**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-210XXXX**

**Electronic Meeting, 12th – 20th April, 2021**

**Agenda item:** 9.2

**Source:** Moderator (Ericsson)

**Title:** Email discussion summary for [98-bis-e][141] FS\_NR\_eff\_BW\_util

**Document for:** Information

# Introduction

This email discussion is for FS\_NR\_eff\_BW\_util study item. The main objective of the study is on efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidth. The following is the agreed agenda:

* Study on Efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidths
  + General and work plan
  + Evaluation of use of larger channel bandwidths than operator licensed bandwidth
  + Evaluation of use of overlapping UE channel bandwidths
  + Others

The following topics are discussed in this email thread:

Topic #1: General TR

Topic #2: Evaluation of Use of Larger Channel Bandwidth

Topic #3: Evaluation of Use of Overlapping UE Channel Bandwidths

# Topic #1: General TR

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2106690 | Ericsson, Nokia, Nokia Shanghai Bell | **Observation:** Current definition of irregular bandwidth is not aligned between agreed WFs [1][2]. Interested companies are encouraged to provide opinon/views on whether “not a multiple of 5 MHz” shall be part of the definition for irregular bandwidth study.  **Irregular bandwidth:** an NR bandwidth that is not a multiple of 5 MHz and is not defined in Rel-17 |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 1-1: Irregular bandwidth definition**

* Proposals
  + Option 1: Update TP (R4-2106690) with Irregular bandwidth definition as: an NR bandwidth that is not a multiple of 5 MHz and is not defined in Rel-17
  + Option 2: Update TP (R4-2106690) Irregular bandwidth shall be defined as: an NR bandwidth that is not defined in Rel-17
  + Option 3: Approve current version of TP (R4-2106690)
  + Note: Additional comments can be captured relating to the TP in Section 1.3.2 that do not pertain to the irregular bandwidth definition discussion
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

*One of the two formats, i.e. either example 1 or 2 can be used by moderators.*

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| --- | --- |
| **Company** | **Comments** |
| DISH | Sub topic 1-1: Option 1 seems ok.  Sub topic 1-2:  ….  Others: |
| ZTE | Option 2 slightly preferred since an operator can anyway request a new CBW in multiple of 5MHz in Rel-17. |
| Huawei | Options 2 is more general and will be ok to us |
| T-Mobile USA | Option 2: It is more general, and the techniques should also apply to 55, 65,etc. MHz |
| Nokia | Option 2, “not a multiple of 5 MHz” is redundant since all defined channel bandwidths are with multiple of 5MHz. |
| OPPO | Option 2 |
| Skyworks | We prefer option 1 as it clarifies for the future also we should consider if it should have an additional criteria to be a multiple of 1MHz |

### TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2106690 | ZTE: In A.5 (Overlapping UE CBW from UE perspective), it implies that one UE may have multiple carriers at the same time, which may work either in CA or DC, and in A.6 (Overlapping CA), it partially repeats A.5 when the UE works in CA mode. |
| Huawei: in A.6, both BS and UE can work in overlapping CA mode. |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic #1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

