**3GPP TSG-RAN WG2 Meeting #122 (To be) R2-23xxxxx**

**Incheon, Korea, 22th - 26th May, 2023**

**Agenda item: x.x.x**

**Source: Xiaomi**

**Title: [Post121][655][IDC] Discussion on Leftover issues for IDC (xiaomi)**

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

# 1. Introduction

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

* [Post121][655][IDC]  Discussion on Leftover issues for IDC (xiaomi)

      Scope: Continue the discussion on leftover issues and issues raised during short post meeting discussion.

      Intended outcome: Report to May meeting (proposals with agreeable TPs)

      Deadline:  Very long

## 1.1 Contacts

Contact person for each participating company:

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| Company | Name | Email Address |
| Xiaomi | Yumin Wu | wuyumin@xiaomi.com |
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# 2. Discussion

## 2.1 Autonomous denial

The following FFS(s) are quoted from the endorsed CRs given in the reference section.

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| R2-2304331 38.331 running CR for introduction of IDC Xiaomi draftCR Rel-18 38.331 17.4.0 NR\_IDC\_enh-Core1> if the *CellGroupConfig* contains the *autonomousDenialParameters*:2> consider itself to be allowed to deny any transmission in a particular UL slot if during the number of slots indicated by *autonomousDenialValidity*, preceding and including this particular slot, it autonomously denied fewer UL slots than indicated by *autonomousDenialSlots* within the same cell group;Editor’s Note: FFS whether the UE sums up the denied UL slots together across all CC(s) in the CG and how the UE calculates the number of denied slots when different CCs have different slot length.Editor’s Note: FFS whether the NR autonomous denial configuration and the LTE autonomous denial configuration can be configured simultaneous for EN-DC.Editor’s note: FFS on the UE behaviour when receiving *autonomousDenialValidity*. |

According to the endorsed CR, when the UE receives the *autonomousDenialValidity* configuration from the network, no extra UE behaviour is specified (as LTE). It is unclear whether any clarification is required in the specification.

#### Question 1: Do you think that extra UE behaviours need to be clarified in the specification when receiving *autonomousDenialValidity*?

(Rapporteur’s comments: Companies providing the answer “Yes”, please also provide the reasons and the required specification changes in the Comments column. A converged solution (if required) would be highly appreciated.)

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According to the LTE specification, the autonoums denial configuration is per UE. However as RAN2 agreed to introduce per-CG autonomous denial configuration, it seems that allowing the simultaneous configuration of the autonoums denial configuration via the LTE MCG and the autonoums denial configuration via the NR SCG will cause confusions at the UE.

#### Question 2: Do you think that the NR autonomous denial configuration and the LTE autonomous denial configuration can be configured simultaneous for EN-DC?

(Rapporteur’s comments: Companies providing the answer “Yes”, please also provide the reasons and the required specification changes in the Comments column. A converged solution (if required) would be highly appreciated.)

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As RAN2 agreed that the autonomous denial configuration is per CG, some companies consider that it is not very clear how the UE counts the UL slots across all CCs in the same CG, while considering the case that different CCs could have different slot length. It seems that if we do not consider the numerology impacts on counting the dropped UL slots, the UE would have to count all UL slot in all CCs. It is also not very clear whether we need to clarify the UE behaivour when the UE sums up the denied UL slots together across all CC(s) in the CG. The rapporter considers that if companies agree with the common UE behaviour as “the UE sums up the denied UL slots together across all CC(s) in the CG”, we could add a NOTE in the specification to avoid some ambiguities.

#### Question 3: Do you think that the UE sums up the denied UL slots together across all CC(s) in the CG?

(Rapporteur’s comments: Companies providing the answer “No”, please also provide the reasons and the required specification changes in the Comments column. A converged solution (if required) would be highly appreciated.)

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## 2.2 Inter-node coordination

The following FFS(s) are quoted from the endorsed CRs given in the reference section.

