**3GPP TSG-RAN WG4 Meeting # 107 R4-2310012**

**Incheon, KR, May 22nd – May 26th , 2023**

**Agenda item:** 8.6

**Source:** Moderator (Ericsson)

**Title:** Topic summary for [107][129] NR\_channel\_raster\_enh

**Document for:** Information

# Introduction

This document is a summary of the proposals made in the contributions submitted under AI 8.6 for the RAN4 #107 meeting.

# Topic #1: Alternatives to address WI objectives

This topic addresses the different approaches and alternatives to answer the WID objectives. Also, it initiates discussion on the the backward compatibility of positioning the SIB1 carrierBandwidth off the 100 kHz channel raster for legacy UEs.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2308786**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2308786.zip) | Qualcomm Incorporated | **Proposal: Only discuss approaches which are proposing to make changes to the UE/gNB channel rasters according to the scope of the current WI.** |
| [**R4-2307501**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307501.zip) | Nokia, Nokia Shanghai Bell | **Proposal 1: RAN4 first solves the backward compatibility of positioning the SIB1 carrierBandwidth off the 100 kHz channel raster and then discusses the details of specifying the future channel raster for the carrierBandwidth in SIB1.**  **Observation 1: For a given SIB1 carrier BW and location, the requirements that anyway apply to the location of the UE specific channel BW result in much fewer allowed locations than any of the proposed new channel rasters.**  **Proposal 2: For new UEs supporting UE specific channel BWs off the 100 kHz channel raster: Instead of specifying any channel raster for the UE specific channel BW, just the restrictive conditions should be applied that anyway must already be fulfilled today.**  **Observation 2: Channel raster step size of 15 kHz is NBC; 20 kHz has the even/odd PRB issue remaining.**  **Observation 3: Operating bands with an SCS spaced channel raster such as band n41 fulfil already the WI objective and do not need the channel raster enhancement.**  **Observation 4: In operating bands with an SCS spaced channel raster, allowing for further carrier frequencies would be incompatible with the synchronization raster.**  **Proposal 3: The channel raster enhancement shall be introduced to all operating bands that currently have the 100 kHz channel raster.**  **Proposal 4: RAN4 discusses if/how placing an additional but unused numerology in SIB1 on the 100 kHz channel raster helps a legacy UE cope with a used carrierBandwidth in SIB1 which determines the channel BW that the UE must configure but which is off the 100 kHz channel raster.**  **Observation 5: If an unused, second numerology is added in SIB1's scs-SpecificCarrierList, it is formally possible to fulfil the 100 kHz channel raster requirement both in SIB1 and in the UE specific channel BW even if the UE specific channel BW has an even number of RBs and the SIB1 carrier BW for the same numerology has an odd number of RBs.**  **Proposal 5: RAN4 to discuss**   * **if the example above (R4-2307501 figure 1) with two numerologies is specification compliant or can be made specification compliant,** * **if legacy UEs supporting the channel BW of 25 MHz can, in this example, support the configuration of their channel BW off the channel raster and** * **if so, why just the proforma addition of a second, unused numerology on the channel raster can change a forbidden into an unproblematic configuration.**   **Observation 6: Ap2 Alt2 cannot support all 5 MHz carrier locations by the sync raster and does not include all useful frequencies on the global frequency raster.**  **Observation 7: Ap2 Alt2 requires a WID revision to support a UE specific channel BW outside the SIB1 resource grid.**  **Observation 8: Ap2 Alt 4 and Alt 5 do not address the SIB1 carrierBandwidth off the 100 kHz channel raster but focus on the UE specific channel BW.** |
| [**R4-2307580**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307580.zip) | CMCC | **Proposal 1: Both Ap1 and Ap2 can serve the purpose of resolving odd/even PRB issue without causing NBC issue.**  **Proposal 2: For future proof, both Ap1 and Ap2 should allow the UE/BS channel raster configuration as the global frequency raster, i.e. ΔFRaster=5KHz, either by defining new channel raster or clarifying the channel raster configuration in RAN4 spec.**  **Proposal 3: Considering RedCap only support 20MHz, in order to solve the odd/even PRB issue, allow UE channel BW configured off 100KHz should be considered.** |
