**3GPP TSG RAN WG1 #117 R1-24xxxxx**

**Fukuoka City, Fukuoka, Japan, May 20th – 24th, 2024**

**Agenda item:** 8.2.1

**Source:** Moderator (NTT DOCOMO, INC.)

**Title:** Summary of discussion on UE features for dedicated spectrum less than 5MHz

**Document for:** Discussion and Decision

# **Introduction**

This document summarizes contributions submitted to AI 8.2.1 regarding UE features for dedicated spectrum less than 5MHz.

According to the updated UE features list agreed in RAN1#116bis [1], there are following feature groups for dedicated spectrum less than 5MHz.

* FGs for NR support for dedicated spectrum less than 5MHz for FR1
	+ 51-1 Support for 3 MHz channel bandwidth
	+ 51-2 Support 12 PRB CORESET0
	+ 51-3 Support 5 MHz channel bandwidth with 20 PRB CORESET0

Following is captured in RAN1 Chair’s note for RAN1#117 meeting, and hence the issue related to the RAN4 LS [2] is discussed in AI 8.2.1.

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| **Rel-18 NR\_FR1\_lessthan\_5MHz\_BW**R1-2403833 LS on UE Capability for Asymmetric BW for less than 5 MHz RAN4, Rakuten MobileTo be further discussed under agenda item 8.2.1 for any necessary changes to Rel-18 UE features.**Relevant tdoc(s)**R1-2404535 Discussion of LS On UE Capability for Asymmetric BW for less than 5 MHz EricssonR1-2404483 Discussion on UE Capability for Asymmetric BW for less than 5 MHz NokiaR1-2404361 Discussion on asymmetric BW for less than 5 MHz CATTR1-2404811 Discussion on LS on UE capability for asymmetric BW for less than 5 MHz ZTER1-2404948 Reply LS on UE Capability for Asymmetric BW for less than 5 MHz Huawei, HiSiliconR1-2405019 Discussion on UE Capability for Asymmetric BW for less than 5 MHz NTT DOCOMO, INC.R1-2405129 Draft Reply to LS on UE Capability for Asymmetric BW for less than 5 MHz Qualcomm IncorporatedR1-2405130 Discussion for RAN4 LS on UE Capability for Asymmetric BW for less than 5 MHz Qualcomm Incorporated |

# **UE Capability for Asymmetric BW for less than 5 MHz**

In [2], following information and request are provided by RAN4.

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| In response to the new operational scenario introduced and endorsed through draft CR R4-2406620, RAN4 has defined an Asymmetric Bandwidth Combination Set for NR band n28 featuring a 3 MHz uplink and a 5 MHz downlink. Currently, UE capability in TS 38.306 for 3 MHz do not distinguish between uplink and downlink bandwidths, which leads to potential issues in scenarios where UEs support asymmetric bandwidth combination sets including 3 MHz channel bandwidth either in uplink or potentially in future also downlink. Currently, there is no request and therefore no urgent need in RAN4 for asymmetric bandwidth combination set including 3 MHz in the downlink.Figure 1 – TS 38.306 Support of 3 MHz Capability2 Actions**To WG RAN 2 and RAN 1****ACTION:** RAN4 respectfully requests RAN2 and RAN1 to examine the necessary modifications and define UE capabilities for optional support of asymmetric bandwidths with * 3 MHz in uplink (and 5 MHz or larger CBW in downlink)
* and potentially also for 3 MHz in downlink (and 5 MHz or larger CBW in uplink) with lower priority and no urgency.
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Following inputs are provided in contributions for the RAN1#116bis meeting.

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| [3] | Samsung | According to the LS from RAN4 [4], an Asymmetric Bandwidth Combination Set for NR band n28 featuring a 3MHz uplink and a 5MHz downlink has been defined. However, the components for the uplink and the downlink are not distinguished in the feature group for dedicated spectrum less than 5MHz. As the result, the update of the feature group is necessary to make it applicable for band n28 with the asymmetric channel bandwidth in downlink and uplink.The simple way to reflect the different channel bandwidth between downlink and uplink is to decouple the component related to the downlink and the uplink, respectively. Because only FG 51-1 is corresponding to NR band n28, the modification on FG 51-1 can be considered as the follow:FG 51-1

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| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-1 | Support for 3 MHz DL channel bandwidth | 1) Reception of 12 PRB PBCH based on RB-level puncturing~~2) Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS~~2) Reception of 15 PRB CORESET0 |  | Yes | N/A | UE is not able to support 3 MHz DL channel bandwidth |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-1a | Support for 3 MHz UL channel bandwidth | 1) Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS |  | Yes | N/A | UE is not able to support 3 MHz UL channel bandwidth |

**Proposal 4:** For FG 51-1, the decoupling of the components for the uplink and the downlink should be supported to address the asymmetric channel bandwidth combination set for NR band n28. |
| [4] | CATT | FGs 51-1/51-2a/51-2b/51-3 were introduced for less than 5MHz assuming symmetric BW for DL and UL [2], where FG 51-1 and FG51-3 include components for both DL and UL.

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| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-1 | Support for 3 MHz channel bandwidth | 1) Reception of 12 PRB PBCH based on RB-level puncturing2) Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS3) Reception of 15 PRB CORESET0 |  |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-2a | Support 12 PRB CORESET0 | 1) Reception of 12 PRB CORESET0 with an associated SS/PBCH block that is located according to Table 5.4.3.1-2 in TS 38.101-1 | 51-1 |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-2b | Support 12 PRB CORESET0 with an associated SS/PBCH block located at GSCN 41637 | 1) Reception of 12 PRB CORESET0 with an associated SS/PBCH block located at GSCN 41637 | 51-1 |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-3 | Support 5 MHz channel bandwidth with 20 PRB CORESET0 | 1) Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS2) Reception of 20 PRB CORESET0 |  |

To support asymmetric BW for less than 5 MHz, it is better to introduce new UE capabilities, i.e. the existing FGs 51-1/51-2a/51-2b/51-3 are applicable to symmetric BW only.For new UE capabilities for optional support of asymmetric bandwidths, one thing that needs to be discussed is whether “Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS” is applicable to the case that DL BW is less than 5MHz and UL transmission BW is equal to or larger than 5MHz. The component “Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS” in FG 51-1 and FG 51-3 is based on the following agreement in RAN1#111. The reason is that PRACH format 3 with 5 kHz SCS exceeds 3MHz [2].

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| **Agreement****Short PRACH formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS are supported for transmission bandwidths <5 MHz for 3MHz and 5MHz channel bandwidth.** |

For asymmetric bandwidths with 3MHz in uplink and 5 MHz or larger CBW in downlink, long PRACH format with 5kHz SCS cannot be supported since the BW exceeds 3MHz.However, for 3MHz in downlink and 5 MHz or larger CBW in uplink, if UL transmission BW is equal or larger than 5MHz, the BW of PRACH is no longer limited so that long PRACH format with 5kHz SCS can also be supported.**Proposal 1: For 3MHz in downlink and UL transmission BW≥5 MHz, long PRACH format with 5kHz SCS is supported.**It is suggested to let RAN2 decide the detailed design of new UE capabilities for optional support of asymmetric bandwidths in RAN2 and send LS to RAN2 with following information.**Proposal 2: Send LS to RAN2 and RAN4 with following information:*** **Existing** **FGs 51-1/51-2a/51-2b/51-3 are only applicable to symmetric BW for less than 5 MHz.**
* **Introduce new UE capabilities to support asymmetric BW for less than 5 MHz**
	+ **“Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS” is only applicable to UL transmission BW<5MHz for 3MHz and 5MHz UL channel bandwidth, i.e. for 3MHz in downlink and UL transmission BW≥5 MHz, all the RACH preamble formats are supported.**
	+ **It is up to RAN2 to decide the detailed design of new UE capabilities.**
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| [5,6] | Nokia | On the first case mentioned in the RAN4 LS, namely 3MHz UL CBW and ≥5MHz DL CBW, one can note that actually there had not been any RAN1 specification changes for the case of 3MHz UL CBW operation (in contrast to 3MHz DL CBW for the support of 12 PRB SSB & 12 / 15 PRB CORESET#0). For the 3MHz UL CBW case only certain operation / applicability are required: * Only 15kHz SCS is supported with 15 PRBs transmission bandwidth (and UL BWP size)
* PRACH formats and configurations not fitting into the transmission BW are not applicable
	+ i.e. only short RACH preamble formats with 15kHz and long PRACH preamble formats with 1.25kHz are supported

as is also visible from the UL related conclusions and agreements during the WI phase:

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| **Conclusion**No enhancements are required for PRACH to operate NR on transmission bandwidths of <5MHz for 3MHz and 5MHz channel bandwidth. * Note: PRACH formats and configurations not fitting into the transmission BW are not applicable

**Agreement**Short PRACH formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS are supported for transmission bandwidths <5 MHz for 3MHz and 5MHz channel bandwidth.**Conclusion** No enhancements are needed for PUCCH to support transmission bandwidths of <5MHz for 3MHz and 5MHz channel bandwidth, * FFS: the necessity for PUCCH FH disabling.

**Conclusion**No consensus in RAN1 to support any enhancements for common PUCCH for dedicated spectrum less than 5MHz transmission BW. |

So from physical layer perspective, there seems to be no enhancements needed for the support of 3MHz UL CBW in an asymmetric band combination set with ≥5MHz DL CBW. **Observation 1: No physical layer enhancements are required to support asymmetric band combination sets (BCS) with 3MHz UL CBW and ≥5MHz DL CBW.** The situation is slightly more complicated when considering the second case, namely 3MHz DL CBW and ≥5MHz UL CBW. The 3MHz DL CBW design based on punctured 12 PRB SSB and 12/15 PRB CORESET #0 is not generically applicable, but only limited to a set of specific (new) sync raster points in the first place. Therefore, simply extending the usage of 3MHz DL CBW to some generic operation with asymmetric band combination sets to other bands (especially without new sync raster points) seems to be not possible. Therefore, depending on the specific case of an envisioned asymmetric BCS some specific investigations and potential changes to the physical layer design may be needed. In addition, there has been no real need identified for the support of 3MHz DL CBW and ≥5MHz UL CBW. We therefore suggest discussing this based on the exact band combination set (and the associated sync raster point) only after a potential need for the support has been identified. **Proposal 1: Discuss the case of 3MHz DL CBW and ≥5MHz UL CBW when a real need for such operation has been identified for the specific identified asymmetric band combination set and associated sync raster points.** Now looking at the need for a UE capability for the 3MHz UL BWP case, from physical layer perspective we don’t think a separate capability would be specifically needed, as the restrictions of 3MHz UL CBW discussed above are rather obvious. For the asymmetric band combination signaling, as currently there is only a single asymmetric BCS with 3MHz UL CBW defined for band n28 (with separate indication), basically there would be no need for a UE capability at this point of time. But to be forward compatible with potential additional asymmetric BCS for other bands and >5MHz DL CBW it could be useful to define a ‘3MHz UL CBW’ capability, as then current procedure to define the supported combinations of asymmetric band combinations for the UE consisting of (i) UL CBW capability, (ii) DL CBW capability and (iii) the asymmetric band combination set capability can then be directly reused. Such 3MHz CBW capability could as an example look as follows, which reuses formulations from 3MHz channel bandwidth capability by removing all DL components and adding a note that this feature is only applicable to asymmetric BCSs (with the red additions):

| ***support-3MHz-ChannelBW-UL-r18***Indicates whether the UE supports the following functional components:*-*     Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS;This feature is supported for 15kHz SCS only.This feature is only applicable to single-carrier operation.This feature is only applicable to bands where asymmetric channel BWs with 3MHz UL are defined (see Table 5.3.6.-1 of TS 38.101-1 [2]). A UE supporting this feature in a band shall also indicate support for an asymmetric bandwidth combination set (BCS) with 3MHz UL (i.e. using *asymmetricBandwidthCombinationSet*) in the same band.This feature is not applicable to UEs indicating *supportOfRedCap-r17* or *supportOfERedCap-r18*.NOTE: The UE supporting this capability supports configuration of 15 PRB UL BWP operation. | Band | No | FDD only | FR1 only |
| --- | --- | --- | --- | --- |

 But as from RAN1 perspective there is no need for an additional UE capability identified, we suggest leaving the decision to either introduce a ‘3MHz UL CBW capability’ as laid out above or by simply relying on the existing asymmetric bandwidth combination set signaling to RAN2. **Observation 2: From physical layer perspective no additional UE capability would be required for the support of 3MHz UL CBW and ≥5MHz DL CBW.** **Proposal 2: Leave it up to RAN2 to introduce a ‘3MHz UL CBW’ capability or rely on the asymmetric Bandwidth Combination Set signaling to indicate the support of 3MHz UL CBW and ≥5MHz DL CBW.**In our view, there is no further work needed for this work item’s RAN1 feature list. However, the RAN LS to RAN1 in agenda item 5 in [3] should be responded and RAN2 should be requested to make the final decision on how to take care of the issue. Nokia’s proposal for the response is provided in [4] to AI5.**Proposal 4: No new RAN1 FGs are to be introduced to the RAN1 FG list. Adress the RAN2 LS in R1-2403833 on asymmetric DL and UL bandwidths by providing a RAN1 view to RAN2 and leave it up to RAN2 to make the final decision on the details.** |
| [7,8] | Ericsson | Before taking any action in RAN1, we performed an analysis on the approach used in the legacy specification (i.e., UE capability signalling for supporting asymmetric bandwidths), and what is described in the LS.From the legacy specification we have the following observation: 1. TS 38.306 describes in clause 4.2.7.2 the UE capability signalling for supporting asymmetric bandwidths.

From the received LS, we have the following observation:1. From the LS in R4-2406717, the following aspects can be highlighted:
* “*RAN4 has defined an Asymmetric Bandwidth Combination Set for NR band n28*”
* “*3 MHz in uplink (and 5 MHz or larger CBW in downlink)*”
* “*potentially also for 3 MHz in downlink (and 5 MHz or larger CBW in uplink) with lower priority and no urgency*”

Moreover, the received LS includes R4-2406620 which corresponds to a “*draft CR to introduce asymmetric UL DL channel BW combinations for n28*” [1].Table 1 shows the contents of the draft CR in R4-2406620, and the description in TS 38.306 of the UE capability signalling for supporting asymmetric bandwidths. In both columns of Table 1, we have highlighted relevant information to consider in relation with the action of the RAN4 LS.**Table 1: RAN4 draft CR to introduce asymmetric UL DL channel BW combinations for n28 and UE capability signalling as per TS 38.306 for supporting asymmetric bandwidths.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Table 5.3.6-1: FDD asymmetric UL and DL channel bandwidth combinations

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| --- | --- | --- | --- |
| NR Band | Channel bandwidths for UL (MHz) | Channel bandwidths for DL (MHz) | Asymmetric channel Bandwidth Combination Sets |
| n5 | 20 | 25 | 0 |
| n8 | 20 | 35 | 0 |
|  | 10, 15, 20 | 25, 35 | 1 |
|  | 10, 15, 20 | 25, 30, 35 | 2 |
| n24 | 10 | 5 | 0 |
| n25 | 40 | 45 | 0 |
| n26 | 20 | 25, 30 | 0 |
| n283 | 3 | 5 | 1 |
| n66 | 5, 10 | 20, 40 | 0 |
|  | 20 | 40 |  |
|  | 5, 10 | 20, 25, 30, 40 | 1 |
|  | 20, 25, 30 | 40 |  |
|  | 5, 10, 15 | 20, 25, 30, 35, 40 | 2 |
|  | 20, 25, 30 | 40 |  |
| n70 | 5, 10 | 15 | 0 |
|  | 5, 10, 15 | 20, 25 |  |
| n71 | 5 | 10 | 0 |
|  | 10 | 15 |  |
|  | 15 | 20 |  |
|  | 5 | 10 | 1 |
|  | 10 | 15 |  |
|  | 15 | 20 |  |
|  | 20 | 35 |  |
|  | 20 | 25, 30, 35 | 2 |
| n911 | 10 | 5 | 0 |
| n921 | 5 | 10, 15, 20 | 0 |
|  | 10 | 15, 20 |  |
| n931 | 10 | 5 | 0 |
| n941 | 5 | 10, 15, 20 | 0 |
|  | 10 | 15, 20 |  |
| n105 | 20 | 25, 30, 35 | 0 |
| n1091 | 5 | 10, 15, 20, 25, 30, 40, 50 | 0 |
|  | 10 | 15, 20, 25, 30, 40, 50 |  |
|  | 15 | 20, 25, 30, 40, 50 |  |
|  | 20 | 25, 30, 40, 50 |  |
|  | 25 | 30, 40, 50 |  |
|  | 30 | 40, 50 |  |
| NOTE 1:   The assignment of the paired UL and DL channels are subject to a TX-RX separation as specified in clause 5.4.4.NOTE 2:   As indicated in TS38.306 [15], it is mandatory for UEs to support asymmetric channel BCS0 if there is an asymmetric BCS0 defined for the band.NOTE 3 :  This BCS1 is limited to uplink 715-718 MHz. |

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| ***asymmetricBandwidthCombinationSet***Defines the supported asymmetric channel bandwidth combination for the band as defined in the TS 38.101-1 [2]. Field encoded as a bit map, where bit N is set to "1" if UE support asymmetric channel bandwidth combination set N for this band as defined in the TS 38.101-1 [2]. The leading / leftmost bit (bit 0) corresponds to the asymmetric channel bandwidth combination set 1, the next bit corresponds to the asymmetric channel bandwidth combination set 2 and so on. UE shall support asymmetric channel bandwidth combination set 0. If the field is absent, the UE supports asymmetric channel bandwidth combination set 0. | Band | No | N/A | N/A |
| --- | --- | --- | --- | --- |

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From Table 1, we can see that the RAN4 draft CR just inserted a new row into the existing Table 5.3.6-1 of TS 38.101-1 (see left-column in Table 1), thus the update in the RAN4 draft CR is already covered by the highlighted legacy text in TS 38.306 (see left-column in Table 1).1. For the support of asymmetric bandwidths of 3 MHz (UL) and 5 MHz (DL) in NR band 28, the RAN4 draft CR in R4-2406620 just inserted a new row into the existing Table 5.3.6-1 of TS 38.101-1.
2. The existing UE capability legacy description in TS 38.306 clause 4.2.7.2 for “*asymmetricBandwidthCombinationSet*” covers the new additions from the RAN4 draft CR in R4-2406620 since it points to TS 38.101-1 (No special handling is required since the legacy approach was followed through adding a new row into the existing Table 5.3.6-1 of TS 38.101-1).

Based on the analysis above, we have the following proposal:1. There is no impact in RAN1, the legacy UE capability description in TS 38.306 clause 4.2.7.2 for “*asymmetricBandwidthCombinationSet*” points to TS 38.101-1, and thus it covers the new additions from the RAN4 draft CR in R4-2406620 (no special handling is required since the legacy approach was followed through adding a new row into the existing Table 5.3.6-1 of TS 38.101-1).

As part of the incoming Liaison Statements, RAN1 and RAN2 through [R4-2406717](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110bis/Docs/R4-2406717.zip) received a Liaison Statement (LS) entitled “LS on UE Capability for Asymmetric BW for less than 5 MHz”. The LS contains the following action to RAN1:

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| **To WG RAN 2 and RAN 1****ACTION:** RAN4 respectfully requests RAN2 and RAN1 to examine the necessary modifications and define UE capabilities for optional support of asymmetric bandwidths with * 3 MHz in uplink (and 5 MHz or larger CBW in downlink)
* and potentially also for 3 MHz in downlink (and 5 MHz or larger CBW in uplink) with lower priority and no urgency.
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Based on the analysis performed in our discussion paper (See [R1-2404535](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_117/Docs/R1-2404535.zip)) submitted under Agenda Item (AI) 5, we have the following observation and proposal:1. For less than 5MHz, the LS received through R4-2406717 does not have any impact in RAN1. This, since the legacy approach was following by just adding a new row into the existing Table 5.3.6-1 of TS 38.101-1, and thus the legacy UE capability description in TS 38.306 clause 4.2.7.2 for “*asymmetricBandwidthCombinationSet*” covers the new additions from the RAN4 draft CR in R4-2406620.
2. For less than 5MHz, there is no impact in RAN1 from the LS received in R4-2406717.
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| [9] | ZTE | In Rel-15, UE RF FG 2-1 shows that a UE can report the maximum channel bandwidth supported in each band for DL and UL separately and for each SCS that UE supports within a single CC.

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| **Features** | **Index** | **Feature group** | **Components** | ***Field name in TS 38.331 [2]*** | **Note** | **Mandatory/Optional** |
| 2. UE RF | 2-1 | Maximum channel bandwidth supported in each band for DL and UL separately and for each SCS that UE supports within a single CC | 1) FR1 channel bandwidths in TS38.101-1 Table 5.3.5-12) FR2 channel bandwidths in TS38.101-2 Table 5.3.5-1 | *channelBWs-DL**channelBWs-UL* | UE capability signalling shall follow RP-172832 (Per-band capability signalling, separately for DL and UL and for each SCS)Whether a bandwidth newly introduced in future is mandatory for UE shall be discussed case by case. | For FR1, all the bandwidths listed in TS38.101-1 v15.0.0 Table 5.3.5-1 for each band shall be mandatory with a single CC. The bandwidths listed in the slide #3 of R4-1805985 are mandatory with a single CC. 90MHz is optional for n41, n77, n78.For FR2, the set of mandatory CBW is 50, 100, 200 MHz. |

In Rel-18, 3 MHz channel bandwidth has been introduced to support dedicated spectrum of less than 5 MHz and some enhancements are introduced, including a new UE capability for 3 MHz channel bandwidth as follows:

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-1 | Support for 3 MHz channel bandwidth | 1) Reception of 12 PRB PBCH based on RB-level puncturing2) Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS3) Reception of 15 PRB CORESET0 |  | Yes | N/A | UE is not able to support 3 MHz channel bandwidth  | Per Band | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyThis FG is applicable only when an associated SS/PBCH block is located according to Table 5.4.3.3-2 in TS 38.101-1 in Rel-18Note: The UE supporting this FG supports configuration of 15 PRB BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1). | Optional with capability signalling |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-3 | Support 5 MHz channel bandwidth with 20 PRB CORESET0 | 1) Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS2) Reception of 20 PRB CORESET0 |  | Yes | N/A | UE is not able to support 5 MHz channel bandwidth with 20 PRB CORESET0 | Per UE | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyThis FG is only applicable when an associated SS/PBCH block is located in band n100 at GSCN 41638 of Table 5.4.3.1-3 in TS 38.101-1 in Rel-18.Note: The UE supporting this FG supports configuration of 20 PRB BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1). | Optional with capability signalling |

It can be seen that UE capability of 3 MHz channel bandwidth and 5 MHz channel bandwidth with 20 PRB CORESET#0 does not distinguish between uplink and downlink, UEs report the capability of FG 51-1 implies the supporting of both 3 MHz uplink channel bandwidth and 3 MHz downlink channel bandwidth, and the UE behaviours and configurations should comply with the restrictions in FG 51-1 in both uplink and downlink transmission. Similarly, UEs that report the capability of FG 51-3 should comply with restrictions in FG 51-3 during both uplink and downlink transmission. This may cause some issues when asymmetric bandwidth combination sets including 3MHz channel bandwidth and 5 MHz channel bandwidth are supported.**Case 1: UL 3 MHz and DL 5 MHz**As specified in the FG 51-1, UEs support 3 MHz channel bandwidth will receive 12 PRB PBCH bases on RB-level puncturing and receive 15 PRB CORESET#0. However, in scenarios where UEs support the asymmetric bandwidth combinations sets of 3 MHz uplink channel bandwidth and 5 MHz downlink channel bandwidth, even take the special 5 MHz channel bandwidth with 20 PRB CORESET#0 defined in Rel-18 into consideration, the UEs are expected to receive 20 PRB PBCH and at least 20 PRB CORESET#0, which is not aligned with the UE capability for supporting 3 MHz channel bandwidth. **Case 2: UL 5 MHz and DL 3 MHz (potentially in future)**Similarly, according to FG 51-1, UEs support 3 MHz channel bandwidth only support short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS. In scenarios where UEs support the asymmetric bandwidth combinations sets of 5 MHz uplink channel bandwidth and 3 MHz downlink channel bandwidth potentially in future, the UEs are expected to have more flexibility in RACH format configuration, which is not aligned with the restriction in FG 51-1 or in FG 51-3.As analysis above, we suggest that FG 51-1 is split into two separate features to differentiate the UE capability of supporting 3 MHz uplink channel bandwidth and the 3 MHz downlink channel bandwidth respectively. In scenarios where UE supports asymmetric bandwidth combination of 3 MHz uplink and 5 MHz downlink, UE reports a Rel-18 UE capability for supporting 3 MHz uplink channel bandwidth, and a Rel-18 UE capability for supporting 5 MHz downlink channel bandwidth with 20 PRB CORESET#0 and/or a legacy UE capability of FG 2-1 for supporting legacy 5 MHz downlink channel bandwidth.***Proposal 1:*** *Split FG 51-1 into two FGs as follows to support asymmetric bandwidth combination sets including 3 MHz channel bandwidth:*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-1 | Support for 3 MHz downlink channel bandwidth | 1) Reception of 12 PRB PBCH based on RB-level puncturing2) Reception of 15 PRB CORESET0 |  | Yes | N/A | UE is not able to support 3 MHz downlink channel bandwidth  | Per Band | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyThis FG is applicable only when an associated SS/PBCH block is located according to Table 5.4.3.3-2 in TS 38.101-1 in Rel-18Note: The UE supporting this FG supports configuration of 15 PRB BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1). | Optional with capability signalling |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-1a | Support for 3 MHz uplink channel bandwidth | Support for 3 MHz uplink channel bandwidth |  | Yes | N/A | UE is not able to support 3 MHz uplink channel bandwidth  | Per Band | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyThis FG is applicable only when an associated SS/PBCH block is located according to Table 5.4.3.3-2 in TS 38.101-1 in Rel-18Note: The UE supporting this FG supports configuration of 15 PRB BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1)The UE supporting this FG supports short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS. | Optional with capability signalling |

Similarly, FG 51-3 can be split into two separate features to differentiate the UE capability of supporting 5 MHz uplink channel bandwidth with 20 available PRBs and the 5 MHz downlink channel bandwidth with 20 PRB CORESET#0 respectively. In scenarios where UE supports asymmetric bandwidth combination of 5 MHz uplink and 3 MHz downlink, UE reports a Rel-18 UE capability for supporting 5 MHz uplink channel bandwidth with 20 available PRBs and/or a legacy UE capability of FG 2-1 for supporting legacy 5 MHz uplink channel bandwidth, and a Rel-18 UE capability for supporting 3 MHz downlink channel bandwidth.***Proposal 2:*** *Split FG 51-3 into two FGs as follows to support asymmetric bandwidth combination sets including 5 MHz channel bandwidth with 20 PRBs:*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-3 | Support 5 MHz downlink channel bandwidth with 20 PRB CORESET0 | 1) Reception of 20 PRB CORESET0 |  | Yes | N/A | UE is not able to support 5 MHz downlink channel bandwidth with 20 PRB CORESET0 | Per UE | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyThis FG is only applicable when an associated SS/PBCH block is located in band n100 at GSCN 41638 of Table 5.4.3.1-3 in TS 38.101-1 in Rel-18.Note: The UE supporting this FG supports configuration of 20 PRB BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1). | Optional with capability signalling |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-3a | Support 5 MHz uplink channel bandwidth with 20 PRB  | Support 5 MHz uplink channel bandwidth with 20 PRB  |  | Yes | N/A | UE is not able to support 5 MHz uplink channel bandwidth with 20 PRB | Per UE | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyThis FG is only applicable when an associated SS/PBCH block is located in band n100 at GSCN 41638 of Table 5.4.3.1-3 in TS 38.101-1 in Rel-18.Note: The UE supporting this FG supports configuration of 20 PRB BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1)Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS. | Optional with capability signalling |

 |
| [10] | Huawei, HiSilicon | **1. Overall Description:**RAN1 thanks RAN4 for the LS on UE capability for asymmetric BW for less than 5 MHz. For the modification in UE capability for 3MHz to distinguish between uplink and downlink bandwidths, RAN1 has the following reply, For the asymmetric BW scenario for less than 5 MHz, no RAN1 specification impact is identified and no new UE capability is needed. * The existing per-band capability *asymmetricBandwidthCombinationSet* in section 4.2.7 of TS 38.306 can be reused.

|  |
| --- |
| asymmetricBandwidthCombinationSetDefines the supported asymmetric channel bandwidth combination for the band as defined in the TS 38.101-1 [2]. Field encoded as a bit map, where bit N is set to "1" if UE support asymmetric channel bandwidth combination set N for this band as defined in the TS 38.101-1 [2]. The leading / leftmost bit (bit 0) corresponds to the asymmetric channel bandwidth combination set 1, the next bit corresponds to the asymmetric channel bandwidth combination set 2 and so on. UE shall support asymmetric channel bandwidth combination set 0. If the field is absent, the UE supports asymmetric channel bandwidth combination set 0. |

* For a UE only capable of 3 MHz uplink and 5 MHz downlink channel BW, capability *support-3MHz-ChannelBW* is not reported as supported.
* For 3 MHz symmetric DL&UL channel BW, as described in capability *support-3MHz-ChannelBW*, only a subset of the existing PRACH preamble formats is supported by UEs. From RAN1 perspective, such a subset of preamble formats can also be applied to 3 MHz UL channel BW in the asymmetric BW case. Instead of a new UE capability to reflect this, an additional note to the relevant row of Table 5.3.6-1 in CR R4-2406620 or to the description of capability *asymmetricBandwidthCombinationSet* in TS 38.306 is recommended.

**2. Actions:****To RAN4 and RAN2****ACTION:** RAN1 respectfully requests RAN4 and RAN2 to take above response into account in the future work. |
| [11,12] | NTT DOCOMO | According to the LS from RAN4 [1], RAN4 has defined an Asymmetric Bandwidth Combination Set for NR band n28 featuring a 3 MHz uplink and a 5 MHz downlink through draft CR R4-2406620, and hence, remaining issue is to address following issue on UE capability:

|  |
| --- |
| Currently, UE capability in TS 38.306 for 3 MHz do not distinguish between uplink and downlink bandwidths, which leads to potential issues in scenarios where UEs support asymmetric bandwidth combination sets including 3 MHz channel bandwidth either in uplink or potentially in future also downlink. Currently, there is no request and therefore no urgent need in RAN4 for asymmetric bandwidth combination set including 3 MHz in the downlink.Figure 1 – TS 38.306 Support of 3 MHz Capability |

As the above UE capability *support-3MHz-ChannelBW-r18* (FG 51-1 in the latest RAN1 UE feature list [2]) has been discussed in RAN1, we think this issue should be discussed in RAN1 at first, and then corresponding reply LS to RAN2/4 should be sent out.We think there are two alternatives to address this issue, especially for the case with 3MHz in uplink (and 5 MHz or larger CBW in downlink), as follows:* Alt.1: Clarify that FG51-1 (*support-3MHz-ChannelBW-r18*) is to report the support of 3MHz channel BW operation for both symmetric and asymmetric cases, i.e., no new FG is introduced for asymmetric channel BW operation.
* Alt.2: Introduce new FG to report the support of asymmetric channel BW operation with 3MHz channel BW in uplink, while FG51-1 (*support-3MHz-ChannelBW-r18*) is to report the support of 3MHz channel BW operation for symmetric case.

We think AI 8.2.1 (UE features for other Rel-18 work items (Topics A)) is the appropriate agenda item to discuss more details on whether/how to update FGs, and our further views are provided in our companion contribution under AI 8.2.1 [3].**Proposal:*** **RAN1 further discusses the UE capability issue mentioned in R1-2403833 under AI 8.2.1 at RAN1#117 and sends corresponding reply LS to RAN2/4.**

RAN1 received LS from RAN4 [6] to examine the necessary modifications and define UE capabilities for optional support of asymmetric bandwidths with * 3 MHz in uplink (and 5 MHz or larger CBW in downlink)
* and potentially also for 3 MHz in downlink (and 5 MHz or larger CBW in uplink) with lower priority and no urgency.

