**3GPP TSG-RAN2 Meeting #125bis** **R2-240xx**

**Changsha, China, April 15-19, 2024**

**Agenda Item:** 7.25.x.x

**Work Item:** NR\_FR1\_lessthan\_5MHz\_BW

**Source:** Qualcomm Incorporated

**Title:** Report of [POST125] [012] [less5MHz] Backward compatibility issue

**Document for:**Discussion/Decision

# Background

RAN2 received LS from RAN1 on inter-frequency neighbour cells supporting NR dedicated spectrum less than 5 MHz for FR1, see R2-2400032/ R1-2312668 [1]. The main content is reproduced here for quick reference:

|  |
| --- |
| RAN1 has discussed the following issue regarding the configuration of inter-frequency neighbour cell list, including the neighbour cells in NR dedicated spectrum less than 5 MHz for FR1 with single carrier operation:According to current specifications, SIB4 indicates the inter-frequency neighbour cell(s) with the dl-CarrierFreq corresponding to a GSCN value. If a common neighbour cell list is indicated, which includes the cell(s) using the legacy (Rel-17) GSCN value in Table 5.4.3.1-1 of TS38.101-1 and the cell(s) using new GSCN values (introduced in Rel-18) in Table 5.4.3.1-2 and Table 5.4.3.1-3 of TS38.101-1, the UEs not supporting the new GSCN values will receive dl-CarrierFreq which do not correspond to the Rel-17 GSCN values. **Question 1:** Does RAN2/RAN4 expect any backward compatibility issue for a UE not supporting less than 5MHz but provided with a neighbour cell with SSB on the new GSCN value in the scenario described above or other similar scenarios if any? For example, if a UE accessed a cell with SSB on the legacy GSCN value, the UE not supporting less than 5MHz may search SSB on the new GSCN values indicated in the common neighbour cell list and wrongly access the neighbour cell(s) in NR dedicated spectrum less than 5 MHz for FR1 with single carrier operation.**Question 2:** If the answer to Question 1 is Yes, is it possible for RAN2 to define a scheme to avoid the backward compatibility issue? |

In NR, SIB4 indicates the cell reselection configuration of inter-frequency neighbour cells, where the *ARFCN-ValueNR* of *dl-CarrierFreq* is the GSCN value for the SSB.

SIB4 ::=                            SEQUENCE {

    interFreqCarrierFreqList            InterFreqCarrierFreqList,

    lateNonCriticalExtension            OCTET STRING                                OPTIONAL,

    ...,

<<skip>>

}

InterFreqCarrierFreqList ::=        SEQUENCE (SIZE (1..maxFreq)) OF InterFreqCarrierFreqInfo

<<skip>>

InterFreqCarrierFreqInfo ::=        SEQUENCE {

    dl-CarrierFreq                      ARFCN-ValueNR,

    frequencyBandList                   MultiFrequencyBandListNR-SIB                                OPTIONAL,   -- Cond Mandatory

    frequencyBandListSUL                MultiFrequencyBandListNR-SIB                                OPTIONAL,   -- Need R

    nrofSS-BlocksToAverage              INTEGER (2..maxNrofSS-BlocksToAverage)                      OPTIONAL,   -- Need S

    absThreshSS-BlocksConsolidation     ThresholdNR                                                 OPTIONAL,   -- Need S

    smtc                                SSB-MTC                                                     OPTIONAL,   -- Need S

    ssbSubcarrierSpacing                SubcarrierSpacing,

    ssb-ToMeasure                       SSB-ToMeasure                                               OPTIONAL,   -- Need S

    deriveSSB-IndexFromCell             BOOLEAN,

    ss-RSSI-Measurement                 SS-RSSI-Measurement                                         OPTIONAL,   -- Need R

<<skip>>

}

|  |
| --- |
| ***dl-CarrierFreq***This field indicates center frequency of the SS block of the neighbour cells, where the frequency corresponds to a GSCN value as specified in TS 38.101-1 [15] or TS 38.101-5 [75]. |

As described in the LS, for legacy UEs, the *ARFCN-ValueNR* of the inter-freq neighbour cells should be only legacy sync raster points with 20PRB SSB, i.e. the Global Synchronization Channel Number (GSCN) from Table 5.4.3.1-1 of TS 38.101-1 (existing in Rel-17). However, for new Rel-18 UEs supporting less than 5MHz in addition to the legacy 5MHz, the *ARFCN-ValueNR* of the inter-freq neighbour cells can be legacy sync raster points with 20PRB SSB or new sync raster points with 12PRB SSB, i.e. the GSCN from Tables 5.4.3.1-2 and 5.4.3.1-3 of TS38.101-1 (added in Rel-18) in addition to the Table 5.4.3.1-1 of TS 38.101-1 (existing in Rel-17).

RAN2#125 discussed the LS and related company contributions [2] – [5], and agreed the following:

**Agreements**

1 Reply to RAN1 indicating that yes there are backward compatibility issues for legacy UEs not supporting less than 5MHz if they are provided with a neighbour cell info in the existing SIB4 and LTE SIB24 list with SSB on the new GSCN value. This is the case for both inter-RAT and inter-frequency.

2 RAN2 will address the issue. Legacy UEs will not be able to measure and reselect to <5MHz neighbor cells, by making use of a second list. FFS the details. FFS if SIB11 should also be considered

Subsequently, RAN2#125 approved an LS to RAN1, RAN4 in [R2-2401885](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_125/Docs/R2-2401885.zip) [6].

Furthermore, RAN2#125 allocated following email discussion:

* [POST125] [012] [less5MHz] Backward compatibility issue(Qualcomm)

 Intended outcome: Agreable solution/proposal to solve the backwards compatibility issue and also whether SIB11 should be considered

 Deadline: March 28, 24

This document is the report of the email discussion [POST125] [012].

# Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Contact Name** | **Email** |
| Qualcomm | Umesh Phuyal | uphuyal@qti.qualcomm.com |
| Nokia | Jarkko Koskela | Jarkko.t.koskela@nokia.com |
| vivo | Xiaodong Yang | Yangxiaodong5g@vivo.com |
| ZTE | Wenting Li | Li.wenting@zte.com.cn |
| Ericsson | Håkan Palm | Hakan.l.palm@ericsson.com |
| Huawei, HiSilicon | Zhenzhen Cao | caozhenzhen@huawei.com |
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|  |  |  |

# Discussion on how to solve the backward compatibility issue in SIB4

As shown above in section 1, RAN2#125 confirmed and replied to RAN1 that indeed there are BC issues for legacy UEs not supporting less than 5MHz if they are provided with a neighbour cell info in the existing SIB4 and LTE SIB24 list with SSB on the new GSCN value and this is the case for both inter-RAT and inter-frequency.

Then how to solve the issue? Any negative impact on legacy UEs needs to be avoided. Solution is needed to allow signalling of the neighbor cells list including <5 MHz cells, while making sure the legacy UEs do not unnecessarily measure those cells and potentially decode SIB1 before figuring out they cannot access that cell.

[5] and [4] explained that a straightforward solution would be to separate lists of inter-frequency neighbour cells for legacy sync raster points and new sync raster points. Then, the *interFreqCarrierFreqList* for SSBs using legacy sync raster points would be used by all the UEs, whereas a new *interFreqCarrierFreqList* for SSBs using the new sync raster points would be introduced which only the new UEs capable of FG51-1/2/3 can detect and use. Something like below:

SIB4 ::= SEQUENCE {

 interFreqCarrierFreqList InterFreqCarrierFreqList,

 lateNonCriticalExtension OCTET STRING OPTIONAL,

 ...,

[[

 interFreqCarrierFreqList-LessThan5MHz-r18 InterFreqCarrierFreqList OPTIONAL -- Need R

]]

}

InterFreqCarrierFreqList ::= SEQUENCE (SIZE (1..maxFreq)) OF InterFreqCarrierFreqInfo

InterFreqCarrierFreqInfo ::= SEQUENCE {

 dl-CarrierFreq ARFCN-ValueNR,

frequencyBandList MultiFrequencyBandListNR-SIB OPTIONAL, -- Cond Mandatory

<<skip>>

}

However, as explained in [2], we notice the following issues:

1. The *interFreqCarrierFreqList* in SIB4 is mandatory to be present with at least one element, and within that element, *dl-CarrierFreq* is also mandatory field. This means the legacy list cannot be omitted. And in the scenarios where all the neighbours are <5MHz, there needs to be a way to signal such that legacy UEs know how to ignore the legacy list (while the new UEs use the new list).
2. There are further extensions of the list *interFreqCarrierFreqList*, e.g. *interFreqCarrierFreqList-v1610, interFreqCarrierFreqList-v1700, interFreqCarrierFreqList-v1720, interFreqCarrierFreqList-v1730, interFreqCarrierFreqList-v1760, interFreqCarrierFreqInfo-v1800*. While not impossible, it would be strange to consider these older release IEs as extension of a new Rel-18 list. Alternatively, we would need to create duplicates of all of these extensions or merge all the fields within them in the new Rel-18 IE.

While the second issue above is easily solvable, the first issue is a bit tricky. Especially given the following existing field description from TS 38.331 (highlighted in yellow), if there is no correspondence to the center frequency of the SS block of the neighbor cell to the GSCN value, the behaviour is unpredictable.

***dl-CarrierFreq***

This field indicates center frequency of the SS block of the neighbour cells, where the frequency corresponds to a GSCN value as specified in TS 38.101-1 [15] or TS 38.101-5 [75].

Note that for the above reasons, the above is not included in the possible solution options below. However, there are solutions options which provide workaround to these issues.

As possible workaround of the above issue, [2] proposed to choose one of the existing GSCN values until Rel-17 which has been defined and in theory can have a valid *frequency corresponding to the GSCN* but not used by any UEs, and use that as ‘*reserved*’ value, e.g. interFreqCarrierFreqList >> dl-CarrierFreq (ARFCN-ValueNR) = 250 (corresponding to GSCN = 2); whereas [4] proposed to choose one of the existing band number values, e.g. interFreqCarrierFreqList >> frequencyBandList >> NR-MultiBandInfo >> freqBandIndicatorNR =1024. The assumption in both [2] and [4] is that the network implementation may choose such value to be placed in the legacy list which the legacy UEs can understand but do not support (and hence gracefully ignore).

In addition to the above potential solutions, [4] also explored the following options:

* Using special band numbers in SIB4 *existing list* for neighbour cells less than 5 MHz, e.g. by adding 900 to the RAN4-defined values (i.e. signal *FreqBandIndicatorNR* =1000 in SIB4 for band n100 for neighbor cells on less than 5MHz carrier). Rapporteur understanding is that based on RAN2 agreement “Legacy UEs will not be able to measure and reselect to <5MHz neighbor cells, by making use of a second list”, this option is excluded.
* Using a new SIB to provide neighbour cell list for less than 5MHz carriers. [4] describes that if there is no inter-frequency neighbor cell on legacy spectrum, the network can only broadcast new SIB to provide the neighbour cell for the less than 5MHz spectrum. However, it should be noted that a legacy cell may need to broadcast both SIBs (legacy SIB4 and new SIB) if some of its neighbours are <5Mhz.

Based on the above, the list of solutions as workaround for SIB4 backward compatibility issue on the table that use a second list are as follows:

* **Option (a):** New list for <5MHz cells in SIB4. As workaround for legacy list mandatory field, use special *ARFCN-ValueNR* number in *interFreqCarrierFreqList* >> *dl-CarrierFreq* (as described in [2])
* **Option (b):** New list for <5MHz cells in SIB4. As workaround for legacy list mandatory field, use special *FreqBandIndicatorNR* number in *interFreqCarrierFreqList >> frequencyBandList >> NR-MultiBandInfo >> freqBandIndicatorNR* (as described in [4] option 2)
* **Option (c):** New list for <5MHz cells using a new SIB (as described in [4] option 3).