# Topic #2: Evaluation of Use of Larger Channel Bandwidth

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2104600 | CMCC | Observation 1: The number of usable RBs for a given irrgegularBW should be equal to or smaller than existing immediately lower channel BW.  Observation 2: SSB should be placed on the sync raster and the overlapping frequency between WiderBW and SmallerBW. |
| R4-2104886 | Apple Inc | Observation 1: Using the next smaller channel bandwidth can be acceptable when the difference between the bandwidth of the operator’s spectrum and the next lower channel bandwidth is not large.  Observation 2: Using the next larger channel bandwidth can be acceptable when the difference between the bandwidth of the operator’s spectrum and the next larger channel bandwidth is not large.  Observation 3: If the next larger channel is relatively large, then the overall utilisation becomes lower, which is especially the case for 30kHz SCS.  Observation 4: Using the next larger channel bandwidth require further 3GPP efforts to define number of schedulable RBs and to check ACS with the emission requirements.  Proposal 1: Capture in the SI TR further technical details on how next larger channel solution can be used to support irregular channel bandwidth.  Proposal 2: For the next larger channel solution, RAN WG4 should work further on how to ensure emission and ACS requirements. |
| R4-2106485 | Huawei, HiSilicon | Observation 1: for co-located adjacent channel deployments, widerCHBW in DL is applicable.  Observation 2: for non-collocated adjacent channel deployments, widerCHBW in DL is not applicable.  Observation 3: for co-located adjacent channel deployments, widerCHBW in UL is applicable for BS.  Proposal 1: WiderCHBW is only applicable for co-located adjacent channel deployments, and no new RF requirement is needed |
| R4-2107253 | Skyworks Solutions, Inc. | Proposal 1 on WiderCHBW:  • WiderCHBW alignment and its allocated BWP should be studied depending on the irregular CHBW position in the band  • Dependency of the exact WiderCHBW positioning on the SSB position for the SmallerCHBW used by legacy UE should be studied  • The 11MHz n29 case should be further studied for the best positioning of the 15MHz WiderCHBW. |
| R4-2107328 | T-Mobile USA | Proposal 1: For the next wider channel BW approach, an operator should be able to configure n85 UEs to use the 6 MHz at the bottom of n85 and n12 UEs that don’t support n85 should be able to be configured to use 5 MHz at the bottom of n12.  Proposal 2: RAN4 to incorporate the TP below into TR 38.844. (Company’s comments on TP should be captured in Section 2.3.2 of this email thread) |
| R4-2104587 | Ericsson France S.A.S | Observation 1: For irregular bandwidths between 5 and 10MHz the overlapping UE channel bandwith solution is not possible given the minimum bandwith of CORESET#0. Hence the method of using immediate wider channel bandwidht is suggested.  Observation 2: SU for the blanking approach is equal on both UE and NW side and optimized to the irregular BW.  Observation 3: SU for the overlapping UE CHBW approach will not provide any end user gain for a deployed irregular bandwidth.  Observation 4: A “legacy” UE not indicating ensured support for unwanted emission while blanking will still be able to attach to the NW but be configured with a smaller UE CHBW providing lower SU.  Observation 5: Additional UE Emission requirements might need to be developed (in a possible WI phase)  Observation 6: The blanking method will need implementation changes for both the NW/base station as well as a UE.  Observation 7: A reduced set of requirements for the irregular bandwidth, only regulatory emissions requirements, are required for irregular bandwidths if next largest standardized bandwidth is supported.  Observation 8: “Fall back” mode to the small regular BW can be used and handled by NW implementation for scenarios where near-far effect has potential problems.  Proposal 1: Agree to further extend the blanking approach for irregular bandwidths also larger than 10 MHz.  Proposal 2: Adding UE capability/capabilities that indicate the UEs support for irregular bandwidths.  Proposal 3: Agree to further develop the “immediate wider channel bandwidth” method (a.k.a blanking) for irregular BW’s between 5 and 10MHz. Since this method provides highest possible SU, less complaxity on BS (and possibly UE), shared the implementation burden between NW and UE. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 2-1: WiderCHBW alignment and Allocated BWP placement**

* Proposals
  + Option 1: SSB should be placed on the sync raster and the overlapping frequency between WiderBW and SmallerBW.
  + Option 2: legacy UEs using SmallerCHBW might use the same SSB to access IrregularCHBW
* Recommended WF
  + TBA

### Sub-topic 2-2

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 2-2: Spectrum Utilization of irregularBW**

* Proposals
  + Option 1: UE SU of smallerCHBW (legacy UEs) and BS in UL SU of irregularBW
  + Option 2: SU is equal on both UE and NW side and optimized to the irregular BW.
  + Option 3: SU > 90% only on NW side
  + Option 4: The number of usable RBs for a given irregularBW should be equal to or smaller than existing immediately lower channel BW
    - If not then reconsider irregularBW to be further studied
* Recommended WF
  + TBA

### Sub-topic 2-3

*Sub-topic description: Regulatory Requirements*

*Open issues and candidate options before e-meeting:*

**Issue 2-3: Near-Far Effects in adjacent channel deployments**

* Proposals
  + Option 1: Emissions requirements for co-located scenarios for BS and the ACS/blocking for UE can be relaxed
  + Option 2: “Fall back” mode to the small regular BW can be used and handled by NW implementation for scenarios where near-far effect has potential problems.
  + Option 3: WiderCHBW is only applicable for co-located adjacent channel deployments, and no new RF requirement is needed
  + Option 4: Assume WiderCHBW guard band used on UE (e.g. 15kHz/6 MHz irregularBW assumes associated guard band for 10 MHz with guard of 312.5 kHz)
  + Option 5: UE receiver will by design not be completely blocked but continue to work, although the ACS performance may be degraded compared to a UE designed for the operator’s spectrum. The degradation due to WiderCHBW approach is a draw back which is tolerable
* Recommended WF
  + TBA

