default PDSCH TDRA table from the application range of minimum k0” 2. “For the PDCCH monitoring case1-2 and case2, only the Zu values are extended from PDCCH monitoring case 1-1. However, all cases share the same formula as PDCCH monitoring case 1-1. The current text should be modified to correctly reflect it.” |
| Sony [7] | Proposal 3: [editorial] Apply consistent subscripting of K0min / K2min in section 5.3.1 of TS38.214. |
| MediaTek [8] | 1. Exceptional case and error handling related issues, including impact to BFR procedure, impact to Msg-B related procedure, and inconsistent joint indication. Suggested TP as follows:  |  | | --- | | -------- Unchanged parts are omitted (Section 5.1.2.1 of TS 38.214-g10) ----------  When the UE configured with [*minimumSchedulingOffset*] in an active DL BWP it applies a minimum scheduling offset restriction indicated by the **[**'Minimum applicable scheduling offset indicator']field in DCI format 0\_1 or 1\_1. UE does not expect to receive at the same monitoring occasion DCI format 1-1 and format 0-1 with different values in ['Minimum applicable scheduling offset indicator'] field. When the UE configured with [*minimumSchedulingOffset*] in active DL BWP and it has not received ['Minimum applicable scheduling offset indicator'] field in DCI format 0\_1 or 1\_1, UE shall apply a minimum scheduling offset restriction indicated based on ['Minimum applicable scheduling offset indicator'] value '0'. When the *minimum scheduling offset restriction* is applied the UE is not expected to be scheduled with a DCI in slot *n* to receive a PDSCH scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI with *K*0 smaller than the applicable minimum scheduling offset restriction *K*0min. The minimum scheduling offset restriction is not applied when PDSCH transmission is scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI in common search space associated with CORESET0 and default PDSCH time domain resource allocation is used or when PDSCH transmission is scheduled with C-RNTI or MCS-C-RNTI a search space set provided by recoverySearchSpaceId or when PDSCH transmission is scheduled with SI-RNTI or RA-RNTI or MsgB-RNTI. The application delay of the change of the minimum scheduling offset restriction is determined in Clause 5.3.1.  ---------------------------------- Unchanged parts are omitted ----------------------------- |  1. Application delay related issues, including numerology conversion and clarifications. Suggested TP as follows:  |  | | --- | | ----------- Unchanged parts are omitted (Section 5.1.2.1 of TS 38.214-g10) ----------  When the UE is scheduled with DCI format 0\_1 or 1\_1 with a ['Minimum applicable scheduling offset indicator']field, it shall determine the *K*0min and *K*2min values to be applied, while the previously applied *K*0min and *K*2min values are applied until the new values take effect after application delay. Change of applied minimum scheduling offset restriction indication carried by DCI in slot *n*, shall be applied in slot *n*+*X* of the scheduling cell. The UE does not expect to be scheduled with DCI format 0\_1 or 1\_1 with ['Minimum applicable scheduling offset indicator'] field indicating another change to the applied *K0min* or *K2min* for the same active BWP before slot *n+X* of the scheduling cell. If there is active BWP change indicated in or after slot *n* for the scheduling cell, numerology conversion is applied to slot time *n+X* in case of numerology change in the scheduling cell.  When the DCI format 0\_1 or 1\_1 with ['Minimum applicable scheduling offset indicator'**]** field indicating a change to the applied *K*0min or *K*2min is contained within the first three symbols of the slot, the value of application delay *X* is determined by, where *K*0minOld is the currently applied *K*0min value of the active DL BWP in the scheduled cell~~,~~; If K0min value is not configured for the active DL BWP in the scheduled cell, *K0minOld* is assumed to take the value zero. ~~and~~ *Zµ* is determined by the subcarrier spacing of the active DL BWP in the scheduling cell, and given in Table 5.3.1-1 and *µ*PDCCH and *µ*PDSCH are the sub-carrier spacing configurations for PDCCH and ~~PDSCH~~ the active DL BWP of the scheduled cell, respectively  -------------------------------- Unchanged parts are omitted ------------------------------- | |
| LG [9] | Proposal 3: The adaptation on the minimum applicable value of K0 does not apply to C-/CS-/MCS-C-RNTI monitored in any search space set associated with any CORESET if default TDRA table is applied. |
| Intel [10] | Proposal 4: DCI format 0\_2/1\_2 does **not** include ['Minimum applicable scheduling offset indicator'] field. |
