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

**April 20th – April 30th , 2020**

Agenda Item: 7.2.7.2

Source: Moderator (MediaTek)

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 scheduling1. **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 delayC. 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 ended1. **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 conclusionThe 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 unchangedIf 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 K0minfor the active DL BWP, if *minimumSchedulingOffset* is configured for the DL BWP | Minimum scheduling offset restriction K2minfor 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:

|  |
| --- |
| [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:

|  |
| --- |
| [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 or PUSCH 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 PUSCH 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 or PUSCH 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**):

|  |
| --- |
| (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):

|  |
| --- |
| (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 or PUSCH 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):

|  |
| --- |
| (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.

|  |  |  |
| --- | --- | --- |
| Company name | Suggested propoasl | Views on Proposals A, B and C. Please provide your specific proposal/TP if none of the proposals are supported by you. |
| Nokia | A, B | We can agree to Proposal A or compromise to Proposal B: * restricting the slot offset in the source BWP DCI by maximum of BWP switching delay and applied (source) K0min/K2min.
* As the BWP switch interruption definition being defined by K0/K2 in DCI (1\_1/1\_0), following proposal A would appear simplest.
 |
| OPPO | C | We don’t think the application delay can go cross BWPs. Even it can be interpreted to that by the current text, it is not right for real case. If the BWP already switched, then it should be tuned up. We are still prefer proposal C. |
| ZTE | C | Our preference is proposal 3. In addition to K0 indicated by the scheduled DCI,K2 should also be considered. Therefore, we have some suggestions for Proposal C .o Application delay is defined only for same-BWP scheduling, and K0min/K2min indicated for target BWP is always applied since the slot of PDSCH or PUSCH scheduled by the cross-BWP scheduling(R15 behavior) |
| Huawei, HiSilicon | A (without numerology conversion for application delay) | We prefer the Proposal A among the three proposals. However, we think the numerology conversion does not need to be applied on the application delay. For the scheduling offset, it is explicitly indicated by the TDRA field in the scheduling DCI, which is in a number of slots. Therefore, it is essential to convert the minimum scheduling offset from the slot number in source BWP to the slot number in target BWP. However, regarding the application delay, it is a delay for UE to apply the indicated new value. The absolute time point corresponding to the application delay is clear for the UE, and it does not need to be converted to a slot number with respective to different subcarrier spacing. UE can implement to apply the indicated value just after the time point corresponding to the application delay. Therefore, we propose to delete the numerology part for application delay in proposal A, and agree the revised proposal A.* ***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 applied**since 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****):*
 |
| Intel | C | First, please update our support for Alt2, not Alt 3, in issue 1.We think the statement “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.” in the paragraph above Fig 1 is not accurate. Scheduling offset is no smaller than K0min/K2min, if restricted as such, and hence, application delay cannot exceed K0.In our view, a UE is configured with multiple BWPs for a reason, each has its own purpose. For example, UE may switch from a BWP that has lower power consumption (e.g. having larger minK0 value) to a BWP which is more suitable for data transmission (e.g. having smaller minK0 value) so that data can be delivered fast and UE may transition to a smaller BWP sooner from power saving perspective. We have concern on applying source BWP K0min/K2min to obtain K0/K2 for scheduling in target BWP. This possibly requires all configured DL or UL BWPs of a UE to have correlated TDRA design and there must be a set of entries in TDRA table of each BWP where K0/K2 is no smaller than configured K0min/K2min of all the BWPs, assuming the flexibility of switching between all configured BWPs by DCI. For example, if existing K0min is 4 in source BWP, then TDRA table of target BWP requires to have some entries of K0 being 4 or larger. Note that the impact of correlated TDRA table is not just limited to cross-BWP scheduling, it also affects same BWP scheduling since some entries of K0/K2 (e.g., those that intend to match K0min/K2min of other BWPs) may not serve the purpose of switching to that BWP, e.g., a larger BWP where smaller values of K0/K2 may be more desirable, and this leads to inefficient TDRA design. A preferable configuration of TDRA table of a larger BWP could include smaller values of K0/K2 only, such as 0, 1, 2 etc. While we understand the intention to have fixed PDCCH to PDSCH gap, in our view BWP switch delay, which is the dominant factor, is expected to cover this purpose to a decent extent. BWP switching by DCI is not a frequent event in our view and hence, BWP switch delay as the gap suffices. Note that if larger gap is desired, UE can be operated with type 2 BWP switch delay. It is questionable what power saving gain is at stake here if K0/K2 in cross-BWP scheduling is only limited by BWP switch delay. Considering the impacts, we do not support the options that include “K0/K2 selection is restricted by K0min/K2min of source BWP”, i.e., Proposal A and B.We support proposal C. We think Rel15 behavior is sufficient for choosing K0/K2 in cross-BWP scheduling DCI. As the UE has to decode DCI by BWP switching time anyways, UE should be able to assume indicated K0min/K2min in target BWP for PDCCH reception. Numerology conversion issue, if at all needed, can be discussed after confirming the first two bullets of the proposals, depending on which one is agreed. In our view, numerology conversion may not be needed at least for Proposal C because application delay does not span two BWPs.Also, we think application delay, based on the definition in spec, should be limited to same BWP scheduling only. This is because there is no scheduling to be done between the DCI that provides cross-BWP scheduling and PDSCH delivery in target BWP, i.e., application of any existing scheduling restriction is not meaningful. |
| SONY | A | Preference: **Proposal A**Comments on proposals:Proposal B:* “K0 min / K2min is applied to the slots after BWP switch and before the application delay…”. Presumably this refers to the K0min / K2min in the source BWP. Although this was our preference in our Tdoc (R1-2001820), we would be OK to apply the K0min / K2min in the target BWP (proposal A).

