**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 |
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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 |
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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.  |
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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

}

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-- 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 |
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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

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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. |
| ***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?

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| **Company** | **Answers** **(Yes/No)** | **Comments** |
| Qualcomm | No | Same comment as Q1. Unclear why those BW values and whether they solve all target IDC issues. |
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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?

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| **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.  |
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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. |
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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.?

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| --- | --- | --- |
| **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.  |
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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.  |
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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. |
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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. |
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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** |
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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** |
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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