**3GPP TSG RAN WG2 Meeting #118-e**   **R2-220xxxx**

**E-Meeting, 9th – 20th April 2022**

**Agenda Item:** **8.20.2**

**Source:**  **Intel Corporation**

**Title:** **Report of [AT118-e][212][71 GHz] 71 GHz UE capability corrections (Intel)**

**Document for:** **Discussion/Decision**

# Introduction

This document aims to summarize all the papers that have been submitted to agenda item 8.20.2 of RAN2#118-e and handle the offline discussion below:

* [AT118-e][212][71 GHz] 71 GHz UE capability corrections (Intel)

Scope: Discuss UE capability corrections for 71 GHz and provide proposals for resolution

Intended outcome: Discussion report in [R2-2206179](file:///C:\Users\terhentt\Documents\Tdocs\RAN2\RAN2_118-e\R2-220xxxx.zip) (for online discussion) and final draft CRs in [R2-2206180](file:///C:\Users\terhentt\Documents\Tdocs\RAN2\RAN2_118-e\R2-220xxxx.zip) and [R2-2206181](file:///C:\Users\terhentt\Documents\Tdocs\RAN2\RAN2_118-e\R2-220xxxx.zip).

Deadline: Deadline 3

# Companies’ point of contact

|  |  |  |
| --- | --- | --- |
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# Supported bandwidths for FR2-2

With the agreement from RAN4 below, UE capabilities related to the supported bandwidth needs to be updated.

At RAN4#100, the following was agreed:

**Agreement:** For intermediate CBWs between min and max CBWs,

* Integer multiples of the min CBW for each SCS
  + 120 kHz: 100 MHz (min), 400 MHz (max)
  + 480 kHz: 400 MHz (min), **800 MHz,** 1600 MHz (max)
  + 960 kHz: 400 MHz (min), **800 MHz, 1600 MHz,** 2000 MHz (max)
* FFS whether 1200Mhz CBW is needed for 480KHz SCS and 960Khz SCS
* FFS whether 200MHz CBW is needed for 120KHz SCS

The followings are the UE capabilities that are impacted by the above agreement and required updating to support FR2-2:

* Per FSPC
  + supportedBandwidthDL
  + supportedBandwidthUL
* Per band
  + channelBWs-DL
  + channelBWs-UL

## Updates to supportedBandwidth (UL/DL)

Since the FeatureSetDownlinkPerCC and FeatureSetUplinkPerCC indicate its corresponding SCS, [1] proposes to further include the new channel bandwidth for SCS 480kHz and SCS 960kHz to the new Rel-17 range for FR2 as follow:

**Proposal#1:** Introduce the new CBWs (800MHz, 1600MHz and 2000MHz) for SCS 480kHz and 960kHz to the SupportedBandwidth-v1700 as follow:

–                  *SupportedBandwidth*

The IE *SupportedBandwidth* is used to indicate the channel bandwidth supported by the UE on one carrier of a band of a band combination.

***SupportedBandwidth* information element**

-- ASN1START

-- TAG-SUPPORTEDBANDWIDTH-START

SupportedBandwidth::=      CHOICE {

    fr1    ENUMERATED {mhz5, mhz10, mhz15, mhz20, mhz25, mhz30, mhz40, mhz50, mhz60, mhz80, mhz100},

    fr2    ENUMERATED {mhz50, mhz100, mhz200, mhz400}

}

SupportedBandwidth-v1700 ::=      CHOICE {

    fr1-r17         ENUMERATED {mhz5, mhz10, mhz15, mhz20, mhz25, mhz30, mhz35, mhz40, mhz45, mhz50, mhz60, mhz70, mhz80, mhz90, mhz100},

    fr2-r17         ENUMERATED {mhz50, mhz100, mhz200, mhz400, mhz800, mhz1600, mhz2000}

}

-- TAG-SUPPORTEDBANDWIDTH-STOP

-- ASN1STOP

And the UE can indicate the new channel bandwidth via a non-critical extension as follow for both *supportedBandwidthDL* and s*upportedBandwidthUL*:

**Proposal#2:** The corresponding ASN.1 update for FeatureSetDownlinkPerCC (also FeatureSetUplinkPerCC) is as follow:

FeatureSetDownlinkPerCC ::= SEQUENCE {

supportedSubcarrierSpacingDL SubcarrierSpacing,

supportedBandwidthDL SupportedBandwidth,

channelBW-90mhz ENUMERATED {supported} OPTIONAL,

maxNumberMIMO-LayersPDSCH MIMO-LayersDL OPTIONAL,

supportedModulationOrderDL ModulationOrder OPTIONAL

}

FeatureSetDownlinkPerCC-v1620 ::= SEQUENCE {

-- R1 16-2a: Mulit-DCI based multi-TRP

multiDCI-MultiTRP-r16 MultiDCI-MultiTRP-r16 OPTIONAL,

-- R1 16-2b-3: Support of single-DCI based FDMSchemeB

supportFDM-SchemeB-r16 ENUMERATED {supported} OPTIONAL

}

FeatureSetDownlinkPerCC-v17xy ::= SEQUENCE {

supportedMinBandwidthDL-r17 SupportedBandwidth-v1700 OPTIONAL,

broadcast-SCell-r17 ENUMERATED {supported} OPTIONAL,

supportedBandwidthDL-v17xy SupportedBandwidth-v1700 OPTIONAL

}

**3-1-1. Do companies agree to the above Proposal#1 and Proposal#2 on the ASN.1 for** **supportedBandwidthDL/UL?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes/No** | **Comments** |
| Intel | Yes |  |
| Nokia | Yes |  |
| Ericsson | Yes |  |

With the above ASN.1 change, [1] further proposes to update the field description for supportedBandwidthDL/UL as follow. For FR2-1, the set of mandatory CBW is 50,100,200MHz. With the same logic, for FR2-2 band, a set of CBW may also be defined as mandatory by RAN4. This can wait for RAN4 progress. From RAN2 point of view, RAN2 just need to update that the mandatory CBW for FR2 in the field description for supportedBandwidthDL/UL is just for FR2-1 bands.

**Proposal#3:** The field description for *supportedBandwidthDL* is updated as follow (similarly also to *supportedBandwidthUL*):

| ***supportedBandwidthDL, supportedBandwidthDL-v17xy***  Indicates maximum DL channel bandwidth supported for a given SCS that UE supports within a single CC (and in case of intra-frequency DAPS handover for the source and target cells), which is defined in Table 5.3.5-1 in TS 38.101-1 [2] for FR1 and Table 5.3.5-1 in TS 38.101-2 [3] for FR2.  For FR1, all the bandwidths listed in TS38.101-1 Table 5.3.5-1 for each band shall be mandatory with a single CC unless indicated optional. For FR2-1, the set of mandatory CBW is 50, 100, 200 MHz. When this field is included in a band combination with a single band entry and a single CC entry (i.e. non-CA band combination), the UE shall indicate the maximum channel bandwidth for the band according to TS 38.101-1 [2] and TS 38.101-2 [3]. For SCS 480kHz and 960kHz in FR2-2, *supportedBandwidthDL* (with suffix) can be set if the maximum DL channel bandwidth supported is greater than 400MHz, otherwise it is absent.  The UE may report a *supportedBandwidthDL* wider than the *channelBWs-DL*; this *supportedBandwidthDL* may not be included in the Table 5.3.5-1 of TS 38.101-1[2]/TS 38.101-2[3] for the case that the UE is unable to report the actual supported bandwidth according to the Table 5.3.5-1 of TS 38.101-1[2]/TS 38.101-2[3]. For each band, RedCap UEs shall indicate its maximum channel bandwidth, which is the maximum of those channel bandwidths that are less than or equal to 20 MHz for FR1 and less than or equal to 100 Mhz for FR2, taking restrictions in TS 38.101-1 [2] and TS 38.101-2 [3] into consideration.  NOTE: To determine whether the UE supports a channel bandwidth of 90 MHz, the network may ignore this capability and validate instead the *channelBW-90mhz*, the *supportedBandwidthCombinationSet* and the *supportedBandwidthCombinationSetIntraENDC*. For serving cell(s) with other channel bandwidths the network validates the *channelBWs-DL*, the *supportedBandwidthCombinationSet*, the *supportedBandwidthCombinationSetIntraENDC*, the *asymmetricBandwidthCombinationSet* (for a band supporting asymmetric channel bandwidth as defined in clause 5.3.6 of TS 38.101-1 [2]), *supportedBandwidthDL/ supportedBandwidthDL (with suffix)* and *supportedMinBandwidthDL*. | FSPC | CY | N/A | N/A |
| --- | --- | --- | --- | --- |

**3-1-2. Do companies agree to the above Proposal#3?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes/No** | **Comments** |
| Intel | Yes |  |
| Nokia | Yes |  |
| Ericsson | Yes |  |

## Updates to channelBWs (UL/DL)

As the existing channelBWs-DL/UL are mandatory with capability signalling only for FR1 and FR2-1 as follow,



A new channelBWs-DL/UL may need to be introduced to include SCS 120kHz, 480kHz and 960kHz channel bandwidth if based on the legacy Rel-15 signalling.

