**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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| Company | Name | Email Address |
| Vivo | Xiaodong Yang | Yangxiaodong5g@vivo.com |
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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** |
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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** |
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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** |
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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** |
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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** |
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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 configurationThe 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; or3> 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* messageThe 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** |
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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 configurationThe 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** |
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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 configurationThe 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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## 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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# 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