| CATT [11] | 1. Proposal 3: The recoverySearchSpace ID would be used for scheduling indication of PDSCH carrying RAR in beam recovery and won’t be used for DCI format 1\_1 with CRC scrambled by C-RNTI or MCS-C-RNTI. There is no support of the minimum scheduling offset field.      1. Proposal 4: for the application delay, it needs to clarify that K0min is assumed to be zero when there is no value configured in the scheduling CC. 2. Proposal 5: UE should fall back to lowest index of minimum scheduling offset if UE is indicated invalid TDRA entry by DCI format 0\_0 or 1\_0. 3. Proposal 6: it is an implementation issue that UE does not expect to receive at the same monitoring occasion DCI format 1-1 and format 0-1 with different 1-bit indications. 4. It support that the CSI-RS triggering offset value range is extended from {0, 1, 2, 3, 4, 16, 24} to {0, 1,2,3,4,5,6…16, 24} slots. 5. Proposal 8: it should configure the minimum scheduling offset in UE side to support both same-carrier scheduling and cross-carrier scheduling. 6. Proposal 9: The minimumSchedulingOffset includes ‘minimumSchedulingOffsetK0-r16’ and ‘minimumSchedulingOffsetK2-r16’. 7. Proposal 10: DCI format 0-2/1-2 does not support the1-bit indication of cross-slot scheduling. 8. Proposal 11: it is not expected to adaptation on the minimum applicable value of K0 for type3 CSS. 9. Proposal 12: time minimum scheduling offset restriction is not applied when PDSCH transmission is scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI in common search space associated with CORESET0 and default PDSCH time domain resource allocation is used or when PDSCH transmission is scheduled with SI-RNTI or RA-RNTI or P-RNTI. |
| Samsung [12] | 1. Proposal 4: UE falls back to lowest applicable value for Kmin when the UE detects an invalid entry in TDRA table by DCI format 0\_0 or 1\_0. 2. Proposal 5: For cross-carrier scheduling, the application delay is defined as X = max(Y, Z), and Y is the minimum applicable value of K0 among all scheduled cells, such that Y = min{ ⌊Kmin,i\*2^(u^PDCCH-u^i ) ⌋} where    * Kmin,i is the current applicable value of Kmin for the active BWP on a scheduled cell with carrier indicator of i    * u^PDCCH and u^i are the subcarrier spacing configurations for the active BWP on scheduled cell i and scheduling cell, respectively.      1. Proposal 6: The adaptation on the minimum applicable value does not apply to C/MCS-C/CS-RNTI when the UE monitors PDCCH candidates corresponding to C-RNTI, MCS-C-RNTI, or CS-RNTI in the one or more search space sets in a slot where the UE monitors PDCCH candidates for at least a DCI format 0\_0 or a DCI format 1\_0 with CRC scrambled by SI-RNTI, RA-RNTI or P-RNTI. |
| CMCC [13] | Proposal 5. The adaptation on the minimum applicable value of K0 does not apply to C/CS/MCS-RNTI monitored in any common search space (of type 0/0A/1/2/3) if default TDRA table is applied. |
| Nokia [14] | 1. Proposal 1: The minimum scheduling offsets is not applied when monitoring C-RNTI or MCS-C-RNTI on recoverySearchSpaceId.  |  | | --- | | ----------- Unchanged parts are omitted (Section 5.1.2.1 of TS 38.214-g10) ----------  When the UE configured with ~~[~~*minimumSchedulingOffset*~~]~~ in an active DL BWP it applies a minimum scheduling offset restriction indicated by the ~~[‘Minimum applicable scheduling offset indicator’~~*‘Minimum applicable scheduling offset indicator’*~~]~~ field in DCI format 0\_1 or 1\_1. When the UE configured with ~~[~~*minimumSchedulingOffset*~~]~~ in active DL BWP and it has not received ~~[‘Minimum applicable scheduling offset indicator’]~~*‘Minimum applicable scheduling offset indicator’* field in DCI format 0\_1 or 1\_1, UE shall apply a minimum scheduling offset restriction indicated based on ~~[‘Minimum applicable scheduling offset indicator’]~~ *‘Minimum applicable scheduling offset indicator’* value ‘0’. When the minimum scheduling offset restriction is applied the UE is not expected to be scheduled with a DCI in slot n to receive a PDSCH scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI with K0 smaller than the applicable minimum scheduling offset restriction K0min. The minimum scheduling offset restriction is not applied when PDSCH transmission is scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI in common search space associated with CORESET0 and default PDSCH time domain resource allocation is used or when PDSCH transmission is scheduled with C-RNTI or MCS-C-RNTI a search space set provided by *recoverySearchSpaceId,* or when PDSCH transmission is scheduled with SI-RNTI or RA-RNTI. The application delay of the change of the minimum scheduling offset restriction is determined in Section 5.3.1.  ---------------------------------- Unchanged parts are omitted --------------------------------  ----------- Unchanged parts are omitted (Section 6.1.2.1 of TS 38.214-g10) ----------  When the UE configured with ~~[~~*minimumSchedulingOffset*~~]~~ in active UL BWP it applies a minimum scheduling offset restriction indicated by the [‘Minimum applicable scheduling offset indicator’] ~~]~~*‘Minimum applicable scheduling offset indicator’* field in DCI format 0\_1 or 1\_1. When the UE configured with ~~[~~*minimumSchedulingOffset*~~]~~ in active UL BWP and it has not received ~~[‘Minimum applicable scheduling offset indicator’] ]~~*‘Minimum applicable scheduling offset indicator’* field in DCI format 0\_1 or 1\_1, the UE shall apply a minimum scheduling offset restriction indicated based on [‘Minimum applicable scheduling offset indicator’] value ‘0’. When the *minimum scheduling offset restriction* is applied the UE is not expected to be scheduled with a DCI in slot *n* to transmit a PUSCH scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI with *K*2 smaller than the applicable minimum scheduling offset restriction *K*2min in slot *n*. The minimum scheduling restriction is not applied when PUSCH transmission is scheduled by RAR UL grant for RACH procedure, or when PUSCH is scheduled with TC-RNTI, or when PUSCH is scheduled with C-RNTI or MCS-C-RNTI a search space set provided by *recoverySearchSpaceId*. The application delay of the change of the minimum scheduling offset restriction is determined in Section 5.3.1.  ---------------------------------- Unchanged parts are omitted -------------------------------- |      1. Proposal 3: From PDSCH and PUSCH scheduling perspective the minimum scheduling offset restriction can be applied to Type3-CSS with C-RNTI, CS-RNTI and MCS-C-RNTI (if configured). UE behaviour related to other DCI formats configured to Type3-CSS should neither be impacted nor delayed. 2. Confirm the working assumption on determination of Y value for application delay 3. Proposal 7: Support applying minimum scheduling offset restriction of K2 to A-SRS so that UE can expect that DCI would not trigger transmission of A-SRS resource(s) with slotOffset<K2min. 4. Proposal 9: Same single suggested value is applicable both in case of cross-carrier scheduling as well as in same-carrier scheduling. 5. Proposal 10: Support cross-slot scheduling also for the new Rel-16 DCI formats 0\_2 and 1\_2 and adopt following TPs to TS 38.212 and 38.214: |
| Spreadtrum [15] | 1. Proposal 3: Add a note under the table 7.3.1.1.2-33: The number of candidate values of minimum applicable K0 and K2 are the same, if configured.      1. Proposal 4: Change the parameter minimumSchedulingOffset in physical specification into minimumSchedulingOffsetK0 and minimumSchedulingOffsetK2 accordingly. 2. Proposal 5: Remove the square brackets for DCI field name Minimum applicable scheduling offset indicator in 38.214. |
| Apple [16] | N/A |
| InterDigital [17] | 1. Proposal 1: When the UE is scheduled with a DCI to receive a PDSCH scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI with K0 smaller than the applicable minimum scheduling offset restriction K0min, UE shall apply a minimum scheduling offset restriction indicated based on ['Minimum applicable scheduling offset indicator'] value '0'. 2. Proposal 2: When the UE is scheduled with a DCI to transmit a PUSCH scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI with K2 smaller than the applicable minimum scheduling offset restriction K2min, UE shall apply a minimum scheduling offset restriction indicated based on ['Minimum applicable scheduling offset indicator'] value '0'. 3. Proposal 3: When the UE is triggered by CSI triggering state indicated by the CSI request field in DCI in which CSI-RS triggering offset is smaller than the currently applicable minimum scheduling offset restriction K0min, UE shall apply a minimum scheduling offset restriction indicated based on ['Minimum applicable scheduling offset indicator'] value '0'. |
| Ericsson [18] | 1. Proposal 1: Adopt TP1 for 38.214, subclause 5.2.1.5.1 to allow aperiodic CSI triggering offset to better match the allowed range of minK0 value.  |  | | --- | | <begin TP1>  When aperiodic CSI-RS is used with aperiodic reporting, the CSI-RS offset is configured per resource set by the higher layer parameter aperiodicTriggeringOffset. The CSI-RS triggering offset has the values of ~~{0, 1, 2, 3, 4, 16, 24}~~ {0, 1,2,3,4,5,6…16, 24} slots. If the UE is not configured with [minimumSchedulingOffset] for any DL or UL BWP and if all the associated trigger states do not have the higher layer parameter qcl-Type set to 'QCL-TypeD' in the corresponding TCI states , the CSI-RS triggering offset is fixed to zero. The aperiodic triggering offset of the CSI-IM follows offset of the associated NZP CSI-RS for channel measurement.  <end TP1> |  1. Proposal 2: Adopt TP2 for 5.2.1.5.1a, 38.214 to add min K0 restriction text explicitly  |  | | --- | | <begin TP2>  When the minimum scheduling offset restriction is applied, UE is not expected to be triggered by CSI triggering state indicated by the CSI request field in DCI in which CSI-RS triggering offset is smaller than the currently applicable minimum scheduling offset restriction *K*0min.  <end TP2> |      1. Proposal 5: The adaptation on the minimum applicable value of K0 does not apply to C/CS/MCS-RNTI monitored in CSS type 3 if default TDRA table is applied.      1. Proposal 6: In cross-carrier scheduling with mixed numerology, the UE suggested minK0 (or minK2) value represents the suggested value for the scheduled carrier based on the scheduled carrier SCS. |
| DoCoMo [19] | Proposal 3: UE should fall back to lowest index of minimum scheduling offset if UE is indicated invalid TDRA entry by DCI format 0\_0 or 1\_0. |
| Qualcomm [20] | 1. Proposal 3: For a time quantity (X) defined in slots (i.e. the application delay, as well as K0min and K2min) corresponding to the original active BWP’s numerology, if the slot definition is changed due to active BWP switch across different numerologies, the time quantity should be converted to the slot definition corresponding to the new BWP’s numerology according to before it is applied. 2. Proposal 4: For application delay determination, if K\_0min is not configured for the currently active DL BWP, K\_0minOld=0 is assumed in the expression for application delay determination. 3. Proposal 5: For cross-carrier scheduling, the maximum value (i.e. 16) of the range of the minimum scheduling offset should be supported as one of the UE suggested values. |