As discussed in our companion contribution in AI 5 [7], there are two alternatives to address this issue, especially for the case with 3MHz in uplink (and 5 MHz or larger CBW in downlink), as follows, and we think it should be discussed under AI 8.2.1 at RAN1#117 on which alternative is taken and corresponding reply LS to RAN2/4 should be sent out. * Alt.1: Clarify that FG51-1 (*support-3MHz-ChannelBW-r18*) is to report the support of 3MHz channel BW operation for both symmetric and asymmetric cases, i.e., no new FG is introduced for asymmetric channel BW operation.
* Alt.2: Introduce new FG to report the support of asymmetric channel BW operation with 3MHz channel BW in uplink, while FG51-1 (*support-3MHz-ChannelBW-r18*) is to report the support of 3MHz channel BW operation for symmetric case.

In Alt.1, * + If UE supports FG 51-1, it works in both asymmetric case (3MHz in UL and 3MHz in DL) and symmetric case (3MHz in UL and >3MHz in DL).
	+ It does not mean NW needs to support both symmetric and asymmetric cases at the same time. It just means UE supporting FG 51-1 can work in both symmetric and asymmetric cases.
	+ In order to support FG 51-1, UE shall be capable of both symmetric and asymmetric cases. It can avoid UE fragmentation (e.g., some UEs only support asymmetric case), while it requires some unnecessary features for asymmetric case (e.g., 12 PRB PBCH reception and 15 PRB CORESET#0 reception).
	+ No additional UE capability signalling is necessary

In Alt 2,* + Two separate UE capabilities, e.g., FG 51-1 and FG 51-1a, are necessary (i.e., additional UE capability signalling).
	+ UE supporting FG 51-1 can work at least in symmetric case, and whether it can also work in asymmetric case or not is reported via FG 51-1a.
	+ UE supporting FG 51-1a can work in asymmetric case only.
	+ It is possible that some UEs only support asymmetric case, as it may be easier than supporting both symmetric and asymmetric cases.

Following is possible update of RAN1 UE feature list for each alternative:* Alt 1:
	+ Add a note in FG 51-1: The UE supporting this FG supports 3 MHz asymmetric uplink and downlink bandwidth operation when *asymmetricBandwidthCombinationSet* as per TS 38.101-1 is signalled
* Alt 2:
	+ Introduce new FG 51-1a for the support of 3 MHz asymmetric uplink and downlink bandwidth operation
		- FG name
			* Support for 3 MHz asymmetric uplink and downlink channel bandwidth
		- Component
			* Support of 3 MHz uplink and 5MHz (or wider) downlink channel bandwidth
		- Prerequisite
			* None
		- Type
			* Per band (FDD only, FR1 only)
		- Note
			* This FG is supported for 15 kHz SCS only
			* This FG is applicable only for the bands where *asymmetricBandwidthCombinationSet* as per TS 38.101-1 is signalled in Rel-18
			* Note: The UE supporting this FG supports configuration of 15 PRB UL BWP operation
			* This FG is only applicable to single-carrier operation.
			* This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1).
		- Mandatory or optional
			* Optional with capability signaling

**Proposal 15: Down-select from one of the following alternatives to address the issue mentioned in R1-2403833*** **Alt 1:**
	+ **Add a note in FG 51-1: The UE supporting this FG supports 3 MHz asymmetric uplink and downlink bandwidth operation when *asymmetricBandwidthCombinationSet* as per TS 38.101-1 is signalled**
* **Alt 2:**
	+ **Introduce new FG 51-1a for the support of 3 MHz asymmetric uplink and downlink bandwidth operation**
		- FG name
			* Support for 3 MHz asymmetric uplink and downlink channel bandwidth
		- Component
			* Support of 3 MHz uplink and 5MHz (or wider) downlink channel bandwidth
		- Prerequisite
			* None
		- Type
			* Per band (FDD only, FR1 only)
		- Note
			* This FG is supported for 15 kHz SCS only
			* This FG is applicable only for the bands where *asymmetricBandwidthCombinationSet* as per TS 38.101-1 is signalled in Rel-18
			* Note: The UE supporting this FG supports configuration of 15 PRB UL BWP operation
			* This FG is only applicable to single-carrier operation.
			* This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1).
		- Mandatory or optional
			* Optional with capability signaling
 |
| [13,14,15] | Qualcomm | 1 Overall descriptionRAN1 thanks RAN4 for the LS on UE Capability for Asymmetric BW for less than 5 MHz. RAN1 discussed the necessary impact on the UE capabilities and agreed:1) For optional support of asymmetric bandwidths with 3 MHz in uplink (and 5 MHz or larger CBW in downlink):* The existing UE capabilities FG51-1 (*support-3MHz-ChannelBW-18*) together with *asymmetricBandwidthCombinationSet* = x (as defined for 3 MHz in uplink and 5 MHz or larger CBW in downlink in a band in TS 38.101-1) can be used to indicate that the UE supports the asymmetric bandwidth combination set and symmetric 3+3 in the band.
* A new UE capability for 3MHz UL only shall be introduced in Rel18, which does not associate with the sync raster points for SSB with 3MHz and is more flexible than UE capability FG51-1 symmetric 3+3 in UL and DL. The UE shall indicate as well *asymmetricBandwidthCombinationSet* = x to support the corresponding asymmetric bandwidth. A UE indicating these two capabilities supports the asymmetric bandwidth configuration, but it does not support symmetric 3+3 in the band.

2) For optional support of asymmetric bandwidths with potentially for 3 MHz in downlink (and 5 MHz or larger CBW in uplink):* The existing UE capabilities FG51-1 (*support-3MHz-ChannelBW-18*) together with *asymmetricBandwidthCombinationSet* = y (if defined to support 3 MHz in downlink and 5 MHz or larger CBW in uplink in a band in TS 38.101-1) can be used to indicate that the UE supports the asymmetric bandwidth combination set and symmetric 3+3 in the band.
* No need to introduce a new UE capability for 3MHz DL only in Rel-18.

2 Actions**ACTIONS:** RAN1 would like to request RAN4 to take the above information into account and provide feedback, if any.1) For optional support of asymmetric bandwidths with 3 MHz in uplink (and 5 MHz or larger CBW in downlink):* The existing UE capabilities FG51-1 (*support-3MHz-ChannelBW-18*) together with *asymmetricBandwidthCombinationSet* = x (as defined for 3 MHz in uplink and 5 MHz or larger CBW in downlink in a band in TS 38.101-1) can be used to indicate that the UE supports the asymmetric bandwidth combination set and symmetric 3+3 in the band.
* A new UE capability for 3MHz UL only shall be introduced in Rel18, which does not associate with the sync raster points for SSB with 3MHz and is more flexible than UE capability FG51-1 symmetric 3+3. The UE shall indicate as well *asymmetricBandwidthCombinationSet* = x to support the corresponding asymmetric bandwidth. A UE indicating these two capabilities supports the asymmetric bandwidth configuration, but it does not support symmetric 3+3 in the band.

2) For optional support of asymmetric bandwidths with potentially for 3 MHz in downlink (and 5 MHz or larger CBW in uplink):* The existing UE capabilities FG51-1 (*support-3MHz-ChannelBW-18*) together with *asymmetricBandwidthCombinationSet* = y (if defined to support 3 MHz in downlink and 5 MHz or larger CBW in uplink in a band in TS 38.101-1) can be used to indicate that the UE supports the asymmetric bandwidth combination set and symmetric 3+3 in the band.
* No need to introduce a new UE capability for 3MHz DL only in Rel-18. Whether to define a new UE capability for 3MHz DL only can be discussed in future release.

**Proposal 1:** **Send LS reply to RAN4 (cc RAN2) that RAN1 discussed the necessary impact on the UE capabilities:****1) For optional support of asymmetric bandwidths with 3 MHz in uplink (and 5 MHz or larger CBW in downlink):*** **The existing UE capabilities FG51-1 (*support-3MHz-ChannelBW-18*) together with *asymmetricBandwidthCombinationSet* = x (as defined for 3 MHz in uplink and 5 MHz or larger CBW in downlink in a band in TS 38.101-1) can be used to indicate that the UE supports the asymmetric bandwidth combination set and symmetric 3+3 in the band.**
* **A new UE capability for 3MHz UL only shall be introduced in Rel18, which does not associate with the sync raster points for SSB with 3MHz and is more flexible than UE capability FG51-1 symmetric 3+3 in UL and DL. The UE shall indicate as well *asymmetricBandwidthCombinationSet* = x to support the corresponding asymmetric bandwidth. A UE indicating these two capabilities supports the asymmetric bandwidth configuration, but it does not support symmetric 3+3 in the band.**

**2) For optional support of asymmetric bandwidths with potentially for 3 MHz in downlink (and 5 MHz or larger CBW in uplink):*** **The existing UE capabilities FG51-1 (*support-3MHz-ChannelBW-18*) together with *asymmetricBandwidthCombinationSet* = y (if defined to support 3 MHz in downlink and 5 MHz or larger CBW in uplink in a band in TS 38.101-1) can be used to indicate that the UE supports the asymmetric bandwidth combination set and symmetric 3+3 in the band.**
* **No need to introduce a new UE capability for 3MHz DL only in Rel-18.**

**Proposal 2:** **Send LS to RAN2 (cc RAN4) to introduce a new UE capability FG51-1a of UL 3MHz only without associating with the sync raster points for SSB with 3MHz in Rel18.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-1 | Support for 3 MHz channel bandwidth | 1) Reception of 12 PRB PBCH based on RB-level puncturing2) Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS3) Reception of 15 PRB CORESET0 |  | Yes | N/A | UE is not able to support 3 MHz channel bandwidth | Per Band | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyThis FG is applicable only when an associated SS/PBCH block is located according to Table 5.4.3.3-2 in TS 38.101-1 in Rel-18Note: The UE supporting this FG supports configuration of 15 PRB BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1). | Optional with capability signalling |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-1a | Support for 3 MHz channel bandwidth in uplink only | Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS3)  |  | Yes | N/A | UE is not able to support 3 MHz channel bandwidth in uplink only | Per Band | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyNote: The UE supporting this FG supports configuration of 15 PRB uplink BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1). | Optional with capability signalling |

RAN1 has received an LS [1] from RAN4 on the UE Capability for Asymmetric BW for less than 5 MHz. Here, we discuss the potential impact on the Rel18 UE features on NR\_FR1\_lessthan\_5MHz\_BW. For scenarios where UEs support asymmetric bandwidth combination sets including 3 MHz CBW in uplink and 5MHz or larger CBW in downlink, a new UE capability for 3MHz UL only shall be introduced in Rel18, which does not associate with the sync raster points for SSB with 3MHz and more flexible than UE capability FG51-1 symmetric 3MHz CBW in DL and UL.**Proposal 1:** **Send LS reply to RAN2 (cc RAN4) to introduce a new UE capability FG51-1a of UL 3MHz only without associating with the sync raster points for SSB with 3MHz in Rel18.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-1 | Support for 3 MHz channel bandwidth | 1) Reception of 12 PRB PBCH based on RB-level puncturing2) Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS3) Reception of 15 PRB CORESET0 |  | Yes | N/A | UE is not able to support 3 MHz channel bandwidth | Per Band | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyThis FG is applicable only when an associated SS/PBCH block is located according to Table 5.4.3.3-2 in TS 38.101-1 in Rel-18Note: The UE supporting this FG supports configuration of 15 PRB BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1). | Optional with capability signalling |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-1a | Support for 3 MHz channel bandwidth in uplink only | Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS3)  |  | Yes | N/A | UE is not able to support 3 MHz channel bandwidth in uplink only | Per Band | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyNote: The UE supporting this FG supports configuration of 15 PRB uplink BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1). | Optional with capability signalling |

 |
| [16] | Rakuten Mobile | **Discussion # 1:** Requirement for clarifying or defining 3Mhz Asymmetric BW combinations.As mentioned in RAN4 LS, the current capability of 3Mhz for DL and UL are coupled and hence UE capability to support only 3MHz UL without supporting 3MHz DL BW cannot be indicated to the network.

| ***support-3MHz-ChannelBW-r18***Indicates whether the UE supports the following functional components:*-* Reception of 12 PRB PBCH based on RB-level puncturing;*-* Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS;*-* Reception of 15 PRB CORESET0.This feature is supported for 15kHz SCS only. It is applicable only when an associated SS/PBCH block is located according to Table 5.4.3.3-2 in TS 38.101-1 [2].NOTE The UE supporting this capability supports configuration of 15 PRB BWP operation. | Band | No | FDD only | FR1 only |
| --- | --- | --- | --- | --- |
| ***support-12PRB-CORESET0-r18***Indicates whether the UE supports reception of 12 PRB CORESET0.A UE supporting this feature shall also indicate support of *support-3MHz-ChannelBW-r18*.This feature is supported for 15kHz SCS only.NOTE: The UE supporting this capability supports configuration of 12 PRB BWP operation. | Band | No | FDD only | FR1 only |

**Discussion #2:** Potencial Scenario’s required to be supported.

|  |  |
| --- | --- |
| Scenario | UE Supported BW  |
| 1 | Asymmetric  | 3MHz UL but only 5MHz DL (or higher) |
| 2 | Asymmetric | 3MHz DL but only 5MHz UL(or higher) |
| 3 | Symmetric | 3MHz UL with 3MHz DL |

In our opinion, Scenario 1 (3 MHz asymmetric uplink with 5 MHz or higher downlink) is the key capability to enable, as supporting 3 MHz downlink is more complex. Since supporting 3 MHz uplink is similar to LTE, we believe Scenario 2 is unlikely to be utilized."**Discussion #3:** Potencial solutions to enable the 3Mhz Uplink bandwidth capability indication with 5Mhz or higher Downlink BW.RAN1 can consider two alternative options to resolve the issue. ***Alt 1: Introduce new capability.*** Add a new capability exclusively for 3MHz uplink support with asymmetric downlink bandwidth and include a note to clarify that this capability is independent of exsisting support-3Mhz-ChannelBW-r18 capability.

| ***support-3MHz-ChannelBW-r18***Indicates whether the UE supports the following functional components:*-*     Reception of 12 PRB PBCH based on RB-level puncturing;*-*     Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS;*-*     Reception of 15 PRB CORESET0.This feature is supported for 15kHz SCS only. It is applicable only when an associated SS/PBCH block is located according to Table 5.4.3.3-2 in TS 38.101-1 [2].NOTE:      The UE supporting this capability supports configuration of 15 PRB BWP operation. | Band | No | FDD only | FR1 only |
| --- | --- | --- | --- | --- |
| ***support-12PRB-CORESET0-r18***Indicates whether the UE supports reception of 12 PRB CORESET0.A UE supporting this feature shall also indicate support of *support-3MHz-ChannelBW-r18*.This feature is supported for 15kHz SCS only.NOTE:      The UE supporting this capability supports configuration of 12 PRB BWP operation. | Band | No | FDD only | FR1 only |
| ***support-3MHz -Asymmetric-ChannelBW-Uplink -r18***Indicates whether the UE supports 3MHz Uplink transmission with 5Mhz or higher Downlink.Note: This capability is to support asymmetric 3Mhz uplink with 5MHz or wider downlink bandwidths, this capability is independent of ***support-3MHz-ChannelBW-r18*** | Band | No | FDD only | FR1 only |

***Alt 2: Add a clarification note to exsisting specification.***

| ***support-3MHz-ChannelBW-r18***Indicates whether the UE supports the following functional components:*-* Reception of 12 PRB PBCH based on RB-level puncturing;*-* Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS;*-* Reception of 15 PRB CORESET0.This feature is supported for 15kHz SCS only. It is applicable only when an associated SS/PBCH block is located according to Table 5.4.3.3-2 in TS 38.101-1 [2].NOTE 1 : The UE supporting this capability supports configuration of 15 PRB BWP operation.NOTE 2: The UE supporting this capability supports 3 MHz asymmetric uplink and downlink bandwidth operation when 'asymmetricBandwidthCombinationSet' as per TS 38.101-1 is signalled” | Band | No | FDD only | FR1 only |
| --- | --- | --- | --- | --- |
| ***support-12PRB-CORESET0-r18***Indicates whether the UE supports reception of 12 PRB CORESET0.A UE supporting this feature shall also indicate support of *support-3MHz-ChannelBW-r18*.This feature is supported for 15kHz SCS only.NOTE: The UE supporting this capability supports configuration of 12 PRB BWP operation. | Band | No | FDD only | FR1 only |

Adding a note can clarify the requirements for capability reporting. However, when a UE exclusively supports asymmetric bandwidth combinations (e.g., 3 MHz uplink and 5 MHz or greater downlink) and does not support symmetric 3 MHz DL/UL, interpreting the note may pose challenges.**Proposal #1** RAN1 Agree to add additional capability to indicate support for asymmetric 3Mhz uplink with 5Mhz or high downlink bandwidths. |

## **Discussion**

### **Proposal 4-1:**

* **For the case of supporting 3 MHz in uplink and 5 MHz or larger CBW in downlink,**
	+ **Alt.1: no RAN1 action is needed, i.e., the support of asymmetric 3MHz in UL and 5MHz in DL can be reported via *asymmetricBandwidthCombinationSet***
	+ **Alt.2-1: FG51-1 is updated for 3 MHz in downlink (by removing UL related component), and new FG51-1a is introduced for 3 MHz in uplink (by reusing UL related component in original 51-1)**
	+ **Alt.2-2: It is clarified that FG51-1 is for symmetric 3 MHz in both DL and UL, and new FG51-1a is introduced for asymmetric 3MHz in uplink and 5 MHz or larger CBW in downlink**
	+ **Alt.3: Send LS to RAN2 to ask them to decide**

|  |  |
| --- | --- |
| Company | Comment |
| Moderator | **Summary of companies’ view:*** Alt.1: no RAN1 action is needed: Ericsson, Huawei/HiSilicon, [DOCOMO]
* Alt.2: split 51-1 into two capabilities
	+ 2-1: 51-1 for DL and 51-1a for UL: Samsung, ZTE (also split 51-3 into two capabilities)
	+ 2-2: 51-1 for symmetric BW and 51-1a for asymmetric BW: CATT, [DOCOMO], Qualcomm, Rakuten
* Alt.3: ask RAN2 to decide either Alt.1 or Alt.2: Nokia
 |
| Nokia | Alt. 3 (first preference) or Alt. 2-2 (second preference, but 51-1a for UL only – see our reply to Proposal 4-2)Rational: Alt. 1 is changing how the asymmetric BCS is used / applied, namely the network checks the asymmetric BCS together with the supported UL & DL bandwidths to identify if a certain asymmetric BCS is really supported. This would therefore require to change the asymmetric BCS determination just for this case – i.e. a very separate case which may in the future if more asymmetric BCS sets with 3MHz UL are added. Therefore, we are not in favor of Alt. 1. Alt. 2-1 could be working, but we think it to be better /cleaner to have the asymmetric capability separately as the capability is not just about carrier bandwidth, but also about UL BWP size.  |
| Ericsson | Alt-1 is our first preference. The reason is that the existing UE capability legacy description in TS 38.306 clause 4.2.7.2 for “asymmetricBandwidthCombinationSet” covers the new additions from the RAN4 draft CR in R4-2406620 since it points to TS 38.101-1 (No special handling is required since the legacy approach was followed through adding a new row into the existing Table 5.3.6-1 of TS 38.101-1). About the comment having the concern related to “*in the future if more asymmetric BCS sets with 3MHz UL*", we are not sure that there will be an issue since the legacy approach could be applicable just as in the case of this LS, it is difficult to judge a future case and whether doing something different will be needed without having the case in front of us as to know what are its elements and applicability. For now, the scenario in the LS is covered by the legacy approach.Alt.3 is our second preference. |
| DOCOMO | After reviewing companies view, we think Alt 1 would be enough and can resolve the issue for the concerned case as below:we already have *support-3MHZ-ChannelBW-r18* and *asymmetricBandwidthCombinationSet* reports from UE so that they can be enough to separately report the support of UL 3MHz+DL 5MHz from the support of UL/DL 3MHz as below.* If UE reports *support-3MHZ-ChannelBW-r18* is supported and set 1 for *asymmetricBandwidthCombinationSet* is supported,
	+ UE supports both UL 3MHz+DL 5MHz and UL/DL 3MHz.
* If UE reports *support-3MHZ-ChannelBW-r18* is supported and set 1 for *asymmetricBandwidthCombinationSet* is NOT supported,
	+ UE supports UL/DL 3MHz and does not support UL 3MHz+DL 5MHz
* If UE reports *support-3MHZ-ChannelBW-r18* is NOT supported and set 1 for *asymmetricBandwidthCombinationSet* is supported,
	+ UE supports UL 3MHz+DL 5MHz and does not support UL/DL 3MHz

To clarify above, a note can be added to FG51-1 (*support-3MHZ-ChannelBW-r18*) that if UE supports set 1 for *asymmetricBandwidthCombinationSet* while does not support FG51-1, UE supports asymmetric UL 3MHz+DL 5MHz and does not support symmetric UL/DL 3MHz.We suggest RAN1 discuss whether there is any critical issue in Alt1, and if not, RAN1 request RAN2 to update FG51-1 as above within this RAN1 meeting, because this is the last RAN1 meeting before ASN.1 freeze.Alt.2-1/2-2 can work as well, but the purpose of the new capability could be covered by *asymmetricBandwidthCombinationSet*. Additionally, we can assume that if there will be new asymmetric bandwidth combination (e.g., UL 3MHz + DL >5MHz, UL 5MHz + DL 3MHz, etc), such asymmetric bandwidth combination will be added into RAN4 table same as UL 3MHz + DL 5MHz, and hence *asymmetricBandwidthCombinationSet* could be sufficient even for such case. |
| Huawei, HiSilicon | Alt.1 with clarification that a RAN1 reply LS to reflect RAN1 view is allowed. Maybe revise Alt.1 as “No RAN1 specification impact, no change to FG 51-1 from RAN1 perspective and the existing capability *asymmetricBandwidthCombinationSet* can be reused and is sufficient.”A new capability for 3MHz UL CBW is not necessary because if a UE indicates an index of band combination set (BCS) via *asymmetricBandwidthCombinationSet* for asymmetric Channel BW, then the UE supports all combinations of BW without any additional UE capability of channel BW. For example, if a legacy UE indicates index 0 of BCS for band n66, the UE must support ALL BW combinations among UL {5,10} and DL {20, 40} and the combination UL 20 and DL 40 MHz, which does not require additional UE capability for a gNB to configure any BW combination within this BCS to the UE. If a UE wants to support an asymmetric BW combination 10MHz UL and 5MHz DL for band n28 in the future, a better solution is to add a sub-row under band n28 with a new index 2 (in the last column) to indicate it, so that a UE capable of both 10MHz UL+ 5MHz DL and 3MHz UL + 5MHz DL can indicate both index 1 and index 2 for band n28 and a UE capable of only some BW combination can only indicate the corresponding index. It is much better than the solution which introduces a new additional UE capability of 3MHz UL BW plus a new sub-row of {3, 10} UL+ 5 DL for band n28. For 3MHz UL CH BW, the legacy interpretation of UE capability of *asymmetricBandwidthCombinationSet* should be applied. Therefore, no additional new UE capability for 3MHz UL CH BW.C:\Users\l00380584\AppData\Roaming\eSpace_Desktop\UserData\l00380584\imagefiles\A72D080B-E1EA-4F01-B6D7-2D05A0E27E5F.png |
| Qualcomm | For legacy, symmetric BCS for 5MHz, 10MHz or larger is mandatory and ‘*asymmetricBandwidthCombinationSet*’ is introduced as a new UE capability to support asymmetric BSC (with prerequisite of symmetric BSC).Now in R18, symmetric 3MHz requires to support FG51-1 (not mandatory). If asymmetric 3+5 is introduced in n28, it will be different from legacy case. It is not clear to us whether 3+5 is dependent on symmetric 3MHz UL/DL or not.The ‘NOTE 3 : This BCS1 is limited to uplink 715-718 MHz’ in Table 5.3.6-1 only says the location of UL 3MHz for n28. But it is not clear what is the corresponding location of DL 5MHz in case to support 3+5 in n28. We think it should be clarified by RAN4 to better understand what is the DL 5MHz location in case of 3+5 in n28.If a new UE capability for UL only (Alt2-2) is introduced, it would be clear that UE can support 3MHz UL only and UL BWP=15PRBs, without associating with the new sync raster points. The 3+5’s prerequisite can be 3MHz UL only, instead of relying on symmetric 3MHz UL/DL. If no new UE capability for 3MHz UL only is introduced, it is necessary to add clarification that the UE not supporting FG51-1 can support ‘*asymmetricBandwidthCombinationSet*=1’ in n28 and UE will use legacy sync raster point to find the corresponding 3+5, which could be a note in 38.306. |
| Rakuten Mobile Inc | We support Alt2:251-1 because "No Action" from RAN1 won't solve the main issue: conflicting capabilities. If a UE supports the Asymmetric BCS Set but doesn't support a 3MHz Channel BW, it could lead to confusion about how to interpret such a capability. The cleanest way to solve the issue will be adding a new capability specific to 3Mhz Asymmetric support, however RAN1 can discuss the content of Note to exsisting 3Mhz Capability and content of new Asymmetric capability. |

### **Proposal 4-2:**

* **For the case of supporting 3 MHz in downlink and 5 MHz or larger CBW in uplink,**
	+ **Alt.1: no RAN1 action is needed in Rel-18, as real need for this case has not been identified**
	+ **Alt.2: If Alt.2-1 or 2-2 is taken for the case of supporting 3 MHz in uplink and 5 MHz or larger CBW in downlink, same principle is applied for the case of supporting 3 MHz in downlink and 5 MHz or larger CBW in uplink**

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| --- | --- |
| Company | Comment |
| Moderator | **Summary of companies’ view:*** Alt.1: no RAN1 action is needed in Rel-18 as real need has not been identified: Nokia, Qualcomm
* Alt.2-1: split 51-1 into two capabilities for 3 MHz DL and 3 MHz UL, and split 51-3 into two capabilities for 5MHz with 20 PRBs DL and 5 MHz with 20 PRBs UL: ZTE
* Alt.2-2: introduce new capability for asymmetric 3 MHz DL and 5 MHz or larger BW UL: CATT
 |
| Nokia | Alt. 1Rational: We don’t see that a real need has been identified for 3MHz DL and >=5MHz UL, as the current motivation for 3UL & 5DL is coming from UL coverage limitations and we don’t see the same logic to apply the other way around.  |
| Ericsson | Alt.1 The case is not even covered yet in the RAN4 CR that was attached to the LS. |
| DOCOMO | Alt1As pointed out by other companies, there have not been real need for this case and even RAN4 CR does not cover this case, we think RAN1 should focus on Proposal 4-1 in this meeting, which is the last meeting before ASN.1 freeze. |
| Huawei, HiSilicon | Similar comment as ours to proposal 4-1. The existing UE capability of *asymmetricBandwidthCombinationSet* is sufficient for forward compatibility.  |
| Qualcomm | Alt1. Even if there is 5+3 in the future, similar clarification is needed: what is DL/UL location and whether it is allowed for UE not supporting 51-1 can support 5+3 if defined. |

# **Conclusions**

To be updated

# **References**

[1] R1-2403703 Updated RAN1 UE features list for Rel-18 NR after RAN1#116bis Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2403833 LS on UE Capability for Asymmetric BW for less than 5 MHz RAN4, Rakuten Mobile

[3] R1-2404101 UE features for other Rel-18 work items (Topics A) Samsung

[4] R1-2404361 Discussion on asymmetric BW for less than 5 MHz CATT

[5] R1-2404483 Discussion on UE Capability for Asymmetric BW for less than 5 MHz Nokia

[6] R1-2404484 UE Features for Other Topics A (SLenh, MCenh, MBS, Sub-5MHz) Nokia

[7] R1-2404523 Rel-18 UE features topics set A Ericsson

[8] R1-2404535 Discussion of LS On UE Capability for Asymmetric BW for less than 5 MHz Ericsson

[9] R1-2404811 Discussion on LS on UE capability for asymmetric BW for less than 5 MHz ZTE

[10] R1-2404948 Reply LS on UE Capability for Asymmetric BW for less than 5 MHz Huawei, HiSilicon

[11] R1-2405019 Discussion on UE Capability for Asymmetric BW for less than 5 MHz NTT DOCOMO, INC.

[12] R1-2405028 Discussion on UE features for other Rel-18 work items (Topics A) NTT DOCOMO, INC.

[13] R1-2405129 Draft Reply to LS on UE Capability for Asymmetric BW for less than 5 MHz Qualcomm Incorporated

[14] R1-2405130 Discussion for RAN4 LS on UE Capability for Asymmetric BW for less than 5 MHz Qualcomm Incorporated

[15] R1-2405141 UE features for other Rel-18 work items (Topics A) Qualcomm Incorporated

[16] R1-2405252 3MHz asymmetric bandwidth UE capability discussion Rakuten Mobile, Inc

# **Appendix**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-1 | Support for 3 MHz channel bandwidth | 1) Reception of 12 PRB PBCH based on RB-level puncturing2) Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS3) Reception of 15 PRB CORESET0 |  | Yes | N/A | UE is not able to support 3 MHz channel bandwidth | Per Band | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyThis FG is applicable only when an associated SS/PBCH block is located according to Table 5.4.3.3-2 in TS 38.101-1 in Rel-18Note: The UE supporting this FG supports configuration of 15 PRB BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1). | Optional with capability signalling |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-2a | Support 12 PRB CORESET0 | 1) Reception of 12 PRB CORESET0 with an associated SS/PBCH block that is located according to Table 5.4.3.1-2 in TS 38.101-1 | 51-1 | Yes | N/A | UE is not able to support 3 MHz channel bandwidth with 12 PRB CORESET0 | Per Band | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyNote: The UE supporting this FG supports configuration of 12 PRB BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1). | Optional with capability signalling |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-2b | Support 12 PRB CORESET0 with an associated SS/PBCH block located at GSCN 41637 | 1) Reception of 12 PRB CORESET0 with an associated SS/PBCH block located at GSCN 41637 | 51-1 | Yes | N/A | UE is not able to support 3 MHz channel bandwidth with 12 PRB CORESET0 when an associated SS/PBCH block is located in band n100 at frequency GSCN 41637 of Table 5.4.3.1-3 in TS 38.101-1 | Per UE | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyThis FG is only applicable when an associated SS/PBCH block is located in band n100 at GSCN 41637 of Table 5.4.3.1-3 in TS 38.101-1 in Rel-18.Note: The UE supporting this FG supports configuration of 12 PRB BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1). | Optional with capability signalling |
| 51. NR\_FR1\_lessthan\_5MHz\_BW | 51-3 | Support 5 MHz channel bandwidth with 20 PRB CORESET0 | 1) Short RACH preamble formats with 15kHz SCS, and long PRACH formats with 1.25kHz SCS2) Reception of 20 PRB CORESET0 |  | Yes | N/A | UE is not able to support 5 MHz channel bandwidth with 20 PRB CORESET0 | Per UE | FDD only | FR1 only | N/A | This FG is supported for 15 kHz SCS onlyThis FG is only applicable when an associated SS/PBCH block is located in band n100 at GSCN 41638 of Table 5.4.3.1-3 in TS 38.101-1 in Rel-18.Note: The UE supporting this FG supports configuration of 20 PRB BWP operationThis FG is only applicable to single-carrier operation. This FG is not applicable to UEs indicating supportOfRedCap-r17 (i.e., FG 28-1) or supportOfERedCap-r18 (i.e., FG 48-1). | Optional with capability signalling |