In the following, the proposed TPs from [2] and [3] are shown for each of the above solutions:

## Potential changes needed for Option (a)

[2] shows the required changes to SIB4 for option (a) will look like below.

SIB4 ::= SEQUENCE {

 interFreqCarrierFreqList InterFreqCarrierFreqList,

 lateNonCriticalExtension OCTET STRING OPTIONAL,

 ...,

<<skip>>

}

InterFreqCarrierFreqInfo-v1800 ::= SEQUENCE {

 dl-CarrierFreq-r18 ARFCN-ValueNR OPTIONAL, -- Cond LessThan5MHz

 frequencyBandListAerial-r18 MultiFrequencyBandListNR-Aerial-SIB-r18 OPTIONAL, -- Need S

 mobileIAB-CellList-r18 PCI-Range OPTIONAL, -- Need R

 eRedCapAccessAllowed-r18 ENUMERATED {true} OPTIONAL, -- Need R

 tn-AreaIdList-r18 SEQUENCE (SIZE (1..maxTN-AreaInfo-r18)) OF TN-AreaId-r18 OPTIONAL -- Need R

}

|  |  |
| --- | --- |
| **Conditional Presence** | **Explanation** |
| *LessThan5MHz* | The field is mandatory present if the neighbor cell supports 12 PRB, 15 PRB or 20 PRB transmission bandwidth configuration as defined in TS 38.101-1 [15], TS 38.211 [16] and TS 38.213 [13]. Otherwise, the field is not present and *dl-CarrierFreq* (without suffix) applies. |

***dl-CarrierFreq***

This field indicates center frequency of the SS block of the neighbour cells, where the frequency corresponds to a GSCN value as specified in TS 38.101-1 [15] or TS 38.101-5 [75]. For a neighbouring carrier frequency when *dl-CarrierFreq-r18* is included, the network sets the corresponding value of *dl-CarrierFreq* (without suffix) to 250, and the UE applies *dl-CarrierFreq-r18* instead of *dl-CarrierFreq* (without suffix).

## Potential changes needed for Option (b)

SIB4 ::= SEQUENCE {

 interFreqCarrierFreqList InterFreqCarrierFreqList,

 lateNonCriticalExtension OCTET STRING OPTIONAL,

 ...,

<<skip>>

 [[

 interFreqCarrierFreqList-v1800 InterFreqCarrierFreqList-v1800 OPTIONAL -- Need R

 interFreqCarrierFreqList2-r18 InterFreqCarrierFreqList OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext1-v18xy InterFreqCarrierFreqList-v1610 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext2-v18xy InterFreqCarrierFreqList-v1700 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext3-v18xy InterFreqCarrierFreqList-v1720 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext4-v18xy InterFreqCarrierFreqList-v1730 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext5-v18xy InterFreqCarrierFreqList-v1760 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext6-v18xy InterFreqCarrierFreqList-v1800 OPTIONAL -- Need R

 ]]

}

|  |
| --- |
| ***frequencyBandList***Indicates the list of frequency bands for which the NR cell reselection parameters apply. If a band number indicated in the list is 1024, the UE shall ignore the frequency indicated in interFreqCarrierFreqList in SIB4. |
| ***interFreqCarrierFreqList***List of neighbouring carrier frequencies and frequency specific cell re-selection information for carriers equal to or larger than 5 MHz. If *interFreqCarrierFreqList-v1610, interFreqCarrierFreqList-v1700, interFreqCarrierFreqList-v1720*, *interFreqCarrierFreqList-v1730,* *interFreqCarrierFreqList-v1760* or *InterFreqCarrierFreqInfo-v1800* are present, they shall contain the same number of entries, listed in the same order as in *interFreqCarrierFreqList* (without suffix). |
| ***interFreqCarrierFreqList2***List of neighbouring carrier frequencies and frequency specific cell re-selection information for carriers less than 5 MHz for FR1. If *interFreqCarrierFreqList2Ext1-v18xy, interFreqCarrierFreqList2Ext2-v18xy, interFreqCarrierFreqList2Ext3-v18xy*, *interFreqCarrierFreqList2Ext4-v18xy,* *interFreqCarrierFreqList2Ext5-v18xy* or *interFreqCarrierFreqList2Ext6-v18xy* are present, they shall contain the same number of entries, listed in the same order as in *interFreqCarrierFreqList2-r18.* |

## Potential changes needed for Option (c)

Note: the TP given in [4] option 3 is incomplete. Rapporteur added some changes below related to SIB scheduling and UE response message. However, in addition to the changes shown above,further changes would be needed either to clarify whether/not SIB4bis applies everywhere SIB4 currently appears in the specification (more than 35 places), or a blanket statement somewhere that supporting UE should always consider SIB4 = SIB4+SIB4bis, if present. Additionally, changes may be needed in section 5.2.2.4.5 Actions upon reception of SIB4.

-- ASN1START

-- TAG-SYSTEMINFORMATION-START

SystemInformation ::= SEQUENCE {

 criticalExtensions CHOICE {

 systemInformation SystemInformation-IEs,

 criticalExtensionsFuture-r16 CHOICE {

 posSystemInformation-r16 PosSystemInformation-r16-IEs,

 criticalExtensionsFuture SEQUENCE {}

 }

 }

}

SystemInformation-IEs ::= SEQUENCE {

 sib-TypeAndInfo SEQUENCE (SIZE (1..maxSIB)) OF CHOICE {

 sib2 SIB2,

<<skip>>

 sib25-v1800 SIB25-r18,

 sib4bis-V18xy SIB4bis-r18

 },

 lateNonCriticalExtension OCTET STRING OPTIONAL,

 nonCriticalExtension SEQUENCE {} OPTIONAL

}

-- TAG-SYSTEMINFORMATION-STOP

-- ASN1STOP

***SI-SchedulingInfo*information element**

SIB-TypeInfo-v1700 ::=              SEQUENCE {

    sibType-r17                         CHOICE {

        type1-r17                           ENUMERATED {sibType15, sibType16, sibType17, sibType18, sibType19, sibType20, sibType21,

                                                        sibType22-v1800, sibType23-v1800 ,sibType24-v1800, sibType25-v1800, sibType4bis-v18xy

                                                        ~~spare5~~, spare4, spare3, spare2, spare1,...},

        type2-r17                           SEQUENCE {

            posSibType-r17                      ENUMERATED {posSibType1-9, posSibType1-10, posSibType2-24, posSibType2-25,

                                                            posSibType6-4, posSibType6-5, posSibType6-6, posSibType2-17a-v1770,

                                                            posSibType2-18a-v1770, posSibType2-20a-v1770, posSibType1-11-v1800,

                                                            posSibType1-12-v1800, posSibType2-26-v1800, posSibType2-27-v1800,

                                                            spare2, spare1,...},

            encrypted-r17                       ENUMERATED { true }                                     OPTIONAL, -- Need R

            gnss-id-r17                         GNSS-ID-r16                                             OPTIONAL, -- Need R

            sbas-id-r17                         SBAS-ID-r16                                             OPTIONAL  -- Cond GNSS-ID-SBAS

        }

    },

    valueTag-r17                            INTEGER (0..31)                                             OPTIONAL, -- Cond NonPosSIB

    areaScope-r17                           ENUMERATED {true}                                           OPTIONAL  -- Need S

}

– *SIB4bis*

*SIB4bis* contains information relevant for less than 5MHz inter-frequency cell re-selection (i.e. information about other NR frequencies and inter-frequency neighbouring cells relevant for cell re-selection), which can also be used for NR idle/inactive measurements. The IE includes cell re-selection parameters common for a frequency as well as cell specific re-selection parameters.

SIB4bis-r18 ::= SEQUENCE {

 interFreqCarrierFreqList2-r18 InterFreqCarrierFreqList OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext1-v18xy InterFreqCarrierFreqList-v1610 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext2-v18xy InterFreqCarrierFreqList-v1700 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext3-v18xy InterFreqCarrierFreqList-v1720 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext4-v18xy InterFreqCarrierFreqList-v1730 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext5-v18xy InterFreqCarrierFreqList-v1760 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext6-v18xy InterFreqCarrierFreqList-v1800 OPTIONAL -- Need R

 lateNonCriticalExtension OCTET STRING OPTIONAL,

 ...,

}

| ***SIB4bis* field descriptions** |
| --- |
| ***interFreqCarrierFreqList2***List of neighbouring carrier frequencies and frequency specific cell re-selection information for carriers less than 5 MHz for FR1. If *interFreqCarrierFreqList2Ext1-v18xy, interFreqCarrierFreqList2Ext2-v18xy, interFreqCarrierFreqList2Ext3-v18xy*, *interFreqCarrierFreqList2Ext4-v18xy,* *interFreqCarrierFreqList2Ext5-v18xy* or *interFreqCarrierFreqList2Ext6-v18xy* are present, they shall contain the same number of entries, listed in the same order as in *interFreqCarrierFreqList2-r18.* |

***UEInformationResponse message***

SIB-Type-r17 ::= ENUMERATED {sibType2, sibType3, sibType4, sibType5, sibType9, sibType10-v1610, sibType11-v1610, sibType12-v1610,

                             sibType13-v1610, sibType14-v1610, sibType4bis-v18xy ~~spare6~~, spare5, spare4, spare3, spare2, spare1}

## Potential changes needed for Option (d)

We would like to give our option d, it is more like to combine option b and option c.

**In the scenarios where all the neighbours are <5MHz: (option c is used)**

NW will not send SIB4 mapped to SI for scheduling using *schedulingInfoList,* and legacy UE thinks NW has not send SIB4. For the UE supported <5MHz, NW will send *SIB4bis* mapped to SI for scheduling using*schedulingInfoList2. SIB4bis* is only applicable for less than 5MHz, which is present only if the SIB4 is not present.

-- ASN1START

-- TAG-SYSTEMINFORMATION-START

SystemInformation ::= SEQUENCE {

 criticalExtensions CHOICE {

 systemInformation SystemInformation-IEs,

 criticalExtensionsFuture-r16 CHOICE {

 posSystemInformation-r16 PosSystemInformation-r16-IEs,

 criticalExtensionsFuture SEQUENCE {}

 }

 }

}

SystemInformation-IEs ::= SEQUENCE {

 sib-TypeAndInfo SEQUENCE (SIZE (1..maxSIB)) OF CHOICE {

 sib2 SIB2,

<<skip>>

 sib25-v1800 SIB25-r18,

 sib4bis-V18xy SIB4bis-r18

 },

 lateNonCriticalExtension OCTET STRING OPTIONAL,

 nonCriticalExtension SEQUENCE {} OPTIONAL

}

-- TAG-SYSTEMINFORMATION-STOP

-- ASN1STOP

***SI-SchedulingInfo*information element**

SIB-TypeInfo-v1700 ::=              SEQUENCE {

    sibType-r17                         CHOICE {

        type1-r17                           ENUMERATED {sibType15, sibType16, sibType17, sibType18, sibType19, sibType20, sibType21,

                                                        sibType22-v1800, sibType23-v1800 ,sibType24-v1800, sibType25-v1800, sibType4bis-v18xy

                                                        ~~spare5~~, spare4, spare3, spare2, spare1,...},

        type2-r17                           SEQUENCE {

            posSibType-r17                      ENUMERATED {posSibType1-9, posSibType1-10, posSibType2-24, posSibType2-25,

                                                            posSibType6-4, posSibType6-5, posSibType6-6, posSibType2-17a-v1770,

                                                            posSibType2-18a-v1770, posSibType2-20a-v1770, posSibType1-11-v1800,

                                                            posSibType1-12-v1800, posSibType2-26-v1800, posSibType2-27-v1800,

                                                            spare2, spare1,...},

            encrypted-r17                       ENUMERATED { true }                                     OPTIONAL, -- Need R

            gnss-id-r17                         GNSS-ID-r16                                             OPTIONAL, -- Need R

            sbas-id-r17                         SBAS-ID-r16                                             OPTIONAL  -- Cond GNSS-ID-SBAS

        }

    },

    valueTag-r17                            INTEGER (0..31)                                             OPTIONAL, -- Cond NonPosSIB

    areaScope-r17                           ENUMERATED {true}                                           OPTIONAL  -- Need S

}

– *SIB4bis*

*SIB4bis* contains information relevant for less than 5MHz inter-frequency cell re-selection (i.e. information about other NR frequencies and inter-frequency neighbouring cells relevant for cell re-selection), which can also be used for NR idle/inactive measurements. The IE includes cell re-selection parameters common for a frequency as well as cell specific re-selection parameters. SIB4bis can be sent only when SIB4 is not used.

SIB4bis-r18 ::= SEQUENCE {

 interFreqCarrierFreqList2-r18 InterFreqCarrierFreqList OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext1-v18xy InterFreqCarrierFreqList-v1610 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext2-v18xy InterFreqCarrierFreqList-v1700 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext3-v18xy InterFreqCarrierFreqList-v1720 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext4-v18xy InterFreqCarrierFreqList-v1730 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext5-v18xy InterFreqCarrierFreqList-v1760 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext6-v18xy InterFreqCarrierFreqList-v1800 OPTIONAL -- Need R

 lateNonCriticalExtension OCTET STRING OPTIONAL,

 ...,

}

| ***SIB4bis* field descriptions** |
| --- |
| ***interFreqCarrierFreqList2***List of neighbouring carrier frequencies and frequency specific cell re-selection information for carriers less than 5 MHz for FR1. If *interFreqCarrierFreqList2Ext1-v18xy, interFreqCarrierFreqList2Ext2-v18xy, interFreqCarrierFreqList2Ext3-v18xy*, *interFreqCarrierFreqList2Ext4-v18xy,* *interFreqCarrierFreqList2Ext5-v18xy* or *interFreqCarrierFreqList2Ext6-v18xy* are present, they shall contain the same number of entries, listed in the same order as in *interFreqCarrierFreqList2-r18.* |

***UEInformationResponse message***

SIB-Type-r17 ::= ENUMERATED {sibType2, sibType3, sibType4, sibType5, sibType9, sibType10-v1610, sibType11-v1610, sibType12-v1610,

                             sibType13-v1610, sibType14-v1610, sibType4bis-v18xy ~~spare6~~, spare5, spare4, spare3, spare2, spare1}

**In both legacy neighbours and <5MHz neighbours need to be broadcasted simultaneously (option b-like is used)**

New list for <5MHz cells in SIB4 is added, i.e. option b-like is used. The difference between option b and option b-like is that there is no special band number is used to distinguish the less 5MHz, all less 5MHz neighbours are put in new list, legacy UE cannot decode the new list and only new UE can decode old list and new list.

SIB4 ::= SEQUENCE {

 interFreqCarrierFreqList InterFreqCarrierFreqList,

 lateNonCriticalExtension OCTET STRING OPTIONAL,

 ...,

<<skip>>

 [[

 interFreqCarrierFreqList-v1800 InterFreqCarrierFreqList-v1800 OPTIONAL -- Need R

 interFreqCarrierFreqList2-r18 InterFreqCarrierFreqList OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext1-v18xy InterFreqCarrierFreqList-v1610 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext2-v18xy InterFreqCarrierFreqList-v1700 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext3-v18xy InterFreqCarrierFreqList-v1720 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext4-v18xy InterFreqCarrierFreqList-v1730 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext5-v18xy InterFreqCarrierFreqList-v1760 OPTIONAL -- Need R

 interFreqCarrierFreqList2Ext6-v18xy InterFreqCarrierFreqList-v1800 OPTIONAL -- Need R

 ]]

}

|  |
| --- |
| ***frequencyBandList***Indicates the list of frequency bands for which the NR cell reselection parameters apply. ~~If a band number indicated in the list is 1024, the UE shall ignore the frequency indicated in interFreqCarrierFreqList in SIB4.~~ |
| ***interFreqCarrierFreqList***List of neighbouring carrier frequencies and frequency specific cell re-selection information for carriers equal to or larger than 5 MHz. If *interFreqCarrierFreqList-v1610, interFreqCarrierFreqList-v1700, interFreqCarrierFreqList-v1720*, *interFreqCarrierFreqList-v1730,* *interFreqCarrierFreqList-v1760* or *InterFreqCarrierFreqInfo-v1800* are present, they shall contain the same number of entries, listed in the same order as in *interFreqCarrierFreqList* (without suffix). |
| ***interFreqCarrierFreqList2***List of neighbouring carrier frequencies and frequency specific cell re-selection information for carriers less than 5 MHz for FR1. If *interFreqCarrierFreqList2Ext1-v18xy, interFreqCarrierFreqList2Ext2-v18xy, interFreqCarrierFreqList2Ext3-v18xy*, *interFreqCarrierFreqList2Ext4-v18xy,* *interFreqCarrierFreqList2Ext5-v18xy* or *interFreqCarrierFreqList2Ext6-v18xy* are present, they shall contain the same number of entries, listed in the same order as in *interFreqCarrierFreqList2-r18.* |

# Preference on solution option for NR SIB4

Based on the above discussion, companies are asked to provide their view on whether any other potential option is missing.

