**3GPP TSG-RAN WG2 Meeting #121 R2-23xxxxx**

**Athens , Greece, 27th Feb- 3rd Mar, 2023**

**Agenda item: 8.10.2**

**Source: Huawei, HiSilicon**

**Title: [Post120][652][IDC] Further details of FDM solution (Huawei)**

**Document for:**  **Discussion**

# 1. Introduction

This paper is to trigger the following email discussion of IDC FDM solutions:

* [Post120][652][IDC] Further details of FDM solution (Huawei)

      Scope:

* Comparison and down-selection of Solution 1, 2 or 2a based on ASN.1 details (granularity for bandwidth, e.g. PRB, RBG, explicit Bandwidth, etc).
	+ Option 1: Central frequency + Bandwidth of the actual affected frequency range
	+ Option 2: Starting frequency + Ending frequency of the actual affected frequency range
	+ Option 2a: starting frequency + Bandwidth of the actual affected frequency range
* Identify the impact of MR-DC, e.g. whether SN can configure IDC for SN (including both FDM and TDM), the coordination granularity of inter-node message, per CG pattern (TDM);
* Signalling details of FDM, e.g. how to configure, how to report..

Intended outcome: Report to next meeting (with Text proposal)

 Deadline: Long

**Deadline for comments:** Long - Kick off: Jan 17th, Deadline for company inputs Feburay 3rd.  Comments on rapporteur summary February 7th to 10th February

## 1.1 Contacts

Contact person for each participating company:

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| --- | --- | --- |
| Company | Name | Email Address |
| Qualcomm | Sherif ElAzzouni | selazzou@qti.qualcomm.com |
| Xiaomi | Yumin Wu | wuyumin@xiaomi.com |
| Samsung  | Weiwei Wang  | ww1016.wang@samsung.com |
| Ericsson | Min Wang | min.w.wang@ericsson.com |
| ZTE | Wenting Li | Li.wenting@zte.com.cn |
| Intel | Yujian Zhang | yujian.zhang@intel.com |
| Nokia | Jarkko Koskela | Jarkko.t.koskela@nokia.com |
| vivo | Xiaodong Yang | Yangxiaodong5g@vivo.com |
| Apple | Yuqin Chen | yuqin\_chen@apple.com |
| Huawei, HiSilicon | Jagdeep Singh  | jagdeep.singh6@huawei.com |
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# 2. Discussion

In the WID for In-Device Co-existence (IDC) enhancements for NR and MR-DC, the following objective for FDM was agreed:

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| This WI expects to address interference between 3GPP (including various MR-DC architectures, i.e. NR-DC and EN-DC) and non-3GPP RAT (e.g. WiFi).* Enhancements to FDM solution, to allow more granular indication of affected frequencies (e.g. granularity of BWP or PRB level). (RAN2)

Note: Enhancements to FDM solution is prioritized.* Introduction of TDM solution (e.g. indication of UE preferred TDM pattern for UL/DL). (RAN2, RAN4).Note: The TDM solution is considered complementary to the FDM solution.
* Specify RRM requirements for TDM solution (RAN4)

Note: LTE IDC solution should be considered as the baseline for the solutions developed in this WI. |

The RAN2 agreements related to the IDC FDM solutions enhancements are quoted as follows:

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| **RAN2#119 meeting agreements:*** The Adjacent channel interference between NR Stand Alone (SA) or MN of NR-DC and non-3GPP should be considered for the FDM enhancement in Rel.18.
* The Adjacent channel interference between SN (NR) of MR-DC and non-3GPP should be considered for the FDM enhancement in Rel.18.
* NE-DC is not considered; We will work on NR freq as SA NR case.
* We will not consider the enhancements on E-UTRA freq for EN-DC scenario.
* FFS, on signalling details;
* The IMD interference from simultaneous Tx in EN-DC to non-3GPP should be considered for the FDM enhancement in Rel.18.
* The IMD interference from simultaneous Tx in NR-DC to non-3GPP should be considered for the FDM enhancement in Rel.18.
* Note: the solution (on freq granularity) for adjacent can be reused for IMD, we will not invent new solution on freq granularity for IMD. FFS on signalling details.
* Granular indications of the affected NR frequency reported for IDC issue needs to consider both serving and non-serving frequency as in the legacy FDM solution.
 |
| **RAN2#120 meeting agreements:*** Reconfirm, The Rel-18 IDC solution should allow for more granular IDC indications both on serving and on non-serving frequencies.
* Only one single new finer granularity report is introduced, that applies for both serving and non-serving frequencies.
* For LTE, problematic frequencies of E-UTRA are indicated by indicating measurement object IDs (same as existing LTE, no specification impact is foreseen.)
* RAN2 down select one of solution 1, 2 or 2a based on ASN.1 details. FFS on the signalling details, how to configure, how to report.
* MN can configure IDC, FFS whether SN can configure IDC for SN
 |

## 2.1 Comparison and down-selection of Solution 1, 2 or 2a

Brief description frequency range solutions 1, 2 or 2a for FDM enhancements are given below

* + Option 1: Central frequency + Bandwidth of the actual affected frequency range
	+ Option 2: Starting frequency + Ending frequency of the actual affected frequency range
	+ Option 2a: starting frequency + Bandwidth of the actual affected frequency range

In RAN2#120 meeting, we have achieved the following two agreements regarding FDM solution enhancements:

* Reconfirm, The Rel-18 IDC solution should allow for more granular IDC indications both on serving and on non-serving frequencies.
* Only one single new finer granularity report is introduced, that applies for both serving and non-serving frequencies.

The first bullet point in the scope of the email discussion is to compare and perform the down-selection of option 1, 2 or 2a based on ASN.1 details taking into consideration the granularity for bandwidth, which can be expressed as PRB, RBG or as explicit Bandwidth.

During the [Post119-e][650][IDC] Comparison of FDM solutions in [1] many companies expressed the view that the PRB and RGB based reporting of the affected frequency range in relation to Option 4 and Option 6 respectively can only be used for the UEs serving frequencies. However, if the affected frequency is the UE’s non-serving frequency, the UE will not be able to report the actually affected PRB or RGB since UE has no information on the PRB or RGB of the non-serving frequency unless virtual BWPs are also configured for the non serving frequencies.

Additionally, to have a common design for both serving frequency and non-serving frequency, we have agreed in RAN2#120 that the **“Only one single new finer granularity report is introduced, that applies for both serving and non-serving frequencies.”.**

Considering the above-mentioned points and to reduce the standardization efforts (i.e not to configure virtual BWPs for the non serving frequencies), the rapporteur suggests that we perform the comparison and down-selection of Solution 1, 2 or 2a based on ASN.1 detail where bandwidth is explicitly indicated by the UE in MHz or the start and end frequencies of the actual affected frequency range is indicated by the UE as both these options will be applicable for both serving and non-serving frequencies and will be in line with the above agreement.

#### Question 1: Do you agree that we perform the comparison and down-selection of Solution 1, 2 or 2a based on ASN.1 detail for

#### Central/Starting frequency + explicit bandwidth in MHz (option 1 and 2a)

#### the start and end frequencies of the actual affected frequency range (option 2)

####  as both these option will be applicable for both serving and non-serving frequencies?

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| **Company** | **Answers** **(Yes/No)** | **Comments (if the answer is “No” please provide any details how PRB or RBG will be reported for the non-serving frequencies)** |
| Qualcomm | Yes | Following the meeting agreements |
| Xiaomi | Yes | Solution 1, 2 or 2a which works for both serving and non-serving frequency is aligned with the RAN2 meeting agreements. |
| Samsung | Yes |  |
| Ericsson | Yes |  |
| ZTE | Yes with comments | Maybe the bandwidth in KHz would be needed for the case that only few PRBs are affected |
| Intel | Yes |  |
| Nokia | Maybe | Not sure how the rapporteur made the down selection. Why is the indication based on indication of bandwidth/end frequency and not done similarly as in the existing signaling e.g. for RA with *locationAndBandwidth* or e.g. *FrequencyInfoDL* i.e. using *pointA+SCS-SpecificCarrier.* Or maybe that is the intention but not very clear from the Question. Anyway we think we have very good existing ASN.1 examples and we don’t need to make anything different for this purpose.Additionally we think it would be beneficial to indicate to the NW 3GPP radio caused intermodulation issues as e.g. discussed in R2-2211969. This would allow NW to understand the situation and make changes to 3GPP ISM causing radio to remove the ISM problem. |
| vivo | Yes |  |
| Apple | See comments | We have the same comment as Nokia that it's too early to say it is “explicit bandwidth in MHz”. Other options are possible to balance the signaling overhead and reporting granularity. |
| Huawei, HiSilicon | Yes | It is aligned with the current agreements |
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**Option 1: Central frequency + Bandwidth of the actual affected frequency range ASN.1 detail**

For this option the UE reports the actually affected bandwidth in MHz and the center frequency (ARFCN) of this bandwidth for each affected frequency range as shown in Figure 1.



Figure 1 - UE reporting for Option 1 including actual affected bandwidth and the central frequency of this bandwidth of the affected frequency range

The ASN.1 framework and field descriptions for Option 1 are as follows.