**Issue 2-4: Tx Emissions Mask**

* Proposals
  + Option 1: Emissions requirements for co-located scenarios for BS can be relaxed
  + Option 2: Use existing emissions mask defined for WiderCHBW
  + Option 3: Define new emissions mask for irregularBW
* Recommended WF
  + TBA

**Issue 2-5: UE ACS and Blocking**

* Proposals
  + Option 1: For co-located BS scenarios the ACS/blocking for UE can be relaxed
  + Option 2: WiderCHBW alignment and its allocated BWP depending on the irregular CHBW position in the band prior as input to ACS/blocking requirements
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1

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| --- | --- |
| **Company** | **Comments** |
| DISH Network | In general, we prefer to list multiple options as methods to use irregular BW’s. While we don’t advocate usage of wider BW’s, we are OK to have them listed as one of the options. The outcome of this study should be something that works for irregular BW’s. If we target to include only one option that is ok for all as the only option, then we are afraid the study would be concluded with no feasible alternatives. |
| ZTE | Option 2. It should be guaranteed that a UE can access to the irregular BW via SmallerCHBW. |
| Huawei | We did not see the dependency between the two options |
| Nokia | Further study is needed regarding SSB placement as discussed in R4-2107253. |
| OPPO | Option 2 |
| Ericsson | Option 2 should be used to ensure UE can search for SSB |
| Skyworks | At least one SSB and smaller BW channel should be available for legacy UEs. As shown in our paper, the wider BW may reuse the same SSB but the wide BW alignment and its allocated BWP may be aligned in different ways to benefit form the RF filter if the irregular BW is at a band edge (which is the case for many of the band/BW that are discussed). We believe this option can be used in complement of other options. |

Sub topic 2-2

Moderator comment: there is type-o corrected with correct Option 4 label

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| **Company** | **Comments** |
| ZTE | Option 3 (>90% at NW side): rom UE perspective, no matter single carrier (SmallCHBW) or multiple carriers (Overlapping CA) is used for irregular BW, the carrier bandwidth is anyway defined in the existing CHBW set, so SU for irregular BW has meanings only at NW side. |
| Nokia | SU shall be at least 90%, otherwise the feature is not attractive. |
| OPPO | Option 3. Same view as ZTE. |
| Ericsson | Option 4: If SU of irregularBW is not >= 90% using WiderCHBW approach then the SmallerCHBW should be used for the irregularBW |
| Skyworks | SU is understood here as the SU at the network level. This may be dictated by both legacy UEs and UEs using widerBW thus wider BW may have a slightly lower SU than the network. |

