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

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

**Agenda item: 8.10.3**

**Source: vivo**

**Title: [Post120][651][IDC]Further details of TDM solution (vivo)**

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

# 1. Introduction

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

* [Post120][651][IDC] Further details of TDM solution (vivo)

Scope:

* Details of periodic pattern, e.g. values (applied use case), ASN.1
* Signalling details of TDM, e.g. how to configure, how to report..
* Details of autonomous denial (LTE as baseline, ASN.1 and procedure)

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

Deadline: Long

**Deadline for comments:** Long - Kick off: Jan 9th, Deadline for company inputs Jan, 20th.   Inactive Period January 23 to 27.  Comments on rapporteur summary Jan. 30th to February 3rd

## 1.1 Contacts

Contact person for each participating company:

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| --- | --- | --- |
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# 2. Discussion

The objective related to the IDC TDM solution is quoted as follows:

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

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

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| RAN2#119 meeting agreements:   * 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. |
| RAN2#120 meeting agreements:   * 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). * Not agreed: the aperiodic gap in the MUSIM-gap solution is supported in Rel-18 IDC. |

## 2.1 Periodic pattern

In RAN2#120 meeting, we have achieved below agreements regarding periodic pattern:

* Periodic pattern is supported; FFS on the values;
* 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.
* NR DRX values can be treated as a starting point for assistance information reported by UE. FFS, on exact values.

To reach a common understanding for periodic pattern parameters, i.e. cycle, start offset and active duration, firstly we would like to use ASN.1 to clarify the field description, then we further discuss the open issues of periodic pattern:

* FFS the exact values;
* FFS whether multiple patterns are supported.
* FFS on per CG pattern

The ASN.1 framework and field descriptions 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-v17xy-IEs OPTIONAL

}

UEAssistanceInformation-v17xy-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 {

tdm-AssistanceInfo-r18 TDM-AssistanceInfo-r18 OPTIONAL,

...

}

TDM-AssistanceInfo-r18 ::= CHOICE {

periodicPatternInfo-r11 SEQUENCE {

cycleLength-r18 ENUMERATED {FFS},

startOffset-r18 INTEGER (FFS) OPTIONAL,

activeDuration-r18 ENUMERATED {FFS}

},

...

}

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,

...

}

*<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. |
| ***activeDuration***  Indicates the desired active duration of periodic pattern that the NR is recommended to configure. FFS Value. |
| ***cycleLength***  Indicates the desired cycle length of periodic pattern that the NR is recommended to configure. FFS Value. |
| ***startOffset***  Indicates the desired starting offset of periodic pattern that the NR is recommended to configure. The UE shall set the value of startOffset smaller than the value of c*ycleLength*. |
| ***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 1: Do you agree that ASN.1 framework and field description for the periodic pattern reported by the UE?

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| **Company** | **Answers**  **(Yes/No)** | **Comments** |
| Xiaomi | Yes | We think that the ASN.1 framework provided by the rapporteur is a good starting point. The field type and the exact values can be discussed in the subsequent questions of the email discussion. |
| Qualcomm | As a start that can be extended | Agree that those fields are necessary for reporting and were already available in LTE. However, we should not preclude adding information that can be helpful to the NW such as the frequency information where the IDC problem happens.  Also, agree with Xiaomi that field type and values can be further worked out. |
| Nokia | Partially | On high level looks fine. See the comments for some details. Should R18 updates be done in ASN.1 as extensions (v18xy)? |
| Huawei, HiSilicon | Yes partially | We also think that the ASN.1 framework provided by the rapporteur is a good starting point.  However, in our understanding currently RAN 2 has only agreed to support the periodic pattern so the TDM-AssistanceInfo-r18 can be a SEQUENCE instead of CHOICE with the these parameters included in the sequence directly instead of including it in the periodicPatternInfo-r11.  Considering this we could have a structure something like  TDM-AssistanceInfo-r18 ::= SEQUENCE {  cycleLength-r18 ENUMERATED {FFS},  startOffset-r18 INTEGER (FFS) OPTIONAL,  activeDuration-r18 ENUMERATED {FFS}  ...  }  The values can also be discussed to finalize this solution. |
| Vodafone | Yes as the starting point | We also wonder why the CHOICE structure is used instead of SEQUENCE. Given that only the periodic patternis agreed, SEQUENCE structure is better suited. |
| Ericsson | Partially | OK starting point. May need alignment with a pointer to frequency information/location as used in the FDM solution. Agree w Huawei that we could signal the periodic pattern directly as base-line. |
| ZTE | Yes as the starting point | Similar view to the other companies, the Choice structure seems unnecessary (for that for the TDM, only periodic Gap and autonomous denial were agreed, for the autonomous denial, no specific UAI info needed) |
| Intel | Yes, partially | Agree with Huawei’s comment that CHOICE structure is not needed. |
| Sharp | Yes partially | And agree with Huawei’s comments on TDM-AssistanceInfo. |
| Samsung | As starting point | Agree to take the above as the starting point. However, it may be pre-mature to determine the ASN.1 since it is related to the discussion on whether multiple TDM patterns are needed or not. On the other hand, we may need discuss whether additional information,e.g., frequency related information, is needed or not.  Agree with Huawei’s comments that CHOICE structure is not needed |
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We would like to discuss the exact values of periodic pattern parameters. 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.

NR DRX values can be treated as a starting point for assistance information reported by UE. According to TS38.331, NR DRX long cycle values are as below, in the range of [10, 10240]ms.

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| -- ASN1START  -- TAG-DRX-CONFIG-START    DRX-Config ::= SEQUENCE {  *<Skipped>*  drx-LongCycleStartOffset CHOICE {  ms10 INTEGER(0..9),  ms20 INTEGER(0..19),  ms32 INTEGER(0..31),  ms40 INTEGER(0..39),  ms60 INTEGER(0..59),  ms64 INTEGER(0..63),  ms70 INTEGER(0..69),  ms80 INTEGER(0..79),  ms128 INTEGER(0..127),  ms160 INTEGER(0..159),  ms256 INTEGER(0..255),  ms320 INTEGER(0..319),  ms512 INTEGER(0..511),  ms640 INTEGER(0..639),  ms1024 INTEGER(0..1023),  ms1280 INTEGER(0..1279),  ms2048 INTEGER(0..2047),  ms2560 INTEGER(0..2559),  ms5120 INTEGER(0..5119),  ms10240 INTEGER(0..10239)  },  shortDRX SEQUENCE {  drx-ShortCycle ENUMERATED {  ms2, ms3, ms4, ms5, ms6, ms7, ms8, ms10, ms14, ms16, ms20, ms30, ms32,  ms35, ms40, ms64, ms80, ms128, ms160, ms256, ms320, ms512, ms640, spare9,  spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1 },  drx-ShortCycleTimer INTEGER (1..16)  } OPTIONAL, -- Need R  drx-SlotOffset INTEGER (0..31)  }    *<Skipped>*  }    -- TAG-DRX-CONFIG-STOP  -- ASN1STOP |

#### Question 2: What’s the values of cycle, start offset and active duration in the periodic pattern recommended by the UE?

Option 1:NR values

Option 2: other values. Please specify.

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| **Company** | **Answers**  **(Option 1/2)** | **Comments** |
| Xiaomi | Option 1 | Option 1 is aligned with the RAN2 agreement. It is probably better to clarify that the NR values of long DRX configuration is used, since the it is unclear how (and in which use case) the short DRX recommended by the UE can resolve the IDC issue. |
| Qualcomm | Option 2 | Disagree with Xiaomi that long DRX configurations only are needed. As mentioned in the rappoterur summary and previously agreed, BT eSCO should be supported which can need a gap <1ms over a ~4ms cycle so those numbers are not covered by the long cycle (to the extent that we will attempt to solve this problem using DRX). On the other hand tailoring values for use cases would be an overkill so we see no issue in including short+long cycle values.  We would also like to add the value “infinity” to enable a one-shot gap request. Due to lack of coordination and synchronization between NR and other RATs, the UE can resort to requesting one-shot gap when an important IDC event is anticipated. In these cases, having a periodic pattern is not useful. For example in a BT scenario, it is very hard for NR and BT to coexist in time periodically due to misalignment between cycles so it’s likely that the UE can apply some combination of autonomous denial and aperiodic request. |
| Nokia | Option 1 | NR values seems fine for the purpose of this WI. Anyway TDM is secondary priority of the WI and we cannot do perfect solution. But we are fine to discuss other values as well.  But we should stick to agreements and for now only consider periodic patterns. |
| Huawei, HiSilicon | Option 1 with comments | 1. We can consider NR Long DRX as the starting point and further study if the NR short DRX can be useful supporting other use cases and introduce the NR short DRX values later on. 2. For cycle and start offset we can use the NR values. For active duration the values can be FFS. |
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| Vodafone | Option 1 | NR values are sufficient and that follows the agreement. We should start from NR long DRX and short DRX could be introduced if justified. |
| Ericsson | Option 1 | NR DRX values natural starting point. Additions for e.g. BT eSCO can be evaluated based on additions from shortDRX and significance of this issue including how detailed and complex the TDM additions need to be.  One approach to address the QC scenario is that RAN2 does not specify explicit signalling for this, but the UE can first indicate that the UE needs a (periodic) gap, and after the gap the UE indicates again that the UE doesn’t need a gap. This would make the specification/solution simpler and RAN2 can consider this. |
| ZTE | Option 1 | We share the similar view as some other companies that NR DRX values can be taken as start point.  For the short DRX, we agree with Vodafone that it can be introduced if justified. |
| Intel | Option 2 | 1) DRX assistance information defined in LTE (*drx-AssistanceInfo-r11* in TS 36.331) is the baseline for the assistance information on periodic pattern. The reported assistance information is mainly related to the traffic characteristics of the coexistence use case, and is mostly RAT-independent. Therefore DRX assistance information based on LTE (as copied below) can be largely reused for NR. The LTE signalling values are selected based on coexistence scenarios (clause 4.2 of TR 36.816 [1]), and were agreed in email discussion “[79#33] [LTE/IDC] IDC Open issues” (R2-124404). Reusing NR DRX configuration as IDC assistance information is not suitable since extremely long DRX cycles (longer than 256 ms) is helpful for power saving but cannot satisfy the delay requirements of coexisting with other radios.  drx-AssistanceInfo-r11 SEQUENCE {  drx-CycleLength-r11 ENUMERATED {sf40, sf64, sf80, sf128, sf160, sf256, spare2, spare1},  drx-Offset-r11 INTEGER (0..255) OPTIONAL,  drx-ActiveTime-r11 ENUMERATED {sf20, sf30, sf40, sf60, sf80, sf100, spare2, spare1}  }  2) In addition, to support BT voice use case (eSCO), it is necessary to introduce cycle length of 3.75 ms, and suitable active duration (less than 3.75 ms). |
| Sharp | Option 1 | Agree NR long DRX values to be starting point and open to further discuss NR short DRX values. |
| Samsung | Option 1 | Agree to take NR long DRX values as the starting point |
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In NR *DRX-Config* IE, the slot offset with 1/32ms granularity is configured for DRX values. We may discuss whether such a slot offset with 1/32ms granularity is required for periodic pattern.