However, [1] understanding is that these per band channel bandwidth capabilities for UL and DL are also being discussed in RAN4 and there is also the option that UE just needs to optionally indicate the SCS supported for FR2-2 (as per RAN1 features 24-1/1a (for 120kHz) SCS) 24-4/4a (for 480kHz SCS) and 24-5/5a (for 960kHz SCS)) and if UE indicates a SCS is supported per R1 feature, UE mandatory supports all the bandwidths corresponding to the SCS without capability signalling. Hence RAN2 should wait for RAN4 conclusion on this.

**Proposal#4:** For the per band channelBWs-DL/UL UE capabilities for FR2-2, RAN2 should wait for RAN4 progress on the R4 feature list.

**3-2-1. Do companies agree to the above Proposal#4?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes/No** | **Comments** |
| Intel | Yes |  |
| Nokia | Yes |  |
| Ericsson | Yes |  |

For the existing ***channelBWs-UL/DL***, it is currently mandatory set. It should be changed to conditional mandatory for FR1 and FR2-1 band.

**Proposal#5:** The existing ***channelBWs-UL/DL*** should be changed to conditional mandatory for FR1 and FR2-1 band as follow:

| ***channelBWs-DL***  Indicates for each subcarrier spacing the UE supported channel bandwidths. Absence of the *channelBWs-DL* (without suffix) for a band or absence of specific scs-XXkHz entry for a supported subcarrier spacing means that the UE supports the channel bandwidths among [5, 10, 15, 20, 25, 30, 40, 50, 60, 80, 100] and [50, 100, 200] that were defined in clause 5.3.5 of TS 38.101-1 version 15.7.0 [2] and TS 38.101-2 version 15.7.0 [3] for the given band or the specific SCS entry. For IAB-MT, to determine whether the IAB-MT supports a channel bandwidth of 100 MHz, the network checks c*hannelBW-DL-IAB-r16*.  For FR1, the bits in *channelBWs-DL* (without suffix) starting from the leading / leftmost bit indicate 5, 10, 15, 20, 25, 30, 40, 50, 60 and 80MHz. For FR2, the bits in *channelBWs-DL* (without suffix) starting from the leading / leftmost bit indicate 50, 100 and 200MHz. The third / rightmost bit (for 200MHz) shall be set to 1. For IAB-MT the third / rightmost bit (for 200MHz) is ignored. To determine whether the IAB-MT supports a channel bandwidth of 200 MHz, the network checks *channelBW-DL-IAB-r16*.  For FR1, the leading/leftmost bit in *channelBWs-DL-v1590* indicates 70MHz, the second leftmost bit indicates 45MHz, the third leftmost bit indicates 35MHz, the fourth leftmost bit indicates 100MHz and all the remaining bits in *channelBWs-DL-v1590* shall be set to 0. The fourth leftmost bit (for 100MHz) is not applicable for bands n41, n48, n77, n78, n79 and n90 as defined in TS 38.101-1 [2].  This feature is mandatory for FR1 and FR2-1 band, otherwise it is absent.  NOTE: To determine whether the UE supports a specific SCS for a given band, the network validates the *supportedSubCarrierSpacingDL* and the *scs-60kHz*. To determine whether the UE supports a channel bandwidth of 90 MHz, the network may ignore this capability and validate instead the *channelBW-90mhz*, the *supportedBandwidthCombinationSet* and the *supportedBandwidthCombinationSetIntraENDC*. For serving cell(s) with other channel bandwidths the network validates the *channelBWs-DL*, the *supportedBandwidthCombinationSet*, the *supportedBandwidthCombinationSetIntraENDC*, the *asymmetricBandwidthCombinationSet* (for a band supporting asymmetric channel bandwidth as defined in clause 5.3.6 of TS 38.101-1 [2]) and *supportedBandwidthDL*. | Band | ~~Yes~~CY | N/A | N/A |
| --- | --- | --- | --- | --- |