**Q1: Please comment whether any other potential option is missing. If yes, please provide details including TP.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Rapporteur (based on email from Huawei) | * **Option (b-2):** Signalling optimized option b, reuse Rel-18 introducedInterFreqCarrierFreqList-v1800 to indicate *frequencyBandList-r18*. As workaround for legacy list mandatory field, use special *FreqBandIndicatorNR* number in *interFreqCarrierFreqList >> frequencyBandList >> NR-MultiBandInfo >> freqBandIndicatorNR.*

Potential changes needed for Option (b-2)SIB4 ::= SEQUENCE { interFreqCarrierFreqList InterFreqCarrierFreqList, lateNonCriticalExtension OCTET STRING OPTIONAL, ...,<<skip>>}InterFreqCarrierFreqInfo-v1800 ::=  SEQUENCE {    frequencyBandList-r18               MultiFrequencyBandListNR-SIB                                OPTIONAL,    -- Cond LessThan5MHz    frequencyBandListAerial-r18         MultiFrequencyBandListNR-Aerial-SIB-r18                     OPTIONAL,    -- Need S    mobileIAB-CellList-r18              PCI-Range                                                   OPTIONAL,    -- Need R    eRedCapAccessAllowed-r18            ENUMERATED {true}                                           OPTIONAL,    -- Need R    tn-AreaIdList-r18                   SEQUENCE (SIZE (1..maxTN-AreaInfo-r18)) OF TN-AreaId-r18    OPTIONAL     -- Need R}

|  |  |
| --- | --- |
| **Conditional Presence** | **Explanation** |
| *LessThan5MHz* | The field is mandatory present if the neighbor cell supports 12 PRB, 15 PRB or 20 PRB transmission bandwidth configuration as defined in TS 38.101-1 [15], TS 38.211 [16] and TS 38.213 [13]. Otherwise, the field is not present and *frequencyBandList* (without suffix) in interFreqCarrierFreqList applies. |

|  |
| --- |
| ***freqBandIndicatorNR***Provides an NR frequency band number as defined in TS 38.101-1 [15], TS 38.101-2 [39], table 5.2-1, and TS 38.101-5 [75], table 5.2.2-1.For a neighbouring carrier frequency when *frequencyBandList-r18* is included, the network sets the corresponding value of *freqBandIndicatorNR* in *frequencyBandList* (without suffix) to 1024, and the UE applies *frequencyBandList-r18* instead of *frequencyBandList* (without suffix). |

 |
| vivo | We added the option (d) in section 3.4. |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

**Summary:** TBD

Based on the above discussion, companies are asked to provide their view on preferred solution option, also indicating the pros and cons of the solution such as specification impact, impact to other WG(s), signalling overhead, logistical overhead in terms of maintenance of the spec if any further extension or changes are needed in the future, applicability to LTE SIB24 and NR SIB11 (later questions) etc.

**Q2: Please comment on your preference regarding the solution options for SIB4. Also consider indicating the pros and cons of the solution such as specification impact, impact to other WG(s), signalling overhead, logistical overhead in terms of maintenance of the spec if any further extension or changes are needed in the future, applicability to LTE SIB24 and NR SIB11 (later questions) etc.**

**Option (a):** New list for <5MHz cells in SIB4, reuse Rel-18 introduced InterFreqCarrierFreqList-v1800 to indicate *dl-CarrierFreq-r18*. As workaround for legacy list mandatory field, use special *ARFCN-ValueNR* number in *interFreqCarrierFreqList* >> *dl-CarrierFreq* (as described in [2])

**Option (b):** New list for <5MHz cells in SIB4, introduce new list interFreqCarrierFreqList2-r18 and corresponding extensions. As workaround for legacy list mandatory field, use special *FreqBandIndicatorNR* number in *interFreqCarrierFreqList >> frequencyBandList >> NR-MultiBandInfo >> freqBandIndicatorNR* (as described in [4] option 2)

**Option (b-2):** Signalling optimized option b, reuse Rel-18 introducedInterFreqCarrierFreqList-v1800 to indicate *frequencyBandList-r18*. As workaround for legacy list mandatory field, use special *FreqBandIndicatorNR* number in *interFreqCarrierFreqList >> frequencyBandList >> NR-MultiBandInfo >> freqBandIndicatorNR.*

