**3GPP TSG RAN WG1 Meeting #114 R1-** **2308350**

**Toulouse, France, August 21nd – 25th, 2023**

**Source: Moderator (Intel Corporation)**

**Title: Summary 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 #114 agenda 9.7.2 Enhancements on cell DTX/DRX mechanism.

# Suggested Proposals for Agreement/Conclusion issues

This section will be completed by the moderator after offline discussions.

# Summary of issues

## 2.1 General cell DRX/DTX operation

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| **Company** | **Proposals & Observations** |
|  Spreadtrum [5] | 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.Observation 3: RAN1 should continue discussion on which PHY signals/channels are impacted during inactive period of cell DTX/DRX. |
| CATT [11] | Proposal 2: For cell DTX/DRX activation and deactivation, the following methods are supported: Cell DTX/DRX is activated and deactivated dynamically by group common DCI at different times.Cell DTX/DRX is activated and deactivated semi-statically by RRC signaling at different times.Cell DTX/DRX is activated by group common DCI and deactivated by RRC signaling.Cell DTX/DRX is activated by RRC signaling and deactivated by group common DCI.Proposal 17: 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 group common DCI for expediting the transition between cell DTX/DRX active time and non-active time. |
| ZTE [12] | Proposal 9: Same configuration for cell DTX and DRX should be supported. |
| Fujitsu [13] | Proposal 4. In CA scenario, L1 signaling for cell DTX/DRX activation/deactivation indication is transmitted per serving cell, i.e., for a UE, DTX/DRX indications carried by a DCI are applied for a single carrier. |
| Xiaomi [16] | Proposal 18: Whether cell DTX and cell DRX should be configured/indicated jointly or separately should be considered.Proposal 19: For CA scenario, the Cell DTX/DRX configuration for multiple cells should be restricted to have overlapping active durations as much as possible.  |
| NTT Docomo [17] | Proposal 1:Some details and additional high layer parameters for cell DTX/DRX mechanism should be considered as follows:* Parameters for periodicity, start slot/offset and on duration for cell DTX and cell DRX are separated or common between cell DTX and cell DRX.
* High layer parameters to enable L1 signaling for cell DTX/DRX activation and deactivation, such as search space set configuration with new DCI format 2\_X are introduced, and they are separated or common between cell DTX and DRX.
* Starting position of a block, which is associated with one UE, in group common DCI for cell DTX/DRX activation and deactivation is indicated.
* DCI size for L1 activation and deactivation of cell DTX/DRX is configured.
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| OPPO [18] | Proposal 1: A set of cell DTX/DRX configurations and the associated cell ID can be configured via RRC signaling.Proposal 2: The new DCI format 2\_X should be used to determine the target cell DTX/DRX configuration and the corresponding activation/deactivation state. |
| China Telecom [19] | Observation 1:When jointly handling the cell DTX/DRX with legal procedure, the principles should be followed:The gNB should take all the procedures into consideration when configure the cell DTX/DRX.The cell DTX/DRX procedure shouldn’t be changed.Modification on the current specification should be as less as possible. |
| Samsung [20] | Proposal 4: When a UE is configured with a serving cell paired with supplemental uplink (SUL), the cell DRX configuration is common for both normal UL and SUL, and the activation/deactivation is indicated using a single bit field in DCI format 2\_X, which applies to both normal UL and SUL. Observation 2: Separately indicating the activation/deactivation of cell DTX and cell DRX for different UEs with different traffic patterns is beneficial for UE power saving. Jointly indicating the activation/deactivation of cell DTX and cell DRX for different UEs with same/similar traffic pattern is beneficial for DCI payload size reduction. Proposal 8: If UE does not detect the new DCI format 2\_X in the configured PDCCH MO, RRC separately configures whether UE assumes the cell DTX and cell DRX is activated or deactivated. |
| ETRI [21] | Proposal 1: For cell DTX and cell DRX, support the following two types of L1 activation and deactivation operation.* Type 1: UE monitors DCI outside cell DTX/DRX on-duration indicating whether or not to wake-up at the next occurrence(s) of cell DTX/DRX on-duration.
* Type 2: UE monitors DCI [within cell DTX/DRX on-duration] indicating whether or not to go-to-sleep at the next occurrence(s) of cell DTX/DRX off-duration.

Proposal 2: UE can be configured with one of Type 1 and Type 2 activation/deactivation operations for cell DTX and/or cell DRX based on RRC signalling.Proposal 3: The new DCI format 2\_X is used for both Type 1 and Type 2 cell DTX/DRX activation and deactivation operations. |
| Transsion Holding [22] | Proposal 2 DCI format 2\_6 or DCI format 2\_7 should not be affected during non-active periods of cell DTX/DRX.Proposal 3 Some constraints on active/non-active time between cell DTX and cell DRX should be discussed.Proposal 4 Configuring different cell DTX/DRX configurations for different power states should be supported. |
| LGE [23] | Proposal #3: Support gNB to configure a set of signals/channels that can be affected by Cell DTX/DRX operation as part of the cell DTX/DRX configuration. |
| Lenovo [24] | Proposal 1 The list of candidate signals/channels that are impacted by inactive periods of cell DTX/DRX are updated based on further input from RAN WG2Proposal 10 Support including the start slot/offset parameter corresponding to cell DTX/DRX configuration to the list of L1 signaling parametersProposal 11 Support higher-layer configuration of multiple cell DTX and/or DRX patterns, where one cell DTX and/or DRX configuration pattern is activated via L1 signaling for cell DTX and/or DRX activation/deactivation |
| Fraunhofer [26] | Proposal 1: RAN1 should consider a DCI 2\_X design, which minimizes overhead regardless of whether a single or multiple Cell DTX/DRX pattern(s) are to be supported to avoid future re-design. |
| Ericsson [28] | Proposal 8 Support at least a cell DTX/DRX mechanism that does not disrupt an ongoing packet delivery including packet transmissions/retransmissions. |
| CEWiT [29] | Proposal 1: Multiple Cell DTX/DRX patterns with different time granularity for duty cycle, periodicity and duration is supported.Proposal 5: Dynamic adaptation of ON duration of the cell DTX/DRX pattern using DCI format for cell DTX/DRX activation and deactivation is supported.Observation 2: Following observation is made about deprioritizing signals and channels over cell DTX/DRX * Deprioritizing results in delay and performance loss at UE
* Rescheduling the entire set of deprioritized signals/channels after DTX/DRX pattern results in additional signaling and redundancy

Proposal 6: Reassigning the deprioritized operation after Cell DTX/DRX duration using a time offset is supported. |
| ASUSTeK [31] | Proposal 2: RAN1 should be careful about turn off a cell common signal via Cell DTX/DRX. A cell common signal could be turn off via cell DTX/DRX only if there is no side effect caused to legacy UE. |

### Summary of Issues

While moderator has categorized many companies inputs in the general cell DTX/DRX operation section, many issues are somewhat related to individual issues such as how DCI format 2\_X is monitored or how the general signaling needs to be designed. Some details of the higher layer signaling is dependent on how the DCI Format 2\_X is designed. As such they may need to be discussed after the DCI Format 2\_X is determined.

### Suggestions for further Discussions

##### Proposal 1-1:

The following high layer signaling are to be included to the RRC parameter list

* Parameters for periodicity, start slot/offset and on duration for cell DTX
* Parameters for periodicity, start slot/offset and on duration for cell DRX
	+ Note separate signaling for cell DRX and cell DTX
* search space set configuration with new DCI format 2\_X
	+ same search space set configuration applies for both cell DTX and DRX configurations
* Starting position of an information block field (within DCI Format 2\_X), for indicating activation and deactivation of cell DTX and DRX,
	+ An information block field is associated with one serving cell, one configuration, and one UE
* DCI size for new DCI format 2\_X for activation and deactivation of cell DTX/DRX

## 2.2 DCI Format 2\_X Design

|  |  |
| --- | --- |
| **Company** | **Proposals & Observations** |
| Nokia, NSB [1] | Proposal 1: At least two bits field is needed for indicating the activation/deactivation of a single cell DTX pattern and a single cell DRX pattern.Observation 1: Multiple cell DTX/DRX patterns can be beneficial to cope with diverse traffic types as well as catering for network implementation with different sleeping mode.Proposal 2: To support the (de-)activation of multiple cell DTX and DRX patterns, the corresponding bit field(s) shall be specified.Observation 2: Defining a block-based design for the new DCI may not be needed as all UEs will have to decode the same DCI content and apply the same cell DTX/DRX (de)-activation indication.Proposal 3: Specify the bit fields in DCI format 2\_X on support of (de-)activation of single cell DTX and DRX pattern, as well as (de-)activation of multiple cell DTX and DRX patterns, based on index approach as example shown in table 2.Table 2: Alternative (2) of the new DCI design for cell DTX/DRX (de)-activation indication based on index-approach

|  |  |  |
| --- | --- | --- |
| Field | Number of bits  | Encoded information |
| 1 | n(number of bits required depends on the network configured cell DTX patterns), e.g. for 3 patterns, 2 bits are needed | 00: Cell DTX Pattern deactivation 01: Cell DTX Pattern #1 activation 10: Cell DTX Pattern #2 activation11: Cell DTX Pattern #3 activation |
| 2 | n(number of bits required depends on the network configured cell DTX patterns), e.g. for 3 patterns, 2 bits are needed | 00: Cell DRX Pattern deactivation 01: Cell DRX Pattern #1 activation10: Cell DRX Pattern #2 activation11: Cell DRX Pattern #3 activation |
| Spare bits | N | Other details, if needed |
| Padding (if needed) | Depends upon DCI size |  |

Proposal 4: To confirm that the new DCI format 2\_X size is indicated by the higher layer configuration. Proposal 5: DCI size budget shall not be increased.Proposal 6: A new RNTI shall be specified for the purpose of cell DTX/DRX activation/deactivation with CRC scrambled of DCI format 2\_X. Proposal 7: The new introduced RNTI can be either hardcoded in the spec or configurable by higher layer.Proposal 8: The new DCI format 2\_X shall be monitored in the common search space.Proposal 9: Discuss on how to specify the configuration of monitoring occasion for DCI format 2\_X, when a cell DTX/DRX pattern is not activated.Proposal 10: RAN1 to confirm that the new DCI format 2\_X monitoring configuration shall consider a common time reference that is based on the cell DTX/DRX configuration commonly applied by UEs, regardless of their C-DRX configuration, if any.Proposal 11: The start of the DCI format 2\_x monitoring occasions shall be based on the common time reference, based on the cell DTX/DRX configuration, and a new configurable offset *Cell\_DTX\_DRX-Offset.*  |
| Huawei [2] | Proposal 1: Define the structure of DCI format 2\_X as follows:* Each block of DCI format 2\_X contains up to M sub-block, where M is the number of cells configured to the UE(s).
* Each sub-block has up to 2 bits, where each bit corresponds to a cell DTX (de)activation or a cell DRX (de)activation for a certain cell, respectively.
* The total bits in the block concatenated in the order corresponding to the cell with lowest to highest serving cell index.
* A new RNTI, and DCI format 2\_X is associated with Type3-PDCCH CSS.
* Each UE should know the start location of its assigned block e.g., configured by the gNB.
 |
| Ruijie Network [3] | Proposal 1: For DCI format for group common L1 signaling using PDCCH for cell DTX/DRX activation and deactivation, support * Alt 2) Based on new DCI format 2\_X
 |
| vivo [6] | Proposal 12: Support DCI 2\_X for cell DTX/DRX configuration activation/deactivation scrambled by a new RNTI with the following transmitted information- block number 1, block number 2, …, block number Nwhere* each block includes 1 bit for DTX configuration activation/deactivation and 1 bit for DRX configuration activation/deactivation;
* DCI size is configurable by higher layers parameter;
* the starting position of checked block by a UE for a serving cell is configured by RRC signaling.
 |
| Panasonic [7] | Proposal 9: DCI format 2\_X should utilize block-based structure. UE is configured with a block starting position and follows the indication within that block. In each block, bit width is configurable, e.g., if both Cell DTX/DRX are configured, 2 bits are configured, each of which indicates ‘activate’ / ‘deactivate’ by 1/0 for Cell DTX and Cell DRX, respectively. |
| Intel [8] | Proposal 1:* DCI format 2\_X for activation and deactivation of cell DTX/DRX configuration consists of following information fields:
	+ Information Block number 1, information block number 2, …, information block number N
	+ Where number of information block N is determined by the size of the DCI.

Proposal 2:* DCI format 2\_X for activation and deactivation of cell DTX/DRX configuration is scrambled with new RNTI dedicated for cell DTX/DRX operations, e.g. *cdd-RNTI*

Proposal 3:* Information block field of the DCI format 2\_X for activation and deactivation of cell DTX/DRX configuration consists of following sub-fields:
	+ Activation/deactivation of configured cell DTX – 1 bit
	+ Activation/deactivation of configured cell DRX – 1 bit

Observation 1:* 2 bit Information block field of the DCI format 2\_X for activation and deactivation of cell DTX/DRX configuration can be applicable to support activation and/or deactivation of a configuration of the multiple cell DTX/DRX configurations.
* No additional reserved bits is necessarily to support future expansions of the feature.
 |
| NEC [9] | Proposal 1: For cell DTX/DRX activation, support 2 bits or 4 bits for independent or aligned cell DTX/DRX activation indication. |
| CATT [11] | Proposal 10: Multiple cell DTX/DRX configurations can be supported and at least one cell DTX/DRX configuration can be activated and deactivated in group common DCI.Proposal 11: For cell DTX/DRX activation and deactivation, the group common DCI contains N blocks and the following designs can be considered:* Option 1: N blocks are corresponding to N UE groups.
* Option 2: One cell specific block is corresponding to all UEs in the cell and N-1 UE group specific blocks are corresponding to N-1 UE groups.

