3GPP TSG RAN WG1 #106bis-e R1-2110564

e-Meeting, October 11 - 19, 2021

**Agenda item: 5**

**Source: Moderator (Nokia)**

**Title:** **[106bis-e-AI5-LSs-01] Moderator summary**

**WI: FS\_NR\_eff\_BW\_util**

**Document for: Discussion and Decision**

# 1 Introduction

This document is facilitating the RAN1#106bis-e email discussion [106bis-e-AI5-LSs-01] Discuss incoming LS on efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidths for a possible reply LS by October 18. The discussion thread is related to an LS from RAN4 in [R1-2108700/R4-2114751](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_106b-e/Docs/R1-2108700.zip)

The following set of documents were identified as relevant to this discussion:

|  |  |  |
| --- | --- | --- |
| **TDoc** | **Title** | **Source** |
| [**R1-2108700**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2108700.zip) | LS on specification impact for methods on efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidths | RAN4, Nokia |
| [**R1-2108948**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2108948.zip) | Discussion on RAN4 LS regarding methods on efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidths | vivo |
| [**R1-2109027**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109027.zip) | Discussion on efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidths | ZTE |
| [**R1-2109028**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109028.zip) | [DRAFT] Reply LS on efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidths | ZTE |
| [**R1-2110010**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110010.zip) | Discussion on RAN4 LS on irregular channel bandwidths | Apple |
| [**R1-2110011**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110011.zip) | Draft Reply to RAN4 LS on irregular channel bandwidths | Apple |
| [**R1-2110296**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110296.zip) | DRAFT LS on specification impact for methods on efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidths | Nokia, Nokia Shanghai Bell |
| [**R1-2110304**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110304.zip) | On efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidths | Ericsson |
| [**R1-2110336**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110336.zip) | [Draft] Reply LS on synchronous operation between Uu and SL in TDD band | Ericsson |

# 2 RAN4 LS questions to RAN1 and RAN2

The RAN4 LS posed the following questions to RAN1

RAN4 is currently studying four methods [1] on efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidths. One of the Study Item objectives is to evaluate and minimize the impact to RAN1 and RAN2.

RAN4 respectfully requests to provide information if each studied method is compatible with RAN1/RAN2 specifications and in particular to clarify/confirm the following aspects:

* For the wider CBW:
  + clarify if there is any limitation for the UL carrier positions (not just BWP positions) legacy UEs support for uplinkChannelBW-PerSCS-List and scs-SpecificCarrierList in symmetric operating bands with a fixed duplex distance and asymmetric UL/DL channel bandwidth.
  + confirm UE behaviour if it is possible to configure a carrier that is not fully contained in the NR band, i.e. the carrier can extend beyond the low edge of the band and/or the high edge of the band?
* For the overlapping CBWs from network perspective (one cell approach):
  + clarify whether a single SSB and CORESET (e.g. for cases where irregular BWs >10 MHz where a 4.28 MHz wide initial BWP can be in the common frequency range), can be used to configure UEs with different channel BWs on different parts of the BS channel.
  + clarify whether two time staggered SSBs and CORESET#0 on the same frequency (when the frequency separation is not enough to send them simultaneously at the same time and thus time staggering is needed) are supported in RAN1/2 specifications so that UEs configured with left and right channels of the next smaller regular size can track their own time staggered SSB and CORESET#0.
* For the overlapping CBWs from UE perspective (two cell approach / CA approach):
  + if two different Bandwidth Parts for the UE are overlapping, and both contain a subset of CSI-RS resources that are mapped to the same subset of overlapping RBs for the same UE, please clarify how does UE report CSI for the overlapped part, e.g. does UE report CSI for each cell separately, or just once for the overlapping part, or something else?
  + clarify how PDCCH reception in overlapped CA when PCell and SCell PDCCH resources partially overlap and whether there are any impacts to cross-carrier scheduling
* For the overlapping CBWs from UE perspective (one cell approach):
  + Is it possible to configure the UE with a dedicated carrierBandwidth in the ServingCellConfig that is wider than/partially outside the carrierBandwidth configured in SIB1?
  + Clarify for equalization purposes in the DL, does the BS need to know the split between the subset of PRBs from a main RF carrier versus PRBs from an additional RF carrier are received on different channel/antenna before combining. If pre-coding assumes all PRBs experience the same channel/antenna, is signalling required so that BS pre-coding can account for the path differences of main carrier PRBs and additional carrier PRBs.

# 3 Reply LS drafting

## 3.1 For the wider CBW

**RAN4 question:**

* For the wider CBW:
  + clarify if there is any limitation for the UL carrier positions (not just BWP positions) legacy UEs support for *uplinkChannelBW-PerSCS-List* and *scs-SpecificCarrierList* in symmetric operating bands with a fixed duplex distance and asymmetric UL/DL channel bandwidth.
  + confirm UE behaviour if it is possible to configure a carrier that is not fully contained in the NR band, i.e. the carrier can extend beyond the low edge of the band and/or the high edge of the band?

