**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. |
| Ericsson | Yes | b - Cell DTX/DRX  | We think that the NW DTX/DRX should be defined at the cell level (i.e., configurable per serving cell). We think that the NW DTX/DRX on the cell would be more flexible for the following reasons. First, the NW DTX/DRX on the cell would have less impact on the legacy UEs, since the NW may keep cells where it does not apply DTX/DRX so that legacy UEs can access those cells, while DTX/DRX could be used on a serving cell of NES capable UEs. Second, the NW DTX/DRX at the cell level would in general have a less latency-related impact on the UEs capable of CA and DC since the NW may apply different DTX/DRX schemes (e.g., with misaligned active and non-active periods) for different cells such that the UE can access at least one of the cells at any time. |
| Intel | Yes | b) | We prefer the term “cell” DTX/DRX, i.e., a given cell is observing DTX/DRX, not NW as a whole. Cell level provides finer granularity in operation than network. In a given time, a certain cell is not serving load or low load, that cell can be in DTX/DRX. |
| Huawei, HiSilicon | Yes | b) | We also think DTX/DRX is configured per cell. |
| Qualcomm | Yes | Cell DTX/DRX | The DTX cycle can be signaled via L1/L2 and is specifically local to DU in our view. Thus, cell DTX/DRX captures the correct granularity of the solution(s).  |
| Interdigital | Yes | b | Either term is okay, though cell DTX is more descriptive and accurate as it reflects cell-specific discontinuity.  |
| LGE | Yes | b) | Each cell in the network may have its own Cell DTX/DRX pattern. |
| CATT | Yes | b) |  |

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. | Agree there is some confusion on the detailed procedure, “RRC signaling” and “one-shot” were removed because they are not mentioned in the agreement. We would like to further clarify the two alternatives you mentioned, and add a 3rd possible understanding.Alt-1: Allow both periodic pattern (configured by RRC) and one-shot pattern (configured by L2/L2 signaling)Alt-2: Allow periodic pattern, configured by RRC and activated by L1/L2 signalingAlt-3: Allow periodic pattern, configured by L1/L2 signalingBut Alt-3 would be weird (not allowing RRC) because DRX are typically configured by RRC.Considering there are also several other companies (OPPO, Ericsson, Intel) mentioned that RRC configuration should be baseline, and no one is against RRC, I will restore “via RRC signaling” and the “also” in L1/L2 signalling. |
| 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? | The wording suggested by Ericsson is adopted in the updated TR. |
| 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. | 1. We had the following agreement:=> Let’s start with understanding solution in the context of connected I think “NW DTX/DRX is applied to at least UEs in RRC\_CONNECTED state” already means whether to indicate DTX/DRX configuration to Idle/Inactive UEs is FFS. I prefer not to add the extra editor’s note, especially when the second part related to benefits were not discussed.[vivo] Sure, we understand your concern and are fine with that.2. In the agreement, we only mentioned “L1/L2 signaling”, RRC signaling was not mentioned.I somewhat agree with you that RRC should not be excluded (as indicated by Apple, there are several interpretations), and the “RRC signaling” is restored in the first paragraph, that’s all I can do now.[vivo] Thank you Lili, but your revisement is not what I intended to say. What I meant is that, the configuration and indication of DTX pattern may be separate. For example, there are some common ways to implement it:1. DTX pattern is configured by RRC signalling, and it is activated upon configuration;2. DTX pattern is configured by RRC signalling, and it is later indicated/activated by L1/L2 signalling;3. DTX pattern is directly indicated/activated by L1/L2 signalling with several bits, and UE refer to the spec, e.g. 38213 to find which DTX pattern the bit string maps to;Therefore, a simpler way may be to move the line from third paragragh from the bottom ‘The NW DTX mode / configuration can also be indicated to the UE via dynamic L1/L2 signalling’ to the first paragragh:A periodic NW DTX/DRX (i.e., active and non-active periods) mode / configuration can be configured/indicated by gNB via L1/L2 signalling or RRC signalling. |