Proposal 12: In addition to cell DTX activation/deactivation indication and cell DRX activation/deactivation indication, the group common DCI for cell DTX/DRX activation and deactivation contains identification of cell DTX/DRX configuration.Proposal 13: A new RNTI is used to scramble the CRC of group common DCI for cell DTX/DRX activation and deactivation. |
| ZTE [12] | Proposal 2: UE should monitor PDCCH scrambled by PS-RNTI (i.e. DCI format 2-6) during cell DTX non-active periods to adapt C-DRX with traffic arrival.Observation 3: For SearchSpace in pdcch-ConfigMulticast, searchSpaceMCCH and searchSpaceMTCH, PDCCH scrambled by G-RNTI and MCCH-RNTI can indicate information for RRC Idle, Inactive or Connected mode UE.Proposal 3: PDCCH scrambled by G-RNTI and MCCH-RNTI should not be impacted by cell DTX.Proposal 4: The UE does not expect to monitor PDCCH scrambled by G-CS-RNTI during cell DTX non-active period.Proposal 12: In CA scenario, a bitmap is used to indicate activation/deactivation of cell DTX/DRX configurations for one or more cells, where each bit corresponds to a single cell or a group of cells.Proposal 13: In order to simplify the cell DTX/DRX operation and reduce the signaling overhead, the cells with the same cell DTX/DRX parameters (e.g. same offset) are preferred to be bundled into a group. |
| Fujitsu [13] | Proposal 1. For the DCI format 2\_X which consists of multiple blocks, the following content can be carried by each block:* A field contains multiple bits for the cell DTX indication, where each bit corresponds to an activation/deactivation indication for the corresponding cell DTX configuration.
* A field contains multiple bits for the cell DRX indication, where each bit corresponds to an activation/deactivation indication for the corresponding cell DRX configuration.

Proposal 2. The following higher layer configuration can be considered for DCI format 2\_X:* The number of bits included in each block for cell DTX indication
* The number of bits included in each block for cell DRX indication
* The number of blocks included in the DCI or the total number of bits for the DCI
* The starting monitoring position for the UE
 |
| CMCC [14] | Proposal 16：Different block numbers in new DCI format 2\_X contain Cell DTX/DRX activation/deactivation indication of different serving cells.Proposal 17: Starting position of activation/deactivation indication in new DCI format 2\_X for each serving cell is RRC configured.Proposal 18: Cell DTX and Cell DRX can share the same activation and deactivation indication bit.Proposal 19: Whether the activation and deactivation indication bit are shared or not can be configured by gNB. |
| Apple [15] | Proposal 1: New RNTI is used to scramble the new DCI format for cell DTX/DRX activation/deactivation.Proposal 2: Each block in DCI content field corresponds to a group of cells that can be activated/deactivated together, i.e., an NES cell group index determines the index to the block number. Fig. 1 Illustration of mapping of cells to blocks |
| Xiaomi [16] | Proposal 11: DCI 2-x can include a cell DTX/DRX indication field with M bits, and a bitmap can be configured for each UE to indicate the exactly bit positions correspond the UE’s serving cells within the M bits.Proposal 12: DCI 2-x can be exploited to carry some information for dynamic adjusting the cell DTX/DRX pattern. |
| NTT Docomo [17] | Proposal 2:Additional details of the new DCI format 2\_X for cell DTX/DRX mechanism should be considered as follows:* Separate activation or deactivation for cell DTX/DRX, e.g., activating Cell DRX while deactivating Cell DTX, is supported.
* Indication of activation/deactivation for cell DTX/DRX can use separated bits or joint coded bits.
* Bit width of block for a UE considers the number of cells/CCs configured with Cell DTX and DRX for the UE.
* Legacy or new RNTI can be used.
 |
| China Telecom [19] | Proposal 3:Support to add 2 bits field for the activation/deactivation of Cell DTX/DRX in the new DCI format 2\_X. Proposal 4:Support to add 1 bit field for the alignment indication of C-DRX and Cell DTX/DRX for each UE configured with C-DRX in the new DCI format 2\_X.Proposal 6:Support to include the fields in the DCI format 2\_6 in the new DCI format 2\_X, i.e., the WUS and Scell dormancy indication for each UE.* The WUS can reuse the alignment indication=n.
* The details of the fields can be configured in the RRC.

Figure 2 illustration of the new DCI format 2\_X |
| Samsung [20] | Observation 1: For a serving cell, separately indicating the activation/deactivation of cell DTX and DRX is beneficial for network energy saving. Proposal 3: Whether the activation/deactivation of Cell DTX and Cell DRX are separately indicated using two bits or jointly indicated using one bit in the DCI format 2\_X is configurable by the gNB. Observation 3：Separately indicating the activation/deactivation of cell DTX and DRX for different serving cells is beneficial for network energy saving.Proposal 5: For the determination of the bit locations in the new DCI format 2\_X, UE specific RRC signalling separately configures the bit location of activation/deactivation indication of cell DTX and cell DRX for each serving cell. Proposal 4: When a UE is configured with a serving cell paired with supplemental uplink (SUL), the cell DRX configuration is common for both normal UL and SUL, and the activation/deactivation is indicated using a single bit field in each block of DCI format 2\_X, which applies to both normal UL and SUL. 🡨 [RRC needed, in case if joint or separate indication for normal UL and SUL is made configurable.] |
| ETRI [21] | Proposal 5: Support multiple cell DTX/DRX modes to allow UE to adapt transmission/reception behaviours during cell DTX/DRX non-active time.Proposal 6: Each cell DTX/DRX mode is associated with a set of DL/UL signals UE receives/transmits (or, equivalently does not receive/transmit).Proposal 7: The new DCI format 2\_X can indicate one of cell DTX/DRX modes to apply during the next cell DTX/DRX off-duration(s). |
| LGE [23] | Proposal #1: For DCI format 2\_X for cell DTX/DRX activation and deactivation,* For field content format, N multiple blocks can be included, and each block can be linked to a specific cell (or cell group)
* For each block should at least support the following:
	+ DTX configuration activation/deactivation
	+ DRX configuration activation/deactivation
	+ Timers for activation/deactivation
	+ DTX/DRX configuration index (if multiple configurations are supported)
 |
| Interdigital [25] | Proposal 3: For handling multiple cells in the new DCI format 2\_X, the following can be considered for activation/deactivation of cell DTX/DRX:* Alt-1: Single DCI for multiple cells (e.g. DCI carries indices of multiple cells)
* Alt-2: Per cell DCI (e.g. each DCI indicates per cell level status)
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| Fraunhofer [26] | Proposal 2: DCI 2\_X could add the following configuration ID field:* Configuration ID, n bits as indicated by higher layers. The configuration ID with all zeroes de-activates Cell DTX/DRX. When the UE receives a configuration ID with other values other than all zeroes:
	+ If Cell DTX/DRX is not yet activated the UE activates the corresponding configuration.
	+ If Cell DTX/DRX is already activated and the configuration ID is different than the previously configured ID the UE switches to the corresponding Cell DTX/DRX configuration.
	+ If the same configuration ID is received again or the ID is not configured the UE should maintain the current configuration.
 |
| Qualcomm [27] | Proposal 5: The number of bits for cell DTX/DRX activation/activation depends on whether cell DTX/DRX operation is jointly configured or not i.e., if cell DTX/DRX configurations are jointly configured, the number of bits is one. Otherwise, two bits are supported (one for DTX and another for DRX). |
| Ericsson [28] | Proposal 4 Following are configured by higher layers for DCI 2\_X a. payload size (between 1 and 140 bits)b. RNTI c. Search space (common search space)d. Starting position of ‘cell DTX/DRX activation/deactivation indication’ field within the DCIProposal 5 Support the following field in DCI 2\_X a. (1-bit DTX activation/deactivation, 1-bit DRX activation/deactivation) per cell, arranged in increasing order of cell index |
| Mediatek [30] | Proposal 1: Design of Group Common DCI for Cell DTX/DRX should consider UE C-DRX related behaviorsObservation 1: Specification should prevent situations where the network needs to send DCI format 2\_6 just to wake up the UE for monitoring DCI for cell DTX/DRX activation or deactivation, despite the absence of data intended for the UE.Proposal 2: DCI format 2\_X for cell DTX/DRX supports• Flexible coexistence with DCI format 2\_6 when it is configured to UE• Flexible allocation within C-DRX on-duration if DCI format 2\_6 is not configured |

### Summary of Issues

Issue 1: General field format

* DCI format 2\_X at least includes,
	+ N information blocks,
	+ Spare/reserved bits (to match the size configured for DCI 2\_X)
* DCI format 2\_X payload size can be configured between 1 and 140 bits.

Issue 2: Handling of multiple cells

* Alt 1: RAN1 assumes information block offset is configured by higher layers for each cell DTX/DRX configuration of a serving cell.
* Alt 2: separate DCI for different serving cell
	+ FFS: whether DCI to include serving cell index

Issue 3: sub-field design for each information block

* Separate indication for (activation/deactivation of) cell DTX and cell DRX
* Option A: Separate 1 bit indication of activation/deactivation for cell DTX and cell DRX, total of 2 bits per information block.
* Option B: multi-bit indication to indicate which configuration of cell DTX or DRX is being activated or deactivated
	+ Note: multi-configuration for cell DTX and DRX has not been yet agreed in RAN2.

Issue 4: inclusion of other information in information block

* Scell dormancy information
* Alignment indication and WUS for UE

### Suggestions for further Discussions

Moderator suggest to discuss the above 4 issues further. For issue 2, there seems to be more companies that favor Alternative 1. Therefore, moderator has combined issue 1 and 2 and provided a proposal 3-1 for discussion.

##### Proposal 2-1:

* DCI format 2\_X, for activation and deactivation of cell DTX and DRX configuration,
	+ at least includes following fields,
		- N information block field(s),
		- Spare/reserved padding bits to match the size configured for DCI 2\_X
	+ payload size can be configured between 1 and 140 bits
	+ an information block field contains signaling of activation or deactivation of ‘a configuration of cell DTX and/or DRX’ of ‘a serving cell’ of ‘a UE’

##### Proposal 2-2:

An information block field of DCI format 2\_X for for activation and deactivation of cell DTX and DRX configuration supports the following:

* separate (activation/deactivation) signaling for cell DTX and cell DRX, i.e. one activation/deactivation signaling sub-field for cell DTX configuration and one activation/deactivation signaling sub-field for cell DRX configuration
* Moderator note: down-select among two options
	+ Option A: Separate 1 bit indication of activation/deactivation for cell DTX and cell DRX, total of 2 bits per information block.
	+ Option B: multi-bit indication to indicate which configuration of cell DTX or DRX is being activated or deactivated
		- Moderator note: multi-configuration for cell DTX and DRX has not been yet agreed in RAN2.

Moderator thinks the following proposal likely requires further discussion. It is a single company proposal.

##### Proposal 2-3:

DCI format 2\_X, for activation and deactivation of cell DTX and DRX configuration, additionally includes the following information in each information block field:

* Scell dormancy information
* Alignment indication and WUS for UE

## 2.3 PDCCH monitoring for DCI Format 2\_X

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| **Company** | **Proposals & Observations** |
| Nokia, NSB [1] | Proposal 5: DCI size budget shall not be increased.Proposal 6: A new RNTI shall be specified for the purpose of cell DTX/DRX activation/deactivation with CRC scrambled of DCI format 2\_X. Proposal 7: The new introduced RNTI can be either hardcoded in the spec or configurable by higher layer.Proposal 8: The new DCI format 2\_X shall be monitored in the common search space.Proposal 9: Discuss on how to specify the configuration of monitoring occasion for DCI format 2\_X, when a cell DTX/DRX pattern is not activated.Proposal 10: RAN1 to confirm that the new DCI format 2\_X monitoring configuration shall consider a common time reference that is based on the cell DTX/DRX configuration commonly applied by UEs, regardless of their C-DRX configuration, if any.Proposal 11: The start of the DCI format 2\_x monitoring occasions shall be based on the common time reference, based on the cell DTX/DRX configuration, and a new configurable offset Cell\_DTX\_DRX-Offset. Observation 3: In some cases, L1 signal monitoring for cell DTX/DRX (de-)activation could be beneficial during cell DTX non-active period.Proposal 13: Discuss on any exception needed for UE monitoring of L1 signalling with DCI format 2\_X for cell DTX/DRX (de-)activation during the non-active period. |
| Huawei [2] | Proposal 2: Introduce a monitor window in every cell DTX/DRX cycle for DCI format 2\_X. |
| Spreadtrum [5] | Proposal 4: Monitoring occasions between the new DCI format 2\_x and legacy DCI format 2\_6 may or may not identical. |
| vivo [6] | Proposal 14: No restriction on alignment of PDCCH monitoring configuration between the new DCI format 2\_X for cell DTX/DRX activation/deactivation and DCI format 2\_6.Proposal 15: Support monitoring DCI 2\_X with CRC scrambled by a new RNTI in non-active period of cell DTX. |
| Panasonic [7] | Proposal 10: To enhance the reliability, more MOs can be configured and reserved for new DCI repetition.Observation 1: MOs of new DCI format are not necessarily be limited to the outside of the predefined period configured by RRC like DCI format 2\_6, as the functionality is different from wake-up indication. Here, the predefined period configured by RRC is similar to OnDuration of C-DRX.Proposal 11: The MOs of new DCI format should be extended to active time to avoid collision/confusion caused by configured DCI format 2\_6.Proposal 12: The MOs of new DCI format in the outside of the predefined period configured by RRC non-active time should also be supported for better reliability and more swift misalignment identification, handling, and recovery.Proposal 13: In case of new DCI format is miss-detected, UE default behaviour needs to be specified. Our first preference is “deactivation” and we can live with making it configurable, as Rel.16 UE power saving. |
| NEC [9] | Proposal 2: Support default or fallback PUCCH resource indication during the cell DTX/DRX non-active period in cell DTX/DRX activation DCI.Proposal 3: Support default or fallback PDCCH search space monitoring during the cell DTX/DRX non-active period in cell DTX/DRX activation DCI. |
| CATT [11] | Proposal 3: The activation and deactivation of cell DTX/DRX by group common DCI 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 4: For cell DTX/DRX activation and deactivation, UE does not monitor group common DCI during cell DTX non-active time.Proposal 5: When cell DTX/DRX is activated, UE can be configured to monitor group common DCI more frequently than UE monitors group common DCI in cell normal state.Proposal 6: For cell DTX/DRX activation and deactivation, if the PDCCH monitoring occasion of group common DCI is determined based on search space configuration, the periods of search space for group common DCI monitoring in normal cell state and cell DTX/DRX state are different.Proposal 7: For cell DTX/DRX activation and deactivation, if the PDCCH monitoring occasion of group common DCI is determined based on search space configuration, the period of search space for group common DCI is determined by the period of cell DTX.Proposal 8: For cell DTX/DRX activation and deactivation, if a periodic time window for monitoring group common DCI is introduced, the periods of time window in normal cell state and cell DTX/DRX state are different.Proposal 9: For cell DTX/DRX activation and deactivation, if a periodic time window for monitoring group common DCI is introduced, the period of time window for group common DCI is determined by the period of cell DTX. |
| ZTE [12] | Observation 1: For the PDCCH scrambled by C-RNTI, MCS-C-RNTI and CS-RNTI, UE cannot know whether the PDCCH carries scheduling information or not until the UE successfully decodes the DCI. Proposal 1: It is proposed that UE does not monitor PDCCH scrambled by C-RNTI, MCS-C-RNTI and CS-RNTI during cell DTX non-active periods.Observation 2: For Type3-PDCCH CSS with searchSpaceType = common, except for C-RNTI, MCS-C-RNTI and CS-RNTI, PDCCHs carrying the DCI formats with CRC scrambled by the RNTIs (e.g. SFI-RNTI, INT-RNTI, TPC-PUSCH-RNTI and TPC-PUCCH-RNTI, etc.) are not used for data transmission.Observation 6: If the detection of new DCI format is confined during a time window, UE does not need to detect new DCI format in every PDCCH occasion and gNB is not required to transmit new DCI format during multiple PDCCH monitoring occasion, so that both UE and gNB can achieve more power savings. Proposal 10: For both UE and gNB power savings, it is proposed UE monitors the new DCI format during the time window before the start of next cell DTX/DRX cycle.Proposal 14: For the fallback mechanism for L1 signaling triggering activation/deactivation of cell DTX/DRX configuration, a timer is used to trigger gNB to fall back to network energy saving state. |
| CMCC [14] | Proposal 14: PDCCH monitoring occasion for new DCI format 2\_X can be enhanced to save UE power consumption and network overhead.Proposal 15: An offset prior to end time of active period can be defined to determine the starting monitoring time for new DCI format 2\_X. Proposal 21: NES specific RNTI is used for CRC scrambling of new DCI format 2\_X.Proposal 22: To improve reliability of PDCCH with new DCI format 2\_X, a lower miss detection rate can be set, for example, 0.1%.Proposal 24: Timer based for activation/deactivation is not introduced. |
| Apple [15] | Proposal 3: A UE without C-DRX configuration monitors PDCCH in CSS set for a DCI format 2\_X with CRC scrambled by NES-RNTI during both cell DTX (if activated) active and non-active period, as configured by the search space configuration.Proposal 4: When UE C-DRX is configured, the PDCCH monitoring behavior should try to avoid increasing UE power consumption too much, UE monitors the new DCI format during UE C-DRX ON duration and during a time window before C-DRX ON duration (similar to DCI format 2\_6). |
| Xiaomi [16] | Proposal 13: Validity duration for cell DTX/DRX can be carried in DCI 2-x. |
| China Telecom [19] | Proposal 5: Support to introduce new RNTI for the new DCI format 2\_X, e.g., nes-RNTI. |
| Samsung [20] | Proposal 6: A new RNTI is introduced to scramble the CRC of the new DCI format 2\_X. |
| ETRI [21] | Proposal 4: The activation/deactivation indication via DCI format 2\_X is applied to all on-durations (for Type 1) or all the off-durations (for Type 2) for cell DTX and/or cell DRX within a time window, where the time window is determined as relative to the location of the PDCCH MO(s) for DCI format 2\_X. |
| Transsion Holding [22] | Proposal 5 New RNTI is used for the new DCI format . |
| Interdigital [25] | Proposal 1: UE monitors PDCCH for detecting DCI format 2\_x during the CDRX Active Time (e.g. when DRX ON duration timer and inavivity timer are running) and during the cell DTX Active PeriodProposal 4: PDCCH monitoring configuration for the new DCI format can be independent and different than that applied for DCI format 2\_6 Proposal 5: Define new RNTI for the DCI format 2\_X |
| Qualcomm [27] | Proposal 2: A new RNTI is introduced for the DCI format 2\_X.Proposal 3: PDCCH monitoring occasion configuration for the DCI format 2\_X is identical to PDCCH monitoring occasion configuration for DCI format 2\_6 if the UE monitors both DCI format 2\_X and DCI format 2\_6.Proposal 6: If the cell DRX is activated/deactivated by the new DCI format 2\_X, the CG PUSCH repetition that is dropped in non-active time of cell DRX is counted in the configured number of repetitions. |
| Ericsson [28] | Proposal 6 UE monitors DCI 2\_X in cell DTX active period. |

