**3GPP TSG RAN WG1 Meeting #112bis-e R1-2303896**

**e-Meeting, April 17th – 26th, 2023**

**Source: Moderator (Intel Corporation)**

**Title: Discussion summary #1 of issues for enhancements on cell DTX/DRX mechanism**

**Agenda item: 9.7.2**

**Document for: Discussion**

# Introduction

In this contribution, moderator summarizes issues identified by the submitted technical contributions for RAN1 #112bis-e agenda 9.7.2 Enhancements on cell DTX/DRX mechanism.

# Summary of issues

## 2.2 General cell DRX/DTX operation

* [1] Futurewei
  + Observation 5: Instead of completely turning off the whole cell, it is more likely that in real deployments that a subset or subsets of the gNB operations are deactivated or muted.
  + Observation 6: RAN2 should support in their specifications Cell DTX/DRX operations that includes more granular deactivation or muting for energy savings purposes such as inter-node beam or spatial configurations activation.
* [2] Huaewi/HiSilicon
  + Proposal 1: Cell DTX/DRX should be applied in a serving cell level.
* [3] Panasonic
  + Proposal 1: Cell DTX design can be more prioritized than Cell DRX, as gNB DL transmission dominates the total energy consumption. The exact UE behaviour impacted by the Cell DRX should be carefully justified for better tradeoff among network energy saving, UE power saving and system stability.
  + Proposal 9: For better network energy saving gain, the cell DTX/DRX patterns/parameters can be considered to be aligned with I-DRX.
* [4] Nokia/NSB
  + Proposal 1: Wait for RAN2 agreements on Cell DTX/DRX configuration/ activation/ deactivation.
  + Proposal 13: Enhancement on cell DTX/DRX mechanism can be jointly considered with adaptation of spatial and power domain techniques.
* [5] vivo
  + Proposal 6: Support the following UE behavior when cell DTX and UE C-DRX are both configured in the following.
    - Cell DTX UE DRX UE behavior
    - active active Normal
    - active Non-active Follow behavior for non-active period of UE C-DRX
    - Non-active active Follow behavior for active period of UE C-DRX on PDCCH monitoring
    - Non-active Non-active Follow behavior for non-active period of cell DTX in 2.2.1
* [6] OPPO
  + Proposal 3: gNB and UE behaviors during non-active periods should be defined when only cell DTX cycle, only cell DRX cycle, or cell DTX/DRX cycle is configured.
  + Proposal 4: gNB is not expected to turn off transmission and reception for common channels/signals during non-active periods when only cell DTX cycle, only cell DRX cycle, or cell DTX/DRX cycle is configured.
* [7] Spreadtrum
  + Observation 1: For low to medium traffic load, gNB can enter micro sleep or light sleep for energy saving in RRC CONNECTED state.
  + Observation 2: It is better that gNB can inform the UEs to skip some activities for a time interval, when gNB enters micro sleep or light sleep.
* [8] CATT
  + Proposal 6: The cell DTX and cell DRX can be configured and operated separately by higher layer signaling to adapt to the individual characteristics of DL and UL operations.
  + Proposal 7: The potential configuration methods related to the cell DTX/DRX can be considered as following:
    - Option 1: The cell DTX/DRX parameters including the DTX/DRX cycle, the starting offset of the DTX/DRX active time and the DTX/DRX active time duration, are semi-static configured.
    - Option 2: The cell DTX/DRX configuration only including the DTX/DRX cycle and the starting offset of the DTX/DRX active time, the end point of cell DTX/DRX active time may be related the UE’s C-DRX active time.
  + Proposal 14: The cell DTX/DRX could be applied for the different serving cells in CA scenario, in which the cell DTX/DRX can be activated or deactivated via the UE-specific RRC signalling or L1/L2 signaling for expediting the transition between cell DTX/DRX active time and non-active time.
* [9] NEC
  + Observation 1: Cell DTX/DRX can be configured either via gNB implementation or cell DTX and DRX patterns can be configured and operated independently.
  + Proposal 3: Support configuration of cell DTX/DRX cycle around SSB transmission.
  + Proposal 4: Support mapping of cell DTX/DRX patterns/configurations to SSB transmission characteristics.
  + Proposal 5: For the cell DTX/DRX configuration in CA scenario, support both the common DTX/DRX configuration and independent DTX/DRX configurations for different cells.
* [10] Intel
  + Proposal 3: Whether to drop or continue with the occasions of the impacted signals/channels outside cell DTX/DRX active time is configurable by the network.
  + Proposal 4: Consider different modes of cell DTX/DRX where each mode may consider impact to a subset of signals/channels outside cell DTX/DRX active time.
  + Proposal 7: Consider specification of application delay following the activation of a cell DTX/DRX pattern.
* [11] Fujitsu
  + Observation 1. The assumption on the length of the cell DTX/DRX non-active period should be discussed first to guarantee an efficient further discussion on which signal can be postponed during Cell DTX/DRX non-active time in RAN1.
  + Proposal 1: In discussion on which signal can be postponed during Cell DTX/DRX non-active time, it assumes that the Cell DTX/DRX non-active time at most lasts for X ms.
    - RAN1 discusses and decides the value of X.
* [12] ZTE/Sanechips
  + Observation: L1 behaviors of CSI-RS and SRS transmission during cell DTX/DRX non-active periods should be configurable by signaling to minimize the impact on link management and beam management.
  + Observation: A semi-static configuration of cell DTX/DRX pattern may not be suitable for various traffic models and not beneficial for the network energy savings when UE is suffered from time-intensive traffic.
* [13] Xiaomi
  + Proposal 6: The impacts of cell DTX/DRX on CSI measurements and reports should be considered.
* [14] Interdigital
  + Observation 3: Utilizing a cell DTX can yield significant energy savings gain, with marginal negative impact on user level QoS (throughput).
  + Observation 4: Utilizing Cell DRX with dynamic activation/deactivation can yield significant energy savings gain, while ensuring marginal negative impact on user level QoS (throughput).
* [15] China Telecom
  + Proposal 1:
    - The mechanism of cell DTX and cell DRX should be discussed separately.
    - At least the alignment with C-DRX should be considered separately.
  + Proposal 4:
    - The activate of cell DTX/DRX should be decided by the network.
    - The assistant information from UE and neighbor cells can reported to the cell for making the decision.
  + Proposal 5:
    - The WUS from UE can be considered for gNB to trigger the de-activating of cell DTX/DRX.
    - The low layer signals, i.e. MAC CE or UCI, should be used as the WUS signal.
    - The assistant information of neighbor cells can also be used for gNB to judge the network condition and de-activate the cell DTX/DRX.
* [16] Google
  + Proposal 1: Study the impact of RLM/BFD procedure during non-active periods of cell DTX.
  + Proposal 2: During non-active periods of cell DTX, UE does not receive the periodic/semi-persistent CSI-RS.
  + Proposal 3: Introduce a multi-burst based aperiodic TRS for fast time and frequency offset tracking after the non-active periods of cell DTX.
  + Proposal 5: The impact of RACH and SR procedure from non-active periods of cell DRX should be studied by RAN2.
  + Proposal 6: Study the impact of BFR procedure from non-active periods of cell DRX.
* [17] Samsung
  + Observation 1: Determining SSB symbols as active durations of cell DTX is beneficial for reducing gNB transmission durations as well as user plane latency.
  + Proposal 1: The SSB transmission symbols are considered as active for the determination of the active durations of cell DTX.
  + Observation 3: Dynamic adaptation of cell DTX/DRX is beneficial for UE power saving.
  + Observation 4: Multiple configurations for cell DTX/DRX is beneficial for network energy saving.
  + Proposal 8: Define the UE behaviour to support the joint operation of cell DTX/DRX and other collision handling.
  + Proposal 9: Support BFR procedure enhancement for the impact of cell DTX/DRX operation.
* [18] ETRI
  + Proposal 8: Support multiple cell DTX/DRX modes to allow UE to adapt transmission/reception behaviours during cell DTX/DRX non-active time.
  + Proposal 9: Each cell DTX(/DRX) mode is associated with a set of DL(/UL) signals UE receives(/transmits) (or, equivalently does not receive(/transmit)).
  + Proposal 10: Deactivation DCI can indicate one of the cell DTX(/DRX) modes to apply during the next cell DTX(/DRX) non-active time.
* [19] CMCC
  + Proposal 2: In case of L1 signalling based cell DTX/DRX activation/deactivation is supported, PDCCH monitoring for the activation/deactivation should be allowed during cell non-active periods.
* [20] CEWiT
  + Proposal 1: Multiple Cell DTX/DRX configurations with different time granularity for starting time, periodicity and durations is supported.
  + Observation 2: Skipping of scheduled operation overlapping with non-active period of cell DTX/DRX causes performance loss at UE
  + Observation 3: gNB rescheduling the skipped operation during active period of DTX/DRX results in signaling overhead
  + Proposal 5: Study enhancements in rescheduling operations skipped during non-active period of Cell DTX/DRX
* [21] Mediatek
  + Observation 3: In [4] and [5], alignment and aggregation of cell and UE active periods can achieve significant network energy saving (NES) gain, particularly for light load scenario. However, there can still be a large amount of active UEs in light load scenario, e.g., as VoIP service.
  + Proposal 3: Efficient cell-wise signaling design is developed for alignment and aggregation of cell and UE activities so as to avoid excess UE-specific signaling overhead due to a large amount of active UEs (e.g., in VoIP service).
  + Proposal 4: Analogous mechanism to Rel-17 TRS for idle/inactive, i.e., SIB for configuration broadcast and paging indications for activation/adaptation of candidate configuration(s), is specified.
    - FFS: Application delay and alignment of UE DRX and Cell DTX/DRX after receiving the indication.
* [22] Transsion Holdings
  + Proposal 2: Some constraints on active/non-active time between cell DTX and cell DRX should be discussed.
* [23] LG Electronics
  + Proposal #2: For network energy saving, a signal/channel to be turned off from the Cell DTX/DRX non-active period can be configured for each signal/channel.
* [25] Lenovo
  + The list of candidate signals/channels that are impacted by inactive periods of cell DTX/DRX are updated based on further input from RAN WG2
  + SSB transmission is independent of cell DTX, i.e., SSB transmission is allowed during cell DTX inactive periods
  + RAN WG1 should only consider UE-common cell DTX/DRX configuration per cell for further discussion on candidate signals/channels, in which the UE may be expected to not receive or transmit specific signals/channels during inactive periods of cell DTX/DRX, respectively
* [26] Qualcomm
  + Observation 1: Cell DTX/DRX mechanism might be achieved by C-DRX operation with proper C-DRX configurations across connected mode UEs in the cell.
  + Observation 2: The UE may need to transmit or receive one or more channels outside its C-DRX active time, which may reduce opportunity for the cell to go into deeper sleep modes.
  + Observation 3: Cell DRX/DTX mechanism can be enhanced by restricting UE transmission and reception of channels within the non-active time of cell DTX/DRX.
  + Observation 4: Restricting UE transmission/reception of channels within the non-active time of cell DTX/DRX should not impact performance of the UEs.
  + Observation 5: Broadcast and multicast should be also considered in addition to unicast when discussing transmission/reception restriction for RRC connected state UEs.
  + Observation 6: Dynamic cell DTX/DRX activation/deactivation mechanism should be performed for a single cell DTX/DRX configuration.
    - Benefit of dynamically switching between multiple DTX/DRX configurations is unclear.
* [27] Rakuten
  + Proposal 4: Dropped channel/signals can be dynamically configured for NES UEs when it is necessary to use to satisfy their QoS, if necessary.
  + Observation 3: The parameter ranges, granularity of DRX related operations for NES can be same as legacy UEs to avoid any impact.
  + Proposal 5: Configurable range of the enhanced DTX/DRX parameters should be within the range of legacy DTX/DRX parameters in Rel-17.
  + Proposal 6: NES applicable UE can be configured for enhanced DRX mode, by defining new DRX Group.
  + Proposal 7: Multiple DRX groups can be configured to satisfy different QoS requirements.
  + Proposal 8: At this moment, there is no significant necessity to define additional functionality relevant to RAN1 to coordinate between cell DTX/DRX and UE C-DRX.
* [29] Ericsson
  + Proposal: Support at least a cell DTX/DRX mechanism that does not disrupt an ongoing packet delivery including packet transmissions/retransmissions.
    - FFS. The detail of such a mechanism, e.g., L1 based cell DTX/DRX active period extension, inactivity timer, etc.
* [30] ITRI
  + Observation: Concentrated Transmission is beneficial for network energy saving
* [31] Fraunhofer
  + Observation 1: Alignment of UE C-DRX can be a main mechanism to enable cell-DTX efficiently.
  + Observation 2: Even with serving a few UEs, the ability of a cell to be inactive as per cell DTX is severely impacted due the need for HARQ retransmissions.
  + Proposal 1: RAN1 to discuss mechanisms to reduce the impact of HARQ retransmissions on cell DTX.