#### Question 3: Whether the slot offset with 1/32ms granularity for cycle, startOffset and active duration is required?

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| **Company** | **Answers**  **(Yes/No)** | **Comments** |
| Xiaomi | Yes  At least for start offset and active duration | For cycle, there is no 1/32ms granularity for DRX cycle in the current RRC specification. We are open to discuss extra granularity for DRX cycle, since some uses cases (e.g. BT eSCO) may have very short interval (e.g. less than 1ms) or non-integer interval (e.g. 3.75ms). According to the current RAN4 specification of 38.133, introducing finer DRX cycle does not impact the RM requirement, as only 160/320ms DRX cycle are used to differentiate the UE RM requirements. However, we should limit the configuration of finer values only for DRX, so as to control the workload in RAN4, as RAN4 does not have sufficient TU reserved to define the RM requirements for extra measurement gap values.  For start offset and active duration, we think that 1/32ms granularity should be reused as the current specification, and this can make the perodic pattern more accurate, as also indicated by the above use cases.. |
| Qualcomm | Yes | Agree with Xiaomi |
| Nokia | Maybe |  |
| Huawei, HiSilicon | Please see comments | We would like to clarify the intention of this question whether it is intend to discuss whether the finer 1/32ms granularity is introduced for cycle, startOffset and active duration?  If the above understanding is correct and if providing finer granularity for DRX cycle or active duration for some of the use cases with very short interval lesser than 1ms is the intention, then we are fine to introduce 1/32ms granularity atleast for start offset and active duration. |
| Vodafone |  | Not clear of the motivation. Is the question to enable finer granurality for DRX cycle, startOffset, and active duration; the granurality to be better than what is supported for NR DRX? |
| Ericsson | Maybe | DRX-xxCycle does not include this granularity currently and it is not clear if needed there. The use cases and interference patterns should be the same as for LTE. |
| ZTE | See comments | We agree with other companies that for the DRX cycle, there is no need to introduce 1/32 ms granularity.  For the active duration, our understanding is that the current DRX doesn’t support 1/32 ms granularity.  For the start offset, we think even for the eSCO with 0.675ms slot, there is still no strong motivation to introduce 1/32ms granularity, for that the current minimum duration is 1ms, which is longer than 0.675ms. |
| Intel | Yes | Agree with Xiaomi in general considering BT eSCO use case. If 1/32 ms granularity is seen too fine, coarser granularities like 1/16 ms or 1/8 ms can be also considered. |
| Sharp | comments | OK at least for start offset and active duration. |
| Samsung | Yes | OK to have 1/32ms granularity for flexibility |
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In RAN2#120, one open issue is whether multiple periodic patterns are supported, some companis clarified that multiple patterns are from MUSIM gaps. Please note that, if multiple periodic patterns are supported, the ASN.1 in Q1 will need an update.