**Option (c):** New list for <5MHz cells using a new SIB (as described in [4] option 3).

**Option (d):** Other

|  |  |  |
| --- | --- | --- |
| **Company** | **Preference** | **Comment** |
| Nokia | C | It seems most self contained to have new SIB4bis for less than 5MHz to ensure there are no legacy UE impacts. Also this would not require any RAN4 impacts to reserve/check if we can reserve some ARFCNs. |
| Qualcomm | A | Option A needs the minimum changes as shown in the TPs above. No need to duplicate the extensions of the lists. Just override the mandatory dl-CarrierFreq (without suffix) with a conditional mandatory dl-CarrierFreq-r18 and set the legacy field to the value that nobody can possibly use. No issues for legacy UEs.Option B uses similar concept as option A, however there is no guarantee that the legacy UEs look into the band numbers to prune out the invalid entries if/when the legacy *dl-CarrierFreq* (no suffix) indicated frequency corresponds to a GSCN. Therefore, there is potential impact to legacy UEs.Option C is the overkill in our view for the following reasons:* It needs a lot of changes throughout the specifications.
* One would need to go through the whole specification to figure out wherever SIB4 was ‘essential’, whether SIB4b is essential or not.
* It not only impacts some fields but also SIB scheduling etc.
* Additional signaling overhead and lot of duplication. If the cell has to indicate some legacy neigh cells and some <5 neigh cells (which is likely scenario since Rel-18 <5 UEs also support legacy cells/bands/frequencies), the Rel-18 cell would need to include both SIB4 and SIB4bis.
* Any future extensions to SIB4 will need to be discussed and copied to SIB4bis.
* Considering ‘similar’ solution is desirable for LTE SIB24 and NR SIB11, that means adding even more new SIBs unnecessarily.
 |
| vivo | D | Option d combines option b and option c. In the scenario where all the neighbours are <5MHz, option c can be used. But what's different from option c is that UE will not read SIB4 and SIB4bis simultaneously, which can solve this problem and does not introduce the additional specification impact. As for the scenario where both legacy neighbours and <5MHz neighbours need to be broadcasted simultaneously, option b-like that introduce the new list of neighbouring carrier frequencies for <5 MHz is clearly for us. |
| ZTE | Option A/B with comments | First we are wondering whether there are scenarios that require the New UE to support mobility between the 3M cell and Legacy cell.If there are, the modification in the option A is not enough for the case that there are both 3M and legacy inter-frequency neighbor cell. Some extension fields are still needed. If there are not, the option A is acceptable to us.For the option B, our understanding is that the key difference from the option A is to use a special band number for the legacy mandatory present issue. For the option C, we don’t see the strong motivation to introduce a new SIB if the option A or B can work. As rapporteur indicated, it may introduce modifications in many places.  |
| Ericsson | Option A or B2 | We understand both Options A and B2 provides valid solutions to the BW issue. They also follow the principle of adding new fields in a “parallel list” to the original list. Maybe Option A is more straightforward, since we lately extended the MFBI, but we need probably look at detailed CR. E.g. in Option A, we need to refer to the correct RAN4 table for the old and new dl carrier freq fields, right?We noted that e.g. SIB16 re-uses the order of inter-frequencies from SIB4. We understand creating completely new lists <5MHz inter-freq (additional list in SIB4 or in new SIB, i.e Options B2, C, D) will have more spec and product impl impact than A/B2. |
| Huawei, HiSilicon | Bor B2 (if it is on the table)or C  | Option A: not sure if the reserved ARFCN is working. RAN2 is not the proper group to provide the ARFCN value. On another hand, it is arguable if this solution is against the solution made in the last meeting (i.e., this option doesn’t use the second list in our understanding).Option B: the second list is added for the carriers less than 5MHz (which is aligned with RAN2 agreements). The reserved/unused band number is used to handle the issue that the network has to provide an entry in the legacy list but the network doesn’t have another neighbor cell frequency >=5MHz.Option B2: The reserved/unused band number is used to handle the issue that the network has to provide an entry in the legacy list but the network doesn’t have another neighbor cell frequency >=5MHz. Same as option A, it is arguable if this solution is against the solution made in the last meeting (i.e., this option doesn’t use the second list in our understanding). Option C: workable, but seems to be overkilled to introduce a new SIB if other solutions are viable.Option D: not clear how it is working, but sounds complicated. |

**Summary:** TBD

# LTE SIB24

RAN2#125 already agreed that there is BC issue with LTE SIB24 as well. Therefore a solution would be needed for LTE SIB24.

Based on the above discussion, companies are asked to provide their view on whether LTE SIB24 solution should also follow ‘similar’ approach as whatever is concluded for NR SIB4. If the preferred solution option for LTE SIB24 is NOT similar as NR SIB4, companies should also indicate the reason why, such as specification impact, impact to other WG(s), signalling overhead, logistical overhead in terms of maintenance of the spec if any further extension or changes are needed in the future, etc.

**Q3: Please comment on your preference whether the solution for LTE SIB24 should follow similar solution as NR SIB4.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment. If ‘no’, explain why.** |
| Nokia | Yes | It seems preferable to have similar solutions for each SIB(s) |
| Qualcomm | Yes |  |
| vivo | Yes  |  |
| ZTE | Yes |  |
| Ericsson | Yes |  |
| Huawei, HiSilicon | Yes |  |

**Summary:** TBD

# NR SIB11

In addition to the discussion about SIB4 and LTE SIB24 above, RAN2 captured “FFS if SIB11 should also be considered”. In NR, *SIB11-r16 >> measIdleConfigSIB-r16 >> measIdleCarrierListNR-r16 >> MeasIdleCarrierNR-r16 >>* *carrierFreq-r17* indicates *ARFCN-ValueNR*. While SIB11 is generally intended for EMR for SCell frequencies, the standard does not preclude other use by the network.

**Q4: Please comment on your preference regarding whether NR SIB11 should also be considered in addition to SIB4 and LTE SIB24.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | Maybe | For completeness we could also handle SIB11 but of course if UE vendors don’t think there is no issue with SIB11 eg. UE supporting SIB11 does not have similar issue with ARFCNs in SIB11. And like rapporteur indicated this SIB is used for speeding up setting CA/DC it seems unlikely that 3MHZ is used for that purpose so maybe not really critical. So maybe we focus at least first on SIB4/24. |
| Huawei, HiSilicon | No | For early measurement reporting for SCell frequencies, the frequencies to be measured by the UE is configured in RRCRelease-> RRCRelease-v1610-IEs-> MeasIdleConfigDedicated-r16, and the gNB should configure the applicable frequencies supported by the UE (i.e. if the UE doesn’t support the less than 5MHz frequencies, the gNB shouldn’t include that in RRC release message).SIB11 will provide some additional information for the frequency, but the UE will not use the frequencies not concerned by itself.We are not sure about other use of SIB11, which is not clear in specs. If there are cases, we should discuss case by case. |
| Qualcomm | Yes | In our view, the standard does not preclude using SIB11 for other than EMR for SCell freqs by the network or UE. So, in our opinion we cannot always depend on the dedicated indication when the list is also signalled in SIB11. We prefer to fix this also. |
| vivo | Yes  | UEs supported idle/inactive measurements have similar issue with ARFCNs in SIB11. Similarly, legacy UEs will not be able to measure and be configured <5MHz neighbor cells as CA/DC. As for using a second list or explicitly indicating which ARFCNs belong to <5MHz through the network, we think both are feasible. |
| ZTE | No | We think there is no need to introduce it in the SIB11 unless there are some valid scenarios. |
| Ericsson | Maybe | It is always difficult to agree if there is valid scenarios or not.SIB11 has two frequency lists:For measIdleCarrierListNR-r16, it seems straightforward to use Option A.For measReselectionCarrierListNR-r18 (new), a CHOICE can indicate the RAN4 table that the dl carrier freq refers to. |