| [**R4-2307737**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307737.zip) | Ericsson | **Observation 1: should additional channel-raster entries be specified, a channel raster granularity > 10 kHz would not meet the objective of the work item.**  **Observation 2: while a BS CHBW can be centred on any NR-ARFCN, a BS raster entry off the 100k grid to accommodate a UE-specific CHBW on the 100k raster would violate the minimum guard-band requirements for the BS/UE CHBW in an operator block of a regular CHBW.**  and propose that  **Proposal 1: regardless of the solution chosen, any restriction(s) of legacy UE implementations at initial access such as BWP location and SIB1 decoding must be clarified to avoid UE malfunction or failed access in the field.**  The objectives of the work item can be met without adding additional raster entries. For enhancing the channel raster, we make the following  **Proposal 2: do not add additional channel raster entries for the BS and UE. Make clear in clause 5.4.2.2 of both the BS and UE specifications that the “RF channel” is mapped to the channel raster at the centre of a carrier grid of a serving cell for at least one numerology as advertised in SIB1.**  **Proposal 3: the network should be able to use the RRC specification for configuring the UE with locations of the UE-specific CHBW within a wider cell-specific bandwidth; if not possible for some legacy UE implementations that pass initial access nevertheless, a UE capability indicating capability of following the RRC without restrictions shall be introduced. Absence of the capability would indicate restrictions either that**   1. **the UE-specific CHBW must be located on the channel raster (functionality and risk of RRC rejection) or** 2. **the UE is not compliant with the 3GPP requirements off the channel raster.**   The capability would only be applicable for FR1 and apply per band. This would solve the odd/even issue. The capability need not be indicated for bands with an SCS-based channel raster. Moreover  **Proposal 4: the changes are considered for early implementation (from Rel-15).**  Notwithstanding, we also propose that  **Proposal 5: should a channel raster be specified nevertheless, then the channel raster granularity shall be 5 kHz and apply to all bands below 3 GHz (with a 100k channel raster in the existing specification).** |
| [**R4-2307763**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307763.zip) | Huawei, HiSilicon | **Observation** 1: 10 kHz raster is the best option to consider the flexibility, compatibility of 100 KHz and limit the number of raster entries.  **Observation** 2: if a new UE capability is introduced, gNB knows which UE can be configured with channel bandwidth on any 10 KHz raster, and which UE (legacy UE) can be configured on 100 KHz raster only. There is no NBC issue for new channel raster approach.  **Observation** 3: all channel bandwidth need to be on channel raster, otherwise the RF requirements may be missing.  **Proposal 1**: it is proposed to introduce 10 kHz channel raster for the bands currently have 100 kHz channel raster. |
| [**R4-2307847**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307847.zip) | ZTE Corporation | ***Observation 1: According to above equation, it can be seen that sync raster spacing is influenced by channel raster spacing. If SIB1 carrierBandwidth is off the 100 kHz channel raster which means channel raster spacing is changed, it may need to change sync raster to ensure sync raster points to cover all possible channel raster.***  ***Proposal 1: SIB1 carrier bandwidth can not be placed any position off 100 kHz channel raster as sync raster is restricted by channel raster.***  ***Proposal 2: Except for the already defined channel rasters, it is feasible to define additional channel raster points according to the needs of the frequency band after evaluating feasibility like band n28. If the existing channel raster can work properly, there is no need to change them.***  ***Proposal 3:*** ***Ap2,Alt 4 should be modified as the following:***   * ***Alternative 4:***    + ***Allow UE channel BW configured by network during connected mode not on 100 kHz channel raster***   + ***Restrict UE specific channel bandwidth must cover initial BWP to cover SSB within initial BWP***   ***Proposal 4: The advantage of the alternative is that it does not require any BS change. An optional capability could be introduced for UE to solve the even/odd PRB issue without any NBC issue. And specification change is rather small. However, the drawback is that it may increase the UE testing burden.*** |
| [**R4-2307976**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307976.zip) | China Telecom | ***Observation 1:*** *Odd/even PRB issue occurs for UE both in RRC\_IDLE and RRC\_CONNECTED state.*  ***Proposal 1：****No need to specify**new channel raster, and the flexible channel raster based on the global channel raster granularity support can be supported, of which the granularity UE supports can be indicated by UE capability.*  ***Proposal 2:*** *SIB1 channel bandwidth should support channel raster based on the global raster, and the granularity can be FFS.* |