| 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.”* | We had the following agreement:=> The gNB provides indication to UE about NW DTX mode/configuration via dedicated dynamic L1/L2 signaling. Therefore I cannot make it an FFS.On the definition for DTX/DRX, the following explanations are in TR 21.905, and they will apply to this TR by default:DTX Discontinuous TransmissionDRX Discontinuous ReceptionBesides, Ericsson also proposed some wording revisions on this aspects, which will be included in the updated TR.On the difference between Example 2 and 4, I think 4 only mentions the transmission of RS, while 2 is about both transmission and reception of RS.On the revisions:I am ok with adding “data” in Example 3.However, I don’t think “RAR” belongs to periodic transmission/reception.And I cannot add group common signaling, as we have the following description:*Whether UE group common signalling is also supported will be further studied.*On the EN:Maybe we can leave the EN as it is, which is in line with the online agreement, the wording improvements are not necessary considering it is not formal text in the TR and will be removed eventually. |
| 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.  | I think SSB belongs to “reference signals”. |
| 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”. | “RRC signaling” will be restored.On the EN: same responses as to vivo. |
| Ericsson  | 1. We think that the configuration via RRC should be considered as a baseline, and hence we suggest restoring “via RRC signalling” in the first paragraph.
2. Having “DTX/DRX ON and OFF durations” in the examples before they were introduced seems incoherent, and hence we suggest their definition earlier before listing the examples. Furthermore, in order to be consistent with already established UE DRX terminology, we suggest using “active period” instead of “ON duration” and “non-active period” instead of “OFF durations”. Based on this and the previous comment we suggest the following rewording:
	1. A periodic NW DTX/DRX (i.e., active and non-active periods in the sleeping pattern) can be configured by gNB via RRC signalling.
	2. Below examples on gNB DTX / DRX behavior during non-active period are assumed to be possible, and the UE behavior / impact will be studied:
	3. Example 1: gNB is expected to turn off all transmission and reception for data traffic and reference signal during Cell DTX / DRX non-active period.
	4. Example 2: gNB is expected to turn off its transmission / reception only for data traffic during Cell DTX / DRX non-active period (i.e. gNB will still transmit / receive reference signals).
	5. Example 3: gNB is expected to turn off its dynamic transmission / reception during Cell DTX / DRX non-active period (i.e. gNB is expected to still perform periodic transmission / reception, including SPS, CG-PUSCH, SR, RACH, and SRS).
3. We agree with Nokia that it is not clear what is meant by “the study will focus on a single UE behavior at any point in time.”. If our understanding is correct that this is about having only one active NW DTX/DRX configuration at a time, we suggest the following wording update:
	1. The study will focus on a UE behavior when at any point in time the NW activates a single DTX/DRX configuration.
4. We think that the UE does not need to be provided with NW DTX configuration, but rather notified about the NW sleeping pattern, and hence we propose the following reformulation:
	1. NW can notify the UE about DTX via dynamic L1/L2 signalling.
 | 1) “RRC signaling is restored”2) I appreciate the suggested definition for NW DTX/DRX, but “sleeping pattern” is another undefined term, so “in the sleeping pattern” can be removed.3) Same understanding, the sentence will be revised as suggested.4) This is related to the different understandings of the role of L1/L2 signaling, whether it provides configuration or just activation. Prefer to keep the current wording until further progress is made. |
| Intel | The ‘via RRC signalling’ should be restored as this Cell DTX/DRX pattern configuration can only be configured via RRC signalling. Whether it is via dedicated or broadcast RRC signalling can be discussed. Note this is the configuration of the cell DTX/DRX pattern and not the indication to trigger the use of it which is based on dynamic L1/L2 signalling.On the sentence ‘The dynamic L1/L2 signalling at least supports UE dedicated indication. Whether UE group common signalling is also supported will be further studied.’, our understanding from the agreement is both dedicated and group signalling are considered by RAN 2. Hence, we propose to replace sentences with the following:‘Both dedicated and UE group-common indication are to be considered for the dynamic L1/L2 signalling’  | “RRC signaling” is restored.I think “dedicated signaling” and “group common signaling” should not be at the same level in the description. According to the agreements, “dedicated signaling” is already agreed, but whether “group common signaling” is supported will be further studied. |
| Apple2 | We are fine with latest version.  |  |
| Qualcomm | 1) We would prefer adding some FFS related to cell DRX. In particular, we do not agree grouping cell DTX/DRX in the TP. We actually think that it doesn’t make sense for cell DRX to operate similar to cell DTX since it relies on UL traffic. So our suggestion: “FFS on whether cell DRX follows the same procedure as DTX.FFS on whether DTX/DRX can be configured jointly”. 2) “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. Whether UE group common signalling is also supported will be further studied.”  Can configuration really be indicated via L1/L2 signalling. It seems configuration is always RRC indicated and L1/L2 would just be indication of pattern change. In case the text is to cover the one-shot scenario, if agreed, then that would also not be a “configuration” but rather a one-shot activation so prefer clarifying that. 3) We agree with Ericsson that we can define NW DTX/DRX before introducing examples.4) Agree with Nokia and Ericsson that this phrase: “the study will focus on a single UE behavior at any point in time.” is confusing since it seems to indicate we are looking at a single UE behavior which is not the case in NW DTX since the whole point is aligning multiple UEs. |  |
| Interdigital | We suggest adding an editor’s note to clarify whether DTX/DRX is also applicable to UEs in idle/inactive states. Also suggest clarifying that handling of UE initiated uplink transmissions during cell DTX is to be studied. |  |
| CATT | - “Below examples on gNB DTX / DRX behaviour in the OFF duration are assumed to be possible options, and the UE behaviour / impact will be studied”- Regarding “OFF duration” terminology, 38.300 uses “on-duration” for the legacy DRX. Maybe we could reuse this terminology: on-duration / off-duration.- Regarding the EN “*FFS if multiple configurations of NW DRX/DTX behaviors are allowed*”, we suggest adding “per serving cell” because we understand this is independent from the CA case.  |  |

# 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 |  |
| Ericsson | Yes, with comments | Similar to our comment for the TR we think that “assuming a single UE behaviour at a time” seems ambiguous and we suggest having “assuming a UE behavior when at any point in time the NW activates a single DTX/DRX configuration.”.1. Regarding the NW DTX/DRX pattern, we think that the periodic pattern should be investigated first, and then later we can assess the other patterns such as single shot and semi-persistent. Furthermore, we would like to clarify that when talking about “detailed information to be configured” we should keep in mind that the objective is not to configure NW DTX/DRX at the UE side, but we rather need to configure the UE behavior to be in accordance with NW availability when using DTX/DRX.
2. Regarding the signalling design, we have the following view:
* We agree with Apple that the configuration via RRC signalling should be a baseline and later we can study the other ways of signaling.
* At this stage, we do not see the need for the NW to signal the exact DTX/DRX mode to the UE, and the need for “NES Mode” is unclear at the moment as pointed out by Nokia. The UE rather needs to be instructed on how to behave during the periods that the NW uses DTX/DRX, but the UE does not need to know the exact NW DTX/DRX mode.
* We think that we should first prioritize dedicated signalling as it is simpler and it would allow for a better understanding of the NW DTX/DRX framework, and then later we can investigate how to make use of group signalling for NW DTX/DRX. Furthermore, we should keep in mind that the main energy savings in the case of the NW DTX/DRX technique come from the opportunities for the NW to go to sleep mode, and not from optimizing how to signal the configuration and inform the UE about NW DTX/DRX. Therefore, we think that it would be reasonable to start by understanding how to maximize the sleep opportunities on the NW side with the minimum impact on the UE performance while assuming the signalling baseline (e.g., via RRC and dedicated).