#### Summary of Issues

There were several inputs received from different companies regarding the configuration and operation of cell DTX/DRX for energy savings in the RRC CONNECTED state. Some companies suggested that cell DTX/DRX operations should include more granular deactivation or muting of signals and channels for energy savings, including support of dynamic adaptation of cell DTX/DRX.

#### Suggestions for further Discussions

Many of the cell DTX/DRX operations from moderator understanding relies on RAN2 agreement/conclusion. Therefore, it might be better for RAN1 to focus on areas that are purely focused on RAN1 aspects or have relatively small reliance on RAN2 agreement.

#### [1st Round of Discussions]

Companies are asked to provide comments and proposals on general cell DTX/DRX operations that may be agreeable in RAN1. Moderator suggests focusing on aspects that do not require RAN2 input, or aspects that RAN2 may input from RAN1’s opinion.

Moderator will take the inputs and suggestions and create a formal proposal (with proposal #) for conclusion and/or agreement.

|  |  |
| --- | --- |
| Company | Comments |
| CMCC | We think the impacted signals and channels that agreed during last RAN1 meeting can be discussed. Then when RAN2 makes conclusion, they can also refer to RAN1’s opinions.  Besides impacted channels and signals, the dynamic activation and deactivation of cell DTX/DRX can also be discussed, including the alignment of cell DTX/DRX with C-DRX.  For the activation/deactivation, the outcome of RAN2 post 121 email discussion made the following proposal, so RAN1 should discuss this.  **Proposal 5:** Cell level common L1 signalling for Cell DTX/DRX activation/deactivation is beneficial from RAN2 perspective, send an LS to RAN1 with our preference and ask about feasibility and design details. (17/28)  For the alignment, if cell DTX/DRX is activated and deactivated dynamically, the alignment should also be done in a dynamic way, otherwise the energy saving of dynamic activation/deactivation will be limited due to distributed UE active period. |

## 2.3 Signaling aspects of cell DTX/DRX

* [1] Futurewei
  + Observation 1: The number of channels/signals that would be allowed to be received and transmitted by the Rel-18 NES capable CONNECTED UE(s) should be kept at absolute minimum to maximize network energy saving gains.
  + Observation 2: A common DTX/DRX pattern can be configured through UE RRC signaling and L1/L2 signaling can be used in addition to the existing common DTX/DRX pattern to perform the following functions:
    - Deactivate the configured pattern DTX/DRX completely for a duration of time, or
    - An updated DTX/DRX pattern is configured that overrides the existing DTX/DRX pattern.
  + Observation 3: To provide the gNB flexibility in transmitting and/or receiving critical channels/signals, multiple Cell DTX/DRX configurations should be supported.
* [2] Huawei/HiSilicon
  + Proposal 2: Consider to support dynamic cell DTX/DRX (de)activation by group-common L1 signaling
    - RAN1 to discuss whether the L1 signaling is based on a new DCI format or an existing DCI format.
* [3] Panasonic
  + Proposal 10: Multiple cell DTX/DRX configurations should be considered for better energy saving adaptation. The switching between configurations needs possible L2/L1 signaling enhancement.
* [5] vivo
  + Proposal 13: Support UE DRX alignment via group common L1 signalling.
* [6] OPPO
  + Proposal 1: Support UE being configured with one or more cell DTX/DRX cycles for network energy saving purpose.
  + Proposal 2: The configuration information of cell DTX/DRX should be indicated to UE via UE-specific RRC signaling per cell or per cell group.
* [8] CATT
  + Proposal 8: Multiple cell DTX/DRX configurations would be supported.
  + Proposal 9: The cell DTX/DRX is configured to Rel-18 CONNECTED UEs via RRC signaling, and L1/L2 signaling or RRC signaling is used to activate at least one cell DTX/DRX configuration.
  + Proposal 10: The activation and deactivation of cell DTX/DRX should consider the following aspects:
    - The cell DTX/DRX is a semi-static procedure and is not activated or deactivated frequently.
    - The activation and deactivation of cell DTX/DRX should reduce the impact to the UE power consumption.
  + Proposal 11: The activation and deactivation of cell DTX/DRX can consider the following options:
    - Option 1: The cell DTX/DRX is activated or deactivated by RRC signaling.
    - Option 2: The cell DTX/DRX is activated or deactivated by L1/L2 signaling.
  + Proposal 12: The L1/L2 signaling or RRC signaling for activation and deactivation of cell DTX/DRX should at least contain the following contents:
    - Activation or deactivation indication.
    - Cell DTX identification.
    - Cell DRX identification.
  + Proposal 13: If L1 signaling is used to activate or deactivate the cell DTX/DRX, the confirmation of L1 signaling such as HARQ-ACK feedback or cell DTX/DRX confirmation MAC CE should be supported.
* [9] NEC
  + Observation 2: (Re)Configuration of UL and/or DL channels and signals in a UE specific manner, to configure cell DTX/DRX, may result in large signalling overhead for relatively large number of connected UEs.
  + Proposal 2: Support group specific or cell specific signaling for cell DTX/DRX configuration and operation.
  + Proposal 6: Support dynamic indication of the activation or inactivation of a cell DTX/DRX on-duration, and dynamic indication of extension or termination of a cell DTX/DRX on-duration.
* [10] Intel
  + Proposal 1: A separate cell DTX/DRX configuration/pattern, including at least {periodicity, start slot/offset, on duration}, is provided to the UE via UE specific RRC signaling.
    - UE would switch to this configuration upon activation of the cell DTX/DRX mode.
    - The cell DTX/DRX configuration becomes effective after an application delay.
  + Proposal 5: Consider DCI based indication to activate a cell DTX/DRX pattern.
    - Deactivation can be based on DCI indication or expiry of validity duration
  + Proposal 6: Consider support of multiple configurations of cell DTX/DRX pattern.
  + Proposal 8: Consider DCI based indication to adjust active time of a cell DTX/DRX pattern.
  + Proposal 9: Consider use of a DCI indication (similar to DCI format 2-6) to indicate whether to monitor the next ON duration of cell DTX/DRX cycle.
* [12] ZTE/Sanechips
  + Proposal: L1 signaling is considered for dynamic indication of cell DTX/DRX to adapt to flexible traffic.
  + Proposal: At least activating/deactivating a single cell DTX/DRX pattern should be considered as indication information of L1 signaling.
  + Observation: In order to ensure that the cell DTX/DRX pattern can be flexibly adapted to various traffic models, the flexible indication of cell DTX/DRX pattern by L1 signaling needs to be considered.
  + Proposal: Activating/deactivating the cell DTX/DRX pattern among multiple cell DTX/DRX patterns, e.g. switching cell DTX/DRX pattern, and dynamic enabling/disabling cell DTX/DRX on duration, should be considered as the indication information of L1 signaling.
  + Proposal: Considering signaling overhead, group-common signaling is proposed for the design of L1 signaling for cell DTX/DRX indication information.
  + Proposal: In CA scenario, cell DTX/DRX indication information for multiple cells should be supported by L1 signaling.
* [13] Xiaomi
  + Proposal 7: Whether cell DTX and cell DRX should be configured/indicated jointly or separately should be considered.
* [14] Interdigital
  + Proposal 7: Support dynamic signaling for indicating the activation/deactivation of a cell DTX/DRX configuration
  + Proposal 8: Support group common signaling as baseline for indicating the activation/deactivation of a cell DTX/DRX configuration
  + Proposal 9: DCI is used for group common signaling for indicating the activation/deactivation of a cell DTX/DRX configuration
* [15] China Telecom
  + Proposal 6: The configuration, activation/de-activation of cell DTX/DRX should be done separately.
* [17] Samsung
  + Proposal 3: Support fast cell DTX/DRX activation/deactivation/adaptation mechanism via L1/L2 signaling.
  + Proposal 4: Support a cell/group common or UE-specific DCI format to activate/deactivate/modify the configured cell DTX/DRX, the following options or the combinations of the options can be considered.
    - Option 1: Dynamically indicates whether the onDuration timer is started for one or more cell DTX/DRX cycles on one or more serving cells
    - Option 2: Dynamically indicates which cell DTX/DRX configuration is activated if multiple cell DTX/DRX configurations are provided.
    - Option 3: Dynamically indicates whether slot(s) in a next period are active or non-active.
    - Option 4: Dynamically indicates activation/deactivation/modification of cell DTX/DRX configuration for one or more cells from a set of cells.
    - FFS: Dynamically indicates the cell DTX/DRX timers.
    - FFS: Implicit indication of cell DTX/DRX.
  + Proposal 5: Support the following mechanism through MAC CE command in addition to L1 signalling,
    - Select one activated cell DTX/DRX configurations from the multiple configurations if multiple configurations are supported for cell DTX/DRX.
    - Update the parameters for the set of configurations of cell DTX/DRX.
  + Proposal 6: Support acknowledgement feedback for reception of cell/group common DCI format for activation/deactivation/modification of a configured cell DTX/DRX, e.g., NACK feedback only when it is not correctly received.
    - FFS: The UE behaviour if the DCI format is missed.
* [18] ETRI
  + Proposal 5: Support dynamic deactivation of cell DTX based on DCI. The deactivation DCI
  + indicates UE whether or not to go-to-sleep at the next occurrence of cell DTX off-duration
    - is monitored within DTX active time (before target off-duration)
  + Proposal 6: Support dynamic activation of cell DTX based on DCI. The activation DCI
    - indicates UE whether or not to wake-up at the next occurrence of cell DTX on-duration
    - is monitored outside DTX active time (before target on-duration)
* [19] CMCC
  + Proposal 12: L1 signalling based cell DTX/DRX activation/deactivation is supported to balance gNB power saving and user experience.
  + Proposal 13: PDCCH can be used for dynamic activation and deactivation of cell DTX/DRX, and can be monitored during cell non-active periods.
* [20] CEWiT
  + Proposal 2: Signaling the parameters of cell DTX/DRX (e.g., type of cell DTX/DRX with a particular time granularity, starting time, periodicty and duration) to UE is supported.
  + Observation 1: For dynamically configured signals/channels the priority should be based on type of DTX/DRX
  + Proposal 3: Dynamically configured signals/channels are prioritized over DTX/DRX activation over MAC-CE
  + Proposal 4: In case of dynamic activation of DTX/DRX conflicting with Dynamically configured signals/channels the prioritization is based on recent indication
* [22] Transsion Holdings
  + Proposal 3: It is suggested that RRC signaling plus Group common dynamic L1/L2 signaling can be considered to notify UE cell DTX/DRX configuration.
  + Proposal 4: Configuring different cell DTX/DRX configurations for different power states should be supported.
* [23] LG Electronics
  + Proposal #1: To align DRX active time for different UEs in the cell, the DRX parameters (e.g., start offsets, DRX cycle and length of ON duration) and its application time (during which indicated DRX parameters are applied) can be jointly indicated by L1/L2 signaling (e.g., group-common DCI or MAC-CE).
  + Proposal #2: For network energy saving, a signal/channel to be turned off from the Cell DTX/DRX non-active period can be configured for each signal/channel.
* [26] Qualcomm
  + Observation 7: If the cell DRX is activated by RRC signaling, determination of available slots for CG PUSCH repetitions may depend on cell DRX configuration.
  + Proposal 2: If the cell DRX is activated by L1/L2 signaling and CG PUSCH repetition is dropped in the non-active time of cell DRX, the dropped CG PUSCH repetition is counted in the configured number of repetitions.
* [27] Rakuten
  + Observation 1: Based on the agreement of the study scope in RAN1#112, RAN1 aim is Semi-static RRC + dynamic L1 signaling.
  + Proposal 1: As signaling types to configure cell DTX/DRX, discuss further about combination of static/semi-static signaling via RRC and dynamic signaling via L1 signaling.
  + Proposal 2: In case that dynamic signaling is supported, RRC signaling can be cell-specific or group common.
* [28] NTT Docomo
  + Proposal 2: Configuration and activation/deactivation mechanisms of Cell DTX/DRX should be discussed.
* [29] Ericsson
  + Proposal: Support UE-specific configuration of cell DTX/DRX.
  + Proposal: Support at least a cell DTX/DRX mechanism that does not require explicit L1/L2 signalling for activation/deactivation.
  + Observation: If L1 based signalling for activation/deactivation of cell DTX/DRX is to be considered, then mechanisms that address UE and gNB misalignment issue need to be considered.

#### Summary of Issues

There are various aspects to signaling for cell DTX/DRX identified by companies in the contributions. The signaling issues seem to be mainly focused on (1) UE, and/or cell specific signaling, (2) whether to support signaling support in L1, L2 MAC CE, and/or L2 RRC (if signaling is needed), and (3) whether to support multiple cell DTX/DRX configurations.

#### Suggestions for further Discussions

Many of the issues are being actively discussed in RAN2, since signaling design aspects are expected to be handled by RAN2, RAN1 can either wait for RAN2 to conclude on signaling design issues or RAN1 can conclude on set of recommendations for RAN2 (and send an LS to RAN2 to consider). Many issue have been discussed in post RAN2 meeting discussions using “[POST121][312][NES] DTX/DRX - Configuration/activation/deactivation and alignment” and “[POST121][311][NES] DTX/DRX - gNB and UE behaviours” thread, which are expected to be discussed and potentially concluded on Wednesday RAN2 meeting session.

Moderator suggests waiting for RAN2 to conclude (potentially on Wednesday), and if RAN2 is unable to make agreements, then discuss in RAN1 on whether RAN1 should try to agree to set aspects and provide recommendations to RAN2.

#### [1st Round of Discussions]

Companies are asked to provide comments and proposals on signaling aspects that may be agreeable in RAN1. Moderator suggests focusing on aspects that do not require RAN2 input, or aspects that RAN2 may input from RAN1’s opinion.

Moderator will take the inputs and suggestions and create a formal proposal (with proposal #) for conclusion and/or agreement.

|  |  |
| --- | --- |
| Company | Comments |
| CMCC | As the moderator summarizes, among the three signalling issues, the first one is about configuration of cell DTX/DRX, it is up to RAN2, and according to our understanding, both cell specific and UE specific configuration signalling can be considered.  The second one is about activation and deactivation. The outcome of RAN2 post 121 email discussion made the following proposal, so RAN1 should discuss this.  **Proposal 5:** Cell level common L1 signalling for Cell DTX/DRX activation/deactivation is beneficial from RAN2 perspective, send an LS to RAN1 with our preference and ask about feasibility and design details. (17/28)  The third one is whether multiple DTX/DRX can be configured, to our understanding, it is beneficial for gNB to adapt to different cell DTX/DRX pattern according to traffic. |

## 2.4 Interaction of cell DTX/DRX with UE DRX

* [1] Futurewei
  + Observation 4: Alignment of the UE DTX with cell DRX can be handled through gNB implementations as part of scheduled UL transmissions that is controlled by the gNB.
* [2] Huawei/HiSilicon
  + Proposal 4: Further discuss the case and UE behavior that cell DTX and UE C-DRX are applied to a same UE simultaneously.
* [3] Panasonic
  + Observation 1: When UE DRX is configured, strict alignment of all UE DRX configurations and cell DTX/DRX may potentially lead to resource congestion.
  + Proposal 11: Multiple UE DRX configurations can be considered for more flexible adaption to achieve alignment with cell DTX/DRX. The switching between configurations needs possible L1/L2 signaling enhancement.
  + Proposal 12: Interaction of Cell DTX/DRX and UE C-DRX needs to be clarified if both are supported and configured.
* [4] Nokia/NSB
  + Observation 1: The Alignment between Cell DTX/DRX and UE C-DRX has no RAN1 impact, and it ups to RAN2 discussions and decision.
* [5] vivo
  + Proposal 12: Support the following UE behavior when cell DRX and UE C-DRX are both configured in following table.

|  |  |  |
| --- | --- | --- |
| **Cell DRX** | **UE DRX** | **UE behavior** |
| active | active | Normal |
| active | Non-active | Follow behavior for non-active period of UE DRX |
| Non-active | active | Follow behavior for non-active period of cell DRX |
| Non-active | Non-active | Follow behavior for non-active period of cell DRX |

* [6] OPPO
  + Proposal 5: The alignment of cell DTX/DRX and UE C-DRX cycles or the alignment of UE C-DRX cycles for different UE can be left to gNB implementation.
  + Proposal 6: gNB and UE behaviors should be defined when both cell DTX/DRX and UE C-DRX cycles are configured.
* [7] Spreadtrum
  + Proposal 1: At least for cell DTX, alignment between cell DTX and UE C-DRX is pursued.
  + Proposal 3: At least for cell DRX, alignment between cell DRX and UE C-DRX is not pursued.
* [8] CATT
  + Proposal 1: The cell DTX/DRX parameters could be configured to ensure the alignment between the cell DTX/DRX and UE C-DRX, i.e. the cell DTX active time should completely capture the DRX-ON of UEs and at least cover the reception window of DCI format 2\_6 in order not to affect the legacy UEs.
  + Proposal 2: If the cell DTX/DRX is applied, the UE behaviors should be specified when the cell DTX active time ends earlier than the UE DRX-ON extended by any of drx-InactivityTimer, drx-RetransmissionTimerDL or drx-RetransmissionTimerUL.
  + Proposal 3: If the cell DTX/DRX is applied, the following options can be considered in order not to impact on the transmission/reception in periodic resources for legacy RRC\_CONNECTED UE:
    - Option 1: The periodic resources outside the C-DRX active time are overlapped with the cell DTX/DRX active time based on gNB implementation.
    - Option 2: Specify that transmission and reception in periodic resources are not affected by cell DTX/DRX.
  + Proposal 4: If the service of Rel-18 RRC\_CONNECTED UE is not periodic or delay-sensitive service such as XR or URLLC, the data should not be transmitted or received in periodic resources outside the C-DRX active time during cell DTX/DRX non-active time.
  + Proposal 5: If the service of Rel-18 RRC\_CONNECTED UE is periodic or delay-sensitive service such as XR or URLLC, the following options can be considered in order not to impact on the transmission/reception in periodic resources outside the C-DRX active time:
    - Option 1: Cell DTX/DRX is not applied.
    - Option 2: The periodic resources outside the C-DRX active time are overlapped with the cell DTX/DRX active time based on gNB implementation.
    - Option 3: Specify that transmission and reception in periodic resources are not affected by cell DTX/DRX.
* [9] NEC
  + Proposal 1: Align C-DRX cycles for different UEs such that ON durations of different UEs are completely contained within cell/gNB active time.
  + Proposal 7: Indicate parameters related to cell DTX/DRX pattern via DTX/DRX activation signalling.
  + Proposal 8: Cell DTX/DRX activation signaling indicates whether cell DTX overrides C-DRX of UEs or not.
* [10] Intel
  + Observation 2: Alignment of on-duration of UE’s C-DRX among UEs to ensure that they are within the Cell DTX on-duration can be achieved by implementation.
  + Proposal 10: Further discuss whether part or all of UE DRX procedures need to be adjusted after cell DTX/DRX pattern is activated.
    - Details can be up to RAN2.
* [12] ZTE/Sanechips
  + During cell DTX/DRX non-active periods that is overlapped with UE CDRX active time, UE can perform CSI-RS reception and CSI report to minimize the impact on link management similar to the mechanism during the timer duration indicated by drx-onDurationTimer in DRX-Config also outside active time.
  + Observations: The alignment of cell DTX on duration and UE CDRX on duration can ensure data scheduling with lower latency and provide a longer cell DTX off duration.
  + Proposal: At least the UE CDRX start offset is proposed to be indicated by L1 signaling to adapt to the dynamic indication of cell DTX/DRX pattern.
* [13] Xiaomi
  + Proposal 5: The interaction between cell DTX and UE C-DRX should be considered. And UE behavior for cell DTX alone should be discussed first as baseline.
* [15] China Telecom
  + Proposal 7: The configuration of cell DTX/DRX should be regarded independently instead of as the enhancement of C-DRX.
  + Proposal 8: The configuration of the longest time for cell DTX/DRX should be introduced to avoid the collision with C-DRX.
* [17] Samsung
  + Proposal 7: When UE is provided with both cell DTX and UE DRX,
    - For the case where the duration is determined as active for cell DTX, UE behaviour is the same as legacy, i.e., cell DTX is not configured.
    - For the case where the duration is determined as non-active for both cell DTX and UE DRX, UE behaviour is the same as the case when cell DTX is configured and UE DRX is not configured or UE follows both cell DTX and UE DRX if there is no collision between cell DTX and UE DRX.
    - For the case where the duration is determined as non-active for cell DTX but active for UE DRX, consider the following two options.
      * Option 1: UE behaviour is the same as non-active time of cell DTX when UE DRX is not configured.
      * Option 2: UE behaviour is the same as non-active time of UE DRX when cell DTX is not configured.
  + Proposal 12: Support cell specific or UE-group specific indication on UE’s DRX cycle to align multiple UE’s ON durations.
* [19] CMCC
  + Proposal 14: Alignment of cell DTX/DRX and UE C-DRX can be triggered dynamically.
  + Proposal 15: Activation of cell DTX/DRX and alignment of cell DTX/DRX and UE DRX can share the same L1 indication signalling.
* [22] Transsion Holdings
  + Proposal 5 How to align the DRX cycles or offsets for different UEs needs to be further studied.
  + Proposal 6 Align UE DRX with cell DTX and DRX between multiple UEs should be studied.
* [23] LG Electronics
  + Proposal #4: It is necessary to discuss UE behaviour when both Cell DTX/DRX and UE C-DRX are configured simultaneously.
* [27] Rakuten
  + Observation 2: Interaction between cell DTX/DRX and UE DRX can be realized based on configuration alignment without any special functionality.
* [28] NTT Docomo
  + Proposal 3: Alignment between Cell DTX and UE DRX should be discussed in accordance with the UE behavior during Cell DTX inactivity periods.

#### Summary of Issues

Some companies commented that UE DRX alignment to work with cell DTX/DRX can be handled through gNB implementation. Some companies commented that some interaction to align the active times for UE DRX might be required.

#### Suggestions for further Discussions

The C-DRX is specified in RAN2, therefore moderator thinks any potential agreements with regards to DRX will need to be sent to RAN2 for recommendation and/or confirmation. Since basic functionality for cell DTX/DRX has not been concluded yet, moderator suggests to first work on the basic cell DTX/DRX functionality before discussing further on interaction between UE DRX and cell DTX/DRX.

#### [1st Round of Discussions]

Companies are asked to provide comments and proposals on C-DRX aspects that may be agreeable in RAN1. Moderator suggests focusing on aspects that do not require RAN2 input, or aspects that RAN2 may input from RAN1’s opinion.

Moderator will take the inputs and suggestions and create a formal proposal (with proposal #) for conclusion and/or agreement.

|  |  |
| --- | --- |
| Company | Comments |
| CMCC | We think the alignment can be discussed in RAN1. This issue is highly related to whether dynamic activation/deactivation is supported. Since if only RRC based activation/deactivation of cell DTX/DRX is introduced, the alignment with C-DRX can also be done based on RRC configuration. However, RRC based configuration can not adapt to the traffic varying flexibly. And RAN2 thinks that Cell level common L1 signalling for Cell DTX/DRX activation/deactivation is beneficial. With L1 based activation/deactivation, when there are much traffic to be served, gNB can deactivate the cell DTX/DRX, and if UE C-DRX active periods are RRC configured to be centralized, the resource for scheduling may be crowed and UPT will be reduced. And on the other hand, if gNB decides to activate the cell DTX/DRX for power saving, while the UE C-DRX active periods are RRC configured to be distributed, the power saving gain will be limited, if cell DTX ON period has to cover all UE’s on duration.  Therefore, we proposed to discuss the dynamic alignment along with the dynamic activation/deactivation of cell DTX/DRX, which RAN2 thinks should be discussed by RAN1. |

## 2.5 Signals/Channels impacted by cell DTX/DRX

* [2] Huawei/HiSilicon
  + Proposal 3: Support the following signals/channels to be applied with Cell DTX/DRX:
    - UE-specific PDCCH
    - SPS PDSCH and CG PUSCH
    - Periodic/Semi-persistent CSI
    - Periodic/Semi-persistent SRS
    - Periodic/Semi-persistent CSI-RS
    - FFS: SR for SCell BFR, CSI-RS for tracking and CSI-RS for SCell BFR.
* [3] Panasonic
  + Proposal 2: UE is not expected to receive periodic/semi-persistent CSI-RS for CSI measurement/report during non-active periods of cell DTX. However, for TRS configured for beam and radio link monitoring and UE mobility, the availability can be at least configurable.
  + Proposal 3: For Cell DTX/DRX, UE behaviour of receiving PRS does not require specification change and can be up to gNB implementation of configuration.
  + Proposal 4: For Cell DTX/DRX, UE is not expected to receive PDCCH scrambled with UE specific RNTI and PDCCH in Type-3 CSS.
  + Proposal 5: For Cell DTX/DRX, UE behaviour of receiving SPS-PDSCH may follow handling of that in C-DRX as starting point.
  + Proposal 6: For Cell DTX/DRX, UE behaviour relevant to SR can be same with that of C-DRX as a starting point.
  + Proposal 7: For Cell DTX/DRX, UE is not expected to transmit periodic/semi-persistent CSI report and periodic/semi-persistent SRS during non-active period.
  + Proposal 8: For Cell DTX/DRX, UE behaviour of transmitting CG-PUSCH may follow handling of that in C-DRX as starting point.
* [4] Nokia/NSB
  + Proposal 2: We propose the following extended list of DL channels/signals to be used as a baseline for more detailed discussion.
    - Periodic/Semi-persistent CSI-RS for L1/L3-RSRP
    - Periodic/Semi-persistent CSI-RS for Radio Link Management (RLM)/beam Failure detection (BFD)
    - Periodic/Semi-persistent CSI-RS for tracking (TRS)
    - PRS
    - PDCCH scrambled with UE specific RNTI
    - PDCCH in Type-3 CSS
    - SPS-PDSCH
  + Proposal 3: Discuss whether all types of periodic/semi-persistent CSI-RS and PRS transmission shall be dropped during cell DTX non-active period.
    - FFS on the potential solutions to overcome the impact from the dropped transmissions due to cell DTX non-active period.
  + Proposal 4: Wait for RAN2 agreements on the gNB/UE behaviour for PDCCH and SPS-PDSCH (re)-transmission during the Cell DTX non-active period.
    - FFS on potential RAN1 impacts.
  + Proposal 6: We propose the following list of UL channels/signals to be used as a baseline for more detailed discussion.
    - SR
    - Periodic/Semi-persistent CSI report
    - Periodic/Semi-persistent SRS
    - HARQ feedback for SPS/DG-PDSCH
    - CG-PUSCH
  + Proposal 7: Discuss whether periodic/semi-persistent CSI CSI-RS-reports and SRS receptions shall be omitted during cell DRX non-active period.
    - FFS on the potential solutions to overcome the impact from the omitted occasions due to cell DRX non-active period.
  + Proposal 8: Wait for RAN2 agreements on the gNB/UE behaviour for SR and DG/CG-PUSCH reception during the cell DRX non-active period.
    - FFS on potential RAN1 impacts.
  + Proposal 9: Wait for RAN2 progress on HARQ feedback for DG/SPS-PDSCH reception during the cell DTX non-active period.
  + Proposal 11: Discuss the impact of cell DTX non-active periods on existing HARQ-ACK codebook generation (at least considering Type 1 HARQ-ACK codebook).
  + Observation 2: PUCCH deferral operations in legacy consist of (i) deferral for PUCCH repetition operation (from Rel-15), and (ii) SPS HARQ-ACK deferral (from Rel-17).
  + Proposal 12: Discuss the interaction of cell DRX (non-active periods) with the existing PUCCH deferral operations, i.e., PUCCH repetition deferral and Rel-17 SPS HARQ-ACK deferral.
* [5] vivo
  + Proposal 1: UE does not monitor PDCCH scrambled by C-RNTI, CI-RNTI, CS-RNTI, INT-RNTI, SFI-RNTI, SP-CSI-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI, TPC-SRS-RNTI, and AI-RNTI in non-active period of cell DTX if UE C-DRX is not configured.
  + Proposal 2: UE doesn’t not expect periodical/semi-persistent CSI-RS resources excluding TRS are available in non-active period of cell DTX if UE C-DRX is not configured.
  + Proposal 3: UE still monitors TRS in non-active period of cell DTX.
  + Proposal 4: UE still monitors PRS in non-active period of cell DTX.
  + Proposal 5: UE doesn’t monitor SPS PDSCH in non-active period of cell DTX if UE C-DRX is not configured.
  + Proposal 7: UE does not need to transmit SR in non-active period of Cell DRX.
  + Proposal 8: UE needs to transmit PUCCH carrying HARQ for transmitted PDSCH in non-active period of Cell DRX.
  + Proposal 9: UE does not need to transmit PUCCH/PUSCH carrying periodical or semi-persistent CSI in non-active period of Cell DRX.
  + Proposal 10: UE does not need to transmit periodical or semi-persistent SRS in non-active period of Cell DRX.
  + Proposal 11: UE doesn’t need to transmit CG PUSCH in non-active period of cell DRX.
* [7] Spreadtrum
  + Observation 3: RAN1 should continue discussion on which PHY signals/channels are impacted during inactive period of cell DTX/DRX.
  + Proposal 2: Whether TRS is not expected not transmit during non-active period of cell DTX should be studied, and UE performance impact should be considered.
* [10] Intel
  + Observation 1: TRS configuration for idle/inactive mode UEs and connected mode UEs can be different by implementation and gNB can control the transmission of TRS for idle/inactive mode UEs via availability indication.
  + Proposal 2: Following signals/channels can impacted outside cell DTX/DRX active time:
    - DL
      * Periodic/Semi-persistent CSI-RS (including TRS)
      * PRS
      * PDCCH scrambled with UE specific RNTI
      * PDCCH in Type-3 CSS
      * SPS-PDSCH
    - UL
      * SR
      * Periodic/Semi-persistent CSI report
      * Periodic/Semi-persistent SRS
      * CG-PUSCH
      * HARQ-ACK for SPS- PDSCH
* [11] Fujitsu
  + Proposal 2: During Cell DTX/DRX non-active time, UE shall expect that at least the following UE-specific channels/signals are not transmitted/received:
    - DL:
      * CSI-RS.
      * UE-specific PDCCH.
      * PRS.
    - UL:
      * PUCCH carrying CSI reports.
      * SRS.
    - Note: For aperiodic CSI-RS/SRS, if it is triggered by PDCCH transmitted during active period, the UE is expected to receive/transmit it.
* [12] ZTE/Sanechips
  + Proposal: In order to save gNBs’ and UEs’ power consumption, at least periodic signals transmission and procedures including periodic CSI-RS, CSI report and SRS should be reduced during cell DTX/DRX non-active periods.
  + Proposal: The following physical signals/channels are proposed to be discussed by RAN2:
    - Dynamic data transmission/reception
    - PDCCH scrambled with UE specific RNTI
    - PDCCH in Type-3 CSS
    - SPS-PDSCH
    - SR
    - CG-PUSCH
* [13] Xiaomi
  + Proposal 1: Dynamically scheduled PDSCH/PUSCH/PUCCH(HARQ-ACK/CSI report)/reference signal, should have higher priority over cell DTX/DRX
  + Proposal 2: Whether and how RLM/BFD/BFR related procedures will be interrupted by cell DTX/DRX should be considered.
  + Proposal 3:
    - DL channels/signals UE expected to not receive during non-active periods of cell DTX
