**3GPP TSG-RAN WG4 Meeting #94-e R4-2002508**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 8.1.3 NR-U BS RF requirements

**Source:** Moderator **(**Nokia)

**Title:** Email discussion summary for RAN4#94e\_#79 \_NR\_unlic\_RF\_BS

**Document for:** Information

# Introduction

This email discussion focuses on BS RF requirements (AI 8.1.3). Only contributions related to BS receiver were submitted. No BS transmitter related Tdocs submitted.

During last RAN4#93 meeting in reno Way Froward [1] with BS receiver simulation assumption was agreed. Companies submitted simulation results, receiver requirements proposal and some discussions on FRCs for NR-U.

For NR-U BS RF requirements (AI 8.1.3) companies submitted two types of contributions:

1) NR-U FRCs simulation results for REFSENSE, ICS and Dynamic range. Simulations were performed based on WF R4-1916162 [1] agreed during RAN4#93 meeting. Also, discussions on NR-U FRCs design were submitted.

2) Proposals of BS REFSENSE, ICS and Dynamic range requirements for NR-U.

[1] R4-1916162, WF on NR-U BS RF RX FRC, ZTE

# Topic #1: FRCs simulation results for REFSENSE, ICS and Dynamic range

Result of simulations are SNR values for 95% throughput that are used later for calculations for specific Rx requirements: REFSENSE, In-channel selectivity and Dynamic range.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000821 | Huawei, HiSilicon | FRCs simulation results for REFSENSE and ICS.  REFSENSE requirements proposal based on FRCs simulation results. |
| R4-2000822 | Huawei, HiSilicon | FRCs simulation results for Dynamic range.  Dynamic range requirements proposal based on FRCs simulation results. |
| R4-2000982 | ZTE Corporation | FRCs simulation results for REFSENS, ICS and Dynamic range. |
| R4-2001463 | Huawei, HiSilicon | FRCs simulation results for REFSENSE and ICS. |
| R4-2001464 | Huawei, HiSilicon | FRCs simulation results for Dynamic range. |
| R4-2001465 | Huawei, HiSilicon | Discussion on NR-U BS FRCs:  Proposal 1: No need to define the FRC for interlace structure for 60 kHz SCS for NRU BS REFSENS/ICS and Dynamic range.  Proposal 2: Redefine the FRC for interlace structure for 15kHz SCS and 30kHz SCS and all feasible bandwidth as shown in Table 3 and Table 4 for NR-U BS REFSENS and Dynamic range. |
| R4-2001675 | Nokia, Nokia Shanghai Bell | FRCs simulation results for REFSENS, ICS and Dynamic range. |
| R4-2001727 | Ericsson, Nokia, Nokia Shanghai Bell | Discussion on NR-U BS FRCs:  Proposal 1: No support for interlacing for NR-U for 60 kHz SCS. Remove above listed FRCs.  Proposal 2: Align FRC interlacing design according to TS 38.211 |
| R4-2001728 | Ericsson | FRCs simulation results for REFSENS, ICS and Dynamic range. |

## Open issues summary

4 companies submitted FRCs simulations results (Ericsson, Huawei, Nokia, ZTE) based on simulation assumptions in WF R41916162. However also 3 companies noticed that NR-U FRCs design that was included in WF with simulation assumption was not correct. Taking into account that FRCs simulations are used to Rx requirement calculations it seems that simulations need to be repeated with updated assumptions (FRCs design).

* Updated list of NR-U FRCs should be aligned and agreed.
* BS Rx requirements needs to be calculated using SNR based on simulation results.

### Update for NR-U FRCs

There are two proposals related to FRCs update submitted in:

* R4-2001465 (Huawei)
* R4-2001727 (Ericsson/Nokia)

Both contributions noticed that current design of NR-U FRCs includes errors.

**Issue 1-1: Correction to NR-U FRCs design**

* Proposals
* Both (R4-2001465 Huawei and R4-2001727 Ericsson/Nokia) Tdocs include the same proposal related to RAN1 design for interlace: **No support for interlacing FRCs for NR-U for 60 kHz SCS**.
* In principle proposal to **update NR-U FRCs** are quite similar, and background for this update is that current NR-U FRCs design is not align with RAN1 TS 38.213 specification. However, here are differences and some options are possible related to interlace design according RAN1 design. Below are described possible options:
  + Option 1:

Based on R4-2001465 (Huawei): **No overlapping, all interlaces can have different number of RBs.**

Note, that in R4-2001465 is mismatch between description in document (*“…e.g. 10MHz BW/15kHz SCS, 52RB is allocated, so floor (52/10) = 5, so all interlaces have at least 5RB, the remaining 2 RB will be allocated 2 of the 10 interlaces, at last 2 interlaces have 6RBs, 8 interlaces have 5 RBs.”)* and FRCs tables where only interlace 1 is included in notes in the table *(“For reference channel A1-10, the allocated RB’s are uniformly spaced over the channel bandwidth at RB index {0, 10, 20, 30, 40}.* “. Moderator understating is that this option should include all interlaces as presented below in the example. Thus, this should be confirmed by proponent.

Example for 10MHz/15kHz SCS:



Disadvantage of this option is that there are different number of RBs for given interlace.

* + Option 2:

Based on R4-2001727 (Ericsson/Nokia): **Overlap between interlaces, but all interlaces have the same number of RBs.**

This option provides the same number of RBs for each interlace, however some overlapping is needed.

Example for 10MHz/15kHz SCS:



* Recommended WF
* **To agree proposal: Not define FRCs with interlacing for NR-U for 60 kHz SCS.**
* **To consider update of NR-U FRCs according RAN1 design for interlace (10 for 15kHz SCS and 5 for 30kHz SCS) using proposed by companies option 1 or option 2 or other option.**
* **To agree updated WF with corrected NR-U FRCs for further SNR simulations.**

## Companies views’ collection for 1st round

### Open issues

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| --- | --- | --- |
| **Company** | **Comments** | |
| ZTE | Sub topic 1-1: agreed to not define FRC with interlacing for NR-U for 60KHz SCS.  Sub topic 1-2: prefer to option 2 and please find the attached excel sheet for FRC PRB configuration, only difference from my side is about 80MHz, we propose PRB number as 43, then smaller FRC could be defined which could reuse the testing time at least.  Sub topic 1-3: okay to update the WF and use the updated version for further SNR simulation . | |
| Ericsson | Sub topic 1-2: Companies should note that the interlace currently proposed has overlapping RBs. Except for the 10 MHz case if we consider an interlace without overlapping (using modified option 2) bandwidth of more than 94% of the total bandwidth is still covered.  Option 2a: Considers interlace without overlapping. | |
| ZTE | ZTE: option 2a could be applied for BW&SCS combinations or only certain combinations? Maybe it’s more straight forward to check the excel sheet based on the proposed values. | |
| Nokia | Sub topic 1-1: agreed to not define FRC with interlacing for NR-U for 60KHz SCS.  Sub topic 1-2: There is also option that somehow “merge” Option 1 and Option 2 – let’s say Option 3 to introduce FRCs without overlapping and all interlaces have the same number of RBs:  In this option 3 some RBs are not used, however all interlaces have the same number of RBs.  Example for 10MHz/15kHz SCS:    What is other companies view on this Option 3 that would avoid overlapping? | |
| ZTE | To Nokia: we had the discussion on NR FRC design and testing, all PRBs should be tested and Dominique has contributions on this topic. E.g. 10MHz with 15KHz, 52PRB, G-FR1-A1-1 with 25PRB, then we need 3 FRCs to cover the whole REFSENS test.  Regarding the Pros and Cons for overlapping and non-overlapping,  For overlapping case, Pros single FRC could be designed and Cons is multiple testing is needed due to overlapping.  For non-overlapping case, Pros maybe only one test with multiple FRCs are needed, Cons multiple FRCs needed to designed. | |
| Ericsson | To ZTE: Yes, this new option (option 2a or now labelled 3 by Nokia) is dependent on BW&SCS, there is no general “note” that we can put on the tables as was have done for LAA. In R4-1914286 we have some FRCs already set for BWs and this maybe we need to revisit. Is that your concern?  To Nokia: Your comment stating “All interlaces have the same number of RBs” my interpretation of that statement is that you mean this highlighted part will end the same for every BW?  For reference channel xx, the allocated RB’s are uniformly spaced over the channel bandwidth at RB index N, N+5, N+10,.., N+45 where N={0,1,2,3,4,5}  Would it be difficult as some cases this would need to extend further for larger BWs. But I guess we can alter the table Table 7.2.2-3a? | |
| ZTE | To Ericsson: option 2a could be applied for BW&SCS combinations or only certain combinations? Maybe it’s more straight forward to check the excel sheet based on the proposed values. | |
| Huawei | | Thank you for pointing out our mistakes in R4-2001465 that the misalignment of the FRC definition and the examples.  As can be seen from the agreement of RAN1, the number of RBs in each interlace can be different:    As per TS 38.211 section 4.4.4.6 as shown below: the number of interlace is fixed, i.e. 10 for 15kHz SCS and 5 for 30kHz SCS    The modified FRC configurations according to our proposals are given in attachment.    No support for interlacing FRCs for NR-U for 60 kHz SCS. |
| Nokia | | To Huawei: Thank you for correction of Option 1 definition, I captured it not correctly in the name. This is true that different number of PRBs is align with RAN1 decision. Going with this option we need to specify all details (i.e. specific number of RBs for given interlace in tables like you did).  To Ericsson: Regarding your question, my understating is that highlighted part will be different for every BW depends on total number of RBs.  In 38.104 specification I think we would introduce separate table on top of NR, to not make mess there. |
| Huawei: | | To align with the agreements of RAN1, we support to define case of non-overlapping. As mentioned by ZTE, there are two different number of RBs of FRCs must be defined for one BW&&SCS if all RBs will be tested. This is so complicated, we suggest only one FRC with larger number of RBs for one BW&&SCS should be defined. For example: In the case of 10MHz&&15KHz, only RB {0 10 20 30 40 50} should be tested. (This is reflected in the attached table REFSENS ICS FRC\_Huawei)  For 60kHz SCS: we support to reuse the results of Rel-15 NR |
| ZTE | | To Huawei, if we use your proposed value as following, then only two PRB sets could be tested which is not allowed from testing perspective, if we use {N+0,N+10,N+20,N+30,N+40}, N=0-11, then all PRBs could be tested, this is also with single FRC for one specific BW.   |  |  | | --- | --- | | 0 | 1 | | 10 | 11 | | 20 | 21 | | 30 | 31 | | 40 | 41 | | 50 | 51 | |
| Ericsson | | Sub topic 1-2: We would like to put support towards Option 3.  As the concerns from some companies that the full BW would not be covered for testing, I would like to illustrate that all scenarios are higher than 80% of the total PRBs covered for testing. See below:   |  |  |  |  | | --- | --- | --- | --- | |  | Total\_PRB | Covered\_PRB | ratio = Covered\_PRB/Total\_PRB | | A1-10/A2-7 | 52 | 50 | 96.20% | | A1-11/A2-8 | 24 | 20 | 83.33% | | A1-13/A2-10 | 106 | 100 | 94.34% | | A1-14/A2-11 | 51 | 50 | 98.04% | | A1-16/A2-13 | 216 | 210 | 97.22% | | A1-17/A2-14 | 106 | 105 | 99.06% | | A1-19/A2-16 | 162 | 160 | 98.77% | | A1-21/A2-18 | 217 | 215 | 99.07% |   Please note that this calculation was based on the interlace example in Option 3.  The advantage of this solution is that the test time would be reduced without much difference in testing result. It could also fit in this “NOTE” format we have in the current TS (similar to the format in LAA). |
| ZTE | | Sub-topic 1-2: To Ericsson, as I mentioned before, if you use the option 3, then how to test PRB 50 and 51 in BW 10MHz&15KHz according to the FRC? It’s not allowed to have non-tested PRBs according to the trandition. We have discussion on whether all RBs should be tested in NR and answer is yes both from operators and vendors.  The same story for other cases, you check that FRC should cover all PRBs at least.  Here OBW 80% is ETSI EN301893V2.1.1(2017-05) instead of 80% PRBs, that means the span of single FRC PRBs should be at least occupy 80% CBW.  For 10MHz, we don’t need to consider that as this is only applied to Indian region and it’s not necessary to follow 80% OBW.. |

### 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:*  Sub-topic 1-1:All companies involved in discussions agree to not define FRC with interlacing for NR-U for 60KHz SCS, due to lack of RAN1 interlacing design for 60 kHz  Sub-topic 1-2:  Two options remain for further discussions supported by companies for FRCs for NR-U design:  Option 1: No overlapping, all interlaces can have different number of RBs.  (supported by: Huawei)  Option 3: No overlapping, all interlaces have the same number of RBs.  (supported by: Ericsson, Nokia)  Option 4: overlapping if necessary, all interlaces have the same number of RBs.  (supported by: ZTE)  *Candidate options:*  *Recommendations for 2nd round:*  To discuss further and agree all FRCs details, specifically interlace arrangements, for NR-U to be used for simulation for next RAN4 meeting.  For Sub-topic 1-2 to agree one option from Option 1,Option 3 and Option 4. In general, these options are not far away from each other. Agreement of FRC should be capture in WF with all details on FRCs for NR-U. Other options are not precluded.  This WF should be supplement to simulation assumption for BS Rx requirements agreed in during RAN4#93 meeting in R4-1916162. All other simulation assumption except FRCs, are keeping as in R4-1916162. |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on NR-U FRCs | Moderator (Nokia) |

### 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”* |

# Topic #2: BS receiver requirements

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

This topic includes contributions submitted and related to BS receiver requirement.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000821 | Huawei, HiSilicon | FRCs simulation results for REFSENSE and ICS.  REFSENSE requirements proposal based on FRCs simulation results. |
| R4-2000822 | Huawei, HiSilicon | FRCs simulation results for Dynamic range.  Dynamic range requirements proposal based on FRCs simulation results. |
| R4-2000983 | ZTE Corporation | REFSENSE and Dynamic range requirements proposals based on FRCs simulation results. |
| R4-2000984 | ZTE Corporation | ICS requirements proposals based on FRCs simulation results.  ICS wanted signal and interfering signal PRB mapping proposed. |
| R4-2000985 | ZTE Corporation | CR to TS 38.104 with NR-U Rx requirements. |
| R4-2001674 | Nokia, Nokia Shanghai Bell | Proposal: It is proposed to use methodology described in subsection 2.1 – 2.3 to derived NR-U Rx requirements (REFSENSE, ICS and Dynamic range). |

## Open issues summary

Based on SNR simulation results BS Rx requirements (REFSENSE, In-channel selectivity, Dynamic range) were derived.

Companies provided simulations results based on not correctly design NR-U FRCs that were in WF R4-1916162, thus these results should not be used for Rx requirements calculations. There is no sense to compare current proposals submitted with Rx requirements that used simulation results based on not correct assumption (due to errors in FRCs design).

When NR-U FRCs will be corrected and agreed, new SNR simulations results can be provided by companies.

### BS receiver requirements derivation

*Sub-topic description:*

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

**Issue 2-1: How to derive BS Rx requirements for 60 kHz SCS**

As RAN1 design for interlace do not include 60 kHz SCS, there is a question how to derive BS RX requirements if there will not be 60kHz SCS FRCs?

This question was only highlighted in R4-2001727 (Ericsson/Nokia), but not fully discussed in any submitted contribution.

* Proposals

There are some possible options how to proceed with BS receiver requirements for 60kHz SCS.

* + Option 1: Not to specify BS receiver requirements for 60kHz SCS cases.
  + Option 2a: To specify BS receiver requirements for 60kHz SCS using NR FRC(s) for 60kHz SCS.
  + Option 2b: To specify BS receiver requirements for 60kHz SCS using NR-U FRC(s) for 15/30kHz SCS.
  + Option 3: Other options are for FFS.
* Recommended WF
  + Companies are encouraging to analyse 60kHz SCS case for BS receiver requirements.

### Sub-topic 2-2

*Sub-topic description*

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

**Issue 2-2: TBA**

* Proposals
  + Option 1: TBA
  + Option 2: TBA
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| ZTE | Sub topic 2-1: just checked QC WID RP-182878 with following objective  - Subcarrier spacing for control and data channels supporting 15kHz, 30kHz, and 60kHz (air-interface perspective; optionality to be discussed separately).  In addition, I checked the discussion in RAN4#96Bis meeting, it seems that interlace for 60KHz will need significant standard work [R1-1901524], therefore it’s not specified in R16 and confirmed by our RAN1 colleagues. Companies are also encouraged to check with RAN1 colleagues.  In other words, 60KHz SCS for NR-U FRC is still needed, just without interlace design. Meanwhile OCB requirement which is bandwidth containing 99% of the power of the signal |
| Ericsson | It seems to be common understanding that 60 kHz SCS does not have any interlace.  But, what do we need to do additional simulation work for NR-U FRC if there is no interlace? Could we not reuse SNR throughput point from NR and derive NR-U Rx RF requirements from that? |
| ZTE | To Ericsson: 1st issue is to confirm that 60KHz is still needed for non-interlace mapping, regarding the SNR value for NR-U with updated FRC, reusing the legacy NR RX SNR or via simulation, both are fine foe me as coding rate is the same and LDPC performance might don’t have big difference between different TBS, but technically we need to do some simulation to further confirm that, anyway it depends on majority view. |
| Nokia | Sub topic 2-1: If we would like to have Rx requirements for 60kHz SCS we need to agree some WF on this. Current situation is that we don’t have 60khz interlaced in RAN1, thus we cannot in RAN4 “design” what is in RAN1 area.  We can look at simulation results submitted for this RAN4#94e meeting even with not correct results and look at 60kHz results – differences to 15/30/60kHz are not significant. We can analize this more and based on this we could decide. |
| ZTE | To Nokia: I copy&paste the RAN1#99 agreement, as mentioned before, due to significant standard work needed for 60KHz interlacing, however it’s also allowed to have non-interlaceed mapping as per R15 which is just following the R15 NR design. In other words, 60KHz is still supported which is contiguous PRB allocation and need to meet OCB requirement.  Agreement:  In Rel-16, for a cell, the UE can expect that UE-specifically configured PUCCH resources and all PUSCH transmissions (scheduled and configured) after dedicated configurations either all have interlaced mapping or all have non-interlaced mapping as per Rel-15 |
| Nokia | To ZTE: I tend to agree we could reuse just NR contiguous allocation for 60kHz SCS. |
| ZTE | To Nokia, maybe full channel bandwidth should be allocated as we need to meet 80% OBW regulatory requirement. In legacy NR FRC, we didn’t touch that all NR bands in R15 is licensed. |

### 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.*

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| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  Sub-topic 2.1:  Companies prefer to include 60kHz SCS FRC with no-interlace. *Candidate options:*  *Recommendations for 2nd round:*  To be further discussed in 2nd round if:   * Option 1: FRCs for 60kHz SCS from NR Rel-15 can be reused, * Option 2: new FRC for 60kHz SCS occupying more than 80% CBW are needed.   Final decision should be agreed to take it into account for next RAN4 meeting when BS Rx requirements aim to be agreed.  Analysis on Options should consider unnecessary test time with respect to the need for multiple FRCs for testing.  To capture outcome of this sub-topic to WF on FRCs for NR-U. |

*Suggestion 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 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”* |
| R4-2000985 | *Can be noted as it is to early to agree stable CR at this stage.* |

## 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** |
| R4-2002465 | WF on NR-U FRCs   * This WF is supplement with correct FRC interlacing to simulation assumption for BS Rx requirements agreed during RAN4#93 meeting in R4-1916162. * All other simulation assumptions except FRC interlacing, are as agreed in R4-1916162. * Companies are encouraged to provide SNR simulation results based on assumption in R4-1916162 and FRCs agreements captured in this WF for next RAN4 meeting.   Status: agreeable, all interesting companies confirmed and agreed WF. |