 |
| Intel | Yes, with comments | We also agree with Apple and Ericsson that on bullet#1 of 2) should be that as baseline, RRC signalling is used for the delivery of the Cell DTX/DRX pattern configuration.As mentioned in our response to Q2, the UE group common indication should be discussed together with dedicated indication and hence we support bullet#3 of 2). |
| Qualcomm | Yes | -We think the second bullet can be revised to “notification procedure and signalling of DTX/DRX patterns”. In our view, the configuration should always happen at the RRC level. Even a one-shot pattern would be signaled but not configured. Thus, the first bullet should only pertain to periodic patterns. What or how is that configured is the configuration part of the study. -The other part is signalling to the UE or a group of UEs, this can include pre-configured patterns or a one-shot pattern (if agreed).-We also agree with other companies that the phrase “assuming a single UE behaviour at a time” is confusing, in the end, the point is aligning all the UEs so a single UE assumption would be counter-intuitive.  |
| Interdigital | Yes |  |
| LGE | Yes, but | We think the UE does not need to know NW DTX configuration because UE DRX can be used for supporting NW DTX. On the other hand, the UE needs to know Cell DTX configuration because the UE needs to know when the cell can receive its UL transmissions. |
| CATT | Partly | We agree with Apple that the configuration (first bullet) is necessarily by RRC. Lower layer signaling can only take place after that, e.g. for adapting/enabling/disabling the RRC configuration. So we suggest removing “or lower layer signaling” in first bullet and moving it to the 2nd bullet.Same view as Ericsson about “single UE behaviour at a time”.We are not sure what “mode” means here. It seems to refer to some kind of switching across NES modes (e.g. those listed as examples in the TR). Maybe we could leave it more generic e.g. “Notification procedure and signalling of DTX/DRX ~~mode~~dynamic control”? |

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.  |
| Ericsson | Yes but | We agree to study these aspects, and we also think that the formulation of question 1) needs to be clarified. We agree with Apple’s suggested way of splitting question 1) into two questions.  |
| Intel | See comments | For 1), we are fine with it as we think this needs to be clarified on what it meant by multiple configurations. For 2), our understanding is that different Cell DTX/DRX modes (i.e. different pattern configurations) can be configured to the UE via RRC signalling but only 1 mode is active at any one time. Hence, we think the current formulation is not right.Hence, we disagree with Apple reformulation on 1) and 2). We do not see the need of 2) as it is still following 1 configuration at a time even with multiple configurations. We think the change should be like below: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 multiple DTX/DRX configurations/modes (based on the definition of multiple configurations from 1)) are allowed to be configured via RRC signalling?
3. The potential signalling impacts.
 |
| Apple2 |  | With latest version, we agree Intel's suggested 2) is more clear.For 1), we still think current formulation may confuse people, and suggest reformulation, i.e. 1) Joint or separate configuration of DTX and DRX mode/operation?2) Whether multiple DTX/DRX configurations/modes (based on the definition of multiple configurations from 1)) are allowed to be configured via RRC signalling? |
| Qualcomm | Yes  | We are fine with Apple’s suggested wording with some modifications: * On the technical aspects themselves, we do not see a reason to couple DTX and DRX. We think the in-meeting agreements were focused on NW DTX, i.e., when the cell refrains from transmitting to save energy. On the other hand, DRX, when the cell does not decode is also worth discussing but we think the mechanisms and the drivers are separate (DL traffic vs UL traffic).