### Summary of Issues

**Issue 1:** RNTI

Several companies all seem to propose use of new RNTI for DCI format 2\_x. Moderator suggests agreeing on the following:

* Support new RNTI, e.g. nes-RNTI, for scrambling of DCI format 2\_X intended to activation/deactivation of a cell DTX/DRX configuration

**Issue 2:** default activation/deactivation behavior based on timer

Few companies propose not support timer based behavior for L1 based activation/deactivation of cell DTX/DRX configuration.

* Timer based for activation/deactivation is not introduced

**Issue 3:** PDCCH monitoring configuration

* new DCI format 2\_X is monitored in the common search space
* Alt 1: intendent search space set configuration for DCI format 2\_X from DCI format 2\_6
* Alt 2: search space set configuration is shared between DCI format 2\_x and DCI format 2\_6

**Issue 4:** default behavior when DCI format 2\_X is missed

One company has proposed to support the following default behavior:

* When UE fails to detect (new) DCI format 2\_X during a PDCCH monitoring occasion, default UE behaviour is “deactivation”
	+ FFS whether default behavior can be configured by higher layers

### Suggestions for further Discussions

##### Proposal 3-1:

* Support new RNTI, e.g. nes-RNTI, for scrambling of DCI format 2\_X intended to activation/deactivation of a cell DTX/DRX configuration

##### Conclusion 3-2:

* Timer based activation and/or deactivation of cell DTX and DRX configuration is supported.

##### Proposal 3-3:

* (new) DCI format 2\_X for activation/deactivation for a cell DTX/DRX configuration is monitored in the common search space
* *Moderator note: down-select among following alternatives:*
* Alt 1: intendent search space set configuration for DCI format 2\_X from DCI format 2\_6
* Alt 2: search space set configuration is shared between DCI format 2\_x and DCI format 2\_6

##### Proposal 3-4:

* When UE fails to detect (new) DCI format 2\_X during a PDCCH monitoring occasion, default UE behaviour is “deactivation”
	+ FFS whether default behavior can be configured by higher layers

## 2.4 Application Time for DCI Format 2\_X

|  |  |
| --- | --- |
| **Company** | **Proposals & Observations** |
| Nokia, NSB [1] | Proposal 14: The consideration of an application delay for cell DTX/DRX activation is not needed.  |
| Huawei [2] | Proposal 3: Define the monitor window of DCI format 2\_X before the expire time of on-duration timer, and monitoring cycle as cell DTX cycle.Proposal 4: The (de)activation indication in DCI format 2\_X should take effect after X symbols/slots from the end time of the monitor window (before the on-duration timer expires). |
| vivo [6] | Proposal 13: Cell DTX/DRX activation/deactivation is applied from the start of the first slot in the indicated serving cell after Pdelay from the ending symbol of detected PDCCH, where value of Pdelay is predefined in spec. |
| CATT [11] | Proposal 14: For cell DTX/DRX activation and deactivation, the group common DCI will take effect immediately and application delay of group common DCI is not supported. |
| ZTE [12] | Proposal 11: Considering the unfinished data transmission and the alignment of data transmission among multiple cells and UEs, we propose that UE applies activation/deactivation of cell DTX/DRX configuration from the start of the next cell DTX/DRX cycle. |
| Fujitsu [13] | Proposal 3. A minimum application delay is considered for the L1 signaling to activation/deactivation cell DTX/DRX configuration. |
| Apple [15] | Proposal 5: Upon reception of the L1 signaling for activation, UE assumes that cell DTX/DRX pattern is effective after k1 slots from the slot it receives the DCI, where k1 is based on UE capability report. Proposal 6: During the k1 slots, if UE C-DRX is configured, UE follows legacy C-DRX behavior assuming cell DTX/DRX pattern is not effective. After the k1 slots, the UE behavior depends on further discussion on the interaction between cell DTX/DRX and UE C-DRX.Proposal 7: If the deactivation signaling is received within the cell DTX/DRX active period, the following two alternatives can be considered, while Alt 2 is preferred to maintain a consistent UE behavior:* Alt 1: UE assumes that cell DTX/DRX pattern is deactivated after the end of cell DTX/DRX active period.
* Alt 2: UE does not expect to receive a deactivation signaling within k2 slots before the end of the cell DTX active period, and UE assumes that cell DTX/DRX pattern is deactivated after k2 slots after it receives the DCI.

Proposal 8: Upon reception of cell DTX/DRX deactivation signaling, UE assumes that cell DTX/DRX pattern is deactivated after k2 slots from the slot that UE receives the DCI, where k2 is based on UE capability report. Proposal 9: UE does not expect to receive a cell DTX/DRX deactivation signaling within k2 slots before the end of the cell DTX active period. Proposal 10: During the k2 slots, if UE C-DRX is configured, the UE behavior follows the cell DTX/DRX behaviors ( further discussion on the interaction between cell DTX/DRX and UE C-DRX needed). After the k2 slots, the UE behavior follows legacy UE C-DRX behaviors if configured . |
| Samsung [20] | Observation 4: Defining the application delay of the new DCI format 2\_X can help ensure UE and gNB to have the same understanding regarding the effective time of the activation/deactivation of cell DTX/DRX.Proposal 7: The application delay of the new DCI format 2\_X is T after the end of the PDCCH reception of the new DCI format 2\_X.* T is no less than PUSCH preparation procedure time $T\_{proc,2}$.
* T is no less than UCI multiplexing procedure time.

Observation 5: In case of a UE does not detect the new DCI format 2\_X in the configured PDCCH MO and gNB indicates the deactivating of cell DTX, UE may miss the PDCCH if UE assumes the cell DTX is activated and the PDCCH MO is within the non-active period.Observation 6: In case of a UE does not detect the new DCI format 2\_X in the configured PDCCH MO and gNB indicates the activating of cell DRX, UE may transmit a CG PUSCH in a non-active period (from gNB’s understanding) and gNB would not receive it and thus the UL data can be dropped.Proposal 8: If UE does not detect the new DCI format 2\_X in the configured PDCCH MO, RRC separately configures whether UE assumes the cell DTX and cell DRX is activated or deactivated.Proposal 9: As a fallback behaviour, a UE is configured with a timer value associated with the Cell DTX/DRX configuration, and the UE assumes a default network operation state if the UE does not detect a new DCI format 2\_X during the configured time duration. Observation 7: It should be up to gNB implementation to configure whether PDCCH monitoring configuration for the new DCI format 2\_X is identical to PDCCH monitoring configuration for DCI format 2\_6 if the UE monitors both DCI formats, i.e., no further agreement is needed. Proposal 7: The application delay of the new DCI format 2\_X is T after the end of the PDCCH reception of the new DCI format 2\_X.* T is no less than PUSCH preparation procedure time $T\_{proc,2}$.
* T is no less than UCI multiplexing procedure time.

🡨 [Application delay can be RRC configured]Proposal 9: As a fallback behaviour, a UE is configured with a timer value associated with the Cell DTX/DRX configuration, and the UE assumes a default network operation state if the UE does not detect a new DCI format 2\_X during the configured time duration.  |
| LGE [23] | Proposal #2: The absolute or relative time offset can be used as a reference time for UE to determine when to start/apply the Cell DTX/DRX configuration* If the absolute time is used as a reference time, UE starts/applies the corresponding Cell DTX/DRX configuration from a specific SFN based on pre-configuration after it receives the DCI.
* If the relative time is used as a reference time, UE starts/applies the corresponding Cell DTX/DRX configuration X slots (where value of X can be configured/indicated) after it receives the DCI.
 |
| Interdigital [25] | Proposal 2: No additional application delay and timers for activation/deactivation need to be supported with the DCI format 2\_X  |
| Fraunhofer [26] | Proposal 3: DCI 2\_X should consider including a time offset to indicate the point in time after receiving the message at which the new configuration is to become effective.  |
| Qualcomm [27] | Proposal 4: The indicated cell DTX/DRX activation/deactivation is effectively applied X slots after the last CORESET symbol where the DCI format 2\_X is received, * Reuse the value 2 in Table 10.3-1 of TS 38.213 for X.
* The sub-carrier spacing to determine X is the SCS of the active DL BWP (containing the CORESET over which the UE monitors PDCCH for the indication).
 |
| Ericsson [28] | Proposal 7 The application time for PDCCH based cell DTX/DRX activation/deactivation is [X] slots (in units of PDCCH SCS) from the slot in which PDCCH ends. |
| CEWiT [29] | Observation 1: Application delay is required before activating DTX/DRX pattern so that* UE can process the DTX/DRX activation command and adapt accordingly.
* UE can complete the ongoing transmission/reception.

Proposal 2: DCI format for cell DTX/DRX activation and deactivation indicating application delay, between the DCI containing activation command and actual activation of the DTX/DRX pattern at the gNB, is supported.Proposal 3: Indicating application delay as slot offset, with respect to the start of the slot in which DCI containing activation command is received, is supported. Proposal 4: DCI format for cell DTX/DRX activation and deactivation indicating validity duration of cell DTX/DRX is supported. |

### Summary of Issues

Several companies proposed to support application time (or some form of timer) of the activation/deactivation of the cell DTX/DRX configuration by the Format 2\_x DCI signaling. Few companies proposed not support an application delay of the DCI signaling.

Moderator suggests resolving this issue first. If application delay is agreed to be applied, discuss further on the exact value of the delay and/or how the delay information can be conveyed. Moderator has formulated the following alternatives based on inputs received that seem to capture the potential variations of the proposals.

Alt 1: No application delay applied to DCI Format 2\_X that activate/deactivate cell DTX/DRX configuration

Alt 2: application delay applied to DCI Format 2\_X that activate/deactivate cell DTX/DRX configuration

* Option A: fixed application delay
	+ X number of slots
	+ FFS: whether a function of SCS
	+ FFS: time to be no less than PUSCH preparation procedure time T\_(proc,2), and no less than UCI multiplexing procedure time.
* Option B: based on signaling in DCI format 2\_X
	+ DCI format 2\_X to indicate ‘k’ slots in which activation/deactivation will be started to be applicable for.
	+ FFS: whether separate k signaling for DTX and DRX configuration
	+ FFS: whether separate k signaling for activation and deactivation

### Suggestions for further Discussions

Moderator suggest further discuss the application time issue for DCI format 2\_X.