## Suggested threads for email discussion

By the above summaries and analysis, the following two threads are suggested for email discussion on cross-slot scheduling adaptation. Further adjustment on the items and scopes for each thread can be further discussed in the preparation email thread.

Proposal 4: The following two email threads are suggested for the maintenance of Rel-16 cross-slot scheduling power saving techniques:

1. **Issues related to active BWP change:**
   * **Issue #1: Whether and how to apply the currently active minimum scheduling offset restriction in the case of cross-BWP scheduling?**
   * **Issue #2: Whether and how to decide the applied minimum scheduling offset restriction for the slots after BWP switch and before the application delay is ended?**
   * **Issue #3: Numerology conversion for application delay in case of active BWP change in the scheduling cell**
2. **Issues related to exception handling:**
   * **Issue #1: Additional exceptional cases, including BFR, MsgB-RNTI, C/CS/MCS-RNTI monitored in CSS type 3 if default TDRA table is applied, SP-CSI-RNTI, etc.**
   * **Issue #2: Error handling if UE receives both DCI format 1\_1 and format 0\_1 with inconsistent values in the 1-bit indications**
   * **Issue #3: Error handling when the UE detects an invalid TDRA entry by DCI format 0\_0/1\_0**

After further preparation phase discussion, the following are finally decided by chairman:

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| [100b-e-NR-UE\_pow\_sav-Cross\_Slot-01] Email discussion/approval to resolve Issues related to active BWP change   * Issue #1: Whether and how to apply the currently active minimum scheduling offset restriction in the case of cross-BWP scheduling? * Issue #2: Whether and how to decide the applied minimum scheduling offset restriction for the slots after BWP switch and before the application delay is ended? * Issue #3: Clarification of numerology conversion in case of active BWP change * Note: Consider proposal(s) to jointly resolve the above three issues   Till 4/24, with potential TP for approval till 4/29 (MTK, Weide) |
| [100b-e-NR-UE\_pow\_sav-Cross\_Slot-02] Email discussion/approval to resolve Issues related to exception handling:   * Issue #1: Additional exceptional cases, including BFR, MsgB-RNTI, C/CS/MCS-RNTI monitored in CSS type 3 if default TDRA table is applied, SP-CSI-RNTI, etc. * Issue #2: Error handling if UE receives both DCI format 1\_1 and format 0\_1 with inconsistent values in the 1-bit indications * Issue #3: Error handling when the UE detects an invalid TDRA entry by DCI format 0\_0/1\_0 * Issue #4: Whether and how resolve the inconsistency between the range of A-CSI triggering offset and that of K0min   Till 4/24, with potential TP for approval till 4/29 (MTK, Weide) |

# Summary for the Email Discussion Threads

In this section, the selected email discussion will be summarized, including proposals, companies’ views, decisions, and final TPs.

## [100b-e-NR-UE\_pow\_sav-Cross\_Slot-01] Email discussion/approval to resolve Issues related to active BWP change

This section is for the following email discussion:

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| --- |
| [100b-e-NR-UE\_pow\_sav-Cross\_Slot-01] Email discussion/approval to resolve Issues related to active BWP change   * Issue #1: Whether and how to apply the currently active minimum scheduling offset restriction in the case of cross-BWP scheduling? * Issue #2: Whether and how to decide the applied minimum scheduling offset restriction for the slots after BWP switch and before the application delay is ended? * Issue #3: Clarification of numerology conversion in case of active BWP change * Note: Consider proposal(s) to jointly resolve the above three issues   Till 4/24, with potential TP for approval till 4/29 (MTK, Weide) |

To achieve the goal, the following phases are suggested:

* **Phase-I (Now 4/19 – 22 pm 4/21 PST)**: Collection of companies’ views on the proposals to jointly resolve issues #1, #2 and #3
* Phase-II (5 am 4/22 – 5 pm 4/24 PST): Converge the proposal to jointly resolve issues #1, #2 and #3
* Phase-III (22 pm 4/27 – 5 pm 4/29 PST): Converge TP for the consensus proposal