      * Periodic/Semi-persistent reference signals (including CSI-RS/TRS/PT-RS/PRS), but reference signals for BFD/BFR can be separately considered.
      * PDCCH in USS/Type-3 CSS
      * SPS-PDSCH
    - UL channels/signals UE expected to not transmit during non-active periods of cell DTX
      * SR. But SR for BFR can be separately considered.
      * Periodic/Semi-persistent CSI report
      * Periodic/Semi-persistent SRS/PRS
      * CG-PUSCH
  + Proposal 4: Besides semi-static configuration, dynamic indication for cell DTX/DRX should also be considered.
* [14] Interdigital
  + Proposal 1: UE is not expected to measure periodic/semi-persistent CSI-RS (including PTRS, TRS, BFD, and RLM RS) during non-active periods of cell DTX
  + Proposal 2: UE is not expected to measure PRS during non-active periods of cell DTX
  + Observation 1: To maximize network and UE power savings, UE should not monitor PDCCH for dynamic grants/assignments for new transmissions during Cell DTX non-active periods, even if the UE is in C-DRX Active time. Such can be decided by RAN2.
  + Observation 2: To maintain HARQ retransmission timely, UE should monitor PDCCH for dynamic grants/assignments for retransmissions during the UE’s C-DRX Active time per legacy behaviour, even during the Cell DTX non-active period. Such can be decided by RAN2.
  + Proposal 3: UE is not expected to transmit periodic/semi-persistent CSI-RS reports during non-active periods of cell DRX.
  + Proposal 4: UE is not expected to transmit periodic/semi-persistent SRS during non-active periods of cell DRX
  + Proposal 5: UE transmits HARQ feedback for Dynamic PDSCH assignments if the PUCCH resource is provided in DCI (per legacy), even when the PUCCH overlaps with non-active period of cell DRX
  + Proposal 6: UE transmits HARQ feedback for SPS-PDSCH if the PUCCH resource is provided in DCI (per legacy), even when the PUCCH overlaps with non-active period of cell DRX
* [15] China Telecom
  + Proposal 2: Support cell DTX applied to at least the following signals/channels.
    - PDCCH in USS
    - SPS-PDSCH
    - PTRS
    - periodic/semi-persistent CSI-RS/TRS
  + Proposal 3: Support cell DRX applied to at least the following signals/channels.
    - PUCCH with periodic/semi-persistent CSI
    - SR
    - CG-PUSCH
    - Periodicity/semi-periodicity SRS
* [16] Google
  + Proposal 4: During the non-active periods of cell DRX, UE does not transmit the periodic/semi-persistent CSI/beam report.
  + Proposal 5: The impact of RACH and SR procedure from non-active periods of cell DRX should be studied by RAN2.
  + Proposal 6: Study the impact of BFR procedure from non-active periods of cell DRX.
* [17] Samsung
  + Proposal 1: The SSB transmission symbols are considered as active for the determination of the active durations of cell DTX.
  + Observation 2: Allowing the reception/transmission of a PDSCH/PUSCH/PUCCH scheduled by a DCI format during non-active time of cell DTX/DRX is beneficial for network energy saving, UE energy saving and latency reduction.
  + Proposal 2: The following signals/channels are not received/transmitted during non-active periods of cell DTX/DRX and the other signals/channels are not impacted by cell DTX/DRX.
    - DL
      * Periodic/Semi-persistent CSI-RS (excluding TRS)
      * PRS
      * PDCCH scrambled with UE specific RNTI
      * Type3-PDCCH in CSS
      * SPS-PDSCH
    - UL
      * SR
      * Periodic/Semi-persistent CSI report
      * Periodic/Semi-persistent SRS
      * CG-PUSCH
      * FFS: Not receiving/transmitting the above channels/signals can be configured by RRC.
  + Proposal 11: The DCI format indicating activation/deactivation/modification of cell DTX/DRX configuration can also indicate parameter updates per spatial domain (SD) and power domain (PD) adaptations, e.g., a value of powerControlOffset or powerControlOffsetSS or an adjustment values to powerControlOffset or powerControlOffsetSS.
* [18] ETRI
  + Observation 1: For behaviours during cell DTX/DRX non-active time, there is ongoing discussion in RAN2 on SPS/CG, SR, PDCCH, and dynamic PDSCH/PUSCH.
  + Proposal 1: Suspend discussions in RAN1 for SPS/CG, SR, PDCCH, dynamic PDSCH/PUSCH, and HARQ-ACK of dynamic/SPS PDSCH until receiving input from RAN2.
  + Proposal 2: For periodic/semi-persistent CSI-RS, periodic/semi-persistent SRS, and periodic/semi-persistent CSI report, during cell DTX/DRX non-active time, down-select from the following options:
    - Option 1: UE skips those transmissions
    - Option 2: UE can be configured whether or not to receive/transmit those transmissions (FFS: configuration unit)
  + Proposal 3: Skipped CSI-RS occasions during cell DTX/DRX non-active time do not contribute to RRM/RLM, CSI/beam report, and BFR.
  + Proposal 4: For aperiodic CSI-RS, aperiodic SRS, and aperiodic CSI report, UE does not expect to be scheduled with those transmissions during cell DTX/DRX non-active time.
  + Proposal 7: Further study the following aspects for dynamic activation and deactivation of cell DTX/DRX.
    - Whether a new DCI format needs to be introduced (against reusing DCI format 2\_6).
    - Whether/how to support L1-based activation/deactivation for cell DRX.
    - Number of DCI formats for indicating cell DTX activation and deactivation, and potentially cell DRX activation and deactivation.
* [19] CMCC
  + Proposal 1: PDCCH monitoring scrambled by MCS-RNTI is not impacted by cell non-active periods.
  + Proposal 2: In case of L1 signalling based cell DTX/DRX activation/deactivation is supported, PDCCH monitoring for the activation/deactivation should be allowed during cell non-active periods.
  + Proposal 3: SPS-PDSCH is not expected to be received by UE during cell non-active periods.
  + Proposal 4: To reduce performance loss of no CSI-RS measurement during cell DTX/DRX non-active periods, CSI-RS can be transmitted with a larger periodicity during cell non-active periods.
  + Proposal 5: If TRS is used for power saving by idle/inactive UEs, it is not impacted by Cell DTX.
  + Proposal 6: NCD-SSB is not transmitted during non-active periods of Cell DTX.
  + Proposal 7: SR can be transmitted during cell DTX/DRX non-active period.
  + Proposal 8: To provide timely and effective CSI for gNB, periodic/semi-persistent CSI report can be allowed with a larger periodicity during cell non-active periods.
  + Proposal 9: gNB can configure whether to skip periodic/semi-persistent CSI-RS and CSI report or to allow them with a larger periodicity.
  + Proposal 10: gNB can configure UE whether to skip periodic/semi-persistent SRS or to allow SRS transmission with a larger periodicity.
  + Proposal 11: CG-PUSCH is skipped during Cell DRX non-active period.
* [21] Mediatek
  + Observation 1: To comply with the constraint, “The impact to IDLE/INACTIVE UEs due to the above enhancement should be avoided”, signals or channels that can be utilized by idle/inactive (legacy) UEs should not be impacted by non-active periods of cell DTX/DRX.
  + Proposal 1: TRS and PRS should not be impacted by non-active periods of cell DTX/DRX, considering the usage by idle/inactive (legacy) UEs.
  + Observation 2: To avoid excess latency for latency constrained use cases, e.g., VoIP and/or AR, schedule of data retransmissions should be allowed in non-active periods of cell DTX/DRX.
  + Proposal 2: New data of UE specific scheduling and PDSCH/PUSCH is not expected in non-active periods of cell DTX/DRX, while retransmission(s) of scheduled data in active periods of cell DTX/DRX is still allowed.
* [22] Transsion Holdings
  + Proposal 1 PDCCH scrambled with UE-specific RNTI, SPS-PDSCH, and CG PUSCH may be expected to not receive or transmit during non-active periods of cell DTX/DRX.
* [23] LG Electronics
  + Proposal #3: At least following signals/channels for connected mode UEs can be expected to not transmit or receive during non-active periods of cell DTX/DRX.
    - DL
      * Periodic/Semi-persistent CSI-RS
      * PRS
      * PDCCH scrambled with UE specific RNTI
      * SPS-PDSCH
    - UL
      * SR
      * Periodic/Semi-persistent CSI report
      * Periodic/Semi-persistent SRS
      * CG-PUSCH
* [24] Apple
  + Proposal 1: UE does not monitor PDCCH including UE-specific RNTI and Type-3 CSS in cell DTX non-active duration,
    - For DG-PDSCH/PUSCH scheduled by PDCCH received during on duration, up to gNB scheduling.
    - HARQ-ACK still allowed based on gNB scheduling for PDSCH scheduled by PDCCH in ON duration.
  + Observation 1: Because gNB has to wake up for preamble reception in all ROs in non-active duration of Cell DRX, marginal NES loss is expected if the occasions of exceptional CG/SR are configured close to ROs.
  + Observation 2: Because gNB has to wake up for SSB/SIB/paging in non-active duration of Cell DTX, marginal NES loss is expected if the exceptional SPS are configured close to occasions to transmit SSB/SIB/paging.
  + Proposal 2: A list of exceptional SPS-ConfigIndex can be included in Cell DTX configuration. gNB only wakes up to transmit low latency traffic in the SPS occasions indicated by the list during non-active duration of Cell DTX.
  + Proposal 3: A list of exceptional ConfiguredGrantConfigIndex can be included in Cell DRX configuration. gNB wakes up to receive low latency CG-PUSCH in the CG occasions indicated by the list during non-active duration of Cell DRX.
  + Proposal 4: A list of exceptional schedulingRequestID can be included in Cell DRX configuration. gNB wakes up to receive SR associated with low latency traffic in the SR occasions indicated by the list during non-active duration of Cell DRX.
  + Proposal 5: To not impact legacy UEs that do not support NES feature, TRS is still maintained during non-active duration of cell DTX.
  + Observation 3: Allowing P/SP CSI-RS to be stopped during cell DTX/DRX non-active duration may significantly increase UE measurement latency.
  + Proposal 6: Send an LS to RAN4 to study on the how much measurement latency increase is foreseen for P/SP CSI-RS before determining the transmission of CSI-RS in cell DTX/DRX non-active duration.
* [25] Lenovo
  + TRS is excluded from the set of signals that are muted during inactive periods corresponding to cell DTX
  + Use SSB to obtain estimates of time/frequency offset values in DL transmission, if TRS is included in the set of signals that are muted during inactive periods corresponding to cell DTX
  + CSI-RS for BM is excluded from the set of signals that are muted during inactive periods corresponding to cell DTX
  + If CSI-RS is included in the set of signals that are muted during inactive periods corresponding to cell DTX, SSB can be used for BM purposes, assuming that a corresponding SSBRI-based beam reporting is configured
  + CSI-RS for channel measurement is included in the set of signals that are muted during inactive periods corresponding to cell DTX
  + CSI reporting for BM is excluded from the set of signals that are muted during inactive periods corresponding to cell DRX
  + CSI reporting for channel measurement is included in the set of signals that are muted during inactive periods corresponding to cell DRX
  + CSI quantities of a CSI report that is muted during an inactive period of a cell DRX can be included as part of the CSI quantities of a subsequent occasion of CSI reporting during an active period of cell DRX, if the CSI reporting setting parameter associated with time restriction for channel measurements is not configured
  + SRS configured with usage set to beam management is excluded from the set of signals that are muted during inactive periods corresponding to cell DRX
  + SRS configured with usage set to antenna switching, codebook or non-codebook are included in the set of signals that are muted during inactive periods corresponding to cell DRX
  + SPS-PDSCH and CG-PUSCH can be configured with a range of possible periodicities that fall within the active periods of cell DTX/DRX, respectively
  + If the allowed range of periodicities of SPS-PDSCH and CG-PUSCH do not fall within the periodicities of the active periods of the cell DTX/DRX, respectively, the SPS-PDSCH and CG-PUSCH should then be excluded from the set of channels that are muted during cell DTX/DRX, respectively
  + SR is included in the set of signals that are muted during inactive periods corresponding to cell DRX
* [26] Qualcomm
  + Proposal 1: RAN1 adopts the UE transmission/reception restriction in the non-active time of cell DTX/DRX provided in the following Table for RRC connected mode UEs.
  + In the following, yes indicates channel dropping within cell DTX/DRX non-active time
  + Downlink
    - PDCCH in USS set, PDCCH in Type3-PDCCH CSS set Yes
    - DG PDSCH No
    - TRS No
    - CSI-RS for BM, BFD No
    - CSI-RS for RLM Yes
    - CSI-RS for RRM Yes, with some additional spec change consideration
    - CSI-RS for positioning (aka PRS) No
    - SPS left to RAN2
  + Uplink
    - Periodic/Semi-persistent SRS Yes
    - Periodic/Semi-persistent CSI report Yes
    - DG PUSCH No
    - PUCCH for HARQ ACK No
    - CG left to RAN2
    - SR left to RAN2
  + Observation 7: If the cell DRX is activated by RRC signaling, determination of available slots for CG PUSCH repetitions may depend on cell DRX configuration.
  + Proposal 2: If the cell DRX is activated by L1/L2 signaling and CG PUSCH repetition is dropped in the non-active time of cell DRX, the dropped CG PUSCH repetition is counted in the configured number of repetitions.
* [27] Rakuten
  + Proposal 3: At least, SSB, SIB1/2, Paging, RACH should not be dropped to avoid any impact to legacy UEs. These channels should not be considered as the further target of dropped channels.
* [28] NTT Docomo
  + Proposal 1: UE behavior during Cell DTX/DRX inactivity periods should be further discussed. Following table can be starting point.
  + DL
    - Periodic/Semi-persistent CSI-RS (FFS: for tracking): Can be dropped. Regarding CSI-RS for tracking, it needs to review impact on time/freq. synchronization.
    - PRS: Can be dropped
    - PDCCH in Type 3-PDCCH CSS and USS: Can be dropped
    - SPS PDSCH: Can be dropped but no scheduling restriction should be imposed (i.e., gNB does not need to ensure that configuration of SPS PDSCH conflicts Cell inactivity periods)
    - SSB: No impact as noted in WID
    - SIB: No impact as noted in WID
    - Paging PDSCH: No impact as noted in WID
    - PDCCH in Type0-PDCCH CSS, Type0A-PDCCH CSS, Type1-PDCCH CSS, and Type2-PDCCH CSS: No impact as noted in WID
    - Dynamic PDSCH: Can be avoided by gNB implementation
  + UL
    - SR: Can be dropped
    - Periodic/Semi-persistent CSI report: Can be dropped
    - Periodic/Semi-persistent SRS: Can be dropped
    - HARQ-ACK for SPS PDSCH reception: Can be dropped
    - CG PUSCH: Can be dropped
    - PRACH No impact as noted in: WID
    - Dynamic grant PUSCH: Can be avoided by gNB implementation
    - Aperiodic CSI report on PUSCH: Can be avoided by gNB implementation
    - Aperiodic SRS: Can be avoided by gNB implementation
    - HARQ-ACK for dynamic PDSCH reception: Can be avoided by gNB implementation
    - HARQ-ACK for SPS PDSCH activation/deactivation: Can be avoided by gNB implementation
* [29] Ericsson
  + Observation: Since PDCCH (addressed to C-RNTI) is dynamically scheduled, such PDCCH transmissions can be turned off today using legacy mechanism.
  + Observation: Prohibiting PDCCH transmissions (e.g. addressed to UE C-RNTI) during cell DTX/DRX non-active period does not bring any additional gNB energy saving compared to what is possible today while it can lead to increased latency and UE throughput loss.
  + Proposal: Support at least a case with no restriction on UE monitoring of PDCCH (addressed to C-RNTI and in Type 3 CSS) during non-active period of cell DTX/DRX.
  + Observation: Restricting reception of TRS during cell DTX/DRX non-active period can save NW energy (e.g. ~ 10% gain).
  + Proposal: Support selective reception of TRS in indicated TRS occasions during non-active period of cell DTX/DRX. Study further details of indication/occasions, e.g., TRS is received in occasions overlapping with a window before on-duration, before data scheduling, etc.
  + Proposal: UE transmits SR in indicated SR resource/occasions during non-active period of cell DTX/DRX. Study further details of indication
  + Proposal: UE receives periodic CSI-RS/transmits periodic SRS in indicated resources/occasions during non-active period of cell DTX/DRX. Study further details of indication(s)
  + Observation: PRS may be used also by idle/inactive UEs, and it may not be necessary to restrict PRS reception during non-active period of cell DTX/DRX.
* [30] ITRI
  + Proposal 1: For enhancements on cell DTX/DRX mechanism, at least the following signal mechanisms for cell DTX/DRX should be discussed:
    - UE specific DCI
    - Group common DCI
    - Cell-wise indication
  + Proposal 2: For enhancements on cell DTX/DRX mechanism, whether to transmit SSB during non-active periods of cell DTX/DRX should be discussed.
    - FFS: UE behavior for SSB reception during non-active periods of cell DTX/DRX