-- ASN1START

-- TAG-UEASSISTANCEINFORMATION-START

UEAssistanceInformation ::= SEQUENCE {

 criticalExtensions CHOICE {

 ueAssistanceInformation UEAssistanceInformation-IEs,

 criticalExtensionsFuture SEQUENCE {}

 }

}

*<skipped>*

UEAssistanceInformation-v1610-IEs ::= SEQUENCE {

 idc-Assistance-r16 IDC-Assistance-r16 OPTIONAL,

 *<skipped>*

 nonCriticalExtension UEAssistanceInformation-v1700-IEs OPTIONAL

}

UEAssistanceInformation-v1700-IEs ::= SEQUENCE {

 ul-GapFR2-Preference-r17 UL-GapFR2-Preference-r17 OPTIONAL,

 musim-Assistance-r17 MUSIM-Assistance-r17 OPTIONAL,

 overheatingAssistance-r17 OverheatingAssistance-r17 OPTIONAL,

 maxBW-PreferenceFR2-2-r17 MaxBW-PreferenceFR2-2-r17 OPTIONAL,

 maxMIMO-LayerPreferenceFR2-2-r17 MaxMIMO-LayerPreferenceFR2-2-r17 OPTIONAL,

 minSchedulingOffsetPreferenceExt-r17 MinSchedulingOffsetPreferenceExt-r17 OPTIONAL,

 rlm-MeasRelaxationState-r17 BOOLEAN OPTIONAL,

 bfd-MeasRelaxationState-r17 BIT STRING (SIZE (1..maxNrofServingCells)) OPTIONAL,

 nonSDT-DataIndication-r17 SEQUENCE {

 resumeCause-r17 ResumeCause OPTIONAL

 } OPTIONAL,

 scg-DeactivationPreference ENUMERATED { scgDeactivationPreferred, noPreference } OPTIONAL,

 uplinkData-r17 ENUMERATED { true } OPTIONAL,

 rrm-MeasRelaxationFulfilment-r17 BOOLEAN OPTIONAL,

 propagationDelayDifference-r17 PropagationDelayDifference-r17 OPTIONAL,

 nonCriticalExtension UEAssistanceInformation-v18xy-IEs OPTIONAL

}

UEAssistanceInformation-v18xy-IEs ::= SEQUENCE {

 idc-Assistance-r18 IDC-Assistance-r18 OPTIONAL, nonCriticalExtension SEQUENCE {} OPTIONAL

}

IDC-Assistance-r16 ::= SEQUENCE {

 affectedCarrierFreqList-r16 AffectedCarrierFreqList-r16 OPTIONAL,

 affectedCarrierFreqCombList-r16 AffectedCarrierFreqCombList-r16 OPTIONAL,

 ...

}

IDC-Assistance-r18 ::= SEQUENCE {

fdm-AssistanceInfo-r18 FDM-AssistanceInfo-r18 OPTIONAL,

 ...

}

FDM-AssistanceInfo-r18::= SEQUENCE {

 affectedCarrierFreqRangeList-r18 AffectedCarrierFreqRangeList-r18 OPTIONAL,

 ...

}

AffectedCarrierFreqList-r16 ::= SEQUENCE (SIZE (1.. maxFreqIDC-r16)) OF AffectedCarrierFreq-r16

AffectedCarrierFreq-r16 ::= SEQUENCE {

 carrierFreq-r16 ARFCN-ValueNR,

 interferenceDirection-r16 ENUMERATED {nr, other, both, spare}

}

AffectedCarrierFreqCombList-r16 ::= SEQUENCE (SIZE (1..maxCombIDC-r16)) OF AffectedCarrierFreqComb-r16

AffectedCarrierFreqComb-r16 ::= SEQUENCE {

 affectedCarrierFreqComb-r16 SEQUENCE (SIZE (2..maxNrofServingCells)) OF ARFCN-ValueNR OPTIONAL,

 victimSystemType-r16 VictimSystemType-r16

}

VictimSystemType-r16 ::= SEQUENCE {

 gps-r16 ENUMERATED {true} OPTIONAL,

 glonass-r16 ENUMERATED {true} OPTIONAL,

 bds-r16 ENUMERATED {true} OPTIONAL,

 galileo-r16 ENUMERATED {true} OPTIONAL,

 navIC-r16 ENUMERATED {true} OPTIONAL,

 wlan-r16 ENUMERATED {true} OPTIONAL,

 bluetooth-r16 ENUMERATED {true} OPTIONAL,

 ...

}

AffectedCarrierFreqRangeList-r18::= SEQUENCE (SIZE (1.. maxFreqIDC-r18)) OF AffectedCarrierFreqRange-r18

AffectedCarrierFreqRange-r18 ::= SEQUENCE {

 centerFreq-r18 ARFCN-ValueNR,

 affectedBandwidth-r18 ENUMERATED {mhz5, mhz10, mhz20, mhz30, mhz40, mhz50, mhz60, mhz80, mhz100, mhz200, mhz300, mhz400, FFS\_spare\_values}

}

*<skipped>*

-- TAG-UEASSISTANCEINFORMATION-STOP

-- ASN1STOP

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| *UEAssistanceInformation* field descriptions |
| ***affectedCarrierFreqList***Indicates a list of NR carrier frequencies that are affected by IDC problem. |
| ***affectedCarrierFreqCombList***Indicates a list of NR carrier frequencie combinations that are affected by IDC problems due to Inter-Modulation Distortion and harmonics from NR when configured with UL CA. |
| ***AffectedCarrierFreqRangeList***Indicates a list of NR carrier frequencies range that are affected by the IDC problem |
| ***centerFreq***Indicates the center frequency of the carrier frequency range which is affected by the IDC problem |
| ***affectedBandwidth***Indicates the bandwidth of the carrier frequency range around the center frequency which is actually affected by the IDC problem.  |
| ***victimSystemType***Indicate the list of victim system types to which IDC interference is caused from NR when configured with UL CA. Value *gps*, *glonass*, *bds*, *galileo* and *navIC* indicates the type of GNSS. Value *wlan* indicates WLAN and value *bluetooth* indicates Bluetooth. |

#### Question 2: Do you agree with the ASN.1 framework and field description for Option 1: Central frequency + Bandwidth of the actual affected frequency range reported by the UE?

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| **Company** | **Answers** **(Yes/No)** | **Comments** |
| Qualcomm | No | It is unclear what is the motivation of those exact BW values specifically. It is not clear to us if those would solve the most important IDC use cases. For example a typical BLE channel is 2MHz, so the expected affected BW due to adjacent channel interference should be even less than that. If we go with this option there should be some reasoning behind the BW values that it would cover WiFi, BT, GNSS, etc.  |
| Xiaomi | Yes as the baseline | We think that the ASN.1 framework provided by the rapporteur can be considered as the baseline. The values for the reported bandwidth which may need more granularities as also pointed by Qualcomm can be polished further.In LTE FDM solution, the whole bandwidth (e.g. 20MHz) of the reported measurement object is expected to be affected. The UE justification details for the affected frequency is left to the UE implementation.We think that how the UE justfifies the affected bandwidth associated with the central frequency can be left to the UE implementation, following the same principal as LTE. The frequency list as provided above seems only for the NR reporting of the harmonic interference. The UL CA case (i.e. IMD issue) and the EN-DC band combination may need more discussions. |
| Samsung  | Comments | We acknowledge the concerns from Qualcomm, i.e., the above bandwidth values need further check. Moreover, depending on the exact IDC problem, the impact frequency may have finer granularity, which is aligned with intention of Rel-18 IDC. To resolve this issue, one possible solution is to use the percentage of cell BW instead of listing all possible BWs, where the cell BW can be the one indicated by *FrequencyInfoDL-SIB*. In addition, the above does not consider UL CA case and DC band combination case, which needs further discussion.  |
| Ericsson | comments | We agree with xiaomi that the ASN.1 framework can be considered as the baseline, however, we have the below concerns1. as other companies pointed out, the BW values/granularities need further discussion considering all possible cases.
2. It may be beneficial to extend the IDT-Assitance-r16 IE with the new r18 field. In this way, it would add a little bit of singalling overhead but keep the ASN.1 structure a bit cleaner.
3. RAN2 can further discuss whether to reuse maxFreqIDC-r16, or define maxFreqIDC-r18.
 |
| ZTE | Yes with comments | 1. Maybe bandwidth with KHz would be needed
2. We assume that this Asn.1 coding is focus on the adjacent channel interferenc. For the NR-DC IMD IDC, it would be a combination of multiple frequency ranges, furthermore, for the EN-DC/NE-DC, the combination with both FreqRange and the EARFCN(or measObjectID) may also needed.

FDM-AssistanceInfo-r18::= SEQUENCE {affectedCarrierFreqRangeList-r18 AffectedCarrierFreqRangeList-r18 OPTIONAL, affectedCarrierFreqRangeCombList-r18 AffectedCarrierFreqRangeCombList-r18 OPTIONAL, ...}AffectedCarrierFreqRangeCombList-r18::= SEQUENCE (SIZE (1.. maxFreqIDC-r18)) OF AffectedCarrierFreqRangeComb-r18 AffectedCarrierFreqRangeComb-r18::= SEQUENCE {affectedCarrierFreqRangeCombNR SEQUENCE (SIZE (1.. maxFreqIDCComb-r18)) OF AffectedCarrierFreqRange-r18, affectedCarrierFreqCombEutra SEQUENCE (SIZE (1.. maxFreqIDCComb-r18)) OF measObjectID Optional}1. The victim type and/or direction as in the legacy LTE shall also be added

For the above bullet 2/3, it can also be further discussed after the down-selection of the 3 candidate options.**Rapporteur response to the comments received so far**1. These BW values are just examples values. We can fine tune these values to cover all the scenarios involving Wi-Fi, GNSS, BT.
2. The ASN.1 structure in the current form is focusing only on reporting of the frequency ranges for the adjacent channel interference. Combination of frequencies for addressing IMD scenarios can be added later on as the next step after down selection. These were not added here as we did not discussed these in detail so far.
3. Similarly the direction of interference can be added after the down selection.
 |
| Intel | Yes (as baseline) | We agree that the ASN.1 framework can be the baseline, with values for further discussion e.g. smaller bandwidth values to cover BT use case. We also agree with others that UL CA and DC band combination cases should be addressed.One question for clarification: maxFreqIDC-r18 is used. Is the intention to use a different value from maxFreqIDC-r16 (which is 128)? |
| Nokia | No | Why not use existing style used for SCS-SpecificCarrier for this signaling where the BW is indicated with pointA+OffsetToCarrier+BW indicated with number of resource blocks. With the proposed signaling how does NW interpret this which PRBs are affected as the signaling will result in siutaiton that “part of PRB” is impacted but part is not. We prefer more clear signaling from the UE without needing to do interpretations in the NW. |
| vivo | Comments | We agree with the comments from above companies. The value of affected BW should be further discussed and UL CA/DC cases should be also considered. In addition, we think the direction of IDC interference should also be reported along with the affected requency.  |
| Apple | See comments | For the affectedBandwidth, we should make it FFS. It could be in a different structure as proposed by Nokia. |
| Huawei, HiSilicon | Yes | We can consider the ASN.1 framework and field description for Option 1 as the starting point. Of course, we will need to fine tune the values for band width and add the other IEs such as direction of interference to it. We can address the case for UL CA and MR-DC frequency combinations after we conclude the details for addressing the adjacent channel interference scenarios as it can then be easily extended to the IMD scenarios. |
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**Option 2: Starting frequency + Ending frequency of the actual affected frequency range ASN.1 detail**

For this option the UE reports the starting and ending frequency (ARFCN) of each affected frequency range as shown in Figure 2.



Figure 2 - UE reporting for Option 2 including starting and ending frequency of the affected frequency range

The ASN.1 framework and field descriptions for Option 2 are as follows.

-- ASN1START

-- TAG-UEASSISTANCEINFORMATION-START

UEAssistanceInformation ::= SEQUENCE {

 criticalExtensions CHOICE {

 ueAssistanceInformation UEAssistanceInformation-IEs,

 criticalExtensionsFuture SEQUENCE {}

 }

}

*<skipped>*

UEAssistanceInformation-v1610-IEs ::= SEQUENCE {

 idc-Assistance-r16 IDC-Assistance-r16 OPTIONAL,

 *<skipped>*

 nonCriticalExtension UEAssistanceInformation-v1700-IEs OPTIONAL

}

UEAssistanceInformation-v1700-IEs ::= SEQUENCE {

 ul-GapFR2-Preference-r17 UL-GapFR2-Preference-r17 OPTIONAL,

 musim-Assistance-r17 MUSIM-Assistance-r17 OPTIONAL,

 overheatingAssistance-r17 OverheatingAssistance-r17 OPTIONAL,

 maxBW-PreferenceFR2-2-r17 MaxBW-PreferenceFR2-2-r17 OPTIONAL,

 maxMIMO-LayerPreferenceFR2-2-r17 MaxMIMO-LayerPreferenceFR2-2-r17 OPTIONAL,

 minSchedulingOffsetPreferenceExt-r17 MinSchedulingOffsetPreferenceExt-r17 OPTIONAL,

 rlm-MeasRelaxationState-r17 BOOLEAN OPTIONAL,

 bfd-MeasRelaxationState-r17 BIT STRING (SIZE (1..maxNrofServingCells)) OPTIONAL,

 nonSDT-DataIndication-r17 SEQUENCE {

 resumeCause-r17 ResumeCause OPTIONAL

 } OPTIONAL,

 scg-DeactivationPreference ENUMERATED { scgDeactivationPreferred, noPreference } OPTIONAL,

 uplinkData-r17 ENUMERATED { true } OPTIONAL,

 rrm-MeasRelaxationFulfilment-r17 BOOLEAN OPTIONAL,

 propagationDelayDifference-r17 PropagationDelayDifference-r17 OPTIONAL,

 nonCriticalExtension UEAssistanceInformation-v18xy-IEs OPTIONAL

}

UEAssistanceInformation-v18xy-IEs ::= SEQUENCE {

 idc-Assistance-r18 IDC-Assistance-r18 OPTIONAL, nonCriticalExtension SEQUENCE {} OPTIONAL

}

IDC-Assistance-r16 ::= SEQUENCE {

 affectedCarrierFreqList-r16 AffectedCarrierFreqList-r16 OPTIONAL,

 affectedCarrierFreqCombList-r16 AffectedCarrierFreqCombList-r16 OPTIONAL,

 ...

}

IDC-Assistance-r18 ::= SEQUENCE {

fdm-AssistanceInfo-r18 FDM-AssistanceInfo-r18 OPTIONAL,

 ...

}

FDM-AssistanceInfo-r18::= SEQUENCE {

 affectedCarrierFreqRangeList-r18 AffectedCarrierFreqRangeList-r18 OPTIONAL,

 ...

}

AffectedCarrierFreqList-r16 ::= SEQUENCE (SIZE (1.. maxFreqIDC-r16)) OF AffectedCarrierFreq-r16

AffectedCarrierFreq-r16 ::= SEQUENCE {

 carrierFreq-r16 ARFCN-ValueNR,

 interferenceDirection-r16 ENUMERATED {nr, other, both, spare}

}

AffectedCarrierFreqCombList-r16 ::= SEQUENCE (SIZE (1..maxCombIDC-r16)) OF AffectedCarrierFreqComb-r16

AffectedCarrierFreqComb-r16 ::= SEQUENCE {

 affectedCarrierFreqComb-r16 SEQUENCE (SIZE (2..maxNrofServingCells)) OF ARFCN-ValueNR OPTIONAL,

 victimSystemType-r16 VictimSystemType-r16

}

VictimSystemType-r16 ::= SEQUENCE {

 gps-r16 ENUMERATED {true} OPTIONAL,

 glonass-r16 ENUMERATED {true} OPTIONAL,

 bds-r16 ENUMERATED {true} OPTIONAL,

 galileo-r16 ENUMERATED {true} OPTIONAL,

 navIC-r16 ENUMERATED {true} OPTIONAL,

 wlan-r16 ENUMERATED {true} OPTIONAL,

 bluetooth-r16 ENUMERATED {true} OPTIONAL,

 ...

}

AffectedCarrierFreqRangeList-r18::= SEQUENCE (SIZE (1.. maxFreqIDC-r18)) OF AffectedCarrierFreqRange-r18

AffectedCarrierFreqRange-r18 ::= SEQUENCE {

 startingFreq-r18 ARFCN-ValueNR,

 endingFreq-r18 ARFCN-ValueNR

}

*<skipped>*

-- TAG-UEASSISTANCEINFORMATION-STOP

-- ASN1STOP

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| *UEAssistanceInformation* field descriptions |
| ***affectedCarrierFreqList***Indicates a list of NR carrier frequencies that are affected by IDC problem. |
| ***affectedCarrierFreqCombList***Indicates a list of NR carrier frequencie combinations that are affected by IDC problems due to Inter-Modulation Distortion and harmonics from NR when configured with UL CA. |
| ***AffectedCarrierFreqRangeList***Indicates a list of NR carrier frequencies range that are affected by the IDC problem |
| ***startingFreq***Indicates the starting frequency of the frequency range which is affected by the IDC problem. |
| ***endingFreq***Indicates the ending frequency of the frequency range which is affected by the IDC problem. |
| ***victimSystemType***Indicate the list of victim system types to which IDC interference is caused from NR when configured with UL CA. Value *gps*, *glonass*, *bds*, *galileo* and *navIC* indicates the type of GNSS. Value *wlan* indicates WLAN and value *bluetooth* indicates Bluetooth. |

#### Question 3: Do you agree with the ASN.1 framework and field description for Option 2: Starting frequency + Ending frequency of the actual affected frequency range reported by the UE?

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| **Company** | **Answers** **(Yes/No)** | **Comments** |
| Qualcomm | Yes | This is straightforward |
| Xiaomi | Yes | The UL CA case (i.e. IMD issue) and the EN-DC band combination may need more discussions. |
| Samsung  | Yes |  |
| Ericsson | Yes with comments | Same comments (bullet 1 and 2) as for Question 2. |
| ZTE | See comments | Similar view as above, we assume this is only for the adjacent channel interference and the Asn.1 frame work seems OK if going to option 2.However, we think the option 2 is quite bits wasting for that the minimum step of the ARFCN is 5k.WE think the granularity with sub-carrier (e.g. 15k) is enough. |
| Intel | Yes |  |
| Nokia | Maybe | So here proposal is to signal point A and then “point B” – it seems more clear to follow existin SCS-SpecificCarrier style signaling instead |
| vivo | See comments | UL CA/DC cases should be also considered. In addition, the direction of IDC interference should also be reported along with the affected requency. |
| Apple | See comments | Using ARFCN of course seems fine. But we are open to investigate other options as Nokia proposed. |
| Huawei, HiSilicon | Yes |  |
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**Option 2a: Starting frequency + Bandwidth of the actual affected frequency range ASN.1 detail**

For this option the UE reports the starting and bandwidth of each affected frequency range as shown in Figure 3.



Figure 3 - UE reporting for Option 2a including starting and bandwidth of the affected frequency range

The ASN.1 framework and field descriptions for Option 2a are as follows.

-- ASN1START

-- TAG-UEASSISTANCEINFORMATION-START

UEAssistanceInformation ::= SEQUENCE {

 criticalExtensions CHOICE {

 ueAssistanceInformation UEAssistanceInformation-IEs,

 criticalExtensionsFuture SEQUENCE {}

 }

}

*<skipped>*

UEAssistanceInformation-v1610-IEs ::= SEQUENCE {

 idc-Assistance-r16 IDC-Assistance-r16 OPTIONAL,

 *<skipped>*

 nonCriticalExtension UEAssistanceInformation-v1700-IEs OPTIONAL

}

UEAssistanceInformation-v1700-IEs ::= SEQUENCE {

 ul-GapFR2-Preference-r17 UL-GapFR2-Preference-r17 OPTIONAL,

 musim-Assistance-r17 MUSIM-Assistance-r17 OPTIONAL,

 overheatingAssistance-r17 OverheatingAssistance-r17 OPTIONAL,

 maxBW-PreferenceFR2-2-r17 MaxBW-PreferenceFR2-2-r17 OPTIONAL,

 maxMIMO-LayerPreferenceFR2-2-r17 MaxMIMO-LayerPreferenceFR2-2-r17 OPTIONAL,

 minSchedulingOffsetPreferenceExt-r17 MinSchedulingOffsetPreferenceExt-r17 OPTIONAL,

 rlm-MeasRelaxationState-r17 BOOLEAN OPTIONAL,

 bfd-MeasRelaxationState-r17 BIT STRING (SIZE (1..maxNrofServingCells)) OPTIONAL,

 nonSDT-DataIndication-r17 SEQUENCE {

 resumeCause-r17 ResumeCause OPTIONAL

 } OPTIONAL,

 scg-DeactivationPreference ENUMERATED { scgDeactivationPreferred, noPreference } OPTIONAL,

 uplinkData-r17 ENUMERATED { true } OPTIONAL,

 rrm-MeasRelaxationFulfilment-r17 BOOLEAN OPTIONAL,

 propagationDelayDifference-r17 PropagationDelayDifference-r17 OPTIONAL,

 nonCriticalExtension UEAssistanceInformation-v18xy-IEs OPTIONAL

}

UEAssistanceInformation-v18xy-IEs ::= SEQUENCE {

 idc-Assistance-r18 IDC-Assistance-r18 OPTIONAL, nonCriticalExtension SEQUENCE {} OPTIONAL

}

IDC-Assistance-r16 ::= SEQUENCE {

 affectedCarrierFreqList-r16 AffectedCarrierFreqList-r16 OPTIONAL,

 affectedCarrierFreqCombList-r16 AffectedCarrierFreqCombList-r16 OPTIONAL,

 ...

}

IDC-Assistance-r18 ::= SEQUENCE {

fdm-AssistanceInfo-r18 FDM-AssistanceInfo-r18 OPTIONAL,

 ...

}

FDM-AssistanceInfo-r18::= SEQUENCE {

 affectedCarrierFreqRangeList-r18 AffectedCarrierFreqRangeList-r18 OPTIONAL,

 ...

}

AffectedCarrierFreqList-r16 ::= SEQUENCE (SIZE (1.. maxFreqIDC-r16)) OF AffectedCarrierFreq-r16

AffectedCarrierFreq-r16 ::= SEQUENCE {

 carrierFreq-r16 ARFCN-ValueNR,

 interferenceDirection-r16 ENUMERATED {nr, other, both, spare}

}

AffectedCarrierFreqCombList-r16 ::= SEQUENCE (SIZE (1..maxCombIDC-r16)) OF AffectedCarrierFreqComb-r16

AffectedCarrierFreqComb-r16 ::= SEQUENCE {

 affectedCarrierFreqComb-r16 SEQUENCE (SIZE (2..maxNrofServingCells)) OF ARFCN-ValueNR OPTIONAL,

 victimSystemType-r16 VictimSystemType-r16

}

VictimSystemType-r16 ::= SEQUENCE {

 gps-r16 ENUMERATED {true} OPTIONAL,

 glonass-r16 ENUMERATED {true} OPTIONAL,

 bds-r16 ENUMERATED {true} OPTIONAL,

 galileo-r16 ENUMERATED {true} OPTIONAL,

 navIC-r16 ENUMERATED {true} OPTIONAL,

 wlan-r16 ENUMERATED {true} OPTIONAL,

 bluetooth-r16 ENUMERATED {true} OPTIONAL,

 ...

}

AffectedCarrierFreqRangeList-r18::= SEQUENCE (SIZE (1.. maxFreqIDC-r18)) OF AffectedCarrierFreqRange-r18

AffectedCarrierFreqRange-r18 ::= SEQUENCE {

 startingFreq-r18 ARFCN-ValueNR,

 affectedBandwidth-r18 ENUMERATED {mhz5, mhz10, mhz20, mhz30, mhz40, mhz50, mhz60, mhz80, mhz100, mhz200, mhz300, mhz400, FFS\_spare\_values}

}

*<skipped>*

-- TAG-UEASSISTANCEINFORMATION-STOP

-- ASN1STOP

|  |
| --- |
| *UEAssistanceInformation* field descriptions |
| ***affectedCarrierFreqList***Indicates a list of NR carrier frequencies that are affected by IDC problem. |
| ***affectedCarrierFreqCombList***Indicates a list of NR carrier frequencie combinations that are affected by IDC problems due to Inter-Modulation Distortion and harmonics from NR when configured with UL CA. |
| ***AffectedCarrierFreqRangeList***Indicates a list of NR carrier frequencies range that are affected by the IDC problem |
| ***startingFreq***Indicates the starting frequency of the frequency range which is affected by the IDC problem. |
| ***affectedBandwidth***Indicates the bandwidth of the carrier frequency range from the *startingFreq* which is actually affected by the IDC problem. |
| ***victimSystemType***Indicate the list of victim system types to which IDC interference is caused from NR when configured with UL CA. Value *gps*, *glonass*, *bds*, *galileo* and *navIC* indicates the type of GNSS. Value *wlan* indicates WLAN and value *bluetooth* indicates Bluetooth. |

#### Question 4: Do you agree with the ASN.1 framework and field description for Option 2b: Starting frequency + Bandwidth of the actual affected frequency range reported by the UE?

|  |  |  |
| --- | --- | --- |
| **Company** | **Answers** **(Yes/No)** | **Comments** |
| Qualcomm | No | Same comment as Q1. Unclear why those BW values and whether they solve all target IDC issues. |
| Xiaomi | Yes as the baseline | Same comment as Q1. We can add more values for BW reported by the UE. The details on how to deternine the BW can be left to the UE implementation.The UL CA case (i.e. IMD issue) and the EN-DC band combination may need more discussions. |
| Samsung  | Comments  | Same comment as Q1. Finer granularity for BW is needed. |
| Ericsson | comments | Same comment as Q1 |
| ZTE | Yes | Same comments as Q2 (for the option 1), and We don’t think there is essential difference between the option 1 and option 2a |
| Intel | Yes (as baseline) | Same comment as Q1. |
| Nokia | Maybe | This seems to be about same as existing style used for SCS-SpecificCarrier for this signaling where the BW is indicated with pointA+OffsetToCarrier+BW indicated with number of resource blocks. With the proposed signaling how does NW interpret this which PRBs are affected as the signaling will result in siutaiton that “part of PRB” is impacted but part is not. We prefer more clear signaling from the UE without needing to do interpretations in the NW. And secondly why would one invent new style for signaling. What is the benefit? |
| vivo | Comments | Same comment as Q1 |
| Apple | See comments | As above in Q2. |
| Huawei, HiSilicon | Yes | Similar comment as Q2. |
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Comapring the three options in terms of the Signalling overhead based on the ASN.1 structure above is summarised in the table below

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| --- | --- | --- |
| **Option** | **Signalling component (with # of bits in bracket)** | **Overhead (bit)** |
| 1 | Centre Freq - ARFCN-ValueNR (22) + affected BW (4) | 26 |
| 2 | Starting Freq - ARFCN-ValueNR (22) + Ending Freq - ARFCN-ValueNR (22) | 44 |
| 2a | Starting Freq ARFCN-ValueNR (22) + affected BW (4) | 26 |

It can be clearly seen that the signalling overhead is largest for option 2 as we indicate both the starting and ending frequency in *ARFCN-ValueNR*.

Option 1 and 2a has the same signalling overhead, however option 1 is the natural extension of the existing FDM Solution in NR that involves the indicating the center frequency along with the bandwidth in MHz.

#### Question 5: Based on the above ASN.1 structure and analysis which option do you prefer for R18?

|  |  |  |
| --- | --- | --- |
| **Company** | **Answers** **(Option 1, 2, 2a)** | **Comments** |
| Qualcomm | Option 2 | Given the unpredictable nature of IDC issues, and the lack of time in this WI, we think it would be a challenge to find the correct BW values to report that would cover all IDC issues (BT, WiFi, GNSS). We are worried that choosing incorrect BW values would undermine the feature altogether.Thus, we are fine with taking an 18-bit overhead hit in the report to guarantee accurate high-granularity reports from the UE that would work in all scenarios and be future compatible to any later-identified scenarios, as the LTE scenarios we are working off may be quite outdated by now. This is the straightforward intuitive solution in this case.  |
| Xiaomi | No strong preference | Firstly, we think that the signaling overhead may not be a big issue, since the reported frequencies will not change frequently.We also understand that Option 2 may require less discussion on the ASN.1 values. However providing more values for affected BW seems not a big problem. |
| Samsung  | Both Opt1 and 2a are fine | The difference between Option 1&2a and Option 2 is mainly about the signalling overhead. In order to resolve concern from QC with less overhead, one possible method is to indicate the percentage of bandwidth, which will take 7 bits, for bandwidth indication, i.e., Centre/starting Freq - ARFCN-ValueNR (22) + affected BW percentage, i.e., 1, …, 100, (7) |
| Ericsson | Option 1 or 2a | Either Option 1 or 2a has the equal signaling overhead. They are somewhat identical. Therefore, either of both options is fine to us. In addition, even for option 2, the signaling overhead is not a big issue since it only affects the dedicated signaling. |
| ZTE | Option 1 | As commented above ,we think the granularity with sub-carrier (e.g. 15k) is enough, ARFCN (with 5k minimum step) is quite bits wasting and seems unnecessary. Maybe the option 1 can add some bandwidth with Khz. |
| Intel | Option 1 or 2a | It is obvious that the signalling overhead is largest for option 2 since end frequency is also indicated in *ARFCN-ValueNR*, but the start and end frequency should be relatively close in terms of *ARFCN-ValueNR* in IDC.Adding more values for Option 1 or 2a will not increase much overhead. Between Option 1 or 2a, we don’t have preference as it is basically a matter of taste. |
| Nokia | None with proposed ASN.1 | In our view we are not too worried about signaling overhead as longs as it is not huge but what we want to see is that UE signaling clearly which PRBs are affected without network trying to figure out from the UE signaling what are impacted resource blocks. To us most simple would be to reuse existing *scs-SpecificCarrier* signaling. |
| vivo | Option 1 | Same comments with ZTE |
| Apple | None | We share the concern from Nokia. From the time the IDC WID was created, the main motivation is for UE to report a finer granularity of affected frequency in the unit of PRB/BWP (BWP is out of scope now). To us, using MHz level granualarity seems not meeting the driving motivation. |
| Huawei, HiSilicon | Option 1 | Comparing Option 1 and 2a, which have similar overhead, we believe that Option 1 is the natural extension of the existing the FDM Solution in NR that involves the use of a center frequency as in the existing FDM solution along with the associated bandwidth to define the affected frequency range with minimum overhead. Hence, we prefer option 1The ASN.1 for the existing FDM solution and the associated field description showing the use of the center frequency is shown belowIDC-AssistanceConfig-r16 ::= SEQUENCE { candidateServingFreqListNR-r16 CandidateServingFreqListNR-r16 OPTIONAL, -- Need R ...}Where field description for ***candidateServingFreqListNR***says that ***candidateServingFreqListNR***Indicates for each candidate NR serving cells, the center frequency around which UE is requested to report IDC issues. |
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## 2.2 Signalling details of FDM, e.g. how to configure, how to report

The current IDC FDM solution for NR is the same as the one used for LTE IDC:

* gNB configures the UE with the candidate serving frequency list, which indicates the center frequency around which the UE is requested to report IDC issues;
* On detecting the IDC issue, the UE reports the affected carrier frequency list, which indicate the center of affected carrier frequencies to the gNB.

However, since the bandwidth of the carrier is large in NR, the actually affected frequency range may only be part of entire carrier, hence the UE reporting the center of affected carrier frequency does not provide enough information to help the gNB to address the IDC issue. That is also the motivation for FDM solution enhancement in Rel.18, i.e. to allow more granular indication of affected frequencies to the gNB.

We can take the existing FDM solution mentioned above as the basis and consider the following two aspects for FDM enhancement.

#### 2.2.1 gNB configuration for IDC

As discussed in section 2.1, if the UE needs to report more granular indication of the affected frequencies, the gNB should also provide more granular indication of the candidate serving frequencies for which the UE is requested to report the IDC issue. Otherwise, what the UE reports may be not what the gNB is interested in knowing.

So, in addition to configuring the candidate serving frequency list (center frequency) as in legacy, the gNB should additionally configure the candidate bandwidth for each of the candidate serving frequency, which is used to indicate the frequency range the UE is requested to report IDC issues as shown in Figure 4.

Such configuration will help the gNB to receive the IDC reports from the UE which it is interested in knowing.



Figure 4 - Enhanced gNB configuration for IDC including candidate serving frequency list and candidate bandwidth

#### Question 6: Do you agree that for each candidate serving frequency (center frequency), the gNB will additionally configure the candidate bandwidth, the combination of these two (centre frequency + bandwidth) is used to indicate the frequency range of the corresponding candidate serving frequency for which the UE should report IDC issues?

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| --- | --- | --- |
| **Company** | **Answers** **(Yes/ No)** | **Comments** |
| Qualcomm | No | We understand that it is useful for the UE to send granular reports, however, we don’t understand why the UE may want to configure a certain BW for reporting as opposed signaling the *candidateServingFreqListNR* as in legacy and add required reporting granularity from the UE. The issue is that this solution requires the gNB to guess where IDC issues may be happening, and generally, a carrier freq. indication/band granularity should be sufficient for configuration. If the issue is excessive reporting, we note that a UE implementation would likely report every IDC problem once via UAI so we don’t think the number of reports can grow out of hand when a whole band as we suggest is configured with granular reporting. This also utilizes the legacy configuration of indicating carrier freq. list for reporting instead of introducing a new one. Only when high granularity is required would the gNB need to indicate that to UE on top of legacy configuration. |
| Xiaomi | Yes as the baseline | In LTE FDM solution, the frequencies reported by the UE is also a subset of the frequency list provided by the network. We understand that the intention is to avoid excessive reporting, especially for non-serving frequencies. However according to the UE implementation, the affected frequency list is not a lot since the interference is between 3GPP and non-3GPP RATs (e.g. WiFi and BT), and the number of affected frequencies are not quite limited.Regarding the combination of centre frequency + bandwidth, we think that this configuration can work for Solution 1, 2 and 2a, but probably more suitable for Solution 1. |
| Samsung  | Yes | By additionally including bandwidth, the UE can evaluate the IDC problem to frequeny range which is interested by gNB only, especailly for non-serving frequency. If the gNB is not intending to allocate an frequency range to the UE, it is unnecessary to ask UE to evaluate IDC problem for such range.  |
| Ericsson | Yes | This would be beneficial to configure the UE to measure the gNB concerned/interested frequency regions.  |
| ZTE | No | We understand that the similar issue was also discussed in the LTE, and at last it was no agreed. The UE would determine bandwidth for each centery frequency based on its own capability. We don’t think there is a need to configure such parameters by the network especially for the non-serving frequency. |
| Intel | No for serving frequency, Yes for non-serving frequency | For serving frequency, UE is aware of the bandwidth and there is no need to configure the bandwidth for IDC report. For non-serving frequency, the configuration of bandwidth is needed to avoid unnecessary IDC reporting from UE side. |
| Nokia | No | In R16 NW already requests *candidateServingFreqListNR –* If UE knows that that frequency is affected already in R16 why we need more information from the NW. UE would just indicate what ever part of the candidate serving frequency can be affected and no need for extra information from NW. We see that providing this could possibly save in some scenario small amount of overhead but this is neglible*.*  |
| vivo | Yes | It is beneficial to configure the UE to measure the gNB interested frequency ranges as they may be laterly configured as Scell  |
| Apple | Tend to Yes | Our question is if without the interested frequency range from network, how should UE determine whether to include it in the reporting if it is a bit far from the candidate frequency? Or should we have a fixed value of interested frequency range (e.g. 100MHz for FR1, 200MHz for FR2) for each candidate serving frequency? |
| Huawei, HiSilicon | Yes | Typically, gNB will configure candidate serving frequencies in the region which is close/ adjacent to channels used by the other non- 3GPP technologies on which it will apply scheduling restrictions to resolve the IDC problems. If such configuration is not provided by the gNB, there can be following potential issues which can arise 1. There will be no way for the network to control reporting from the UE.
2. UE will be unsure if it should report actually affected frequency range that is far away from the NR carrier centre frequency as shown below as there is no guidance from the network. Some UE implementation will send the reports while others may decide not to.

1. If the gNB implementation/configuration is such that it addresses IDC issues only if it receives the report that fall within certain preconfigured frequency ranges, many of the reports from the UE covering entire carrier frequency will be discarded silently by the gNB without taking any action.

All these issues will cause excessive signalling and waste of air interface resources. To prevent such issues, we believe it is necessary that the gNB configures the candidate serving frequency ranges to the UE and the UE reports the IDC issues within those frequency ranges. |
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The ASN.1 framework and field descriptions for gNB configuration are as follows

-- ASN1START

-- TAG-OTHERCONFIG-START

OtherConfig ::= SEQUENCE {

 delayBudgetReportingConfig CHOICE{

 release NULL,

 setup SEQUENCE{

 delayBudgetReportingProhibitTimer ENUMERATED {s0, s0dot4, s0dot8, s1dot6, s3, s6, s12, s30}

 }

 } OPTIONAL -- Need M

}

OtherConfig-v1540 ::= SEQUENCE {

 overheatingAssistanceConfig SetupRelease {OverheatingAssistanceConfig} OPTIONAL, -- Need M

 ...

}

CandidateServingFreqListNR-r16 ::= SEQUENCE (SIZE (1..maxFreqIDC-r16)) OF ARFCN-ValueNR

OtherConfig-v1610 ::= SEQUENCE {

 idc-AssistanceConfig-r16 SetupRelease {IDC-AssistanceConfig-r16} OPTIONAL, -- Need M

 drx-PreferenceConfig-r16 SetupRelease {DRX-PreferenceConfig-r16} OPTIONAL, -- Need M

 maxBW-PreferenceConfig-r16 SetupRelease {MaxBW-PreferenceConfig-r16} OPTIONAL, -- Need M

 maxCC-PreferenceConfig-r16 SetupRelease {MaxCC-PreferenceConfig-r16} OPTIONAL, -- Need M

 maxMIMO-LayerPreferenceConfig-r16 SetupRelease {MaxMIMO-LayerPreferenceConfig-r16} OPTIONAL, -- Need M

 minSchedulingOffsetPreferenceConfig-r16 SetupRelease {MinSchedulingOffsetPreferenceConfig-r16} OPTIONAL, -- Need M

 releasePreferenceConfig-r16 SetupRelease {ReleasePreferenceConfig-r16} OPTIONAL, -- Need M

 referenceTimePreferenceReporting-r16 ENUMERATED {true} OPTIONAL, -- Need R

 btNameList-r16 SetupRelease {BT-NameList-r16} OPTIONAL, -- Need M

 wlanNameList-r16 SetupRelease {WLAN-NameList-r16} OPTIONAL, -- Need M

 sensorNameList-r16 SetupRelease {Sensor-NameList-r16} OPTIONAL, -- Need M

 obtainCommonLocation-r16 ENUMERATED {true} OPTIONAL, -- Need R

 sl-AssistanceConfigNR-r16 ENUMERATED{true} OPTIONAL -- Need R

}

OtherConfig-v1700 ::= SEQUENCE {

 ul-GapFR2-PreferenceConfig-r17 ENUMERATED {true} OPTIONAL, -- Need R

 musim-GapAssistanceConfig-r17 SetupRelease {MUSIM-GapAssistanceConfig-r17} OPTIONAL, -- Need M

 musim-LeaveAssistanceConfig-r17 SetupRelease {MUSIM-LeaveAssistanceConfig-r17} OPTIONAL, -- Need M

 successHO-Config-r17 SetupRelease {SuccessHO-Config-r17} OPTIONAL, -- Need M

 maxBW-PreferenceConfigFR2-2-r17 ENUMERATED {true} OPTIONAL, -- Cond maxBW

 maxMIMO-LayerPreferenceConfigFR2-2-r17 ENUMERATED {true} OPTIONAL, -- Cond maxMIMO

 minSchedulingOffsetPreferenceConfigExt-r17 ENUMERATED {true} OPTIONAL, -- Cond minOffset

 rlm-RelaxationReportingConfig-r17 SetupRelease {RLM-RelaxationReportingConfig-r17} OPTIONAL, -- Need M

 bfd-RelaxationReportingConfig-r17 SetupRelease {BFD-RelaxationReportingConfig-r17} OPTIONAL, -- Need M

 scg-DeactivationPreferenceConfig-r17 SetupRelease {SCG-DeactivationPreferenceConfig-r17} OPTIONAL, -- Cond SCG

 rrm-MeasRelaxationReportingConfig-r17 SetupRelease {RRM-MeasRelaxationReportingConfig-r17} OPTIONAL, -- Need M

 propDelayDiffReportConfig-r17 SetupRelease {PropDelayDiffReportConfig-r17} OPTIONAL -- Need M

}

OtherConfig-v18Xy ::= SEQUENCE {

 idc-AssistanceConfig-r18 SetupRelease {IDC-AssistanceConfig-r18} OPTIONAL -- Need M

}

MUSIM-GapAssistanceConfig-r17 ::= SEQUENCE {

 musim-GapProhibitTimer-r17 ENUMERATED {s0, s0dot1, s0dot2, s0dot3, s0dot4, s0dot5, s1, s2, s3, s4, s5, s6, s7, s8, s9, s10}

}

MUSIM-LeaveAssistanceConfig-r17 ::= SEQUENCE {

 musim-LeaveWithoutResponseTimer-r17 ENUMERATED {ms10, ms20, ms40, ms60, ms80, ms100, spare2, spare1}

}

SuccessHO-Config-r17 ::= SEQUENCE {

 thresholdPercentageT304-r17 ENUMERATED {p40, p60, p80, spare5, spare4, spare3, spare2, spare1} OPTIONAL, --Need R

 thresholdPercentageT310-r17 ENUMERATED {p40, p60, p80, spare5, spare4, spare3, spare2, spare1} OPTIONAL, --Need R

 thresholdPercentageT312-r17 ENUMERATED {p20, p40, p60, p80, spare4, spare3, spare2, spare1} OPTIONAL, --Need R

 sourceDAPS-FailureReporting-r17 ENUMERATED {true} OPTIONAL, --Need R

 ...

}

OverheatingAssistanceConfig ::= SEQUENCE {

 overheatingIndicationProhibitTimer ENUMERATED {s0, s0dot5, s1, s2, s5, s10, s20, s30,

 s60, s90, s120, s300, s600, spare3, spare2, spare1}

}

IDC-AssistanceConfig-r16 ::= SEQUENCE {

 candidateServingFreqListNR-r16 CandidateServingFreqListNR-r16 OPTIONAL, -- Need R

 ...

}

DRX-PreferenceConfig-r16 ::= SEQUENCE {

 drx-PreferenceProhibitTimer-r16 ENUMERATED {

 s0, s0dot5, s1, s2, s3, s4, s5, s6, s7,

 s8, s9, s10, s20, s30, spare2, spare1}

}

MaxBW-PreferenceConfig-r16 ::= SEQUENCE {

 maxBW-PreferenceProhibitTimer-r16 ENUMERATED {

 s0, s0dot5, s1, s2, s3, s4, s5, s6, s7,

 s8, s9, s10, s20, s30, spare2, spare1}

}

MaxCC-PreferenceConfig-r16 ::= SEQUENCE {

 maxCC-PreferenceProhibitTimer-r16 ENUMERATED {

 s0, s0dot5, s1, s2, s3, s4, s5, s6, s7,

 s8, s9, s10, s20, s30, spare2, spare1}

}

MaxMIMO-LayerPreferenceConfig-r16 ::= SEQUENCE {

 maxMIMO-LayerPreferenceProhibitTimer-r16 ENUMERATED {

 s0, s0dot5, s1, s2, s3, s4, s5, s6, s7,

 s8, s9, s10, s20, s30, spare2, spare1}

}

MinSchedulingOffsetPreferenceConfig-r16 ::= SEQUENCE {

 minSchedulingOffsetPreferenceProhibitTimer-r16 ENUMERATED {

 s0, s0dot5, s1, s2, s3, s4, s5, s6, s7,

 s8, s9, s10, s20, s30, spare2, spare1}

}

ReleasePreferenceConfig-r16 ::= SEQUENCE {

 releasePreferenceProhibitTimer-r16 ENUMERATED {

 s0, s0dot5, s1, s2, s3, s4, s5, s6, s7,

 s8, s9, s10, s20, s30, infinity, spare1},

 connectedReporting ENUMERATED {true} OPTIONAL -- Need R

}

RLM-RelaxationReportingConfig-r17 ::= SEQUENCE {

 rlm-RelaxtionReportingProhibitTimer ENUMERATED {s0, s0dot5, s1, s2, s5, s10, s20, s30,

 s60, s90, s120, s300, s600, infinity, spare2, spare1}

}

BFD-RelaxationReportingConfig-r17 ::= SEQUENCE {

 bfd-RelaxtionReportingProhibitTimer ENUMERATED {s0, s0dot5, s1, s2, s5, s10, s20, s30,

 s60, s90, s120, s300, s600, infinity, spare2, spare1}

}

SCG-DeactivationPreferenceConfig-r17 ::= SEQUENCE {

 scg-DeactivationPreferenceProhibitTimer-r17 ENUMERATED {

 s0, s1, s2, s4, s8, s10, s15, s30,

 s60, s120, s180, s240, s300, s600, s900, s1800}

}

RRM-MeasRelaxationReportingConfig-r17 ::= SEQUENCE {

 s-SearchDeltaP-Stationary-r17 ENUMERATED {dB2, dB3, dB6, dB9, dB12, dB15, spare2, spare1},

 t-SearchDeltaP-Stationary-r17 ENUMERATED {s5, s10, s20, s30, s60, s120, s180, s240, s300, spare7, spare6, spare5,

 spare4, spare3, spare2, spare1}

}

PropDelayDiffReportConfig-r17 ::= SEQUENCE {

 threshPropDelayDiff-r17 ENUMERATED {ms0dot5, ms1, ms2, ms3, ms4, ms5, ms6 ,ms7, ms8, ms9, ms10, spare5,

 spare4, spare3, spare2, spare1} OPTIONAL, -- Need M

 neighCellInfoList-r17 SEQUENCE (SIZE (1..maxCellNTN-r17)) OF NeighbourCellInfo-r17 OPTIONAL -- Need M

}

NeighbourCellInfo-r17 ::= SEQUENCE {

epochTime-r17 EpochTime-r17,

ephemerisInfo-r17 EphemerisInfo-r17

}

IDC-AssistanceConfig-r18 ::= SEQUENCE {

 candidateServingFreqRangeListNR-r18 CandidateServingFreqRangeListNR-r18 OPTIONAL, -- Need R

 ...

}

CandidateServingFreqRangeListNR-r18 ::= SEQUENCE (SIZE (1..maxFreqIDC-r18)) OF CandidateServingFreqRangeNR-r18

CandidateServingFreqRangeNR-r18 ::= SEQUENCE {

 CenterFreq-r18 ARFCN-ValueNR,

 candidateBandwidth-r18 ENUMERATED {mhz5, mhz10, mhz20, mhz30, mhz40, mhz50, mhz60, mhz80, mhz100, mhz200, mhz300, mhz400, FFS\_spare\_values}

}

-- TAG-OTHERCONFIG-STOP

-- ASN1STOP

| *OtherConfig* field descriptions |
| --- |
| ***bfd-RelaxationReportingConfig***Configuration for the UE to report the relaxation state of BFD measurements. |
| ***candidateServingFreqListNR***Indicates for each candidate NR serving cells, the center frequency around which UE is requested to report IDC issues. |
| ***candidateServingFreqRangeListNR***Indicates for each candidate NR serving cells, the frequency range, indicated by the center frequency and the candidate bandwidth, around which UE is requested to report IDC issues. |
| ***centerFreq***Indicates the center frequency of the candidate serving frequency range. |
| ***candidateBandwidth***Indicates the bandwidth of the candidate serving frequency range. |
| ***connectedReporting***Indicates that the UE can report a preference to remain in RRC\_CONNECTED state following a report to leave RRC\_CONNECTED state. If absent, the UE cannot report a preference to stay in RRC\_CONNECTED state. |
| ***delayBudgetReportingProhibitTimer***Prohibit timer for delay budget reporting. Value in seconds. Value *s0* means prohibit timer is set to 0 seconds, value *s0dot4* means prohibit timer is set to 0.4 seconds, and so on. |

#### Question 7: Do you agree with ASN.1 framework and field description for gNB configuration around which UE is requested to report IDC issues for FDM solution enhancements.?

|  |  |  |
| --- | --- | --- |
| **Company** | **Answers** **(Yes/No)** | **Comments** |
| Qualcomm | No | gNB configuration can configure reporting for the carrier freq./band as legacy and add the granularity requirement if needed. Same reasoning as the previous question.  |
| Xiaomi | Yes as the baseline | The UL CA case (i.e. IMD issue) and the EN-DC band combination may need more discussions. |
| Samsung  | Comments | ASN.1 framework can be used as the starting point. However, the indication of bandwidth can be further discussed, depending on Q2~Q5.  |
| Ericsson | Yes with comments | This option corresponds to the option 1 for UE assistance info report. The option should be designed corresponding to what option is adopt for UE assistance info report. Therefore, suggest RAPP to discuss 2.1 and 2.2 together, according to companies’ inputs, the same/corresponding option should be adopted for both UE report and NW configurationIn addition, we also agree with other companies that the exact BW values need further discussion. |
| ZTE | No | Same view as Qualcomm that “gNB configuration can configure reporting for the carrier freq./band as legacy and add the granularity requirement if needed. ”  |
| Intel | Yes as baseline | As in our reply in Q6, we prefer that *candidateBandwidth-r18* is optional, i.e. it is only needed for non-serving frequency. Field description of *candidateBandwidth-r18* should also be changed to reflect this. |
| Nokia | No | As indicated we don’t need any of this enhancement in R18. We only need to allow UE to indicated more granular information. |
| vivo | Comments | ASN.1 framework can be used as baseline.However, UL CA/DC cases should also be considered. |
| Apple | Yes |  |
| Huawei, HiSilicon | Yes | Additionally we agree with other companies that the same corresponding option should be adopted for both UE report and NW configuration.  |
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#### 2.2.2 IDC UE assistance information reporting

The ASN.1 detiails of the three option for IDC UE assistance information reporting are already covered in section 2.1. Based on the company inputs for section 2.1 and the selected option, signalling details for the UE reporting for FDM soluton will be finalised and provided in the text proposal.

In addition, considering that the actually affected frequency range for the interference from NR TX to non-3GPP RX and the interference from non-3GPP TX to NR RX could be different as shown in Figure 5, the UE should be allowed to report two different frequency range for each candidate serving frequency. These issues are mentioned in [4] and [5].



Figure 5 – Different affected frequency range for the interference from NR TX to non-3GPP RX and the interference from non-3GPP TX to NR RX

#### Question 8: Do you agree that for each candidate serving frequency, the actually affected frequency range for the interference from NR TX to non-3GPP RX and the interference from non-3GPP TX to NR RX could be different hence the UE should be allowed to report two different frequency range for each candidate serving frequency?

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| **Company** | **Answers** **(Yes/ No)** | **Comments** |
| Qualcomm | Confused about question | UE should report all IDC issues in configured frequency band. In this sense, NR Tx interference to non-3GPP and non-3GPP interference to NR Rx, if affected frequency ranges are different, should be in different reports. However, there can also be other IDC issues from same/different non-3GPP RATs which will also be other IDC reports so we don’t understand the purpose of this question, nothing stopping the UE from reporting all IDC issues from all RATs in all directions in separate reports.  |
| Xiaomi | Yes | We are not sure whether any extra standard effort is required, because the UE is allowed to report all affected frequencies and the corresponding interference direction for each interference since LTE. |
| Samsung  | Yes | The affected frequency range can be reported together with interference direction.  |
| Ericsson | No with comments | The intention seems to be aligned with the legacy FDM framework, where UE can indicate interferenceDirection. Therefore, the intention is ok to let UE to report the interferenceDirection.However, we are uncertain on the meaning of “report two different frequency range”. UE only reports IDC and the affected frequency regions. For the same frequency region which is configured by the gNB, UE can not report two times (with slight differences on the affected bandwidtch) in the same report message. Since the reported affected bandwidtchs for the same frequency candidate which is configured for IDC measurement by the gNB are overlapping, the gain may be marginal.For each frequency region, UE can just reuse the legacy framework to indicat the detected interference direction (e.g., ‘NR’, ‘other’, or ‘both’).  |
| ZTE | Yes | Our understanding is that this may happen for the adjacent channel interference as in the LTE, and can be solved by additionally indicating interferenceDirection. **Rapporteur response to the comments received so far**1. Yes the intention for this is that the affected frequency range can be reported together with interference direction as in the legacy FDM framework.
2. Additionally, the actually affected frequency ranges form interference could be different in different directions so indicating “both” as the direction with just one affected frequency range may not be optimum if the difference between the affected frequency ranges in different direction is significant.
 |
| Intel | Yes | We think it is beneficial that UE reports the affected frequency range for DL and UL separately. |
| Nokia | Yes and No | In fact why only two ranges? Wouldn’t it be possible that there is need for even more? But on the other hand even just indicating one frequency range with more detailed information can work but of course if there would be multiple non-contiguous impacted bands then one would not allow scheduling on some of possible PRBs. Thus we don’t have very strong view on this as long as we at least report one range but we are open to introduce more.Additionally we think it would be beneficial to indicate to the NW 3GPP radio caused intermodulation issues as e.g. discussed in R2-2211969. This would allow NW to understand the situation and make changes to 3GPP ISM causing radio to remove the ISM problem.  |
| vivo |  | We are not sure whether such use case really exists. |
| Apple | Yes | It should be possible for UE to indicate two lists for two interference directions.In addition, we also feel for one candidate frequency, there is a need to UE to report multiple affected frequency ranges. |
| Huawei, HiSilicon | Yes | If we show the Centre Frequencies for the two actual affected frequency regions in red and blue colour for option 1 in Figure 5 we can see that the UE will have to include two different entries in the UE report in AffectedCarrierFreqRangeList for the red and the blue regions (which are different) along with the respective interference direction as shown below.  AffectedCarrierFreqRange 1 : { centerFreq : Centre freq for Red region; affectedBandwidth : BW of Red region; interferencedirection: Other;  } AffectedCarrierFreqRange 2 : { centerFreq : Centre freq for Blue region; affectedBandwidth : : BW of Blue region; interferencedirection: NR; }We think such a report from the UE will provide precise information to the gNB for addressing the IDC issue.  |
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## 2.3 FDM and TDM solution enhancement for MR-DC

For the MR-DC scenarios there can be two cases that we need to consider

Case 1 – Individual candidate frequencies are affected by the IDC issue

Case 2 – Combination of frequencies are affected by the IDC issue

For these two cases there can be two options in terms of which node configures the UE with the candidate serving frequency range list.

Option 1 – Only MN Configures the UE with the candidate serving frequency range list for reporting

Option 2 – Both MN and SN can configure the UE with the the candidate serving frequency range list for reporting

It clear that the MN can provide the IDC configuration in both the options. However, the open point from the discussion in RAN 2 #120 was that whether the SN can also configure the UE for IDC or do we want to restrict that only MN configure the UE for IDC.

#### Question 9: Do you agree that in MR-DC scenarios SN can also configure the UE for IDC reporting, including both FDM and TDM solution ?

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| **Company** | **Answers** **(Yes/No)** | **Comments** |
| Qualcomm | Yes | Since some IDC issues can fully happen within SN, it would make sense if SN configured the behavior, obtained the report from UE and solved the problem. In our view this is the cleanest way to solve SN IDC problems. Furthermore, in EN-DC, since we agreed not to modify LTE, we would need an NR report (configured, reported to and solved) in the SN if we want to tackle the IDC problem for this scenario. |
| Xiaomi | Yes | For MR-DC (especially for EN-DC), allowing NR SN to configure the Rel-18 enhanced-FDM and TDM solutions could reduce the impacts to the (LTE) MN.According to the NR Rel-16 IDC FDM solution, we think that SN is also allowed to configure it. The standarded efforts are minor.  |
| Samsung  | Yes  |  |
| Ericsson | Yes | It is beneficial to let UE to only report IDC to the affected node, which will address the issue through scheduling. Therefore, beneficial to allow SN to configure IDC on frequency regions which only affects SCG. Then, UE can report IDC on frequency regions which only affects SCG to SN.In addition, we think it is sufficient that MN only configures IDC on frequency regions which only affects MCG. In this way, we can avoid MN and SN to coordinate for configuraing the UE for IDC. Based on the configuration, UE will ONLY report IDC on MCG frequencies to MN, and only report IDC on SCG frequencies to SN. Coordination is needed for neithther IDC configuration nor the UE report.  |
| ZTE | See comments | If our understanding was right, the procedure for the option 1 is similar to belowFor the option 2, based on the companies contributions in the previous meeting, it seems that there are 3 sub-options:Option 2a: SN IDC was configured by MN with separate listOption 2b SN IDC was configured through SRB3Option 2C: SN configure the IDC within a container (no SRB3 case)For the above option 2b/2c, at least the below issues need to be further discussed:(1)How to avoid the overlap between the MN and SN?(2) Whether the UE need to report UAI for the MR-DC IDC when receive the SN candidate frequency list (if the MN has configured the candidate frequency list before). If needed, then how does the MN distinguish that this UAI is triggered by the SN configured IDC and how to control the prohibit timer?So it seems that the SN configuration scheme are too complex and we prefer to only support option 1. |
| Intel | Yes | Allowing SN to configured IDC is beneficial e.g. in EN-DC. |
| Nokia | Question for clarification | Is the intention to do something differently from release 16 IDC for this? And if yes, why would that be done? |
| vivo | Yes |  |
| Apple | Yes | We think it is beneficial to allow SN configures IDC to UE. Regarding the question from ZTE, our understanding is MN and SN should better not (or not need to) configure the same candidate frequency as normally MN and SN nodes would be deployed with different frequencies..In addition, even though the same frequency is configured on two legs, UE could just simply report it to both nodes if not involving across leg (not IMD issue). |
| Huawei, HiSilicon | Yes | For the EN-DC scenarios we see some benefits at least for the case where SN also provides the SN candidate serving frequency list directly to the UE using SRB 3.Then UE can report IDC issues involving SN frequencies directly to SN via SRB 3 and SN can take action for the cases where individual SN frequencies are affected by the IDC issue.  |
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#### Question 10: Do you think that in MR-DC scenarios the co-ordination between the MN and SN is needed for configuring the UE for IDC, including both FDM and TDM solution?