* We think at least two NW DTX configurations (normal and NES) need to be configured as a starting point. We are open to more configurations if a good case is made for them
* For NW DRX, it is assumed here by the rapporteur that DRX would follow the exact mechanism of NW DTX (even if it’s separate). We actually disagree with this assumption; NW DRX can, for example, be L1 signaled only and does not need a pre-configuration like NW DTX (which corresponds to UE C-DRX), thus we prefer leaving NW DRX more open ended, for example:

The mechanism to activate NW/Cell DRX, if different from NW/cell DTX.  |
| Interdigital | Yes | We think the network can configure the UE with multiple sets of DTX/DRX modes, but the serving cell can indicate to the UE only one mode using L1/L2 signaling. Another question is the association between DTX/DRX mode and NES mode. |
| LGE | Yes | We think a UE can be configured with multiple sets of configurations for UE DRX (to support Cell DTX operation) and one configuration for NW DRX. It can be discussed whether UE can use a combination of multiple configurations for UE DRX at a time or not. Separate configuration between DTX and DRX is beneficial for handling different characteristics of UL transmission and DL transmission if RX power is much less than TX powers. |
| CATT | Yes with adjustments | We agree with the changes proposed by Apple |

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. |
| Ericsson |  | Assuming that the configuration is per serving cell, the solution should be applicable to CA. Hence, we agree with Nokia that it is not clear what the issue is. |
| Intel |  | Since the DTX and DRX is per cell, we do not see an issue with CA. |
| Apple2 |  | We tried to avoid technique discussion before. But since some companies were confused, we would like to make technique issues clearly:1) Whether valid to keep CA in Cell DTX/DRX: As we know, CA is used when NW want to increase UE throughput with cost of more power consumption. However, when NW enters DTX/DRX inactive duration, it should be low loading traffic (as mentioned in SID), then it is questioned why CA is still kept with increased power consumption. Please note that during Handover, the current spec was specified that gNB will release all SCells due to similar reason. 2) If company can achieve consensus that CA can be kept in 1), then RAN2 will have a tricky question on how to model cell DTX/DRX for UE. As we know, UE CDRX is performed per MAC entity (configured within *MAC-CellGroupConfig*), which means a single UE DRX configuration across all serving cells within one cell group. If Cell DTX/DRX is configured per serving cell, does it mean we need to apply a different MAC modeling for cell DTX/DRX? Meanwhile, this question is also related to alignment between cell DTX and UE DRX. Thus, we suggest to first conclude 1), and then discuss per MAC entity config per serving cell if RAN2 can agree to keep CA during cell DTX/DRX inactive duration.   |
| Qualcomm | Yes  | DTX with CA/DC is a non-trivial problem since UEs accessing a certain Scell would need some enhancements to align with the cell’s DTX pattern |
| Interdigital | Yes | DTX/DRX modes are configured per serving cell, as some cell may be in NES while others won’t. |
| LGE | Yes | Cell DTX/DRX can be configured with CA. It is a possible requirement that the maximum data rate during the UE Active time or Cell DTX ON duration to be supported is higher than the data rate supported by a single serving cell. |
| CATT | Yes | Support to study and discuss the scenarios. |

### #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.  |
| Ericsson | Yes but | We agree that these aspects need to be discussed eventually, but we think that it is too early to go into a detailed discussion and that it would be better to first prioritize and address the other higher-level questions. |
| Intel |  | We agree that the detailed discussion may need to be discussed eventually but then it will require RAN1/RAN4 input. Maybe a high level view is sufficient at the SI phase. |
| Qualcomm | Yes |  |
| Interdigital | Yes |  |
| LGE | Yes | The possible gNB behaviors seems already identified at high level by the given examples. The study on corresponding UE behavior and impact needs to be further focused. |
| CATT | Yes |  |

### #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. |
| Ericsson | Yes for 1)No for 2) | We think that it is important to study how the NW DTX/DRX can be combined with UE DRX in the case of single and multiple UEs, respectively. However, we think that the NW DTX/DRX should not be simply defined based on the alignment of the DRX patterns of multiple UEs, and it should rather depend on the NW implementation. We also think that there is a need to clarify and understand what is meant by “alignment”. |
| Intel | Yes | We think that both should be studied together to achieve the maximum NES gain, via UE group common signalling. |
| Qualcomm | Yes | 1) and 2) should be discussed. Need to extend the discussion in the cases in which BS DTX is not necessarily aligned with UE C-DRX |
| Interdigital | Yes for 1)No for 2) | Agree with comments above that the focus should be on aligning DTX and DRX, with the focus on single UE behavior |
| LGE | Yes for 1)No for 2) | How to align UE DRX among multiple UEs is up to NW implementation. Nothing can be done from UE side for multiple UEs. |
| CATT | Yes | Beside 1), how to reduce the signaling overhead can be considered in 2). |

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