**Summary:** TBD

**Q5: If you answer to Q4 is ‘yes’, please indicate your preference on whether NR SIB11 should follow similar solution as SIB4.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment. If ‘no’, explain why.** |
| Nokia | Yes (if one thinks SIB11 needs to be handled) |  |
| Qualcomm | Yes  |  |
| vivo | Yes  | Similar solution as SIB4 or the network explicitly indicates which ARFCNs belong to <5MHz. |
|  |  |  |
|  |  |  |
|  |  |  |

**Summary:** TBD

# Misc/Other

**Q6: Please list below if there are other open issues which should be addressed in this email discussion.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Issue/Question** | **Comment/Details** |
| QC (Rapporteur) | Paging in <5MHz cell | It was raised offline to the rapporteur that there may be issue of paging the UEs in the new <5MHz cell. To use the new cells for paging, network should know that the intended/paged UE is capable of receiving paging message in <5MHz cell (i.e. Rel-18 UE supporting this feature). Companies are asked to indicate their view on this issue and/or anything needs to be done in RAN2/RAN3. E.g. UE in RRC\_CONNECTED can report the capability indicating support/no support of <5 MHz cells in a band and corresponding GSCN values. After the UE moves to RRC\_IDLE/INACTIVE, how does the 5GC/RAN decide the cells to be used for paging the new UEs? |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

**Summary:** TBD

# Summary

TBD

# References

[1] [R2-2400032](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_125/Docs/R2-2400032.zip) LS on inter-frequency neighbour cells supporting NR dedicated spectrum less than 5 MHz for FR1 (R1-2312668; contact: Qualcomm) RAN1 LS in Rel-18 NR\_FR1\_lessthan\_5MHz\_BW To:RAN2, RAN4

[2] [R2-2400430](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_125/Docs/R2-2400430.zip) Discussion regarding LS on inter-frequency neighbour cells supporting NR dedicated spectrum less than 5 MHz for FR1 Qualcomm Incorporated discussion Rel-18

[3] [R2-2400259](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_125/Docs/R2-2400259.zip) Discussion on RAN1 LS in [R2-2400032](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_125/Docs/R2-2400032.zip) on inter-frequency configuration in SIB4 with new CSGN for less-than-5MHz CATT discussion

[4] [R2-2400714](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_125/Docs/R2-2400714.zip) Discussion on indicating inter-frequency neighbour cells of less than 5 MHz Huawei, HiSilicon discussion Rel-18 NR\_FR1\_lessthan\_5MHz\_BW

[5] [R2-2400706](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_125/Docs/R2-2400706.zip) On NR neighbour cells supporting dedicated spectrum less than 5MHz for FR1 MediaTek Inc. discussion Rel-18 NR\_FR1\_lessthan\_5MHz\_BW-Core

[6] [R2-2401885](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_125/Docs/R2-2401885.zip) Reply LS on inter-frequency neighbour cells supporting NR dedicated spectrum less than 5 MHz for FR1 Qualcomm Incorporated LS out Rel-18 NR\_FR1\_lessthan\_5MHz\_BW-Core To:RAN1, RAN4

# Appendix: Relevant tables from TS 38.101-1

Table 5.4.3.3-2: Applicable SS raster entries per operating band for 3 MHz channel bandwidth

|  |  |  |  |
| --- | --- | --- | --- |
| NR operating band | SS Block SCS | SS Block pattern1 | Range of GSCN(First – <Step size> – Last) |
| n26 | 15 kHz | Case A | 30937 – <1> – 31100 |
| n28 | 15 kHz | Case A | 30432 – <1> – 30644 |
| n31 | 15 kHz | Case A | 28955 – <1> – 28967 |
| n72 | 15 kHz | Case A | 28947 – <1> – 28959 |
| n85 | 15 kHz | Case A | 30282 – <1> – 30359 |
| n100 | 15 kHz | Case A | 31240 – <1> – 31242,31244 – <1> – 31253,41637 |
| n106 | 15 kHz | Case A | 31317 – <1> – 31329 |
| NOTE 1:  SS Block pattern is defined in clause 4.1 in TS 38.213 [8].NOTE 2:  Only applicable for 12 PRB transmission bandwidth configuration within 3 MHz channel with punctured PBCH defined in TS 38.211 [6] clause 7.4.3.1. |

Table 5.4.3.1-2: GSCN parameters for the global frequency for 3 MHz channel bandwidth

|  |  |  |  |
| --- | --- | --- | --- |
| Range of frequencies (MHz) | SS block frequency position SSREF | GSCN | Range of GSCN |
| 0 – 1000 | N \* 600 kHz + M \* 50 kHz + 300 kHz,N = 1:1665, M ϵ {1,3,5} (Note 1) | 26638+3N + (M-3)/2 | 26640 – 31634 |
| NOTE 1:  Only applicable for 15 PRB DCH transmission within 3 MHz channel bandwidth with punctured PBCH defined in TS 38.211 [6] clause 7.4.3.1. |

Table 5.4.3.1-3: Additional GSCN parameters for band n100

|  |  |  |
| --- | --- | --- |
| SS Block frequency position SSREF(MHz) | GSCN | Note |
| 920.73 | 41637 | Only applicable for 12 PRB transmission bandwidth configuration within 3 MHz channel with punctured PBCH defined in TS 38.211 [6] clause 7.4.3.1. |
| 921.45 | 41638 | Only applicable for 20 PRB transmission bandwidth configuration within 5 MHz channel with unpunctured PBCH defined in TS 38.211 [6] clause 7.4.3.1. |