| [**R4-2308385**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2308385.zip) | MediaTek Inc. | **Observation 1: From RAN4 perspective BS RF carrier is the union of the SCS-specific carriers indicated by SIB1 carrierBandwidth. However, for single numerology operation, BS RF carrier is equal to the functioning SCS-Specific carrier.**  **Observation 2: The original intended objective for this WID is only applicable in RRC\_CONNECTED state.**  **Proposal 1: From RAN4 perspective, if the number of PRBs configured in SIB1 carrierBandwidth is a maximum transmission bandwidth configuration, then it should be on a valid channel raster point, otherwise, this requirement can be waived, i.e., can be off 100kHz channel raster.**  **Proposal 2: To achieve a maximized flexibility of channel raster enhancement, UE with such enhancement should support its UE specific channel bandwidth on a valid global frequency grid, no matter whether or not we call it a “new channel raster”.**  **Proposal 3: Do not re-define the global frequency grid as a new channel raster if an off-100k-raster capable UE supports its UE specific channel bandwidth on the global frequency grid.** |
| [**R4-2308787**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2308787.zip) | Qualcomm Incorporated | **Observation 1: Option 3(15kHz) and Option 4(20kHz) do not enable the placement of a narrower channel within a wider channel.**  **Observation 2: Option 1,2 and 5 all enable the placement of a narrower channel withing a wider channel.**  **Observation 3: Options 1 and 2 lead to an increase of 20x/10x of the number of valid channel raster points.**  **Proposal 1: Introduce new channel raster entries with 50kHz granularity.**  **Proposal 2: The new channel raster entries should be specified for both UE and base station.**  **Proposal 3: The channel raster changes(additions of new channel raster entries) should be based on operator requests.**  We also made the following observations for the options based on approach 2. These options are not technically feasible and not covered by the scope of the current WI [4]  **Observation 4: UE/gNB RF requirements apply based on the condition that the channel is placed on a valid channel raster entry.**  **Observation 5: “Offraster” placement would violate one of the basic principles of the RAN4 requirements.**  **Observation 6: The same UE RF requirements apply irrespective of how the UE channel BW is configured.**  **Observation 7: “The NR-ARFCN is only used for signaling of different frequency positions, it is not the actual channel raster.”**  **Observation 8: NR-AFRCN is not used to signal directly the UE channel raster entry. The UE channel placement is signaled indirectly.**  **Observation 9: The RRC specifications (TS 38.331) do not “supersede” the RAN4 specifications. Not any possible RRC parameter configuration is defined/supported by the RAN4 specifications.** |
| [**R4-2309049**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2309049.zip) | Apple | Proposal 1a: Consider enhanced channel raster as 5 or 10kHz.  Proposal 1b: Enhanced channel raster is defined at least for the UE side  Proposal 1c: Enhanced channel raster can be defined also for the network side  Proposal 2: Enhanced channel raster is applicable at least for the FR1 bands below 3GHz.  Proposal 3a: Enhanced channel raster is optional for bands in earlier releases  Proposal 3b: It should be discussed further whether enhanced channel raster is optional or mandatory for the bands starting from Rel-18 |
| [**R4-2309711**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2309711.zip) | T-Mobile USA, TELUS | * Allow UE specific channel BWs to be positioned on any RBs of the cell specific channel bandwidth regardless of the UE specific channel BW center frequency   + This consistent with how BWPs can be configured and what most companies though was allowed prior to the RAN4 discussions in August 2022 * UE specific channel BWs still need to use a number of RBs in a channel BW defined by RAN4 * The network shall ensure the minimum guard band is met for each UE specific channel BW * Add a new UE capability to indicate that the UE supports UE specific channel BWs not centered in the 100 kHz raster. * The new capability would be mandatory for UEs from Rel-18 onwards, and optional for earlier UEs. * The operator would have the choice for how to handle UEs that don’t indicate the new capability IE. The gNB could be configured to use the new UE capability to either:   + Configure legacy UEs only with UE specific channel BWs on the 100 kHz raster, or   + Move legacy UEs to a different band, or carrier   + Ignore the capability, and configure UE channel BWs on any RBs within the Cell specific channel BW at their own risk * If it is deemed that 5 or 10 kHz raster (or more accurately ΔFRaster) is needed, we would support that as a means to achieve the above |
| [**R4-2309712**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2309712.zip) | T-Mobile USA | Input on the WF on channel raster enhancements |

