3GPP TSG-RAN WG2 Meeting #121bis-e R2-22xxxxx

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

Agenda Item: 8.11.2

Source: ZTE

Title: Report of [Post121][606][eMBS] Service continuity and notifications (ZTE)

Document for: Discussion, Decision

# 1 Introduction

This document is the report of the following email discussion,

* [Post121][606][eMBS] Service continuity and notifications (ZTE)

Scope: Based on the companies' contributions discuss:

* + - Service continuity (frequency/cell prioritization, neighbor cell list etc.)
    - Notifications for session activation, deactivation etc. (e.g. group paging or MCCH change notification, "special" UEs handling etc.)

Outcome: Report

Deadline: 5th Apr. 23:59 UTC.

Please provide your comments before 5th Apr. 23:59 UTC.

The summary for discussion is organized as above scope per chair guide.

* Service continuity in section 3. Other than the frequency/cell prioritization, neighbor cell list, this part also includes the analysis to some scenarios as well, to cover several outstanding UE behaviour/flow for service continuity.
* Notification mechanism in section 4. This part includes whether and how to notify UE upon events like session state change, data availability and "special" UE handling.
* Issues not covered, if found, please kindly add them to the list in section 5.

# 2 Contact information

Participants are encouraged to leave their contact information in the following table.

|  |  |
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| Company | Contact info (name, email address) |
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# 3 Service continuity

Agreements made so far that's related to service continuity.

RAN2#119-e:

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| * **Multicast service continuity after cell reselection in RRC\_INACTIVE state (i.e. without resuming RRC connection) will be supported (if the configuration of the new cell is available for the UE). FFS whether there are cases where the UE needs to resume the connection. FFS RAN3 impacts due to inter-gNB mobility.** * **Upon cell reselection to neighbour cells during active multicast session, if the configuration of the session is not available for the new cell for UEs in INACTIVE, then the UE is required to resume RRC connection to get the Multicast MRB configuration.** * **We will have a mixed approach and we start with the following:**   1. When NW configures UE to continue the multicast reception in INACTIVE state, NW provides the PTM configuration for the activated multicast session via the RRC dedicated signalling, at least for the serving cell (FFS other cases).  2. MCCH is used in case there is a need to indicate a PTM configuration in case there is a need for change in PTM config or during mobility beyond serving cell / gNB. FFS session status change and other indications.  3. We assume that the UE can only receive multicast service after it joined the session.  FFS whether MCCH configuration is initially provided to the UE via dedicated signalling. |

RAN2#120:

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| * **We will have a mixed approach and we start with the following:**   **1. When NW configures UE to continue the multicast reception in INACTIVE state, NW provides the PTM configuration for the activated multicast session via the RRC dedicated signalling, at least for the serving cell (FFS other cases).**  **2. MCCH is used in case there is a need to indicate a PTM configuration in case there is a need for change in PTM config or during mobility beyond serving cell / gNB. FFS session status change and other indications.**  **3. We assume that the UE can only receive multicast service after it joined the session.**  **FFS whether MCCH configuration is initially provided to the UE via dedicated signalling.** |

RAN2#121:

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| * **Serving cell will not provide the PTM configuration of neighbour cells from other gNBs.** * **FFS whether the network can provide PTM configuration for intra-gNB cells.** |

Service continuity in this section will be covering the issues on frequency/cell prioritization, neighbor cell list etc. Before that, we aim to confirm the scenarios brought up by companies. It should be noted that Access categories and RRC resume cause value were also mentioned in companies contributions. However it is suggested to firstly have a common understanding on the essential service continuity scenarios and related solutions first (e.g., when will UE trigger RRC connection resumption).

## 3.1 Scenarios

The following service continuity scenarios/solutions were proposed by companies for UE in RRC\_INACTIVE [2, 4, 9, 11, 14-17, 19].

* **1. Similar to Rel-17 broadcast reception procedure, UE acquires new SIB and multicast MCCH to get PTM configuration after cell reselection**. This is consistent with RAN2#121 agreement that new SIB/MCCH for multicast reception in RRC\_INACITVE, and also earlier agreement that "MCCH is used in case there is a need to indicate a PTM configuration in case there is a need for change in PTM config or during mobility beyond serving cell / gNB".
* **2. When a UE enters to a cell for which PTM configuration is not available in multicast MCCH, the UE may return to RRC\_CONNECTED state for an active multicast session.** This is also a natural continuation of RAN2#119-e agreement that "if the configuration of the session is not available for the new cell for UEs in INACTIVE, then the UE is required to resume RRC connection to get the Multicast MRB configuration."
* **3. UE is able to trigger RRC connection resumption if the reception quality of the multicast data is below a configured threshold**. Companies are concerned that in RRC\_INACTIVE the reception quality might not meet the QoS requirement and network is not aware. Therefore it is reasonable for UE to resume to RRC\_CONNECTED to have the QoS requirement met. This is also related to previous RAN2 FFS on "if there are other cases when UE triggers resume."

**Q1: Companies are invited to provide their views on the following,**

* **1. Similar to Rel-17 broadcast reception procedure, UE acquires new SIB and multicast MCCH to get PTM configuration after cell reselection.**
* **2. When a UE enters to a cell for which PTM configuration is not available in multicast MCCH, the UE may return to RRC\_CONNECTED state for an active multicast session.**
* **3. UE is able to trigger RRC connection resumption if the reception quality of the multicast data is below a configured threshold.**

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| Company | List the supported bullet  (acceptable/unacceptable) | Comments if any |
| NEC | 1. acceptable  2. comment  3. acceptable | **For 1**  PTM configuration of neighbor cell provided by dedicated RRC is not needed if MCCH is introduced, also even though UE acquires the PTM configuration of neighbor cell, the valid is not guaranteed, so that UE anyway need to read MCCH for a new PTM configuration after cell reselection.  **For 2**  The intention is no problem, but we are wondering whether UE can initiate RRCResumeRequest without entering RRC\_CONNECTED to acquire the PTM configuration in this case.  **For 3**  Agree. As Mcast scheduling is common for multiple UEs, NW can not ensure a RRC\_INACTIVE UE’s channel state since there is no CSI feedback from such kind of UEs. UE should be responsible for its Mcast scheduling. |
| Ericsson | 1 and 2: comment  3: acceptable/addition | **1 and 2:**  In case mobility is based on cell re-selection there are issues to be resolved:   * Congestion happens dynamically, on a cell level, and cannot be pre-planned * It is not efficient to enable multicast reception in RRC\_INACTIVE in all cells of the gNB, when there is only congestion in one cell. And it is cumbersome to update the set of cells dynamically (e.g. update NCL info in the active set, and add SIB/MCCH in the new cells). * The Rel-17 broadcast frequency prioritization is not suitable to handle this dynamic congestion scenario. And in case there is congestion, we assume that the gNB will only release UEs to RRC\_INACTIVE when there is no capacity left in RRC\_CONNECTED on all carriers. In this Rel-18 use case there is a not a single “MBS frequency”.   **3:**  The gNB may release stationary and UEs in good coverage with preference, but still the UE may roam into bad coverage, in which case it should resume. In addition to the QoS issue, we also think that mobility should be based on HO, i.e. the UE resumes when the quality is above the threshold and the UE initiates cell re-selection. |
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## 3.2 Frequency/cell prioritization

Frequency based cell reselection is the very basic mechanism to enable service continuity for broadcast, that was defined in LTE and later adopted in MBS broadcast in Rel-17. Since UE is also able to receive MBS multicast in RRC\_INACTIVE, companies suggest that such mechanism can be applied as well [4, 6, 14, 16, 18]. That is, it is beneficial if UE can be guided to frequencies or cells on which the multicast service may also be provided (for UE in RRC\_INACTIVE).

There are concerns though: the way how multicast service for RRC\_INACTIVE UEs is deployed shall be different from broadcast service, i.e., no per frequency deployment. Per frequency deployment may be usual for broadcast which is intended for larger area broadcasting, while multicast reception for UEs in RRC\_INACTIVE may be across only a few cells where congestion is happening. Therefore, there is doubt whether the such mechanism can be reused [3]. Moreover, whether current USD are ready to be reused needs to be confirmed by other working group [14], and whether a new SIBx may be needed as the SIB21 equivalent, are undetermined.

**Q2: Whether a frequency prioritization/de-prioritization mechanism is needed for cell reselection for multicast reception in RRC\_INACTIVE?**

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| Company | Yes or No | Comment if any |
| NEC | Yes | As long as cell reselection mechanism is performed, frequency priority is anyway helpful. |
| Ericsson | See comment | The UE will not be happy if it is released to RRC\_INACTIVE on F1 because there is congestion, but on F2 and F3 there is still connected mode capacity.  We are not sure what a suitable solution is, but we think that the Rel-17 broadcast way is not suitable. |
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A related issue is if multicast reception for UEs in RRC\_CONNECTED might not be enough based on frequency prioritization/de-prioritization, whether other per cell based prioritization should be defined?

**Q3: Whether a mechanism should be defined to help UE to choose the right cell to camp on, i.e., per cell based prioritization in cell re-selection, to continue the multicast reception in RRC\_INACTIVE?**

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| Company | Yes or No | Comment if any |
| NEC | No | We prefer simply reusing frequency priority mechanism. Otherwise more specification impact is needed.  Also legacy neighbor cell list (NCL) in the MCCH can provide the cell information as assistance information and it is enough. |
| Ericsson | No | The right cell to camp on is the strongest/best ranked cell on the frequency.  And the UE does not prefer to select a cell where it can receive multicast in RRC\_INACTIVE, but RRC\_CONNECTED is preferred. |
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## 3.2 Neighbour cell list

MCCH in legacy system functions for both PTM configuration provisioning and service availability in cells inside a neighbouring cell list (NCL). Different from the frequency prioritization in above section, based on NCL UE can be aware of the service availability in one specific neighbouring cell, and then UE can decide whether to apply unicast bearer in the target cell.

It is agreed that a new MCCH (with new SIB) is to be defined, to support multicast reception in RRC\_INACTIVE in RAN2#121. For multicast reception in RRC\_INACTIVE, similar mechanism can be adopted, suggested by companies [3, 15, 19], e.g., UE resumes RRC connection immediately if service is not available in the re-selected cell if known by UE beforehand. In such case, there is no need for UE to monitor MCCH in the re-selected cell to be aware of service availability. There are concerns from [17] that the benefits to reduce the latency is quite limited though.

So the next question is whether to apply the similar NCL mechanism that was defined for broadcast, to multicast in Rel-18 as well.

**Q4: Whether the neighbor cell list mechanism for multicast reception in RRC\_INACTIVE is needed, e.g., UE resumes RRC connection immediately if service is not available in the re-selected cell by NCL, without reading MCCH in the re-selected cell?**

Please also note NCL here is not used for cell re-selection which is handled in Q3.

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| Company | Yes or no | Comment if any |
| NEC | No strong view | The intention of Cell priority (Q3) is to determine which cell UE need to re-select;  The intention of NCL is that, after cell reselection, UE immediately initiate RRC connection resume. But still can be considered as an assistance information facilitating Cell reselection.  We are open for NCL as this is a legacy mechanism can be reused. |
| Ericsson | No | It is complex for the NW to configure and the benefit is very low.  Extreme congestion, where there are only mission critical UEs in connected mode, and some need to be released to RRC\_INACTIVE to avoid service denial, are expected rare cases, and we do not see a need for this optimization.  PS: there can also be cases where the session is provided on the neighbour cell, but the PTM configuration is different. This discussion is related to the discussion in which area the PTM configuration is valid. |
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# 4 Notification mechanism

Agreements made so far (since we are going with a mixed solution, specific agreements/assumption on option1/2 only will not be considered).

RAN2#119-e:

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| * **In Rel-18, multicast reception for UEs in INACTIVE supports at least the following scenarios, with the assumption that the UE already has a valid PTM configuration:**   **- Scenario 1: a UE has been receiving multicast in CONNECTED, and it enters INACTIVE and continues the multicast reception.**  **- Scenario 2: a UE has joined a multicast session and has been directed to INACTIVE, the UE starts to receive the multicast session**  **FFS for state changes, e.g. due to service being not provided in INACTIVE anymore etc.** |

RAN2#119bis-e:

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| * For both option 1 and option 2, as a baseline, group paging can be used to switch UEs receiving multicast from RRC\_INACTIVE to RRC\_CONNECTED, and UEs continue the multicast reception in CONNECTED. FFS if there is any potential issue if Rel-17 group paging is reused. FFS if there are other cases when UE triggers resume. FFS if MCCH can also be used in case of option 2. * Rel-18 UE in INACTIVE can be informed when the session is activated (Details FFS). * As a baseline, group paging can be used to inform Rel-18 UE(s) about the session activation (Details FFS, e.g., UE behavior when receiving such group notification). * If a UE is in RRC\_INACTIVE and is configured to receive a multicast session in RRC\_INACTIVE, the UE may be notified when the multicast session is deactivated. FFS how (e.g., informed via group paging, MCCH, or other ways). * Rel-17 mechanism (NAS-based indication) is applicable for multicast session release. FFS if any enhancement is needed. * FFS how UE determines whether it can receive the multicast session in RRC\_INACTIVE or not when the session is activated, taking into account the following solutions (can further update the descriptions if needed, and several solutions may be needed, some solutions may apply only for certain configuration options)   **1. When the multicast session is activated, UE can receive the multicast session in RRC\_INACTIVE if the PTM configuration used in RRC\_INACTIVE for the session is available to the UE and the UE has joined the session already (e.g., configuration provided to UE via dedicated RRC signaling or via MCCH), otherwise it goes back to RRC\_CONNECTED to receive the multicast session.**  **2. When the multicast session is activated, UE is indicated by group paging whether it can receive the multicast session in RRC\_INACTIVE or not (detailed signaling FFS).**  3. UE is configured "whether it can receive the multicast session in RRC\_INACTIVE" by dedicated signaling before UE is released. When the multicast session is activated, UE stays in RRC\_INACTIVE or resumes RRC connection accordingly (detailed signaling FFS). |

RAN2#120:

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| * **We will have a mixed approach and we start with the following:**   **1. When NW configures UE to continue the multicast reception in INACTIVE state, NW provides the PTM configuration for the activated multicast session via the RRC dedicated signalling, at least for the serving cell (FFS other cases).**  **2. MCCH is used in case there is a need to indicate a PTM configuration in case there is a need for change in PTM config or during mobility beyond serving cell / gNB. FFS session status change and other indications.**  **3. We assume that the UE can only receive multicast service after it joined the session.**  **FFS whether MCCH configuration is initially provided to the UE via dedicated signalling.** |

In Rel-17, one UE in non RRC\_CONNENCTED state may be notified when the session is activated/released, or when multicast data is available to be transmitted. Upon such notification (i.e., group paging), UE resumes to RRC\_CONNECTED state to receive the multicast data.

While in Rel-18, UE is also able to receive multicast data in RRC\_INACTIVE, e.g., in case of large number of UEs and potential high level of network congestion. Therefore a preferred UE behaviour may be UE to start or stop monitoring multicast transmission accordingly without RRC connection resumption, if UE is already in RRC\_INACITVE while being capable and allowed to receive multicast data in RRC\_INACTIVE. There are possible session state change or its implications that may need to be notified to UE:

* Session activation. Previous RAN2 discussion confirmed UE may be notified upon multicast session activation and continues to stay in RRC\_INACTIVE for multicast data reception. Detailed notification mechanism is FFS;
* Session deactivation. It was also agreed that UE may be notified when the multicast session is deactivated;
* Session release. While Rel-17 mechanism (NAS-based indication) is applicable for multicast session release, it is FFS if any enhancement is needed.

Based on [25, 34], UE might not be aware of the difference between "session activation" and "data transmission resumed", or the difference between "session deactivation" and "temporary no data". In the following text, they are suggested to be handled together for simplicity. However whether this is a feasible way shall still be open, if there are different views.

Companies' inputs to RAN2#121 showed a trend or interest that upon such notifications from network a UE that is already in RRC\_INACTIVE, it should stay in RRC\_INACTIVE and start/stop monitor multicast service (or G-RNTI) accordingly. Below table shows the categorized events (e.g., session state change, data availability, among others), and the potential UE behaviour (e.g., RRC state transitioning, G-RNTI monitoring) based on companies' contribution. The design aims for one purpose: to enable UE to stay in RRC\_INACTIVE, if possible. Consequently, mechanism shall be clear on how to transition UE to RRC\_CONNECTED when network thinks it is needed, if legacy mechanism is enhanced.

Please note this table full of question mark is only for "Example UE behaviour upon various events including session state change" with confirmed and not confirmed issues, i.e., the table is not the final proposal, but only an input to the discussion itself.