##### Proposal 4-1:

No application delay applied to DCI Format 2\_X that activate/deactivate cell DTX/DRX configuration

##### Proposal 4-2:

Application delay applied to DCI Format 2\_X that activate/deactivate cell DTX/DRX configuration is based on

Moderator note: down-select among option A or B

* Option A: fixed application delay
	+ X number of slots
	+ FFS: whether X is a function of SCS
	+ FFS: whether X is time to be no less than PUSCH preparation procedure time T\_(proc,2), and no less than UCI multiplexing procedure time.
* Option B: based on signaling in DCI format 2\_X
	+ DCI format 2\_X to indicate ‘k’ slots in which activation/deactivation will be started to be applicable for.
	+ FFS: whether separate k signaling for DTX and DRX configuration
	+ FFS: whether separate k signaling for activation and deactivation

## 2.5 Signals/Channels impacted by cell DTX

|  |  |
| --- | --- |
| **Company** | **Proposals & Observations** |
| Nokia [1] | Proposal 12: the default UE behavior is that the UE monitors for the DCI format 2\_x during active time of the active cell DTX pattern.Proposal 17: OFDM symbols and slot(s) containing SSB that falls during the cell DTX non-active period shall not be considered part of active period for cell DTX.Proposal 18: Utilizing SSB Tx occasions to transmit UE-specific signals/channels in cell DTX non-active period shall be configurable by the NW on UE basis.Observation 4: If the NW non-active period is long, and if with no signal/channel transmitted at all, there will be serious performance/accuracy impact.Observation 5: If NW non-active period is short, NW may decide by configuration to drop all transmissions during non-active period.Proposal 21: Transmission of PRS, CSI-RS for RRM/RLM/BFD/BM, and TRS during non-active time of cell DTX can be configurable by NW.Proposal 22: NW may configure the transmission of PRS, CSI-RS for RRM/RLM/BFD/BM and TRS during non-active time of cell DTX to be either dropped or continue with the same or different Tx periodicity as in active time of cell DTX.Proposal 23: If the Tx periodicity of PRS, CSI-RS for RRM/RLM/BFD/BM and TRS during non-active time is different from the Tx periodicity in active time, the Tx periodicity during non-active time can be configured relatively to the Tx periodicity in active time.Proposal 24: RAN1 to discuss if the UE is allowed to request transmission of CSI-RS in cell DTX non-active scenarios when fallback to SSB measurements is not possible. Proposal 25: Discuss transmission of PRS in the serving and neighbor cells with respect to the serving cell DTX pattern and its handling by the UE.Proposal 26: RAN1 to discuss if enhancements to the legacy means for pre-configuring UL allocations are needed to enable UL transmissions more flexibly during cell DRX active periods coinciding with cell DTX inactive periods.Proposal 27: Discuss SRS transmission for positioning with respect to cell DRX pattern when enabled.Proposal 28: Based on RAN2 outcome, HARQ feedback shall be allowed during the cell DRX non-active period when the corresponding SPS PDSCH occurred during cell DTX active period.Observation 6: Accounting for non-active periods of cell DTX in the HARQ-ACK codebook generation can help to reduce the HARQ-ACK payload size drastically especially for Type 1 HARQ-ACK codebook by simply neglecting 'invalid' PDSCH resource allocations.Proposal 30: RAN1 considers the impact of cell DTX non-active periods, specifically the omitting/dropping of some PDSCHs, on existing HARQ-ACK codebook generation (at least considering Type 1 HARQ-ACK codebook) as follows:* For HARQ-ACK codebook generation, the UE omits any PDSCH time allocation, and thus HARQ-ACK bits, corresponding to a PDSCH that would overlap with a cell DTX non-active period.

Observation 7: 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 31: RAN1 shall account for cell DRX non-active periods in the PUCCH repetition and SPS HARQ-ACK deferral operations in order to avoid unnecessary dropping of PUCCH repetitions and SPS HARQ-ACK.Proposal 32: RAN1 considers the impact of cell DRX non-active periods on the intra-UE handling of overlapping UL transmissions, in order to avoid unnecessary loss of HARQ-ACK / UCI information, by adopting the following operation/order:* First, exclude/drop any PUSCH from a set of PUSCH that would overlap with a PUCCH if this PUSCH overlaps with a cell DRX non-active period.
* Then, handle the overlapping between the PUCCH and the remaining (non-dropped/ non-excluded) PUSCHs of the set of PUSCHs.
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| Huawei [2] | Proposal 5: The default behaviour could be defined assuming there will be a DCI format 2\_X during the monitoring window, and when UE does not detect any DCI format 2\_X, after the monitoring window, the UE assumes that:

|  |  |
| --- | --- |
| channels/signals | Default UE behavior when DCI 2\_X is not detected |
| PDCCHs, PDSCH | UE monitors the corresponding transmission during the configured inactive time of the cell DTX (UE considered as deactivation). |
| CSI-RSs for different use | UE does not monitor the corresponding transmission during the configured inactive time of the cell DTX (UE considered as activation). |
| CG PUSCH, SR | UE does not transmit the corresponding transmission during the configured inactive time of the cell DRX (UE considered as activation). |
| P/SP SRS, P/SP CSI (in PUCCH) | UE transmits the corresponding transmission during the configured inactive time of the cell DRX (UE considered as deactivation). |

Proposal 6: Support the following signals/channels to be applied with cell DTX/DRX:- PDCCHs associate with DCI format 2\_0 – DCI Format 2\_5- P/SP CSI-RS for RRM, potentially conditioned by SSB presence- P/SP CSI-RS for BM- P/SP CSI-RS for RLM- P/SP CSI-RS for BFD- For P/SP CSI-RS for BM/RLM/BFD, simple requirement relaxation for evaluation/indication period is feasible from RAN1 perspective, and final decision can be up to RAN4 with noting RAN4 that RAN1 does not expect further work on this.Proposal 7: Support the following signals/channels NOT to be applied with cell DTX/DRX:- PDCCHs associate with DCI format 2\_6 and 2\_X- HARQ-ACK of SPS PDSCH- SR for SCell BFR- P/SP CSI-RS for SCell BFR- P/SP CSI-RS for tracking- P/SP CSI-RS for positioning- P/SP SRS for positioningProposal 8: Support UCI/PUSCH impacted by cell DRX be considered within UCI multiplexing procedure during the inactive time of cell DRX.- Follows the multiplexing rule as legacy- Treats the UCI that impacted by cell DRX e.g. SR as negative. |
| Futurewei [4] | 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) during non-active period of Cell DTX/DRX should be kept at a minimum to maximize network energy saving gains.Proposal 1: The following channels/signals should be allowed to be transmitted by the gNB during non-active DTX period: * P/SP CSI-RS for BM
* P/SP CSI-RS for RRM
* P/SP CSI-RS for RLM/BFD
 |
| Spreadtrum [5] | Proposal 1: PDCCH in Type-3 CSS can be transmitted by gNB during non-active period.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.Proposal 3: UE does not monitor the new DCI format 2\_x inside UE active time. |
| vivo [6] | Proposal 1: UE doesn’t 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 within a serving cell except the following cases:1. ra-ContentionResolutionTimer or msgB-ResponseWindow is running (already agreed in RAN2);
2. a PDCCH indicating a new transmission addressed to the C-RNTI of the MAC entity has not been received after successful reception of a Random Access Response for the Random Access Preamble not selected by the MAC entity among the contention-based Random Access Preamble;
3. a Scheduling Request is sent on PUCCH and is pending;
4. RetransmissionTimerDL or RetransmissionTimerUL is running (already agreed in RAN2 when UE C-DRX is configured).

Proposal 2: UE doesn’t expect a CSI-RS for RRM is available in non-active period of cell DTX in a serving cell if the cell-id configured for the CSI-RS matches the serving cell or a configured cell list; Otherwise, UE expects the CSI-RS for RRM is available.Proposal 3: UE doesn’t expect a CSI-RS for RLM/BFD is available in non-active period of cell DTX in a serving cell.Proposal 4: UE doesn’t expect a CSI-RS for CBD is available in non-active period of cell DTX in a serving cell.Proposal 5: UE doesn’t expect a periodical/semi-persistent CSI-RS for L1-RSRP/L1-SINR computation is available in non-active period of cell DTX in a serving cell.Proposal 6: UE expects a CSI-RS for tracking is available in non-active period of cell DTX.Proposal 7: Send LS to RAN4 to inform the agreeable proposals on UE behavior for CSI-RS in non-active period of cell DTX and request them to define corresponding requirement if the CSI-RS is not expected available in non-active period of cell DTX/DRX.Proposal 8: UE expects a DL PRS is available in non-active period of cell DTX.Proposal 10: UE transmits SRS for positioning in non-active period of cell DRX.Proposal 16: Whether to transmit HARQ feedback of cancelled SPS PDSCH is dependent on cell DTX/DRX activation mode. |
| Panasonic [7] | Proposal 1: CSI-RS configured for tracking, beam and radio link monitoring and UE mobility, the availability can be at least configurable during non-active periods of Cell DTX.Proposal 2: For Cell DTX, UE behaviour is not impacted and can receive PRS during Cell DTX non-active period. If network wants to save energy and does not transmit PRS during non-active period, it can be achieved by gNB implementation of configuration.Proposal 3: For Cell DRX, UE is not expected to receive PDCCH in USS and Type-3 CSS. |
| Intel [8] | Proposal 4:* Rel-18 UE supporting cell DTX does not expect to receive and/or process the following signals/channels from the gNB, during non-active periods of cell DTX
	+ CSI-RS associated with RadioLinkMonitoringConfig and BeamFailureDectection (for RLM and BFD)
	+ Periodic CSI-RS configured with trs-Info ‘true’ (for tracking)

Proposal 5:* The following signals/channels are not impacted by cell DTX operation:
	+ CSI-RS configured by measObjectNR (for RRM)
	+ PRS
 |
| Google [10] | Proposal 1: Rel-18 UE supporting cell DTX does not expect to receive and/or process the following signals/channels from the gNB, during non-active periods of cell DTX:* PDCCH in USS/Type3 CSS other than SS-BFR
* CSI-RS for mobility/RLM/BFD/BM/Tracking
* PRS

Proposal 2: Introduce a multi-burst based aperiodic TRS for fast time and frequency offset tracking after the non-active periods of cell DTX.Proposal 6: Support to configure TRP/cell-specific RNTI for the DCI for cell DTX/DRX indication.Proposal 7: Support the DCI for cell DTX/DRX indication to provide the following information:* Timing information for the cell DTX activate/non-activate period
* Timing information for the cell DRX activate/non-activate period
* Additional impacted channel during cell DTX/DRX non-activate period
 |
| CATT [11] | Proposal 15: Rel-18 UE supporting cell DTX does not expect to receive and/or process the following signals/channels from the gNB, during non-active periods of cell DTX. * PDCCH in USS
* PDCCH in Type-3 CSS
* PRS
* CSI-RS configured by measObjectNR (for RRM)
* CSI-RS associated with RadioLinkMonitoringConfig and BeamFailureDectection (for RLM and BFD)
* Periodic CSI-RS configured with trs-Info ‘true’ (for tracking)
* Periodic/Semi-persistent CSI-RS (for BM)
 |
| ZTE [12] | Proposal 5: PRS for idle/inactive UEs should not be impacted by cell DTX non-active period.Observation 4: Impact of cell DTX/DRX on CSI-RS for RRM/RLM/BFD/BM measurement requirement needs RAN4’s involvement. |
| Fujitsu [13] | Proposal 5. Whether to monitor DCI format 2\_X during cell DTX non-active period or cell DTX active period is configurable.Proposal 6. During Cell DTX non-active time, Rel.18 UE shall expect that at least the following UE-specific channels/signals are not transmitted:* CSI-RS from the serving cell configured by measObjectNR
* CSI-RS associated by RadioLinkMonitoringConfig and BeamFailureDetection (for RLM and BFD)
* Periodic/semi-persistent CSI-RS for beam management
* PRS (for the UEs in RRC\_CONNNECTED mode)

Proposal 20: Introduction of new DCI format 2\_X does not change UE capability about BD and non-overlapping CCEs. |
| CMCC [14] | Proposal 1: Rel-18 UE supporting cell DTX does not expect to monitor PDCCH in USS for new transmission during cell non-active periods.Proposal 2: Rel-18 UE supporting cell DTX does not expect to monitor PDCCH in Type-3 CSS scrambled by INT-RNTI, SFI-RNTI, TPC-PUSCH-RNTI, TPC-PUCCH-RNTI, TPC-SRS-RNTI, CI-RNTI or PS-RNTI during cell non-active periods.Proposal 3: PDCCH in Type-3 CSS for cell DTX/DRX activation/deactivation should be monitored during cell DTX non-active periods.Proposal 4: gNB can configure whether the transmission of periodic/semi-persistent CSI-RS for CSI reporting is impacted or not during cell DTX non-active periods.Proposal 5: To balance the transmit efficiency and gNB power saving, CSI-RS can be configured to transmit with a larger periodicity during cell DTX non-active periods.Proposal 6: If UE supports IDLE/INACTIVE TRS (29-2) and is aware that its TRS configuration is configured for IDLE/INACTIVE UEs, then it can expect to receive TRS. Otherwise, UE does not expect to receive and/or process TRS from the gNB during non-active periods of cell DTX.Proposal 23: UE behavior enhancement as following can be considered for case 2, e.g. Cell DTX is activated, and gNB sends deactivation indication, but it is miss detected by UE, * UE keeps monitoring PDCCH in USS or type-3 CSS during the following cell DRX non-active period until it receives activation/deactivation indication in next occasion.
* UE can also measure CSI-RS during the following cell DRX non-active period before it receives next activation/deactivation indication.
 |
| Apple [15] | Proposal 11: To not impact legacy UEs that do not support NES feature, TRS is still maintained during non-active duration of cell DTX.Observation 1: Allowing P/SP CSI-RS to be stopped during cell DTX/DRX non-active duration may significantly increase UE measurement latency.Proposal 12: Support network configuration of a list of P/SP CSI-RS for L1-RSRP/SINR measurement, RRM, RLM, for UE to not expect to receive and/or process during non-active period of cell DTX. Proposal 13: Whether UE supports not receiving and/or processing P/SP CSI-RS during non-active period of cell DTX is reported as UE capability. |
| Xiaomi [16] | Proposal 1: If gNB transmit a DCI before cell DTX/DRX non-active period, and the scheduled channels fall into the cell DTX/DRX non-active period, UE should be allowed to transmit/receive the scheduled during non-active period of cell DTX/DRX.Proposal 3: UE does not expect to monitor PDCCH in Type 3 CSS during non-active period of cell DTX. FFS: DCI 2-5 in Type 3 CSS.Proposal 4: Periodic reference signals related to RLM/BFD/BFR procedures should be transmitted during non-active period of cell DTX.Proposal 5: PRS should be maintained since turning off which will impact R18 RRC idle/inactive UE positioning.Proposal 6: CSI-RS for RRM should be turned off during non-active period of cell DTX.Proposal 7: TRS for RRC idle/inactive UE should be maintained while TRS for RRC connected UE can be turned off during non-active period of cell DTX.Proposal 9: During cell DTX non-active period CSI report with reportQuantity including RI is not transmitted.Proposal 16: Support to resume gNB scheduling during the cell DTX non-active period when DL retransmission timer is running. |
| NTT Docomo [17] | Proposal 3:UE behavior during Cell DTX/DRX inactivity periods for remaining signals/channels should be further discussed and clarified based on Table.1.