## Open issues summary

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

### Sub-topic 1-1

**Issue 1-1: Channel raster scope**

* Proposals: Only discuss approaches which are proposing to make changes to the UE/gNB channel rasters according to the scope of the current WI. The work item scope clearly states : “specify necessary changes to the UE channel raster such that …”. “Change” is defined as the process of replacing something with something new or different; a thing that is used to replace something.
  + Agree.
  + Disagree.
* Recommended WF
  + Discuss how “change” is interpreted and whether proposals under alternative 2 fall within the work item scope or not

### Sub-topic 1-2

*Sub-topic description:* It has been agreed that, from RAN1/RAN2 perspective, it’s already possible to position SIB1 carrierBandwidth off the 100kHz channel raster, but no conclusion has been made from RAN4 perspective. RAN4 has not agreed yet on a backward compatible possibility to place the carrierBandwidth in SIB1 off the 100 kHz channel raster

*Open issues and candidate options before meeting:*

**Issue 1-2: SIB1 positioning off the 100 kHz grid for legacy UEs**

* Proposals: Before discussing the details of specifying the future channel raster for the carrierBandwidth in SIB1, RAN4 first solves the backward compatibility of positioning the SIB1 carrierBandwidth off the 100 kHz channel raster for legacy UEs.
  + Agree (then make proposals).
  + Disagree, that’s not possible.
  + There is no backwards compatibility issue, the carrierBandwidth advertised in SIB does not have to be placed on the 100kHz raster.
* Recommended WF
  + TBA

### Sub-topic 1-3

*Sub-topic description* In the last RAN4#106-bis meeting, several approaches and alternatives were discussed. Many companies have compared them for this meeting, as agreed in the way forward R4-2306598. Based on the approaches and alternatives captures in this way forward, this sub-topic is compiling the analysis made for this meeting, proposing a down-selection of the different options.

Note that the approach 2 – alternative 4 has been updated (text in red) based on contribution to this meeting.

**Issue 1-3: Approaches and alternatives comparison.**

* Proposals
  + Approach 1: Specify a new channel raster

1. FFS what would be the new channel raster step size:

Option 1: 5 kHz

Option 2: 10 kHz

Option 3: 15 kHz

Option 4: 20 kHz

Option 5: 50 kHz

1. FFS if the new channel raster should be specified for:

Option 1: UE only

Option 2: both UE and gNB.

Option 3: gNB only

1. FFS on for which bands this new channel raster should be specified:

Option 1: All FR1 bands below 3GHz

Option 2: Operating bands that currently have 100 kHz channel raster

Option 3: On operators’ request

* + Approach 2: Do not specify new channel raster entries
    - Alternative 1
    1. Clarify in clause 5.4.2.2 of both the BS and UE specifications that the “RF channel” is mapped to the channel raster at the centre of a carrier grid of a serving cell for at least one numerology as advertised in SIB1.
    2. The network should be able to use the RRC specification for configuring the UE with locations of the UE-specific channel BW within a wider cell-specific bandwidth;
    - Alternative 2:
    1. Support configuration of UE-specific channel BW off the channel raster.
    2. SIB1 channel BW should support SCS-based channel raster (if no coexistence issue is concerned).
    3. UE-specific channel BW can be configured outside the SIB1 grid for future release.
    - Alternative 3:

1. For operating bands with a 100 kHz channel raster, the UE can signal a capability to support a UE specific channel BW that
   * consists of a contiguous subset of RBs from SCS-SpecificCarrier in SIB1 and
   * is a maximum transmission BW configuration
   * but need not be centered on the channel raster.
2. For UEs with the capability to support a UE specific channel BW off the 100 kHz raster in corresponding operating bands, the natural raster for the UE specific channel BW is the RB grid of the carrier bandwidth in SIB1. (For a given numerology and location of the SIB1 carrier bandwidth, its RB grid is considerably sparser than the proposed channel rasters and it includes only valid frequency locations, hence rather the RB grid of the carrier bandwidth in SIB1 should be specified as raster for the UE specific channel BW than a new channel raster.)
3. For UEs with the capability to support a UE specific channel BW off the 100 kHz raster in corresponding operating bands, it is suggested that they support SIB1 carrier bandwidths off the 100 kHz raster as well (step size given here by the global frequency raster) – at least, if a backward compatible solution for SIB1 carrier bandwidths off the 100 kHz raster is found. (Otherwise, the network would only be able to safely make use of it in new operating bands in which all UEs must have this capability, and the benefit would be very limited.)
4. Clarify in TS 38.104 that the channel raster only applies to
   * the SCS-SpecificCarrier in SIB1 and
   * the UE specific channel BW