**Table 1. Example UE behaviour upon various events including session state change.**

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| **Section** | **Events, e.g., multicast session states, or data transmission states change** | **UE behaviour** | |
| **UE's RRC state** | **whether UE needs to monitor G-RNTI** |
| 4.1 | Session activation (or data transmission resumed) | UE stays in RRC\_INACTIVE (confirmed) | yes (confirmed) |
| 4.2 | Session deactivation (or temporary no data) | UE stays in RRC\_INACTIVE? | no? |
| 4.3 | Session release | UE stays in RRC\_INACTIVE? | no? |
| 4.4 | Network intends to resume UE's RRC connection, e.g., service being not provided in INACTIVE anymore. | UE resumes to RRC\_CONNECTED | follow RRC\_CONNECTED configuration |

Various notification mechanism were proposed by companies (with candidate solutions like, group paging, MCCH, or PTM configuration availability), on how to notify UE, as the continuation of discussion from RAN2#119bis-e in which a few options were proposed.

The discussion is organized in the following way that in corresponding sections (4.1 to 4.3),

* 1. The scenarios are to be confirmed first, e.g., should UE be kept in RRC\_INACTIVE upon session release? Apparently companies have different views.
* 2. Notification mechanism is to be discussed for each supported scenario in later part of that section. It should be well known that the solutions from section 4.1 to 4.4 are actually coupled, e.g., in some of the proposed solutions group paging is enhanced such that RRC state/whether to monitor G-RNTI/session state are explicitly indicated. Such mechanisms work for more than one events, e.g., for both session activation/deactivation, etc.

Current discussion are organized to discuss them separately for clearer understanding although the solutions may overlap.

## 4.1 Session activation or data transmission resumed

According to the agreements in RAN2#119bis-e meeting, Rel-18 UE in RRC\_INACTIVE UE can be informed when session is activated. And as a baseline, group paging can be used to inform Rel-18 UE about the session activation. Moreover, UE can receive the multicast session in RRC\_INACTIVE upon session activation, and the detailed solution is FFS, with a few options on the table.

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| * **Rel-18 UE in INACTIVE can be informed when the session is activated (Details FFS).** * **As a baseline, group paging can be used to inform Rel-18 UE(s) about the session activation (Details FFS, e.g., UE behavior when receiving such group notification).** * **FFS how UE determines whether it can receive the multicast session in RRC\_INACTIVE or not when the session is activated, taking into account the following solutions (can further update the descriptions if needed, and several solutions may be needed, some solutions may apply only for certain configuration options)**   **1. When the multicast session is activated, UE can receive the multicast session in RRC\_INACTIVE if the PTM configuration used in RRC\_INACTIVE for the session is available to the UE and the UE has joined the session already (e.g., configuration provided to UE via dedicated RRC signaling or via MCCH), otherwise it goes back to RRC\_CONNECTED to receive the multicast session.**  **2. When the multicast session is activated, UE is indicated by group paging whether it can receive the multicast session in RRC\_INACTIVE or not (detailed signaling FFS).**  **3. UE is configured "whether it can receive the multicast session in RRC\_INACTIVE" by dedicated signaling before UE is released. When the multicast session is activated, UE stays in RRC\_INACTIVE or resumes RRC connection accordingly (detailed signaling FFS).** |

The first coming question is about the "special UE" handling from the latest SA2 progress. It is understood that 5GC's UE level MBS assistance information suggests that such UE is preferred to be handled differently. It might be a leading UE in a group, therefore the UE might need special treatment in network scheduling with less control/user plane latency, e.g., by keeping the UE in RRC\_CONNECTED. However, such UE may be released to RRC\_INACTIVE too, e.g., for an deactivated multicast session [35]. How to resume only such "special" UE while keeping other "normal" UEs in RRC\_INACTIVE, is the issue companies are trying to resolve.

* Companies suggest that UE needs a pre-configuration, e.g., a valid PTM configuration in dedicated RRC signaling [36] or an indication that allows UE [24] to stay in RRC\_INACTIVE, and start multicast data reception upon session activation/data transmission resumed. Such PTM configuration is only for UE that is suitable to receive multicast data in RRC\_INACTIVE, but not the ones indicated by 5GC's UE level MBS assistance information that reception in RRC\_CONNECTED is suggested [36]. Therefore, this "special" UEs without such configuration will always resume to RRC\_CONNECTED.
* Meanwhile, [24, 35] suggests that UEs, e.g., the ones preferred by 5GC to be served in RRC\_CONNECTED for a multicast session, can be configured when UEs are released to RRC\_INACTIVE state, e.g., to always come to RRC\_CONNECTED state in case of session activation.

Others think it might not be needed, as if the gNB wants to select a subset of UEs to perform the RRC state change, it can use some POs for the group paging. Furthermore, the gNB can also use the legacy paging to trigger the RRC state transition for a specific UE. No enhancement is needed for Rel-17 group paging [32].

Therefore we have the question as below.

**Q5: Rel-18 UE can stay in RRC\_INACTIVE and start multicast data reception upon session activation/data transmission resumed only if there is a pre-configuration (e.g., valid PTM configuration or an indication that allows one UE to receive multicast data in RRC\_INACTIVE.)?**

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| Company | Yes or no | Comment if any |
| NEC | Comment  (YES only for PTM config) | This is involved with UE specific Mcast reception requirement, we think there is no need for an explicit indication that allows one UE to receive Mcast data in RRC\_INACTIVE.  The presence/absence of PTM configuration in RRCRelease can already implicitly indicate whether UE can receive Mcast in RRC\_INACTIVE or not. |
| Ericsson | Yes only for PTM config and session activation | We do not think that a “special” UE would be released to RRC\_INACTIVE when the session is de-activated to save power. The UE may experience delay to comeback, and should not be released.  RAN2 has not agree that the UE will be notified when there is temporarily no data, and when there is new data again. We also think that the gNB should not be required to do so, i.e. this can be left to gNB implementation. |
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On the "**FFS how UE determines whether it can receive the multicast session in RRC\_INACTIVE or not when the session is activated**", several options were proposed as summarized below:

* **Option 1. PTM config availability** (e.g., the configuration was previously provided to UE via dedicated RRC signaling or via MCCH) to the UE [39]. It works with the benefits of less paging signaling overhead, however this option may require UE to consistently monitor MCCH and also cause frequent MCCH change with higher UE power consumption [25]. It may also ask for a different treatment between Rel-17 and Rel-18 UEs, e.g., Rel-18 UE to ignore group paging, which may result in potential compatibility issue [25].
* **Option 2. Group paging** [24, 25, 28, 30, 32, 35-38, 40-44]. This is the most supported option, as RAN2 already agreed that group paging is the baseline for session activation, and it features less spec impact and shorter latency, as companies stated. One [38] suggest that if UE has pre-configured information of multicast reception state, it follows the indication in group paging but ignore the pre-configured one. And there are variations on whether and what enhancement is needed.
  + Enhanced group paging by adding different indication per session in group paging, e.g., when the multicast session is activated, UE is indicated by group paging whether it can receive the multicast session in RRC\_INACTIVE or not [25, 30-32, 35, 36, 38, 40, 43]. This option enables gNB to control the inactive reception dynamically, and UE does not need to always monitor MCCH.
  + While some others suggest adding session state explicitly in group paging. [33, 44]
  + [37] suggests that in the group paging it is explicitly indicating UE whether to monitor G-RNTI, i.e., multicast data transmission.
  + While some suggest legacy group paging without enhancement could be used to indicate session activation, as long as UE is with valid pre-configuration [29] or UE can also start acquiring the PTM config upon Rel-17 group paging [26]. There are also concerns [24, 43]suggesting that a pre-configuration can not deal with the varying network condition with dynamic parameters, e.g., cell load, audience size and congestion level at the gNB, if a pre-configuration is required. However this is not always needed as in [26], the PTM config can be indicated in MCCH. This sub-option features the least spec impact without further enhancing the paging design.
* **Option 3. Indication in MCCH**. MCCH is already agreed for PTM configuration update and mobility, it would be good to use MCCH for informing session activation [34], e..g, together with activation indication in the MCCH. However, relying on MCCH may lead to following issues: 1) UE has to always monitor MCCH [25], and 2) higher control plane latency. There are also different MCCH based solution though: notification of start/stop monitoring is added to the multicast MCCH for better reliability in case UE might miss the group paging since UE stays in RRC\_INACTIVE [37].
* **Others**, if needed.

**Q6: How to notify Rel-18 UE to stay in RRC\_INACTIVE and start monitoring corresponding G-RNTI upon session activation/data transmission resumed?**

* **Option 1. PTM config availability.**
* **Option 2. Group paging. Please also indicate whether and what enhancement is needed.**
* **Option 3. Enhanced MCCH. Please also indicate whether and what enhancement is needed.**
* **Others. Please elaborate the details in comment.**

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| Company | Which option(s) | Comment if any |
| NEC | Option 2 | RRC\_INACTIVE UE anyway need to monitor paging, also group paging is already a per-TMGI (session) configuration. When Mcast session activation, reusing group paging to indicate which RRC state UE will receive Mcast session is more straightforward, an example like each TMGI in the PagingGroupList can be corresponded to one paging cause – e.g., session in connected, session in inactive.  Compared with MCCH, the indication about e.g., session in connected, session in inactive anyway need to be designed in MCCH or paging, but MCCH method cause UE continuously monitoring MCCH which bring more power consumption than paging. |
| Ericsson | Option 3  Option 2 when MCCH is not configured | The MCCH is optionally, when the PTM configuration does not change, and mobility is based on HO. In such case group paging is needed to indicate the session state change.  But when the MCCH is configured, it does not make sense to use group paging and impact legacy UEs, i.e. the MCCH can be used. |
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An immediate question is, upon session activation or data transmission resumed, if PTM configuration is not available to UE (e.g., either UE is not pre-configured, or there is no corresponding PTM config available in MCCH), does UE resume RRC connection? (this may be a mis-configuration from network or intended by network, but it would be good to clarify UE behaviour).

**Q7: Upon session activation/data transmission resumed, if PTM configuration is not available to UE, does UE need to resume RRC connection?**

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| Company | Yes or no | Comment if any |
| NEC | YES but | As long as a UE is interested one Mcast session and this session is activated, UE can acquire the PTM configuration by RRCResumeRequest if no PTM configuration is available, but more detail like RRC resume without entering RRC\_CONNECTED which is more efficient can be further considered. |
| Ericsson | Yes | If the UE is no longer interested in the multicast session, it needs to leave the session and notify the NW about this, i.e. this is Rel-17 behavior. |
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## 4.2 Session deactivation or temporary no data

According to the agreements in RAN2#119bis-e meeting, Rel-18 UE in RRC\_INACTIVE UE may be informed when session is deactivated. This sounds reasonable to avoid unnecessary monitoring of the multicast transmission [35, 40]. How to notify and the behavior of RRC\_INACTIVE UEs are FFS.

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| * If a UE is in RRC\_INACTIVE and is configured to receive a multicast session in RRC\_INACTIVE, the UE may be notified when the multicast session is deactivated. FFS how (e.g., informed via group paging, MCCH, or other ways). |

Similarly, to avoid worsening network congestion, companies prefer UE to stay in RRC\_INACTIVE upon session deactivation or temporary no data. Again, it is suggested to confirm upon session deactivation/temporary no data, a UE who is already in RRC\_INACTIVE, can stay in RRC\_INACTIVE and stop monitoring corresponding G-RNTI.

**Q8: For one UE already in RRC\_INACTIVE, it can stay in RRC\_INACTIVE and stop monitoring corresponding G-RNTI upon session deactivation/temporary no data?**

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| Company | Yes or no | Comment if any |
| NEC | Yes | It is for power saving, there is no need for UE to always monitor G-RNTI when session is (temporarily) deactivated in RRC\_INACTIVE. |
| Ericsson | Yes for deactivation only | RAN2 did not agree that the gNB has to notify the UE in RRC\_INACTIVE when there is temporary not data. However this can be left to gNB implementation. |
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Views are even more diverse on how to notify UE to stay in RRC\_INACTIVE and stop monitoring G-RNTI upon session deactivation deactivated/temporary no data.

* **Option 1. PTM config availability in MCCH**. No explicit indication is needed, but notify UE via the removal of PTM configuration of the multicast service [39]. MCCH can be used to notify the UEs in RRC\_INACTIVE about the multicast session similar as broadcast [36, 30] as MCCH is agreed to be used to notify PTM config change.
* **Option 2. Group paging** [25, 26, 31, 37, 43, 44]. An indication in Paging message to indicate UE to start/stop monitoring G-RNTI upon session deactivation or temporarily no data [25, 37, 43]. While there are some others suggest adding session state explicitly in group paging [26, 31, 44]. It may also be good to have a unified solution for both session activation and deactivation to avoid the complexity [32]. [35] proposes to add a new group of identity indicating which multicast session is deactivated.
* **Option 3. Enhanced MCCH** [28, 30, 37]. Notification of start/stop monitoring is added to the multicast MCCH for better reliability, i.e., UE might miss the group paging while network is not aware [37].
* **Option 4. A new MAC CE** [26, 40]. Upon the reception of the deactivation MAC CE, the UE suspends the corresponding PTM configuration (e.g. stop GC-PDCCH monitoring). Companies' concern is, group paging might not be a suitable way to carry deactivation notification since there may be impacts on non-MBS or non-interested UEs to increase their probability and power consumption of checking with irrelevant paging messages [26]. The MAC CE method, compared to MCCH, features less delay, less impact on other UEs and more power-saving gain.
* **Option 5. DCI**. It is stated that compared with MAC CE, DCI indication have lower latency and less overhead, which has been used for the broadcast MCCH change notification. Considering the resource efficiency and latency, DCI indication may be a good way for the notification of session deactivation for UEs receiving multicast in RRC INACTIVE [29]. After reception of such indication in DCI, UE stops monitoring G-RNTI and stays in RRC\_INACTIVE when receiving the notification for session deactivation.
* **Others**. Please elaborate in comments.

**Q9: How to notify Rel-18 UE to stay in RRC\_INACTIVE and stop monitoring corresponding G-RNTI upon session deactivation/temporary no data?**

* **Option 1. PTM config availability in MCCH.**
* **Option 2. Group paging. Please also indicate what enhancement is needed.**
* **Option 3. Enhanced MCCH. Please also indicate what enhancement is needed.**
* **Option 4. MAC CE. (MAC CE multiplexed with data? Please elaborate.)**
* **Option 5. DCI. (DCI associated to the PDCCH addressed to MCCH-RNTI? Please elaborate.)**
* **Others. Please elaborate the details in comment.**

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| Company | Which option(s) | Comment if any |
| NEC | Option 2 | To our understanding, UE anyway need to monitor paging and group paging is already a per-TMGI(session) configuration. One simple solution can solve all the problems is that adding additional indication to each TMGI in the pagingGroupList, example like, usging paging cause (session activate in Connected / Inactive, session deactivate) to correspond to each TMGI.  For option 3, note that we agree that MCCH can carry updated PTM configuration, but for notification, it is not efficient as UE will always (continuously) monitor MCCH which cause more power consumption than paging.  In a word, enhanced group paging can notify UE of any session state with less spec impact. |
| Ericsson | Option 3  Option 2 when MCCH is not configured | PS: we were not sure why activation and deactivation is discussed separately, and why companies have different solutions for both cases.  The MCCH is optionally, when the PTM configuration does not change, and mobility is based on HO. In such case group paging is needed to indicate the session state change.  But when the MCCH is configured, it does not make sense to use group paging and impact legacy UEs, i.e. the MCCH can be used. |
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## 4.3 Session release

According to the agreements in RAN2#119bis-e meeting, Rel-17 mechanism is applicable for multicast session release, but whether any enhancement is needed is FFS.

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| * Rel-17 mechanism (NAS-based indication) is applicable for multicast session release. FFS if any enhancement is needed. |

In Rel-17, upon session release, Rel-17 UE in RRC\_INACTIVE or RRC\_IDLE shall be paged back to RRC\_CONNECTED, e.g., to release PTM config, and finish the NAS procedure.

It was proposed that, to avoid aggravating the congestion of the cell, UE can also stay in the RRC\_INACTIVE state and stop monitoring corresponding G-RNTI upon session release [28, 31, 43, 44]. Companies further suggest that, UE might not be required to transit to RRC\_CONNECTED immediately, e.g. when a group paging with session release is received. For instance, if UE is already receiving another multicast session in RRC\_INACTIVE or network is too congested; forcing all UEs at once to transit to RRC\_CONNECTED and to immediately respond to group paging with session release is not desirable.

There are also proposal that suggesting session release in current SA2 procedure requires UE to resume RRC connection, therefore no enhancement is needed [32, 34, 39]. Others think the notification of session deactivation could work for session release, e.g., to stop monitoring the data transmission. UE just stops the G-RNTI monitoring, the rest is network implementation, e.g., network ignores the group paging intentionally when needed, or network delays the NAS message delivery until UE re-connects to RRC\_CONNECTED [37, 40].

**Q10: For one UE already in RRC\_INACTIVE, it can stay in RRC\_INACTIVE and stop monitoring corresponding G-RNTI upon session release?**

Note: whether there will be NAS layer interaction issues, is one of the possible concern, e.g., what happens if NAS message can not reach one UE, this might be out of RAN2 expertise but worth some attention.

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| Company | Yes or no | Comment if any |
| NEC | No strong view | In legacy, when session release happen, NW will use legacy unicast paging to explicitly release UE when UE enter RRC\_CONNECTED, e.g., release MRB confg…  However considering congestion situation, UE may not back to RRC\_CONNECTED and just directly release the session, which is a good intention. But as rapporteur’s note, we are not sure whether this could impact NAS layer… |
| Ericsson | No | The NW is not required to inform the UE when the session is release via group paging, but it can inform the UE later when the is in RRC\_CONNECTED, see 23.247 section 7.2.2:  *Alternatively, for UEs without activated UP, the SMF does not trigger message to the AMF, instead the SMF marks that the UE is to be informed of the MBS Session release. In this case, the SMF initiates PDU Session Modification to inform the UE of the MBS Session release at next UP activation of the associated PDU Session, if needed.* |
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Therefore it is suggested that to explicitly indicating UE the session state (e.g., session released) in group paging, to align the session state between 5GC and UE without resumption of UE's RRC connection [28, 31, 44, 43].

This can also be achieved by explicitly indicate whether to monitor G-RNTI upon session release, i.e., UE shall be notified later on NAS message (PDU session modification on session release) [37].

**Q11: How to notify Rel-18 UE to stay in RRC\_INACTIVE and stop monitoring corresponding G-RNTI upon session release?**

* **Option 1. No enhancement needed.**
* **Option 2. Indicating UE the multicast session state through group paging.**
* **Option 3. Indicating UE to stop monitoring G-RNTI.**

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| Company | Which option(s) | Comment if any |
| NEC | Opt-1/2 |  |
| Ericsson | Option 1 | There is no need to notify the UE about session state (activation, deactivation, temporary data,  temporary no data, session release), but just “start/stop” monitoring for a TMGI. |
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## 4.4 Network resumes UE's RRC connection

It could happen that network wants to resume UE's RRC connection, e.g, upon turning off the multicast reception for UE in RRC\_INACTIVE when network congestion is over/eased or reception UE number is lower, network may enable Rel-17 delivery mode instead. Depending on the design details in above section, there are different solutions:

* **Legacy group paging** (or a group paging without the Rel-18 enhancement) [24, 25, 31, 32].
* **Enhancement to group paging** to explicitly resume UE's RRC connection.
* **Enhanced MCCH**. Other companies [26, 28] also consider to enhance MCCH to indicate preferred UE state per session. Based on such explicit UE RRC state, UE resumes to RRC\_CONNECTED if needed. The Multicast MCCH includes a new indicator for state transition per service level. If there is a transition indicator included in the MCCH message for UE’s interested & joined service, the UE immediately transfers from RRC\_INACTIVE to RRC\_CONNECTED state. While [32] think the MCCH based notification has a too high granularity, it can not notify only a subset of the UEs to resume RRC connection.

**Q12: How to indicate RRC\_INACTIVE UE to transition to RRC\_CONNECTED state.**

* **Option 1: Group paging with no enhancement.**
* **Option 2: Enhanced group paging to indicate preferred UE RRC state.**
* **Option 3: Enhanced MCCH to indicate preferred UE RRC state.**
* **Others. Please elaborate in comments.**

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| Company | Which option(s) | Comment if any |
| NEC | Opt-2 | Same comment as Q6/9.  To our understanding, UE anyway need to monitor paging and group paging is already a per-TMGI(session) configuration. One simple solution can solve all the problems is that adding additional indication to each TMGI in the pagingGroupList, example like, usging paging cause (session activate in Connected / Inactive, session deactivate, session release and so on) to correspond to each TMGI.  In a word, enhanced group paging can notify UE of any session state with less spec impact. |
| Ericsson | Option 1 | We do not understand what “preferred UE RRC state” means: preferred RRC state from NW or UE perspective? If the NW tells the UE to comeback this is then up to UE implementation whether to comply, i.e. NW pages for nothing? We do not see a need for that. |
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# 5 Issues not covered

**Q13: For any issues not covered in current questions, please kindly add it up here.**

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| Company | Comment if any |
| NEC | To consider the MCCH monitoring issue:  The cost of this mechanism is that UE needs to continuously monitor MCCH during RRC\_INACTIVE for possible updated PTM configuration (or notification if agreed) even if there is no any updated PTM configuration, which increase UE power consumption. |
| Ericsson | @NEC: in case PTM reconfiguration happens only seldom, the NW could decide to only configure the MCCH in SIB when a PTM change is pending, and release the MCCH configuration in SIB when the reconfiguration is completed. |
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# 6 Conclusions

TBD

# 7 Reference

*# PTM config and mobility*

1. R2-2300286 Discuss on PTM configuration for multicast in RRC INACTIVE MediaTek inc. discussion Rel-18 NR\_MBS\_enh-Core
2. R2-2301036 PTM configuration for multicast reception in RRC\_INACTIVE LG Electronics Inc. discussion Rel-18
3. R2-2300242 Initial Considerations on Mixed Approach vivo Mobile Com. (Chongqing) discussion Rel-18 NR\_MBS\_enh-Core
4. R2-2301586 PTM configuration and mobility aspects on multicast reception in RRC INACTIVE Kyocera discussion Rel-18
5. R2-2300335 PTM configuration and mobility aspects for multicast reception in RRC\_INACTIVE Qualcomm Incorporated discussion Rel-18 NR\_MBS\_enh-Core
6. R2-2300178 Discussions on PTM Configuration and Mobility CATT, CBN discussion NR\_MBS\_enh-Core
7. R2-2300100 Discussion on multicast reception in RRC\_INACTIVE state OPPO discussion Rel-18 NR\_MBS\_enh-Core
8. R2-2300243 Discussion on Mixed Approach from PHY Aspect vivo Mobile Com. (Chongqing) discussion Rel-18 NR\_MBS\_enh-Core
9. R2-2300283 Analysis of MCCH for sending PTM configuration TD Tech, Chengdu TD Tech discussion Rel-18
10. R2-2300525 Discussion on PTM configuration aspects and mobility Samsung R&D Institute India discussion Rel-18
11. R2-2300666 Discussion on PTM configuration and Mobility Spreadtrum Communications discussion Rel-18
12. R2-2300672 Discussion on PTM configuration and mobility NEC Corporation discussion Rel-18 NR\_MBS\_enh-Core
13. R2-2300735 PTM Configuration and Mobility for INACTIVE Multicast Reception Apple discussion Rel-18 NR\_MBS\_enh-Core
14. R2-2300876 PTM configuration aspects and mobility Nokia, Nokia Shanghai Bell discussion Rel-18 NR\_MBS\_enh-Core
15. R2-2300947 PTM configuration and mobility for multicast reception in RRC\_INACTIVE Lenovo discussion Rel-18
16. R2-2301162 PTM configuration and mobility for multicast reception in RRC\_INACTIVE Huawei, HiSilicon discussion Rel-18 NR\_MBS\_enh-Core
17. R2-2301206 PTM configuration aspects and mobility Ericsson discussion Rel-18 NR\_MBS\_enh-Core
18. R2-2301235 Discussion on PTM configuration and mobility CMCC discussion Rel-18 NR\_MBS\_enh-Core
19. R2-2301559 PTM configuration for multicast reception in RRC\_INACTIVE Intel Corporation discussion Rel-18 NR\_MBS\_enh-Core
20. R2-2301672 Multicast in RRC\_INACTIVE Sharp discussion
21. R2-2301691 Considerations on the PTM configuration and mobility for multicast reception in RRC\_INACTVE state Beijing Xiaomi Software Tech discussion Rel-18
22. R2-2301843 PTM Configuration delivery for multicast reception in RRC\_INACTIVE ZTE, Sanechips discussion Rel-18 NR\_MBS\_enh
23. R2-2301070 Ensuring desired level of reliability for an MBS session in RRC\_INACTIVE InterDigital Inc. discussion Rel-18 NR\_MBS\_enh-Core

*# notification*

1. R2-2300877 Notifications and RRC state transitions Nokia, Nokia Shanghai Bell discussion Rel-18 NR\_MBS\_enh-Core
2. R2-2300179 Discussion on Notifications and RRC state transitions CATT, CBN discussion NR\_MBS\_enh-Core
3. R2-2300244 Discussion on (De)Activation and State Transition vivo Mobile Com. (Chongqing) discussion Rel-18 NR\_MBS\_enh-Core
4. R2-2300252 HARQ operation during RRC state transitions for multicast reception NEC discussion NR\_MBS\_enh-Core
5. R2-2300284 Common signalling for multicast reception in RRC\_INACTIVE state TD Tech, Chengdu TD Tech discussion Rel-18
6. R2-2300287 Notification and state transition for multicast in RRC INACTIVE MediaTek inc. discussion Rel-18 NR\_MBS\_enh-Core
7. R2-2300336 Notifications and RRC state transitions multicast reception in RRC\_INACTIVE Qualcomm Incorporated discussion Rel-18 NR\_MBS\_enh-Core
8. R2-2300526 Discussion on Notification and RRC state transitions Samsung R&D Institute India discussion Rel-18
9. R2-2300667 Discussion on Notification and RRC state transition 32 Communications discussion Rel-18
10. R2-2300736 Group Notification and RRC State Transition for Multicast Reception Apple discussion Rel-18 NR\_MBS\_enh-Core
11. R2-2300948 Notification and State Transmission for Multicast Reception in RRC\_INACTIVE Lenovo discussion Rel-18
12. R2-2301037 Multicast activation deactivation notification and RRC state transitions LG Electronics Inc. discussion Rel-18
13. R2-2301163 Notification and RRC state transition for multicast reception in RRC\_INACTIVE Huawei, HiSilicon discussion Rel-18 NR\_MBS\_enh-Core
14. R2-2301205 Notifications and RRC state transitions Ericsson discussion Rel-18 NR\_MBS\_enh-Core
15. R2-2301236 Discussion on notification for RRC\_INACTIVE multicast reception Ues CMCC discussion Rel-18 NR\_MBS\_enh-Core
16. R2-2301560 Notification and RRC state transition for multicast reception in RRC\_INACTIVE Intel Corporation discussion Rel-18 NR\_MBS\_enh-Core
17. R2-2301587 Notification and RRC state transition aspects on multicast reception in RRC INACTIVE Kyocera discussion Rel-18 R2-2212521
18. R2-2301594 Session state change for UEs receiving Multicast in RRC\_INACTIVE state TCL Communication Ltd. discussion
19. R2-2301674 Group Paging and Multicast session received in RRC\_INACTIVE Sharp discussion
20. R2-2301692 Considerations on the notification and RRC transitions for the multicast reception in RRC\_INACTIVE state Beijing Xiaomi Software Tech discussion Rel-18
21. R2-2301844 Multicast session status change notification ZTE, Sanechips discussion Rel-18 NR\_MBS\_enh