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| R2-2303884 37.340 Running CR for Introduction of IDC ZTE Corporation, Sanechips draftCR Rel-18 37.340 17.4.0 B NR\_IDC\_enh-Core* Editor’s Note: FFS whether any additional coordination is needed for network to resolve the problem when network receives an IDC report from UE.
 |
| RAN2#121 meeting agreement:* FFS whether any additional coordination is needed for network to resolve the problem when network receives the reporting from UE.
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#### Question 4: Do you think that additional coordination between MN and SN is needed when network receives an IDC report from UE?

(Rapporteur’s comments: Companies providing the answer “Yes”, please also provide the reasons and the required specification changes (e.g. whether the coordination is required for either FDM or TDM or both) in the Comments column. A converged solution (if required) would be highly appreciated.)

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As requested by companies offline, it seems that some companies consider that reusing some signaling similar as the legacy IDC configuration coordination between MN and SN should not be considered as “additiaonl” coordination. Rapporteur considers that companies may need to clarify what the expected “coordination” (or signaling) is required for the IDC configuration coordination between MN and SN

#### Question 5: Do you think that additional coordination between MN and SN is needed when network configures IDC assistance information reporting or autonomous denial for the UE?

(Rapporteur’s comments: Companies providing the answer “Yes”, please also provide the reasons and the required specification changes (e.g. whether the coordination is required for either FDM or TDM or both) in the Comments column. A converged solution (if required) would be highly appreciated.)

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## 2.3 Others

The following FFS(s) are quoted from the endorsed CRs given in the reference section.

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| R2-2304331 38.331 running CR for introduction of IDC Xiaomi draftCR Rel-18 38.331 17.4.0 NR\_IDC\_enh-Core* Editor’s Note: FFS on the dependency between FDM and TDM configuration.
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According to the LTE specification for reporting the TDM assistance information, there is not separate configuration for allowing the UE to report the TDM assistance information. Only one bit configuration is provided for both FDM and TDM assistance information in Rel-11, as quoted below:

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| 36.331:IDC-Config-r11 ::= SEQUENCE { idc-Indication-r11 ENUMERATED {setup} OPTIONAL, -- Need OR autonomousDenialParameters-r11 SEQUENCE { autonomousDenialSubframes-r11 ENUMERATED {n2, n5, n10, n15, n20, n30, spare2, spare1}, autonomousDenialValidity-r11 ENUMERATED { sf200, sf500, sf1000, sf2000, spare4, spare3, spare2, spare1} } OPTIONAL, -- Need OR ..., [[ idc-Indication-UL-CA-r11 ENUMERATED {setup} OPTIONAL -- Cond idc-Ind ]], [[ idc-HardwareSharingIndication-r13 ENUMERATED {setup} OPTIONAL -- Need OR ]], [[ idc-Indication-MRDC-r15 CHOICE{ release NULL, setup CandidateServingFreqListNR-r15 } OPTIONAL -- Cond idc-Ind ]]} |

The consequence is that the UE would have to report FDM assistance information when reporting TDM assistance information, as quoted below:

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| 1> if there is at least one E-UTRA carrier frequency, for which a measurement object is configured, that is affected by IDC problems:2> include the field *affectedCarrierFreqList* with an entry for each affected E-UTRA carrier frequency for which a measurement object is configured;2> for each E-UTRA carrier frequency included in the field *affectedCarrierFreqList*, include *interferenceDirection* and set it accordingly;2> include Time Domain Multiplexing (TDM) based assistance information, unless *idc-HardwareSharingIndication* is configured and the UE has no Time Doman Multiplexing based assistance information that could be used to resolve the IDC problems:3> if the UE has DRX related assistance information that could be used to resolve the IDC problems:4> include *drx-CycleLength*, *drx-Offset* and *drx-ActiveTime*;3> else (the UE has desired subframe reservation patterns related assistance information that could be used to resolve the IDC problems):4> include *idc-SubframePatternList*;3> use the MCG as timing reference if TDM based assistance information regarding the SCG is included; |

#### Question 6: Do you think that FDM configuration and TDM configuration can be configured independently?

(Rapporteur’s comments: Companies providing the answer “No”, please also provide the reasons and the required specification changes in the Comments column. A converged solution (if required) would be highly appreciated.)

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According to the LTE specification as quoted below, as the TDM assistance information is only allowed for MCG, the timing referenc for IDC TDM assistanc information uses MCG.

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| 36.331:2> include Time Domain Multiplexing (TDM) based assistance information, unless *idc-HardwareSharingIndication* is configured and the UE has no Time Doman Multiplexing based assistance information that could be used to resolve the IDC problems:3> if the UE has DRX related assistance information that could be used to resolve the IDC problems:4> include *drx-CycleLength*, *drx-Offset* and *drx-ActiveTime*;3> else (the UE has desired subframe reservation patterns related assistance information that could be used to resolve the IDC problems):4> include *idc-SubframePatternList*;3> use the MCG as timing reference if TDM based assistance information regarding the SCG is included; |

Since the NR TDM assistance information is per CG, the rapporteur considers that we can reuse the LTE solution to use the CG for reporting TDM as the timing reference. The following FFS(s) are quoted from the endorsed CRs given in the reference section.

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| R2-2304331 38.331 running CR for introduction of IDC Xiaomi draftCR Rel-18 38.331 17.4.0 NR\_IDC\_enh-Core3> include Time Domain Multiplexing (TDM) based assistance information as indicated by *idc-TDM-Assistance* that could be used to resolve the IDC problems;3> if *idc-TDM-AssistanceConfig* is provided from MCG:4> use the MCG as timing reference;3> else:4> use the SCG as timing reference;Editor’s Note: FFS whether the time reference for *idc-TDM-AssistanceConfig* is needed. |

#### Question 7: Do you think that the time reference for *idc-TDM-AssistanceConfig* is needed, as LTE?

(Rapporteur’s comments: Companies providing the answer “No”, please also provide the reasons and the required specification changes in the Comments column. A converged solution (if required) would be highly appreciated.)

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The following FFS(s) are quoted from the endorsed CRs given in the reference section.

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| R2-2304331 38.331 running CR for introduction of IDC Xiaomi draftCR Rel-18 38.331 17.4.0 NR\_IDC\_enh-CoreIDC-TDM-Assistance-r18 ::= SEQUENCE {cycleLength-r18 ENUMERATED {ms2, ms3, ms4, ms5, ms6, ms7, ms8, ms10, ms14, ms16, ms20, ms30, ms32, ms35, ms40, ms60, ms64, ms70, ms80, ms128, ms160, ms256, ms320, ms512, ms640, ms1024, ms1280, ms2048, ms2560, ms5120, ms10240},startOffset-r18 INTEGER (0..10239),slotOffset-r18 INTEGER (0..31), activeDuration-r18 CHOICE { subMilliSeconds INTEGER (1..31), milliSeconds ENUMERATED { ms1, ms2, ms3, ms4, ms5, ms6, ms8, ms10, ms20, ms30, ms40, ms50, ms60, ms80, ms100, ms200, ms300, ms400, ms500, ms600, ms800, ms1000, ms1200, ms1600, spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1 } }}AffectedCarrierFreqRangeList-r18 ::= SEQUENCE (SIZE (1..FFS)) OF AffectedCarrierFreqRange-r18Editor’s Note: FFS whether to use maxFreqIDC-r16.AffectedCarrierFreqRange-r18 ::= SEQUENCE { centerFreq-r18 ARFCN-ValueNR, affectedBandwidth-r18 ENUMERATED {mhz5, mhz10, mhz20, mhz30, mhz40, mhz50, mhz60, mhz80, mhz100, mhz200, mhz300, mhz400, whole}, interferenceDirection-r18 ENUMERATED {nr, other, both, spare}}Editor’s Note: FFS on the values of bandwidth, and the meaning of the “whole” bandwidth of the frequency or whether to make *affectedBandwidth* optional.Editor’s Note: FFS whether the codepoint of “both” and “spare” for interferenceDirection-r18 is needed.AffectedCarrierFreqRangeCombList-r18 ::= SEQUENCE (SIZE (1..maxCombIDC-r16)) OF AffectedCarrierFreqRangeComb-r18 AffectedCarrierFreqRangeComb-r18 ::= SEQUENCE { affectedCarrierFreqRangeComb-r18 SEQUENCE (SIZE (2..FFS)) OF AffectedCarrierFreqRangeComb-r18 OPTIONAL, victimSystemType-r18 VictimSystemType-r16}Editor’s Note: FFS whether to reuse the Rel-16 IDC ASN.1 framework of adding *interferenceDirection* and *victimSystemType*.Editor’s Note: FFS on the number of entries (e.g. maxNrofServingCells) of affectedCarrierFreqRangeComb-r18.AffectedCarrierFreqRangeComb-r18 ::= SEQUENCE { centerFreq-r18 ARFCN-ValueNR, affectedBandwidth-r18 ENUMERATED {mhz5, mhz10, mhz20, mhz30, mhz40, mhz50, mhz60, mhz80, mhz100, mhz200, mhz300, mhz400, whole},}Editor’s Note: FFS on the values of bandwidth and the meaning of the “whole” bandwidth of the frequency or whether to make *affectedBandwidth* optional. |

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| AffectedCarrierFreqRangeList-r18 ::= SEQUENCE (SIZE (1..FFS)) OF AffectedCarrierFreqRange-r18Editor’s Note: FFS whether to use maxFreqIDC-r16. |

#### Question 8: Do you think that *maxFreqIDC-r16* is reused for *AffectedCarrierFreqRangeList-r18*?

(Rapporteur’s comments: Companies providing the answer “No”, please also provide the reasons and the required specification changes in the Comments column. A converged solution (if required) would be highly appreciated.)

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As quoted below, *interferenceDirection-r18* reuses the same values of *interferenceDirection-r16*.

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| AffectedCarrierFreq-r16 ::= SEQUENCE { carrierFreq-r16 ARFCN-ValueNR, interferenceDirection-r16 ENUMERATED {nr, other, both, spare}} |
| interferenceDirection-r18 ENUMERATED {nr, other, both, spare} |

#### Question 9: Do you think that *interferenceDirection-r18* reuses the values of *interferenceDirection-r16*?

(Rapporteur’s comments: Companies providing the answer “No”, please also provide the reasons and the required specification changes in the Comments column. A converged solution (if required) would be highly appreciated.)

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According to the endorsed CR, the Rel-16 IDC ASN.1 framework of adding *interferenceDirection* and *victimSystemType* is reused for the Rel-18 IDC FDM assistance information.

#### Question 10: Do you think that the Rel-16 IDC ASN.1 framework of adding *interferenceDirection* and *victimSystemType* is reused for the Rel-18 IDC FDM assistance information?

(Rapporteur’s comments: Companies providing the answer “No”, please also provide the reasons and the required specification changes in the Comments column. A converged solution (if required) would be highly appreciated.)

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| AffectedCarrierFreqRangeComb-r18 ::= SEQUENCE { centerFreq-r18 ARFCN-ValueNR, affectedBandwidth-r18 ENUMERATED {mhz5, mhz10, mhz20, mhz30, mhz40, mhz50, mhz60, mhz80, mhz100, mhz200, mhz300, mhz400, whole},}Editor’s Note: FFS on the values of bandwidth and the meaning of the “whole” bandwidth of the frequency or whether to make *affectedBandwidth* optional. |
| AffectedCarrierFreqRange-r18 ::= SEQUENCE { centerFreq-r18 ARFCN-ValueNR, affectedBandwidth-r18 ENUMERATED {mhz5, mhz10, mhz20, mhz30, mhz40, mhz50, mhz60, mhz80, mhz100, mhz200, mhz300, mhz400, whole}, interferenceDirection-r18 ENUMERATED {nr, other, both, spare}}Editor’s Note: FFS on the values of bandwidth, and the meaning of the “whole” bandwidth of the frequency or whether to make *affectedBandwidth* optional. |
| CandidateServingFreqRangeNR-r18 ::= SEQUENCE { candidateCenterFreq-r18 ARFCN-ValueNR, candidateBandwidth-r18 ENUMERATED {mhz5, mhz10, mhz20, mhz30, mhz40, mhz50, mhz60, mhz80, mhz100, mhz200, mhz300, mhz400, whole}}Editor’s Note: FFS on the values of bandwidth and the meaning of the “whole” bandwidth of the frequency or whether to make *affectedBandwidth* optional. |