that are signaled to UEs even if the BS transmits a wider bandwidth than signaled in SIB1.

* + - Alternative 4:
  + Allow UE channel BW configured by network during connected mode not on 100 kHz channel raster ~~for some legacy RedCap UEs and future UEs.~~
  + Restrict UE specific channel bandwidth must cover initial BWP to cover SSB within initial BWP
    - Alternative 5

1. The center of UE dedicated channel bandwidth should be on a valid global frequency grid instead of a valid 100kHz channel raster for a UE in RRC\_CONNECT state.

* Recommended WF
  + Based on the contributions to this meeting and the analysis table proposed in the way forward R4-2306598, the following tables recaps very shortly the analysis made by participating companies.
    - Solve even/odd PRB issue:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Alternative | T -Mobile USA | Nokia | CMCC | Ericsson | Qualcomm |
| Ap1, Alt 1 | Yes if 5 or 10 kHz raster  50 kHz raster would not be usable. | Yes if 5 or 10 kHz | Can solve even/odd PRB issue and also can solve other potential issues related to 100KHz raster restriction. | Yes, but restrictions on the location of the UE-specific CHBW any channel raster granularity > 10 kHz | Yes if 5, 10 or 50 kHz |
| Ap2, Alt 1 | Yes | Yes | Alt 1 can solve the problem of odd/even PRB, but other issue, like misaligned guard band between 30MHz and 40MHz bandwidth is still FFS. | Yes |  |
| Ap2,Alt 2 | No. | Yes Item 1 solves the issue, but a corresponding UE capability is needed | Ap2, Alt2 can solve odd/even PRB issue, but with granularity of SCS based raster, it cannot solve other channel raster issue, e.g. misaligned guard band between 30MHz and 40MHz. | Yes item 1 |  |
| Ap2,Alt 3 | Yes | Yes Item 1 solves the issue, but a corresponding UE capability is needed | Alt 3 is not mutually exclusive with Alt1 and Alt2. | Yes, Item 1 |  |
| Ap2,Alt 4 | it lacks details. | Yes | Alt4 can solve the even/odd PRB issue, is not mutually exclusive with other alternatives. | Yes, with restriction |  |
| Ap2,Alt 5 | it lacks details. | Yes | Alt5 can solve the even/odd PRB issue, is not mutually exclusive with other alternatives. | Yes |  |

* + - NBC issue?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Alternative | T -Mobile USA | Nokia | CMCC | Ericsson |
| Ap1, Alt 1 | No NBC issue if UE capability |  | No if new capability | Restrictions apply for some UE implementations |
| Ap2, Alt 1 | No, if there is a UE capability | If introduced before Rel-18 without capability signaling, the proposed change may not fit to legacy UEs | Alt 1 can solve the problem of odd/even PRB, but for other issue, like misaligned guard band between 30MHz and 40MHz bandwidth, still FFS. | Restrictions apply for some UE implementations |
| Ap2,Alt 2 | Yes, but with granularity of SCS based raster, it cannot solve other channel raster issue, e.g. misaligned guard band between 30MHz and 40MHz. | To prevent NBC problems, SIB1 related changes should only be applied in operating bands without legacy UEs. | There is no NBC issue. | Restrictions apply for some UE implementations |
| Ap2,Alt 3 | No, if there is a UE capability | To prevent NBC problems, SIB1 related channel raster changes might have to be limited to operating bands without legacy UEs. | There is no NBC issue. | Restrictions apply for some UE implementations |
| Ap2,Alt 4 | Need capability signalling to avoid NBC issue | A corresponding UE capability is needed | There is no NBC issue. | Restrictions apply for some UE implementations |
| Ap2,Alt 5 | Need capability signalling to avoid NBC issue | A corresponding UE capability is needed | There is no NBC issue. | Restrictions apply for some UE implementations |