#### Question 4: Whether multiple periodic patterns are supported? If yes, whether the assistance information enhancement is needed from UE reporting?

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| **Company** | **Answers**  **(Yes/No)** | **Comments** |
| Xiaomi | No strong view | We see some benefits of introducing multiple periodic patterns from UE reporting. Since it is possible that the UE could be using several RATs simultaneously (e.g. WiFi for data transmission, BT for ear pod and NR for phone call), the periodic traffic patterns in different RAT(s) could be different and could also cause different interferences (e.g. 2.4GHz/ 5GHz / 6GHz) in different NR bands, providing multiple periodic patterns can help resovling the IDC issues in more complicated cases. However the proponents are recommended to provide the details on how the multiple periodic patterns are reported (e.g. per-UE patterns or others). The maximum number (e.g. 4) of multiple periodic patterns should also be limited to reduce the complexity at the gNB and the UE.  After the reception of the assistance information, we consider that the gNB can reuse the Rel-17 muliple DRX configurations (i.e. up-to 2 DRX groups) and measurement gap configurations (e.g. up-to 4 (3 MUSIM periodic measurement gap and 1 legacy measurement gap)) . No extra standard effort is required. |
| Qualcomm | Yes | Since the most problematic bands (N40/N41) are the ones that see most interference from WiFi different channels (possibly with different configurations) and/or Bluetooth, it is very possible that a single UE can see multiple IDC patterns. In this case it is beneficial to the UE to report multiple DRX patterns. For this case, we can use 4 patterns as suggested by Xiaomi and following the MUSIM precedent, since many companies wanted to support MUSIM reporting. The UE can report up to 4 patterns in the same way it is suggested that one pattern is reported.  We would like to emphasize that the UE reporting an issue via requested “DRX” cycle does not mean th gNB has to solve the problem via DRX configuration only as this is not always possible since the UE supports a single DRX configuration per-cell group. On the contrary, the gNB can use these reports for information and utilize any implementation tool at it’s disposal to solve the problem, e.g., avoid scheduling the UE at the problematic slots, balance several IDC issues in one DRX configuration, choose to ignore some IDC issues while solving the most severe ones, or enabling autonomous denials; thus we think there is no extra standard work required beyond UAI signalling details and no modifications in DRX operations are needed.  If deployment complexity is an issue then we can stick to reporting one pattern with multiple patterns support configurable by the NW. |
| Nokia | Maybe | it seems possible that there are multiple different sources of interference in the UE having different periodicities, thus we would be fine to consider adding multiple patterns. This would allow more information to be given to NW which can choose appropriate solution e.g. DRX/MUSIM gaps whatever solution could work. But as the whole TDM solution is second priority in the WI we should not focus on this now but finalize the details of single patterns first. |
| Huawei, HiSilicon | No | We think generally only one periodic gap/pattern will be enough for resolving the IDC problem.  In LTE we only defined one periodic pattern for the UE to be used to resolve the IDC issue and we don’t see any difference for NR.  Even if we need to consider multiple RATs, one combined periodic pattern can be used to cover multiple RATs . |
| Vodafone | No | We share similar view as Huawei that one periodic gp/pattern would e sufficient for resolving IDC issue similar to what used in LTE. |
| Ericsson | No | Given the priority for an TDM solution a single pattern would reduce complexity and would be able to cover most scenarious. Again, the use cases and interference patterns should be the same as for LTE. |
| ZTE | See comments | We think it also depends on the answer to the next question, whether the per-CG gap pattern needed. |
| Intel | No | We share the similar view as Huawei. |
| Sharp | Comments | If it means per-CG pattern it is related to Q5, else it is not needed. |
| Samsung | Comments | In LTE case, we can notice that TDM assistant information can be selected between one DRX pattern and multiple subframe patterns. In NR, we go for periodic pattern only. So, for this question, we may need justify if the single DRX pattern can realize the effect achieved by multiple subframe patterns. |
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One open issue is whether per CG pattern is supported. In the rapporteur’s understanding, this is regarding the IDC handling for MR-DC, including how to configure IDC for MCG and SCG, How to report the recommended periodic pattern for MCG and SCG.

#### Question 5: Whether per CG pattern is supported? If yes, whether and whats the enhancemens are needed from UE side and network side?

