**3GPP TSG-RAN WG4 Meeting # 97-e-Bis R4-201xxxx**

**Electronic Meeting, 2 – 13 November 2020**

**Agenda item:** 13.3

**Source:** Moderator (Ericsson)

**Title:** Email discussion summary for [94e Bis][142] FS\_NR\_eff\_BW\_util

# 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, SID, TR Skeleton

Topic #2: General Aspects for Irregular Bandwidths

Topic #3: Overlapping Channel Bandwidths

# Topic #1: Workplan, SID, TR Skeleton

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2016456 | T-Mobile USA, Ericsson | Revised SID (editorial updates) for information |
| R4-2015721 | Ericsson | Work Plan for Study on Efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidth |
| R4-2015722 | Ericsson | TR Skeleton |

## 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: Work plan discussion for coming meetings*

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

**Issue 1-1: Work plan**

* Proposals
  + Option 1: Work plan in R4-2015721
  + Option 2: TBA
* Recommended WF
  + Comment and approve work plan

### Sub-topic 1-2

*Sub-topic description: TR skeleton and SID revision approval*

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

**Issue 1-2: SID revision and TR skeleton**

* Proposals
  + Option 1: TR skeleton and SID revision approval
  + Option 2: TBA
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Sub topic 1-1: It is not clear what “initial drafts to TR on BS/UE general requirements” mean. It should be allowed to agree on any text proposal in RAN4#98e if TP is stable enough.  Sub topic 1-2: Option 2, revise TR skeleton. For note in 5.6, analysis/study between solutions (whether they are generic according to objective 6) shall be included. Do we need a conclusion Clause? Furthermore, in the No Markup view, the font size in section 4 below the table requires an editorial fix.  ….  Others: |

### 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: General Aspects for Irregular Bandwidths

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014895 | Apple | Summary of observed solutions:  Table 3.4-1: Summary of the solutions.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Option | New channel bandwidth for BS | New channel bandwidth for UE | Specification impact for 38.101 | Full usage of spectrum at BS | Full usage of spectrum at UE | | Carrier Aggregation | No | No | No | Yes/No | Yes/No | | Next smaller bandwidth | No | No | No | No | No | | Next larger bandwidth | No | No | To be checked within this SI | Yes | Yes | | Overlapping carriers | Yes | No | No | Yes/No | No |   Observation 1: Adding new channel bandwidths, which have not been specified yet, will result in significantly higher complexity of use cases and significantly higher development and test effort for the UE.  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 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 and the emission requirements.  Proposal 1: Capture in the SI TR further technical details on how solutions – next smaller and next larger channel, overlapping carriers – can be used to support irregular channel bandwidth. |
| R4-2015723 | Ericsson | Proposal 1: As an initial consideration for nominal granularity consider only 7 MHz between 5- 10 MHz, and 2 MHz steps for 50-100MHz |
| R4-2014507 | 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 * 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 2:   * Usage of the immediately lower existing UE channel bandwidth is the default UE mode of operation in UL and DL * When overlapped immediately lower existing UE channel bandwidths are used only one channel is scheduled to the EU: the overlapping is from network point of view only   Proposal 3: The solutions for lower UE BW 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% | 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 |  | | 15 kHz only | 30 / 160 / 87% | 175 / 96% | Common 15 kHz SSB | 50kHz GB shift |   Observation: The SSB design for 7 MHz and 6 MHz bandwidths needs further study with possible SSB raster points in the actual band and its position within the band to know if the solution is feasible.  Proposal 4:   * 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 * 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 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 |
| R4-2016111 | ZTE | 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. |
| R4-2016201 | Nokia, Nokia Shanghai Bell | Conformance testing needs to take into account that the support of a carrier by overlapping channel bandwidths consumes two RF carriers.  Each of the 2 RF carriers clearly defines the size and position of the guard band on its side of the combined channel bandwidth. This allows for an unambiguous placement of the overlapping channel filters and thus prevents problems with OBUE, ACS or in-band blocking. |

## 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: It is needed to ensure a baseline set of bandwidths of which need to be studied for this SI and approach to discuss future coming irregular bandwidths*

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

**Issue 2-1: Step size for irregular bandwidths for study**

* Proposals
  + Option 1: Integer multiple step irregular bandwidth approach (e.g. 1 MHz, 2 MHz, 5MHz)
  + Option 2: Study only irregular bandwidths requested which do not have immediate issues (e.g. SSB raster alignment, etc)
  + Option 3: Adding new irregular channel bandwidths in this SI to existing or new bands should be done with agreement at plenary
  + Option 4: Applying irregular channel bandwidths agreed in this SI to new bands should be done with agreement at plenary
  + Option 5: 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)
  + Option 6: A generic, future proof solution shall be chosen such that it can support also other possible FR1 frequency blocks than the current requested ones, the bandwidth granularity being determined by the method
* Recommended WF
  + TBA

### Sub-topic 2-2

*Sub-topic description: Additional numerology aspect to consider for SI*

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

**Issue 2-2: Aspects pertaining to 30 kHz SCS**

* Proposals
  + Option 1: Include 15 kHz and 30 kHz SCS into SI
  + Option 2: 30 kHz SSB is not applicable to Band n5 irregular channel bandwidth (at least for 7 MHz)
  + Option 3: If the next larger channel is relatively large, then the overall utilisation becomes lower, which is especially the case for 30kHz SCS.
* Recommended WF
  + TBA

### Sub-topic 2-3

*Sub-topic description: Conformance aspects for irregular bandwidth*

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

**Issue 2-3: Conformance and regulatory considerations**

* Proposals
  + Option 1: Adding new channel bandwidths, which have not been specified yet, will result in significantly higher complexity of use cases and significantly higher development and test effort for the UE.
  + Option 2: 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.
  + Option 3: No change to the UE 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
  + Option 4: 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.
  + Option 5: 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
  + Option 6: 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
  + Option 7: In the framework of overlapping channel bandwidths, each of the two overlapping RF carriers clearly defines the size and position of the guard band on its side of the combined channel bandwidth. This allows for an unambiguous placement of the overlapping channel filters and thus prevents problems with OBUE, ACS or in-band blocking.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 2-1:  Sub topic 2-2:  ….  Others: |
| Qualcomm | These options are quite confusing because they are not exclusive. First a higher level discussion is needed and then details of what each solution implies can be debated/agreed. Are we supposed to pick between them or comment on which is feasible or not? Many of the options are more like observations that we agree with(Option 4, for example) |
| Skyworks | Issue 2-1: we do not believe it is even agreed to enable any BW to any band so there no step size discussion, only the request BW that are in the WI should be studied case by case thus both option 3 and 4 are reasonable for the R17 scope.  In any case there is no way nor justification to enable 2MHz granularity >50MHz. in our opinion above 50% there is no real case or the loss in SU is small by default so the efficiency discussion is on important at low channel BW. Both Option 1 or Option 6 do not reflect what has been agreed. Depending on the solution found for the current cases we can look later on at what can be supported.  We support option 5 for n28 as 33MHz is not compatible with today’s implementations and has further issues.  Issue 2-2: this issue has to be clarified. The main issue is which SSB SCS can be supported. For now only n5 has 30kHz SSB so if that can be excluded then we can find solution for 15kHz SSB first. 30kHz SSB need at least 7.2MHz TX BW (NRB)  Issue 2-3:  Some solutions are not exclusive to each other. In UL at least using the immediately lower channel BW is the only way to not have any impact to spec AND guarantee regulatory requirements.  In fact all option are true to some extent and point at the fact that on the UE side using the immedaitelly lower channel BW should be the default and some cases with immediately higher channel BW can be studied for DL as an optional UE solution assuming no change in ACS/blocking |
| Nokia | Sub topic 2-1: In this early phase of 5G, is makes sense to address once and for all the operators' problem of spectrum blocks whose bandwidth does not match today's NR channel bandwidths. Hence, we support option 6 which is aligned with SID objective 6), bandwidth granularity shall be determined on the basis of the respective studied method(s). It should be noted different spectrum blocks (whose bandwidth does not match today's NR channel bandwidths) for UL and DL should not be excluded from the study. A comparison of the achievable spectrum utilization may be based on the exemplary bandwidths in section 3 of the SID.  Sub topic 2-2: Support option 1, both 15 and 30kHz SCS shall be considered.  Sub-topic 2-3: Support option 1 and 7, for overlapping channel bandwidths method where there are two overlapping carriers, there is a clear size and position of the guard band which indicates the placement of overlapping channel filters and satisfies regulatory requirements.  Others:  Proposal 4 of R4-2014507 which is reflected in option 6 of issue 2-3 does not provide details about wherein the optional UE capability consists, the more so as the same proposal 4 of R4-2014507 explicitly assumes no UE specification changes. |

### 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:* |

*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: Overlapping 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** |
| R4-2014487 | Qualcomm Incorporated | | Proposal: Introduce new channel BW only for gNBs and use existing channel BW for UE, by means of offset to carrier configured between UE1 and UE2 |
| R4-2015562 | Intel Corporation | | Observation #1: RB scheduling restricion on channel edge(s) is required to comply regulartory requirements.  Observation #2: RB scheduling restriction on channel edge(s) is still required in an overlapping channel bandwidths from network perspective, to comply with regulartory requirements.  Observation #3: Even with RB scheduling restriction, overlapping channel bandwith from network perspective could have a benefit to utilize an operator holding spectrum.  Observation #4: Unoverlapped channel bandwidth should be larger than SSB bandwidth, i.e., 3.6 MHz and 7.2 MHz with 15 kHz and 30 kHz SCS, respectively.  Observation #5: Overlapping channel bandwidth from UE perspective requires more implementation complexity compared to define a dedicated channel bandwidth. |
| R4-2015724 | Ericsson | | Observation 1: RB placement needs to be further considered.  Observation 2: Emissions requirements based upon wider channel bandwidth which may not meet regulatory license conditions  Observation 3: Using the larger bandwidth approach may not provide sufficient protection for ACS and blocking requirements.  Observation 4: Additional conformance testing may be needed for partial use of channel bandwidths |
| R4-2015713 | 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: The impact to RF core requirements is very limited to support intra-band overlapping CA.  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 |
| R4-2016201 | Nokia, Nokia Shanghai Bell | | Proposal 1: 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. |
| R4-2016455 | T-Mobile USA | | Observation 1: With 6 MHz of licensed spectrum it is possible that a single SSB can be used for two overlapping 5 MHz carriers, but the frequency position would be limited by the SSB raster  Observation 2: With 8 or 9 MHz of licensed spectrum, overlapping 5 MHz carriers can use separate SSBs that are time aligned, although frequency position for covering 8 MHz might be limited by the SSB raster  Observation 3: With 7 MHz of licensed spectrum, separate SSBs that overlap in frequency but not in time will be required.  Proposal 1: RAN4 needs to decide if subcarrier alignment or RB alignment is required.  Proposal 2: Any potential issues for overlapping carriers need to be addressed including increased overhead and handover issues when the gNB moves UEs from one carrier to the overlapping carrier. |
| R4-2014507 | 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 * 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 2:   * Usage of the immediately lower existing UE channel bandwidth is the default UE mode of operation in UL and DL * When overlapped immediately lower existing UE channel bandwidths are used only one channel is scheduled to the EU: the overlapping is from network point of view only   Proposal 3: The solutions for lower UE BW 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% | 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 |  | | 15 kHz only | 30 / 160 / 87% | 175 / 96% | Common 15 kHz SSB | 50kHz GB shift |   Observation: The SSB design for 7 MHz and 6 MHz bandwidths needs further study with possible SSB raster points in the actual band and its position within the band to know if the solution is feasible.  Proposal 4:   * 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 * 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 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 |
| R4-2014895 | Apple | | Observation 4a: Overlapping carriers can utilise full spectrum of "non-standard" channels.  Observation 4b: To use the full spectrum, the BS needs to support the full bandwidth, while from the UE perspective existing standard channels can be used. |

## 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: Items to study for overlapping channel bandwidth approach and/or introducing new channel bandwidth for handling irregular bandwidth*

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

**Issue 3-1: Study overlapping channel bandwidths**

* Proposals
  + Option 1: Consider UE scheduling offset from channel edge(s)
  + Option 2: Consider intra-band overlapping CA support
  + Option 3: When overlapped immediately lower existing UE channel bandwidths are used only one channel is scheduled to the UE: the overlapping is from network point of view only
  + Option 4: RAN4 needs to decide if subcarrier alignment or RB alignment is required and if both RF carriers must be positioned on the channel raster
  + Option 5: 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.
  + Option 6: Any potential issues for overlapping carriers need to be addressed including increased overhead and handover issues when the gNB moves UEs from one carrier to the overlapping carrier.
  + Option 7: Overlapping carriers can utilize full spectrum of “non-standard” channels. The BS needs to support full bandwidth while UE only support standard channels to be used
* Recommended WF
  + TBA

**Issue 3-2: Introduce new channel BW**

* Proposals
  + Option 1: New channel BW only for gNB, use existing channel BW for UE
  + Option 2: New channel BW considered for gNB and UE
  + Option 3: No new channel BW for UE or gNB
  + Option 4: New channel BW not explicitly defined for UE and gNB, irregular channel bandwidths can be supported by overlapping RF carriers
* Recommended WF
  + TBA

### Sub-topic 3-2

*Sub-topic description: Impact to current PHY (specifically SSB) design with overlapping channel bandwidth approach*

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

**Issue 3-3: SSB consideration for Overlapping CBW**

* Proposals
  + Option 1: single SSB can be used for two overlapping carriers
  + Option 2: multiple SSBs needed (for each UE) for overlapping carriers
  + Option 3: subcarrier alignment or RB alignment requirement
  + Option 4: increased overhead and handover issues when the gNB moves UEs from one carrier to the overlapping carrier
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 2-1:  Sub topic 2-2:  ….  Others: |
| Qualcomm | Overall these options are also confusing because they are not exclusive, combinations are needed or some are sub-options of others.  **Subtopic 3-1**: Option 3 is the preferred way to go, supported by current specs and implicitly by legacy UEs also.. Option 4 is needed otherwise the implementation, at least on the base station side will be very complicated. Option 5 is based on the assumption that the UE has separate receivers for the 2 overlapped channels, we disagree with this as being unreasonable. For such bandwidth, the UEs will have a single receiver (like for intra-band CA) to process the entire BW. The absolute gain in throughput from adding a few MHz will be too small to justify this extra complexity.  Option 7 is talking about overlapping carriers from a UE or from a BS point of view.  **Sub-topic 3-2**: Option 1 should be the baseline. It has least overall impact. A new filter for gNB will be needed anyway  **Sub-topic 3-3**: Options are not disjoint. Option 1 is clearly preferable because it reduces the overhead. It can be used for all bandwidths other than 7MHz for which 2 SSBs in different locations will be needed. Option 3 is clearly preferable and should be the baseline. Option 4 needs more discussion because the impact is not clear. |
| Skyworks | Agree with Qualcomm that these are not exclusive options.  Subtopic 3-1: Option 3 for us is also the baseline and we have provided detailed analysis for those and what the constraints should be. Once we have a common understanding with these we can look at other solutions but they need to be compatible with the baseline. Option 4 may only be needed for cases where SSBs are partially overlapping and there no solution form SSB raster points but this actually means that:  SSB needs to be staggered in time and guard bands dynamically moved to make sure RB alignment is always achieved for the UE and contains the SSB. This should only be used as a last resort solution based on no solution from baseline. In our analysis is may be critical for 7MHz but even there the 6MHz solution would work with potentially less penalty in term of complexity and single SSB can be used. This is why “option 6” is actually a sanity check that a given solution actually is helping. We suggest this is done for 15kHz SCS only.  We would like to see feedback and/or agreement on rules established in our paper.  Issue 3-2: Option 1 is the only reasonable, for the BS there is an additional constraint/specification but this is OK if this is the exception for only a few bands and associated BW, in that sense it would be useful to understand if bands that have multiple BW request could do with only a limited set as a solution. This is why we don’t think any of the requested BW should become a generic BW.  Issue 3-3: again these are not options. In our analysis there are cases where SSB overlap exists but the issue is when partial overlap is needed since it creates a further dependency on SSB raster. There are good solutions for full overlap or no overlap. Option 3: RB alignment should be the default approach, even for 7MHz reusing the 6MHz solution is feasible and the separate SSB, staggering in time and needed guard bands may not provide significant improvement at the cost of significant complexity and potential RAN1/4 impact. Option 4 is only an issue when partial overlap and SSB need to be staggered in time.  For R4-2014487: although the CA with 1/2/3/4MHz “abutted virtual channels” idea is of interest we are not sure it actually results in a fixed solution in terms of resulting guard bands for carrier spacing and channel edges so may only be further studied in DL assuming that ACS/Blocking performance is not changed, also this will have impact to specification. |
| Nokia | Sub-topic 3-1, issue 3-1: Support option 5. For option 4, we consider PRB alignment as important to keep the design of reference signals throughout the combined channel bandwidths consistent and to make a single, large BWP filling the operator's spectrum block possible. For the channel raster position, as shown in R4-2016201, we see a benefit if one of both carriers need not be positioned on the channel raster.  Issue 3-2: Support option 4.  Sub-topic 3-2 (issue 3-3): Support option 1. For option 4, impacts (e.g., mobility) overheads and spectral efficiency in the case of 2 SSBs would need to be studied, including a potential need to have in addition to the second SSB also further separate broadcast and common control channels.  Others: About the observation #4 in R4-2015562 (related to issue 3-3): No clear reason for the observation is provided. If there were UEs which have a problem when receiving an entire SSB plus a part of another SSB (overlapping in frequency but not in time) in their BWP, the problem should be described more clearly so that it can be considered in the analysis of the proposals' legacy UE impact. |

### 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:* |

*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”* |