Sub topic 2-3

|  |  |
| --- | --- |
| **Company** | **Comments** |
| DISH Network | Issue 2-3: None of these options work well at least in US as the irregular BW is in most if not all cases adjacent to other operator. Hence operator has very limited control on co-location.  Issue 2-4: Somehow the regulator requirements must be met; RAN4 should find the most convenient way for that. If the definition of new emission masks for irregular BW can be avoided, good, but are there any alternatives?  Issue 2-5: None of these options work well at least in US as the irregular BW is in most if not all cases adjacent to other operator. Hence operator has very limited control on co-location.  ….  Others: |
| ZTE | Issue 2-3:  Option 2 if considering its simplicity.  Issue 2-4:  Option 3 seems inevitable because it is not clear on what is the minimum requirement for the emission in the gap between irregularBW and WiderCHBW.  Issue 2-5:  Strictly speaking two options listed here are not in parallel. They are talking about different things.  ….  Others: |
| Huawei | Issue 2-3:  Option 3, but the applicable scenario is quite limited.  Issue 2-4:  Option 1, we can check whether it needs new requirement for co-located scenario.  Issue 2-5:  Option 1, we can check whether it needs new requirement for co-located scenario. |
| Nokia | Issue 2-3: Near-Far Effects in adjacent channel deployments  The coexistence shall be ensured for non-collocated deployment with the same ACLR/ACS level as legacy channels, otherwise this feature is useless. The presented options are not providing any coexistence solution.  Issue 2-4: Tx Emissions Mask  The coexistence cannot be ensured with option 1 and 2. That’s why we are proposing to assume the overlapping legacy channel bandwidths so that the filter characteristics follow the smaller legacy channels and the coexistence can be ensured.  Issue 2-5: UE ACS and Blocking  How coexistence would be guaranteed with proposed options? |
| OPPO | **Issue 2-3: Near-Far Effects in adjacent channel deployments**  Option 2, “Fall back” mode to the small regular BW can be used and handled by NW implementation for scenarios where near-far effect has potential problems.  **Issue 2-4: Tx Emissions Mask**  If this relates to regulation requirements, then Option 3 (Define new emissions mask for irregularBW) needs to be defined.  **Issue 2-5: UE ACS and Blocking**  Option 1. For co-located BS scenarios the ACS/blocking for UE can be relaxed |
| Ericsson | **Issue 2-3: Near-Far Effects in adjacent channel deployments**  Support Option 2: “Fall back” mode to the small regular BW can be used and handled by NW implementation for scenarios where near-far effect has potential problems.  **Issue 2-4: Tx Emissions Mask**  A minimum set of BS requirements are needed from regulatory point of view such as TX emissions. Therefore as part of a subset of requirements rather than a full set of requirements (as would be done for NR regular BWs) irregular BWs would require a SEM for each irregular BW. Support Option 3. |
| Skyworks | Issue 2-3: Even if collocated scenario is not the main scenario it can be at least aknowledge that widerBW approach is well suited for this and if near-far issue arises the UE could fall back to smaller BW  For non-collocated scenarios where the irregular BW is at the band edge a shifted widerBW may work well. And some band/BW proposed cases correspond to this.  Issue 2-5: at least in some cases the ACS and blocking may need lower relaxation at band edges. Option2 is worth studying further and corresponding cases identified |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2107328 | ZTE: Perhaps better to wait until n85 is completed. |
| T-Mobile USA: To ZTE: While we agree that n85 cannot be part of a WI until the n85 WI is complete, we hope that we will be able to document anticipated operator requirements in the SI TR. Because this band has an aspect that is different than any other band, we would like to make sure it is considered |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Topic #3: Evaluation of Use of Overlapping UE Channel Bandwidths

