**3GPP TSG-RAN WG4 Meeting # 97-e-Bis R4-210XXXX**

**Electronic Meeting, 25th January – 5th February 2021**

**Agenda item:** 12.3

**Source:** Moderator (Ericsson)

**Title:** Email discussion summary for [98e][147] 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
  + Input on operator licensed channel bandwidths in FR1 that do not align with existing NR channel bandwidths
  + Evaluation of use of larger channel bandwidths than operator licensed bandwidth
  + Evaluation of use of overlapping UE channel bandwidths (from both UE and network perspective)
    - UE perspective
    - Network perspective
  + Others

The following topics are discussed in this email thread:

Topic #1: Workplan, TR Updates

Topic #2: Evaluation of Use of Larger Channel Bandwidth

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

# Topic #1: General Work Plan and TR

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2100804 | CMCC | Proposal 1: Generic solution(s) should be prioritized in the study item and restriction on the irregular bandwidth request and step size are not required.  Proposal 2: Study only 15KHz SCS for bandwidth<10MHz, and both 15KHz and 30KHz SCS for bandwidths>10MHz.  Proposal 3: Do not consider the solutions which have low spectral utilization for 30KHz SCS, low spectral utilization means that the number of usable RBs is equal or smaller than next lower supported channel bandwidth..  Proposal 4: In order to meet the regulatory requirements, it is not suitable for uplink transmission with the next higher channel BW, downlink transmission with the next higher channel BW can be considered assuming no new requirements for ACS/blocking/REFSENS. |
| R4-2101555 | Ericsson | Updated TR 38.844 v0.0.2 |
| R4-2102288 | Skyworks Solutions, Inc. | Proposal 1:   * 30 kHz SSB is not applicable to Band n5 irregular channel bandwidth (at least for 7 MHz) * Only 30 MHz UE bandwidth is considered for 33 MHz in Band n28 with current position limitations (note 7 in 38.101-1 Table 5.3.5-1) * For Band 29, current maximum BW is 10 MHz but since it is a DL only band and thus no regulatory emissions apply, support of 11 MHz can be studied * To enable legacy UEs use of immediately lower channel bandwidth with overlap form Network only should be the baseline operation Use of the immediately higher bandwidth is not supported in UL to avoid specifying and testing NS related emissions, if needed asymmetric UL/DL UE operation can be used   Proposal 5:   * Irregular channel bandwidths should be an integer multiple of 1 MHz * Applying irregular channel bandwidths agreed in this SI to new bands should be done with agreement at plenary * Adding new irregular channel bandwidths in this SI to existing or new bands should be done with agreement at plenary |

## 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: Numerologies for study prioritization*

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

**Issue 1-1: Subcarrier spacing SI scope**

* Proposals
  + Option 1: Update SID to only consider 15 kHz SCS for BW < 10 MHz, both 15 kHz and 30 kHz for BW > 10 MHz
  + Option 2: Other
* Recommended WF
  + Update SI Scope to align with Option 1

### Sub-topic 1-2

*Sub-topic description: Channel bandwidth updates*

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

**Issue 1-2: Irregular Channel Bandwidths SI scope**

* Proposals
  + Option 1: Update the study to reflect the following:

|  |  |
| --- | --- |
| Band (s) | Channel Bandwidth(s) |
| n5 | 7 11MHz |
| n12 | 6,12 MHz |
| n26 | 7 MHz |
| n28 | 13 MHz |
| n29 | 6, 11 MHz |