**3-2-2. Do companies agree to the above Proposal#5?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes/No** | **Comments** |
| Intel | Yes |  |
| Nokia | Yes |  |
| Ericsson | Yes |  |

# UE capability for new values for drx-HARQ-RTT-TimerDL and drx-HARQ-RTT-TimerUL

RAN2 agreed to the introduce conditional mandatory UE capability for

* **RAN2 to confirm to introduce values up to 448 (integer 0..448) for DRX parameters for SCS of 480 and 960 kHz, for drx-HARQ-RTT-TimerDL and drx-HARQ-RTT-TimerUL. These are conditionally mandatory for FR2-2 UEs.**
* **The capability clarification can be done in the next meeting.**

From the RRC implementation, 2 new IEs are added {*drx-HARQ-RTT-TimerDL-r17* and *drx-HARQ-RTT-TimerUL-r17*} with the following field description:

|  |
| --- |
| ***drx-HARQ-RTT-TimerDL***  Value in number of symbols of the BWP where the transport block was received. *drx-HARQ-RTT-TimerDL-r17* is only applicable for SCS 480 kHz and 960 kHz. If configured, the UE shall ignore *drx-HARQ-RTT-TimerDL* (without suffix). |
| ***drx-HARQ-RTT-TimerUL***  Value in number of symbols of the BWP where the transport block was transmitted. *drx-HARQ-RTT-TimerUL-r17* is only applicable for SCS 480 kHz and 960 kHz. If configured, the UE shall ignore *drx-HARQ-RTT-TimerUL* (without suffix). |

Conditionally mandatory can be introduced with or without signalling. [1] thinks that these new configurations are only applicable to UE supporting FR2-2 bands using SCS 480kHz and 960kHz. Hence, we assume that it is for without signalling. A new conditionally mandatory UE cap can be added to Section 6 of TS38.306 as follow:

| Features | Condition |
| --- | --- |
| Extended values for drx-HARQ-RTT-TimerDL/UL | It is mandatory for UEs which support FR2-2 bands with SCS 480kHz and/or 960kHz. |

**Proposal#6:** Introduce new conditionally mandatory without capability signalling for UE supporting the extended values of DRX HARQ RTT Timer {*drx-HARQ-RTT-TimerDL-r17* and *drx-HARQ-RTT-TimerUL-r17*} as follow in Section 6:

| Features | Condition |
| --- | --- |
| Extended values for drx-HARQ-RTT-TimerDL/UL | It is mandatory for UEs which support FR2-2 bands with SCS 480kHz and/or 960kHz. |

**4. Do companies agree to the above Proposal#6?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes/No** | **Comments** |
| Intel | Yes |  |
| Nokia | Yes |  |
| Ericsson | Yes |  |

# Miscellaneous Corrections

## Rel-16 DRX adaptation UE capability

[1] noticed that the following UE capability in MAC with FRx differentiation has not been implemented for further differentiation between FR2-1 and FR2-2

| ***drx-Adaptation-r16***  Indicates whether the UE supports DRX adaptation comprised of the following functional components:  - Configured *ps-Offset* for the detection of DCI format 2\_6 with CRC scrambling by *ps*-RNTI and reported *MinTimeGap* before the start of *drx-onDurationTimer* of Long DRX  - Indication of UE whether or not to start *drx-onDurationTimer* for the next Long DRX cycle by detection of DCI format 2\_6  - Configured UE wakeup or not when DCI format 2\_6 is not detected at all monitoring occasions outside Active Time  - Configured periodic CSI report apart from L1-RSRP (*ps-TransmitOtherPeriodicCSI*) when impacted by DCI format 2\_6 that *drx-onDurationTimer* does not start for the next Long DRX cycle  - Configured periodic L1-RSRP report (*ps-TransmitPeriodicL1-RSRP*) when impacted by DCI format 2\_6 that *drx-onDurationTimer* does not start for the next Long DRX cycle  The capability signalling includes the minimum time gap between the end of the slot of last DCI format 2\_6 monitoring occasion and the beginning of the slot where the UE would start the *drx-onDurationTimer* of Long DRX for each SCS. The value *sl1* indicates 1 slot. The value *sl2* indicates 2 slots, and so on. Support of this feature is reported for licensed and unlicensed bands, respectively. When this field is reported, either of *sharedSpectrumChAccess-r16* or *non-SharedSpectrumChAccess-r16* shall be reported, at least. | UE | No | No | Yes |
| --- | --- | --- | --- | --- |

Hence, it needs to be also aligned with the other UE capabilities in MAC parameters.

**Proposal#7:** Introduce further differentiation between FR2-1 and FR2-2 for drx-Adaptation-r16.

**5-1 Do companies agree to the above Proposal#6?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes/No** | **Comments** |
| Intel | Yes |  |
| Nokia | Yes |  |
| Ericsson | uncertain | Can rapporteur explain what is the reason for this further differentiation?  [Rapp] The reason is that drx-Adaptation-r16 is FR1 and FR2 differentiation. Like the other MAC parameters with FRx-diff = yes, we assume that further differentiation between FR2-1 and FR2-2 is also needed. |

## FR2-1 and FR2-2 differentiation

A CR [3] has the following reason for change:

In RAN2#116-e meeting, it was agreed that:

* #2: For an existing capability that required further FR2-1 and FR2-2 differentiation, a new IE specifically for FR2-2 (xxParametersFR2-2) is included in the existing per UE IE (XXParameters) as shown in [R2-2109883](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_116-e/Docs/R2-2109883.zip), where xx/XX can be mac-/MAC-, phy-/PHY-, measAndMob/MeasAndMob, ims-/IMS- and powSav-/PowSav- associated with per UE capabilities.

According to the above agreement and the implementation in TS 38.331, for an existing capability that requires further FR2-1 and FR2-2 differentiation, a new capability field with suffix ‘-r17’ is introduced to indicate the corresponding UE capability for FR2-2. However, such intention has not been clearly captured in the specification, which may lead to confusion. For example, there could be ambiguity in the spec TS 38.306 whether or not a capability field with suffix ‘-r17’ is also applicable for FR2-1 or FR1.

**Q5-2 Do companies agree with the proposed changes in the CR? For companies agreeing to the proposed changes, please also comment on the contents of the CR, if any.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Intel | No | There is already a sentence that the added -r17 capability is for FR2-2:  “(Incl FR2-2 DIFF)” in the column by "FR1-FR2 DIFF" indicates the UE capability field can have a different value for between FR2-1 and FR2-2.  Also in the ASN.1, this ‘-r17’ is under IE indicating that it is for FR2-2. For example:  MAC-ParametersFR2-2-r17 ::= SEQUENCE {  directMCG-SCellActivation-r17 ENUMERATED {supported} OPTIONAL,  directMCG-SCellActivationResume-r17 ENUMERATED {supported} OPTIONAL,  directSCG-SCellActivation-r17 ENUMERATED {supported} OPTIONAL,  directSCG-SCellActivationResume-r17 ENUMERATED {supported} OPTIONAL,  ...  } |
| Nokia | No | OK with above explanation from Intel |
| Ericsson | No | Rapp’s comments make sense. |
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|  |  |  |
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# Conclusion

To be added latter

# References

[1] [R2-2205792](file:///C:\Users\terhentt\Documents\Tdocs\RAN2\RAN2_118-e\R2-2205792.zip) Remaining UE capabilities on NR operation for upto 71GHz Intel Corporation discussion Rel-17 NR\_ext\_to\_71GHz-Core

[2] [R2-2204870](file:///C:\Users\terhentt\Documents\Tdocs\RAN2\RAN2_118-e\R2-2204870.zip) Correction to 38.306 for Ext71GHz Huawei, HiSilicon CR Rel-17 38.306 17.0.0 0705 - F NR\_ext\_to\_71GHz-Core

[3] [R2-2205793](file:///C:\Users\terhentt\Documents\Tdocs\RAN2\RAN2_118-e\R2-2205793.zip) Further updates for 71GHz UE capabilities (TS38.306) Intel Corporation draftCR Rel-17 38.306 17.0.0 B NR\_ext\_to\_71GHz-Core

[4] [R2-2205794](file:///C:\Users\terhentt\Documents\Tdocs\RAN2\RAN2_118-e\R2-2205794.zip) Further updates for 71GHz UE capabilities (TS38.331) Intel Corporation draftCR Rel-17 38.331 17.0.0 B NR\_ext\_to\_71GHz-Core