As per RAN2 agreement, the endorsed CR adds the value “whole” for *affectedBandwidth-r18*. As RAN2 did not discuss the meaning of the value “whole”, it is better to clarify how this value “whole” for *affectedBandwidth-r18* is used in the specification.

#### Question 11: Do you think that the value “whole” for *affectedBandwidth-r18* is needed?

(Rapporteur’s comments: Companies providing the answer “Yes”, please also provide the reasons and the required specification changes (e.g. the meaning of the value “whole”) in the Comments column. A converged solution (if required) would be highly appreciated.)

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#### Question 12: Do you think that *affectedBandwidth-r18* can be optional for the FDM configuration from the network, e.g. if the value “whole” for *affectedBandwidth-r1* is not applicable?

(Rapporteur’s comments: Companies providing the answer “Yes”, please also provide the reasons and the required specification changes (e.g. what would be expected UE behavior when this field is not present) in the Comments column. A converged solution (if required) would be highly appreciated.)

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#### Question 13: Do you think that *affectedBandwidth-r18* can be optional for the FDM assistance information reported from the UE, e.g. if the value “whole” for *affectedBandwidth-r1* is not applicable?

(Rapporteur’s comments: Companies providing the answer “Yes”, please also provide the reasons and the required specification changes (e.g. what would be expected UE behavior when this field is not present) in the Comments column. A converged solution (if required) would be highly appreciated.)

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# 3. Conclusion

After collecting companies’ feedbacks, the discussion on the remaining issues of IDC is summarized as follows:

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# 4. Reference

[1] R2-2302979 38.306 running CR for Rel-18 IDC UE capabilities Intel Corporation draftCR Rel-18 38.306 17.4.0 B NR\_IDC\_enh-Core

[2] R2-2302980 38.331 running CR for Rel-18 IDC UE capabilities Intel Corporation draftCR Rel-18 38.331 17.4.0 B NR\_IDC\_enh-Core

[3] R2-2304331 38.331 running CR for introduction of IDC Xiaomi draftCR Rel-18 38.331 17.4.0 NR\_IDC\_enh-Core

[4] R2-2303884 37.340 Running CR for Introduction of IDC ZTE Corporation, Sanechips draftCR Rel-18 37.340 17.4.0 B NR\_IDC\_enh-Core

[5] R2-2304107 38.300 running CR for IDC Enhancements Huawei, HiSilicon draftCR Rel-18 38.300 17.4.0 B NR\_IDC\_enh-Core

[6] RAN2#121 meeting agreements

# Annex - RAN2 agreements

Green highlight – agreement captured in the specification

Blue highlight – agreement captured as editor’s notes

No highlight – agreement with no direct impact on specifications

## RAN2#119-e

**FDM**

* 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.

**TDM**

* The use cases (e.g. BT voice, BT eSCO and WLAN beacon) as described in 3GPP TR 36.816 for LTE TDM solutions are considered for developing the Rel-18 IDC TDM solution in RAN2.
* Rel-18 IDC TDM solution(s) targets at resolving the adjacent channel interference issue and the intermodulation distortion interference issue, as LTE.
* As the baseline, the UE reports the TDM assistance information for IDC affected frequency list , as LTE.
* Note, this does not exclude MUSIM gap like solution.

**General**

* RAN2 consider “hardware sharing indication” is out of scope. Company should bring this to RANP if want to support it.

## RAN2#120

**FDM**

* 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

**TDM**

* Periodic pattern is supported; FFS on the values.
* Option 3 (i.e. UL and/or DL transmission occasion(s) solution) is not supported in Rel-18.
* The periodic pattern reported by the UE includes cycle, start offset and active duration. FFS, whether multiple patterns are supported. FFS on per CG pattern.
* RAN2 confirms the understanding that in Rel-17 NR RRC, the values from periodic pattern in MUSIM-gap is a subset of the DRX parameters.
* NR DRX values can be treated as a starting point for assistance information reported by UE. FFS, on exact values.
* RAN2 reconfirms the previous RAN2 agreement that the aperiodic traffics as described in 3GPP TR 36.816 are considered for developing the Rel-18 IDC TDM solution in RAN2.
* Autonomous denial solution is supported in Rel-18 IDC, RAN2 will not introduce other solution on aperiodic use case (i.e. no report from UE on this aperiodic issue).

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**FDM**

* Adopt Option 1 based frequency range reporting to the network i.e Center frequency + bandwidth in KHz/MHz for the actual affected frequencies is reported by the UE to the network for addressing IDC problem in R18.
* Take the ASN.1 framework for option 1 as a starting point in the Text proposal section and work on the following enhancements
	+ 1. Add granular values for band width (including BW in KHz/Mhz) to cover all the scenarios involving Wi-Fi, GNSS, BT
	+ 2. Add the other IEs such as direction of interference.
	+ 3. Add combination of frequencies’ range for addressing IMD scenarios.
	+ 4. Check whether to reuse maxFreqIDC-r16, or define maxFreqIDC-r18
* In MR-DC scenarios, SN can also configure the UE for IDC reporting in SN, including both FDM and TDM solution.
* no additional co-ordination is needed for IDC configuration, apart from the existing mechanism between MN and SN (i.e. candidateServingFreqListNR in CG-Config for EN-DC).
* The gNB configures the candidate frequency ranges using (centre frequency + bandwidth) for which the UE should report IDC issues. Network may indicate the whole bandwidth of the freq.
* The frequency range (centre frequency + bandwidth) reported by the UE shall at least overlap with the frequency range (centre frequency + bandwidth) configured by the network.
* The centre frequency reported by the UE is within the frequency range (centre frequency + bandwidth indicated by network in the configuration) configured by the network.
* If the UE detects interference in both directions for one candidate frequency range indicated by the gNB, the UE can report two affected frequency ranges with the respective interference direction, as legacy. No extra specification change is required.
* LTE MN does not configure the UE with R18 NR IDC configuration.

**TDM**

* The NR values of long/short DRX cycle and start offset are used for periodic pattern. RAN2 will not introduce new DRX value for network configuration for IDC purpose.
* The slot offset with 1/32ms granularity is included in UEAssistanceInformation-v18xy-IEs for start offset.
* Multiple periodic patterns for IDC are not supported in R18.
* Per CG pattern is supported for MR-DC. SN can configure the UE to report the TDM assistance information directly to SN, either through SRB 1 (if SRB3 is not configured) or SRB 3.
* FFS whether any additional coordination is needed for network to resolve the problem when network receives the reporting from UE.
* Slot as time unit for autonomous denial
* Agree to send LS to RAN4, indicate the progress in RAN2
* For NR-DC, per CG idc-AssistanceConfigTDM-r18 is introduced to indicate whether TDM assistant information needs to be reported.
* For NR-DC, per CG idc-AssistanceConfigFDM-r18 is introduced to indicate whether FDM assistant information needs to be reported. FFS on dependency between FDM and TDM configuration.
* The values of drx-onDurationTimer in NR is used as the baseline for active Duration in UE assistant information. FFS on other values.
* The same values of validity period and number of denial slots as in LTE is reused. FFS on other values.
* The autonomous denial configuration is per CG.

**UE capabilities**

* Rel-18 IDC UE capability(ies) defined in NR side is/are per UE, not FDD-TDD DIFF, not FR1-FR2 DIFF.
* In NR side, 3 capability bit is introduced for FDM, periodic pattern and autonomous denial separately.
* The pre-requisite of autonomous denial is FDM solution (R16 or R18) or periodic pattern.