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| **Company** | **Answers** **(Yes/No)** | **Comments**  |
| Qualcomm | No  | For configuration, no coordination is needed . We can follow legacy procedures for other UAI e.g. for power savings or overheating. reports are configured separately, reported separately. In EN-DC, such coordination is not possible without modifying LTE so in our view, it is necessary to maintain an SN solution that needs no coordination. The only case where some coordination may happen is coordinating a solution between MN and SN for IMD in NR-DC only. In this specific case, we can coordinate the solution, but not the configuration and reporting as in the question. |
| Xiaomi | No strong view | Since the UE follows the network configuration to report the FDM and TDM assistance information to either MN or SN. If the MN and the SN can coordinate with each other on the IDC configuration, some signal overheads via the Uu interface can be saved.  |
| Samsung  | * Already support the coordination for IDC configuration.
* Yes for coordination on IDC solutions
 | As legacy, the IDC related configurations can be provided by OtherConfig, which will be transmitted between MN and SN. In this sense, the existing signalling structure already support the coordinated configuration between MN and SN, so no additional coordination is needed. On the other hand, we tend to agree with QC, i.e., the coordination between MN and SN on the IDC solution may be needed, and we can further discuss this.  |
| Ericsson | No | As we commented for Q9, coordination is needed for neithther IDC configuration nor the UE report. |
| ZTE | Similar view to Qualcomm and Samsung on the MN-SN coordination | We think for the IMD IDC FDM solution, some coordination between MN and SN would be needed. In the last meeting we also submit a paper (R2-2212743) to describe the reason and an example was also given as below:For exampleMN: F1: PRB( or Frequency) Range1, PRB( or Frequency) Range2 SN: F2: PRB( or Frequency) Range1, PRB( or Frequency) Range2 IDC 1: F1 PRB( or Frequency) Range1+ F2 PRB( or Frequency) Range1 IDC 2: F1 PRB( or Frequency) Range2 + F2 PRB( or Frequency) Range2**Fig : IDC Comb with PRB ranges**If the MN only indicates the SN that F1 was selected , but doesn’t indicate the PRB( or Frequency) Range information to the SN, the SN would take all frequency ranges on the F2 as invalid. |
| Intel | No | As in Q9, if SN can configure IDC issue, there seems not much motivation for the coordination between MN and SN for IDC configuration. |
| Nokia | Question for clarification | Is the intention to do something differently from release 16 IDC for this? And if yes, why would that be done? |
| vivo | NO |  |
| Apple | See comments | For configuration, we can further discuss whether interested frequency range in Q6 (if agreed) should be sent from SN to MN. This is for the case where MN only provides the IDC configuration.Same as others, we think for solutions to address IMD, it is needed for MN and SN to coordinate. |
| Huawei, HiSilicon | See Comments | For IDC ConfigurationAt least for the over lapping issues mentioned by ZTE, we think co-ordination between MN and SN for configuration is not needed. If MN and SN configures the same frequencies to UE it means that both MN and SN wants to know the IDC problem on this frequency. Then the UE needs to report the IDC assistance information to both MN and SN. For IDC Solution* For the case where, Individual candidate frequencies are affected by the IDC issue, there is no need for co-ordination for the solution between MN and SN.
* For the case where, Combination of frequencies involving MN and SN are affected by the IDC issue,
	+ if MN decides to address the IDC issue itself, then it does not need forward any information to SN.
* If MN chooses not to address the IDC issue itself, then it can forward the affected frequency combination list to SN for it to take action to resolve the IDC issue.
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#### Question 11: If the answer to Question 10 is “yes” please provide the details of the information that needs to be exchanged between MN and SN for applying FDM solution for MR-DC?

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| **Company** | **Details of the information that needs to be exchanged between MN and SN for FDM solution** |
| Xiaomi | We think that the IDC configuration from MN or SN can be included in the inter-node RRC message (e.g. CG-Config and CG-ConfigInfo), the IDC assistance information can also be added in the inter-node RRC message. The IDC assistance information is in UAI which has already been included in the inter-node RRC messages between MN and SN.The IDC configuration is to be included in the otherConfig, which has also been included in the inter-node RRC messages between MN and SN.Companies can double-check whether extra standard efforts are required. |
| Samsung  | For IDC FDM solution, if the IDC problem is referring to the frequency combination, the IDC problem can be resolved as long as one frequency range in such combination is in deactived status. For DC case, such frequency combination may contain the frequency ranges belonging to MN and SN, respectively, and the activation/deactivation of each frequency range (e.g., BWP) is controlled dynamically by MN and SN independently. In this case, MN and SN can coordinate the status of the frequency range in the frequency combination. Specifically, MN can indicate to SN whether its frequency range is activated or deactivated, and vice verse.  |
| ZTE | Besides the UE reported MR-DC IDC list, MN should provide enough information for the SN to determine which frequency range can be determined.Two detail questions shall be further discussed1. *Which additional information shall also be exchanged between the MN and SN?*
* Option 1: The UE only exchange the current serving frequency ranges that are included in MR-DC IDC combination
* Option 2: The UE exchange both the current serving frequency ranges and the potential serving PRB ranges that are included in MR-DC IDC combination
1. *How to exchange these additional information between the MN and SN?*
* the UE can exchange the related frequency ranges information explicitly or implicitly ( e.g. affected MR-DC IDC combination Index )

For exampleAssume MN serving cell f1 PRB range 1SN serving cell f2 PRB range 1and the f3 is the non-serving frequencyThe UE report IDC comb 1~5 and IDC comb x for the MR-DC, and if the MN would serving the UE on F1 PRB range 1/2 or f3 PRB range 1,the MN can indicate some assistance information (e.g. IDC comb 1/x/2/4, or the PRB range that occupied by the MN) to the SN, then the SN would avoid to serve the UE on the PRB range 1/2 of f2. |
| Apple | The issue can be separately discussed for MN only IDC configuration and MN/SN simultaneous IDC configuration.For MN only IDC configuration, as we also mentioned in Q10, potentially the interested frequency range (if agreed) from SN should be sent to MN. For the solution coordination, the exact affected resources should be transmitted from MN to SN. But we also agree those info can be simply extended in current Xn signaling.For MN/SN simultaneous IDC configuration, if the IDC issue does not involve two legs (3GPP RAT as victim, harmonic interference), there is no need to coordinate. Otherwise, if the IDC issue involves two legs (IMD issue), UE should only report the IDC signaling to MN then MN is responsible to handle the issue (whether to release the affected carrier in MCG or in SCG) and indicate the available/or non-available resources to SN. |
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#### Question 12: If the answer to Question 10 is “yes” please provide the details of the information that needs to be exchanged between MN and SN for applying TDM solution for MR-DC?

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| **Company** | **Details of the information that needs to be exchanged between MN and SN for TDM solution** |
| Xiaomi | For UE assistance information of TDM, our answer is the same as provided for Question 11.For autonomous denial solution, if the autonomous denial configuration is per CG, our answer is also the same as provided for Question 11. If the autonomous denial configuration is per UE (or other granularity), more discussion may be needed on the inter-node coordination. |
| Samsung  | For IDC TDM solution, the existing signalling can already support the DRX configuration exchange between MN and SN. Thus, at this stage, we didn’t see the necessity of further coordination.  |
| ZTE | Agree with Samsung |
| Nokia | Agree with Samsung |
| Apple | We think autonomous denial should be done per CG as it mainly impacts link adaptation at gNB which is within the leg. For DRX configuration, the current Xn signaling can be extended to include more info (Rel-18 IDC specific info like the TDM info). Note that in current Xn signaling, ueAssistanceInformationSourceSCG-r16 is only for SN change which may need more discussion whether UAI can be transparently transferred to SN. |
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# 3. Conclusion

After collecting companie’s feedbacks, the discussion on the IDC FDM solution enhancements is summarized as follows:

TBD

# 4. Text proposal

To be updated according to conclusion.

# 4. Reference

[1] R2-2212420 Report from [Post119-e][650][IDC] Comparison of FDM solutions (Ericsson)

[2] R2-2211740 Discussion on FDM solutions in IDC Apple

[3] R2-2211581 FDM Solutions in IDC Qualcomm Incorporated

[4] R2-2211608 Discussion on FDM enhancement Huawei, HiSilicon

[5] R2-2211618 Enhanced FDM solution for IDC Intel Corporation

[7] R2-2211756 Discussion on FDM solution enhancements for IDC OPPO

[8] R2-2211969 FDM solutions Nokia, Nokia Shanghai Bell

[9] R2-2211979 Discussion on the FDM Option 1 and 2 Xiaomi

[10] R2-2212412 More granular FDM indications Ericsson

[11] R2-2212652 Discussion on FDM solution for R18 IDC vivo

[12] R2-2212668 Discussion on FDM solution enhancements Sharp

[13] R2-2212743 Further Consideration on the IDC FDM Solutions ZTE Corporation, Sanechips

[14] R2-2212816 Discussion on FDM solution for IDC Samsung

[15] R2-2212921 IDC FDM solution LG Electronics

[16] R2-2212931 FDM solution for IDC Lenovo