**3GPP TSG-RAN WG2 Meeting #120 R2-220xxxx**

**Toulouse, France, 14 – 18 November, 2022**

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

**Source: Xiaomi**

**Title: (Draft) - Summary of [Post119-e][651][IDC] Comparison of TDM solutions (Xiaomi)**

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

# 1. Introduction

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

* [Post119-e][651][IDC] Comparison of TDM solutions (Xiaomi)

      Scope: Analyse the details of following TDM candidate solutions, and compare solutions , e.g. applied scenarios (e.g. BT voice, BT eSCO and WLAN beacon), complexity, etc;

* DRX solution;
* MUSIM gap like solution;
* UL and/or DL transmission occasion(s);
* Autonomous denial solution;

Intended outcome: Report to RAN2#120

Deadline:  Nov 3rd (Rapporteur may introduce intermediate deadlines, but no deadline during an inactive period, and no deadline in the period from Submisssion deadline to EOM of R2-119bis).

The guidance provided by the Chair is quoted below:

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| Extra Long email discussions after R2-119-e, for R2-120, Deadline: Nov 3rd Outcome tdocs for long email discussions shall be submitted to RAN2 120-e (Nov meeting). Please request tdoc numbers as for any other input tdoc to next meeting, i.e. by 3GU. NOTE that these discussions shall consider the duration of R2 119bis-e to be an inactive period (in addition to the general 3GPP inactive periods).  |

To facilitate the discussion as indicated above, the rapporteur would like to split the discussion into the following two phases. The intention is to understand how the candidate solution would work before comparing the solution with other candidates.

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| **Phase-1 discussion:**Scope: Analyse the details of the following TDM candidate solutions:* DRX solution;
* MUSIM gap like solution;
* UL and/or DL transmission occasion(s);
* Autonomous denial solution;

Intended outcome: The solution details (e.g. specification impacts) from the Phase-1 discussion are to be provided based on the companies’ feedbacks. The solution details provided via Phase-1 discussion will be used as the baseline for further polishment if the solution is adopted in the Rel-18 IDC.Deadline for the Phase-1 discussion: Sept 23rd 00:30 AM UTC. |
| **Phase-2 discussion:**The phase-2 discussion will be kicked off once the solutions details (e.g. specification impacts) provided from the Phase-1 discussion are relatively stable.Scope: Based on the solution details provided by the Phase-1 discussion, compare solutions, e.g. applied scenarios (e.g. BT voice, BT eSCO and WLAN beacon), complexity, etc. Selection of TDM solutions to be specified in Rel-18.Deadline for the Phase-2 discussion: Nov 3rd 00:30 AM UTC. |

## 1.1 Contacts

Contact person for each participating company:

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| Company | Name | Email Address |
| Xiaomi | Yumin Wu | wuyumin@xiaomi.com |
| Ericsson | Henrik Enbuske | henrik.enbuske@ericsson.com |
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# 2. Phase-1 discussion

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| **Phase-1 discussion:**Scope: Analyse the details of the following TDM candidate solutions:* DRX solution;
* MUSIM gap like solution;
* UL and/or DL transmission occasion(s);
* Autonomous denial solution;

Intended outcome: The solution details (e.g. specification impacts) from the Phase-1 discussion are to be provided based on the companies’ feedbacks. The solution details provided via Phase-1 discussion will be used as the baseline for further polishment if the solution is adopted in the Rel-18 IDC.Deadline for the Phase-1 discussion: Sept 23rd 00:30 AM UTC. |

## 2.1 DRX solution

The LTE DRX solution is quoted as follows:

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| **Procedure:**Step 1: The eNB indicates whether the IDC reporting for TDM assistance information is allowed.Step 2: When detecting the IDC issue, the UE reports the DRX assistance information for the affected frequencies. The TDM assistance information uses the MCG as timing reference. The DRX assistance information includes: *drx-CycleLength*, *drx-Offset* and *drx-ActiveTime* in the granularity of subframe.  |
| **ASN.1 signaling:**Step 1: Network configurationidc-Indication-r11 ENUMERATED {setup} OPTIONAL, -- Need ORStep 2: UE reporting signalingdrx-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} }, |

The candidate DRX solution for NR is as follows:

**Option 1: (By using the LTE DRX solution as the baseline)**

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| **Procedure:**Step 1: The gNB indicates whether the IDC reporting for TDM assistance information is allowed.Step 2: When detecting the IDC issue, the UE reports the DRX assistance information for the affected frequencies. The TDM assistance information uses the MCG as timing reference. The DRX assistance information includes: *drx-LongCycleStartOffset* including *drx-LongCycle* and *drx-StartOffset* in the granularity of ms, *drx-SlotOffset* in the granularity of 1/32 ms (subMilliSeconds), and *drx-ActiveTime* in the granularity of ms or 1/32 ms (subMilliSeconds).  |
| **ASN.1 signaling example:**Step 1: Network configurationidc-TDM-Indication-r18 ENUMERATED {setup} OPTIONAL, -- Need RStep 2: UE reporting signalingDRX-AssistanceInfo-r18 ::= SEQUENCE { 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) },drx-SlotOffset INTEGER (0..31),drx-ActiveTime-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 } }} |

#### Task 1: Please provide your suggested modification for above Option 1 or other options for the DRX solution for NR.

(Rapporteur’s comment: Please provide the changes for the above option or other options in the “Comments” column. The ASN.1 signaling example provided above is to be polished further while drafting the CR. Companies can provide FFS for specific technical points. However the increasing number of FFS(s) could also cause the dropping of the solution due to the very limted TU for the Rel-18 IDC work.)

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| **Company** | **Comments** |
| ZTE | Generally agree, but we don’t think the slot offset with 1/32ms granularity is necessary.  |
| Ericsson | It seems that the rapporteur has simply copied from the IE DRX-Config, and removed field which the UE shall not have an opinion about. This looks like a decent starting-point. |
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## 2.2 MUSIM gap like solution

The Rel-17 MUSIM gap solution is quoted as follows:

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| **Procedure:**Step 1: The gNB indicates whether the MUSIM reporting for gap assistance information is allowed. And a prohibit timer is provided for gap assistance information .Step 2: When detecting the need for gap for MUSIM, the UE reports its preferred gap configuration when the prohibit timer is not running. If the UE prefers periodic gap, the preferred gap configuration includes *musim-GapPreferenceList* with an entry for each periodic gap. Each peridodic gap configuration includes *musim-GapLength* and *musim-GapRepetitionAndOffset* including the gap repetition period and the gap offset in the granularity of ms.If the UE prefers aperiodic gap, the preferred gap configuration includes *musim-GapPreferenceList* with an entry for each aperiodic gap. Each aperidodic gap configuration includes *musim-GapLength* in the granularity of ms and *musim-Starting-SFN-AndSubframe* including *starting-SFN* in the granularity of SFN and *startingSubframe* in the granularity of subframe. |
| **ASN.1 signaling:**Step 1: Network configurationMUSIM-GapAssistanceConfig-r17 ::= SEQUENCE { musim-GapProhibitTimer-r17 ENUMERATED {s0, s0dot1, s0dot2, s0dot3, s0dot4, s0dot5, s1, s2, s3, s4, s5, s6, s7, s8, s9, s10}}Step 2: UE reporting signalingMUSIM-GapPreferenceList-r17 ::= SEQUENCE (SIZE (1..4)) OF MUSIM-GapInfo-r17MUSIM-GapInfo-r17 ::= SEQUENCE { musim-Starting-SFN-AndSubframe-r17 MUSIM-Starting-SFN-AndSubframe-r17 OPTIONAL, -- Cond aperiodic musim-GapLength-r17 ENUMERATED {ms3, ms4, ms6, ms10, ms20} OPTIONAL, -- Need S musim-GapRepetitionAndOffset-r17 CHOICE { ms20-r17 INTEGER (0..19), ms40-r17 INTEGER (0..39), ms80-r17 INTEGER (0..79), ms160-r17 INTEGER (0..159), ms320-r17 INTEGER (0..319), ms640-r17 INTEGER (0..639), ms1280-r17 INTEGER (0..1279), ms2560-r17 INTEGER (0..2559), ms5120-r17 INTEGER (0..5119), ... } OPTIONAL -- Cond periodic}MUSIM-Starting-SFN-AndSubframe-r17 ::= SEQUENCE { starting-SFN-r17 INTEGER (0..1023), startingSubframe-r17 INTEGER (0..9)} |

The candidate MUSIM gap like solution for NR is as follows:

**Option 1: (By using the Rel-17 MUSIM gap solution as the baseline)**

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| **Procedure:**Step 1: The gNB indicates whether the IDC reporting for gap assistance information is allowed. And a prohibit timer is provided for gap assistance information.Step 2: When detecting the IDC issue, the UE reports its preferred gap configuration for the affected frequencies when the prohibit timer is not running. The TDM assistance information uses the MCG as timing reference.If the UE prefers periodic gap, the preferred gap configuration includes *idc-GapPreferenceList* with an entry for each periodic gap. Each peridodic gap configuration includes *idc-GapLength* and *idc-GapRepetitionAndOffset* including the gap repetition period and the gap offset in the granularity of ms.If the UE prefers aperiodic gap, the preferred gap configuration includes *idc-GapPreferenceList* with an entry for each aperiodic gap. Each aperidodic gap configuration includes *idc-GapLength* in the granularity of ms and *idc-Starting-SFN-AndSubframe* including *starting-SFN* in the granularity of SFN and *startingSubframe* in the granularity of subframe. |
| **ASN.1 signaling example:**Step 1:IDC-GapAssistanceConfig-r17 ::= SEQUENCE { musim-GapProhibitTimer-r17 ENUMERATED {s0, s0dot1, s0dot2, s0dot3, s0dot4, s0dot5, s1, s2, s3, s4, s5, s6, s7, s8, s9, s10}}Step 2: UE reporting signalingIDC-GapPreferenceList-r17 ::= SEQUENCE (SIZE (1..4)) OF IDC-GapInfo-r17IDC-GapInfo-r17 ::= SEQUENCE { idc-Starting-SFN-AndSubframe-r17 IDC-Starting-SFN-AndSubframe-r17 OPTIONAL, -- Cond aperiodic idc-GapLength-r17 ENUMERATED {ms3, ms4, ms6, ms10, ms20} OPTIONAL, -- Need S idc-GapRepetitionAndOffset-r17 CHOICE { ms20-r17 INTEGER (0..19), ms40-r17 INTEGER (0..39), ms80-r17 INTEGER (0..79), ms160-r17 INTEGER (0..159), ms320-r17 INTEGER (0..319), ms640-r17 INTEGER (0..639), ms1280-r17 INTEGER (0..1279), ms2560-r17 INTEGER (0..2559), ms5120-r17 INTEGER (0..5119), ... } OPTIONAL -- Cond periodic}IDC-Starting-SFN-AndSubframe-r17 ::= SEQUENCE { starting-SFN-r17 INTEGER (0..1023), startingSubframe-r17 INTEGER (0..9)} |

#### Task 2: Please provide your suggested modification for above Option 1 or other options for the MUSIM gap like solution for IDC.

(Rapporteur’s comment: Please provide the changes for the above option or other options in the “Comments” column. The ASN.1 signaling example provided above is to be polished further while drafting the CR. Companies can provide FFS for specific technical points. However the increasing number of FFS(s) could also cause the dropping of the solution due to the very limted TU for the Rel-18 IDC work.)

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| **Company** | **Comments** |
| ZTE | Generally OK with the ASN.1 structure in the Step 2, as Rapporteur said, the detail values can be further polished.For the step 1, it’s about whether a prohibit timer is needed for the IDC reporting, we think it can be discussed as a separate topic. |
| Ericsson | Unclear if any change is needed since this solution needs more stage-2 type of discussion. The MUSIM-gap solution requires additional discussion to evaluate required gap-lenghts and periodicities as they have now been defined for another use case, including RAN4 work.It is also unclear to us if/how the gap prohibit timer should be applied. More study/discussion would be needed if the gap-solution should be adopted.But more importantly, we are not sure whether this solution adds anything benefit beyond DRX. Is it not just yet another time-pattern? |
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## 2.3 UL and/or DL transmission occasion(s)

The LTE HARQ reservation solution is quoted as follows:

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| **Procedure:**Step 1: The eNB indicates whether the IDC reporting for TDM assistance information is allowed.Step 2: When detecting the IDC issue, the UE reports the desired subframe reservation patterns for the affected frequencies. The TDM assistance information uses the MCG as timing reference. The desired subframe reservation patterns is included in *idc-SubframePatternList*. A bitmap with value 0 indicates that E-UTRAN is requested to abstain from using the subframe.For FDD, the radio frame in which the pattern starts (i.e. the radio frame in which the first/leftmost bit of the *subframePatternFDD* corresponds to subframe #0) occurs when SFN mod 2 = 0.For TDD, the first/leftmost bit corresponds to the subframe #0 of the radio frame satisfying SFN mod x = 0, where x is the size of the bit string divided by 10. |
| **ASN.1 signaling:**Step 1: Network configurationidc-Indication-r11 ENUMERATED {setup} OPTIONAL, -- Need ORStep 2: UE reporting signalingIDC-SubframePatternList-r11 ::= SEQUENCE (SIZE (1..maxSubframePatternIDC-r11)) OF IDC-SubframePattern-r11IDC-SubframePattern-r11 ::= CHOICE { subframePatternFDD-r11 BIT STRING (SIZE (4)), subframePatternTDD-r11 CHOICE { subframeConfig0-r11 BIT STRING (SIZE (70)), subframeConfig1-5-r11 BIT STRING (SIZE (10)), subframeConfig6-r11 BIT STRING (SIZE (60)) }, ...} |

The candidate UL and/or DL transmission occasion solution for NR is as follows:

**Option 1: (By using the LTE HARQ reservation solution as the baseline)**

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| **Procedure:**Step 1: The gNB indicates whether the IDC reporting for TDM assistance information is allowed.Step 2: When detecting the IDC issue, the UE reports the desired subframe reservation patterns for the affected frequencies. The TDM assistance information uses the MCG as timing reference. The desired subframe reservation patterns is included in *idc-SubframePatternList*. A bitmap with value 0 indicates that NR is requested to abstain from using the subframe.For FDD, the radio frame in which the pattern starts (i.e. the radio frame in which the first/leftmost bit of the *subframePatternFDD* corresponds to subframe #0) occurs when SFN mod 2 = 0.For TDD, the UE indicates its *preferredTDD-UL-DL-Pattern* with *referenceSubcarrierSpacing*, and its desired subframe reservation pattern *preferredSubframePatternTDD* for the *preferredTDD-UL-DL-Pattern*. The first/leftmost bit of *preferredSubframePatternTDD* corresponds to the subframe #0 of the radio frame satisfying SFN mod x = 0, where x is the size of the bit string divided by 10. |
| **ASN.1 signaling example:**Step 1: Network configurationidc-TDM-Indication-r18 ENUMERATED {setup} OPTIONAL, -- Need RStep 2: UE reporting signalingIDC-SubframePatternList-r18 ::= SEQUENCE (SIZE (1..maxSubframePatternIDC-r18)) OF IDC-SubframePattern-r18IDC-SubframePattern-r18 ::= CHOICE { subframePatternFDD-r18 BIT STRING (SIZE (4)), subframePatternTDD-r18 SubframePatternTDD-r18, ...}SubframePatternTDD-r18 ::= SEQUENCE { referenceSubcarrierSpacing-r18 SubcarrierSpacing,  preferredTDD-UL-DL-Pattern-r18 TDD-UL-DL-Pattern, preferredSubframePatternTDD-r18 BIT STRING (SIZE (1..70))}TDD-UL-DL-Pattern ::= SEQUENCE { dl-UL-TransmissionPeriodicity ENUMERATED {ms0p5, ms0p625, ms1, ms1p25, ms2, ms2p5, ms5, ms10}, nrofDownlinkSlots INTEGER (0..maxNrofSlots), nrofDownlinkSymbols INTEGER (0..maxNrofSymbols-1), nrofUplinkSlots INTEGER (0..maxNrofSlots), nrofUplinkSymbols INTEGER (0..maxNrofSymbols-1), ..., [[ dl-UL-TransmissionPeriodicity-v1530 ENUMERATED {ms3, ms4} OPTIONAL -- Need R ]]} |

#### Task 3: Please provide your suggested modification for above Option 1 or other options for the UL and/or DL transmission occasion solution for NR.

(Rapporteur’s comment: Please provide the changes for the above option or other options in the “Comments” column. The ASN.1 signaling example provided above is to be polished further while drafting the CR. Companies can provide FFS for specific technical points. However the increasing number of FFS(s) could also cause the dropping of the solution due to the very limted TU for the Rel-18 IDC work.)

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| **Company** | **Comments** |
| ZTE | We know that the down selection will be done in Phase 2, but we still don’t think there is a need to further discuss such HARQ based solution in NR, for that the NR take the flexible timing which is quite different from the LTE. Furthermore, as in the 36816, the HARQ based solution is mainly for the LTE+BT cases. However DRX-based scheme can also work for these cases, so we prefer to focus on DRX(or MUSIM) based scheme.Back to the option 1:For the FDD, In the LTE, the k1=4, so there is a 4 bits bitstring, in NR, K1 is configured by network, so we don’t think it’s reasonable to set size as 4. subframePatternFDD-r18 BIT STRING (SIZE (4)),For the TDD, in LTE the 70bits is adopted for the LTE TDD pattern 0,while for the pattern 6, 60bits is adopted, preferredSubframePatternTDD-r18 BIT STRING (SIZE (1..70))LTE: subframeConfig0-r11 BIT STRING (SIZE (70)), subframeConfig1-5-r11 BIT STRING (SIZE (10)), subframeConfig6-r11 BIT STRING (SIZE (60))so it seems hard to set bits size for the different DL/UL subframe configurations in the NR for both the TDD and FDD. |
| Ericsson | In our understanding we cannot simply reuse this solution from LTE due to in NR we have symbols instead of subframes, many and dynamic TDD patterns, a different HARQ process use, etc.We would be concerned in the amount of work this would bring compared to the DRX-solution.Also, for the gNB to actually respect this pattern it would impact the scheduler. With the DRX-solution on the other hand, it is already built-in to the DRX feature that the gNB does not schedule the UE outside active time, aside from ensuring that the inactivity timer is not extended in to the time when the UE is experiencing IDC issues. |
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## 2.4 Autonomous denial solution

The LTE autonomous denial solution is quoted as follows:

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| **Procedure:**Step 1: The eNB provides the *autonomousDenialParameters* including *autonomousDenialSubframes* and *autonomousDenialValidity* in the granularity of subframe.Step 2: The UE is 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*  |
| **ASN.1 signaling:**Step 1: Network configuration 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 |

The candidate autonomous denial solution for NR is as follows:

**Option 1: (By using the LTE autonomous denial solution as the baseline)**

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| **Procedure:**Step 1: The gNB provides the *autonomousDenialParameters* including *autonomousDenialSubframes* and *autonomousDenialValidity* in the granularity of subframe.Step 2: The UE is 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*  |
| **ASN.1 signaling example:**Step 1: Network configuration 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 |

#### Task 4: Please provide your suggested modification for above Option 1 or other options for the autonomous denial solution for NR.

(Rapporteur’s comment: Please provide the changes for the above option or other options in the “Comments” column. The ASN.1 signaling example provided above is to be polished further while drafting the CR. Companies can provide FFS for specific technical points. However the increasing number of FFS(s) could also cause the dropping of the solution due to the very limted TU for the Rel-18 IDC work.)

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| **Company** | **Comments** |
| ZTE | Generally Ok with the Option 1 if autonomous denial for the NR was supported |
| Ericsson | The RAN2 signalling part of this solution looks OK. One can of course discuss the granularity of this solution, e.g. should the validity-period/number of subframes be as proposed needs further checking.However, we expect that the autonomous denial solution alone cannot solve all possible problems. This would require significant RAN4 work and it is unclear if this solution would bring additional gains (e.g. compared to DRX) which would justify this enhancement. |
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# 2. Phase-2 discussion

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| **Phase-2 discussion:**The phase-2 discussion will be kicked off once the solutions details (e.g. specification impacts) provided from the Phase-1 discussion are relatively stable.Scope: Based on the solution details provided by the Phase-1 discussion, compare solutions, e.g. applied scenarios (e.g. BT voice, BT eSCO and WLAN beacon), complexity, etc. Selection of TDM solutions to be specified in Rel-18.Deadline for the Phase-2 discussion: Nov 3rd 00:30 AM UTC. |

TBD…

# 3. Conclusion

TBD…

# 4. Reference

1. R2-2207379 TDM Assistance Information for IDC Nokia, Nokia Shanghai Bell discussion Rel-18 NR\_IDC\_Enh-Core
2. R2-2207718 TDM solution for IDC problem Lenovo discussion Rel-18
3. R2-2207805 Candidate TDM solutions for IDC Xiaomi discussion Rel-18 NR\_IDC\_Enh-Core
4. R2-2207845 Discussion on TDM solution for in-device co-existence interference avoidance Samsung discussion Rel-18 NR\_IDC\_Enh-Core
5. R2-2207937 Discussion on TDM solution in IDC Apple discussion Rel-18 NR\_IDC\_Enh-Core
6. R2-2207969 TDM solution for IDC Intel Corporation discussion Rel-18 NR\_IDC\_Enh-Core
7. R2-2208113 TDM Solution for NR IDC Ericsson discussion Rel-18 NR\_IDC\_Enh-Core
8. R2-2208118 TDM Solutions in IDC Qualcomm Incorporated discussion Rel-18
9. R2-2208231 Discussion on TDM solution for NR IDC Huawei, HiSilicon discussion Rel-18 NR\_IDC\_Enh-Core
10. R2-2208397 Discussion on TDM solution for IDC vivo discussion Rel-18 NR\_IDC\_Enh-Core
11. R2-2208525 IDC TDM solution LG Electronics discussion Rel-18
12. R2-2207161 Clarification on the IDC scope ZTE Corporation, Sanechips discussion Rel-18 NR\_IDC\_Enh-Core
13. R2-2208952, Xiaomi, "Summary of [AT119-e][652][IDC] TDM solution (Xiaomi)"