**3GPP TSG-RAN WG2 Meeting #119bis-e draft R2-22xxxxx
Online, 10 - 19 Oct, 2022**

**Source:** Huawei/Apple

**Title:** Report of [AT119bis][303][NES] TP on NW DTX/DRX (Huawei/Apple)

**Agenda Item:** 8.3.2

**WID/SID:** FS\_Netw\_Energy\_NR– Release 18

**Document for:** Discussion and decision

# 1 Introduction

This document is the report of the following discussion:

* [AT119bis][303][NES] TP on NW DTX/DRX (Huawei/Apple)

- Review TP for NW DTX/DRX. Aim to capture some details on how DTX/DRX.

- Identify remaining questions/details that are required to be discussed for next meeting.

Deadline: Friday, Oct. 21th

Please provide your comments before Thursday 2022-10-20 10:00 UTC. Thanks!

# 2 Draft TR

Based on below agreements RAN2 made online, we provide a draft TR on NW DTX/DRX in the [folder](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_119bis-e/Inbox/Drafts/%5BOffline-303%5D%5BNES%5D%20TP%20on%20NW%20DTX%EF%BC%8FDRX%20%28Huawei%EF%BC%8FApple%29).

=> Let’s start with understanding solution in the context of connected

• Example 1: gNB is expected to turn off all transmission and reception for data traffic and reference signal during Cell DTX / DRX OFF duration.

• Example 2: gNB is expected to turn off its transmission / reception only for data traffic during Cell DTX / DRX OFF duration (i.e. gNB will still transmit / receive reference signals).

• Example 3: gNB is expected to turn off its dynamic transmission / reception during Cell DTX / DRX OFF duration (i.e. gNB is expected to still perform periodic transmission / reception, including SPS, CG-PUSCH, SR, RACH, and SRS).

• Example 4: gNB is expected to only transmit reference signals (e.g. CSI-RS for measurement).

**=> RAN2 assumes that the options above are possible for gNB DTX/DRX behavior and discuss UE RAN2 behavior/impact during the DTX/DRX.**

**=> For the purpose of our discussion we will focus on a single UE behavior at any point in time. FFS if we allow multiple configuration of NW DRX/DTX behaviors.**

=> Periodic DTX is assumed as a baseline. The gNB provides indication to UE about NW DTX mode/configuration via dedicated dynamic L1/L2 signaling.

=> Dynamic L1/L2 group signalling from NW to provide NW DTX mode/configuration is also considered in RAN2

=> It is beneficial to align UE DRX with network DTX and DRX alignment among multiple UEs. Details are FFS, including UE transmission/reception behavior during DTX. RAN2 to study the alignment.

Rapporteur first has a quick question on terminology alignment: in above agreement, both "NW DTX/DRX" and "Cell DTX/DRX" are used, but they seem to refer to the same thing. To avoid potential misunderstanding, Rapporteur would like to quickly check companies’ views on whether the terminology can be aligned in the TR.

**Q1: do you agree to align the following terminology in TR? If yes, which one do you prefer?**

1. **NW DTX/DRX**
2. **Cell DTX/DRX**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Yes / No (to align terminology)** | **If Yes, which option do you prefer** | **Detailed Comments if any** |
| Apple | Yes | b) or gNB DTX/DRX | We used "NW DTX/DRX" because some companies were not sure whether it is cell level or not before. During RAN2 online discussion, it seems a consensus that the configuration is cell specific. Meanwhile, RAN1 discussion also used the wording "cell specific DTX/DRX cycle". So, it seems consensus in both RAN1 and RAN2 that it is cell level or gNB level.  |
| Nokia |  |  | For SI phase TR, probably either one is fine. For stage 3 specifications, we will likely need to refer to cells since the UE only sees cells. |
| Samsung | Yes | NW DTX/DRX | NW DTX/DRX could be other-level, i.e. multiple cells could be aligned or it could be BWP-level. |
| vivo | Yes | b | We think DTX/DRX is configured at per cell level. |
| Fujitsu | Yes | NW DTX/DRX | NW DTX/DRX may stand for the spirit that the network transmits signal discontinuously no matter the exact level of operation, such as cell level, cell group level or gNB level DTX/DRX. We prefer to use a general terminology. |
| Fraunhofer | Yes | b - Cell DTX/DRX | A gNB should have the freedom to apply DTX/DRX to some cells while keeping other cells at high capacity (and energy consumption) state. Therefore, cell granularity seems more appropriate and “Cell DTX/DRX” is a better term.  |
| OPPO | Yes | b | We think the most important thing is to understand whether DTX/DRX is configured per cell or cell group and what the UE behaviour is when CA is supported for this case. Once it is clear, we can have proper terminology and see if any update is needed. At this stage, we are fine with b, but no strong view. |

Next, companies are invited to share their detailed comments on the draft TR in below Table. **Please do not insert / make comments in the TR document, which will be hard for Rapporteur to track and respond your comments.**

**Q2: Companies are invited to share their detailed comments on the draft TR in the table below.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Detailed comments** | **Rapporteur response** |
| Apple | We are overall fine with current version with Rapporteur's trackable changes (i.e. removing "via RRC signaling" and "one-shot"..). However, we want to clarify two different understandings on related agreements ("Periodic DTX is assumed as a baseline. The gNB provides indication to UE about NW DTX mode/configuration via dedicated dynamic L1/L2 signaling"):1) Alt-1: we agreed both periodic pattern, and one-shot pattern (as implied by "via dedicated dynamic L1/L2 signaling").2) Alt-2: we agreed semi-persistent pattern (i.e. RRC configures a periodic pattern and L1/L2 signaling to activate it).Our original version is with understanding Alt-1, while the current version (i.e. after Rapporteur removing "on-shot") seems to be with understanding Alt-2. We are OK if company prefer to clarify it in next meeting. |  |
| Nokia | Even though “The study will focus on a single UE behavior at any point in time.” was captured in the agreement, not clear what it meant. The online discussion seemed to e related to NW behaviour (Proposal 7: RAN2 discuss whether to allow multiple expected gNB DTX and DRX behaviors during NW DRX / DTX OFF duration which are associated with different NES states.) It can be left out for now and to be added later with more concrete descriptions? |  |
| vivo | 1. cell DTX/DRX may be also applied to RRC\_IDLE UE. We suggest to add a note: ‘FFS if NW DTX/DRX configuration is indicated to UEs in IDLE/INACTIVE state, which is beneficial for UEs to skip some DL/UL channels/signals transmissions/receptions.’2. The NW DTX mode / configuration can also be indicated by RRC signalling, we don’t understand why we have to put an emphasis on ‘via L1/L2 signalling’ and suggest to remove it as:The NW DTX mode / configuration can be indicated to the UE ~~via dynamic L1/L2 signalling. The dynamic L1/L2 signalling at least supports UE dedicated indication.~~3. We are generally fine with the rapporteur removing ‘the one shot pattern’ as we observe quite limited NES gain from enabling it. |  |
| Fujitsu | We are generally ok with current version and agree that the rapporteur removing ‘the one shot pattern’.For the sentence: “The NW DTX mode / configuration can be indicated to the UE via dynamic L1/L2 signalling.”, we think it should be FFS the NW configuration is indicated to UE since the indication may not be necessary if only one DTX configuration is supported. The definition for NW DTX mode should be described clearly (e.g., it refers to NW transmission/non-transmission).On the examples for gNB DTX / DRX behavior, there seems no clear difference between Example 2 and Example 4. Could Rapporteur clarify that?We wonder whether RAR should be considered in gNB DTX/DRX behaviour and whether the group common signal should also be considered if group L1/L2 signalling is introduced to indicate the UE on NW DTX mode. Following is the example for changes of the TP on gNB behavior when RAR and group common signalling are considered:* Example 1: gNB is expected to turn off all transmission and reception for data traffic, reference signal as well as group common signal during Cell DTX / DRX OFF duration.
* Example 2: gNB is expected to turn off its transmission / reception only for data traffic during Cell DTX / DRX OFF duration (i.e. gNB will still transmit / receive reference signals and group common signal)
* Example 3: gNB is expected to turn off its dynamic data transmission / reception during Cell DTX / DRX OFF duration (i.e. gNB is expected to still perform periodic transmission / reception, including SPS, CG-PUSCH, SR, RAR, RACH, SRS reference signal and group common signal).
* Example 4: gNB is expected to only transmit reference signals (e.g. CSI-RS for measurement).

And we also propose a small change to following Editor’s note:*“Editor's note: FFS details of alignment, including UE transmission/reception behavior if configured with NW DTX/DRX.”* |  |
| Fraunhofer | None of the examples currently provided in the draft TR mentions the presence of SSB and the need for alignment of Cell DTX/DRX with the SSB periodicity. But that will be the case. The goal for energy saving is to create the largest time gap possible (without excessively affecting QoS/data rates) between transmissions. This can only be done by aligning further transmissions to be close in time to SSB transmissions.  |  |
| OPPO | Based on the agreement achieved, we understand that the NW DTX mode/configuration can be indicated via L1/2 signalling and RRC signalling, as typically RRC signalling can provide a periodic NW DTX/DRX from gNB.For point 1 mentioned by vivo, we are fine to have an EN in the TR, “FFS if NW DTX/DRX configuration is indicated to UEs in IDLE/INACTIVE state”. |  |

# 3 Remaining issues

According to the discussion during this RAN2 meeting, the agreements and FFSes are captured as below:

• Example 1: gNB is expected to turn off all transmission and reception for data traffic and reference signal during Cell DTX / DRX OFF duration.

• Example 2: gNB is expected to turn off its transmission / reception only for data traffic during Cell DTX / DRX OFF duration (i.e. gNB will still transmit / receive reference signals).

• Example 3: gNB is expected to turn off its dynamic transmission / reception during Cell DTX / DRX OFF duration (i.e. gNB is expected to still perform periodic transmission / reception, including SPS, CG-PUSCH, SR, RACH, and SRS).

* Example 4: gNB is expected to only transmit reference signals (e.g. CSI-RS for measurement).

**=> RAN2 assumes that the options above are possible for gNB DTX/DRX behavior and discuss UE RAN2 behavior/impact during the DTX/DRX.**

**=> For the purpose of our discussion we will focus on a single UE behavior at any point in time. FFS if we allow multiple configuration of NW DRX/DTX behaviors.**

=> Periodic DTX is assumed as a baseline. The gNB provides indication to UE about NW DTX mode/configuration via dedicated dynamic L1/L2 signaling.

=> Dynamic L1/L2 group signalling from NW to provide NW DTX mode/configuration is also considered in RAN2

=> It is beneficial to align UE DRX with network DTX and DRX alignment among multiple UEs. Details are FFS, including UE transmission/reception behavior during DTX. RAN2 to study the alignment.

Rapporteur identifies the following issues to be further addressed at next RAN2 meeting accordingly:

### #1 Configuration and signalling

The aspects need to be addressed are summarized as below, assuming a single UE behaviour at a time:

1. The detailed information to be configured, e.g. DTX/DRX pattern etc.
2. The signalling design, including but not limited to:
* Configuration by RRC signalling or lower layer signalling?
* Notification procedure and signalling of DTX/DRX mode?
* How group signalling applies to the configuration or mode notification?

**Q3: Do companies agree with the above observation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Comments** |
| Apple | Yes with comments | We basically agree with Rapporteur. However, we have two comments / suggestions:1) For signaling design, we think 1st point "Configuration by RRC signalling or lower layer signalling " seems to be unnecessary. Because we have agreed periodic pattern, it is our understanding that RRC signaling is must (it doesn't make sense that lower layer signaling alone can configure a periodic pattern).2) As we mentioned in Q2, our understanding is that RAN2 agreed both periodic pattern and one-shot pattern. If so, the signaling design should be separately discussed for periodic pattern and one-shot pattern. But it depends on whether companies have consensus in Q2. Thus, we suggest to modify it to: - Clarify whether support one-shot DTX/DRX pattern and/or semi-persistent pattern* Configuration procedure and signalling ~~by~~ (e.g.RRC signalling and/or lower layer signalling)?
 |
| Nokia | Yes  | Whether there is a need to introduce “NES Mode” could be decided later after the functionalities are clear. |
| Samsung | Yes |  |
| vivo | Yes |  |
| Fujitsu | Yes | We assume that if a semi-static or periodic NW DTX/DRX pattern (i.e., the NW transmission mode is periodically present) is supported, the parameters related to the configuration is necessary, such as NW DTX/DRX on-duration and periodicity and something else. And the signal for delivering the configuration can be studied, such as using broadcasted or dedicated RRC signaling to UE.As for notification of NW DTX/DRX mode, we understand that if DTX/DRX mode refers to gNB’s transmission/non-transmission status the motivation is to consider the dynamic NW DTX/DRX pattern (i.e., the NW transmission is available dynamically) apart from the periodic pattern. In the dynamic pattern, group signaling can be applied to indicate multiple UEs for changing the NW mode between transmission and non-transmission.  |
| Fraunhofer | Yes, but | We consider it is premature to discuss the signaling at this level of detail.  |
| OPPO | Yes |  |

In addition to this, there is one FFS on whether to support multiple configurations. It is also worthwhile to address this at next RAN2 meeting. From rapporteur’s observation, the below needs to be addressed:

1. Whether multiple configurations refer to separate configuration between DTX and DRX, or refer to different sets of configurations for DTX, and different sets of configurations for DRX respectively?
2. Whether this brings benefits compared with the assumption of one configuration at a time?
3. The potential signalling impacts.

**Q4: Do companies agree the above aspects need to be addressed for multiple configuration of DRX/DTX?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Comments** |
| Apple | Disagree 1) and 2) | For 1), we think there are two issues mixed which makes 1) look confusing. Our understanding is:a. Joint or separate configuration of DTX and DRX mode/operation? b. Whether multiple sets of DTX/DRX configurations (joint or separate depends on conclusion of a) are allowed.Please note that we use the same RAN1 discussion wording for a).For 2), our agreement is "a single UE **behavior** at any point in time" rather than "a single **configuration** at a time". We think the intention is that RRC can configure multiple sets of DTX and/or DRX modes, but gNB only notify UE with one mode via L1/L2 signaling. Thus, we suggest below changes:1. ~~Whether multiple configurations refer to separate configuration between DTX and DRX, or refer to different sets of configurations for DTX, and different sets of configurations for DRX respectively?~~ Joint or separate configuration of DTX and DRX mode/operation?
2. Whether multiple sets of DTX/DRX configurations/modes are allowed~~? this~~ to brings benefits compared with ~~the assumption of~~ only one configuration at a time?
 |
| Nokia | Yes |  |
| Samsung | No | NES gain will be maximized when the gNB turns off the functionalities as much as possible. Then, multiple configurations or separate DTX&DRX seems not necessary. NW may have multiple NES options, but one configuration is sufficient at a time for a UE. |
| vivo | Yes | 1) we think it refers to different sets of configurations for DTX/DRX.2) We assume the question here is not about whether enabling multiple configurations brings more or less NES gain. Rather, without clear definition of cell DTX, we are not sure whether one set of configuration is enough to implement cell DTX without affecting much UE performance. one UE may be submissive to several cell DTX configurations, since the original C-DRX pattern may be downgraded to cell DTX pattern. For example, the cell may configure different groups of UE with different DTX patterns. If UE-A is originally configured with 10ms DRX cycle, UE-B with 20ms, UE-C with 40ms…and if DTX for (UE-A, B, C) is configured with 40ms DTX cycle, UE-A may need to apply several DTX patterns at the same time to compensate its original DRX cycle loss. If the original C-DRX pattern can already be aligned with direct NW implementation, we do not see there is any need on spec change. |
| Fujitsu | No | Before discussing 1) and 3), the necessity on multiple pre-configured patterns for DTX/DRX should be evaluated, i.e., 2) should be discussed first. We understand multiple DTX configurations may be needed for NES, but different configurations can not be applied at the same time.For the configuration indication to UE, not only L1/L2 signalling but also RRC message is possible just as vivo points out. |
| Fraunhofer | No | 1. In our view the DTX/DRX configuration should be a bundle (a configuration contains both DTX configuration and DRX configuration). Multiple configurations should then refer to different bundle of configurations (not separate DTX and DRX)
2. Traffic varies a lot, so it can be useful to have more than 1 DTX/DRX configuration (but not too many)
3. In our view it is premature to dig into signaling details.
 |
| OPPO | See comments | We would like to clarify the multiple configurations of DRX/DTX are from the UE perspective or the NW perspective, we understand that the former is the intention, right? In addition, it is unclear whether the multiple configurations of DRX/DTX focus on multiple DRX/DTX patterns, or one DRX/DTX pattern but different UE behaviours (e.g. the four examples captured in the TR). We think either can work but not sure about the intention of the question here.  |

According to the papers from [R2-2210253](file:///C%3A%5CUsers%5Cmtk65284%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2_RL2%5CTSGR2_119bis-e%5CDocs%5CR2-2210253.zip) and [R2-2210595](file:///C%3A%5CUsers%5Cpanidx%5COneDrive%20-%20InterDigital%20Communications%2C%20Inc%5CDocuments%5C3GPP%20RAN%5CTSGR2_119bis-e%5CDocs%5CR2-2210595.zip) (although not discussed online), there is one open question on whether this DRX/DTX applies per serving cell or per UE. The scenario needs to be understood first: in which cases, when gNB is already in energy saving mode, it still needs to support multiple serving cells as CA. Therefore this aspect may need further discussion on which scenarios are supported.

**Q5: Do companies agree to discuss the scenarios where DTX/DRX is already configured and the gNB still needs to configure multiple serving cells as CA (i.e., DTX/DRX configured together with CA)?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Comments** |
| Apple | Yes with comments | We think below change seems to be more aligned with Rapporteur text:**discuss whether there are valid ~~the~~ scenarios where DTX/DRX is already configured and the gNB still needs to configure multiple serving cells as CA (i.e., DTX/DRX configured together with CA)?** |
| Nokia | - | Not clear what the issue is about. Cell specific configurations are per serving cell with or without CA. |
| Samsung | Yes | RAN2 is also considering other NES options for CA. We do not need to exclude CA scenario for DTX/DRX. |
| vivo | Yes |  |
| Fujitsu | Yes | We should first make clear whether the scenario that multiple serving cells of the same NW node apply DTX/DRX concurrently is available. We think there may be different scenarios to consider, that whether DTX/DRX applies per cell or per NW node can be FFS depending on different scenarios. |
| Fraunhofer | Yes | In our understanding what to do first (whether to apply DTX/DRX or to adapt from CA to single-carrier) is dependent on the hardware architecture. Therefore, some flexibility for vendors and operators is desirable. Also it could be that CA is used for reliability or SUL for uplink coverage. In those cases it could be that DTX/DRX is useful while still maintaining CA.  |
| OPPO | Yes with comments | We think the intention is to ask for a valid case of DTX/DRX configured together with CA. If so, we are fine with Apple’s suggestion. |

### #2 UE behaviour and gNB behavior

There are 4 examples agreed for DTX/DRX. It would be good that for each example, the detailed UE and gNB behaviour can be analysed. This is also important to assess the benefits of each direction. For each example, it is suggested to analyse the below aspects:

1. From gNB side, which information needs to be transmitted and potential benefits for energy saving
2. from UE side, the behaviour like which information needs to be received, monitoring etc., performance impact compared with normal access, impact on legacy UEs if any

**Q6: Do companies agree with the above observation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Comments** |
| Apple |  | We think maybe some high level gNB/UE behavior can be discussed for next meeting, but detailed behaviors should be discussed in normative phase. We tend to think current part of TR (i.e. providing 4 possible examples) is sufficient to conclude SI.  |
| Nokia | Yes with comment for 2) | Legacy UEs wouldn’t see the new command so it will follow legacy procedure. Not clear what impact on legacy UEs is referring to. |
| Samsung | Yes |  |
| vivo | Yes |  |
| Fujitsu | Yes | Among the 4 mechanisms in examples, the impact on legacy UEs can be assumed as that: Example 3 < Example 2 < Example 4 < Example 1.Maybe the TP can add the text on which DTX/DRX mechanism can be applied to the serving cell of the legacy UE considering the impact to legacy UEs on operations such as random access, monitoring, measurement, for different DTX/DRX mechanism. |
| Fraunhofer | No | It is a bit premature to make a detailed analysis of multiple levels. For now it should suffice to rank the given examples in terms of expected energy saving and impacts. From maximal to minimal energy saving: example 1, example 4, example 3, example 2. Cumulative Impact (naturally the reverse order of savings): Example 3 – only latency for dynamic transmission. Example 2 – The same as example 3 and further setup delayExample 4 – The same as example 2 and further synchronization delayExample 1 – The same as example 4 and suboptimal scheduling when the traffic starts to ramp up again.  |
| OPPO |  | We understand the detailed discussion may need further RAN1/RAN4 input/evaluation. At this SI stage, maybe a general discussion is sufficient.  |

### #3 Alignment

According to the discussion, there will be at least two aspects for discussion:

1. Whether/how to align UE DRX with network DTX, including UE transmission/reception behavior during DTX
2. Whether/how to align DRX alignment among multiple UEs

**Q7: Do companies agree with the above observation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Comments** |
| Apple | Yes |  |
| Nokia | Yes for 1)No for 2) | How to align DRX configuration for multiple UEs is up to NW implementation. Nothing can be done from UE side for multiple UEs. |
| Samsung | Yes |  |
| vivo | Yes for 1)No for 2) | As commented in Q4, we think 2) is up to NW implementation without spec change. |
| Fujitsu | Yes for 1)No for 2) | On alignment between UE DRX and NW DTX, we think coordination between UE DRX and NW DTX can be considered. For example, what’s the UE reception behavior during the DRX active time when the NW is in non-transmission mode.The necessity on aligning DRX among UEs should be clarified. Then how to do DRX alignment among multiple UEs can be FFS on whether it is applied by implementation or not. |
| Fraunhofer | Yes | The alignment should be a goal. It is essential for global energy saving (network + UE). But the exact details (how to do it) should be FFS.  |
| OPPO | Yes for 1)No for 2) | For 2), we also think it can depend on the NW implementation. |

In addition to the above, there were also a couple of papers discussing UE assistant information. However from rapporteur’s observation, this can be done in a later stage, e.g. normative work directly. As if the above aspects are made clear and feasible, there would be no big problem to re-use existing UE assistance information or enhance whenever needed. So it is better to focus on the above aspects which are more fundamental for the DTX/DRX mechanism.

# 4 Conclusion

To be completed