Proposal C:* Our issue here is that the UE will have to decode PDCCH according to min(BWP switching delay, K0min/K2min of source BWP), which might make the cross-slot scheduling rules redundant for cells with a small BWP switching delay

We note that it appears that none of the proposals support relaxed PDCCH processing, since there is no change to the BWP switch delay (the UE needs to be able to monitor PDCCH in the target BWP immediately after the BWP switch delay or from when PDSCH is received in the target BWP). If an implementation were to wish to do relaxed PDCCH monitoring, it seems like it would have to “compress” the RF tuning aspects etc of the BWP switching operation.  |
| IDCC | A | We think Option A may be sufficient to resolve the issue. |
| Qualcomm | B, A (without “**Current application delay value (X) is defined only for same-BWP scheduling**”) | We support Proposal B, and can compromise to a modified Proposal A without “**Current application delay value (X) is defined only for same-BWP scheduling**”, which should be discussed and agreed separately and in conjunction with the original Issue #2. In fact, rather than the proposals A-C listed above, we think it is more logical to continue discussion with the original Issue #1 and Issue #2. If Alt 1 for Issue #1 is accepted, Issue #2 is a corner case, which is related to UL BWP switching as described in the text above Figure 1 in this FL summary. (However, the blue text corrected by the FL doesn’t look accurate to us. The issue is more related to UL BWP switching, i.e., PUSCH scheduled by cross-BWP scheduling, not PDSCH. ZTE also made similar comment above)The corner case can be avoided by network implementation (e.g., proper configuration of K2min such that it is always larger than or equal to K0min). However, if the corner case could really happen, Proposal B is more consistent in the sense that both the min scheduling offset restriction and application delay are determined by the scheduling BWP regardless of same and cross-BWP scheduling.We don’t think the statement in Proposal A and C, “the current application delay value (X) is defined only for same-BWP scheduling” is equivalent to the original Issue #2, and we do not follow how this proposal came about to become a key idea among two of the proposals for selection. We think the statement should be discussed and agreed separately, and not necessarily have to be part of Proposal A or C; Instead it should be discussed further together with Issue #2. The original description in the summary can be used instead, with some clarification:* Majority support for issue #2 is Alt 2: **The indicated K0min/K2min in target BWP is applied ~~to the slot(s) after BWP switch~~ since the slot of PDSCH/PUSCH scheduled by the cross-BWP scheduling and before the application delay is ended**

Similarly, the text in Proposal B can be revised: * **K0min/K2min of source BWP is applied ~~to the slot(s)~~ since the slot of PDSCH/PUSCH scheduled by the cross-BWP scheduling ~~after BWP switch~~ and before the application delay (based on K0min of source BWP) is ended, if available**
 |
| Spreadtrum  | A  | We prefer the Proposal A. Regarding the numerology conversion, we share the same view with HW, numerology conversion does not need to be applied on the application delay.  |
| MediaTek | C | Our preference is Proposal C since R15 behavior with proper UE reported BWP switch delay is sufficient for UE power saving. For network where R15 BWP framework has been deployed, BWP switch mechanism based on UE reported BWP switch delay is also implemented. To minimize the impact to existing network and UE implementations, keeping R15 behavior for cross-BWP scheduling case will also minimize the change effort for migrating to R16.  |
| vivo | Other (still prefer Alt 1 in Issue#1 and Alt 4 in Issue#2)  | The original Alt 1 in Issue#1 and Alt 4 in Issue#2 is our first preference. However, so far it is not on the list A,B,C. The reason is that the original Alt 1 in issue #1 because if currently active minimum scheduling offset restriction does not apply in the case of cross-BWP scheduling, UE cannot save power because that UE cannot know it is cross-BWP or same-BWP scheduling until the DCI is decoded. For issue #2, also alt 2 is slightly majority compared to other alt 4, but we would like to have more clarification on how does it work since this is effectively to say only BWP switch delay is considered even when the application delay is longer. Actually, the application delay is being shortened.On the other hand, we think the application delay for Cross-carrier scheduling and cross-BWP scheduling should be jointly considered, and retrieve to keep alignment between those two.Among A, B, C, we would like to hear more opinions on some modifications to allow Alt 1 in Issue#1 and Alt 4 in Issue#2. |
| Ericsson  | A, C (with that the K0min/K2min indicated for the target BWP in the BWP switching DCI is always appliedright after BWP switching) | We are OK with modified proposal A or modified proposal C – with modification that the K0min/K2min indicated for the target BWP in the BWP switching DCI is always appliedright after BWP switching. Otherwise, the UE assumption K0min/K2min in the slots after BWP switching (and until slot of PDSCH scheduled) would be unclear and this is not desirable from NW perspective. We agree the application delay is defined only for same-BWP scheduling.  |
| LG | A | Our preference is the proposal A. Regarding the proposal C, a UE may not achieve power saving gain when minimum K0/K2 is larger than BWP switch delay, because the UE should perform PDCCH processing considering BWP switch regardless of same/cross-BWP scheduling. |
| CATT | C | Our preference is the proposal C. This could be avoided by good gNB implementation. If gNB expects to trigger BWP switching, gNB could delay the scheduling after the completion of the BWP switching. We are fine to have no conclusion on this issue and leave to gNB implementation.  |
| CMCC | B, C | We are fine with Proposal B or C.Regarding Proposal A, same as Proposal C, the new K0min/K2min is actually applied since the slot of PDSCH scheduled by the cross-BWP scheduling (R15 behavior), which means UE needs to decode the received PDCCH as soon as possible so that UE can switch to the target BWP in time once the PDCCH carries a cross-BWP scheduling DCI. It also means that even the DCI is actually a same-BWP scheduling DCI, UE still needs to decode it as soon as possible, which means no PDCCH processing relaxation gain can be exploited. In that case, there is no big difference whether K0/K2 selection is restricted by K0min/K2min of source BWP in addition to BWP switch delay (i.e. Proposal A) or K0/K2 selection is only restricted by BWP switch delay (R15 behavior, i.e. Proposal C), since even with Proposal A UE still cannot guarantee the PDCCH only needs to be decoded before K0min/K2min of source BWP when K0min/K2min of source BWP is larger than BWP switch delay. Therefore, in this case we prefer Proposal C to keep the same behavior as in R15.Regarding Proposal B, UE can exploit some PDCCH processing relaxation gain compared with Proposal C when K0min/K2min of source BWP is larger than BWP switch delay. However, some companies may have concern since there is some cross relationship between source BWP and target BWP, i.e., K0min/K2min is applied to the slot(s) after BWP switch and before the application delay (based on K0min) is ended when K0min/K2min of source BWP is larger than BWP switch delay.Regarding Proposal B and Proposal C, we do not have strong view, either one is OK for us. If some companies have strong concern on the cross relationship between source BWP and target BWP in Proposal B, maybe Proposal C can be a way forward. |
| NTT DOCOMO | A, C | We prefer proposal A or proposal C.Regarding numerology conversion, we are wondering why numerology conversion needs to be applied to the application delay, although the application delay is defined only for same-BWP scheduling. Does it mean the new application delay for cross-BWP scheduling, i.e., scheduling offset for PDSCH/PUSCH? |
| Samsung  | A (numerology conversion due to the SCS change in the scheduling cell is not needed) | We prefer the Proposal A. We also think the parts related to the numerology conversion due to the SCS change in the scheduling cell is not needed. It seems enough to clarify that the SCS of the PDCCH corresponds the SCS of the BWP where the UE receives the PDCCH. We have updated Proposal A as below:* **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 or PUSCH 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)~~
	+ Clarify that for determining application delay, the SCS of PDCCH corresponds to the SCS of the BWP where the UE receives the PDCCH.
	+ Note: Potential TP is as follows (reference only; **not to be decided in phase-I**):

It seems TP for 38.213 below is needed to complete this CR?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] and minimum applicable scheduling offset.  |
| Panasonic | A, B (to have sum(K0min/K2min, BWP switch delay) for K0/K2) | To make it clear on how UE behaves to achieve power saving gain and deal with cross-BWP scheduling properly, here is our understanding:* UE does not know whether the DCI triggers BWP switch or not until it decodes the DCI. So no matter the DCI triggers BWP switch or not, UE shall following the K0min/K2min to deal with the PDCCH processing timeline
* After UE decodes DCI,
	+ If same BWP scheduling, there is no problem
	+ If cross-BWP scheduling, UE needs to start perform BWP switching.
* The K0/K2 slot offset should be able to cover the duration for all the potential UE operation.

Thus the safest option is to have sum(K0min/K2min, BWP switch delay) for K0/K2, particular for cross-BWP scheduling. **Although feature lead clarified the intention of Proposal A and B is max(K0min/K2min, BWP switch delay), we think it would be good to keep it open under the expression of “K0/K2 selection is restricted by K0min/K2min of source BWP in addition to BWP switch delay”.** Because otherwise none of the proposals addresses the problem and UE always needs to decode the PDCCH immediately after receiving PDCCH.So we support Proposal A and can compromise to Proposal B with the above understanding. |
|  |  |  |

By the above companies’ views, the following statistics can be obtained:

|  |  |
| --- | --- |
| Proposal (#support companies) | Supporting companies |
| Proposal A (12) | Nokia, HW, HiSilicon, Sony, IDCC, QC, Spreadtrum, Ericsson, LG, DoCoMo, SS, Panasonic* HW, HiSilicon, SS: No need of numerology conversion for application delay
* QC: To discuss how to implement majority view of issue #2 without “Current application delay value (X) is defined only for same-BWP scheduling”
* Ericsson: To ensure the indicated K0min/K2min of target BWP is applied right after BWP switch
* Panasonic: K0/K2 of cross-BWP scheduling should be no smaller than K0min/K2min of source BWP + BWP switch delay
 |
| Proposal B (4) | Nokia, QC, CMCC, Panasonic |
| Proposal C (8) | OPPO, ZTE, Intel, MTK, Ericsson\*, CATT, CMCC, DoCoMo |
| Other (1) | VIVO: Prefer Alt 1 in Issue#1 and Alt 4 in Issue#2 |