* + Option 2: Other
* Recommended WF
  + Update SI Scope to align with Option 1

### Sub-topic 1-3

*Sub-topic description: Spectral Utilization Considerations*

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

**Issue 1-3: Do not consider Operator licensed bandwidths with low spectral utilization**

* Proposals
  + Option 1: Only SCS/BW combinations which have number of usable RBs higher than the next lower supported channel bandwidth should be considered in SI.
  + Option 2: Only spectral utilization of 90% or higher operator licensed bandwidth (with 15 kHz or 30 kHz SCS) should be considered in SI
  + Option 3: Use cell throughput as figure of merit, i.e. only SCS/BW combinations which overall throughput increase compared with next lower supported channel bandwidth
  + Option 4: Use UE throughput as figure of merit, i.e. only SCS/BW combinations which overall throughput increase compared with next lower supported channel bandwidth
  + Other
* Recommended WF
  + TBA

### Sub-topic 1-4

*Sub-topic description: Updated TR*

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

**Issue 1-4: Agree Updated TR**

* Recommended WF
  + Agree R4-2101555

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  **Issue 1-1: Subcarrier spacing SI scope**  Sub topic 1-2:  **Issue 1-2: Irregular Channel Bandwidths SI scope**  Sub topic 1-3:  **Issue 1-3: Do not consider Operator licensed bandwidths with low spectral utilization**  Sub topic 1-4:  **Issue 1-4: Agree Updated TR**  ….  Others: |
| Huawei | Sub topic 1-1: ok with option 1. Furthermore, based on the request, it is also ok to further restrict to 15 KHz SCS for channel bandwidth less than 20 MHz.  Sub topic 1-2: ok with option 1  Sub topic 1-3: option 2 could be a starting point.  Sub topic 1-4: we are not sure if the introduction part is necessary and found it is repeated in clause 4 background. |
| ZTE | Sub topic 1-1:  **Issue 1-1: Subcarrier spacing SI scope**  Fine with the recommended WF (Option 1). Think about the 4 possible values under this restriction only supporting 15k SCS: 6/7/8/9.  Sub topic 1-2:  **Issue 1-2: Irregular Channel Bandwidths SI scope**  Fine with the recommended WF (Option 1) to narrow down the possible candidates at this stage.  Sub topic 1-3:  **Issue 1-3: Do not consider Operator licensed bandwidths with low spectral utilization**  We would like to propose to make a bit change for Option 1. If we take the next lower supported CBW as a baseline as proposed by Skyworks, then the final spectrum utilization should be improved compared with that in the base line. For example, for 6MHz bandwidth, its reference case is CBW 5MHz whose spectrum utilization is 90%, then the spectrum utilization for 6MHz should be larger than 90%, i.e., the number of useable PRBs for 6MHz should be larger than 30 PRBs. With the current wording in Option 1, even 27 PRBs is acceptable, but is not intended at all.  Sub topic 1-4:  **Issue 1-4: Agree Updated TR**  Reference [2] should be updated to the latest WID. |
| Skyworks | Sub topic 1-1: Issue 1-1: Subcarrier spacing SI scope: option 1 15kHz <10MHz  Sub topic 1-2: Issue 1-2: Irregular Channel Bandwidths SI scope: option 1: 1MHz multiples and no 33MHz in n28  Sub topic 1-3: Issue 1-3: Do not consider Operator licensed bandwidths with low spectral utilization  We think that we should only consider the cases that allow good SU: for example at least 5RB/additional MHz vs the lower existing BW at 15kHz and at least 2RB/additional MHz vs the lower existing BW at 30kHz  Sub topic 1-4: Issue 1-4: Agree Updated TR. TR may be updated with additional criteria agreed like for 1-3 |
| CMCC | **Issue 1-1: Subcarrier spacing SI scope**  OK with the recommended WF  **Issue 1-3: Do not consider Operator licensed bandwidths with low spectral utilization**  We support option1. And option 3 and option 4 somehow have the similar consideration with option 1. |
| Qualcomm | **Issue 1-1: We support Option 1**  **Issue 1-2: We support Option 1**  **Issue 1-3: It’s not straightforward to pick any of the options because there are several trade-offs between complexity and performance. Option 2 is inline with the original goal of NR but should not be taken as a hard requirement. Option 3 or 4 by themselves are not good criteria as they do not take into account complexity.** |
| Apple | Issue 1-1: Subcarrier spacing SI scope  Option 1 is Ok as a principle.  Issue 1-2: Irregular Channel Bandwidths SI scope  Option 1 is Ok  Issue 1-3: Do not consider Operator licensed bandwidths with low spectral utilization  Option 1 and Option 2 are good as a principle, but we have to be careful with the way Option 2 is formulated. As an example, 6MHz has 90% SU if overlapping channels are used, but it has 87% SU if the next larger channel solution is applied. However, even though overlapping channels provide better SU from the viewpoint of the overall system performance, using next larger channel will provide better performance for an individual UEs. So, it could be up to the operator to decide which solution to use. Last but not least, 30kHz SCS yields lower SU for almost any solution, but an operator may still decide to use 30kHz SCS if so wished due to deployment reasons (e.g. for some TDD band).  Issue 1-4: Agree Updated TR |
| Ericsson | Issue 1-1: Support Option 1  Issue 1-2: Support Option 1  Issue 1-3: Support Option 1. Do not consider operator licensed bandwidth if the next lower channel bandwidth has higher spectral utilization than feasible operator licensed channel bandwidth.  We share the views stated above by Skyworks and ZTE with regards to SU.  Issue 1-4: The TR in R4-2101555 will be updated to capture any agreements at this meeting. |

### 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** |
| XXX | Company A |
| Company B |
|  |
| 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:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

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

|  |  |
| --- | --- |
| **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)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# 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** |
| R4-2101556 | Ericsson | Observation 1: For irregular bandwidths between 5 and 10MHz the overlapping UE channel bandwidth solution is not possible given the minimum bandwidth of CORESET#0. Hence the PRB blanking solution is suggested.  Observation 2: 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 3: SU for the blanking approach is equal on both UE and NW side and optimized to the irregular BW.  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.  Proposal 1: Consider adding a UE capability that indicate the UEs support for irregular bandwidths. |
| R4-2101959 | ZTE Corporation | Observation 1: BS or UE passing the RF conformance testing requirement for larger regular NR channel bandwidth doesn’t mean it could pass the that for lower irregular NR channel bandwidth.  Observation 2: if any irregular NR channel bandwidth defined in MHz units requested to be supported in future, then any fractional sampling in DDC/DUC need also to be supported which will increase lots of implementation difficulty.  Observation 3: if new irregular NR bandwidth requested need significant BW extensions vs the existing maximum supported channel bandwidth, CFR/DPD/DDC/DUC/front-end duplexer module would be impacted. |
| R4-2100522 | Apple Inc. | Observation 3a: 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 3b: 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 3c: If the next larger channel is relatively large, then the overall utilisation becomes lower, which is especially the case for 30kHz SCS..  Observation 3d: Using the next larger channel bandwidth might require some amount of 3GPP efforts to define number of schedulable RBs and to check ACS with the emission requirements. |
| R4-2101459 | Qualcomm Incorporated | Observation 3. Evaluation of the feasibility of configuring a larger channel BW is difficult for both Tx and Rx. |

## 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: Regulatory Requirements for the next larger channel bandwidth approach (BS)*

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

**Issue 2-1: BS RF conformance testing requirement for irregular NR CBW**

* Proposals
  + Option 1: only regulatory emissions requirements are required for irregular bandwidths if next largest standardized bandwidth is supported (and tested)
  + Option 2: all BS RF conformance requirements are required for irregular bandwidth
  + Option 3: no additional BS RF conformance requirements are added for irregular bandwidths
* Recommended WF
  + TBA.

### Sub-topic 2-2

*Sub-topic description: Regulatory Requirements for the next larger channel bandwidth approach (UE)*

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

**Issue 2-2: UE RF conformance testing requirement for irregular NR CBW**

* Proposals
  + Option 1: Use next smaller channel bandwidth approach only.
  + Option 2: Use next larger channel bandwidth and next lower channel bandwidth to ensure ACS requirement is met for irregular bandwidth (i.e. no new ACS requirement is needed if next lower and higher channel bandwidth is supported)
  + Option 3: Define regulatory emission requirements only (including MPR) for UE irregular bandwidth
  + Option 4: Define all UE conformance requirements for irregular bandwidths
  + Option 5: Combine Option 2 and Option 3
* Recommended WF
  + TBA

### Sub-topic 2-3

*Sub-topic description: Feasibility of configuring a larger CBW and implementation concerns.*

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

**Issue 2-3:**

* Proposal 1
  + Use next larger channel bandwidth if the difference between the bandwidth of operator’s spectrum and next channel bandwidth is within [X] MHz.
    - The difference of acceptable channel bandwidth needs to be defined for support for irregular bandwidth definition, possibly on a case by case basis.
* Proposal 2
  + Use the next larger channel bandwidth but only schedule the irregular allocation bandwidth
    - This Proposal suitable for smaller irregular BW’s
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 2-1:  **Issue 2-1: BS RF conformance testing requirement for irregular NR CBW**  Sub topic 2-2:  **Issue 2-2: UE RF conformance testing requirement for irregular NR CBW**  Sub topic 2-3:  **Issue 2-3:**  ….  Others: |
| Huawei | Sub topic 2-1: Option 3, use of larger channel bandwidth can be treated as a implementation solution  Sub topic 2-2: Use of larger channel bandwidth can be treated as a implementation solution |
| ZTE | Sub topic 2-1:  **Issue 2-1: BS RF conformance testing requirement for irregular NR CBW**  For the three options, Option 1 seems not fully in parallel to Option 2/3. As in our contribution, using the immediate larger CBW may have impact on emission and receiver interference suppression requirements. So we would revise Option 1 to “Only impacted requirements are required for irregular bandwidths if next largest standardized bandwidth is supported (and tested)”  Sub topic 2-2:  **Issue 2-2: UE RF conformance testing requirement for irregular NR CBW**  Option 5. If an irregular channel bandwidth is introduced, it should be treated from the scratch.  Sub topic 2-3: |
| Skyworks | Sub topic 2-2: Issue 2-2: UE RF conformance testing requirement for irregular NR CBW  For UL we see that only lower CH BW can be used so no additional testing is needed. For DL, the UE may only use larger CH BW if ACS and blocking requirements are left as for the larger BW. it can be discussed if this may still be beneficial for case where adjacent channels are co-located or when the difference is small (less than 2MHz ie the larger channel has 1MHz extra each side?)  Sub topic 2-3:Issue 2-3: not sure of the two proposals: if the UE uses the next higher channel BW in DL it should center its LO to the useful RBs and only those should be used by the BS |
| Qualcomm | Issue 2-2: Support Option 1.  Using any larger channel bandwidth will create problems and there is no guarantee that regulatory emissions can be met. Also, ACS will be too loose.  Issue 2-3:  WE do not agree with proposal 1, how will we decide X?  We do not agree with proposal 2 either, this will create issues with meeting emissions and ACS. |
| Apple | Issue 2-1: BS RF conformance testing requirement for irregular NR CBW  Issue 2-2: UE RF conformance testing requirement for irregular NR CBW  Option 1 is the legacy behaviour, maybe we do not need to discuss much about it.  The easiest approach would be to consider using next larger channel only for DL provided that 3GPP finds a way to address ACS, i.e. we use only Option 2. Using the next larger channel can be also applied for UL, but 3GPP will have to devise a mechanism that can ensure that all the emission requirements will be met. Option 3 is one example of how the corresponding emission requirements could be met.  Issue 2-3:  Proposals 1 and 2 are not clear. For Proposal 1, it would be difficult to agree on [X]. And proposal 2 is effectively how “using the next larger channel” solution works. |
| Ericsson | **Issue 2-1:** In order to reduce testing effort, and with understanding that regulatory requirements are mandatory for all vendors Option 1 seems to strike a balance of minimum testing whilst ensuring good operability and co-existence.  Option 2 would require as much test time as if specifying a new channel bandwidth. Take for example 6 MHz case, it can be conceived that the requirement levels between 5 MHz and that of 6 MHz would not differ too drastically; perhaps companies who feel that a full suite of tests/requirements can indicate which requirement would be insufficient for taking Option 1?  **Issue 2-2:** Same reasoning and approach as described above in Ericsson comment on Issue 2-1. We support Option 3  **Issue 2-3:**  Proposal 2:  Support this proposal. Suitable for scenarios where irregular operator bandwidth < 10 MHz, for these cases this is the most straight forward solution due to CORESET#0 / Initial BWP size constraint. BS as well as UE requirements might need to be further studied when it comes to unwanted emissions outside the irregular BW. This proposal also makes it possible for legacy UE’s to utilize part of the irregular BW block. |

### 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** |
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| Company B |
|  |
| 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:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### 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)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# 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** |
| R4-2100522 | Apple Inc, | Observation 2a: Contiguous intra-band CA can be used to support non-standard channel bandwidths which are not multiples of 5MHz.  Observation 2b: Contiguous intra-band CA cannot address efficiently small channel bandwidths, which are not multiple of 5MHz, such as 7 and 13MHz.  Observation 4a: Overlapping carriers can utilise the whole spectrum of "non-standard" channels.  Observation 4b: To use the full spectrum with overlapping carriers, the network needs to support the full bandwidth, while from the UE perspective existing standard channels can be used.  Proposal: Capture in the SI TR further technical details on how solutions – next larger channel, overlapping carriers from the network perspective – can be used to support irregular channel bandwidth. |
| R4-2101507 | 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.  Observation 2: In some cases the spectrum utilization of solution 2 is higher than that of solution 1  Observation 3: there is no impact on RAN1 and RAN2 of intra-band overlapping CA to support the irregular channel bandwidth except for capability and necessary RRC signaling to enable the overlapping CA.  Observation 4: The impact to RF core requirements is very limited to support intra-band overlapping CA.  Observation 5: if new BS channel bandwidth is introduced, the impact is significant for RF requirements  Proposal 1: New dedicated channel bandwidths are not considered for both BS and UE.  Proposal 2: Intra-band overlapping CA is optional support from both UE and network perspective |
| R4-2100805 | CMCC | Proposal 1: It is proposed to study the overlapping UE channel bandwidths. New gNB channel bandwidth can be considered to cover the irregular bandwidth.  Proposal 2: Both single and multiple SSBs can be used for overlapping carriers depending on the deployment scenarios and bandwidths.  Proposal 3: SSBs for different carriers can transmit separately in time domain (e.g. different SSB indexes) if there is frequency overlapping between SSBs for different carriers (including both single SSB and multiple SSBs). |
| R4-2101557 | Ericsson | UE Perspective:  Observation 1: Overlapping UE channel bandwidths approach can only be considered for operator block size larger than 10 MHz due to CORESET#0 size.  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. |
| R4-2102288 | Skyworks Solutions, Inc. | Proposal 2: The solutions in following Table are adopted for further study:   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Target BW | SCS | UE CH BW /  RB / SU% | BS RB /  SU % | SSB constraint | other | | 6 MHz | 15 kHz only | 5 / 25 / 75% | 30 / 90% | 15 kHz common in exact 20RB overlap  Need to be on SSB raster point | 50kHz GB shift | | 7 MHz | 15 kHz and  30 kHz | 5 / 25 / 64% | 35 / 90% | 15kHz Partial overlap only, need to be staggered in time and SSB raster point | Lost BW due to SSB resources | | 11 MHz | 15 kHz only | 10 / 52 / 85% | 57 / 93% | Common 15 kHz SSB | 50kHz GB shift | | 12 MHz | 15 kHz and  30 kHz | 10 / 52 / 78%  10 / 24 / 72% | 62 / 93%  29 / 87% | Common 15 kHz SSB | none | | 12.5 MHz | 15 kHz and  30 kHz | 10 / 52 / 75%  10 / 24 / 69% | 62 / 89%  29 / 84% | Use 12 MHz solution | | | 13 MHz | 15 kHz and  30 kHz | 10 / 52 / 72%  10 / 24 / 67% | 62 / 86%  29 / 80% | Use 12 MHz solution | | | 15 kHz only | 10 / 52 / 72% | 67 / 93% | Common 15 kHz SSB | 50kHz GB shift | | 33 MHz | 15 kHz and  30 kHz | 30 / 160 / 87%  30 / 78 / 85% | 170 / 93%  83 / 91% | Common 15 kHz SSB | Not for n28 | | 15 kHz only | 30 / 160 / 87% | 175 / 96% | Common 15 kHz SSB | 50kHz GB shift |   Proposal 3:   * Solution using the immediately higher existing UE channel bandwidth can be further studied for DL only:   + It should be an optional UE capability   + It should be compatible with the default UL/DL operation using immediately lower existing UE channel BW with overlap from network point of view * No change to the EU specification should be assumed and ACS/blocking/REFSENS characteristics are those of the related existing UE channel bandwidth: It may not be feasible for all channel bandwidths and deployments   Proposal 4:   * Overlap from UE point of view is not supported in UL * 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 |
| R4-2102558 | 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.  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.  Proposal 4: It is proposed first to focus on the overlapping channel bandwidths from UE perspective in downlink, where uplink is based on the legacy channel bandwidth.  Observation 1: 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 5: 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).` |
| R4-2101459 | Qualcomm Incorporated | Observation 1. The scheme of configuring different channel BWs at the edges of the gNB bandwidth as depicted in Fig. 1 is compatible with channel bandwidths of 1MHz granularity.  Observation 2: The use of overlapping channel bandwidths from the UE perspective is not justified from a UE throughput increase perspective. |
| R4-2101558 | Ericsson | BS perspective:  Proposal 1: In order to fully define carrier bandwidths for BS an associated spectral utilization would be needed.  Proposal 2: Reduce many permutations of test configurations by limiting only to regulatory emission requirement and testing only. |

## 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: UE channel bandwidth placement/alignment*

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

**Issue 3-1: Overlapping UE channel BW numerology alignment**

* Proposals
  + Option 1: Overlapping UE channel BW to be aligned with PRB grid
  + Option 2: Overlapping UE channel BW to be aligned with 100 kHz raster
  + Option 3: Overlapping UE channel BW to be aligned with PRB grid and 100 kHz raster
  + Option 4: No requirement on UE channel BW alignment
* Recommended WF
  + TBA

### Sub-topic 3-2

*Sub-topic description: Continuous intra-band CA approach*

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

**Issue 3-2: Continuous intra-band overlapping CA approach**

* Proposals
  + Option 1: Use intra-band overlapping CA as optional support from both UE and network perspective
  + Option 2: Use overlapping UE CBW (non intra-band CA approach) from both network and UE perspective
  + Option 3: Use intra-band CA only for large channel bandwidths (approach cannot address small channel bandwidths (e.g. 7, 13 MHz)
  + Option 4: SSB considerations for intra-band overlapping CA approach.
    - Overlapping carriers with 2 SSBs. SSBs for different carriers can transmit separately in time domain (e.g. different SSB indexes) if there is frequency overlapping between SSBs for different carriers (including both single SSB and multiple SSBs).
* Recommended WF
  + TBA

### Sub-topic 3-3

*Sub-topic description: Consideration of overlapping UE CBW (non CA approach)*

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

**Issue 3-3: UL/DL Support**

* + Option 1: Consider overlapping UE perspective is not supported in UL
  + Option 2: Consider overlapping UE perspective is supported in DL and UL
  + Option 3: Others
* Recommended WF
  + TBA

**Issue 3-4: Support overlapping UE CBW approach**

* Proposals
  + Option 1: Consider overlapping UE CBW approach only for irregular bandwidths larger than 10 MHz only
  + Option 2: Single SSB can be utilized if only bandwidths of larger than 10 MHz are considered for overlapping approach
  + Option 3: Consider overlapping UE CBW approach only for irregular bandwidths larger than 10 MHz and use next larger channel bandwidth for irregular bandwidths between 5 and 10 MHz
  + Option 4: Do not support UE CBW approach for all irregular bandwidths
  + Option 5: For overlapping UE CBW, solutions with only a single SSB are considered with higher priority for all irregular BWs. 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.
  + Option 6: Others.
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| XXX | Sub topic 3-1:  **Issue 3-1: Overlapping UE channel BW numerology alignment**  Sub topic 3-2:  **Issue 3-2: Continuous intra-band overlapping CA approach**  Sub topic 3-3:  **Issue 3-3: UL/DL Support**  Sub topic 3-4:  **Issue 3-4: Support overlapping UE CBW approach**  ….  Others: |
| Huawei | Sub topic 3-1: for overlapping CA solution, it should be option 2, and for non-CA solution, it should be option 3.  Sub topic 3-2: we support option 1. Option 2 is the proposal for contiguous CA. For overlapping CA there is no such restriction. And for option 4 we think both single SSB and 2 SSBs can be options depend on the overlapping size.  Issue 3-3: option 1 will be ok  Issue 3-4: disagree option 1 and 3 and such restriction is not necessary. For channel bandwidth less than 10 MHz, overlapping CA and UE channel bandwidth can also be considered. |
| ZTE | Sub topic 3-1:  **Issue 3-1: Overlapping UE channel BW numerology alignment**  As a more generic Option 3: “Overlapping UE channel BW to be aligned with PRB grid and channel raster” (Not only for 100k raster, but also SCS based channel raster). From BS perspective, the overlapped UE CBW should be part of its larger channel bandwidth, which requires alignment of PRB grid. From UE perspective, it is regarded as a normal carrier, which requires aligned to channel raster.  Sub topic 3-2:  **Issue 3-2: Continuous intra-band overlapping CA approach**  Reducing SSB occupation is one of the potential benefits by introducing overlapping CA. And of the first three options, each may be applicable for different cases, so there is no single option.  Sub topic 3-3:  **Issue 3-3: UL/DL Support**  At this stage, we need to consider both UL and DL support for overlapping UE CBW (Option 2).  Sub topic 3-4:  **Issue 3-4: Support overlapping UE CBW approach**  At this stage, Option 5 is reasonable. |
| Skyworks | Sub topic 3-1: **Issue 3-1: Overlapping UE channel BW numerology alignment**  Overlapping (regardless of network/UE/BS) should be PRB aligned and channel raster aligned (at least for one of the overlapping channel so that legacy UEs can still connect with one lower BW channel. This essential as the baseline for the UE should be to be able to connect with at least the lower channel BW.  Sub topic 3-2: **Issue 3-2: Continuous intra-band overlapping CA approach**  Overlapping (intra band CA or channel overlap) should not be supported in UL as it would require specific emission requirements (MPR/AMPR). For DL we are not convinced that overlap form UE prospective brings a significant improvement vs using only overlap from network prospective. For us overlap from network prospective already provides the main benefit of using the entire spectrum available. One aspect that is unclear on intra-band UL CA proposal is whether it requires to define requirements for additional 1/2/3/4MHz? we believe this has larger impact to the spec.  Sub topic 3-3: **Issue 3-3: UL/DL Support**  Overlap form UE prospective is not supported in UL and is not our prefered approach for DL. To justify it we should see if there is any significant cell throughput benefit vs overlap from network only  Sub topic 3-4: **Issue 3-4: Support overlapping UE CBW approach**  Unclear if this is for overlap for UE prospective or networks prospective. From networks prospective, overlapping channel BW can work provided SSB is managed for any BW. W believe that the focus should be anyhow for CH BW from 6 to 19MHz as these are cases where the additional RBs at the networks level have the highest impact. Best case we have about 5RB per additional MHz at 15kHz so above 20MHz the gain is <5%/MHz  ….  Others: |
| CMCC | **Issue 3-1: Overlapping UE channel BW numerology alignment**  Option 3 can be considered as baseline  **Issue 3-2: Continuous intra-band overlapping CA approach**  We support option 1 and option 4.  **Issue 3-4: Support overlapping UE CBW approach**  There is no need to restrict the single SSB transmission or multiple SSB transmissions. For option 5, it is difficult to confirm from operators that whether it is sufficient to serve all legacy UEs on one side of a spectrum block. In our contribution, we provide analysis, both single SSB and multiple SSBs are feasible.  There is also no need to restrict the bandwidth for adopting overlapping CA. The overlapping solution should be applicable to all the irregular bandwidth. |
| Qualcomm | **First of all, this seems to be about overlapping CHBW from the UE perspective. We disagree to use this method because the complexity is not justified. Instead of discussing this options here, we should first discuss whether this method is worth pursuing or not. So far, there is no such agreement.**  **Issue 3-1: Option 3 would be the only one that makes sense in this case. Without PRB alignment, the extra Res cannot be scheduled anyway.**  **Issue 3-2: If overlapping CHBW from the UE perspective is introduced, option 1 is the only possible options. Option 4 is not disjoint from the others.**  **Issue 3-3: Support Option 1**  **Issue 3-4: Support Option 4. These options are not disjoint though.** |
| Apple | Firstly, we would like to echo Qualcomm’s comment that it is not entirely clear which solution – overlapping from the UE or the network perspective – we discuss in each issue. It would be beneficial if we concentrate first on these two major approaches before delving into the details.  Issue 3-1: Overlapping UE channel BW numerology alignment  Option 3. To ensure good SU and compatibility with legacy devices, we need to have both channel raster and PRB alignment. In principle we can have only channel raster alignment, but it will not be possible to schedule all RBs at the same time.  Issue 3-2: Continuous intra-band overlapping CA approach  Overlapping channels from the UE perspective will create a noticeable impact to the UE design and architecture. This solution should be not be pursued since all the major benefits can be achieved with overlapping channels from the network perspective, which can be used with legacy devices.  Issue 3-3: UL/DL Support  For overlapping channel from the network perspective, both DL/UL are supported because from an individual UE perspective this is just a legacy carrier with the standard channel size.  Issue 3-4: Support overlapping UE CBW approach  Firstly, it is not clear whether this issue refers to overlapping channels from the network or UE perspective. Secondly, quite many options are disjoint and belong to different functional aspects. In principle overlapping channels from the network perspective can address any channel bandwidth, so some of the options are very confusing. |
| Ericsson | **Issue 3-2:**  Option 1: Not supporting this, overlapping intra-band CA requires significant co-ordination between the two serving cells that makes up the CA combo. This could remove any benefit for this “variant” of intra band CA compared with a single carrier of a smaller regular BW within the irregular BW block.  Option 2: Could be used for irregular BW > 10MHz only since the CORESET#0 must fit in both overlapping UE CH BW’s. Further studies might be needed.  Option 3: We are open to study this as a possible solution only for large channel bandwidths due to feasibility of intra-band CA approach for smaller bandwidth is not possible. Note: This is “regular” intra band CA with non-overlapping grids.  **Issue 3-4:**  Option 1 &2: Can be a starting point for study, see issue 3-2. |

### 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.*

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| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
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## 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.*

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

*Recommendations on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

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

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| **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)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |