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

**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:

|  |
| --- |
| 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.

|  |
| --- |
| **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:

|  |  |  |
| --- | --- | --- |
| Company | Name | Email Address |
| Xiaomi | Yumin Wu | wuyumin@xiaomi.com |
| Ericsson | Henrik Enbuske | henrik.enbuske@ericsson.com |
| Intel | Yujian Zhang | yujian.zhang@intel.com |
| Nokia | Jarkko Koskela | Jarkko.t.koskela@nokia.com |
| Samsung | Weiwei Wang  | ww1016.wang@samsung.com |
| Huawei, HiSilicon | Jagdeep Singh  | jagdeep.singh6@huawei.com |
| Qualcomm | Sherif ElAzzouni | selazzou@qti.qualcomm.com |
| LGE | Hanseul Hong | hanseul.hong@lge.com |
| Sharp | LIU Lei | lei.liu@cn.sharp-world.com |
| vivo | Xiaodong Yang | Yangxiaodong5g@vivo.com |
| Apple | Yuqin Chen | yuqin\_chen@apple.com |
| OPPO | Xinlei Yu | yuxinlei@oppo.com |
| Ericsson | Henrik Enbuske | Henrik.enbuske@ericsson.com |
|  |  |  |
|  |  |  |

# 2. Phase-1 discussion

|  |
| --- |
| **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:

|  |
| --- |
| **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)**

|  |
| --- |
| **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).FFS whether to use the LTE DRX configuration or the NR DRX configuration.FFS on the granularity of slot offset if NR DRX configuration is used. |
| **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-r18 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.)

|  |  |
| --- | --- |
| **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. |
| Intel | Generally OK with Option 1.For the UE report signalling, our understanding is that we can use the values in LTE signalling (e.g. DRX cycle length in the range of 40 ms ~ 256 ms) as baseline. The reason is that the LTE signalling values are selected based on coexistence scenarios (clause 4.2 of TR 36.816), and were agreed in email discussion “[79#33] [LTE/IDC] IDC Open issues” (R2-124404).We also agree with ZTE that slot offset is not necessary. |
| Nokia | For general understanding it would be good also to describe a bit about expected NW behaviour with these solutions. With this particular approach (DRX solution) NW tries not to schedule outside active time preferred by the UE. As a generic comment on TDD approaches (drx, musim, harq) there would need to be capability in the UE to get timing information between ISM modem and 3GPP radio(s). IF that kind of capability is not present in the UE they really cannot support any TDD approach.For this particular solution proposed solution would seem feasible baseline – of course we can consider in detail possible value ranges for parameters.  |
| Samsung | As one of options, we generally fine with the modification above for option 1. Moreover, option 1 allows more fine granularity on the time domain than option 2, which is aligned with the NR design. We understand that down-selection will be carried out in Phase 2. However, Option 1 and option 2 have some similarity as below

|  |  |  |
| --- | --- | --- |
| **Option 1** | **Option 2** | **Comments**  |
| drx-LongCycleStartOffset | idc-GapRepetitionAndOffset-r17 | Option 1 has more values |
| drx-SlotOffset |  | Option1 gives fine granularity of start |
| drx-ActiveTime-r18 | idc-GapLength-r17 | Option 1 gives fine granularity of time length |
|  | musim-Starting-SFN-AndSubframe-r17 | Option 2 can support aperiodic case.  |

It can be observed that option 1 can provide more fine granularity than option 2 in terms of starting offset and time length. The missing part of option 1 is the support of aperiodic case. In our understanding, the TDM assistant information aims at helping the TDM configuration from the network side. In LTE, the DRX assistant information for IDC helps network configure the DRX to adapt to IDC problem. In NR, the network may have two meanings to configure the TDM, i.e., DRX, and MUSIM-gap. That’s why we have a discussion on option 1 and option 2. However, essentially, the key issue of TDM solution is how to indicate a time pattern which can help network generate the TDM configuration. Compared to LTE, the big difference is fine granularity of time domain. Thus, we think a TDM solution applicable for NR should be the one providing fine granularity of time, no matter what kind name is used in the assistant information. In this sense, a generalized solution harmolizing option 1 and option 2 would be preferred, which can include the following three parameters:* IDC-CycleStartOffset
* IDC-slotoffset: the value can be same as drx-SlotOffset
* IDC-ActiveTimeLength, which indicates the time length used for NR module, and the value can be same as drx-ActiveTime-r18

After providing the above assistant information, the gNB can configure either DRX or MUSIM gap to the UE to avoid the IDC problem.In summary, we prefer to **a generalized solution containing three parameters, i.e., IDC-CycleStartOffset, IDC-slotoffset, and IDC-ActiveTimeLength, with fine granularity**. For the support of aperiodic case, we may need clarify the benefit first. Do we consider some cases that ISM module has some short-term traffic?Maybe we can discuss **the support of aperiodic case in phase2**. In addition, we **suggest that this discussion should cover the topic on whether multiple TDM assistant information can be reported to the network** since Rel-18 considers the MR-DC case. |
| Huawei, HiSilicon | We agree that the signalling details described above can be considered as the baseline for DRX based solution. Furthermore, our view is that DRX-based TDM solution has been well designed in LTE and we don't see any issue to apply it in NR and should be considered with highest priority. |
| Qualcomm | Agree with the proposed baseline for DRX. The specific values can be worked out later if the solution is agreed to depending on IDC needs.  |
| LGE | Fine with Option 1 in general as a starting point. The signalling details can be further discussed later after the down selection. |
| Sharp | Generally fine with the modification. And MR-DC case can be further considered.  |
| vivo | it looks like a part of exsiting *DRX-Config* IE. We agree with QC that The specific values can be worked out later if the solution is agreed to depending on IDC needs. .   |
| Apple | In general we are fine with the signaling. True the values can be defined later as it’s related to whether the subframe pattern framework would be supported. If not, some even finer value might be needed. |
| OPPO | Simlar view as QC, we can use this as baseline and the signaling details (i.e., the values) can be further discussed in stage3. |
|  |  |

## 2.2 MUSIM gap like solution

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

|  |
| --- |
| **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)**

|  |
| --- |
| **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.FFS whether the MUSIM gap configuration (e.g. gap length and periodicity) designed for MUSIM use case can be reused for IDC use case, or whether the values of gap period (repetition) and length need to be aligned with the LTE DRX values as the value range is related to the coexistence scenarios of IDC. This may need RAN4 evaluation on the feasibility of the MUSIM gap configuration for the IDC use case.FFS whether the prohibit timer is needed.FFS whether (multiple) aperiodic gap(s) is needed. |
| **ASN.1 signaling example:**Step 1:IDC-GapAssistanceConfig-r18 ::= SEQUENCE { musim-GapProhibitTimer-r18 ENUMERATED {s0, s0dot1, s0dot2, s0dot3, s0dot4, s0dot5, s1, s2, s3, s4, s5, s6, s7, s8, s9, s10}}Step 2: UE reporting signalingIDC-GapPreferenceList-r18 ::= SEQUENCE (SIZE (1..4)) OF IDC-GapInfo-r18IDC-GapInfo-r18 ::= SEQUENCE { idc-Starting-SFN-AndSubframe-r18 IDC-Starting-SFN-AndSubframe-r18 OPTIONAL, -- Cond aperiodic idc-GapLength-r18 ENUMERATED {ms3, ms4, ms6, ms10, ms20} OPTIONAL, -- Need S idc-GapRepetitionAndOffset-r18 CHOICE { ms20-r18 INTEGER (0..19), ms40-r18 INTEGER (0..39), ms80-r18 INTEGER (0..79), ms160-r18 INTEGER (0..159), ms320-r18 INTEGER (0..319), ms640-r18 INTEGER (0..639), ms1280-r18 INTEGER (0..1279), ms2560-r18 INTEGER (0..2559), ms5120-r18 INTEGER (0..5119), ... } OPTIONAL -- Cond periodic}IDC-Starting-SFN-AndSubframe-r18 ::= SEQUENCE { starting-SFN-r18 INTEGER (0..1023), startingSubframe-r18 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.)

|  |  |
| --- | --- |
| **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? |
| Intel | Similar to comment to Task 1 (DRX), the values of gap period (repetition) and length need to be aligned with the LTE DRX values as the value range is related to the coexistence scenarios.We don’t think a prohibit timer is needed. In LTE IDC, there was discussion on whether a prohibit timer is needed or not and the final decision was that prohibit timer is not needed. In addition, there is no prohibit timer for NR Rel-16 IDC with FDM solution.  |
| Nokia | Assistance information as such should be quite similar here as with DRX solution – probably it is more matter of taste how the assistance information is provided to the NW. But isn’t there big difference between MUSIM based solution compared to DRX based solution on how NW would react to the UE assistance information?In MUSIM based solution one does decouple the provision of gaps from the provision of a DRX configuration. Gaps are running on top of the DRX and there wont be transmission during the gap. This way there is no need to impact DRX implementations as such but one would ensure that there is no scheduling during the gap in similar manner as is done with e.g. measurement gaps. |
| Samsung  | As commented in Task 1, we see the similarity between option 1 and option 2. In this sense, we prefer to **a generalized solution containing three parameters, i.e., IDC-CycleStartOffset, IDC-slotoffset, and IDC-ActiveTimeLength, with fine granularity.**For prohibit timer, we didn’t see the necessity for IDC problem since this is a dedicated feature for MUSIM gap. |
| Huawei, HiSilicon | General comment: Benefit of considering MUSIM gap like solution instead of DRX based solution in Rel 18 is unclear to us. We should first discuss any benefits or advantages of having MUSIM gap like solution over DRX solution, which has worked well in LTE, before we can look at the stage 3 details of the MUSIM gap solutions. For the proposed signanling, two comments:1. What’s the motivation/use case for the aperiodic gap; - We don’t think this is needed for IDC.
2. What’s the motivation/use case to have more than one periodic gap - We think only one periodic gap is enough for IDC.
3. Whether to define prohibit timer can be discussed once the MUSIM like solution is agreed.

Editorial comment for the ASN.1 structure above - suffix -r17 should be changed to -r18 for the IEs used. |
| Qualcomm | Fine with current phrasing as a baseline. Gap details and proposed lengths can be worked out later if the solution is agreed. Aperiodic gap is needed for the same reason autonomous denial may be needed. Sometimes a UE anticipates a Tx or Rx event from another RAT and needs a single short-notice gap to fit WLAN/BT traffic into this gap. In fact, in some cases this is more beneficial than periodic gaps when its hard to coordinate timings and/or hard for WLAN/BT to adjust their traffic into a pattern, so to summarize, we agree with current baseline. |
| LGE | Fine with Option 1 as a starting point. We also think that prohibit timer for gap assistance information in IDC report is not needed. Rather, the gNB only needs to configure whether the IDC reporting for gap assistance information is allowed in Step 1, as in other solutions.In addition, since the MUSIM gap-like solution looks similar to the DRX-like solution (i.e., providing cycle, period, and length), just one solution is needed between DRX-like solution and MUSIM gap-like solution, i.e., should not support both solutions. |
| Sharp | Prefer to focus on DRX solution. And agree with Ericsson’s comments on MUSIM gap like solution including RAN4 work. |
| vivo | OK. MUSIM gap like solution can provide gaps for IDC purpose. At least aperiodic gap can be used for IDC purpose without change for the same reason autonomous denial.The detail values of period gap can be further polished.  |
| Apple | General fine with the signaling.For prohibit timer, we also do not think it is needed. It’s not there in LTE IDC and NR FDM IDC.Regarding the debate on selection between DRX and gap like solution, our view is DRX is more complex than gap due to the many timers (on duration timer, DRX inactivity timer, DRX HARQ RTT timer, DRAX retransmission timer). Thus we prefer MUSIM gap like solution. |
| OPPO | Similar as Ericsson, it’s not clear to us what additional benefits we have on top of DRX approach. |
|  |  |

## 2.3 UL and/or DL transmission occasion(s)

The LTE HARQ reservation solution is quoted as follows:

|  |
| --- |
| **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)**

|  |
| --- |
| **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.FFS on the number of bits used for the FDD/TDD subframe pattern.FFS whether TDD pattern is needed.FFS whether finer granularity (e.g. slot and/or symbol) is needed.FFS how the NR asynchronous HARQ procedure impacts the pattern.FFS how the dynamic TDD pattern impacts the pattern.FFS whether RAN4 needs to be involved. |
| **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 ]]} |

**Option 2: (Based on the inputs from Intel)**

|  |
| --- |
| **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 both FDD and TDD, the radio frame in which the pattern starts (i.e. the radio frame in which the first/leftmost bit of the *IDC-SubframePattern* corresponds to subframe #0) occurs when SFN mod 2 = 0.FFS on the number of bits used for the subframe pattern.FFS whether finer granularity (e.g. slot and/or symbol) is needed.FFS how the NR asynchronous HARQ procedure impacts the pattern.FFS how the dynamic TDD pattern impacts the pattern.FFS whether RAN4 needs to be involved. |
| **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 ::= BIT STRING (SIZE (1..20) |

#### 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.)

|  |  |
| --- | --- |
| **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. |
| Intel | First of all, we’d like to note that DRX assistance information as discussed in Task 1 has *coarse* granularity, and is not suitable for coexistence use case of BT voice, which requires *finer* granularity (that’s why HARQ process reservation solution was used in LTE in addition to DRX assistance information).Subframe pattern in LTE (as well as the Option 1 in this section) might not be directly applicable in NR since it is based on synchronous HARQ, while NR HARQ is asynchronous. In LTE, subframe pattern length is related to FDD/TDD and TDD UL-DL configuration. For example, although the periodicity of TDD UL-DL configuration is 10 ms, the subframe pattern length is 70 ms due to UL synchronous HARQ. In NR, HARQ is asynchronous. Therefore there is no need to report TDM pattern based on synchronous HARQ operation. In NR TDD, the pattern periodicity for IDC can be related to the TDD UL-DL transmission periodicity (*dl-UL-TransmissionPeriodicity*). A simple TDM pattern with fine granularity (compared with DRX assistance information) can be considered. For example, the pattern periodicity for NR IDC can be a single value (e.g. 20 ms) irrespective of the actual TDD UL-DL configuration since TDD transmission periodicity is a divisor of 20 ms. The pattern periodicity for FDD can the same as that of TDD, e.g. 20 ms. For each bit indicated in the pattern, the pattern unit can be subframe (ms), i.e. each bit in the pattern indicates whether NG-RAN is requested to abstain from using the subframe (ms).An example ASN.1 signaling for UE assistance information is as follows:IDC-SubframePatternList-r18 ::= SEQUENCE (SIZE (1..maxSubframePatternIDC-r18)) OF IDC-SubframePattern-r18IDC-SubframePattern-r18 ::= BIT STRING (SIZE (1..20) |
| Nokia | With asynchronous HARQ and flexible TDD, we don’t believe the NR baseline is simple enough to make any HARQ-based solution more attractive than a DRX- or MUSIM-gaps- based one. |
| Samsung | We are fine to support the preferred subframe pattern to tackle with HARQ reservation. Moreover, such pattern should be adapt to the subframe structure design in NR. The above modification can be considered as the starting point of phase2 discussion. |
| Huawei, HiSilicon | Similar view as ZTE. In our understanding for the HARQ pattern to work, the UE needs to know the UL scheduling pattern of the NW for the HARQ process. In NR this is up to the gNB scheduler implementation. Hence for NR IDC we think the HARQ process reservation based solution is not applicable. Moreover, as pointed by ZTE, all the usage scenarios that the HARQ reservation is applicable the DRX-based solution is also applicable.Although the signalling aspects described above looks ok, we would like to focus on DRX based solution given the limited time we have for Rel 18 and suggest that we don’t spend time discussing this solution further. |
| Qualcomm | Same point of view as the companies above. The concept of subframe TDD is not applicable in NR.In LTE, the UE simply indicated a preferable bitmask for all 7 allowed subframe-based TDD patterns.In NR, the TDD pattern is symbol-based and has much more configurations than LTE and HARQ is asynchronous so unclear what the UE is supposed to report. If we understand the proposal correctly, the UE gets to recommend a TDD UL-DL pattern, but then why would the gNB follow that recommendation? There are other considerations for the NW to choose TDD for the whole cell and for specific UEs. Also, that was not the case for LTE as the UE did not choose a TDD pattern but indicated a subframe bitmask preference for every possible TDD frame. The way we see it, we cannot use LTE as a baseline here. This can be considered a new solution that requires completely new procedures and ASN.1 coding, preferably without relating this to previous LTE solutions. We also note that this would have some RAN4 impact because it’s not exactly reusing a LTE solution. |
| LGE | Same view with other companies that it would be more complicated and LTE solution cannot be used as a baseline considering the dynamic TDD patterns and the asynchronous HARQ operation in NR.Regarding signalling aspects, it seems that the suggested parameters are based on *TDD-UL-DL-ConfigCommon* IE, which is cell-specific parameters. It is fine in general as a starting point, but it is unclear how the network would handle the cell-specfic parameters after receiving the TDM assistance information.  |
| Sharp | Open to discuss this solution and the modification proposed by rapporteur can be used as starting point. |
| vivo | We agree with other companies that NR is different with LTE. UL and/or DL transmission occasion is not needed for NR. |
| Apple | We share the view of many companies that due to the asynchronous HARQ timeline and flexible TDD patterns, there is no need to mimic this to NR.If it is identified that the time duration in DRX/gap solution is too long to be used for Bluetooth, we can work on the values to make them finer. |
| OPPO | We share majorities that the solution is complicated compared with the situation in LTE. |
|  |  |

## 2.4 Autonomous denial solution

The LTE autonomous denial solution is quoted as follows:

|  |
| --- |
| **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)**

|  |
| --- |
| **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* FFS whether other granularity for denial parameters is needed. |
| **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.)

|  |  |
| --- | --- |
| **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. |
| Intel | Generally OK with Option 1 if autonomous denial will be supported for RAN2. We understand that some details will be discussed in later stage, e.g. the unit in configuration (current UL subframe is used, however there is no concept of UL subframe in NR). |
| Nokia | Solution option as such seems feasible but generally UE autonomous dropping sending in UL will impact Quality of Service and spectrum efficiency compared with a DRX based solutions. Latency may increase, although it may depend on exact use case. It is not so clear what would be additional gain of this solution – especially compared to MUSIM solution which will ensure specific timings when 3GPP won’t be doing transmissions anyway.  |
| Samsung | The above option 1 defines the number of denials in terms of subframe. However, considering the fine granularity of NR, we prefer to have a generalized time period as the unit of denial, i.e, autonomousDenialLength + autonomousDenialNumber. In addition, we **suggest that this discussion should cover the topic on whether multiple autonoumous denial configuraitons can be configured to the UE** since Rel-18 considers the MR-DC case. |
| Huawei, HiSilicon | ASN.1 signaling example looks ok .Our view is that we can consider it after the more general DRX based solution and FDM enhancements for NR is finalised as the autonomous denial solution is to be used in very specific scenarios e.g. for the reception of WiFi beacon. |
| Qualcomm | Fine as a baseline for discussion |
| LGE | Fine in general if this solution is supported. |
| Sharp | Generally fine with the modification if the solution is supported. |
| vivo | Aperiodic MUSIM gap can be used for IDC purpose without change for the same reason autonomous denial.We also agree with Ericsson that autonomous denial will involve RAN4 work.  |
| Apple | In general we are OK if it is supported. |
| OPPO | In general we’re ok if it’s supported |
|  |  |

# 2. Phase-2 discussion

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

It seems that the solutions with a list of FFS issues as provided from the Phase-1 discussion can be considered as the baseline for the Phase-2 discussion, targeting at the selection of TDM solutions to be specified in Rel-18. One FFS which is common to all solutions is listed as follows:

* FFS whether multiple TDM assistant information can be reported to the network.

#### Question 1: Do you think that the solutions (with the list of FFS issues) provided from the Phase-1 discussion can be considered as the baseline for further study?

(Rapporteur’s comment: The selection of TDM solutions is to be discussed in the subsequent Questions. More FFS points for each solution can be provided via the Comments column.)

|  |  |  |
| --- | --- | --- |
| **Company** | **Answers** **(Yes/No)** | **Comments** |
| OPPO | No | We think option 1/4 can be taken as baseline for further discussion. For option 2/3, we think we can remove and simplify the whole work. |
| Qualcomm | Yes | We can use this email discussion, specifically Q6, to downselect from these techniques. No need to introduce new techniques |
| Apple | Can consider down selection | We should better do down selection based on the final status of this email discussion.  |
| Xiaomi | Yes | We understand companies’ concerns on having too many solutions in Rel-18. We think that after we have some down selections, the Phase-1 technical procedures for whatever selected solutions can be the baseline for further discussion, so that we can reduce the workload for the subsequent meetings.  |
| Samsung  | Yes with comment | We are fine to start from the above options. However, it does not mean the final solution should be selected from them. In our understanding, a generalized solution would be preferred where the UE provides the preferred TDM pattern, and then gNB configures the TDM pattern based on the UE reporting. In other words, the final solution is unnecessarily linked to either DRX or MUSIM.  |
| ZTE | Yes |  |
| Huawei, HiSilicon | Yes with comments | We think we can have a two step approach for selecting a TDM solution in R18In the first step, we can have further discussion for Task/option 1,2 and 4 as Task/option 3 (HARQ process reservation based solution) can be ruled out straight away for NR based on the majority views expressed by the companies during Phase 1 discussions.In the second step we can perform further downslelection between option 1,2 and 4 based on opinion expressed in response to Q6 in phase 2 of this email discussion. We think that ASN.1 and signaling described for IDC procedure in Phase-1 can then be used as the baseline for the selected R18 TDM solution for further specifying at the stage 3 details. |
| Intel | Yes | We can use the solutions in phase 1 as baseline for further down selection (as in Question 6). |
| Ericsson | Yes, comment | We think already now option 3 can be left out as it seems clear it comes with complexity and little support. |
| vivo | Yes | We may further study and do down selections based on the Phase-1 output. |
| Sharp | Yes | Can be used as baseline for the solutions which are decided to be further studied. |

According to the RAN2#119-e meeting discussion, RAN2 made the following agreements for the targeting scenarios of the NR IDC TDM solutions:

|  |
| --- |
| Agreements:1 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 RAN2.2 Rel-18 IDC TDM solution(s) targets at resolving the adjacent channel interference issue and the intermodulation distortion interference issue, as LTE. |

According to the 3GPP TR 36.816, the applicability of TDM solutions for each usage scenario (including periodc and aperiodic services) is summarized in Table 5.3-1 in 36.816.

Table 5.3‑1: Applicability of different TDM solutions

|  |  |
| --- | --- |
| **TDM solution** | **Usage scenario** |
| **LTE+BT earphone (VoIP service)** | **LTE+BT earphone (Multimedia service)** | **LTE+WiFi portable router** | **LTE+WiFi offload** | **LTE+GNSS Receiver** |
| HARQ process reservation based solution | Applicable | Applicable for BT Master, but not applicable for BT Slave | FFS | FFS | Applicable |
| DRX based solution | Applicable | Applicable | Applicable | Applicable | Applicable |
| Uplink scheduling restriction based solution | Not applicable | Not applicable | Not applicable | Not applicable | Applicable |
| Autonomous denial solution | Complementary solution for receiving important signalling |

According to the 3GPP TS 38.331, the applicable interference type for TDM solutions is quoted as follows:

|  |
| --- |
| 3GPP TS 36.331: 1> if there is at least one E-UTRA carrier frequency, for which a measurement object is configured, that is affected by IDC problems:2> include the field *affectedCarrierFreqList* with an entry for each affected E-UTRA carrier frequency for which a measurement object is configured;2> for each E-UTRA carrier frequency included in the field *affectedCarrierFreqList*, include *interferenceDirection* and set it accordingly;2> include Time Domain Multiplexing (TDM) based assistance information, unless *idc-HardwareSharingIndication* is configured and the UE has no Time Doman Multiplexing based assistance information that could be used to resolve the IDC problems:3> if the UE has DRX related assistance information that could be used to resolve the IDC problems:4> include *drx-CycleLength*, *drx-Offset* and *drx-ActiveTime*;3> else (the UE has desired subframe reservation patterns related assistance information that could be used to resolve the IDC problems):4> include *idc-SubframePatternList*;3> use the MCG as timing reference if TDM based assistance information regarding the SCG is included; |

In LTE, the TDM-based assistance information (including DRX solution and HARQ reservation solution) is for *affectedCarrierFreqList*, which refers to the adjacent channel interference issue. The autonomous denial solution can be used for both the adjacent channel interference issue and the intermodulation distortion interference issue without specification restriction.

#### Question 2: What are the benefits and drawbacks for DRX solution?

(Rapporteur’s comment: The discussion shall focus on the applicable use cases (e.g. BT voice, BT eSCO and WLAN beacon) as described in 3GPP TR 36.816, the applicable interference issues (including the adjacent channel interference and the intermodulation distortion interference issue) and the complexity of the solution.)

|  |  |  |
| --- | --- | --- |
| **Company** | **Benefits** | **Drawbacks** |
| OPPO | * Finer granurity for the duration than MUSIM gap-like solution.
* DRX solution has general applicability on each IDC usage scenario.
* Most likely can re-use LTE as baseline
 |  |
| Qualcomm | * UAI already signals some recommended DRX patterns, so these fields can simply be reused.
* Stable solution from LTE can be resued with necessary changes.
 | * Only applicable for long term solutions like WLAN beacons, i.e., DRX cannot be sufficient IDC solution since it doesn’t work for few ms granularity such BT eSCO
* UE needs to track a few timers
* Only works with high-level of coordination between NR and the other system to align transmissions
* Cannot work for all IDC cycle lengths (e.g. BT esCO6 cycle is 3.75ms which is not an applicable DRX cycle value)
 |
| Apple | * DRX is a well defined framework and has been used in LTE IDC
* Wide applicability
 | * Many timers to maintain, which makes it complex
 |
| Xiaomi | * More applicable for periodic traffic.
* Finer granularity than other solutions
* The stable LTE baseline can be easily implemented in NR.
* NR DRX reporting via UAI can be considered as an good exmpale.
 | * Stopping all UL transmission is a little bit overkill for IMD issue, since single UL transmission can already resolve the IMD issue.
* Stopping both UL and DL transmission is a little bit overkill when the intereferenc is UL-only or DL-only.
* Not applicable for aperiodic service (e.g. some events during BT/WiFi connection-setup or other important signalling)
* No applicable for some periodic service with smaller cycle.
 |
| Samsung  | DRX solution has been well applied in LTE. NR DRX information can provide finer granularity for the active time start offset.  |  |
| ZTE | Can reuse the legacy DRX patterns | The duration of DRX Off is up to the short/long cycle, which depends on the data transfer status. |
| Huawei, HiSilicon | * The biggest benefit of adopting DRX based solution is that DRX will in general mostly be configured by the network for the UEs in RRC\_CONNECTED state for reducing the UE power consumption. Reusing the DRX framework for resolving IDC is that we essentially get DRX solution almost for free as network just needs to configure / adjust DRX based on TDM assistance information from UE in UAI.
* DRX solution has wider applicability than the other solutions and can provide wide range of granuality for different usage scenarios.
* DRX-based TDM solution has been used in LTE and we don't see any issue to apply it in NR
 |  |
| Intel | DRX solution is a well established solution in LTE and can be reused for NR with minimal specification efforts | Not applicable for BT voice case (eSCO) which requires fine granularity of TDM pattern. |
| Ericsson | As the solutions have the same goal in general, and considering that the DRX based solution, as a well understood option, is in many ways with only some smaller changes a natural choice.Agree with Huawei on finer points. |  |
| vivo | DRX solution can be applied for each IDC usage scenario | Difficult for NW to configure the DRX timers. The active time depends on the transfer status. |
| Sharp | DRX solution needs less standard effort and offers finer granularity. |  |

#### Question 3: What are the benefits and drawbacks for MUSIM gap-like solution?

(Rapporteur’s comment: The discussion shall focus on the applicable use cases (e.g. BT voice, BT eSCO and WLAN beacon) as described in 3GPP TR 36.816, the applicable interference issues (including the adjacent channel interference and the intermodulation distortion interference issue) and the complexity of the solution.)

|  |  |  |
| --- | --- | --- |
| **Company** | **Benefits** | **Drawbacks** |
| OPPO | * Similar to DRX solution, MUSIM gap-like solution also has general applicability on each IDC usage scenario.
* The delta part than DRX solution is the support for (multiple) aperiodic gap(s) and prohibit timer.
 | * MUSIM gap-like solution has coarser granurity than DRX solution.
* Benefits compared with DRX approach is not clear, and it bring extra specification efforts.
 |
| Qualcomm | * Can be applied to every targeted scenario
* Most straightforward solution that does not affect other aspects unlike DRX and autonomous denials
* Can reuse Rel-17 MUSIM framework
* Can react quickly to request for aperiodic gaps
* Needs less coordination than DRX (but more coordination than autonomous denials)
 | * More spec.load than DRX
 |
| Apple | * Simple to implement
* MUSIM-gap is already available in spec
* Wide applicability
 |  |
| Xiaomi | * The periodic gap is more applicable for periodic traffic.
* Can reuse Rel-17 MUSIM framework
 | * Stopping all UL transmission is a little bit overkill for IMD issue, since single UL transmission can already resolve the IMD issue.
* Stopping both UL and DL transmission is a little bit overkill when the intereferenc is UL-only or DL-only.
* It is unclearer whether the aperiodic gap can be applcialbe for aperiodic traffic in IDC issue.
* No applicable for some periodic service with smaller cycle.
* Less granularity compared with DRX solution
* More standard effort compared with DRX solution, but still possible for Rel-18 timeline.
 |
| Samsung | MUSIM can provide a TDM pattern separating 3GPP module and non-3GPP module. Moreover, the aperiodic case can be supported | The granularity provided by existing MUSIM is less than DRX. |
| ZTE | * Can be applied to every targeted scenario
* Can reuse Rel-17 MUSIM framework
 |  |
| Huawei, HiSilicon | * Similar to DRX solution, MUSIM gap-like solution is applicable to each IDC usage scenario.
 | * Benefits of MUSIM gap like solution compared to DRX based solution is unclear and it bring extra specification efforts.
* MUSIM gap like solution cannot be directly adopted for IDC as the motivation/usecase for having the multiple periodic gaps, the need for aperiodic gap and an associated prohibit timer is unclear
* MUSIM gap-like solution has coarser granurity than DRX solution.
* More RAN4 work is needed compared to the DRX-based solution
 |
| Intel | * May use MUSIM framework.
* Can support aperiodic gap (note that the use case and feasibility (e.g. delay aspects) for aperiodic gap needs to be discussed).
 | * Gap solution does not provide flexible gap ratios, which is essential in IDC to allow flexible resource distribution between NR and other RATs.
* Might not be applicable for BT voice case (eSCO) which requires fine granularity of TDM pattern.
* More standardization efforts.
 |
| Ericsson | Can be made to work as an viable TDM solution. | * it is clear that a MUSIM-gap solution requires additional discussion as they have now been defined for another use case.
* Extensive work have been spent in RAN4 historically and this could be the case here also
* The granularity may need special solutions
* Unclear if we end up with multiple patterns, hysteresis etc
 |
| vivo | Similar to DRX solution, MUSIM gap-like solution is applicable to each IDC usage scenario. And, it’s simpler to control the active time than DRX solution. |  |
| Sharp | Can reuse Rel-17 MUSIM framework | More complex and needs more standard efforts |

#### Question 4: What are the benefits and drawbacks for UL and/or DL transmission occasion(s) solution?

(Rapporteur’s comment: The discussion shall focus on the applicable use cases (e.g. BT voice, BT eSCO and WLAN beacon) as described in 3GPP TR 36.816, the applicable interference issues (including the adjacent channel interference and the intermodulation distortion interference issue) and the complexity of the solution.)

|  |  |  |
| --- | --- | --- |
| **Company** | **Benefits** | **Drawbacks** |
| OPPO |  | It has difficulty to make it applicable for NR since NR is quite different from LTE on more flexiable TDD and asynchronous HARQ. |
| Qualcomm |  | * The concept of subframe TDD is not applicable in NR, thus LTE solution cannot be reused. Thus, this needs a completely new solution for development.
* In NR, the TDD pattern is symbol-based and has much more configurations than LTE and HARQ is asynchronous so unclear what the UE is supposed to report.
* Would likely be a high overhead solution.
* gNB has different considerations when choosing TDD for the cell and the UE, thus, unclear if the gNB would follow the UE recommendation.
 |
| Apple |  | * NR has a more flexible TDD pattern
* NR HARQ is asynchronous, different than LTE
 |
| Xiaomi | * More accurate control on interference, due to the available subframe bitmap indicated
* Applicable for periodic and periodic service
 | * More standard efforts on finding a proper UL/DL pattern in NR, as which UL/DL pattern is applicable for NR and IDC is still unclear
* It is unclear whether/how the solution is related to HARQ transmission/feedback.
 |
| Samsung | The DL and UL differentiation can provide more fine time domain separation between 3GPP and non-3GPP module, e.g., follow NR HARQ timeline. | Since NR has symbol-level TDD pattern design, LTE solution cannot be simply reused. In addition, the asynchronous HARQ timeline and flexible TDD patterns in NR will complex the UL and/or DL transmission occasion design.  |
| ZTE |  | Agree with OPPO and Qualcomm |
| Huawei, HiSilicon |  | HARQ process reservation based solution is not directly applicable to NR as NR has a more flexible TDD pattern and furthermore NR HARQ is asynchronous as commented by the other companies. |
| Intel | Can support the BT voice (eSCO) use case well. | Might require more standardization efforts as LTE solution can be simply reused. |
| Ericsson | - | See earlier comments, this does not seem feasible given alternatives. |
| vivo |  | It’s unclear how to apply HARQ process reservation based solution for asynchronous HARQ in NR. |
| Sharp | May provide more information | Need more standard efforts |
|  |  |  |

#### Question 5: What are the benefits and drawbacks for autonomous denial solution?

(Rapporteur’s comment: The discussion shall focus on the applicable use cases (e.g. BT voice, BT eSCO and WLAN beacon) as described in 3GPP TR 36.816, the applicable interference issues (including the adjacent channel interference and the intermodulation distortion interference issue) and the complexity of the solution.)

|  |  |  |
| --- | --- | --- |
| **Company** | **Benefits** | **Drawbacks** |
| OPPO |  | It should be consider as a complementary solution compared with DRX approach. |
| Qualcomm | * LTE solution can be resused.
* Very fast reaction time since it does not rely on signalling to obtain the gap in time.
* Does not need very stringent coordination between RATs.
* Autonomous TDM solutions can be used to protect high priority but rare ISM events, e.g., WiFi beacons and other connection setup events.
 | * Reduced cell throughput due to missed PUSCH.
* May trigger link adaptation and increased PDCCH load
* High long-term signalling overhead since denial needs to be reset after validity period.
* Does not leverage the UE possible knowledge of IDC events
 |
| Apple | * Can work as a complementary solution when network does not provide a solution to UE.
 |  |
| Xiaomi | * Applicable for periodic and periodic service
* More applicable for IMD issue compared with other solutions, since the UE can use single UL transmission.
* More applicable for UL interference
* The stable LTE baseline can be easily implemented in NR.
 | * Not applicable for DL interference to NR.
* Autonomous dropping may not be an issue, as RAN4 already allows the UE to use power backoff to autonomously drop some UL transmission due to interference.
 |
| Samsung | Autonomous denial can be used to avoid the interference to some critical signal in non-3GPP module, e.g., WIFI beacon | This solution alone cannot solve all IDC problem in time domain.  |
| ZTE |   |  As in LTE, it can be only used for rare case |
| Huawei, HiSilicon |  | Autonomous denial solution alone cannot solve all the IDC problem hence should only be considered as an addon after a general TDM solution (DRX / MUSIM like gap based solution) is finalised.  |
| Intel | * Can be a complementary solution
* LTE solution can be largely reused
 | Impacts on link adaptation and RAN4 work. |
| Ericsson |  | Cannot be the only solution, i.e would only apply for some special use cases. Given additional complexity, and that TDM is of less importance for NR IDC as a whole, the addition may not be feasible. This includes the risk of increased market fragmentation. |
| vivo |  | The Applicability of autonomous denial solution is rare. However, aperiodic MUSIM gap can be used for IDC purpose without change for the same reason. |
| Sharp | May be a complementary solution. | Only used for some special use cases. |

#### Question 6: Which of the following solution(s) are included in Rel-18?

* Option 1: DRX solution
* Option 2: MUSIM gap-like solution
* Option 3: UL and/or DL transmission occasion(s)
* Option 4: Autonomous denial solution

(Rapporteur’s comment: As LTE, multiple TDM solutions can be supported, if necessary)

|  |  |  |
| --- | --- | --- |
| **Company** | **Answers** **(Option 1/2/3/4)** | **Comments** |
| OPPO | Option 1 and Option 4 | Option 1 and Option 2 are similar solutions, therefore we only needs to support one of them. Considering the work load of solutions and the extreme short WI, we prefer Option 1 since for Option 2 we have to discuss the FFS on whether to support aperiodic gap or prohibit timer, and we do not see the benefit from Option 2.For Option 3, it is not needed for NR since it does not add supporting for more IDC scenarios. And Option 3 is not directly applicable for NR since NR is quite different from LTE on more lexible TDD and asynchronous HARQ. For Option 4, we are open for autonomous denial solution, but it should be consider as a complementary solution with low priority than Option ½. |
| Qualcomm | Option 2Option 1Option 4 (in order for preference) | * Option 2 is our preference since it combines reasonable standardization load and effectiveness in all targeted scenarios.
* Option 1 is simple but does not cover all IDC solutions and may be the least effective in alleviating IDC issues.
* Option 4 is effective for some type of immediate rare IDC events but comes with radio link complications.
* Option 3 as it stands is not a developed solution in our view as the LTE framework cannot be resued, and there is no time to design a solution from scratch.
 |
| Apple | Option 2Option 1Option 4 | Between Option 2 and Option 1, we prefer Option 2 as it is much simpler. If majority selects Option 1, we can compromise for the sake of progress.Option 4 can be used a complementary solution if network does not respond in time.Option 3 is not suitable any more for NR. |
| Xiaomi | At least, Option 1 and 4Open for Option 2 | Having both Option 1 and Option 4 can achieve a good balance on resolving IMD interference issue and harmonic interference issue, and can resolve most issues for diverse traffic types including periodic and aperiodic traffics.On the other hand, considering the limited time for Rel-18 IDC work, the LTE baselines for Option 1 and Option 4 seem requiring less standard efforts compared with other solutions.For Option 2, we are fine to follow the majority. However the periodic gap seems having some overlaps with the DRX solution, and how/whether the aperiodic gap is used to resolve the IDC issue is still unclear. We think that the peroidc gap may not require RAN4 evaluation since lots of periodic traffic types could cause periodic interference. However we may need RAN4 involvement for the aperiodic gap applicability for IDC issues, which should be avoided, as the limited RAN4 TU(s) reserved is only to define the RM requirements for TDM solution selected by RAN2, not to evaluate/compare different TDM solutions.For Option 3, we would suggest to not consider it in Rel-18, as lots of discussions/evaluations are required to find a proper UL/DL pattern for TDD and FDD frequencies. |
| Samsung | Generalized solution on top of Option 1 and option 4.  | In our understanding, option 1~3 have the similar intention, i.e, the UE provides assistant information on preferred TDM pattern, and then, the gNB determines a TDM pattern accordingly and configures it to the UE. The above options1~3 represents different ways of TDM pattern provision. Actually, which way to indicate the preferred TDM pattern is not so important. A generalized way is that the UE provides a preferred TDM pattern to gNB with parameters as :* IDC-CycleStartOffset
* IDC-slotoffset: the value can be same as drx-SlotOffset
* IDC-ActiveTimeLength, which indicates the time length used for NR module, and the value can be same as drx-ActiveTime-r18

After that, the gNB can configure either DRX or MUSIM gap to the UE to avoid the IDC problem. Moreover, the above parameters should take the fine granularity of NR into account. In summary, we prefer to a generalized solution containing three parameters, i.e., IDC-CycleStartOffset, IDC-slotoffset, and IDC-ActiveTimeLength, with fine granularity. For option 4, we support to have it in NR considering the protection of some critical signal in non-3GPP module. In addition, to support MR-DC case, the above options should consider the multiple TDM pattern/autonomous denial configurations.  |
| ZTE | Option 2 | We prefer to take a common solution for all of the cases |
| Huawei, HiSilicon | Atleast Option 1.Option 4 (if time permits). | * Option 1- The biggest benefit of adopting DRX based solution (Option 1) is that DRX will in general mostly be configured by the network for the UEs in RRC\_CONNECTED state for reducing the UE power consumption. Reusing the DRX framework for resolving IDC is that we essentially get DRX solution almost for free as network just needs to configure / adjust DRX based on TDM assistance information from UE in UAI.
* Option 2 - Benefits of MUSIM gap like solution compared to DRX based solution is unclear and it needs more discussions regarding motivation/usecase for having the multiple periodic gaps, the need for aperiodic gap and will need extra specification efforts compared to option 1.
* Option 3 - We would suggest to not discuss this further in Rel-18 for the reasons given by the companies.
* Option 4 – We are open for Autonomous denial solution but it should only be considered as an addon solution after a general TDM solution is finalised.
 |
| Intel | Option 1 and Option 3, open for Option 4 | When discussing solutions (Option 1/2/3), it would be better to decouple the assistance data and the applied solution. For example, in LTE, for assistance data, either DRX assistance data or HARQ bitmap can be reported, while gNB configures DRX as TDM solution to handle IDC issue. From assistance data’s point of view, Option 1 and 2 are similar that a coarse granularity on/off pattern is reported. Option 3 addresses BT voice (eSCO) use case, which requires fine granularity of TDM pattern between NR and Bluetooth. Such fine granularity cannot be supported by Option 1. Therefore we propose to support Option 3.After gNB receives the assistance information, it is up to gNB implementation which solution can be applied, e.g. DRX, MUSIM or scheduling avoidance.We can follow majority view regarding Option 4. |
| Ericson | Option 1 | Wait with option 4. |
| vivo | Option 2 (as a common solution)Please notice: almost 3 periodic MUSIM gaps and one Aperiodic MUSIM gap can be configured for the UE simutanously in R17. It means that it is flexible enough to cover all cases.  | MUSIM gap like solution can be applied as a common solution. - Periodic gaps can be configured for IDC purpose instead of DRX (option1);- Aperiodic gaps can be configured as complementary solution for receiving important signalling instead of autonomous denial (option4). |
| Sharp | Option 1 | Also open for Option 3 and 4. |

# 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)"