* + - Major drawbacks

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Alternative | Nokia | CMCC | Ericsson | ZTE | Huawei/Qualcomm |
| Ap1, Alt 1 | For the UE specific channel BW, the introduction of a new channel raster would not add value but be misleading because other, more restrictive conditions anyway apply. |  | Conformance test specifications affected |  |  |
| Ap2, Alt 1 | "carrier grid" is an unclear term (not defined in 3GPP), and "RF channel" is not well defined either. Furthermore, this Alternative 1 does not aim at finding a backward compatible solution for centering the SIB1 carrierBandwidth off the 100 kHz channel raster. |  |  |  | All channel bandwidth need to be on channel raster, otherwise the RF requirements may be missing. |
| Ap2,Alt 2 | Ap2 Alt2 cannot support all 5 MHz carrier locations by the sync raster and does not include all useful frequencies on the global frequency raster.  Ap2 Alt2 requires a WID revision to support a UE specific channel BW outside the SIB1 resource grid. |  | Item 3 not in the scope.  Item 2 adds additional channel raster entries. |  | All channel bandwidth need to be on channel raster, otherwise the RF requirements may be missing. |
| Ap2,Alt 3 |  |  | Additional restrictions introduced in Items 3 and 4. These appear to be related to specific proposals for irregular BW. |  | All channel bandwidth need to be on channel raster, otherwise the RF requirements may be missing. |
| Ap2,Alt 4 | Ap2 Alt 4 and Alt 5 do not address the SIB1 carrierBandwidth off the 100 kHz channel raster but focus on the UE specific channel BW. |  |  | However, the drawback is that it may increase the UE testing burden | All channel bandwidth need to be on channel raster, otherwise the RF requirements may be missing. |
| Ap2,Alt 5 | Ap2 Alt 4 and Alt 5 do not address the SIB1 carrierBandwidth off the 100 kHz channel raster but focus on the UE specific channel BW. |  |  |  | All channel bandwidth need to be on channel raster, otherwise the RF requirements may be missing. |

Based on the above analysis and companies’ proposals:

* Approach 1:
  + Only 5, 10 and 50 kHz would solve the even/odd PRB issue, but 50 kHz seems not convenient.
  + The majority of companies consider the new channel raster should be introduced on both UE and gNB side.
  + The majority of companies consider the new channel raster should be introduced for bands below 3 GHz specified today with a 100 kHz channel raster.
* Approach 2
  + Alternative 1:
    1. Companies consider it will solve the even/odd PRB issue and there is no NBC issue.
    2. One company would like to see further analysis for the misaligned guard band between 30MHz and 40MHz.
  + Alternative 2:
    1. One company thinks it would not solve the odd/even PRB issue, and another company thinks it would not solve other channel raster issue.
    2. Two companies consider that it would require a WID update.
  + Alternative 3:
    1. Companies consider it will solve the even/odd PRB issue and there is no NBC issue.
    2. One company would like to see further analysis for the misaligned guard band between 30MHz and 40MHz.
  + Alternative 4:
    1. One company would like to have more details and another one considers it focuses on the UE specific channel BW issue., not addressing the SIB1 carrierBandwidth off the 100 kHz raster issue.
    2. One company thinks it would increase UE testing effort.
    3. One company thinks this alternative is not exclusive to the other alternatives.
  + Alternative 5:
    1. One company would like to have more details and another one considers it focuses on the UE specific channel BW issue., not addressing the SIB1 carrierBandwidth off the 100 kHz raster issue.
    2. One company thinks this alternative is not exclusive to the other alternatives.

Based on the above summary, the moderator’s suggestion would be to further discuss the proposed approaches and alternatives but focusing on the following down-selection.:

* + Approach 1: Specify a new channel raster

1. FFS what would be the new channel raster step size:

Option 1: 5 kHz

Option 2: 10 kHz

1. FFS if the new channel raster should be specified for:

Option 1: UE only

Option 2: both UE and gNB.

1. FFS on for which bands this new channel raster should be specified:

Option 1: All FR1 bands below 3GHz that that currently have 100 kHz channel raster

* + Approach 2: Do not specify new channel raster entries
    - Alternative 1
    1. Clarify in clause 5.4.2.2 of both the BS and UE specifications that the “RF channel” is mapped to the channel raster at the centre of a carrier grid of a serving cell for at least one numerology as advertised in SIB1.
    2. The network should be able to use the RRC specification for configuring the UE with locations of the UE-specific channel BW within a wider cell-specific bandwidth;
    - Alternative 3:

1. For operating bands with a 100 kHz channel raster, the UE can signal a capability to support a UE specific channel BW that
   * consists of a contiguous subset of RBs from SCS-SpecificCarrier in SIB1 and
   * is a maximum transmission BW configuration
   * but need not be centered on the channel raster.
2. For UEs with the capability to support a UE specific channel BW off the 100 kHz raster in corresponding operating bands, the natural raster for the UE specific channel BW is the RB grid of the carrier bandwidth in SIB1. (For a given numerology and location of the SIB1 carrier bandwidth, its RB grid is considerably sparser than the proposed channel rasters and it includes only valid frequency locations, hence rather the RB grid of the carrier bandwidth in SIB1 should be specified as raster for the UE specific channel BW than a new channel raster.)
3. For UEs with the capability to support a UE specific channel BW off the 100 kHz raster in corresponding operating bands, it is suggested that they support SIB1 carrier bandwidths off the 100 kHz raster as well (step size given here by the global frequency raster) – at least, if a backward compatible solution for SIB1 carrier bandwidths off the 100 kHz raster is found. (Otherwise, the network would only be able to safely make use of it in new operating bands in which all UEs must have this capability, and the benefit would be very limited.)
4. Clarify in TS 38.104 that the channel raster only applies to
   * the SCS-SpecificCarrier in SIB1 and
   * the UE specific channel BW

that are signaled to UEs even if the BS transmits a wider bandwidth than signaled in SIB1.

### Sub-topic 1-4

*Sub-topic description:* Below example could be used to further discuss and understand expected UE behaviour.



A Rel-17 RedCap UE shall be used with a channel BW of 20 MHz in a 25 MHz wide cell at the lower edge of band n3. To this end, it is assumed that a 20 MHz wide UE specific channel BW on the 100 kHz channel raster needs to be signaled to the legacy RedCap UE.

The 20 MHz wide UE specific channel BW is for the RedCap UEs supporting 20 MHz. Their BWP is the same as their UE specific channel BW.

For UEs that support 25 MHz, the BWP is the same as the SIB1 carrier BW for 15 kHz SCS.

**Issue 1-4: Example**

* Proposals: According to your view:
  + The example above with two numerologies is specification compliant or can be made specification compliant.
    - Yes
    - No
  + Legacy UEs supporting the channel BW of 25 MHz can support the configuration of their channel BW off the channel raster
    - Yes:
      * why just the proforma addition of a second, unused numerology on the channel raster can change a forbidden into an unproblematic configuration?
    - No
* Recommended WF
  + Share your view on above example

### Sub-topic 1-5

**Issue 1-5: SIB1 carrierBandwidth**

* Proposals: If the number of PRBs configured in SIB1 carrierBandwidth is a maximum transmission bandwidth configuration, then it should be on a valid channel raster point, otherwise, this requirement can be waived, i.e., can be off 100kHz channel raster
  + Agree
  + Disagree
* Recommended WF
  + TBA

### Draft CRs

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2307738**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307738.zip) | Ericsson | Draft CR: Clarification of the channel raster and capability for UE-specific channel bandwidth TS 38.101-1 |
| [**R4-2307739**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307739.zip) | Ericsson | Draft CR: Clarification of the channel raster – TS 38.101-2 |
| [**R4-2307740**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307740.zip) | Ericsson | Draft CR: Clarification of the channel raster – TS 38.104 |

# Topic #2: UE capability

**Note that some contributions listed in topic#2 made also some proposals related to a new UE capability. Even if those contributions are not listed below, those proposals have still been captured in this section.**

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2307502**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307502.zip) | Nokia, Nokia Shanghai Bell | ***Proposal 1: The channel raster enhancement is a capability per UE.***  ***Proposal 2: The channel raster enhancement is release independent from Rel-15.***  ***Proposal 3: The channel raster enhancement should be mandated from Rel-18 and optional for Rel-15/16/17.***  ***Proposal 4: It is proposed to ask RAN2 that the new UE capability signalling is provided for early implementation from Rel-15.*** |
| [**R4-2307581**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307581.zip) | CMCC | **Proposal 1: For eMBB UEs, support of configuration of off 100KHz channel raster is optional and can be release independent from Rel-15.**  **Proposal 2: For RedCap UEs, support of configuration of off 100KHz channel raster is mandatory from Rel-17.**  **Proposal 3: For UEs from Rel-18 onwards, support of new channel raster should be mandated.**  **Proposal 4: If it is agreed to define UE capability, define per UE capability.** |
| [**R4-2307741**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307741.zip) | Ericsson | [DRAFT] LS on a capability for UE-specific channel bandwidth location |
| [**R4-2307764**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307764.zip) | Huawei, HiSilicon | **Observation 1**: a new UE capability is needed for the UE to support new channel raster.  **Observation 2**: further discuss whether all these bands with 100 kHz channel raster are required to support denser channel raster, or it will depend on the operator’s request.  **Observation 3:** further discuss which release can be optional supported after the new channel raster is decided. |
| [**R4-2307848**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307848.zip) | ZTE Corporation | ***Proposal 1: Whether one band needs to do channel raster enhancement is unclear, there is no reason to require the new capability supported by some bands, it’s better that new UE capability is applicable to per UE.***  ***Proposal 2: To increase configuration flexibility, this UE capability shall be specified in earlier release as much as possible. It’s better to start from Rel-15 and be mandatory from Rel-18.*** |
| [**R4-2308386**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2308386.zip) | MediaTek Inc. | **Proposal 1: To help network to differentiate enhanced channel raster capable UEs from legacy UEs, a new optional UE capability should be introduced to support the feature.**  **Proposal 2: Introduce the optional UE capability supporting enhanced channel raster as per-UE capability.**  **Proposal 3: The optional UE capability can be implemented early from Rel-15 if no potential NBC issue is identified, otherwise, early implementation can be from Rel-17.** |
| [**R4-2309050**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2309050.zip) | Apple | Proposal 1: Send LS to RAN WG2 asking to add a new *per-band* UE capability to indicate whether a UE supports enhanced channel raster for a particular band.  Proposal 2: Send LS to RAN WG2 asking whether the per-band UE capability for the flexible channel raster can be introduced to earlier releases, and if so, which release. |

## Open issues summary

### Sub-topic 3-1: New UE capability

**Issue 3-1-1: UE capability**

* Proposals: Whatever new enhancements will be decided (new channel raster support, SIB1/UE-specific channel BW updates, …), shall they be supported via a new UE capability:
  + Yes (Nokia, ZTE, Apple, MediaTek, T-Mobile USA, CMCC, Ericsson)
  + No
* Recommended WF
  + Yes, a new UE capability is needed to support the objectives of this WI.

**Issue 3-1-2: UE capability applicability**

* Proposals: The new UE capability should be applicable:
  + Per band, assuming RAN4 introduces enhanced channel raster (Apple)
  + Per UE (Nokia, MediaTek, ZTE)
* Recommended WF
  + This would depend on what information will be given with this capability (e.g. new channel raster).

**Issue 3-1-3: UE capability – Release applicability**

* Proposals: From which release the UE capability should be introduced?
  + From Rel-15 (Ericsson, Nokia, CMCC, MediaTek if no NBC issue)
  + Mandatory from Rel-18 (T-Mobile USA, Nokia, CMCC)
  + Optional before Rel18 (Apple, Nokia, CMCC)
  + For Redcap UEs, support of configuration of off 100KHz channel raster is mandatory from Rel-17 (CMCC)
* Recommended WF
  + Optional from Rel-15 and mandatory from Rel-18.

And for RedCap UEs, mandatory from Rel-17.

### Sub-topic 3-2: LS to RAN2

**Issue 3-2: LS to RAN2**

* Proposals: RAN4 shall send LS to RAN2 requesting to add the new capability
  + Yes (T-Mobile, Apple, Nokia, Ericsson)
  + No
* Recommended WF
  + Yes, a LS should be sent to RAN2 requesting for the new UE capability

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