### 3.1.1 Round #1

**Proposed RAN1 reply:**

* RAN1 specifications require placing the BWP within the *carrierBandwidth* of the *scs-SpecificCarrier*, a BWP cannot extend outside the configured *carrierBandwidth*.
* RAN1 specifications do not place any limitations on the frequency location of the *scs-SpecificCarrier.*

**Comments on the proposal:**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| vivo | Fine in general |
| QC | We are fine with the second bullet in the proposal.  For the first bullet, although the content in the bullet is correct, but the proposed RAN1 reply does not answer RAN4’s question. RAN4 question is “confirm UE behaviour if it is possible to configure a carrier that is not fully contained in the NR band, i.e. the carrier can extend beyond the low edge of the band and/or the high edge of the band?” In our understanding, it is better to answer RAN4 question directly to give a firm yes/no answer, as suggested in the following.  **QC’s answer to RAN4 question is: UE behaviour is not clear for this case. RAN1 has no plans to clarify the support of this particular configuration** |
| ZTE | For the first question, it doesn’t fall into RAN1’s scope thus RAN1 doesn’t have any answer for it. For the second question, at least for now, all RAN1 specifications assume that the carrier bandwidth is within one band. It is not clear what the UE behaviour is if a carrier that is not fully contained in the NR band. |
| NTT DOCOMO | We are generally fine with the proposed reply. |
| Huawei, HiSi | For bullet 1, UE behaviour is undetermined.  For bullet 2, ok |
| Ericsson | For the first question, our understanding is that there are no such limitations in RAN1 specifications.  For the second question, given that the RAN1 specifications are band agnostic, we do not see that it would be RAN1 specifications that would handle the case of placing the carrier outside the band edges, but this would be a discussion for RAN4. Hence, RAN1 should not answer that the UE behavior is undetermined but send the question back to RAN4. |
| Nokia, NSB | We’d be OK with the original proposals in general.  We tend to agree that it is not possible to place a carrier outside a band, but this is not something that RAN1 specs state. The bands are visible in RAN2 and RAN4 specs and RAN4 doesn’t need to send an LS to RAN1 so that we can explain RAN4 specs and what they mean back to them. Hence we don’t see any reason why RAN1 specifications would lead to undefined UE behaviour if a carrier is placed fully in an NR band, though. |

### 3.1.2 Round #2

**Moderator commentary after round #1:** The philosophy of the response might benefit from broadening it from just reading out loud the RAN1 specs, but going to discussion like how RAN2 signalling should configure RAN1 operation in context of RAN4 specs is something that RAN4 should be capable of discussing. Hence limiting the answers to what RAN1 specs consists of seems justified. Regardless I have added a sentence that goes beyond just reciting RAN1 specs. I have also attempted a rework on the structure to clearly differentiate answers to each bullet in the question.

**Updated proposed RAN1 reply:**

* For the wider CBW:
  + clarify if there is any limitation for the UL carrier positions (not just BWP positions) legacy UEs support for *uplinkChannelBW-PerSCS-List* and *scs-SpecificCarrierList* in symmetric operating bands with a fixed duplex distance and asymmetric UL/DL channel bandwidth.

RAN1 answer: RAN1 specifications do not place any limitations to this as RAN1 specifications are agnostic to the definitions of operating bands, bandwidths and duplex distances. RAN2 capability and configuration signalling and RAN4 band, duplex and bandwidth definitions are assumed to place such restrictions.

* + confirm UE behaviour if it is possible to configure a carrier that is not fully contained in the NR band, i.e. the carrier can extend beyond the low edge of the band and/or the high edge of the band?

**RAN1 answer:** RAN1 specifications are agnostic to NR band definitions, and do not place any such limitations. RAN2 capability and configuration signalling and RAN4 band, duplex and bandwidth definitions are assumed to place such restrictions.