|  |  |  |
| --- | --- | --- |
| DL/UL | Channel/signal | View |
| DL | Periodic/Semi-persistent CSI-RS for tracking | UE should be expected to receive it to avoid potential impact on time/freq. synchronization for PDCCH reception after inactivity period. |
| Periodic/Semi-persistent CSI-RS for RRM | UE should not be expected to receive it |
| Periodic/Semi-persistent CSI-RS for RLM | UE should not be expected to receive it |
| Periodic/Semi-persistent CSI-RS for BM/BFD | UE should be expected to receive it to avoid potential impact on PDCCH reception after inactivity period. |
| PRS | It should be configurable whether UE is expected to receive PRS or not. It should depend on whether high positioning accuracy is required or not. |
| PDCCH in Type 3-PDCCH CSS and USS | UE should not be expected to receive it similar to PDCCH in USS as agreed. |

 |
| OPPO [18] | Proposal 3: UE is not expected to receive and/or process the following signals/channels from the gNB during non-active periods of cell DTX:* PDCCH in USS for retransmission or some specific RNTI
* PDCCH in Type-3 CSS for retransmission or some specific RNTI
* Periodic/Semi-persistent CSI-RS (for BM)

Proposal 4: UE can receive and/or process the following signals/channels from the gNB during non-active periods of cell DTX:* PRS
* CSI-RS configured by measObjectNR (for RRM)
* CSI-RS associated with RadioLinkMonitoringConfig and BeamFailureDectection (for RLM and BFD)
* Periodic CSI-RS configured with trs-Info ‘true’ (for tracking)

Proposal 5: RACH procedure can be performed normally during non-active periods of cell DTX.Proposal 6: UE shall receive a PDSCH which is at least partially overlapped with non-active period of cell DTX if this PDSCH is dynamically scheduled by a DCI transmitted during active period of cell DTX. |
| China Telecom [19] | Proposal 1:Support gNB not to transmit the following signals/channels to UE during the non-active period of cell-DTX.* CSI-RS for serving cell configured by measObjectNR
* CSI-RS associated with RLM configuration
* CSI-RS associated with beam failure detection (BFD)
* PRS

Observation 2: The overlap of SPS PDSCH and inactivate period of cell DTX can be avoided by gNB configuration, even if not avoided, the UE can simply generate the NACK in the codebook according to the current specification.Proposal 8: The HARQ-ACK codebook generation procedure should be the same as current specifications.Proposal 10: The signals/channels that transmitted/received repeatedly during non-active periods of cell DTX/DRX should be ignored. |
| Samsung [20] | Proposal 1: The following signals/channels are not received during non-active periods of cell DTX. The other DL signals/channels are not impacted by cell DTX.* Periodic/Semi-persistent CSI-RS (excluding TRS)
* PRS
* PDCCH scrambled with UE specific RNTI
* Type3-PDCCH in CSS

Proposal 2: UE transmits HARQ-ACK of a DCI format without scheduling a PDSCH and transmits PUSCH with AP-CSI during non-active periods of cell DRX.Proposal 10: When a PDCCH schedules a PDSCH overlapping with a SPS PDSCH where the SPS PDSCH is not expected to be received by the UE due to cell DTX, the overriding timeline condition does not need to be satisfied.Proposal 11: A UE first determines SPS PDSCH reception based on cell DTX non-active period and then the UE resolves the overlapping SPS PDSCHs on a same serving cell.Proposal 14: A UE does not transmit the HARQ-ACK information bit for a SPS PDSCH if the SPS PDSCH overlaps with the non-active period and there is no other HARQ-ACK information bit in the same PUCCH slot with the HARQ-ACK information bit for the SPS PDSCH. UE generates a NACK information bit for a SPS PDSCH if the SPS PDSCH overlaps with the non-active period and there is another HARQ-ACK information bit in the same PUCCH slot with the HARQ-ACK information bit for the SPS PDSCH. |
| ETRI [21] | Proposal 8: UE does not expect to receive and/or process the following signals/channels during cell DTX non-active time (with no support of configurability):* PDCCH in USS for all RNTIs (to confirm RAN2 agreement)
* PDCCH in Type-3 CSS
	+ FFS: Potential exceptions (e.g., activation/deactivation DCI for cell DTX/DRX, DCI format 2\_6)
* CSI-RS for RRM
* CSI-RS for RLM and BFD
* Periodic/Semi-persistent CSI-RS for CSI reporting
* Periodic/semi-persistent CSI-RS for BM

Proposal 9: UE can be configured whether or not to receive/transmit the following signals/channels during cell DTX/DRX non-active time:* PRS
* SRS for positioning

Proposal 10: For Type I HARQ-ACK codebook, if a SPS PDSCH is not received due to collision with a symbol belonging to the cell DTX non-active time, a corresponding SPS HARQ-ACK bit is not mapped to the HARQ-ACK codebook (thereby, not transmitted). |
| Transsion Holdings [22] | Proposal 1 Rel-18 UEs supporting Cell DTX may not receive and/or process CSI-RS from gNB for RRM, RLM and beam failure detection during non-active periods of cell DTX. |
| LGE [23] | Proposal #4: The impacts and potential solutions should be considered for each signal/channel that can be turned off in the Cell DTX/DRX non-active period for network energy saving.* For CSI-RS, if CSI-RS for RLM/beam failure can be turned off during Cell DTX/DRX non-active period, depending on the active or non-active period, different procedures can be considered in terms of RLM/BFD-RS determination, timer/counter related behaviors, or Q\_in/Q\_out adjustment.
* For SPS-PDSCH, it may be necessary to discuss whether or not to allow PUCCH transmission for SPS-PDSCH received just before the non-active period when HARQ-ACK PUCCH for SPS-PDSCH can be turn-off together automatically if the SPS-PDSCH is turn-off in the Cell DTX inactive period.
* For SR transmission, it may be necessary to discuss whether to allow transmission in the Cell DTX non-active period. If SR transmission is allowed in the Cell DTX non-active period, PDCCH transmission can be temporarily allowed after SR is transmitted in Cell DTX non-active period.
* For SRS transmission, if the UE transmits SR, periodic/semi-persistent-SRS can be transmitted even if periodic/semi-persistent-SRS is configured to be turned off in the Cell DTX (or Cell DRX) non-active period to obtain UL channel information.
* For PDCCH transmission, if the UE transmits RACH for BFRQ (beam failure recovery request), PDCCH transmission can be allowed even if PDCCH scrambled with UE specific RNTI is configured to be turned off in the Cell DTX non-active period as an exception.

Proposal #5: The following handlings should be discussed considering the interaction between Cell DTX/DRX with legacy operations.* For HARQ-ACK codebook generation, considering that (SPS) PDSCH may not be received by UE during Cell DTX non-active period, the HARQ-ACK corresponding to (SPS) PDSCH overlapping Cell DTX inactive period can also be omitted.
* For PUCCH deferral, if the PUCCH transmission corresponding to SPS PDSCH is not allowed during Cell DRX non-active period, the PUCCH transmission corresponding to SPS PDSCH that would be transmitted during Cell DRX non-active period can be deferred until the active period of Cell DRX, with consideration of the configured maximum defer duration.
* In the case of handling of signals/channels (e.g., PDCCH/PDSCH/CSI-RS/PUCCH/PUSCH/SRS) configured with repeated transmission, if the resources of signals/channels are included in or partially overlapped with the Cell DTX/DRX inactive period, the resource may skip or defer transmission or reception until the end of the inactive period.
* Considering that Cell DTX/DRX configurations can be configured by cell or group of cells, how to handle the case where multiple cells with or without Cell DTX/DRX configurations are mixed for CA (carrier aggregation) or DC (dual connectivity) scenarios should be considered.
 |
| Lenovo [24] | Proposal 2 TRS is excluded from the set of signals that are muted during inactive periods corresponding to cell DTXProposal 3 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 DTXProposal 4 CSI-RS for BM is excluded from the set of signals that are muted during inactive periods corresponding to cell DTXProposal 5 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 |
| Interdigital [25] | Proposal 6: UE is not expected to measure periodic/semi-persistent CSI-RS (for tracking, BM, RLM and BFD) during non-active periods of cell DTXProposal 7: UE is not expected to measure PRS during non-active periods of cell DTXProposal 8: UE is not expected to transmit SRS for positioning (SRSp) during non-active periods of cell DRX |
| Qualcomm [27] | Proposal 1: RAN1 adopts the UE transmission/reception restriction in the non-active time of cell DTX/DRX provided in Table 1 for RRC connected mode UEs.Table 1: UE transmission/reception restriction within non-active time of cell DTX/DRX

|  |  |  |
| --- | --- | --- |
| Channel | Drops channel within cell DTX/DRX non-active time | Discussion |
| Downlink |
| PDCCH in Type3-PDCCH CSS set | Yes | UE does not monitor PDCCH in non-active time of cell DTX.  |
| DG PDSCH | No | It should be clarified that PDSCH is scheduled by PDCCH in USS set or in Type3-PDCCH CSS set. |
| TRS | No | Some reasons to not drop TRS: * The UE is not able to perform T/F tracking and AGC adjustment based on TRS before PDCCH monitoring. Hence, it impacts PDCCH/PDSCH reception performance and UE power consumption. Note that SSB based T/F tracking is not good enough due to narrow BW, sparse transmission and possible SSB collision across cells. Furthermore, based on analysis in TR 38.940, using TRS instead of SSB for receiving PDCCH/PDSCH can save 19%-38% UE power consumption (although the analysis was for paging, it is also true for any PDCCH/PDSCH reception in general). Hence, dropping TRS removes UE power savings gain that TRS brings.
* TRS is typically shared across UEs in the cell in practical implementation although it is a UE-specific signal. In addition, there are R18 UEs that are incapable of supporting cell DTX/DRX feature. If the R18 UEs incapable of the feature share TRS with the R18 UEs capable of the feature, TRS can’t be dropped due to spec-incompliant impact to feature-incapable R18 UEs. On the other hand, if the R18 UEs incapable of the feature do not share TRS with the R18 UEs capable of the feature, the gNB needs to send separate TRS for different R18 UE types, consuming more network power.
* Idle mode UEs are not able to use R17 TRS feature for improving T/F tracking for paging reception.

It should be noted that the UE may be configured with TRS for R17 propagation delay compensation i.e., CSI-RS resource set NZP-CSI-RS-ResourceSet with trs-info set to true and with pdc-info-r17 set to true. For this TRS type, we are open to discuss possibility of dropping it. |
| CSI-RS for BM, BFD | No | Some reasons to not drop CSI-RS for BM and/or BFD:* The UE performs beam management for beam refinement and/or BFD/BFR based on CSI-RS before PDCCH monitoring. Hence, dropping CSI-RS impacts PDCCH reception performance.
* In case of implicit BFD RS, the QCL source RS in the TCI for CORESET will serve as the implicit BFD RS, and the QCL source RS must be CSI-RS. The implicit BFD RS may be more popular in the deployment since no additional signaling is required. So, UE needs to measure CSI-RS as BFD RS in case of implicit BFD RS.
 |
| CSI-RS for RLM | Yes |  |
| CSI-RS for RRM | Yes, with some additional spec change consideration | For RRM, some cells may implement cell DTX/DRX while other cells may not. Furthermore, for cells with cell DTX/DRX, aligning cell DTX/DRX patterns may be possible but may reduce some implementation flexibility. Hence, if the CSI-RS for RRM is dropped, one of the following considerations should be adopted:* Option 1: The UE is provided with cell DTX configurations associated with the cells that UE performs RRM measurement.
* Option 2: gNB further indicates a subset of the cell DTX non-active time for RRM measurement.

Option 1 avoids the necessity of cell DTX alignment across the cells while Option 2 assumes some cell DTX alignment across the cells.  |
| CSI-RS for positioning (aka PRS) | No | * Dropping PRS reduces positioning accuracy and latency. If the UE requests the positioning before or during the cell DTX non-active time, the time to the first positioning fix will be longer. For positioning update, PRS dropping means less samples for averaging; hence impacting positioning accuracy.
* It should also be noted that the UE may be configured with PRS at the serving cell (by nr-dl-PRS-PDC-Info in ServingCellConfig) for R17 propagation delay compensation. For this PRS type, we are open to discuss possibility of dropping it.
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| Ericsson [28] | Proposal 1 OFDM symbols and slot(s) containing SSB are considered part of active period for cell DTX.Observation 1 Restricting reception of TRS during cell DTX/DRX non-active period can save NW energy (e.g. ~ 10% gain).Proposal 2 Support selective reception of TRS in only indicated TRS occasions during non-active period of cell DTX.Observation 2 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.Observation 3 gNB can configure the UE to perform RRM, RLM/BFD, and BM based on SSBs. If CSI-RS based RRM, RLM are configured instead, then it may not be necessary to restrict their transmission during the non-active time of cell DTX/DRX. Proposal 3 Restriction on UE reception of CSI-RS for RRM, RLM/BFD, and BM during cell DTX non-active period, if supported, can be separately configured by higher layers.Proposal 6 UE monitors DCI 2\_X in cell DTX active period. |

### Summary of Issues

From the contributions the following signals/channels have been identified as potential candidates to restrict during non-active periods of cell DTX. Moderator suggests further discussion on each signal/channel and make final conclusions on each signal/channel. This will be the final meeting for discussion and adoption of the agreements on these channels. If no agreement is reached, moderator assumes RAN1 should conclude no consensus was made to restrict the signal/channels.

Issue 1: OFDM symbols and slot(s) containing SSB that falls during the cell DTX non-active period shall not be considered part of active period for cell DTX

Issue 2A: PDCCHs associate with DCI format 2\_0 – DCI Format 2\_5

Issue 2B: PDCCH in Type-3 CSS

Issue 2C: 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 with exceptions:

* ra-ContentionResolutionTimer or msgB-ResponseWindow is running (already agreed in RAN2);
* a PDCCH indicating a new transmission addressed to the C-RNTI of the MAC entity has not been received after successful reception of a Random Access Response for the Random Access Preamble not selected by the MAC entity among the contention-based Random Access Preamble;
* a Scheduling Request is sent on PUCCH and is pending;
* RetransmissionTimerDL or RetransmissionTimerUL is running (already agreed in RAN2 when UE C-DRX is configured).