To move forward, we suggest to consolidate Proposal A in phase-II discussion by 5 pm 4/24 PST:

Proposal:

For cross-BWP scheduling,

* K0/K2 is no smaller than max(K0min/K2min of source BWP (converted to target BWP numerology if needed), BWP switch delay)
* K0min/K2min of target BWP is always applied since the slot of PDSCH or PUSCH scheduled by the cross-BWP scheduling, i.e., current application delay value (X) is defined only for same-BWP scheduling.
	+ Discuss whether and how to specify application delay for cross-BWP scheduling
* 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)
	+ Discuss whether not to apply numerology conversion on the application delay

## [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:

|  |
| --- |
| [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.

|  |  |  |  |
| --- | --- | --- | --- |
| Company name | Supported case | Objected case  | Company view for issue #1 |
| Panasonic | Type3-CSS w/ default TDRA |  | Basically, it is reasonable to include the cases using default TDRA table into the exceptional cases. |
| Nokia | BFR,MsgB-RNTI,Type3-CSS w/ default TDRA, SP-CSI-RNTI |  | We are fine to apply exception cases to all; BFR, MsgB-RNTI and whenever default TDRA is applied as well as SP-CSI-RNTI.  |
| OPPO | Type3-CSS w/ default TDRA |  | We support the defining the exception case for type3 CSS with default table, or, extend that for all other SS with default table.  |
| ZTE | BFR,MsgB-RNTI,Type3-CSS w/ default TDRA, SP-CSI-RNTI |  | We are okay to include BFR, MsgB-RNTI, SP-CSI-RNTI as exceptional cases.Regarding the cases when default table is used, we think at least type 3 CSS should be considered. And we are okay to further extend to any case that default table is used. |
| Huawei, HiSilicon | BFR,SP-CSI-RNTI | Type3-CSS w/ default TDRA | Please find following our views on the exceptional cases:* BFR: we think it is reasonable.
* C/CS/MCS-RNTI monitored in CSS type 3 if default TDRA table is applied: If the network configures minimum scheduling offset restriction for a UE, why does the network not configure TDRA table for Type3 CSS? This seems a corer case.
* SP-CSI-RNTI: we support it.
 |
| Intel | BFR,MsgB-RNTI,Type3-CSS w/ default TDRA, SP-CSI-RNTI |  | We are fine to support the cases |
| IDCC | BFR,MsgB-RNTI,Type3-CSS w/ default TDRA, SP-CSI-RNTI |  | We are fine to apply the exception cases. |
| Qualcomm | BFR (only during BFR window) | Type3-CSS w/ default TDRA, SP-CSI-RNTI | * We partially agree that it is beneficial to exclude BFR search space. However, we think the exception should be applied only during the BFR process, not all the time. That is, during the BFR window (configured by BeamFailureRecoveryConfig), the exception can be applied. Otherwise, the exception is not applied.
* For C/CS/MCS-RNTI monitored in Type3 CSS, we share the same view as Huawei/HiSilicon. If the network wants to attain power saving gain by cross-slot scheduling, it would configure common or dedicated TDRA table for Type3 CSS.
* In our view, SP-CSI-RNTI should NOT be an exception of K2min application, because it is transmitted in the USS.
 |
| Spreadtrum | BFR,MsgB-RNTI,SP-CSI-RNTI |  | We are fine to include BFR, MsgB-RNTI, SP-CSI-RNTI as exceptional cases. |
| MediaTek | BFR,MsgB-RNTI, | Type3-CSS w/ default TDRA, SP-CSI-RNTI | We support additional exceptional case for BFR and MsgB-RNTI since the portion of occasions for such cases is limited. On the other hand, we are not supportive to exclude C/CS/MCS-RNTI monitored in Type3 CSS with default TDRA table is applied and SP-CSI-RNTI since these exception cases can cause UE not being able to apply cross-slot scheduling. |
| Ericsson | BFR,MsgB-RNTI,Type3-CSS w/ default TDRA |  | OK to add exception for case of default TDRA table, including for Type-3 CSS and to BFR, MsgB-RNTI. |
| LG | BFR,MsgB-RNTI,Type3-CSS w/ default TDRA, SP-CSI-RNTI |  | Regarding the exceptional cases, we are fine to apply the proposed cases as exceptional cases. In addition to those cases, USS with default TDRA table could be included. So, our proposal is that the adaptation on the minimum applicable value of K0 does not apply to C-/CS-/MCS-C-RNTI monitored **in any search space type (i.e., CSS/USS) associated with any CORESET if default TDRA table is applied**. |
| CATT | BFR,MsgB-RNTI (with default TDRA table) |  | We are fine with the exception cases for BFR and MsgB-RNTI with default TDRA table. However, UE does not expect to decode other DCI as in Clause 10.1 of 38.213If a UE is provided - one or more search space sets by corresponding one or more of *searchSpaceZero, searchSpaceSIB1*, *searchSpaceOtherSystemInformation*, *pagingSearchSpace*, *ra-SearchSpace*, or a CSS set by *PDCCH-Config*, and - a SI-RNTI, a P-RNTI, a RA-RNTI, a MsgB-RNTI, a SFI-RNTI, an INT-RNTI, a TPC-PUSCH-RNTI, a TPC-PUCCH-RNTI, or a TPC-SRS-RNTIthen, for a RNTI from any of these RNTIs, the UE does not expect to process information from more than one DCI format with CRC scrambled with the RNTI per slot. |
| CMCC | BFR,MsgB-RNTI,Type3-CSS w/ default TDRA, SP-CSI-RNTI |  | We are supportive about the new exceptional cases in this issue. |
| NTT DOCOMO | BFR,MsgB-RNTI,Type3-CSS w/ default TDRA, SP-CSI-RNTI |  | We are fine to add the exceptional cases. |
| Samsung | BFR,MsgB-RNTI,Type3-CSS w/ default TDRA  | SP-CSI-RNTI | Our views are as below:* BFR: We agree that it is beneficial but don’t think this is essential one. Beam failure event would be rarely happen and even if the beam failure happens, the latency incensement due to the minimum slot offset will be marginal.
* Default TDRA table: We are okay for all other SS with default table.
* SP-CSI-RNTI: We don’t think this is necessary. There is no motivation to exclude this case.