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2104599 | CMCC | Observation 1: legacy BWP configuration allows configuring a BWP that is not centred on 100KHz channel raster.  Observation 2: If carriers are not centred around a channel raster frequency  • in LTE-NR co-existence scenario, there may be some problem  • in NR only scenario, existing specs only allow carriers centred around channel raster and need to be revisited  Observation 3: Both single SSB and multiple SSBs should be supported for overlapping CBWs. |
| R4-2107253 | Skyworks Solutions, Inc. | Proposal 2 on overlap from network point of view:  • One of the channel shall use SmallerCHBW and use the current SSB and channel raster (legacy UE channel)  • The second channel also uses SmallerCHBW and should be RB aligned with legacy UE channel and should be applicable to UE supporting overlap from network point of view  • UEs supporting WiderCHBW should not be precluded to operate in a network using overlapped channels and should be able to align with the legacy UE channel at least  Proposal 3 on overlap from UE point of view: Unless it can be demonstrated that better DL performance is obtained versus using a BW part of the immediately higher BW as optional UE support, overlap from UE point of view should not be the priority to study. |
| R4-2104707 | Qualcomm Incorporated | Regarding the overlapping CBW for spectrum allocations narrower than 10MHz, it should be possible to serve UEs that are assigned channels anywhere within the spectrum block as this will be a deployment choice.  Regarding the frequency alignment, if a channel is not placed on a valid channel raster position, the UE will most likely not use this channel since it is not certified to work in it. Whether it would be feasible to design a UE that would be able to use such channel, this is possible, however, the system level gains do not justify the added complexity. |
| R4-2104887 | Apple Inc. | Observation 1: Overlapping carriers can utilise the whole spectrum of "non-standard" channels.  Observation 2: To use the full spectrum with overlapping carriers from the network perspective, the network needs to support the full bandwidth, while from the UE perspective existing standard channels can be used.  Observation 3: While overlapping carriers provide good utilisation for 15kHz SCS, this solution becomes less efficient for 30kHz and provides good spectral utilisation only for certain channel bandwidths.  Observation 4: Overlapping carriers from the network perspective do not require any UE side enhancements, and thus approach can be used with any legacy device.  Observation 5: A solution base on overlapping channels (RF carriers) from the UE perspective still assumes a single baseband and a component carrier.  Observation 6: From the system perspective, this approach can be viewed as "the next larger channel" whereupon guard bands from the next smaller channel are assumed.  Observation 7: Overlapping channels from the UE perspective do not provide any noticeable gain over solution based on using "next larger channel".  Proposal: Capture in the SI TR further technical details on how overlapping channels from the network perspective can be used to support irregular channel bandwidth. |
| R4-2106486 | Huawei, HiSilicon | Observation 1: for channel bandwidths less than 50 MHz, integer-multiples of 5MHz channel bandwidths are supported/will be supported in BS/UE specifications.  Proposal 1: New dedicated channel bandwidths are not considered for both BS and UE.  Observation 2: The impact to RF core requirements is very limited to support overlapping CA. |
| R4-2106689 | Ericsson | Observation 1: Studying the overlapping CBWs approach needs to take comparison with other approaches for considering additional implementation complexities and system gains.  Observation 2: The SU will be different and “unbalanced” between the NW and a single UE.  Observation 3: RAN4 should consider on a definition on SU for these irregular bandwidth cases.  Proposal 1: Overlapping UE channel bandwidths approach can only be considered for operator block size larger than 10 MHz due to CORESET#0 size. |
| R4-2107040 | Nokia, Nokia Shanghai Bell | Proposal 1: In order to maximize the spectrum utilization while keeping the PRB grid alignment between the main and the additional RF carrier, an alignment of the additional RF carrier with the 100 kHz channel raster is not required.  Observation 1: The proposed method does not have impact to existing RAN2 signalling as well as to RAN1 specifications.  Proposal 2: The study of overlapping channel bandwidths from UE perspective, according to objective 3 of the SID, shall include an approach with a single carrier from baseband perspective, allowing for a single BWP to cover the combined channel bandwidths.  Proposal 3: The PRB grid alignment is mandatory among overlapping channel bandwidths.  Observation 2: Overlapping carriers with two SSBs are less spectrum efficient due to redundant radio resource allocations for common channels and signals. Furthermore, the scheduling of those resources is complicated.  Proposal 4: For spectrum efficiency, solutions with only a single SSB are considered with higher priority than solutions needing a second SSB. Feedback from operators is desired on whether it is sufficient to serve all legacy UEs on the same side of a spectrum block if it is smaller than 10 MHz (e.g. in the main RF carrier's 5 MHz on the left-hand side of figure 2). |
| R4-2107319 | ZTE Corporation | Observation 1: PRB grid should be aligned for the overlapping part of the two carriers, so for the current list of bands intended for irregular channel bandwidth, the distance between the channel raster of the two overlapping channels should be a multiple of 900kHz for both SCS 15kHz and 30kHz.  Observation 2: The minimum guard band at one end should be no less than the minimum requirement by the channel bandwidth next to the end.  Observation 3: Symmetric arrangement of the two overlapping channels are preferred, and the channel bandwidth of each overlapped channel is the immediate larger regular channel bandwidth of the half of irregular bandwidth.  Observation 4: For irregular bandwidth less than 10MHz, a 90% SU can be achieved with a symmetric overlapped channels and the channel raster of the overlapping channels are multiples of 900kHz.  Proposal: Take Option 1 for the case where spectrum blocks is less than 10MHz. |
| R4-2107329 | T-Mobile USA | Proposal 1: For the overlapping UE channel bandwidth approach, an operator should be able to configure n85 UEs to use the 5 and/or 6 MHz at the bottom of n85 and n12 UEs that don’t support n85 should be able to be configured to use 5 MHz at the bottom of n12.  Proposal 2: RAN4 to incorporate the TP below into TR 38.844. (Company’s comments on TP should be captured in Section 3.3.2 of this email thread) |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 3-1

*Sub-topic description: Alignment between overlapping UE channel bandwidths concerns*

*Open issues and candidate options before e-meeting:*

**Issue 3-1: Discuss challenges that comes with Alignment of channel raster vs. Alignment of PRB**

* Proposals
  + Option 1: BWP configuration that is centred on 100 kHz channel raster
  + Option 2: PRB alignment
  + Option 3: PRB grid alignment between the main and the additional RF carrier, an alignment of the additional RF carrier with the 100 kHz channel raster is not required.
* Recommended WF
  + TBA

### Sub-topic 3-2

*Sub-topic description: SSB placement (*R4-2103387, R4-2107040)

*Open issues and candidate options before e-meeting:*

**Issue 3-2: Discuss SSB placement for overlapping channel bandwidths for spectrum blocks narrower than 10 MHz**

* Proposals
  + Option 1: It is sufficient to serve all UEs (including legacy) that operate only at one CBW of 5 MHz on the same side of the spectrum block.
  + Option 2: Serve UEs that operate only at one CBW of 5 MHz on both sides of the spectrum block – even if this requires the overhead due to redundant radio resource allocations for common channels and signals.
* Recommended WF
  + TBA

### Sub-topic 3-3

*Sub-topic description: Companies are encouraged to comment regarding Overlapping CA approach (Solution 2 in R4-2106486)*

Solution 2: Overlapping CA

Overlapping CA for gNB

Overlapping CA for UE3

UE1: legacy channel bandwidth

UE2: legacy channel bandwidth

*Open issues, pros/cons relating to the method before e-meeting:*

1. Single common SSB where the SSB is only configured for PCell
2. The impact to RF core requirements is very limited to support overlapping CA.
3. RB alignment is not needed only subcarrier alignment is required with channel spacing multiple of 300 kHz
4. Spectral utilization is >= 90% for 15kHz for all irregularBW

### Sub-topic 3-4

*Sub-topic description: Companies are encouraged to comment regarding Overlapping CBW with combined UE CBW (Figure 1 in R4-2107040)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| UE's 1st channel bandwidth, e.g. 5 MHz | | |  |  |
|  |  | UE's 2nd channel bandwidth, e.g. 5 MHz with 2 MHz offset | | |
| Combined UE channel bandwidth, e.g. 7 MHz | | | | |

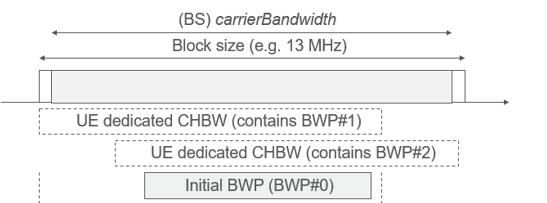
*Open issues, pros/cons relating to the method before e-meeting:*

1. UE’s combined channel bandwidth is equal to irregularBW
2. No impact to RAN2 signaling as well as to RAN1 specifications
3. No additional channel filters need to be designed and tested
4. UEs supporting non-continuous intra-band CA have at least two RF carriers support capability therefore hardware support is already available in downlink

### Sub-topic 3-5

*Sub-topic description: Companies are encouraged to comment regarding Overlapping carriers from the network perspective (Figure 2.1-2 in R4-2104887, Figure 1 in R4-2106689)*





*Open issues, pros/cons relating to the method before e-meeting:*

1. Carriers can be configured on raster points that correspond to the least common multiple of the channel raster and the RB size. (i.e. more flexible options and case-by-case scenarios)
2. UE dedicated CHBW need not be the same
3. Using next larger channel will always provide better performance (compared to overlapping carriers from network perspective) from an individual UE perspective
4. Initial BWP (BWP#0) does not align/fit between overlapping UE CHBWs for < 10 MHz irregularBWs

## Companies views’ collection for 1st round

### Open issues

Sub topic 3-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | Issue 3-1:  Options listed in this issue are not directly comparable.  Others: |
| Huawei | Issue 3-1:  For overlapping CA, the PRB alignment is not needed. While for single BB carrier, the PRB should be aligned. |
| Nokia | Issue 3-1:  Option 3, in order to maximize the spectrum utilization. Alignment of the additional RF carrier with the 100 kHz channel raster would reduce spectrum utilization by up to two RBs for considered scenarios (see R4-2107040). |
| Ericsson | Issue 3-1:  In order for UE to be able to perform initial access SSB need to be placed on 100 kHz channel raster. Support Option 1. Alignment between 2nd UE CHBW (overlapping) it would be up to the approach how this should be handled (PRB or 100 kHz raster) |
| Skyworks | To enable legacy UEs at least one of smallerCHBW should be on the 100KHZ rater and the corresponding SSB raster.  PRB alignment is needed for cases where SSB is in the overlapped region, this is the case for irregular BW <15MHz for wider bW there is only 11RB (<180kHz) to gain. We do not see significant benefit from nor being RB aligned. The main constraint that needs some relaxation would be the intrinsic 900KHz multiple but since we are looking at 1MHz increment this may not be a significant issue. We are fine to further study option 3 at least for overlapping form a network prospective only. |