Issue 2D: PDCCHs associate with DCI format 2\_6 and 2\_X

Issue 3A: P/SP CSI-RS for BM

Issue 3B: P/SP CSI-RS for RLM

Issue 3C: P/SP CSI-RS for BFD

Issue 3D: CSI-RS for RRM

Issue 3E: CSI-RS for tracking

Issue 4: PRS

### Suggestions for further Discussions

Moderator suggests discussing the list of potential candidate signals/channels that may be restricted during non-active period of cell DTX. The following are summary of offline inputs from companies.

**Issue 1:**

* Alt 1: OFDM symbols and slot(s) containing SSB that falls during the cell DTX non-active period shall not be considered part of active period for cell DTX
	+ 3 company with concerns
* Alt 2: OFDM symbols and slot(s) containing SSB are considered part of active period for cell DTX.
	+ 9 company with concerns

**Issue 2A:**

* UE expects PDCCHs associate with DCI format 2\_0 – DCI Format 2\_5 to be not transmitted and therefore does not need to monitor during non-active period of cell DTX
	+ 8 companies with concerns

**Issue 2B:**

* UE expects PDCCH in Type-3 CSS to be not transmitted and therefore does not need to monitor during non-active period of cell DTX

**Issue 2C:**

* 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 are not monitored during non-active periods of cell DTX with exceptions:
	+ ra-ContentionResolutionTimer or msgB-ResponseWindow is running (already agreed in RAN2);
	+ a PDCCH indicating a new transmission addressed to the C-RNTI of the MAC entity has not been received after successful reception of a Random Access Response for the Random Access Preamble not selected by the MAC entity among the contention-based Random Access Preamble;
	+ a Scheduling Request is sent on PUCCH and is pending;
	+ RetransmissionTimerDL or RetransmissionTimerUL is running (already agreed in RAN2 when UE C-DRX is configured).

**Issue 2D:**

Conclusion:

* PDCCHs associate with DCI format 2\_6 and 2\_X are monitored during non-active periods of cell DTX

**Issue 3A:**

* UE assumes P/SP CSI-RS for BM are not transmitted during non-active periods of cell DTX
	+ At least 1 company with concerns

**Issue 3B:**

* UE assumes P/SP CSI-RS for RLM are not transmitted during non-active periods of cell DTX
	+ At least 1 company with concerns

**Issue 3C:**

* UE assumes P/SP CSI-RS for BFD are not transmitted during non-active periods of cell DTX
	+ At least 1 company with concerns

**Issue 3D:**

Conclusion:

* CSI-RS for RRM is not restricted (i.e. expected to be transmitted as normal) during non-active periods of cell DTX
	+ 2 companies raised concerns

**Issue 3E:**

UE assumes CSI-RS for tracking are not transmitted during non-active periods of cell DTX

* Several companies raised concerns

**Issue 4:**

Conclusion:

* PRS is not restricted during non-active periods of cell DTX
	+ 2 companies raised concerns

## 2.6 Signals/Channels impacted by cell DRX

|  |  |
| --- | --- |
| **Company** | **Proposals & Observations** |
| Nokia [1] | Proposal 18: Utilizing SSB Tx occasions to transmit UE-specific signals/channels in cell DTX non-active period shall be configurable by the NW on UE basis.Observation 4: If the NW non-active period is long, and if with no signal/channel transmitted at all, there will be serious performance/accuracy impact.Observation 5: If NW non-active period is short, NW may decide by configuration to drop all transmissions during non-active period.Proposal 26: RAN1 to discuss if enhancements to the legacy means for pre-configuring UL allocations are needed to enable UL transmissions more flexibly during cell DRX active periods coinciding with cell DTX inactive periods.Proposal 27: Discuss SRS transmission for positioning with respect to cell DRX pattern when enabled.Proposal 28: Based on RAN2 outcome, HARQ feedback shall be allowed during the cell DRX non-active period when the corresponding SPS PDSCH occurred during cell DTX active period.Observation 6: Accounting for non-active periods of cell DTX in the HARQ-ACK codebook generation can help to reduce the HARQ-ACK payload size drastically especially for Type 1 HARQ-ACK codebook by simply neglecting 'invalid' PDSCH resource allocations.Proposal 30: RAN1 considers the impact of cell DTX non-active periods, specifically the omitting/dropping of some PDSCHs, on existing HARQ-ACK codebook generation (at least considering Type 1 HARQ-ACK codebook) as follows:* For HARQ-ACK codebook generation, the UE omits any PDSCH time allocation, and thus HARQ-ACK bits, corresponding to a PDSCH that would overlap with a cell DTX non-active period.

Observation 7: 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 31: RAN1 shall account for cell DRX non-active periods in the PUCCH repetition and SPS HARQ-ACK deferral operations in order to avoid unnecessary dropping of PUCCH repetitions and SPS HARQ-ACK.Proposal 32: RAN1 considers the impact of cell DRX non-active periods on the intra-UE handling of overlapping UL transmissions, in order to avoid unnecessary loss of HARQ-ACK / UCI information, by adopting the following operation/order:* First, exclude/drop any PUSCH from a set of PUSCH that would overlap with a PUCCH if this PUSCH overlaps with a cell DRX non-active period.
* Then, handle the overlapping between the PUCCH and the remaining (non-dropped/ non-excluded) PUSCHs of the set of PUSCHs.

Proposal 33: RAN1 shall account for cell DRX non-active periods in the PUCCH cell switching operation in order to avoid unnecessary loss of HARQ-ACK / UCI information. |
| Huawei [2] | Proposal 7: Support the following signals/channels NOT to be applied with cell DTX/DRX:- HARQ-ACK of SPS PDSCH- SR for SCell BFR- P/SP SRS for positioningProposal 8: Support UCI/PUSCH impacted by cell DRX be considered within UCI multiplexing procedure during the inactive time of cell DRX.- Follows the multiplexing rule as legacy- Treats the UCI that impacted by cell DRX e.g. SR as negative. |
| Futurewei [4] | 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) during non-active period of Cell DTX/DRX should be kept at a minimum to maximize network energy saving gains. |
| vivo [6] | Proposal 10: UE transmits SRS for positioning in non-active period of cell DRX.Proposal 16: Whether to transmit HARQ feedback of cancelled SPS PDSCH is dependent on cell DTX/DRX activation mode. |
| Panasonic [7] | Proposal 4: When Cell DRX and DTX are simultaneously operated, UE behaviour on HARQ-ACK feedback for SPS PDSCH is not impacted because of no SPS transmission by the network. For Cell DRX only operation, no UE behaviour is changed. |
| Intel [8] | Proposal 6:* The following signals/channels are not impacted by cell DRX operation:
	+ HARQ feedback for SPS transmissions
 |
| NEC [9] | Proposal 4: For UL transmission during cell DRX, support indication whether the UCI is allowed to be transmitted.Proposal 5: For UL control resource configurations during cell DRX, support delta parameters only for PUCCH resource configurations, SR or CSI report configurations and configured grant.Proposal 9: Support UCI multiplexing during cell DRX non-active duration. |
| Google [10] | Proposal 3: During the non-active periods of cell DRX, UE does not transmit the periodic/semi-persistent CSI/beam report.Proposal 4: The impact of RACH and SR procedure from non-active periods of cell DRX should be studied by RAN2.Proposal 5: Study the impact of BFR procedure from non-active periods of cell DRX. |
| CATT [11] | Proposal 16: Rel-18 UE supporting cell DRX does not expect to transmit the following signals/channels to gNB during non-active periods of cell DRX:* Periodic/Semi-persistent SRS for positioning
* HARQ feedback for SPS PDSCH
* HARQ feedback for DG PDSCH
 |
| ZTE [12] | Proposal 7: Cell DRX should not impact the transmission of SRS for RRC\_INACTIVE mode positioning.Proposal 8: UE can report a ‘NACK’ for the SPS PDSCH occasion during cell DTX non-active period. |
| Fujitsu [13] | Proposal 7. During Cell DRX non-active time, Rel.18 UE is not expected to transmit at least the following UE-specific channels/signals:* SRS for positioning (for the UEs in RRC\_CONNNECTED mode)
 |
| CMCC [14] | Proposal 8: gNB can configure UE whether to transmit periodic/semi-persistent CSI report or not during cell DRX non-active period.Proposal 9: To balance the transmit efficiency and gNB power saving, periodic/semi-persistent CSI report can be configured to transmit with a larger periodicity during cell non-active periods.Proposal 10: gNB can configure UE whether to transmit periodic/semi-persistent SRS or not during cell DRX non-active period.Proposal 11: When periodic/semi-persistent SRS is allowed to transmit during cell DRX non-active period, it can be configured to transmit with a larger periodicity.Proposal 12: For long cell DRX cycle, UE can transmit HARQ feedback for SPS PDSCH to the gNB during non-active periods of cell DRX.Proposal 13: For short cell DRX cycle, further study for SPS HARQ-ACK feedback.  |
| Apple [15] | Proposal 14: HARQ feedback for SPS PDSCH is no longer needed for occasions within the non-active period of cell DTX. HARQ feedback corresponding to the SPS occasion in active period is not affected by the cell DRX non-active period. |
| Xiaomi [16] | Proposal 1: If gNB transmit a DCI before cell DTX/DRX non-active period, and the scheduled channels fall into the cell DTX/DRX non-active period, UE should be allowed to transmit/receive the scheduled during non-active period of cell DTX/DRX.Proposal 2: How to transmit the HARQ-ACK of empty SPS PDSCH should be discussed for each HARQ-ACK codebook type separately.Proposal 8: Support UE to transmit high priority SR during Cell DRX non-active period.Proposal 10: During cell DRX non-active period, CSI-RS/CSI-IM related to periodic/semi-persistent CSI report is not transmitted.Proposal 17: During cell DRX non-active period for a cell, PUCCH cell switching to another cell not in DRX non-active period should be considered. |
| NTT Docomo [17] | Proposal 3:UE behavior during Cell DTX/DRX inactivity periods for remaining signals/channels should be further discussed and clarified based on Table.1.

|  |  |  |
| --- | --- | --- |
| DL/UL | Channel/signal | View |
| UL | HARQ-ACK for SPS PDSCH reception | For HARQ-ACK for SPS PDSCH received during inactivity period, UE should not be expected to transmit it. UE is not expected to receive SPS PDSCH according to the RAN2 agreement. There is no sense to allow HARQ-ACK for SPS PDSCH reception since no SPS PDSCH is expected.For HARQ-ACK for SPS PDSCH received before inactivity period, it would be better to allow UE to transmit it during inactivity period to reduce latency. However, if RAN2 agree that HARQ-ACK for dynamic PDSCH reception is not allowed during inactivity period, the HARQ-ACK for SPS PDSCH should not be allowed to keep consistency and save NW energy consumption. |

 |
| OPPO [18] | Proposal 7: UE can transmit the following signals/channels to the gNB during non-active periods of cell DRX:* SRS for positioning
* HARQ feedback for SPS PDSCH

Proposal 8: UE shall transmit a PUSCH/PUCCH/SRS which is at least partially overlapped with non-active period of cell DRX if this PUSCH/PUCCH/SRS is dynamically scheduled by a DCI. |
| China Telecom [19] | Proposal 2: Support UE not to transmit the following signals/channels to UE during the non-active period of cell-DRX.* Periodic/Semi-persistent CSI report
* Periodic/Semi-persistent SRS
	+ SRS for positioning
* HARQ feedback for SPS PDSCH

Proposal 9: When the cell DRX is adopted, the valid UL symbols/slots for PUCCH deferral should be in the active period of cell DRX.Proposal 10: The signals/channels that transmitted/received repeatedly during non-active periods of cell DTX/DRX should be ignored.Observation 3:For the UE with capability of PUCCH cell switching, the UE can be different according to the condition when cell DRX is adopted.* The PUCCH cell switching can be conducted as current specs if only PCell is configured with cell DRX;
* The UE should decide whether to switch to SCell for PUCCH transmission according to the active state of SCell if only SCell is configured with cell DRX.
* The UE should transmit the PUCCH on the cell in active period if both PCell and SCell are configured with cell DRX.
 |
| Samsung [20] | Proposal 12: Define the UE behaviour to support the joint operation of cell DTX/DRX and other collision handling. |
| ETRI [21] | Observation 2: If Proposal 10 is adopted, for the case where a SPS PDSCH outside active time is not received, UE will not transmit the corresponding SPS HARQ-ACK outside active time as well.Proposal 11: Even if a SPS PDSCH is successfully received, UE does not transmit the corresponding SPS HARQ-ACK if it falls outside DRX active time.Proposal 12: If a PUCCH repetition or a SPS HARQ-ACK (when Rel-17 SPS HARQ-ACK deferral is configured) collides with a symbol belonging to the cell DRX non-active time, the PUCCH repetition or the SPS HARQ-ACK is deferred to a next valid UL resource.* The symbol belonging to the cell DRX non-active time is regarded as an invalid symbol
 |
| LGE [23] | Proposal #5: The following handlings should be discussed considering the interaction between Cell DTX/DRX with legacy operations.* For HARQ-ACK codebook generation, considering that (SPS) PDSCH may not be received by UE during Cell DTX non-active period, the HARQ-ACK corresponding to (SPS) PDSCH overlapping Cell DTX inactive period can also be omitted.
* For PUCCH deferral, if the PUCCH transmission corresponding to SPS PDSCH is not allowed during Cell DRX non-active period, the PUCCH transmission corresponding to SPS PDSCH that would be transmitted during Cell DRX non-active period can be deferred until the active period of Cell DRX, with consideration of the configured maximum defer duration.
* In the case of handling of signals/channels (e.g., PDCCH/PDSCH/CSI-RS/PUCCH/PUSCH/SRS) configured with repeated transmission, if the resources of signals/channels are included in or partially overlapped with the Cell DTX/DRX inactive period, the resource may skip or defer transmission or reception until the end of the inactive period.
* Considering that Cell DTX/DRX configurations can be configured by cell or group of cells, how to handle the case where multiple cells with or without Cell DTX/DRX configurations are mixed for CA (carrier aggregation) or DC (dual connectivity) scenarios should be considered.
 |
| Lenovo [24] | Proposal 6 CSI reporting for BM is excluded from the set of signals that are muted during inactive periods corresponding to cell DRXProposal 7 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 configuredProposal 8 SPS-PDSCH and CG-PUSCH can be configured with a range of possible periodicities that fall within the active periods of cell DTX/DRX, respectivelyProposal 9 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 |
| Qualcomm [27] | Proposal 1: RAN1 adopts the UE transmission/reception restriction in the non-active time of cell DTX/DRX provided in Table 1 for RRC connected mode UEs.Table1: UE transmission/reception restriction within non-active time of cell DTX/DRX

|  |  |  |
| --- | --- | --- |
| Channel | Drops channel within cell DTX/DRX non-active time | Discussion |
| Uplink |
| Periodic SRS for positioning | No | SRS based positioning is not supported during non-active time of cell DRX |
| DG PUSCH | No | It should be clarified that PUSCH is scheduled by PDCCH in USS set or in Type3-PDCCH CSS set. Furthermore, the UE receives the PDCCH in active time of cell DRX and its DRX active time if configured with C-DRX operation. |

 |

### Summary of Issues

From the contributions the following signals/channels have been identified as potential candidates to restrict during non-active periods of cell DTX. Moderator suggests further discussion on each signal/channel and make final conclusions on each signal/channel. This will be the final meeting for discussion and adoption of the agreements on these channels. If no agreement is reached, moderator assumes RAN1 should conclude no consensus was made to restrict the signal/channels.

Issue 1A: HARQ-ACK of SPS PDSCH

* Conclude HARQ-ACK of SPS PDSCH is not impacted by non-active period of cell DRX

Issue 1B: HARQ-ACK of DG PDSCH

* Conclude HARQ-ACK of SPS PDSCH is not impacted by non-active period of cell DRX

Issue 2: SR for SCell BFR

Issue 3: P/SP SRS for positioning

Issue 4: PUCCH as part of PUCCH cell switching

Issue 5: multiplexing of SR from an active duration of cell DRX to potentially dropped CSI report from a non-active duration of cell DRX.



Issue 6: Multiplexing of HARQ-ACK from a active cell to a non-active cell PUSCH



There are proposals to adopt signaling to indicate whether specific signal/channels will be restricted during non-active periods of cell DRX. This can be discussed together with each signal/channel discussion.

### Suggestions for further Discussions

Moderator suggests discussing the list of potential candidate signals/channels that may be restricted during non-active period of cell DRX.

The following are summary of offline inputs from companies.

**Issue 1A:** HARQ-ACK of SPS PDSCH

Conclusion:

* HARQ-ACK of SPS PDSCH received ~~or not received~~ when cell DTX is not configured or during active periods of cell DTX is not impacted by non-active period of cell DRX
	+ FFS: HARQ-ACK of SPS PDSCH not received

*Moderator note: Need bit more discussion (intent seem to be generally ok)*

**Issue 2:** SR for SCell BFR

Conclusion

* SR for SCell BFR is not impacted by non-active periods of cell DRX

*Moderator note: check whether RAN2 is discussing this case (could be potentially covered by general SR discussion in RAN2)*

**Issue 3:** P/SP SRS for positioning

Conclusion

* P/SP SRS for positioning is not impacted by non-active periods of cell DRX
	+ At least 1 company raised concerns

**Issue 4:**

How to handle PUCCH when PUCCH needs to be transmitted in non-active period of cell DRX of a serving cell as part of PUCCH cell switching operation

*Moderator note: issue 4 requires more discussion*

**Issue 5:**

How to handle the multiplexing of SR from an active duration of cell DRX to potentially dropped CSI report from a non-active duration of cell DRX.



*Moderator note: issue 5 requires more discussion*

**Issue 6:**

How to handle multiplexing of HARQ-ACK from an active cell to a non-active cell PUSCH



*Moderator note: issue 6 requires more discussion*

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

|  |  |
| --- | --- |
| **Company** | **Proposals & Observations** |
| Nokia [1] | Proposal 15: RAN1 to define the network can configure whether the UE shall monitor the DCP when the DCP monitoring occasion occurs during the cell DTX non-active time.Proposal 16: RAN1 to define the network can configure whether the UE shall start the C-DRX On Duration when the related DCP monitoring occasion occurs during the cell DTX non-active time.Proposal 19: From RAN1 perspective, the same UE behavior is expected when cell DTX is activated regardless of whether C-DRX is configured or not. Proposal 20: RAN1 to align with RAN2 outcome for PDCCH (re)-transmission handling in USS and in Type-3 CSS during cell DTX non-active period. |
| Futurewei [4] | Observation 2: Alignment of the UE DTX with cell DRX can be handled through gNB implementations as part of scheduled UL transmissions that are controlled by the gNB. Proposal 2: No special handling is needed for UE uplink transmissions during non-active periods of cell DRX. The same UE behavior is expected during cell DTX with or without C-DRX.  |
| vivo [6] | Proposal 9: Support the following UE behavior when cell DTX and UE C-DRX are both configured in Table 1.Table 1: UE behaviours on DL channel/signal when cell DTX and UE C-DRX are both configured

|  |  |  |
| --- | --- | --- |
| 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 non-active period of cell DTX |
| Non-active | Non-active | Follow behavior for non-active period of cell DTX and UE C-DRX |

Proposal 11: Support the following UE behavior when cell DRX and UE C-DRX are both configured in Table 2.Table 2: UE behaviour on UL channels/signals when cell DRX and UE C-DRX are both configured

|  |  |  |
| --- | --- | --- |
| 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 and UE DRX |

 |
| Panasonic [7] | Proposal 5: For better network energy saving gain, the cell DTX/DRX patterns/parameters can be considered to be aligned with I-DRX.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 7: 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 8: Interaction of Cell DTX/DRX and UE C-DRX needs to be clarified:- When Cell DTX is configured, different UE behaviour is applicable with or without C-DRX. When C-DRX is also configured, UE is expected to receive the DL signals/channels only in the non-active period of both Cell DTX and C-DRX.• L1 signaling to activate/deactivate Cell DTX is equivalent with switching between Cell DTX and C-DRX.- When Cell DRX and C-DRX are configured, the UE behaviour should be the same with the case that only Cell DRX is configured.Proposal 14: When Cell DTX/DRX is configured together with C-DRX, timer related operation should be clarified (most likely RAN2 should do that) for RAN1 to define the UE behaviour clearly. |
| NEC [9] | Proposal 6: For UL high priority data transmissions during cell DRX, support the activation of a short Cell DRX cycle within the long cell DRX non-active duration.Proposal 7: For high priority data transmissions during cell DRX, UE may be required to monitor for UL grant from gNB after SR is transmitted.Proposal 12: Cell DTX/DRX activation signaling indicates whether cell DTX overrides C-DRX of UEs or not. |
| CATT [11] | 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. |
| ZTE [12] | Observation 5: During cell DTX/DRX non-active period that is overlapped with UE CDRX active time, UE can perform CSI-RS reception and CSI report to minimize the impact on link adaptation.Proposal 6: CSI measurement and report during C-DRX on duration timer overlapped with cell DRX non-active periods should not be impacted. |
| CMCC [14] | Proposal 25: Alignment of cell DTX/DRX and UE C-DRX can be triggered dynamically.Proposal 26: Activation of cell DTX/DRX and alignment of cell DTX/DRX and UE DRX can share the same L1 indication signaling. |
| Xiaomi [16] | Proposal 14: When both UE C-DRX and cell-DTX is configured, all the timers running in C-DRX should be kept the same as if cell DTX is not configured.Proposal 15: * For Status 1, the UE/gNB behavior are kept as normal.
* For Status 2, the UE/gNB behavior follows the specification of UE C-DRX.
* For Status 3, the UE/gNB behavior follows the specification of cell DTX.
* For Status 4, suggest to complete specification of cell DTX first, and handle the conflicting behaviours defined separately by cell DTX and UE C-DRX case by case.
 |
| NTT Docomo [17] | Proposal 4:Alignment between Cell DTX and UE DRX should be discussed in accordance with the UE behavior during Cell DTX inactivity periods.Proposal 9: 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 10: When both cell DTX/DRX and UE-specific C-DRX are configured, the cell DTX non-active time will always be the non-active time for UE, i.e. in cell DTX/DRX non-active, the UE always follows the behaviour designed for cell DTX/DRX non-active.Proposal 11: When both cell DTX/DRX and UE-specific C-DRX are configured, UE C-DRX active time is only possible in the cell DTX/DRX active time, i.e. in cell DTX/DRX active, the UE always follows the behaviour designed for UE-specific C-DRX.Observation 4:For solving the conflict between UE C-DRX and cell DTX/DRX,* The gNB should try to avoid the conflict when configure the RRC parameters as much as possible at first. If such alignment can’t be achieved, then the alignment indication can be sent to UE to adjust the periodicity of C-DRX align with the cell DTX/DRX.
 |
| ETRI [21] | Observation 1: To provide a clear benefit of network energy saving gains over the legacy C-DRX mechanism, transmissions and receptions during cell DTX/DRX non-active time should be minimized. |
| Transsion Holding [22] | Proposal 6 How to align the DRX cycles or offsets for different UEs needs to be further studied.Proposal 7 Align UE DRX with cell DTX and DRX between multiple UEs should be studied. |
| Ericsson [28] | Proposal 9 During non-active period of cell DTX, when C-DRX HARQ retransmission timer is running, UE monitors PDCCH for HARQ retransmissions. |
| ASUSTeK [31] | Observation 1: Allowing different UE behavior/expectation for with C-DRX and without C-DRX could reduce the benefit of energy saving brought by Cell DTX/DRX.Observation 2: There is no relationship between whether C-DRX is configured or not and whether a signal is preferred to be turn on or turn off.Proposal 1: A same UE behavior/expectation is applied irrespective with or without C-DRX. |

### Summary of Issues

vivo has provided a table that provides all the combination of cell DTX/DRX and UE DRX that needs to be addressed.

Moderator suggests to use the table for further discussions. Moderator has captured the suggestion from vivo as a starting point, but the actual behavior may need to be updated based on discussion.

|  |  |  |
| --- | --- | --- |
| **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 non-active period of cell DTX |
| Non-active | Non-active | Follow behavior for non-active period of cell DTX and UE C-DRX |

|  |  |  |
| --- | --- | --- |
| **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 and UE DRX |

Second issue that may not be addressed by the UE behavior table above is the handling of the retransmission timer during DRX. Moderator suggests having further discussion on the issue. Few companies proposed the following.

* During non-active period of cell DTX, when C-DRX HARQ retransmission timer is running, UE monitors PDCCH for HARQ retransmissions.

### Suggestions for further Discussions

Moderator suggests discussing the issues listed above.

##### Proposal 7-1:

Adopt the following UE behavior for interaction between cell DTX and UE DRX

|  |  |  |
| --- | --- | --- |
| **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 non-active period of cell DTX |
| Non-active | Non-active | Follow behavior for non-active period of cell DTX and UE C-DRX |

##### Proposal 7-2:

Adopt the following UE behavior for interaction between cell DRX and UE DRX

|  |  |  |
| --- | --- | --- |
| **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 and UE DRX |

##### Proposal 7-3:

* During non-active period of cell DTX, when C-DRX HARQ retransmission timer is running, RAN1 assumes UE monitors PDCCH for HARQ retransmissions.

## 2.8 Others

|  |  |
| --- | --- |
| **Company** | **Proposals & Observations** |
| Nokia [1] | Proposal 29: Enhancement on cell DTX/DRX mechanism can be jointly considered with adaptation of spatial and power domain techniques. |
| Panasonic [7] | Proposal 6: Multiple cell DTX/DRX configurations should be considered for better energy saving adaptation in future release. The switching between configurations needs possible L2/L1 signaling enhancement. |
| NEC [9] | Proposal 8: Support larger values of HARQ-ACK feedback timing indication.Proposal 10: Support UE fallback operation for cell DTX/DRX during cell DTX/DRX non-active duration.Proposal 11: Support mapping of cell DTX/DRX patterns/configurations to SSB transmission characteristics. |
| CMCC [14] | Proposal 7: NCD-SSB is not transmitted during non-active periods of Cell DTX. |
| Samsung [20] | Proposal 13: Support BFR procedure enhancement for the impact of cell DTX/DRX operation. |
| Fraunhofer [26] | Observation 1: Each additional retransmission consumes not only extra power of the retransmission itself but it also prevents the cell to enter light sleep for a whole additional HARQ RTT, in case of TDD a whole TDD period.Observation 2: With 2.5 ms TDD period a single re-transmission increases the energy consumption on the planned Cell DTX inactive time by 15% and 2 retransmissions increase it by 33%. The effect would be even larger with larger TDD periods.Observation 3: HARQ retransmissions deserve special treatment during Cell DTX/DRX and the number of HARQ retransmissions should be minimized to allow network energy savings.Observation 4: In order to significantly save energy, the activity of the cell should be limited to Cell DTX/DRX on-duration.Observation 5: Introducing a new CQI table (e.g. for 1% BLER) would help the gNB implementation to have precise feedback to achieve a better initial BLER target for Cell DTX/DRX.Proposal 4: A new CQI table (e.g. for 1% BLER) is defined to help achieving higher reliability for initial transmissions when Cell DTX/DRX is activated. |
| Ericsson [28] | Proposal 10 Introduce an explicit field in at least the scheduling DCI formats (0\_1/1\_1) to indicate extension of cell DTX/DRX active period.a. When the field indicates ‘0’, there is no additional extension of cell DTX/DRX active period.b. When the field indicates ‘1’, the cell DTX/DRX active period is additionally extended by a number of slots configured by higher layers. |

### Summary of Issues

The following are list of other issues from contributions. For each of the issues, moderator believes further discussion is needed. Most proposals are single company proposals.

**Issue 1:** consideration of joint optimization between cell DTX/DRX and spatial/power domain technique

**Issue 2:** Support larger values of HARQ-ACK feedback timing indication

**Issue 3:** Support mapping of cell DTX/DRX patterns/configurations to SSB transmission characteristics

**Issue 4:** NCD-SSB is not transmitted during non-active periods of Cell DTX.

**Issue 5:** Introducing a new CQI table to aid gNB achieve better BLER for L1 signaling for cell DTX/DRX activation/deactivation

**Issue 6:** Introduce an explicit field in at least the scheduling DCI formats (0\_1/1\_1) to indicate extension of cell DTX/DRX active period.

a. When the field indicates ‘0’, there is no additional extension of cell DTX/DRX active period.

b. When the field indicates ‘1’, the cell DTX/DRX active period is additionally extended by a number of slots configured by higher layers.

### Suggestions for further Discussions

Moderator suggest further discussion on the issues.