For Phase-I, let us first review the conditions we have so far:

* Majority support for issue #1 is Alt 1: **Agree and to clarify how K0min/K2min of source BWP is applied to target BWP of cross-BWP scheduling**
* Majority support for issue #2 is Alt 2: **The indicated K0min/K2min in target BWP is applied since the slot of PDSCH scheduled by the cross-BWP scheduling**
* For BWP switch, the compliance of BWP switch delay in RAN1 specification follows Section 12 of TS 38.213, as quoted below. The selected K0/K2 value of the cross-BWP scheduling determines the time duration UE doesn’t need to receive or transmit, and R15 specification only consider BWP switch delay in the selection of K0/K2 for cross-BWP scheduling.

|  |
| --- |
| <Section 12 of TS 38.213>  A UE does not expect to detect a DCI format 1\_1 or a DCI format 0\_1 indicating respectively an active DL BWP or an active UL BWP change with the corresponding time domain resource assignment field providing a slot offset value for a PDSCH reception or PUSCH transmission that is smaller than **a delay required by the UE for an active DL BWP change or UL BWP change [10, TS 38.133]**.  If a UE detects a DCI format 1\_1 indicating an active DL BWP change for a cell, the UE is **not required to receive or transmit** in the cell during a time duration from the end of the third symbol of a slot where the UE receives the PDCCH that includes the DCI format 1\_1 in a scheduling cell until the beginning of a slot indicated by the slot offset value of the time domain resource assignment field in the DCI format 1\_1.  If a UE detects a DCI format 0\_1 indicating an active UL BWP change for a cell, the UE is **not required to receive or transmit** in the cell during a time duration from the end of the third symbol of a slot where the UE receives the PDCCH that includes the DCI format 0\_1 in the scheduling cell until the beginning of a slot indicated by the slot offset value of the time domain resource assignment field in the DCI format 0\_1. |

* In addition to BWP switch delay, the following R16 text in Section 5.3.1 of TS 38.214 looks allowing “the previously applied K0min and K2min” to be considered for the K0/K2 section of cross-BWP scheduling, as quoted below. This is also the argument point since some companies think our previous agreements only specify the applicability of K0min/K2min to the active BWP. In this meeting we should clarify the expected UE behavior for cross-BWP scheduling.

|  |
| --- |
| <Section 5.3.1 of TS 38.214>  When the UE is scheduled with DCI format 0\_1 or 1\_1 with a ['Minimum applicable scheduling offset indicator']field, it shall determine the *K*0min and *K*2min values to be applied, **while the previously applied *K*0min and *K*2min values are applied until the new values take effect after application delay**. Change of applied minimum scheduling offset restriction indication carried by DCI in slot *n*, shall be applied in slot *n*+*X* of the scheduling cell. The UE does not expect to be scheduled with DCI format 0\_1 or 1\_1 with ['Minimum applicable scheduling offset indicator'] field indicating another change to the applied *K0min* or *K2min* for the same active BWP before slot *n+X* of the scheduling cell. |

For cross-BWP scheduling, If K0min/K2min of source BWP is applied to the selection of K0/K2, there can still appear ambiguity slot(s) if application delay is longer than the selected K0/K2. Bellow illustrates an example of UL BWP switch with BWP switch delay = 6 slots, K2min = 6 slots, and K0min = 8 slots, where the application delay based on K0min is 8 slots (larger than BWP switch delay of 6 slots). According to current spec wording, K2min of source BWP should still be applied for the ambiguity slot, but it conflicts with the majority view (Alt 2) of issue #2, i.e., K2min of target BWP should be appliedsince the slot of PDSCH scheduled by the cross-BWP scheduling. Note that one consideration for Alt 2 of issue #2 is that there may be no valid entry in TDRA of target BWP that can comply with K2min of source BWP. One possible solution is to restrict the definition of application delay only to same-BWP scheduling.

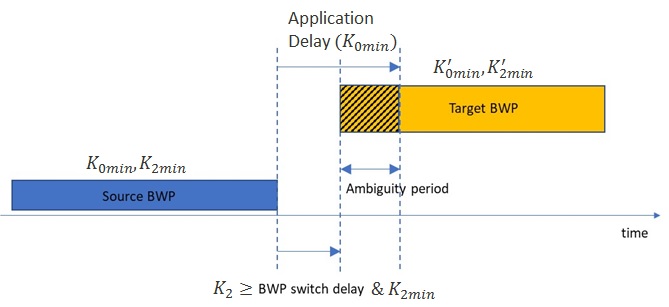


Figure 1: UL BWP switch case with application delay of cross-slot scheduling   
longer than BWP switch delay and K2min of source BWP

For the minimal specification impact, the following proposals are suggested for further discussion:

* **Proposal A (accommodates both majorities views)**: For cross-BWP scheduling,
  + K0/K2 selection is restricted by K0min/K2min of source BWP in addition to BWP switch delay
  + **Current application delay value (X) is defined only for same-BWP scheduling**, and K0min/K2min of target BWP is always appliedsince the slot of PDSCH scheduled by the cross-BWP scheduling (**R15 behavior**).
    - Discuss whether to specify application delay for cross-BWP scheduling in TP phase
  + Numerology conversion is applied to K0min/K2min in case of numerology change between target BWP and source BWP. It also applies to application delay when there is numerology change after an application delay is started (e.g., numerology change in the scheduling cell after a cross-carrier scheduling that changes K0min/K2min of a scheduled cell)
  + Note: Potential TP is as follows (reference only; **not to be decided in phase-I**):

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| --- |
| (Revision to 1st paragraph of Section 5.3.1 of TS 38.214 )  When the UE is scheduled with DCI format 0\_1 or 1\_1 with a ['Minimum applicable scheduling offset indicator'] field, it shall determine the K0min and K2min values to be applied, while the previously applied K0min and K2min values are applied until the new values take effect ~~after application delay~~. Change of applied minimum scheduling offset restriction ~~indication~~ for the same active BWP carried by DCI in slot n, shall be applied in slot n+X of the scheduling cell. The UE does not expect to be scheduled with DCI format 0\_1 or 1\_1 with ['Minimum applicable scheduling offset indicator'] field indicating another change to the applied K0min or K2min for the same active BWP before slot n+X of the scheduling cell.  … (Unchanged paragraphs are omitted)…  (Additional paragraph in Section 5.3.1) For a time quantity (X) defined in slots (i.e. the application delay, as well as *K*0min and *K*2min) corresponding to the original active BWP’s numerology, if the slot definition is changed due to active BWP switch across different numerologies, the time quantity should be converted to the slot definition corresponding to the new BWP’s numerology according to before it is applied. |

* **Proposal B (prioritizes the majority view of issue #1)**: For cross-BWP scheduling,
  + K0/K2 selection is restricted by K0min/K2min of source BWP in addition to BWP switch delay
  + **K0min/K2min is applied to the slot(s) after BWP switch and before the application delay (based on K0min) is ended, if available**
  + Numerology conversion is applied to K0min/K2min in case of numerology change between target BWP and source BWP. It also applies to application delay when there is numerology change after an application delay is started (e.g., numerology change in the scheduling cell after a cross-carrier scheduling that changes K0min/K2min of a scheduled cell)
  + Note: This proposal will **not** follow the majority view of issue #2. But the target is minimized specification impact with the majority view of issue #1. Potential TP is as follows (reference only; not to be decided in phase-I):

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| --- |
| (Additional paragraph in Section 5.3.1) For a time quantity (X) defined in slots (i.e. the application delay, as well as *K*0min and *K*2min) corresponding to the original active BWP’s numerology, if the slot definition is changed due to active BWP switch across different numerologies, the time quantity should be converted to the slot definition corresponding to the new BWP’s numerology according to before it is applied. |

* **Proposal C (prioritizes the majority view of issue #2)**: For cross-BWP scheduling,
  + **K0/K2 selection is only restricted by BWP switch delay (R15 behavior)**
  + **Current application delay value (X) is defined only for same-BWP scheduling**, and K0min/K2min of target BWP is always appliedsince the slot of PDSCH scheduled by the cross-BWP scheduling (**R15 behavior**).
    - Discuss whether to specify application delay for cross-BWP scheduling in TP phase
  + Numerology conversion is needed only for application delay if there is numerology change after an application delay is started (e.g., numerology change in the scheduling cell after a cross-carrier scheduling that changes K0min/K2min of a scheduled cell)
  + Note: Potential TP is as follows (reference only; not to be decided in phase-I):

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| (Revision to 1st paragraph of Section 5.3.1 of TS 38.214 )  When the UE is scheduled with DCI format 0\_1 or 1\_1 with a ['Minimum applicable scheduling offset indicator'] field, it shall determine the K0min and K2min values to be applied in the active DL and UL BWPs, while the previously applied K0min and K2min values are applied until the new values take effect after application delay. Change of applied minimum scheduling offset restriction ~~indication~~ for the same active BWP carried by DCI in slot n, shall be applied in slot n+X of the scheduling cell. The UE does not expect to be scheduled with DCI format 0\_1 or 1\_1 with ['Minimum applicable scheduling offset indicator'] field indicating another change to the applied K0min or K2min for the same active BWP before slot n+X of the scheduling cell. Numerology conversion is applied to slot time n+X in case of numerology change in the scheduling cell. |

Please help to provide your views on Proposals A, B and C **by 22pm 4/21 PST**. Supporting multiple proposals is allowed but not encouraged.