**Comments on the proposal:**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Apple | We are ok with first answer, although we do see some restriction for TDD regarding the central alignment of UL/DL BWP/CC that is explicitly stated in TS 38.213 and limits the location of UL CC for TDD. On the other hand, the target band seems FDD band and then TDD restriction becomes irrelevant.  For answer on Question 2, it should directly answer the question as Qualcomm and other companies commented.  The following sentence should be added:   * ‘There is no defined UE behaviour for a carrier that is not fully contained in a NR band’.   It is simply a fact/use case we followed in LTE and NR that a CC within a band is assumed when defining UE behaviour in RAN1 specification. This is also used in UE capability report for CA support. |
| vivo | We have the preference to delete the sentence talking about RAN2 and RAN4 specs, as RAN2 will provide their answer anyway… |
| ZTE | We can accept the draft response from FL above. |
| NTT DOCOMO | We are ok with the updated answers, although we also think the second answer looks a bit indirect to the RAN4 question as Apple pointed. |
| Nokia, NSB | We’d be OK with the proposed response with or without the sentence in cyan, although don’t see any value in that sentence.  We’d be OK to indicate that there is a requirement to the UL BWP and DL BWP to have the same central frequency as indicated by Apple as this is indeed a RAN1 restriction.  @Apple, it is RAN4 business that the UE cannot operate outside a defined band, but there is no such restriction in RAN1 specifications. It makes no sense for RAN1 to answer to RAN4 that RAN4 doesn’t specify for UEs that are outside defined bands, nor RAN2 defines any capabilities to do so, but the cyan sentence anyway does this already. Even this is not really a justified RAN1 answer and stating universal facts should be unnecessary as RAN4 must be at least as well aware of the restrictions their spec place on the UE as RAN1 is. RAN1 just doesn’t add anything more to those restrictions in place in RAN4 (and RAN2), and that’s what the answer should be. |
| Huawei, HiSi | Although it is true that in core specs there is almost no band mentioned in RAN1, it is also the case that UE features are created from RAN1 wherein most of the UE capabilities can only be reported per band or per BC. Thus, UE behaviour for the transmissions outside a band is undetermined. There are no UE capabilities reported/assumed for that part. |
| Samsung | Fine with the updated proposal. One editorial suggestion - The highlighted sentences can start with “It is RAN1 understanding that…”. |
| Ericsson | The proposed reply is fine with us. We do not see a need to address the TDD case since it is not in scope of the WI.We do not see the relevance that the UE capabilities are per band as raised by Hauwei. The band definitions are anyway for RAN4 to discuss. |
| QC | We are fine with the proposed answer to first question.  For answer to question 2, we’d like to repeat our comment in first round. We think RAN1 should answer RAN4’s question directly. We agree with Apple that UE behaviour is not defined for this case. At least from UE capability point of view, UE capability to support any RAN1 feature for a carrier that is out of a NR band is not defined. Therefore, we also request to add the sentence Apple suggested:   * **There is no defined UE behaviour for a carrier that is not fully contained in a NR band**   If the above is not agreeable to the group, then we request at least the LS reply should capture the following:   * **At least one company expressed their view that while the RAN1 specification does not address this scenario, the UE behavior is unpredictable**   If Apple and Huawei agree with the above bullet, then the LS should capture the following to reflect the situation in RAN1 discussion.   * **At least three companies expressed their view that while the RAN1 specification does not address this scenario, the UE behavior is unpredictable** |

### 3.1.3 Moderator conclusion after Round #2

The 1st bullet seems stable. Adopted the Samsung suggestions and made a note of the TDD DL and UL configuration th

For the 2nd bullet, there doesn’t seem to be any difference in views on what is possible and what is not possible, but on what level the LS response should read. UE capability spec and related signalling is RAN2 and the relation of CA bands and their placement is between RAN2 and RAN4 and RAN1 addressing this question is very odd. Furthermore, he UE behaviour for a functionality that UE cannot indicate support for cannot be unpredictable, it is not supported by that UE, but it doesn’t make the functionality not supported by the spec. I will attempt a completely different approach and hope that covers the concerns. The newly-proposed text goes very far in explaining non-RAN1 specs to RAN4, though.

**Updated proposed RAN1 reply:**

* For the wider CBW:
  + clarify if there is any limitation for the UL carrier positions (not just BWP positions) legacy UEs support for *uplinkChannelBW-PerSCS-List* and *scs-SpecificCarrierList* in symmetric operating bands with a fixed duplex distance and asymmetric UL/DL channel bandwidth.

RAN1 answer: RAN1 specifications do not place any limitations to this for FDD bands as RAN1 specifications are agnostic to the definitions of operating bands, bandwidths and duplex distances while for TDD bands RAN1 requires that the active UL and DL BWP pair must have the same center frequency. It is RAN1 understanding that RAN2 capability and configuration signalling and RAN4 band, duplex and bandwidth definitions ~~are assumed to~~ place ~~such~~ restrictions to carrier positions.

* + confirm UE behaviour if it is possible to configure a carrier that is not fully contained in the NR band, i.e. the carrier can extend beyond the low edge of the band and/or the high edge of the band?

**RAN1 answer:** if it were possible to configure a UE with a carrier that is not fully contained in the NR band, RAN1 specifications would be compatible with such a configuration (ref the answer to the previous question). However, it is RAN1 understanding that such a capability cannot be indicated by the UE (RAN2 to confirm) and a UE configured to do something it did not indicate being capable of cannot be assumed to follow the configuration. Hence, according to RAN1 understanding of RAN2 and RAN4 specifications, such a configuration is not possible.

## 3.2 For the overlapping CBWs from network perspective (one cell approach)

**RAN4 question:**

* For the overlapping CBWs from network perspective (one cell approach):
  + clarify whether a single SSB and CORESET (e.g. for cases where irregular BWs >10 MHz where a 4.28 MHz wide initial BWP can be in the common frequency range), can be used to configure UEs with different channel BWs on different parts of the BS channel.
  + clarify whether two time staggered SSBs and CORESET#0 on the same frequency (when the frequency separation is not enough to send them simultaneously at the same time and thus time staggering is needed) are supported in RAN1/2 specifications so that Ues configured with left and right channels of the next smaller regular size can track their own time staggered SSB and CORESET#0.

### 3.2.1 Round #1

**Proposed RAN1 reply:**

* In idle mode, all Ues “camp” on the same initial BWP. Once connected, each UE can be configured to different parts of the carrier using a dedicated BWP. A single SSB is enough if a SSB position can be found that allows two Ues placed at either end of the frequency allocation and still receive the SSB within their respective dedicated BWPs.
* RAN1 specifications allow for configuring staggered SSBs and CORESET#0s on the same frequency so that Ues configured with left and right channels of the next smaller regular size can track their own time staggered SSB and CORESET#0.