# Reference

1. R1-2306473, “Enhancements on cell DTX/DRX mechanism,” Nokia, Nokia Shanghai Bell
2. R1-2306505, “Cell DTX/DRX mechanism for network energy saving,” Huawei, HiSilicon
3. R1-2306577, “Discussions on enhancements on cell DTX/DRX mechanism,” Ruijie Network Co. Ltd
4. R1-2306625, “Cell DTX/DRX for NES,” FUTUREWEI
5. R1-2306658, “Discussion on enhancements on cell DTXDRX mechanism,” Spreadtrum Communications
6. R1-2306763, “Discussions on enhancements on cell DTX/DRX mechanism,” vivo
7. R1-2306803, “Cell DTX/DRX enhancement for network energy saving,” Panasonic
8. R1-2306829, “Discussion on enhancements on cell DTX/DRX mechanism,” Intel Corporation
9. R1-2306948, “Cell DTX/DRX Configuration for Network Energy Saving,” NEC
10. R1-2306964, “Network Energy Saving on Cell DTX and DRX,” Google
11. R1-2307100, “DTX/DRX for network Energy Saving,” CATT
12. R1-2307140, “Discussion on cell DTX/DRX,” ZTE, Sanechips
13. R1-2307163, “Discussion on cell DTX/DRX mechanism,” Fujitsu
14. R1-2307208, “Discussion on cell DTX/ DRX mechanism,” CMCC
15. R1-2307291, “Discussion on remaining issues for cell DTX/DRX mechanism,” Apple
16. R1-2307397, “Discussions on cell DTX-DRX for network energy saving,” xiaomi
17. R1-2307484, “Discussion on enhancements on Cell DTX/DRX mechanism,” NTT DOCOMO, INC.
18. R1-2307541, “Discussion on enhancements on cell DTX/DRX mechanism,” OPPO
19. R1-2307624, “Discussion on the mechanism of Cell DTX/DRX for NES,” China Telecom
20. R1-2307691, “Remaining issues on cell DTX/DRX mechanism,” Samsung
21. R1-2307749, “Discussion on cell DTX/DRX mechanism,” ETRI
22. R1-2307766, “Discussion on Enhancement on cell DTX DRX mechanism,” Transsion Holdings
23. R1-2307793, “Discussion on cell DTX/DRX mechanism,” LG Electronics
24. R1-2307814, “Enhancements on cell DTX/DRX mechanism,” Lenovo
25. R1-2307822, “Discussion on enhancements on cell DTX/DRX mechanism,” InterDigital, Inc.
26. R1-2307838, “Considerations of Cell DTX/DRX Signaling and Reliability,” Fraunhofer IIS, Fraunhofer HHI
27. R1-2307939, “Enhancements on cell DTX and DRX mechanism,” Qualcomm Incorporated
28. R1-2307988, “RAN1 aspects of cell DTX/DRX,” Ericsson
29. R1-2308009, “Discussion on cell DTX/DRX mechanism for network energy saving,” CEWiT
30. R1-2308082, “On enhancements of cell DTX/DRX mechanism,” MediaTek Inc.
31. R1-2308106, “Discussion on cell DTX/DRX,” ASUSTeK

# Appendix A: RAN1 Agreements

## RAN1 #112 (Feb-2023)

**Agreement**

* RAN1 continues discussion on the at least following physical layer related aspects of cell DTX/DRX aspects
	+ physical layer signals/channels and procedures expected to be impacted during non-active periods of cell DTX/DRX
		- consider impact to at least KPIs from the SI when physical layers/signals/channels are impacted by cell DTX/DRX
* Further discussions on other aspects are not precluded

**Agreement**

At least the following candidate signals/channels for connected mode UEs, which the UE may be expected to not transmit or receive during non-active periods of cell DTX/DRX, are considered from RAN1 perspective for further discussion. The exact set of signals/channels that the UE may be expected to not transmit or receive is FFS.

* 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

Other signals/channels are not precluded

## RAN1 #112bis (Apr-2023)

**Agreement**

From RAN1 point of view, Rel-18 UE supporting cell DTX does not expect to receive and/or process the following signals/channels from the gNB, during non-active periods of cell DTX. The list of signals/channels may be updated based on RAN2/RAN4 input and other signals/channels are not precluded from further discussions.

* Periodic/Semi-persistent CSI-RS configured in CSI report configuration in CSI-ReportConfig with reportQuantity including RI (for CSI reporting)
* FFS:
	+ PDCCH in USS
		- UE behavior for retransmission
		- if some specific RNTI scrambled PDCCH in USS will be excluded from cell DTX operation
	+ PDCCH in Type-3 CSS
		- UE behavior for retransmission
		- if some specific RNTI scrambled PDCCH in Type-3 CSS will be excluded from cell DTX operation
	+ PRS
	+ CSI-RS configured by measObjectNR (for RRM)
	+ CSI-RS associated with RadioLinkMonitoringConfig and BeamFailureDectection (for RLM and BFD)
	+ Periodic CSI-RS configured with trs-Info ‘true’ (for tracking)
	+ Periodic/Semi-persistent CSI-RS (for BM)
		- FFS on how to differentiate (if needed) with other CSI-RS used for CSI reports for BM
* FFS: Whether the same or different UE behavior is applicable with or without C-DRX
* FFS: Whether the list of impacted signals/channels can be configurable
* FFS: Whether there will be exception case(s) for UE receiving and/or processing listed signals/channels during non-active periods of DTX
* FFS: RAN1 to consider impact on system if the channels/signals are not transmitted during non-active period

**Agreement**

Study L1 signalling for enhancing cell DTX/DRX including activation/deactivation for a single configuration which will have the following characteristics:

* PDCCH based signaling
	+ FFS: Whether enhancing legacy DCI or introducing new DCI
	+ FFS: DCI content
	+ FFS: Whether L1 signaling is UE specific DCI or group common DCI
	+ FFS: Timer or validity duration based activation/deactivation of cell DTX/DRX
	+ FFS: whether to specify a reference time for activation/deactivation of cell DTX/DRX
	+ FFS: If multiple Cell DTX/DRX patterns are to be supported
* FFS on detailed UE behavior upon reception of L1 signaling at least including application delay
* FFS how to guarantee reliability of the L1 signaling
* FFS whether the L1 signal can be monitored in non-active periods.

**Agreement**

From RAN1 point of view, Rel-18 UE supporting cell DRX is not expected to transmit the following signals/channels to the gNB during non-active periods of cell DRX. The list of signals/channels may be updated based on RAN2/RAN4 input and other signals/channels are not precluded from further discussions.

* Periodic/Semi-persistent CSI report
* Periodic/Semi-persistent SRS
	+ FFS: SRS for positioning
* FFS:
	+ HARQ feedback for SPS PDSCH
* FFS whether there will be exception case(s) for UE transmitting listed signals/channels during non-active periods of DRX
* FFS Whether the listed signals/channels can be configurable by gNB
* FFS: Whether the same or different UE behavior is applicable with or without C-DRX
* FFS: RAN1 to consider impact on system if the channels/signals are not transmitted during non-active period

**Further study the following in RAN1:**

* Handling of HARQ-ACK codebook generation when configured with cell DTX/DRX
* Handling of PUCCH deferral operation during non-active periods of cell DRX
* Handling of overlapping channels where a least a channel overlaps with non-active periods of cell DTX/DRX
* Handling of signals/channels that can be received/transmitted repeatedly during non-active periods of cell DTX/DRX
* Handling of PUCCH switching during non-active period to an active cell
* Other enhancements are not precluded.

**Agreement**

For PDDCH monitoring, further work on Rel-18 NES in RAN1 is to follow the RAN2 agreement below:

*10. The understanding for the gNB scheduling behaviour for new transmissions during Cell DTX non-active period is that the gNB does not schedule UE-specific dynamic grants/assignments, even if the UE is in C-DRX Active Time. UE doesn’t monitor PDCCH for dynamic grants/assignments for new transmissions during Cell DTX non-active period, even if the UE is in C-DRX Active time. FFS how to deal with any exceptions (e.g. SR if agreed and RACH).*

**Working Assumption**

* Support of L1 signaling at least for activation/deactivation of a cell DTX and/or DRX configuration is feasible (e.g., in terms of enabling/disenabling the feature) from RAN1 perspective.
	+ This does not imply that L1 activation/deactivation is supported in Rel-18\
	+ Note: Reliability, overhead, and benefits are FFS

## RAN1 #113 (May-2023)

**Agreement**

RAN1 supports the group common L1 signaling using PDCCH for cell DTX/DRX activation and deactivation without HARQ feedback

* Send an LS to RAN2 to consider the additional support of a MAC CE based indication
* Subject to UE capability

**Agreement**

Confirmation of WA from previous meeting with removal of the two sub-bullets.

**Working Assumption**

* + Support of L1 signaling at least for activation/deactivation of a cell DTX and/or DRX configuration is feasible (e.g., in terms of enabling/disenabling the feature) from RAN1 perspective.
		- ~~This does not imply that L1 activation/deactivation is supported in Rel-18\~~
		- ~~Note: Reliability, overhead, and benefits are FFS~~

**Agreement**

DCI format for group common L1 signaling using PDCCH for cell DTX/DRX activation and deactivation (downselect just one among alternatives)

* Alt 1) DCI Format 2\_6 (power saving information outside DRX Active Time)
	+ FFS: Monitoring within DRX active time
	+ FFS: Field content
* Alt 2) Based on new DCI format 2\_X
	+ Field content format
		- Block number 1, block number 2, …, block number N
		- For each block should at least support the following:
			* DTX configuration activation/deactivation
			* DRX configuration activation/deactivation
		- FFS: other field details, mapping of UE and each blocks
	+ DCI size indicated by higher layers
	+ FFS: RNTI
* FFS: application delay, timers for activation/deactivation
* FFS: handling of multiple cells including when UE supports different number of cells
* FFS: details on PDCCH monitoring aspects, including but not limited to:
	+ Search Space
	+ PDCCH monitoring occasion
	+ slots to monitor (during cell DTX/DRX non-active periods, and active periods)
	+ BD/CE aspects
* FFS: UE behavior upon reception of the group common PDCCH (during cell DTX/DRX non-active periods, and active periods), including fallback behavior (if any)

. **Agreement**

For the group common L1 signaling using PDCCH for cell DTX/DRX activation and deactivation

* Alt 2) Based on new DCI format 2\_X
	+ DCI size budget is not increased
	+ Number of required BDs is not increased
	+ FFS: PDCCH monitoring configuration for the new DCI format is identical to PDCCH monitoring configuration for DCI format 2\_6 if the UE monitors both DCI formats
		- FFS: New RNTI is used

# Appendix B: RAN2 Agreements

## RAN2 #121 (Feb-2023)

Agreements

1. There will be no impact to RACH, paging, and SIBs in idle/inactive for both gNB and Rel-18 and legacy UEs

2. Rel-18 NES capable CONNECTED UE(s) can perform RACH and receive SIBs in non-active duration of cell DTX and/or DRX (i.e., same behavior for cell DTX and cell DRX). No further enhancements for CBRA and CFRA will be pursued.

3. Pattern configuration for cell DRX/DTX is common for Rel-18 UEs in the cell. FFS whether we have DTX UE specific inactivity timer . FFS on configuration signaling and stage 3.

4. Confirm study item agreement that we can have separate DTX and DRX configuration. We will focus on designing DTX/DRX for at least single configuration. FFS whether multiple configuration of cell DTX or DRX will be supported.

Agreements:

1. RAN2 confirms that non-NES UEs can access to NES cells if NES solution is backwards compatible

## RAN2 #121-bis-e (April-2023)

Agreements

1. A periodic cell DTX/DRX configuration is explicitly signalled to the UEs.

2. A periodic cell DTX/DRX pattern is configured by UE specific RRC signalling.

3. The Cell DTX/DRX configuration contains at least: periodicity, start slot/offset, on duration.

4. As a baseline Cell DTX/DRX is activated/deactivated implicitly by RRC signalling, i.e. activated immediately once configured by RRC and deactivated once the RRC configuration is released.

5. From RAN2 point of view, majority companies see a benefit with L1 signalling for Cell DTX/DRX activation/deactivation, send a LS to RAN1 (email 308) with our preference and ask about feasibility and design details. Ask about feasibility and reliability of using L1 signaling. Clarify that the question is about activation/deactivation copy the agreement from last meeting that we are focusing on single configuration. Extract a few key benefits of dynamic signaling from email discussion and online discussions

6. As baseline, UE doesn’t monitor SPS occasions during Cell DTX non-active period. As baseline, gNB is assumed to be not transmitting PDSCH to that UE on such SPS occasions during the Cell DTX non-active period

7. As baseline, UE does not transmit on CG occasions during Cell DRX non-active periods

8. As baseline, UE does not transmit SR occasions overlapping with Cell DRX non-active periods, e.g. SR transmissions are dropped during the non-active period

FFS: whether we will allow to configure the UE per SR configuration with whether SR can be transmitted during Cell DRX non-active period to to support high priority traffic

9. (for the SRs that will be dropped) If SR is not to be transmitted on an PUCCH occasion during Cell DRX non-active time, the UE keep the SR pending, i.e., the UE delays the SR transmission till the Cell DRX active period without triggering RACH. For the FFS case there may be some exceptions.

10. The understanding for the gNB scheduling behaviour for new transmissions during Cell DTX non-active period is that the gNB does not schedule UE-specific dynamic grants/assignments, even if the UE is in C-DRX Active Time. UE doesn’t monitor PDCCH for dynamic grants/assignments for new transmissions during Cell DTX non-active period, even if the UE is in C-DRX Active time. FFS how to deal with any exceptions (e.g. SR if agreed and RACH).

FFS how to deal with retransmissions

## RAN2 #122 (May-2023)

Agreements:

1 UE monitors PDCCH for RAR during Cell DTX non-active time. The ra-ResponseWindow could be started as legacy.

2 UE monitors PDCCH for msg4 during Cell DTX non-active time. The ra-ContentionResolutionTimer could be started as legacy.

3 Working assumption: When the retransmission timer is running (if C-DRX is configured), the UE is expected to monitor PDCCH, like in legacy. It is up to the network whether it schedules retransmissions out of the Cell DTX active period, i.e., when the DRX retransmission timer is running, the UE should monitor PDCCH regardless of the Cell DTX.

4 Once gNB recognizes there is an emergency call or public safety related service (e.g. MPS/MCS), the NW should ensure there is no impact to the emergency call (e.g. may deactivate Cell DTX/DRX). The behavior is captured in stage 2 spec

5 When an DG grant is received, by the gNB during cell DRX/DTX, the UE follows the grant assignment (i.e. like in legacy). This includes DL HARQ feedback.