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| Company name | Views on Proposals A, B and C. Please provide your specific proposal/TP if none of the proposals are supported by you. |
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## [100b-e-NR-UE\_pow\_sav-Cross\_Slot-02] Email discussion/approval to resolve Issues related to exception handling

This mail is to kick off the following email discussion:

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| [100b-e-NR-UE\_pow\_sav-Cross\_Slot-02] Email discussion/approval to resolve Issues related to exception handling:   * Issue #1: Additional exceptional cases, including BFR, MsgB-RNTI, C/CS/MCS-RNTI monitored in CSS type 3 if default TDRA table is applied, SP-CSI-RNTI, etc. * Issue #2: Error handling if UE receives both DCI format 1\_1 and format 0\_1 with inconsistent values in the 1-bit indications * Issue #3: Error handling when the UE detects an invalid TDRA entry by DCI format 0\_0/1\_0 * Issue #4: Whether and how resolve the inconsistency between the range of A-CSI triggering offset and that of K0min   Till 4/24, with potential TP for approval till 4/29 (MTK, Weide) |

To achieve the goal, the following phases are suggested:

* **Phase-I (Now 4/19 – 22 pm 4/21 PST)**: Collection of companies’ views on issues #1, #2, #3 and #4
* Phase-II (5 am 4/22 – 5 pm 4/24 PST): Converge the proposals for issues #1, #2, #3 and #4
* Phase-III (22 pm 4/27 – 5 pm 4/29 PST): Converge TP(s) for the proposal(s) with specification impact

Please help to provide your valuable views in the following tables corresponding to issues #1 - #4 **by 22pm 4/21 PST**:

* **For issue #1**, new exceptional cases are suggested, including BFR (R1-2002219), MsgB-RNTI (R1-2001584), C/CS/MCS-RNTI monitored in CSS type 3 if default TDRA table is applied (R1-2002216, R1-2002415), SP-CSI-RNTI (R1-2001540). In the following table, please provide your views on whether and what exceptional case(s) you think necessary to be include.

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| --- | --- |
| Company name | Company view for issue #1 |
| Panasonic | Basically, it is reasonable to include the cases using default TDRA table into the exceptional cases. |
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* **For issue #2**, error handling if UE receives both DCI format 1\_1 and format 0\_1 with inconsistent values in the 1-bit indications in the same slot is suggested for further discussion (R1-2001683). One possible solution is to add a sentence “UE doesn’t expect to receive different [‘Minimum applicable scheduling offset indicator’] value indicated by DCI format 1\_1 and format 0\_1 at the same monitoring occasion” In Section 5.1.2.1 of TS 38.214. On the other hand, some companies think the following text in Section 5.3.1 of TS 38.214 already resolves such error case: “The UE does not expect to be scheduled with DCI format 0\_1 or 1\_1 with ['Minimum applicable scheduling offset indicator'] field indicating another change to the applied K0min or K2min for the same active BWP before slot n+X of the scheduling cell”. In the following table, please provide your views on whether and how to resolve the error case.

|  |  |
| --- | --- |
| Company name | Company view for issue #2 |
| Panasonic | Firstly, whether inconsistent values are deemed as error case should be concluded. As there are only two value for 1-bit indication, if one DCI indicates current K0\_min/K2\_min and the other DCI indicates the different K0\_min/K2\_min, UE can just start to change the minimum scheduling offset. So far, the UE operation is no problem in our understanding.  If this is deemed as an error case, in general, the current specification can not cover it, as two indications are assumed to be transmitted in the same monitoring occasion. Thus it is difficult to justify which indication is the first one. |
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* **For issue #3**, there are multiple companies (R1-2001683, R1-2002143, R1-2002452) suggesting error handling when the UE detects an invalid TDRA entry from DCI format 0\_0/1\_0. In current specification, the scheduling offset restriction can be indicated via DCI format 0\_1 or 1\_1. If UE is indicated once, it will keep the active K0min and K2min until next change is applied, according to the text quoted from Section 5.3.1 of TS 38.214:

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| When the UE is scheduled with DCI format 0\_1 or 1\_1 with a ['Minimum applicable scheduling offset indicator']field, it shall determine the *K*0min and *K*2min values to be applied, **while the previously applied *K*0min and *K*2min values are applied until the new values take effect after application delay** |

Before a change indication, if UE receives a fallback DCI indicating an invalid TDRA entry, whether UE needs to perform some special behavior is to be decided. One example is that UE approaches cell boundary and can only receive DCI format 0\_0/1\_0. Then DCI format 0\_0/1\_0 becomes one solution for gNodeB to align UE’s setting for cross-slot scheduling. In the following table, please provide your view in whether and how to specify a special UE behavior if UE detects invalid TDRA entry from DCI format 0\_0/1\_0.

|  |  |
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| Company name | Company view for issue #3 |
| Panasonic | As discussed long time before, the indication is protected by HARQ-ACK. So the error can rarely happen. Even if happened, self-recovery is also possible after certain period and gNB can also choose most “secured” TDRA table entry by implementation to avoid the possible error continuously happening once receiving more NACKs than expected. |
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* **For issue #4**, it is suggested to align the range of A-CSI triggering offset with that of K0min (R1-2002415) so that network can avoid any conflict in supporting both features. In the following table, please provide your view in whether and how to align the ranges of the two parameters.