**Comments on the proposal:**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| vivo | Fine in general. |
| QC | We are fine with the spirit of the proposal. We have some suggested editorial change as following.   * In idle mode, all Ues “camp” on the same initial BWP. Once connected, each UE can be configured to different parts of the carrier using a dedicated BWP. A single SSB is enough if a SSB position can be found that allows two Ues placed at either end of the frequency allocation and still receive the SSB within their respective dedicated BWPs, as long as the configuration on each cell in this “one cell” approach is compliant with existing requirements in RAN1, RAN2, and RAN4 specifications. * RAN1 specifications allow for configuring staggered SSBs and CORESET#0s on the same frequency so that Ues configured with left and right channels of the next smaller regular size can track their own time staggered SSB and CORESET#0, as long as the configuration on each cell in this “one cell” is compliant with existing requirements in RAN1, RAN2, and RAN4 specifications. |
| ZTE | OK with the draft reply. |
| NTT DOCOMO | We are generally fine with the proposed reply. |
| Huawei, HiSi | Ok with the original texts. The texts from QC are unnecessary since this is the legacy behaviour in our assessment. |
| Ericsson | We are fine with the draft response. The Qualcomm additions are also OK. |
| Nokia, NSB | We are OK with the original proposal with the fix of Ues to UEs. We don’t see the Qualcomm-proposed addition necessary. |

### 3.2.2 Round #2

**Moderator commentary after round #1:** The proposals seem quite stabile. On Qualcomm comment I would argue that RAN1 specs allow also for things that are NOT compliant to existing requirements in RAN2 and RAN4, these are not allowed because of those requirements in RAN2 and RAN4 requirements. As the 1st bullet goes somewhat out of the RAN1 realm and talk of idle mode and camping, I revised the 1st bullet along the lines of the Qualcomm proposal.

**Updated proposed RAN1 reply:**

* In idle mode, all UEs “camp” on the same initial BWP. Once connected, each UE can be configured to different parts of the carrier using a dedicated BWP. A single SSB is enough if a SSB position can be found that allows two UEs placed at either end of the frequency allocation and still receive the SSB within their respective dedicated BWPs, obviously as long as the configuration on each cell in this “one cell” approach is otherwise configured in compliance with the RAN1/2/4 specifications.
* RAN1 specifications allow for configuring staggered SSBs and CORESET#0s on the same frequency so that UEs configured with left and right channels of the next smaller regular size can track their own time staggered SSB and CORESET#0.

**Comments on the proposal:**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Apple | We are generally ok with updated proposal.  One minor comment to make it complete is to add ‘inactive state’ as follows:   * In idle mode and inactive state, all UEs “camp” on….. |
| vivo | We are fine with the updated proposal, and also fine with adding inactive state as proposed by Apple. |
| ZTE | OK with the draft response. |
| NTT DOCOMO | We are ok with the updated answers. |
| Nokia, NSB | OK with the response and OK to ad inactive state even though that’s more of a RAN2 detail. |
| Huawei, HiSi | Can live with it. |
| Samsung | We are ok with the first answer.  For the second one, we want to get a clarification: what is the meaning of “two time staggered SSBs and CORESET#0 on the same frequency” and the UEs “can track their own time staggered SSB and CORESET#0” in RAN4 question? Since it is one cell approach, SSBs would be common for all UEs not designated for left or right UE. |
| Ericsson | We are fine with the reply. |
| QC | We are fine with the updated proposal. A minor editorial comment: “otherwise” in the red highlighted text should be deleted? – Maybe my English is not good but “otherwise” seems not needed in the sentence to me. |

### 3.2.3 Moderator conclusion after Round #2

The proposals seem to be stable. Adopted the Apple suggestion for completeness as well as the Qualcomm-proposed editorial. To Samsung, the second bullet addresses the incoming LSs second sub-bullet of the one-cell approach question, where RAN4 specifically asked for time staggered SSBs and CORESET#0s.

**RAN4 question:**

* For the overlapping CBWs from network perspective (one cell approach):
  + clarify whether a single SSB and CORESET (e.g. for cases where irregular BWs >10 MHz where a 4.28 MHz wide initial BWP can be in the common frequency range), can be used to configure UEs with different channel BWs on different parts of the BS channel.
  + clarify whether two time staggered SSBs and CORESET#0 on the same frequency (when the frequency separation is not enough to send them simultaneously at the same time and thus time staggering is needed) are supported in RAN1/2 specifications so that Ues configured with left and right channels of the next smaller regular size can track their own time staggered SSB and CORESET#0.

**Updated proposed RAN1 reply:**

* In idle mode and inactive state, all UEs “camp” on the same initial BWP. Once connected, each UE can be configured to different parts of the carrier using a dedicated BWP. A single SSB is enough if a SSB position can be found that allows two UEs placed at either end of the frequency allocation and still receive the SSB within their respective dedicated BWPs, obviously as long as the configuration on each cell in this “one cell” approach is ~~otherwise~~ configured in compliance with the RAN1/2/4 specifications.
* RAN1 specifications allow for configuring staggered SSBs and CORESET#0s on the same frequency so that UEs configured with left and right channels of the next smaller regular size can track their own time staggered SSB and CORESET#0.