It seems our proposal for the additional exceptional case in R1-2002149 is missed as below:* when the UE monitors PDCCH candidates for the C-RNTI, CS-RNTI, or MCS-C-RNTI in the one or more search space sets 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

We think above case should be excluded since a UE does not know whether the DCI format is for C/MCS-C/CS-RNTI or SI/RA/P-RNTI before finishing decoding. |
|  |  |  |  |

By the above companies’ inputs, the following statistics can be obtained:

|  |  |  |
| --- | --- | --- |
| Additional exceptional case | Yes | No |
| BFR | Nokia, ZTE, HW, HiSilicon, Intel, IDCC, QC, Spreadtrum, MTK, Ericsson, LG, CATT, CMCC, DoCoMo, SS |  |
| MsgB-RNTI | Nokia, ZTE, Intel, IDCC, Spreadtrum, MTK, Ericsson, LG, CATT, CMCC, DoCoMo, SS |  |
| Type3-CSS with default TDRA | Panasonic, Nokia, OPPO, ZTE, Intel, IDCC, Ericsson, LG, CMCC, DoCoMo, SS | HW, HiSilicon, QC, MTK,  |
| SP-CSI-RNTI | Nokia, ZTE, HW, HiSilicon, Intel, IDCC, Spreadtrum, LG, CMCC, DoCoMo, | QC, MTK, SS |

Since there is no objection for BFR and MsgB-RNTI, the following proposal is suggested for phase-II:

Proposal:

The minimum scheduling offset restriction is not applied 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 MsgB-RNTI.

* **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 | Specify this error handling? | Company view for issue #2 |
| Panasonic | Neutral | 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.  |
| Nokia  | Neutral | Firstly, we think that this is an error case (inconsistent NW behavior), for which we should not define any special UE behavior. Then in felt beneficial we can introduce wording to specification clarifying that UE does not need to support inconsistent indication in a monitoring occasion. |
| OPPO | Yes (revise text of previous TP) | We had agreements that we will not receive another indication of K0min/K2min before the application delay. We thought this can be covered by the agreements. Unfortunately, I realized the last meeting, TP is not accepted as I suggest. The way I propose is to slight modify the text in 214. Say:”UE does not expect change of Kmin indication from the current occasion to the application delay.” |
| ZTE | No | We think this case can be avoided by implementation. |
| Huawei, HiSilicon | Yes | If inconsistent indications for the minimum scheduling offset are received at the same monitoring occasion, it must be the case where one value of 0 is received in one scheduling DCI and meanwhile the other value of 1 is also received in another scheduling DCI in the same slot. We only have two values that can be indicated by 1-bit ['Minimum applicable scheduling offset indicator'] field, therefore, if one value is considered as a change of minimum scheduling offset, the other value must be the same one corresponding to the current applicable minimum scheduling offset in the slot, which is clearly not ‘another change’. Therefore, we don’t think the current description of “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 specification can cover this issue. We are fine 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. |
| Intel  | No | This is gNB misconfiguration and chance of which happening is very slim to zero. Special UE behavior is usually not captured in spec due to inconsistent NW behavior. There can be many different combinations of wrong/inconsistent scheduling decisions, and UE behaviors for such cases are not specified. We do not think anything needs to be captured for this case. Note that spec supports the behavior that UE discards a DCI format if inconsistent information is identified.  |
| SONY | Neutral | Sending inconsistent values of K0min / K2min seems like a gNodeB implementation error that shouldn’t happen. If companies are really concerned about this error scenario, our preference would be the addition of the sentence suggested by the FL: “*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*” |
| IDCC | Yes | We are fine with adding “UE doesn’t expect to receive different [‘Minimum applicable scheduling offset indicator’] values indicated by DCI format 1\_1 and format 0\_1 at the same monitoring occasion”. |
| Qualcomm | Yes (revise text of previous TP) | We think the current spec text can cover the case with some clarification:“The UE does not expect to be scheduled with DCI format 0\_1 or 1\_1 with an inconsistent value of ['Minimum applicable scheduling offset indicator'] field from the value in slot n indicating the ~~another~~ change to the applied K0min or K2min for the same active BWP on or after slot n and before slot n+X of the scheduling cell”. |
| Spreadtrum | Yes | We also think this is an error case, and the current specification cannot cover it. Regarding the TP, we are fine with the sentence suggested by FL: “*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*” |
| MediaTek | Yes | We support to specify this error handling since it allows UE to proceed the restriction change after detecting the indication from the first DCI; otherwise, UE cannot do anything before the consistency check across all related DCIs. Compared with interpreting or revising current spec text to include this error handling, a separated sentence is clear and preferred. |
| Vivo | Yes | Regarding Section 5.3.1 of TS 38.214: “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”, we think this is mainly for inconsistent indication of minK0/K2 in DCIs of different slots/MOs. However, the new issue raised here is for the inconsistent indication of minK0/K2 in DCIs of same slot/MO.We think adding a sentence in spec can solve this issue: **UE is not expected to receive at the same monitoring occasion DCI format 1-1 and format 0-1 with different ['Minimum applicable scheduling offset indicator'] indications.** |
| Ericsson | No | We don’t see a need to add more clarification as this error case (handled by NW implementation) can be handled using following text in 38.213. *If a UE detects a DCI format with inconsistent information, the UE discards all the information in the DCI format.* |
| CATT | No | The inconsistent information is an implementation issue and does not need to further resolve this issue.  |
| CMCC | No | We think the current spec “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” can cover this error case. Therefore, no additional UE behaviour need to be defined. |
| NTT DOCOMO | Yes | We are not sure whether or not the current specification can cover the same monitoring occasion case. We are fine to add the new sentence. |
| Samsung | No | We share the same view with Nokia - It is just an error case and does not need to capture in the spec. |
|  |  |  |