#### Summary of Issues

While many of the cell DTX/DRX operations require RAN2 inputs, there are specific aspects that RAN1 may be able to agree and even provide inputs to RAN2 for recommendation. These are signals and channels that are mainly specified in RAN1 specifications, such as CSI reporting, physical layer signals (such as CSI-RS and SRS), HARQ feedback, and PDCCH monitoring. For these signals and channels, RAN2 may not be able to conclude the impact from cell DTX/DRX and require RAN1 input and guidance.

The following (RAN1 domain) signals/channels are suggested by companies that may be disabled during cell DTX/DRX.

* DL
  + Periodic/Semi-persistent CSI-RS (for RRM)
  + Periodic/Semi-persistent CSI-RS (for L1-RSRP)
  + Periodic/Semi-persistent CSI-RS (for RLM)
  + Periodic/Semi-persistent CSI-RS (for BM, RFD)
  + Periodic/Semi-persistent CSI-RS (for tracking)
  + PRS
  + PDCCH scrambled by C-RNTI, CI-RNTI, CS-RNTI, INT-RNTI, SFI-RNTI, SP-CSI-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI, TPC-SRS-RNTI, and AI-RNTI
  + PDCCH in USS
  + PDCCH in Type-3 CSS
  + SPS PDSCH – (should wait for RAN2 input?)
* UL
  + Periodic/Semi-persistent CSI report
  + Periodic/Semi-persistent SRS
  + HARQ feedback for SPS PDSCH
  + HARQ feedback for DG PDSCH
  + CG PUSCH – (should wait for RAN2 input?)
  + SR – (should wait for RAN2 input?)

Also following issues has been identified by companies:

* Impact to HARQ-ACK codebook generation from cell DRX
* PUCCH deferral operations during cell DRX

#### Suggestions for further Discussions

Moderator suggests discussing the list of potential signals/channels (from RAN1 perspective). The starting point could be the list compiled from summary of company’s views.

Moderator also suggest discussing the issue on HARQ-ACK codebook generation, and PUCCH deferral operation during cell DRX.

One of the most controversial aspects seems to be on impact to TRS during cell DTX periods, which moderator suggest starting the discussions with.

##### Proposal #5-1

The following signals/channels are assumed by RAN1 to be not transmitted by the gNB during cell DTX (if cell DTX information is provided to the UEs). Other signals/channels may be added based on RAN2 input and are not precluded from further discussions.

* Periodic/Semi-persistent CSI-RS (for RRM)
* Periodic/Semi-persistent CSI-RS (for L1-RSRP)
* Periodic/Semi-persistent CSI-RS (for RLM)
* Periodic/Semi-persistent CSI-RS (for BM, RFD)
* Periodic/Semi-persistent CSI-RS (for tracking)
* PRS
* PDCCH in USS
  + C-RNTI, CS-RNTI(s), MCS-C-RNTI
  + SP-CSI-RNTI
  + SL-RNTI, SL-CS-RNTI, V-RNTI
  + AI-RNTI
* PDCCH in Type-3 CSS
  + INT-RNTI, SFI-RNTI, TPC-PUSCH-RNTI, TPC-PUCCH-RNTI, TPC-SRS-RNTI, CI-RNTI
  + C-RNTI, MCS-C-RNTI, CS-RNTI(s), PS-RNTI
  + G-RNTI, G-CS-RNTI
  + MCCH-RNTI
  + AI-RNTI

##### Proposal #5-2

The following signals/channels assumed by RAN1 to be not transmitted by the UE during cell DRX (if cell DRX information is provided to the UEs). Other signals/channels may be added based on RAN2 input and are not precluded from further discussions.

* Periodic/Semi-persistent CSI report
* Periodic/Semi-persistent SRS
* HARQ feedback for SPS PDSCH
* HARQ feedback for DG PDSCH

#### [1st Round of Discussions]

Companies are asked to provide comments and inputs on the Proposal #5-1 and #5-2.

##### Issue #1

|  |  |
| --- | --- |
| Company | Comments |
| CMCC | For Periodic/Semi-persistent CSI-RS / SRS/ CSI report, they are related to transmit quality of PDSCH/PUSCH during active period, if long non-active period can be configured for cell DTX/DRX, out of date CSI may reduce the transmit efficiency of both uplink and downlink. So it can up to gNB to configure whether these RS or report are totally skipped or can be allowed with a larger periodicity. |

##### Issue #2

Companies are also asked to provide comments on handling of

* HARQ-ACK codebook generation,
* PUCCH deferral operation during cell DRX

|  |  |
| --- | --- |
| Company | Comments |
|  |  |

## 2.6 Combining Spatial/Power Domain Enhancement with cell DTX/DRX enhancements

* [4] Nokia/NSB
  + Proposal 13: Enhancement on cell DTX/DRX mechanism can be jointly considered with adaptation of spatial and power domain techniques.
* [17] Samsung
  + Proposal 10: Support joint operation of cell DTX/DRX and NES spatial/power domain techniques.

#### Summary of Issues

Few companies suggested that enhancements for cell DTX/DRX mechanism can be jointly considered with adaptation of spatial and power domain techniques. Further clarification and discussion on what would be the specification common framework that would support both spatial/power adaptation and cell DTX/DRX will look like is likely needed

#### Suggestions for further Discussions

Moderator suggest discussing other aspects first, while RAN1 make further progress on the feature framework for spatial and power domain enhancements. Once some agreements on spatial and power domain enhancements are made, RAN1 could further discuss on methods to potentially combine cell DTX/DRX related operations with spatial/power domain enhancements.

#### [1st Round of Discussions]

Companies are asked to provide comments on combining the cell DTX/DRX operations with spatial and power domain techniques. Moderator will take the inputs and suggestions and create a formal proposal (with proposal #) for conclusion and/or agreement.

|  |  |
| --- | --- |
| Company | Comments |
|  |  |

## 2.7 Any Other Issues

#### [1st Round of Discussions]

Companies are asked to provide comments on any other issues that need to be discussed in RAN1 that is not correctly reflected in the discussion summary above. Moderator will take the inputs and suggestions and create a formal proposal (with proposal #) for conclusion and/or agreement.

|  |  |
| --- | --- |
| Company | Comments |
|  |  |

# List of Moderator Proposals for Conclusion/Agreement

TBD

# List of Conclusions/Agreements from RAN1 #112-bis-e

TBD

# Reference

1. R1-2302334, “Cell DTX/DRX for NES,” FUTUREWEI
2. R1-2302338, “Cell DTX/DRX mechanism for network energy saving,” Huawei, HiSilicon
3. R1-2302390, “Cell DTX/DRX enhancement for network energy saving,” Panasonic
4. R1-2302394, “Enhancements on cell DTX/DRX mechanism,” Nokia, Nokia Shanghai Bell
5. R1-2302499, “Discussions on enhancements on cell DTX/DRX mechanism,” vivo
6. R1-2302562, “Discussion on enhancements on cell DTX/DRX mechanism,” OPPO
7. R1-2302614, “Discussion on enhancements on cell DTXDRX mechanism,” Spreadtrum Communications
8. R1-2302717, “DTX/DRX for network Energy Saving,” CATT
9. R1-2302747, “Cell DTX/DRX Configuration for Network Energy Saving,” NEC
10. R1-2302810, “Discussion on enhancements on cell DTX/DRX mechanism,” Intel Corporation
11. R1-2302913, “Discussion on cell DTX/DRX mechanism,” Fujitsu
12. R1-2302945, “Discussion on cell DTX/DRX,” ZTE, Sanechips
13. R1-2302996, “Discussions on cell DTX-DRX for network energy saving,” xiaomi
14. R1-2303025, “Discussion on enhancements on cell DTX/DRX mechanism,” InterDigital, Inc.
15. R1-2303031, “Discussion on mechanism of cell DTX/DRX for network energy saving,” China Telecom
16. R1-2303057, “Network Energy Saving on Cell DTX and DRX,” Google
17. R1-2303142, “Enhancements on cell DTX/DRX mechanism,” Samsung
18. R1-2303203, “Enhancements on cell DTX/DRX mechanism,” ETRI
19. R1-2303248, “Discussion on cell DTX DRX enhancements,” CMCC
20. R1-2303310, “Discussion on cell DTX/DRX mechanism for network energy saving,” CEWiT
21. R1-2303345, “On NW energy saving enhancements for cell DTX/DRX mechanism,” MediaTek Inc.
22. R1-2303380, “Discussion on Enhancement on cell DTX DRX mechanism,” Transsion Holdings
23. R1-2303427, “Discussion on cell DTX/DRX mechanism,” LG Electronics
24. R1-2303497, “Discussion on cell DTX/DRX mechanisms,” Apple
25. R1-2303532, “Enhancements on cell DTX/DRX mechanism,” Lenovo
26. R1-2303604, “Enhancements on cell DTX and DRX mechanism,” Qualcomm Incorporated
27. R1-2303647, “Discussion on cell DTX/DRX mechanism,” Rakuten Mobile, Inc
28. R1-2303723, “Discussion on enhancements on Cell DTX/DRX mechanism,” NTT DOCOMO, INC.
29. R1-2303758, “RAN1 aspects of cell DTX/DRX,” Ericsson
30. R1-2303781, “Discussion on potential enhancements on cell DTX/DRX mechanism for NR,” ITRI
31. R1-2303815, “RAN1 Considerations for Cell DTX and DRX,” Fraunhofer IIS, Fraunhofer HHI