## 3.3 For the overlapping CBWs from UE perspective (two cell approach / CA approach)

**RAN4 question:**

For the overlapping CBWs from UE perspective (two cell approach / CA approach):

* + if two different Bandwidth Parts for the UE are overlapping, and both contain a subset of CSI-RS resources that are mapped to the same subset of overlapping RBs for the same UE, please clarify how does UE report CSI for the overlapped part, e.g. does UE report CSI for each cell separately, or just once for the overlapping part, or something else?
  + clarify how PDCCH reception in overlapped CA when PCell and Scell PDCCH resources partially overlap and whether there are any impacts to cross-carrier scheduling

### 3.3.1 Round #1

**Proposed RAN1 reply:**

* RAN1 specification do not prevent configuring overlapping carriers for CA for a single UE. In case of CA, the CSI-RS measurement and reporting for the component carriers are performed independently per-carrier and PDCCH monitoring are also performed independently for each component carrier.
* gNB scheduler is responsible for avoiding collisions of different transmissions in general, this would be the case with overlapped CA as well.
* There is no impact to cross-carrier scheduling

**Comments on the proposal:**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| vivo | Although it is true that RAN1 spec does not prevent overlapping CA, but it was not a use case that RAN1 agreed to support in Rel-15/16 either. It is unclear if the current specification is sufficient to enable such deployment, for example, there is no solution provided in the current spec to handle the resource collision between the overlapping carriers. It is also unclear if gNB scheduler is able to fully handle all the collision cases, as it depends on the target carrier BW and the size of the overlapping portion.  We suggest to also inform RAN4 about the above issues. |
| QC | We are fine with the proposal in general. We request to add a sub-bullet to clarify if this “two cell approach” is introduce, a new UE capability signalling should be added, i.e., add a sub-bullet as the following   * A new UE capability is added to with this “two cell” approach |
| ZTE | Ok with the draft reply. |
| NTT DOCOMO | We are generally fine with the proposed reply, although configuring overlapping carriers for CA to a single UE has not been assumed/discussed in RAN1. |
| Huawei, HiSi | RAN4 questions seems not being fully addressed yet. It can be more specific like,   * RAN1 specification do not prevent configuring overlapping carriers for CA for a single UE. In case of CA, the CSI-RS measurement and reporting for the component carriers are performed independently per-carrier and PDCCH monitoring are also performed independently for each component carrier. * gNB scheduler is responsible for avoiding collisions of different transmissions in general, this would be the case with overlapped CA including cross-carrier scheduling as well.   + The UE behaviour is undetermined otherwise when CSI-RS resources are overlapped and a UE is required to measure/report the overlapping part simultaneously for both carriers.   + The UE behaviour is undetermined otherwise when CORESET/SS resources are overlapped and a UE is scheduled by the PDCCHs from two carriers in the overlapping part simultaneously. * ~~There is no impact to cross-carrier scheduling~~ |
| Ericsson | We are fine with the proposed reply. Given that this is a RAN4 work item, needed UE capabilities can be given be discussed in RAN4. |
| Nokia, NSB | We tend to agree with vivo and Qualcomm that even though the spec support seems to be there, one cannot really expect the UEs to accept that sort of configurations even if they indicate support for intra-band CA. This maybe worthwhile communicating to RAN4. |

### 3.3.2 Round #2

**Moderator commentary after round #1:**

* The vivo concern on spec support for resource collision seems odd. An NR carrier can overlap with an LTE carrier and manage the resource collisions of all signals when the only thing specified is collision handling of LTE CRS to connected mode NR PDSCH. The collision handling of partially overlapped NR carriers may lead to inefficiencies depending on the level of overlap, and a gNB scheduler’s ability to fully handle the collision cases depends on how the scheduler implemented, but such speculation doesn’t belong to RAN1 LS response to RAN4.
* The Huawei suggestion of UE behaviour being undefined would call for some clarification that what is undefined. The UE is specified to perform measurements on a carrier from the CSI-RS resources configured on that carrier and the UE is specified to monitor PDCCH on CORESET/SSs configured on that carrier. There are no exceptions with CA configuration to this. Specifically there doesn’t seem to be anything in the spec that lead to overlapped resources leading to undefined UE behaviour. It may well be that in all cases it is not possible to schedule a PDCCH or transmit a CSI-RS on the overlapped CORESET/SS or CSI-RS resources without there being a collision in transmission messing up with the PDCCH decoding or CSI-RS measurement, but this is an issue of configuration/scheduling, not an issue of UE behaviour being undefined.
* As commented by many, it may not be fully evident that such case is not something RAN1 foresees supported by UEs of today, so I have introduced a point on that.

**Updated proposed RAN1 reply:**

* RAN1 specification do not prevent configuring overlapping carriers for CA for a single UE. In case of CA, the CSI-RS measurement and reporting for the component carriers are specified to be performed independently per-carrier and PDCCH monitoring are also specified to be performed independently for each component carrier.
* gNB scheduler is responsible for avoiding collisions of different transmissions in general, this would be the case with overlapped CA including cross-carrier scheduling as well.
* ~~There is no impact to cross-carrier scheduling~~
* RAN1 would like to note that overlapped CA configuration case has not been considered in RAN1 and the UE capabilities agreed in RAN1 for Rel-15/16 were not designed to be able to indicate UE’s support for overlapped CA configuration.

**Comments on the proposal:**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Apple | The added sentence should be put at the start of reply, instead of end. The reason is that this newly added sentence is critical high-level message we should make clear for RAN4. Otherwise, reply for CSI measurement and PDCCH monitoring behaviour may lead to misinterpretation that ‘two-cell’ overlapping has been considered when define CSI/PDCCH monitoring behaviour.  We also propose to delete the sentence that ‘RAN1 specification do not prevent configuring overlapping carriers for CA for a single UE.’ as it may be interpreted as RAN1 specification allows this. We can just focus on the RAN1 specification context related to the questions. Therefore, the following modification is suggested (Highlighting the changes with yellow color):     * RAN1 would like to note that overlapped CA configuration case has not been considered in RAN1 and the UE capabilities agreed in RAN1 for Rel-15/16 were not designed to be able to indicate UE’s support for overlapped CA configuration. * ~~RAN1 specification do not prevent configuring overlapping carriers for CA for a single UE.~~ In case of CA, the CSI-RS measurement and reporting for the component carriers are specified in TS 38.213 to be performed independently per-carrier and PDCCH monitoring are also specified in TS 38.213 to be performed independently for each component carrier. * gNB scheduler is responsible for avoiding collisions of different transmissions in general, this would be the case with overlapped CA including cross-carrier scheduling as well. |
| vivo | We are fine with either the updated proposal from moderator or the further update from Apple. |
| ZTE | We are ok with the draft response. |
| NTT DOCOMO | We are ok with the updated answers and Apple’s modifications. |
| Nokia, NSB | We are OK with the updated proposal with or without Apple’s modifications. |
| Huawei, HiSi | In legacy CA, gNB does not have to avoid collisions between two CCs and there are UE capability support of simultaneous transmission/reception; but now it seems to be restriction/requirement for overlapping CA. The UE capability for simultaneous transmission/reception therefore could be problematic as Apple mentioned, that’s also why we propose the previous wording.  To be short, the below is proposed as replacement of our previous adding   * gNB scheduler is responsible for avoiding collisions of different transmissions ~~in general, this would be the case~~ as a network restriction for the overlapping part with overlapped CA, including cross-carrier scheduling as well.   The first bullet added by Apple, “RAN1 would like to note…” is also OK for us. |
| Samsung | Apple’s updates are fine for us. |
| Ericsson | We are OK with either the original or the Apple update. |
| QC | Either moderator’s updated proposal or the version from apple is fine to us. |

### 3.3.3 Moderator conclusion after Round #2

The proposals seem fairly stable on the basic idea, but there is again a philosophical debate on the level of response. If we go to “there is no capability” then we should keep the “there is no RAN1 functional restriction” as none has been identified in RAN1 specification. So – I added again the RAN1 explaining RAN2 specs to RAN4 part but kept the part where RAN1 specs are also explained (RAN1 specs do not place any restriction on placement of one carrier in frequency relative to a placement of another carrier in frequency). Adopted some other suggested edits from Apple and Huawei.

**Updated proposed RAN1 reply:**

* RAN1 specification do not restrict ~~prevent~~ configuring overlapping carriers for CA for a single UE. However, RAN1 would like to note that in Rel-15/16 RAN1 did not discuss UE capabilities for overlapped CA in Rel-15/16, and it is RAN1 understanding that RAN2-specified UE capability signalling does not provide any possibility for UE to indicate support for overlapped CA.
* In case of CA, the CSI-RS measurement and reporting for the component carriers are specified in TS38.213 to be performed independently per-carrier and PDCCH monitoring are also specified in TS38.213 to be performed independently for each component carrier.
* gNB scheduler is responsible for avoiding collisions of different transmissions ~~in general, this would be the case~~ as a network restriction for the overlapping part with overlapped CA including cross-carrier scheduling as well.
* RAN1 would like to note that overlapped CA configuration case has not been considered in RAN1 and the UE capabilities agreed in RAN1 for Rel-15/16 were not designed to be able to indicate UE’s support for overlapped CA configuration.

## 3.4 For the overlapping CBWs from UE perspective (one cell approach):

**RAN4 question:**

* For the overlapping CBWs from UE perspective (one cell approach):
  + Is it possible to configure the UE with a dedicated *carrierBandwidth* in the *ServingCellConfig* that is wider than/partially outside the *carrierBandwidth* configured in SIB1?
  + Clarify for equalization purposes in the DL, does the BS need to know the split between the subset of PRBs from a main RF carrier versus PRBs from an additional RF carrier are received on different channel/antenna before combining. If pre-coding assumes all PRBs experience the same channel/antenna, is signalling required so that BS pre-coding can account for the path differences of main carrier PRBs and additional carrier PRBs.

### 3.4.1 Round #1

**Proposed RAN1 reply:**

* RAN1 specifications are agnostic to the message in which the *carrierBandwidth* is provided, but it is RAN1 understanding that TS 38.331 prevents configuring the UE with a dedicated *carrierBandwidth* in the *ServingCellConfig* that is wider than/partially outside the *carrierBandwidth* configured in SIB1.
* There is no need for the transmitter to know if there is a frequency discontinuity point within the carrier in the receiver implementation, this will need to be accounted for in the receiver implementation so that channel estimate is not interpolated across the discontinuity.

**Comments on the proposal:**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| vivo | Fine in general. |
| QC | We disagree with the proposal. We think the answer to RAN4 question should be the following   * Is it possible to configure the UE with a dedicated *carrierBandwidth* in the *ServingCellConfig* that is wider than/partially outside the *carrierBandwidth* configured in SIB1?   Answer: This particular mode of operation is not currently supported and RAN1 has made no plans to introduce it.   * Clarify for equalization purposes in the DL, does the BS need to know the split between the subset of PRBs from a main RF carrier versus PRBs from an additional RF carrier are received on different channel/antenna before combining. If pre-coding assumes all PRBs experience the same channel/antenna, is signalling required so that BS pre-coding can account for the path differences of main carrier PRBs and additional carrier PRBs.   Answer: Given the answer to the previous question, RAN1 has made no plans to evaluate this aspect. |
| ZTE | It seems the first question doesn’t fall into RAN1’s scope. It’s more like a configuration issue, which can be left to RAN2.  For the second question, we think some simulations may be needed to evaluate whether/how network can account for the path differences of main carrier PRBs and additional carrier PRBs. If RAN1 is going to do so, then more details from RAN4 may be necessary. |
| NTT DOCOMO | We are generally fine with the proposed reply. |
| Huawei, HiSi | For bullet 1, ran2 to answer.  For bullet 2, may need to clarify that this is assuming that the UE capability for each RF part is the same. |
| Ericsson | As indicated in the first answer and stated by ZTE, the RAN2 specifications explicitly prevents this configuration, and we should probably leave the answer to them. Looking at the proposal in total, as indicated in our contribution the problems we see with is the configuration of a BWP that is outside the *carrierBandwidth* and the OFDM generation. Given that the WI does not include RAN1 work, we agree with the answers given by Qualcomm |
| Nokia, NSB | We tend to agree that 1st bullet is for RAN2 and we could just indicate that this is not a RAN1 issue as it is a bit funny for RAN1 to tell RAN4 what RAN2 specs read as if RAN4 guys aren’t allowed to read other than RAN4 specs.  In our understanding gNB would be totally unaware if the UE had discontinuity in frequency domain reception, but it might be difficult for the UE to pass performance requirements in all cases. We are anyway OK with an answer along the lines Qualcomm is suggesting. |

### 3.4.2 Round #2

**Moderator commentary after round #1:**

* It seems better to let RAN2 answer on the RRC restriction.
* Attempted to formulate the second answer based on Qualcomm suggestion
* Restructured the answer to clearly differentiate what answer is to which bullet.

**Updated proposed RAN1 reply:**

* For the overlapping CBWs from UE perspective (one cell approach):
  + Is it possible to configure the UE with a dedicated *carrierBandwidth* in the *ServingCellConfig* that is wider than/partially outside the *carrierBandwidth* configured in SIB1?

RAN1 answer: RAN1 leaves the configuration related question for RAN2 to answer.

* + Clarify for equalization purposes in the DL, does the BS need to know the split between the subset of PRBs from a main RF carrier versus PRBs from an additional RF carrier are received on different channel/antenna before combining. If pre-coding assumes all PRBs experience the same channel/antenna, is signalling required so that BS pre-coding can account for the path differences of main carrier PRBs and additional carrier PRBs.

RAN1 answer: RAN1 has not evaluated, nor plans to evaluate the need for the gNB to know this aspect.

**Comments on the proposal:**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Apple | Fine with the draft. |
| vivo | We are fine with the updated proposal. |
| ZTE | We are ok with the draft response. |
| NTT DOCOMO | We are ok with the updated answers. |
| Nokia, NSB | We are OK with the proposal. |
| Huawei, HiSi | We don't see obvious issue for the mentioned case, since each of the RF part can be just one BWP with RF partitioned from a UE channel BW/carrier bandwidth – this tends to be the same case as a UE is configured with such BWP. The concerned case does not seem to ask whether there are two receptions for each RF part separately – rather, gNB and UE will use the combined RF part.  The following can be proposed  RAN1 has not evaluated, while at least for the concerned cases, there is no issue identified if the two RF parts are viewed as if a BWP is configured as such. ~~nor plans to evaluate the need for the gNB to know this aspect.~~ |
| Samsung | Fine with the updated proposal |
| Ericsson | We are fine with the proposal. |
| QC | We are fine with the update proposal.  We don’t support Huawei’s revision. If RAN1 has not evaluated that case, then we cannot draw any conclusion for now. We don’t see justification to add the text in blue. |

### 3.4.3 Moderator conclusion after Round #2

While I tend to think that we could have done better in answering a what looks like a fairly trivial question, there is very limited appetite among the commenting companies to aim for anything but a non-committing response. Hence

**Moderator proposal is to keep the response as it was for Round #2.**

# 4 Conclusion

A draft response LS to RAN4 and RAN2 was created based on the moderator conclusions of the discussions captured in section 3 (copied here for convenience) in R1-2110565 *[DRAFT] Reply LS on specification impact for methods on efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidths.*

**RAN4 question:**

* For the wider CBW:
  + clarify if there is any limitation for the UL carrier positions (not just BWP positions) legacy UEs support for *uplinkChannelBW-PerSCS-List* and *scs-SpecificCarrierList* in symmetric operating bands with a fixed duplex distance and asymmetric UL/DL channel bandwidth.

RAN1 answer: RAN1 specifications do not place any limitations to this for FDD bands as RAN1 specifications are agnostic to the definitions of operating bands, bandwidths and duplex distances while for TDD bands RAN1 requires that the active UL and DL BWP pair must have the same center frequency. It is RAN1 understanding that RAN2 capability and configuration signalling and RAN4 band, duplex and bandwidth definitions ~~are assumed to~~ place ~~such~~ restrictions to carrier positions.

* + confirm UE behaviour if it is possible to configure a carrier that is not fully contained in the NR band, i.e. the carrier can extend beyond the low edge of the band and/or the high edge of the band?

**RAN1 answer:** if it were possible to configure a UE with a carrier that is not fully contained in the NR band, RAN1 specifications would be compatible with such a configuration (ref the answer to the previous question). However, it is RAN1 understanding that such a capability cannot be indicated by the UE (RAN2 to confirm) and a UE configured to do something it did not indicate being capable of cannot be assumed to follow the configuration. Hence, according to RAN1 understanding of RAN2 and RAN4 specifications, such a configuration is not possible.

**RAN4 question:**

* For the overlapping CBWs from network perspective (one cell approach):
  + clarify whether a single SSB and CORESET (e.g. for cases where irregular BWs >10 MHz where a 4.28 MHz wide initial BWP can be in the common frequency range), can be used to configure UEs with different channel BWs on different parts of the BS channel.
  + clarify whether two time staggered SSBs and CORESET#0 on the same frequency (when the frequency separation is not enough to send them simultaneously at the same time and thus time staggering is needed) are supported in RAN1/2 specifications so that Ues configured with left and right channels of the next smaller regular size can track their own time staggered SSB and CORESET#0.

**RAN1 answer:**

* In idle mode and inactive state, all UEs “camp” on the same initial BWP. Once connected, each UE can be configured to different parts of the carrier using a dedicated BWP. A single SSB is enough if a SSB position can be found that allows two UEs placed at either end of the frequency allocation and still receive the SSB within their respective dedicated BWPs, obviously as long as the configuration on each cell in this “one cell” approach is ~~otherwise~~ configured in compliance with the RAN1/2/4 specifications.
* RAN1 specifications allow for configuring staggered SSBs and CORESET#0s on the same frequency so that UEs configured with left and right channels of the next smaller regular size can track their own time staggered SSB and CORESET#0.

**RAN4 question:**

For the overlapping CBWs from UE perspective (two cell approach / CA approach):

* + if two different Bandwidth Parts for the UE are overlapping, and both contain a subset of CSI-RS resources that are mapped to the same subset of overlapping RBs for the same UE, please clarify how does UE report CSI for the overlapped part, e.g. does UE report CSI for each cell separately, or just once for the overlapping part, or something else?
  + clarify how PDCCH reception in overlapped CA when PCell and Scell PDCCH resources partially overlap and whether there are any impacts to cross-carrier scheduling

**RAN1 answer:**

* RAN1 specification do not restrict ~~prevent~~ configuring overlapping carriers for CA for a single UE. However, RAN1 would like to note that in Rel-15/16 RAN1 did not discuss UE capabilities for overlapped CA in Rel-15/16, and it is RAN1 understanding that RAN2-specified UE capability signalling does not provide any possibility for UE to indicate support for overlapped CA.
* In case of CA, the CSI-RS measurement and reporting for the component carriers are specified in TS38.213 to be performed independently per-carrier and PDCCH monitoring are also specified in TS38.213 to be performed independently for each component carrier.
* gNB scheduler is responsible for avoiding collisions of different transmissions ~~in general, this would be the case~~ as a network restriction for the overlapping part with overlapped CA including cross-carrier scheduling as well.
* RAN1 would like to note that overlapped CA configuration case has not been considered in RAN1 and the UE capabilities agreed in RAN1 for Rel-15/16 were not designed to be able to indicate UE’s support for overlapped CA configuration.

**RAN4 question and RAN1 answer:**

* For the overlapping CBWs from UE perspective (one cell approach):
  + Is it possible to configure the UE with a dedicated *carrierBandwidth* in the *ServingCellConfig* that is wider than/partially outside the *carrierBandwidth* configured in SIB1?

RAN1 answer: RAN1 leaves the configuration related question for RAN2 to answer.

* + Clarify for equalization purposes in the DL, does the BS need to know the split between the subset of PRBs from a main RF carrier versus PRBs from an additional RF carrier are received on different channel/antenna before combining. If pre-coding assumes all PRBs experience the same channel/antenna, is signalling required so that BS pre-coding can account for the path differences of main carrier PRBs and additional carrier PRBs.

RAN1 answer: RAN1 has not evaluated, nor plans to evaluate the need for the gNB to know this aspect.