Sub topic 3-2

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| **Company** | **Comments** |
| DISH Network | Issue 3-2: Couldn’t we capture both of these as alternatives? Option 2 is very straightforward from UE side and can be supported by Rel-15 devices. Option 2 has it’s Pro’s as well.  ….  Others: |
| ZTE | Issue 3-2:  Option 2. We would expect there is some gain of Option 2 over Option 1.  ….  Others: |
| Huawei | Issue 3-2:  It could be left to network’s choice and both can work. |
| Nokia | Issue 3-2:  Option 1 since Option 2 is less spectrum efficient due to redundant radio resource allocations for common channels and signals. Furthermore, the scheduling of those resources would be complicated (if aggregated channel bandwidth is not large enough (<10 MHz) to carry two non-overlapping SSBs, two SSB transmissions may conflict each other in frequency domain and may be transmitted in a staggered manner in time domain). |
| OPPO | **Issue 3-2: Discuss SSB placement for overlapping channel bandwidths for spectrum blocks narrower than 10 MHz**  Option 2, Serve UEs that operate only at one CBW of 5 MHz on both sides of the spectrum block – even if this requires the overhead due to redundant radio resource allocations for common channels and signals. |
| Ericsson | Issue 3-2:  These options were agreed in last RAN4 meeting in WF R4-2103387 however it doesn’t seem clear to us how serving only one CBW of 5 Mhz would assist in the 7 MHz irregularBW as an example. For the amount of implementation efforts we believe that irregularBW < 10 MHz would require quite extensive coordination on the gNB side for SSB coordination using TDM of SSB rather than the single SSB alignment for irregularBW > 10 MHz for overlapping UE approach. |

Sub topic 3-3

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| **Company** | **Comments** |
| ZTE | Open issues:   1. Single common SSB where the SSB is only configured for PCell   Only PCell is discoverable by UEs, so it could have a heavy access burden.   1. The impact to RF core requirements is very limited to support overlapping CA.   Agree. Only a very few requirements need to be revisited.   1. RB alignment is not needed only subcarrier alignment is required with channel spacing multiple of 300 kHz   Not agreed. Non-aligned PRB in the overlapping parts would result in a potential subcarrier fragments.   1. Spectral utilization is >= 90% for 15kHz for all irregularBW   This can be served as a target for the work in this SID. |
| Huawei | To ZTE on RB alignment, even it may result in subcarrier fragments, the subcarrier alignment can have higher SU as discussed in our paper. |
| Nokia | PRB alignment (together with not required alignment of the additional RF carrier with the 100 kHz channel raster) provides higher SU for 7, 11 and 13MHz spectrum blocks (the same SU is observed for 6 and 12MHz spectrum blocks). Not requiring a PRB alignment could cause a gap of some subcarriers that can neither be used by UEs operating in the lower part nor by those operating in the upper part of the spectrum. Hence not requiring a PRB grid alignment would not increase the cell capacity. |
| Ericsson | To our understanding the “UE1” BW is considered to be PCell and “UE2” is SCell and by means of Carrier Aggregation they are combined into “UE3”. IS this correct understood?  Is the overlapping part scheduled in only one of the cells after a UE is configured with CA? |
| Skyworks | Since it was agreed that RB alignment is needed anyhow for common or non exclusive SSBs we do not see that RB alignment restriction would be a large penalty for the wider BW and could be compatible with wider BW approach and overlapping from NW prospective  Also we are not sure about the overall benefit if many UEs anyhow use smallerBW (like UE1 and UE2) thus that overlap from network point of view is that main feature  It is unclear to us if UE3 in the figure has its RF configured like for a single widerBW channel (1LO) or two smaller BW channels (two LO) in general it would be good that the UE RF and BB configurations are clear for all the overlapping options. |