From the above table, companies’ views are diverse in making the specification change for this error case, as shown below:

|  |  |
| --- | --- |
| Specify this error handling? | Company list |
| Yes (9) | OPPO, HW, HiSilicon, IDCC, QC, Spreadtrum, MTK, VIVO, DoCoMo |
| Neutral (3) | Panasonic, Nokia, Sony,  |
| No (6) | ZTE, Intel, Ericsson, CATT, CMCC, SS |

Therefore, it is suggested that we capture a conclusion without specification change:

Conclusion:

At the same monitoring occasion, network should ensure the same value in ['Minimum applicable scheduling offset indicator'] field of DCI format 1-1 and that of format 0-1, if both transmitted.

* Note: No specification change
* **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:

|  |
| --- |
| 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.

|  |  |  |
| --- | --- | --- |
| Company name | Specify this error handling? | Company view for issue #3 |
| Panasonic | No | 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. |
| Nokia | Neutral | We don’t have a strong view if UE behavior needs to be captured in specification, but if captured in purpose of minimizing the missed detection impact, UE behavior should be such that it would fall to smallest applicable K0min/K2min values (i.e. zero or larger).  |
| OPPO | No | We do not see this is a problem to be solved. If the scheme choose, network should be able to fallback to some k by intentionally indicate the “wrong” TDRA? |
| ZTE | Yes (Prefer fallback to same slot scheduling) | If UE detects invalid TDRA entry from DCI format 0\_0/1\_0, it means the understanding of minimum value between gNodeB and UE is not aligned, we are okay to clarify UE’s behavior. The following alternatives have been proposed in the previous meetings.ALT1: fall back to same slot scheduling. ALT2: use the K value indicated in TDRA entry as the minimum valuesALT3: use the default minimum values.From our perspective, to make sure that the subsequent data can be transmitted correctly, ALT 1 is preferred.Regarding ALT 2, as the indicated K value is no smaller than the actual minimum value. UE may need to update the minimum value again if another DCI indicate a smaller K value in TDRA entry.As to ALT3, when UE realizes the indicated TDRA entry from DCI format 0\_0/1\_0 is invalid, it always means that the K value in the indicated TDRA entry is smaller than the minimum value at the UE side, UE need to update the minimum value to a smaller one to receive data transmission. However, the default K value can not be always guaranteed to be the smaller one.  |
| Huawei, HiSilicon | No | When UE detects invalid TDRA entry from DCI format 0\_0/1\_0, we think it can be two cases:Case 1): This detected DCI is a false detection.Case 2): The UE is a bad coverage and the network decide to use fallback DCI to schedule the UE. This also means a DCI format 1\_0/1\_1 with scheduling offset indication may be miss-detected by the UE.For the above two cases, the UE can always fallback to use the smaller scheduling offset. This can always resume the reception of PDSCH and transmission of PUSCH after the invalid TDRA entry is detected. However, it seems this can be a UE implementation, and some justification is needed to specify it. |
| Intel | No | Again, we do not see anything to be captured for this purpose. RAN1 97 agreement below seems to cover this sufficiently, i.e., UE does not expect to receive invalid entry and it is not limited to any given DCI format. Such events, e.g., back to back DCI miss-detection, may happen rarely and at least based on HARQ-ACK feedback, gNB can adjust indication accordingly, as Panasonic also mentioned. Agreements:When UE is indicated of the minimum applicable value of K0 (K2) for an active DL (UL) BWP, the application method to the selection of a DL (UL) TDRA entry is to be decided from:* An entry in the active DL (UL) TDRA table with K0 (K2) value smaller than the indicated minimum is not expected by or not valid for the UE for the TDRA indication(s)

  |
| SONY | Yes | When the UE receives DCI 0\_0 / 1\_0 with an invalid TDRA entry, the UE should use the minimum RRC configured values of K0min / K2min. The scenario described above (by the FL) is one where the gNB intentionally signals an invalid TDRA entry using DCI 1\_0 when the UE is at the cell edge. The scenario can also occur when the gNB transmits DCI 1\_1 and this is not received by the UE, as shown in the figure below.In the above figure, the UE does not detect the first DCI (“A”) that changes K0min. When it receives the second DCI (“B”) with the invalid TDRA entry, the UE changes K0min to the lowest RRC configured value (according to the proposal), but it cannot decode the associated PDSCH. With the updated K0min value, the UE is able to decode the PDSCH associated with the third DCI (“C”). The issue is whether the UE should send a PUCCH associated with the second DCI (“B”). The UE cannot decode the PDSCH in time, so could send NACK on PUCCH. However our view is that the UE should not send PUCCH at all. This allows the gNB to [correctly] take action based on the invalid DCI and to [correctly] not take action based on the undecodable PDSCH.**Summary: If UE receives a fallback DCI indicating an invalid TDRA entry, (1) UE updates K0min / K2min with lowest RRC configured values and (2) UE does not send PUCCH**. |
| IDCC | Yes | We think that it is beneficial to specify the UE behavior. If the UE detects an invalid K0/K2 entry, then it can either (i) use the TDRA table without any restriction, or (ii) set K0min/K2min to the smallest configured value. We can discuss the possible solutions in the second phase of the e-mail discussion.If the UE receives a DCI with K0/K2 smaller than the applicable K0min/K2min, this may mean that the UE has missed a DCI, resulting in a misalignment between the UE and the gNB. In some cases, this error case can be corrected in the following slots, however, this would result in throughput loss until the error is corrected. In some other cases, correction may not be possible at all. For example, if DCI without the indication field (i.e., format 0\_0, 1\_0), is used in the following slots, this error cannot be corrected. So, it is desirable to specify the UE behavior so that it can correct the misalignment as soon as it is detected. |
| Qualcomm | Neutral | We think handling the misdetection is mostly up to UE’s implementation issue. However, we are also fine to add some description on the UE behavior, e.g., assuming a pair of (K0min, K2min) value that are consistent with the TDRA in the scheduling DCI. |
| Spreadtrum | No | As we already agreed “An entry in the active DL (UL) TDRA table with K0 (K2) value smaller than the indicated minimum is not expected by or not valid for the UE for the TDRA indication(s)”, so we think this error case should be handling by gNB, and additional clarification for UE behavior is unnecessary. |
| MediaTek | No | We think alignment on the scheduling offset restriction can be done via default BWP mechanism which handles the analogous issue for BWP framework as BWP index is only carried by DCI format 1\_1/0\_1. In this regard, it may not be necessary to include this error handling behavior.  |
| vivo | Yes (Prefer fallback to smallest K0min/K2min) | The misalignment period between gNB and UE exists before gNB sent another DCI format 0\_1/1\_1, thus it will lead to some interruption to receive PDCCH/PDSCH. DCI format 0\_0/1\_0 most likely can improve reliability when UE is at the cell edge, error handling for DCI format 0\_0/1\_0 is more critical in this regard, otherwise the error will not being recovered until receiving a normal DCI format 1\_1/0\_1. It will impact the system performance greatly especially when UE is at cell edge.We agree with Nokia’s opinion. To solve this issue, the straightforward way is that UE assume the active applicable min K0/K2 has changed, e.g., UE applies lowest indexed minimum scheduling offset, which corresponds to a smaller value of min K0/K2. |
| Ericsson | No | We don’t see a clear need to introduce this – if introduced, it can have significant impact on the spec at this late stage. |
| LG | Yes (Prefer fallback to no restriction) | In our perspective, a minimum value of configured TDRA table can be regarded as a minimum K0/K2, if the UE detects an invalid TDRA entry by DCI format 0\_0/1\_0. |
| CATT | No | This is an implementation issue. There is no signification consequence if UE just discards the DCI.  |
| CMCC | No | The only case which UE receives a fallback DCI indicating an invalid TDRA entry is as the following: First, UE is in cell center with cross-slot scheduling and then moves to cell boundary. But gNB want to schedule UE in same-slot scheduling, because UE cannot detect DCI format 0\_1/1\_1 correctly, gNB can only transmit fallback DCI and indicate an invalid TDRA table e.g., K0=0. After receiving the invalid TDRA table indicating in DCI format 0\_1/1\_1, UE can change to same-slot scheduling automatically.We think this case is a small probability event and have no strong view to capture this UE behaviour in Rel-16 maintenance stage. |
| NTT DOCOMO | Yes (Prefer fallback to the smallest K0min/K2min) | We think it is beneficial to specify the UE behavior to resolve this issue. We agree with Nokia and vivo, and UE should fall back to lowest index of minimum scheduling offset, i.e., a smaller value of min K0/K2, if UE is indicated invalid TDRA entry by DCI format 0\_0 or 1\_0. |
| Samsung | Yes (Prefer fallback to no restriction or a default restriction) | We support this proposal and strongly prefer to specify the default UE behavior. For DCI format 0\_1/1\_1, it can be self-recovered by indicating the K0min/K2min value again after UE missed previous one, however, for DCI format 0\_0/1\_0 this is not possible. This issue cannot be efficiently resolved by UE and/or gNB implementation. The UE will discard the DCI format 0\_0/1\_0 indicating invalid TDRA entry as referred to below description in 38.213. - [38.213] If a UE detects a DCI format with inconsistent information, the UE discards all the information in the DCI format.Therefore, the UE will not transmit HARQ-ACK feedback to gNB, so that the gNB cannot be aware of whether the UE receives the transmitted DCI format 0\_0/1\_0. When HARQ-ACK is not received at gNB side, the gNB can be aware of something is wrong to the UE, but difficult to know whether it is because of the poor channel quality or UE’s behavior on discarding the invalid DCI format. It makes the situation worse than before. To minimize the impact from the miss-detection, it is preferred to have a default UE behavior in the specification such that either fallback to same slot scheduling or use the default minimum values, etc. |
|  |  |  |

By the above table, companies’ views are diverse, as shown below:

|  |  |
| --- | --- |
| Specify this error handling? | Company list |
| Yes (7) | ZTE, Sony, IDCC, VIVO, LG, DoCoMo, SS |
| Neutral (2) | Nokia, QC,  |
| No (10) | Panasonic, OPPO, HW, HiSilicon, Intel, Spreadtrum, MTK, Ericsson, CATT, CMCC |

A potential way forward is to capture a conclusion without specification change:

Conclusion:

It is up to UE implementation when UE detects invalid TDRA entry from DCI format 0\_0/1\_0.

* + Note: No specification change
* **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.

|  |  |  |
| --- | --- | --- |
| Company name | Resolve the inconsistency? | Company view for issue #4 |
| Panasonic | Yes | This is okay. |
| Nokia | Yes | OK |
| OPPO | No | We don’t see the need to change it. |
| ZTE | Yes | we support to extend CSI-RS triggering offset value range from {0, 1, 2, 3, 4, 16, 24} to {0, 1,2,3,4,5,6…16, 24} slots. |
| Huawei, HiSilicon | No | We don’t see the need to change the value range of the A-CSI-RS trigging offset. The current value range can work well with minimum scheduling offset K0. |
| SONY | Yes | OK to align the ranges of A-CSI triggering offset and K0min. |
| IDCC | Yes | We support this proposal. |
| Qualcomm | Yes | We are fine with the proposal, but the detailed set of values may need further discussion. |
| Spreadtrum  | Yes  | We are fine with this. |
| MediaTek | Yes | We can support the alignment to minimize the conflicts across R16 features. |
| Vivo | Yes | We are fine with this. |
| Ericsson | Yes | We support the proposal. Without agreeing to this, if UE indicates assistance min K0 of e.g. 6, the NW has to select 16 for A-CSI triggering offset with cross-slot scheduling, which is unnecessary restriction given RRC already supports full range. |
| LG | Yes | OK |
| CATT | Yes | OK |
| CMCC | Yes | We are fine about this. The triggering offset from 0 to 16 slots can be added in A-CSI triggering. |
| NTT DOCOMO | Yes | We are fine to extend the value range of A-CSI triggering offset. |
| Samsung | Yes | OK |
|  |  |  |

By the above table, there is significant support to resolve the inconsistency between the list of A-CSI-RS triggering offset and that of possible K0min/K2min values, as shown below:

|  |  |
| --- | --- |
| Resolve the inconsistency? | Company list |
| Yes (15) | Panasonic, Nokia, ZTE, Sony, IDCC, QC, Spreadtrum, MTK, VIVO, Ericsson, LG, CATT, CMCC, DoCoMo, SS |
| No (3) | OPPO, HW, HiSilicon |

Looking at the example by Ericsson and referring the previous agreement, as quoted below:

|  |
| --- |
| Agreements:* For K0/K2 under same-carrier scheduling, possible suggested values by the UE are:
	+ 15kHz/30kHz SCS: {1, 2, 4, 6} slots
	+ 60kHz/120kHz SCS: {2, 4, 8, 12} slots
 |

one possible way forward is to slightly extend the list of A-CSI-RS triggering offset so as to better match the potentially used K0/K2 values. Therefore, the following proposal is suggested for further discussion:

 Proposal:

Aperiodic CSI-RS triggering offset value range is extended from {0, 1, 2, 3, 4, 16, 24} to {0, 1, 2, 3, 4, 6, 8, 12, 16, 24}

# 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

1. “Draft Report of 3GPP TSG RAN WG1 #100-e v0.2.0”, on-line available @ <https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100_e/Report>
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