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| **Company** | **Answers**  **(Yes/No)** | **Comments** |
| Xiaomi | Yes | This is required for EN-DC, since the NR periodic pattern reported to the eNB of LTE MCG is supposed to be used by the gNB of the NR SCG. It is probably more accurate to say that the periodic pattern reported is for NR affected frequencies.  For the NR-DC, this per-CG pattern is not essential as the periodic pattern is reported together with the affected frequency list. The UE is not able to know whether a non-serving NR frequency reported in the affected frequency list will be configured for MCG or SCG. |
| Qualcomm | Yes | For MR-DC deployments, SN can configure and receive reporting via SRB3 without much MN involvement. This issue is especially important in EN-DC where the IDC problem is reported and solved fully within the NR SN. Since we did agreed not to do any LTE enhancements, it makes sense to enable SN reporting within NR.  Modifications would be to allow configuration and reporting to happen in SN with the details identical to MN, and allow this signalling to happen over SRB3 when available. |
| Nokia | Maybe | As we have agreed not to impact LTE It seems quite difficult to realize this. And having intra-NR CG reporting does not seem useful? So maybe we need to enable then SN handling of IDC reporting e.g. something what Qualcomm above mentions. Or of course we could just omit from the WI this aspect as well. TDM is anyway secondary priority of the WI. |
| Huawei, HiSilicon | Yes | We think that per CG pattern could be used when either MN or SN needs to configure DRX to the UE to resolve the IDC issue.  For example when the UE is configured with EN-DC and there is no IDC problem between the UE and the MN frequencies, but there could be IDC problem between the UE and the SN frequencies then in this case the UE can report per CG pattern to be used between UE and SN to resolve the IDC issue.  In terms of enhancements , in case per CG pattern is supported, the SN should be able to configure the UE to report the TDM pattern to directly to SN, either through SRB 1 or SRB 3, and then the SN can configure appropriate DRX based on it to resolve the IDC problem. |
| Vodafone | yes | Use of per CG periodic pattern could be beneficial of handling IDC issues in EN-DC scenario. |
| Ericsson | Maybe | If the UE can indicate IDC issues to MN and SN independently: for the scenario where only SCG cells are impacted by IDC issues, the UE would indicate a TDM indication only to the SN.  Unclear to us what additional enhancements are suggested (if any?). |
| ZTE | Similar view to Xiaomi | We think for the EN-DC, the periodic Gap pattern can be introduced for the NR-frequencies, for the NR-DC, the UE even can’t distinguish the candidate frequencies of the SCG from that of the MCG, so seems unessential to introduce per-CG gap |
| Intel | Maybe | This is related to SN/MN cooridination, which is partially overlapping with the issue in email discussion “[Post120][652][IDC] Further details of FDM solution (Huawei)”, with the relevant scope copied below. It is preferable to resolve the issue in the same email discussion.  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);  If UE can indicate IDC issue independently to MN and SN, our understanding is that additional signalling enhancement is not needed as anyway SN and MN can infer which node has IDC issue based on reported FDM information. |
| Sharp | Yes | At least for EN-DC case. NR-DC case can be further discussed. |
| Samsung | Yes | In DC case, the IDC problem may exist in one leg only. Even for IDC problem in two legs, TDM pattern may be different between two legs. Thus, per-CG TDM assistant information is a useful tool to resolve IDC problem in DC case. |
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Regarding the signaling procedure, there are two open issues:

* How to configure the UE to report the TDM assistance information;

In LTE IDC solution, the UE is allowed to provide Time Domain Multiplexing (TDM) based assistance information when it is configured to provide IDC indications and upon change of IDC problem information, i.e. the UE may be configured to provide IDC assistance information, no matter for FDM or TDM.

* How does the UE provide the TDM assistance information.

In LTE IDC solution, when detecting the IDC issue, the UE provides the TDM assistance information for the affected frequencies.

Taking LTE solution as baseline, we have the text proposal for TS38.331 as below:

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| 5.3.5 RRC reconfiguration5.3.5.9 Other configuration The UE shall:  1> if the received *otherConfig* includes the *idc-AssistanceConfig*:  2> if *idc-AssistanceConfig* is set to *setup*:  3> consider itself to be configured to provide IDC assistance information in accordance with 5.7.4;  2> else:  3> consider itself not to be configured to provide IDC assistance information; 5.7.4 UE Assistance Information5.7.4.2 Initiation *<skipped>*  A UE capable of providing IDC assistance information in RRC\_CONNECTED may initiate the procedure if it was configured to do so, upon detecting IDC problem if the UE did not transmit an IDC assistance information since it was configured to provide IDC indications, or upon change of IDC problem information.  *<skipped>*  Upon initiating the procedure, the UE shall:  1> if configured to provide IDC assistance information:  2> if the UE did not transmit a *UEAssistanceInformation* message with *idc-Assistance* since it was configured to provide IDC assistance information:  3> if on one or more frequencies included in *candidateServingFreqListNR*, the UE is experiencing IDC problems that it cannot solve by itself; or  3> if on one or more supported UL CA combination comprising of carrier frequencies included in *candidateServingFreqListNR*, the UE is experiencing IDC problems that it cannot solve by itself:  4> initiate transmission of the *UEAssistanceInformation* message in accordance with 5.7.4.3 to provide IDC assistance information;  2> else if the current IDC assistance information is different from the one indicated in the last transmission of the *UEAssistanceInformation* message:  3> initiate transmission of the *UEAssistanceInformation* message in accordance with 5.7.4.3 to provide IDC assistance information;  NOTE 1: The term "IDC problems" refers to interference issues applicable across several subframes/slots where not necessarily all the subframes/slots are affected.  NOTE 2: For the frequencies on which a serving cell or serving cells is configured that is activated, IDC problems consist of interference issues that the UE cannot solve by itself, during either active data exchange or upcoming data activity which is expected in up to a few hundred milliseconds. For frequencies on which a SCell or SCells is configured that is deactivated, reporting IDC problems indicates an anticipation that the activation of the SCell or SCells would result in interference issues that the UE would not be able to solve by itself. For a non-serving frequency, reporting IDC problems indicates an anticipation that if the non-serving frequency or frequencies became a serving frequency or serving frequencies then this would result in interference issues that the UE would not be able to solve by itself. 5.7.4.3 Actions related to transmission of *UEAssistanceInformation* message The UE shall set the contents of the *UEAssistanceInformation* message as follows:  *<skipped>*  1> if transmission of the *UEAssistanceInformation* message is initiated to provide IDC assistance information according to 5.7.4.2 or 5.3.5.3:  2> if there is at least one carrier frequency included in *candidateServingFreqListNR*, the UE is experiencing IDC problems that it cannot solve by itself:  3> include the field *affectedCarrierFreqList* with an entry for each affected carrier frequency included in *candidateServingFreqListNR*;  3> for each carrier frequency included in the field *affectedCarrierFreqList*, include *interferenceDirection* and set it accordingly;  3> include Time Domain Multiplexing (TDM) based assistance information, unless the UE has no Time Doman Multiplexing based assistance information that could be used to resolve the IDC problems:  4> if the UE has periodic pattern related assistance information that could be used to resolve the IDC problems,  5> include *cycleLength*, *startOffset* and *activeDuration*;  4> use the MCG as timing reference if TDM based assistance information regarding the SCG is included(FFS);  2> if there is at least one supported UL CA combination comprising of carrier frequencies included in *candidateServingFreqListNR*, the UE is experiencing IDC problems that it cannot solve by itself:  3> include *victimSystemType* for each UL CA combination included in *affectedCarrierFreqCombList*;  3> if the UE sets *victimSystemType* to *wlan* or *bluetooth*:  4> include *affectedCarrierFreqCombList* with an entry for each supported UL CA combination comprising of carrier frequencies included in *candidateServingFreqListNR*, that is affected by IDC problems;  3> else:  4> optionally include *affectedCarrierFreqCombList* with an entry for each supported UL CA combination comprising of carrier frequencies included in *candidateServingFreqListNR*, that is affected by IDC problems;  NOTE 1: When sending an *UEAssistanceInformation* message to inform the IDC problems, the UE includes all IDC assistance information (rather than providing e.g. the changed part(s) of the IDC assistance information).  NOTE 2: Upon not anymore experiencing a particular IDC problem that the UE previously reported, the UE provides an IDC indication with the modified contents of the *UEAssistanceInformation* message (e.g. by not including the IDC assistance information in the *idc-Assistance* field). |

#### Question 6: Do you agree the above signaling procedure of TDM?

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| **Company** | **Answers**  **(Yes/No)** | **Comments** |
| Xiaomi | Partially yes | We think the procedural texts provided by the rapporteur can be a baseline for NR 38.331.  We think that the EN-DC case may require some modification in the LTE specification, so that the UE can also provide the NR periodic pattern of the NR affected frequencies via the LTE MCG. |
| Qualcomm | Postpone | Text can be worked out afte most details are agreed. We see no concerns with rappoteurs suggestion as a starting point, but prefer concluding most critical issue before we assess procedural text. |
| Nokia | Yes | This is starting point for further discussions |
| Huawei, HiSilicon | Postpone | We think that the procedural texts provided by the rapporteur can be a staring point for 38.331 However there are many open point that needs to be addressed before we finalize the signalling procedural text |
| Ericsson | Postpone | Agree with others in that the procedure is straightforward to design when the signalling elements are in place, no need to jump ahead. |
| ZTE | Postpone | Similar view as others |
| Intel | Postpone | Although this can be the starting point for further discussion, we’re fine to postpone the discussion once we agree on critical aspects. |
| Sharp | Postpone | Similar view as others. |
| Samsung | Postpone | Similar view as others. |
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## 2.2 Autonomous denial

According to TS36.331, the LTE autonomous denial solution is quoted as follows:

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| **Procedure:** 5.3.10.9 Other configuration The UE shall:  1> if the received *otherConfig* includes the *idc-Config*:  2> if *idc-Indication* is included (i.e. set to *setup*):  3> consider itself to be configured to provide IDC indications in accordance with 5.6.9;  3> if *idc-Indication-UL-CA* is included (i.e. set to *setup*):  4> consider itself to be configured to indicate UL CA related information in IDC indications in accordance with 5.6.9;  3> if *idc-HardwareSharingIndication* is included (i.e. set to setup):  4> consider itself to be configured to indicate IDC hardware sharing problem indications in IDC indications in accordance with 5.6.9;  3> if *idc-Indication-MRDC* is included (i.e. set to *setup*):  4> consider itself to be configured to provide IDC indications for MR-DC in accordance with 5.6.9;  2> else:  3> consider itself not to be configured to provide IDC indications;  2> if *autonomousDenialParameters* is included:  3> consider itself to be allowed to deny any transmission in a particular UL subframe if during the number of subframes indicated by *autonomousDenialValidity*, preceeding and including this particular subframe, it autonomously denied fewer UL subframes than indicated by *autonomousDenialSubframes*;  2> else:  3> consider itself not to be allowed to deny any UL transmission; |
| **ASN.1:**  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  ]]  } |

Firstly, we discuss the time unit for NR autonomous denial. In LTE solution, the time unit is one subframe. The UE may autonomously deny fewer UL subframes than indicated by autonomousDenialSubframes. For NR, The UE may autonomously deny fewer UL slots.

Based on the time unit, we need futher confirm the values for Validity period and number of time units.

#### Question 7: What’s the values of Validity period and number of Subframes?

**Option 1:** Subframe as time unit, reuse the values of LTE solution.

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| autonomousDenialParameters-r18 SEQUENCE {  autonomousDenialSubframes-r18 ENUMERATED {n2, n5, n10, n15,  n20, n30, spare2, spare1},  autonomousDenialValidity-r18 ENUMERATED {  sf200, sf500, sf1000, sf2000,  spare4, spare3, spare2, spare1}  } OPTIONAL, -- Need R |

**Option 2:** Slot as time unit. Please specify the values.

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| **Company** | **Answers**  **(Option 1/2)** | **Comments** |
| Xiaomi | No strong view | We think both Option 1 and Option 2 can work. Option 2 is more adaptive to the NR framework, since slot is the transmission unit in NR.  If we choose Option 1, some clarifications are needed on how many transmissions can be dropped within a NR subframe.  If we choose Option 2, new values and parameters need to be defined.  From our understanding, Option 1 is slightly simpler considering the specification change. |
| Qualcomm | Option 2 | We think slot as time unit would be simpler. The NW and UE can count any subslot dropping as a slot. We think subframe would be more complicated since NR does not utilize the subframe concept as much as LTE.  More importantly, due to the flexible numerology of NR, it would be clearer to operate with slot time units since a dropped subframe can involve a different number of slots depending on numerology. We think the rest of LTE framework can be adopted while working on the appropriate values. |
| Nokia | Not clear | To us option1 seems simpler as subframe is fixed to 1ms regardless of numerology in NR, isn’t it? Then we don’t need to consider in RAN2 signaling numerology impacts – especially as those can even change. |
| Huawei, HiSilicon | Option 2 | Option 2 is preferable to us. Same values as in LTE can be reused for option 2. |
| Vodafone |  | No strong view on option 1 or option 2. |
| Ericsson | Option 1 | Subframes have different no. slots in NR but would be numerology independent, and hence is simpler. As the use cases and interference patterns should be the same as for LTE and considering a simple solution from a NW point of view, Option 1 would be preferred using a fixed subframe indication based on the LTE base line. |
| ZTE | Option 1 | Option 1 seems quite simpler |
| Intel | Option 1 | Option 1 is simpler. |
| Sharp | Option 1 | Slightly prefer Option 1 since it is simpler. |
| Samsung | Option 2 | Slot is preferable to us in that this can provide enough flexibility towards the denial.  In addition, on top of option 2, we may need discuss whether autonomous denial should be frequency range-specific or not, whether autonomous denial should be per-CG or not. |
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By using the LTE autonomous denial solution as the baseline, the text proposal for the autonomous denial solution for NR is as follows.

Please note that the time unit uses subframe temporarily. the time unit and values could be further updated according to Q7.

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| 5.3.5 RRC reconfiguration5.3.5.9 Other configuration The UE shall:  1> if the received *otherConfig* includes the *idc-AssistanceConfig*:  2> if *idc-AssistanceConfig* is set to *setup*:  3> consider itself to be configured to provide IDC assistance information in accordance with 5.7.4;  2> else:  3> consider itself not to be configured to provide IDC assistance information;  2> if *autonomousDenialParameters* is included:  3> consider itself to be allowed to deny any transmission in a particular subframe if during the number of subframes indicated by *autonomousDenialValidity*, preceeding and including this particular subframe, it autonomously denied fewer subframes than indicated by *autonomousDenialSubframes*; |
| **ASN.1:**  IDC-AssistanceConfig-r16 ::= SEQUENCE {  candidateServingFreqListNR-r16 CandidateServingFreqListNR-r16 OPTIONAL, -- Need R  ...  [[autonomousDenialParameters-r18 SEQUENCE {  autonomousDenialSubframes-r18 ENUMERATED {FFS},  autonomousDenialValidity-r18 ENUMERATED {FFS}  } OPTIONAL -- Need R  ]],  } |

#### Question 8: Do you agree the ASN.1 and signalling procedure of autonomous denial?

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| **Company** | **Answers**  **(Yes/No)** | **Comments** |
| Xiaomi | Partially yes | We think that the the ASN.1 and signalling procedure of autonomous denial provided by the rapporteur can be considered as the baseline.  As also indicated in our answer for Question 7, either subframe-granularity or the slot-granularity may require some clarifications in the procedural text.  If we choose Option 1, some clarifications are needed on how many transmissions can be dropped within a NR subframe.  If we choose Option 2, new values and parameters need to be defined. |
| Qualcomm | No | This can be worked out after agreeing in Q7, but following the LTE mechanism by including some variation of the proposed two fields should be agreeable. |
| Nokia | Yes | Basic principle seems ok and we don’t think Q7 really impacts this. Why would it? |
| Huawei, HiSilicon | Yes | We think that the ASN.1 and procedure text for autonomous denial provided by the rapporteur can be considered as the baseline.  If RAN 2 finally agree to go with option 2 in Q7, then we need to change the subframe to slot in ASN.1 and accordingly change the signalling procedure part. |
| Vodafone | yes | Proposal seems ok |
| Ericsson | Yes | Based on Q7, the base line above seems straightforward. Otherwise slots per subframe may need to be taken into account (numerology etc)  ASN.1 corrections:  IDC-AssistanceConfig-r16 ::= SEQUENCE {  candidateServingFreqListNR-r16 CandidateServingFreqListNR-r16 OPTIONAL, -- Need R  ...,  [[autonomousDenialParameters-r18 SEQUENCE {  autonomousDenialSubframes-r18 ENUMERATED {FFS},  autonomousDenialValidity-r18 ENUMERATED {FFS}  } OPTIONAL -- Need R  ]]~~,~~  } |
| ZTE | Yes | Can be taken as the baseline |
| Intel | Yes | This can be taken as the baseline. |
| Sharp | Yes | Can be considered as the baseline. |
| Samsung | Depending on Q7 |  |
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## 2.3 RAN4 Impact

Autonomous denial solution needs new RAN4 performance requirements. From the rapporteur’s understanding, A LS to RAN4 could be needed, to inform RAN4 the agreements of TDM solution, such as the values of autonomous denial parameters.

#### Question 9: Whether an LS to RAN4 is needed?

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| **Company** | **Answers**  **(Yes/No)** | **Comments** |
| Xiaomi | Yes | As indicated in the WID and workplan, we need to inform RAN4 at least of the autonomous denial parameters.  Furthermore, we consider that we could also inform RAN4 that the finer values (if agreed) for the periodic pattern is used for the DRX configuration, and no extra measurement gap configuration is required. |
| Qualcomm | Yes | Agree with Xiaomi |
| Nokia | No | I’m confident RAN4 can find RAN2 agreements. But if there is something that is not clear from RAN2 then we can have explanatory LS to RAN4 but no need to send LS about agreements. |
| Huawei, HiSilicon | Yes | Agree with Xiaomi. |
| Vodafone | Yes |  |
| Ericsson |  | Not sure this needs an email discussion agreement, but RAN4 should be informed in one way or another and discuss and decide on performance req. |
| ZTE | Yes | Agree with Xiaomi |
| Intel | Yes | Agree with Xiaomi. |
| Sharp | Yes |  |
| Samsung | Yes |  |
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# 3. Conclusion

After collecting companies’ feedbacks, the discussion on the IDC TDM solutions is summarized as follows:

TBD

# 4. Text proposal

To be updated according to conclusion.

# 4. Reference

[1] R2-2211978 Summary of [Post119-e][651][IDC] Comparison of TDM solutions (Xiaomi) Xiaomi discussion Rel-18 NR\_IDC\_enh-Core