Sub topic 3-4

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| **Company** | **Comments** |
| ZTE | *Open issues, pros/cons relating to the method before e-meeting:*   1. UE’s combined channel bandwidth is equal to irregularBW   Yes, however, we could use an existing term “aggregated CBW”, no need to introduce a new term “UE’s combined CBW”.   1. No impact to RAN2 signaling as well as to RAN1 specifications   Agree.   1. No additional channel filters need to be designed and tested   Agree.   1. UEs supporting non-continuous intra-band CA have at least two RF carriers support capability therefore hardware support is already available in downlink   Agree. |
| Huawei | We do not agree on the statement “an alignment of the additional RF carrier with the 100 kHz channel raster is not required”. The UE is verified with 100 kHz channel raster hence the 100 kHz should be fulfilled. |
| Nokia | On top of benefits of this proposal, also the following is observed:   * future proof solution (not limited to considered spectrum blocks within this SI) * ensured co-existence with very limited impact to RF core requirements (adopt 5/10MHz existing requirements for each overlapping carrier) * SU >=90% * the signalling overhead for the additional RF carrier is small since there is only one carrier from baseband perspective   To Huawei: Not required alignment of the additional RF carrier with the 100 kHz channel raster (together with PRB alignment) provides higher SU. Statement above would apply only to new UEs (which would support this feature) when using additional RF carrier. UEs with 100kHz channel raster would use main carrier. |
| OPPO | Question for clarification:  1. How the 2nd CC is configured to UE via CA or DC? If via the IE *SCS-SpecificCarrier*, not sure whether it is possible to configure the RBs out of CC width.  2. For the overlapping part of two CBW, is it only applied to one CBW rather than two CC?  3. Does UE is required to implement two separate TRx chain to support the whole irregular BW? |
| Nokia | To Oppo:  1. There is one carrier only from baseband perspective.  2. As above, there is one carrier only for new UE from baseband perspective, which is a composite of two RF carriers. The entire bandwidth can be always accessed.  For legacy UE with legacy channel bandwidth, the overlapping part is a part of legacy channel bandwidth.  3. The assumption is UEs which would support this feature have capability of non-contiguous intra-band DL CA. Single Tx chain and two RF Rx chains would be used. |
| Ericsson | It is not possible to configure a BWP that is outside the Carrier Grid.  According to TS38.211, the following is stated “*The starting position and the number of resource blocks in a bandwidth part shall fulfil and , respectively. Configuration of a bandwidth part is described in clause 12 of [5, TS 38.213].*”  It is possible to locate a BWP in a wide region but it cannot be configured. |
| Skyworks | It would help to clarify the underlying UE architecture. How many LO, which channel BW each “carrier” it is configured with….at RF and at BB. |

Sub topic 3-5

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| **Company** | **Comments** |
| DISH Network | Open issue #3 statement is technically confusing. How come it is possible to say that using larger BW is always better from individual UE perspective?  Open issue #4 is irrelevant, as there is a possibility to use 2 SSB’s staggered in time. |
| ZTE | *Open issues, pros/cons relating to the method before e-meeting:*   1. Carriers can be configured on raster points that correspond to the least common multiple of the channel raster and the RB size. (i.e. more flexible options and case-by-case scenarios)   Yes, it can be further elaborated as 900kHz = LCM(100k,180k) for SCS 15kHz.   1. UE dedicated CHBW need not be the same   Agree. However, a symmetric arrangement (i.e., immediate larger CBW of the half irregularBW at each side) could be preferrable.   1. Using next larger channel will always provide better performance (compared to overlapping carriers from network perspective) from an individual UE perspective   Not agreed. It depends on deployment scenarios and size of BWs and UE locations etc.   1. Initial BWP (BWP#0) does not align/fit between overlapping UE CHBWs for < 10 MHz irregularBWs   Yes for BW > 7MHz and less than 10MHz, but for 6MHz, it is possible. |
| Huawei | Issue#1: Overlapping CA do not require RB alignment  Issue#3: it depends. As said the applicable scenarios is quite limited for use of next wider channel bandwidth.  Issue#4: Agree with DISH comments. |
| Nokia | Issue 3: It is challenging to compare it without clarification on WiderCHBW requirements (including internal guard band) to guarantee co-existence with adjacent channels. It has been shown overlapping channel BWs from UE perspective has very high SU thanks to small guard band and signalling overhead for the additional RF carrier.  Issue 4: Agree with Dish. However, solution with two SSBs is less spectrum efficient due to redundant radio resource allocations for common channels and signals. Furthermore, the scheduling of those resources is complicated. |
| Skyworks | From our understanding, the main difference is the 900kHz raster constraint and the fact that overlap is from network only. Which anyhow is a possibility for the the other approaches. With RB alignment, this may also be compatible with widerBW. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2107329 | ZTE: Better to wait until n85 is completed. |
| T-Mobile USA: To ZTE: While we agree that n85 cannot be part of a WI until the n85 WI is complete, we hope that we will be able to document anticipated operator requirements in the SI TR. Because this band has an aspect that is different than any other band, we would like to make sure it is considered |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
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Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents