**3GPP TSG-RAN WG2 Meeting #112-e R2-200xxx**

Online, 2-13 November 2020

Agenda Item: 8.2.1

Source: CMCC

Title: Summary of email discussion [Post111-e][918][R16 DCCA] SCell SMTC window for Unaligned CA

Document for: Discussion and Decision

# 1 Introduction

This document is for the following offline discussion, particularly for topics in 8.2.1:

* [Post111-e][918][R16 DCCA] SCell SMTC window for Unaligned CA (CMCC)

Discuss the problem and attempt to come up with a solution.

 Intended outcome: Email discussion report + CR (if needed)

 Deadline: Long

In RAN2 #111 meeting, there is a hot discussion on one issue related to SCell slot slit for unaligned CA which had been identified and discussed in RAN1 and the potential RAN2 impact of the issue, triggered by [1]:

** Issue 1: Interpretation of slots indicated by the bitmap in measurementSlots in TS38.331 for unaligned CA case**

Moreover, in RAN# 89 meeting, the way forward in [2] as follows had been endorsed:

* How to handle the ambiguities, including SMTC window & DRX timing, for Case B is up to WGs

Meanwhile, supporting UE capability signaling for Rel-16 inter-band CA with non-aligned frame boundaries for the following cases was discussed in [2] as well:

* + **Case A: The lowest subcarrier spacing of the subcarrier spacings given in *scs-SpecificCarrierList* for PCell/PSCell is smaller than or equal to the lowest subcarrier spacing of the subcarrier spacings given in *scs-SpecificCarrierList* for each of the Scells**
	+ **Case B: The lowest subcarrier spacing of the subcarrier spacings given in *scs-SpecificCarrierList* for PCell/PSCell is larger than the lowest subcarrier spacing of the subcarrier spacings given in *scs-SpecificCarrierList* for each of the Scells**

And the endorsed conclusion is:

* **RAN2 to work on the remaining details on the UE capability signaling to support the above cases separately without impacting ASN.1 backward compatibility once the ambiguities for Case B are resolved**
	+ **For UE capability signaling design, UE capability for Case A is a pre-requisite of UE capability for Case B**

To progress the topic, this document provides questions with respect to the issue and potential RAN2 impact of the issue and companies are requested to provide their views on those.

# 2 Discussion

As descripted in [1] [3] [4], the issue comes from that when unaligned CA is applied, there will be slots partially overlapped with the SMTC window. For example, for Pcell=60kHz, SCell=15kHz, N = -1 (ca\_slot\_offset = -1), it is not clear whether slot 0 or slot 1 shown below (in red rectangle) should be the first slot in measurementSlots for the SCell. And in the below figure, SF means subframe, MO means measurement occasion; SMTC window is defined by PCell timing.



On the other hand, in TS 38.331 [3], the definition of “first slot in the SMTC window” is highlighted in yellow, then for unaligned CA case, it is not clear whether a partially overlapped slot with SMTC window should be treated as “a slot in the SMTC window”. Then to avoid ambiguity, some companies propose only complete slots inside the SMTC window are indicated by the bitmap in *measurementSlots.*



Regarding RSSI measurement, RSSI is a measured value not related to cell dimension, but rather an aggregated measured value from all cells in a specific frequency layer. Then, in the definition of SS reference signal received quality (SS-RSRQ) in TS38.215 [4], it is noted that:

***- For intra-frequency measurements, NR Carrier RSSI is measured with timing reference corresponding to the serving cell in the frequency layer***

This means a reference RSSI measurement timing based on one serving cell in this frequency layer needs to be determined. If there is only one SCell (no PCell) in this frequency layer, and the SCell has a slot offset compared to PCell, then this issue arises.

Additionally, with the definition of “*periodicityAndOffset”*in TS38.331 for SMTC configuration, the offset is subframe-based granularity, however, in the case of unaligned CA or slot-aligned CA, the offset between Pcell/PScell and Scellis is slot-based granularity, which will produce the case that [2] exemplified, however, even in non-CA case, such example may present between two TDD bands when their frame boundaries are not aligned, furtherly, it may present in asynchronized FDD system for inter-frequency measurement, therefore, RAN2 is required to handle this issue in a unified way.

Therefore, when unaligned CA is applied, there will be slots partially overlapped with the SMTC window.

**Question 1: For unaligned CA case, do you agree that it is not clear of the definition of “first slot in the SMTC window” in TS 38.331, i.e. whether a partially overlapped slot with SMTC window should not be treated as “a slot in the SMTC window” or not.**

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| **Company** | **Yes/No** | **Comment / alternative proposal** |
| CMCC | Yes | There is the ambiguity in the definition of the SMTC window requiring clarification. |
| ZTE | Partially agree | For intra-frequency measurement, we agree with rapporteur that the current description in TS 38.331 causes ambiguity issue when the UE is configured with unaligned CA. But we think the issue may also exist for inter-freqency measurement scenario, based on TS 38.215, RSSI measurement for inter-frequency is defined as below: - For inter-frequency measurements, NR Carrier RSSI is measured with timing reference corresponding to any cell in the target frequency layerNote that, the timing reference of RSSI measurement corresponding to any cell in the target frequency layer, while SMTC window is based on the timing reference of sPCell. Thus if target measured frequency is not sychronized with sPCell, there is also a misalignment of slot boundary even if async CA is not configured. |
| MediaTek | Yes | We also agree with ZTE that the problem already exist in inter-frequency case from Rel-15. |
| Qualcomm | Yes with comments | We agree that there is some ambiguity in the definition of the SMTC window on partially overlapping slot in async CA as rapporteur mentioned. However, we don’t think it is a big issue: * It can be resolved by proper Network implementation. For example, network can configure the SMTC window starting from slot boundary of SCell.
* It is possible that only a small part of slot is overlapped, e.g. 5% overlapping of a slot in SCell. Then, it seems not necessary to discard the full slot just because of the 5% loss, i.e. it seems like an overkill in some cases.

For the Inter-frequency issue mentioned by ZTE, we think no clarification is required because it will impact Rel-15 sync CA. In addition, for sync CA, the max time difference is like half a symbol, i.e. less than 5% of a slot if the example showed by rapporteur. We don’t think it is necessary to discard the full slot because of such small overlapping. Based on above reason, we show some preference to keep the spec for async CA, i.e. the partially overlapped slot of SCell is still regarded as “a slot in SMTC window”. Please note that Network can set such slot as “0” in *measurementSlots* if Network identified a large part of this slot is overlapped and should be discarded by the UE. We think it also provides some flexibility for different cases.As we mentioned before, we don’t think it is a big issue. However, in this case, we will insist that such clarification should be only for intra-frequency RSSI measurement of Rel-16 async CA.  |
| Nokia | Yes with comments | There is ambiguity in case the PCell SCS is higher than the SCell SCS in case of unaligned CA. Whether this ambiquity causes any actual problem is not that clear. Maybe one could even consider it to be up to UE to decide which non-complete slots to apply as long as performance requirements are met. In case of regular (aligned CA) in rel-15 is minimal and does not require any changes. |
| Lenovo, Motorola Mobility | Yes | The SMTC window definition is unclear as explained in the description and we also agree with ZTE similar ambiguity exists for inter-frequency scenario. |
| vivo | Yes  | There is the ambiguity in the definition of the SMTC window for both intra-frequency and inter-frequency. |
| OPPO | Yes  | We also agree with ZTE analysis for inter-frequency measurement scenario. |
| Huawei | Yes with comments | We have the similar views as Qualcomm.For inter-frequency case, we think no spec change is needed considering there is no big difference on performance interpreting the spec in either way, otherwise it may introduce NBC issue.For intra-frequency case in unaligned CA, the ambiguity maybe more noticeable. We are fine with some clarifications, and we also prefer to go with the way that the partially overlapped slot of SCell is still regarded as “a slot in SMTC window”, UE can measure the symbols within the SMTC window. |
| CATT | Yes  | We agree with rapporteur that there is an ambiguity in the definition of the SMTC window for the case of unaligned CA in Rel-16. |
| Ericsson | Yes with comments | We agree that in the network configuration chosen in the example of higher SCS PCell and lower SCS SCell, it is not fully clear for unaligned CA. We agree with Qualcomm that for the inter frequency case, no change is needed. For the intra frequency case, we also agree it would be best if partially covered slots can be included in the SMTC window. Then network can control whether it is considered or not by setting 0 or 1 in *measurementSlots*. For other deployments with higher SCS in SCell, the situation can be avoided with proper SMTC offset and measurement slot configuration. |
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**Summary of Question 1:**

**The opinions relating whether the definition of “first slot in the SMTC window” in TS 38.331 needs to be clarified from the participants seem to be quite diverse , and can be summarized as follows:**

1. **There is the ambiguity in the definition of the SMTC window and the clarification is required:**
	1. **only for intra-frequency RSSI measurement of Rel-16 async CA and prefer that the partially overlapped slot of SCell is still regarded as “a slot in SMTC window”(Qualcomm, Huawei, Ericsson)**
	2. **only for intra-frequency RSSI measurement of Rel-16 async CA and can accept the majority’s view that the UE always discards the partially overlapped slot (Qualcomm, Ericsson)**
	3. **for both intra-frequency and inter-frequency.(ZTE, MediaTek, Lenovo, Motorola Mobility, vivo, OPPO, CMCC)**
2. **It to be up to UE to decide which non-complete slots to apply as long as performance requirements are met (Nokia)**

Regarding RSSI measurement, a reference RSSI measurement timing based on one serving cell in this frequency layer needs to be determined.

**Question 2: Do you agree that the issue will arise if there is only one SCell (no PCell) in this frequency layer, and the SCell has a slot offset compared to PCell?**

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| **Company** | **Yes/No** | **Comment / alternative proposal** |
| CMCC | Yes |  |
| ZTE | See comments | The question is a bit unclear because intra-frequency must be performed on serving frequency. As we responsed to Q1, we think the issue not only appears in intra-frequency measurement, for normal inter-frequency measurement (since Rel-15), as long as the measured target frequency/cell is not sychronized with sPCell, the ambiguity issue also exists. In summary, we think the issue appears in the following cases:1. Intra-frequency measurement, when UE is configured with async CA, and the subframe boundary of sPCell is not aligned with the slot boudary of SCell.
2. Inter-frequency measurement when the subframe boundary of sPCell is not aligned with the slot boudary of target measured cell.
 |
| MediaTek | Yes for intra-frequency case | For intra-frequency measurement, this issue arises due to async CA. For inter-frequency measurement, there is already some ambiguity started from Rel-15. |
| Qualcomm  | See comments | As we commented in Q1: * For intra-frequency case, we don’t think it is a big issue, and we prefer to keep the spec for async CA, i.e. the partially overlapped slot of SCell is still regarded as “a slot in SMTC window”. if majority prefer to clarify in rapporteur’s solution (i.e. UE always discards the partially overlapped slot), it is also acceptable to us. But it is only needed for async CA of Rel-16
* For inter-frequency case, we think no clarification is needed because it may impact Rel-15 sync CA. And as we analyzed, the loss in sync CA will be small and not worth for the UE to discard the full slot.
 |
| Nokia | Likely yes - See response to clarify the question | Using “frequency layer” may not be ambiguous, but in our understanding there can be just **one** cell on a given frequency layer in a CA setup, not several cells . Hence the question would reduce to “*Do you agree that the issue will arise if* ***an SCell*** *has a slot offset to PCell*” - so quite similar to first question. In this case, this is maybe a similar SMTC window issue here with regard to the measurement timing. |
| Lenovo, Motorola Mobility | Yes | Agree with Nokia that the question can be rephrased a bit.  |
| vivo  | Yes  | It is the same question with Q1. |
| OPPO | Yes  | Agree with ZTE and Nokia.We can find a common solution or clarification to fix this issue. |
| Huawei | Yes with comments | Agree with Qualcomm. |
| CATT | Yes | Same view as in Q1. |
| Ericsson | See comments | The question is not clear, but we agree with input from Qualcomm |
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**Summary of Question 2:**

**Firstly, we agree that Nokia’s comment of rephrasing the question as do you agree that the issue will arise if a SCell has a slot offset to PCell. Secondly, the positions relating to this question from the participants are similar as that of question 1.**

If you confirm the above issues, then please provide your answer the question 3:

**Question 3: Do you agree the following proposal:**

**For the IE *measurementSlots* defined in 38.331, only complete slots inside the SMTC window are indicated by the bitmap in *measurementSlots* in case of both intra- frequency measurement and inter-frequency measurement, and add the corresponding clarification for the slot bitmap interpretation of *measurementSlots* in TS38.331.**

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| **Company** | **Yes/No** | **Comment / alternative proposal** |
| CMCC | Yes | The clarification for the ambiguity is needed.  |
| ZTE | Yes | We are ok with the proposal and it covers both “intra-frequency measurement” and “inter-frequency measurement” cases. As we responsed to Q1, we understand the issue (for inter-frequency measurement) has existed since Rel-15, so it would be good to confirm whether all Rel-15 UEs have already implemented as the proposed way. Otherwise, we need to find another solution.  |
| MediaTek | Yes | At least for intra-frequency case in Rel-16, we support this clarification. We could further discuss on whether we want to clarify this also for inter-frequency measurement. And if yes, do we want to clarify this from Rel-15 or from Rel-16? We would like to emphasize that including partial overlapped slots for the *measurementSlots* configuration is still confusing. In this case, we would need one more bit to indicate all the slots in the SMTC window (two partial overlap slot, one in the beginning and one in the end). We prefer to consider only complete slots in the SMTC window.Note that for intra-freq measurement on some SCell (e.g. FR2 cell), there will be scheduling restriction on data transmission. Thus it is important to clarify which slot the UE is measuring so that no ambiguity between UE and NW. |
| Qualcomm  | See comments | As we commented in Q1: * For intra-frequency case, we don’t think it is a big issue, and we prefer to keep the spec for async CA, i.e. the partially overlapped slot of SCell is still regarded as “a slot in SMTC window”. if majority prefer to clarify in rapporteur’s solution (i.e. UE always discards the partially overlapped slot), it is also acceptable to us. But the clarification is only needed for async CA of Rel-16
* For inter-frequency case, we think no clarification is needed because it may impact Rel-15 sync CA. And as we analyzed, the loss in sync CA will be small and not worth for the UE to discard the full slot.
 |
| Nokia | Maybe | Definition of “complete slot” is not that clear as this is already now existing due to timing inaccuracies between serving cells in case of aligned CA. So it is not fully clear what is the proposal but we agree that ambiquity should be removed if it causes performance issues but if the impact is minimal it would not really justify specification impacts.  |
| Lenovo, Motorola Mobility | Yes | The ambiguity is well understood, and we are fine with rapporteur’s proposal. There might not be critical performance issue, but still good to unify the implementation. On the other hand, if companies believe there is no need to adopt the change for inter-frequency case due to e.g. possible impact on Rel.15, then we prefer to not make any change to intra-frequency case neither. It’s just even worse if intra-frequency and inter-frequency follow different principles.  |
| vivo | Yes  | We are OK to have clarification for SMTC case.  |
| OPPO | Yes | It is good to have this clarification for RSSI configuration. |
| Huawei | See comments | As we commented in Q1-2, if companies think clarification is needed, we prefer to go with the way that the partially overlapped slot is still regarded as “a slot in SMTC window”, UE can measure the symbols within the SMTC window only for R16 unaligned CA case. For R15 inter-frequency case, no spec change is needed. |
| CATT | yes |  We support this clarification for unaligned CA in Rel-16. |
| Ericsson | See comments | We agree with Qualcomm and Huawei that partially overlapped slots should be regarded as inside the SMTC window. |
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**Summary of Question 3:**

**Similar as the situation of question 1, the opinions from the participants seem to be quite diverse, and can be summarized as follows:**

1. **For intra-frequency measurement of Rel-16 async CA, the ambiguity in the definition of the SMTC window requires the clarification:**
	1. **only complete slots inside the SMTC window are indicated by the bitmap in measurementSlots (8 companies: ZTE, MediaTek, Lenovo, Motorola Mobility, vivo, OPPO, CATT, CMCC)**
	2. **and prefer that the partially overlapped slot of SCell is still regarded as “a slot in SMTC window”( 3 companies: Qualcomm, Huawei, Ericsson)**
	3. **can accept the majority’s view that the UE always discards the partially overlapped slot (2 companies: Qualcomm, Ericsson)**
	4. **it to be up to UE to decide which non-complete slots to apply as long as performance requirements are met (1 company: Nokia)**
2. **For inter-frequency measurement, since this issue has existed since Rel-15 sync CA, some companies are afraid of the impact on the implementation in Rel-15 RSSI measurement, the views are as follows:**
	1. **no clarification is required**, **i.e.,** **no spec change is needed (Qualcomm, Huawei, Ericsson)**
	2. **clarification is required (ZTE, MediaTek, Lenovo, Motorola Mobility, vivo, OPPO, CATT, CMCC)**
	3. **it to be up to UE to decide which non-complete slots to apply as long as performance requirements are met (1 company: Nokia)**

**Obviously, for intra-frequency measurement of Rel-16 async CA, for majority (10/12), the clarification that the partially overlapped slot of SCell is still regarded as “a slot in SMTC window” can be accepted. Therefore, the rapporteur recommend the majority’s view as agreed conclusion:**

**For inter-frequency measurement, as ZTE, Qualcomm, Mediatak and Lenovo mentioned that the issue (for inter-frequency measurement) has existed since Rel-15, so it would be good to confirm whether all Rel-15 UEs have already implemented as the proposed way. Form the rapporteur point of view, it is reasonable. Hence, for inter-frequency measurement, we recommend postpone the decision to the next meeting and the UE vendors can check with your product colleagues for more information.**

**Question 4: If you are positive to the proposal in Question 3, companies are expected to provide your preferred clarification way in the specification.**

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| **Company** | **Preferred Clarification Way in the Specification** |
| MediaTek | Given that some companies are reluctant to change R15 SPEC and inter-frequency case. We would like to suggest the following change in the field description of *measurementSlots* in R16.***measurementSlots***Indicates the slots in which the UE can perform RSSI measurements. The length of the BIT STRING is equal to the number of slots in the configured SMTC window (determined by the duration and by the subcarrierSpacing). The first (left-most / most significant) bit in the bitmap corresponds to the first slot in the SMTC window, the second bit in the bitmap corresponds to the second slot in the SMTC window, and so on. The UE measures in slots for which the corresponding bit in the bitmap is set to 1. In case this field is configured for an SCell with *ca-SlotOffset-r16*, the first (left-most / most significant) bit in the bitmap corresponds to the first slot that is fully contained in the SMTC window, the second bit in the bitmap corresponds to the second slot that is fully contained in the SMTC window, and so on. |
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Regarding the conclusion as follows:

* **RAN2 to work on the remaining details on the UE capability signaling to support the above cases separately without impacting ASN.1 backward compatibility once the ambiguities for Case B are resolved**
	+ **For UE capability signaling design, UE capability for Case A is a pre-requisite of UE capability for Case B**

**Question 5: Companies are expected to provide your preferred design on the UE capability signalling to support the above cases required in the RAN’s conclusion.**

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| **Company** | **Preferred design on the UE capability signaling** |
| vivo |  If clarification is needed for Case B. we prefer having separated capabilities for both case A and case B.  |
| Huawei | We understand the RP conclusion is that separate UE capabilities are needed for case A and case B, i.e. legacy capability is for case A and new capability for case B. |
| MediaTek | We think that the RP conclusion is quite clear. RAN2 should define separate capability for case A and B. For case B, we have to clarity the ambiguities on DRX and SMTC first before defining the capability. SMTC issue is discussed in this previous questions and companies also discuss DRX issue via e-mail. We believe that RAN2 could resolve the ambiguities in the coming meeting. Therefore, we just need to modify 38.331 and 38.306 so that we have separate capabilities for the case A and B. There is already one capability bit for async-CA and that could be used for case A. We could add one more capability bit for case B. |
| Ericsson | We also agree on separate capabilities for case A and B. E.g. case A could be covered by the existing capability interCA-NonAlignedFrame-r16. Then a new one can be added for case B. |
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**Summary of Question 5:**

**The companies generally agree that RAN2 should define separate capability for case A and B.**

# **3 Summary and conclusions**

The opinions related to the clarification on SMTC window for measurement from the participants seem to be quite diverse, and can be summarized as follows:

1. For intra-frequency measurement of Rel-16 async CA, the ambiguity in the definition of the SMTC window requires the clarification:
	1. only complete slots inside the SMTC window are indicated by the bitmap in measurementSlots (8 companies: ZTE, MediaTek, Lenovo, Motorola Mobility, vivo, OPPO, CATT, CMCC)
	2. and prefer that the partially overlapped slot of SCell is still regarded as “a slot in SMTC window”( 3 companies: Qualcomm, Huawei, Ericsson)
	3. can accept the majority’s view that the UE always discards the partially overlapped slot (2 companies: Qualcomm, Ericsson)
	4. it to be up to UE to decide which non-complete slots to apply as long as performance requirements are met (1 company: Nokia)
2. For inter-frequency measurement, since this issue has existed since Rel-15 sync CA, some companies are afraid of the impact on the implementation in Rel-15 RSSI measurement, the views are as follows:
	1. no clarification is required, i.e., no spec change is needed (Qualcomm, Huawei, Ericsson)
	2. clarification is required (ZTE, MediaTek, Lenovo, Motorola Mobility, vivo, OPPO, CATT, CMCC)
	3. it to be up to UE to decide which non-complete slots to apply as long as performance requirements are met (1 company: Nokia)

Obviously, for intra-frequency measurement of Rel-16 async CA, for majority (10/12), the clarification that the partially overlapped slot of SCell is still regarded as “a slot in SMTC window” can be accepted. Therefore, the rapporteur recommend the majority’s view as agreed conclusion:

For inter-frequency measurement, as ZTE, Qualcomm, Mediatake, Huawei and Lenovo mentioned that the issue (for inter-frequency measurement) has existed since Rel-15, so it would be good to confirm whether all Rel-15 UEs have already implemented as the proposed way. Form the rapporteur point of view, it is reasonable. Hence, for inter-frequency measurement, we recommend postpone the decision to the next meeting and the UE vendors can check with your product colleagues for more information.

Regarding design on the UE capability signalling, the companies generally agree that RAN2 should define separate capability for case A and B.

**Conclusion 1: For the IE *measurementSlots* defined in 38.331, only complete slots inside the SMTC window are indicated by the bitmap in *measurementSlots* in case of intra- frequency measurement, and add the corresponding clarification for the slot bitmap interpretation of *measurementSlots* in TS38.331.**

**Conclusion 2: RAN2 should define separate capability for case A and B, i.e. legacy capability is for case A and new capability for case B.**

**And the corresponding CRs for TS 38.331 and TS 38.306 are accepted by participants.**

# 4 References

1. R2-2001627 Impact of CG/SPS with periodicities non dividing HF length Sequans Communications[R2-2008365](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_111-e/Docs/R2-2008365.zip) Issue on SCell Slot Slit for Unaligned CA CMCC
2. RP-202030 Moderator’s Summary for Email Discussion [89E][12][R16\_DCCA\_unaligned\_frames], MediaTek

1. **R1-2007008** FL summary on support of unaligned frame boundary for R16 NR inter-band, CMCC
2. R1-2005626, Remaining issues on Rel-16 carrier aggregation, MediaTek Inc..
3. 3GPP TS 38.331 V16.0.0, ”NR; Radio Resource Control (RRC) protocol specification”
4. 3GPP TS 38.215 V16.2.0, ”NR; Physical layer measurements”