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| Company name | Company view for issue #4 |
| Panasonic | This is okay. |
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# Summary

In this document, companies’ views related to the maintenance of Rel-16 cross-slot scheduling power saving techniques are summarized and analyzed. In particular, the following are provided:

**Proposal 1: For cross-BWP scheduling, K0min/K2min of source BWP is applied to restrict the selection of the scheduling offset. Further consolidate the details based on companies’ views on Question 1.**

**Question 1: For the cross-BWP scheduling that triggers active UL BWP change, if application delay is different from scaled K2min, what factor(s) should be considered for the selection of scheduling offset K2?**

* **Example case: UL BWP switch with BWP switch delay of 6 slots, K2min of 6 slots, and K0min of 8 slots. Assume no numerology change after BWP switch, should K2 be larger than 6 slots (K2min) or 8 slots (application delay based on K0min)?**

**Proposal 2: The indicated K0min/K2min of target BWP is applied after BWP switch. Specify the TP, if necessary, based on the outcome of Proposal 1.**

**Proposal 3: Include issues related to exception handling in the email discussion for the maintenance of Rel-16 cross-slot scheduling power saving techniques.**

**Proposal 4: The following two email threads are suggested for the maintenance of Rel-16 cross-slot scheduling power saving techniques:**

1. **Issues related to active BWP change:**
   * **Issue #1: Whether and how to apply the currently active minimum scheduling offset restriction in the case of cross-BWP scheduling?**
   * **Issue #2: Whether and how to decide the applied minimum scheduling offset restriction for the slots after BWP switch and before the application delay is ended?**
   * **Issue #3: Numerology conversion for application delay in case of active BWP change in the scheduling cell**
2. **Issues related to exception handling:**
   * **Issue #1: Additional exceptional cases, including BFR, MsgB-RNTI, C/CS/MCS-RNTI monitored in CSS type 3 if default TDRA table is applied, SP-CSI-RNTI, etc.**
   * **Issue #2: Error handling if UE receives both DCI format 1\_1 and format 0\_1 with inconsistent values in the 1-bit indications**
   * **Issue #3: Error handling when the UE detects an invalid TDRA entry by DCI format 0\_0/1\_0**

# References

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2. R1-2001211, “Summary#2 for Cross-Slot Scheduling Power Saving Techniques”, MediaTek Inc., RAN1#100b-e
3. R1-2001540, “Remaining issues on cross-slot scheduling based power saving”, Huawei, HiSilicon, RAN1#100b-e
4. R1-2001584, “Remaining issues on cross-slot scheduling power saving techniques”, ZTE, RAN1#100b-e
5. R1-2001683, “Maintenance of procedure of cross-slot scheduling power saving techniques “, vivo, RAN1#100b-e
6. R1-2001769, “Remaining issues for cross-slot scheduling”, OPPO, RAN1#100b-e
7. R1-2001820, “Remaining issues on cross-slot scheduling for UE power saving”, Sony, RAN1#100b-e
8. R1-2001844, “Remaining issues on cross-slot scheduling adaptation”, MediaTek, RAN1#100b-e
9. R1-2001944, “Remaining issues on procedure of cross-slot scheduling power saving techniques”, LG Electronics, RAN1#100b-e
10. R1-2002009, “Remaining details of cross-slot scheduling power saving techniques”, Intel, RAN1#100b-e
11. R1-2002094, “Remaining issues on Power saving scheme with cross-slot scheduling”, CATT, RAN1#100b-e
12. R1-2002143, “Remaining issues for cross-slot scheduling power saving techniques”, Samsung, RAN1#100b-e
13. R1-2002216, “Remaining issues on cross-slot scheduling adaptation in cross-BWP scheduling”, CMCC, RAN1#100b-e
14. R1-2002219, “Procedure of cross-slot scheduling power saving techniques, Nokia, Nokia Shanghai Bell, RAN1#100b-e
15. R1-2002258, “Remaining issues on cross-slot scheduling”, Spreadtrum Communications, RAN1#100b-e
16. R1-2002343, “Remaining Issues on Cross-Slot Power Save”, Apple, RAN1#100b-e
17. R1-2002367, “Remaining Issues for Cross-Slot Scheduling for UE Power Saving”, InterDigital, RAN1#100b-e
18. R1-2002415, “Remaining issues for cross-slot scheduling “, Ericsson, RAN1#100b-e
19. R1-2002452, “Maintenance for procedure of cross-slot scheduling power saving techniques”, NTT DOCOMO, INC., RAN1#100b-e
20. R1-2002556, “Remaining issues in cross-slot scheduling power saving”, Qualcomm Incorporated, , RAN1#100b-e