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) |
| NEC | Rao Shi, shi\_rao@nec.cn |
| Ericsson | martin.van.der.zee@ericsson.com |
| Samsung | Vinay Kumar Shrivastava, shrivastava@samsung.com |
| MediaTek | Xiaonan Zhang(xiaonan.zhang@mediatek.com) |
| CATT | zhourui@catt.cn |
| Qualcomm | Umesh Phuyal (uphuyal@qti.qualcomm.com) |
| LGE | sangwon7.kim@lge.com |
| Nokia | Jarkko.t.koskela@nokia.com |
| TD Tech, Chengdu TD Tech | limei.wei@td-tech.com |
| Huawei, HiSilicon | xubin10@huawei.com |
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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. |
| Samsung | 1. support  2. support  3. comment | **For 2**: We understand if the PTM configuration is not available in multicast MCCH, the cell is likely not supporting multicast (or specific session) in RRC\_INACTIVE. It is therefore natural continuation as indicated by Rapporteur to resume RRC connection and move to RRC\_CONNECTED  **For 3**: We think the UEs which may face reception quality issue are more likely be the cell-edge UEs. For these UEs, cell reselection may be more relevant in order to continue multicast reception. Moreover, UE by its own may not know the congestion situation at network which may have, in the first place, caused the UE to be in RRC\_INACTIVE. We may need to consider the extreme situation if all cell-edge UEs may attempt to move to RRC\_CONNECTED due to threshold!  To address the issue related to congestion raised by Ericsson, we think we should consider a cell level indication to UEs about congestion status that may help the mobility and state transition procedure. |
| MediaTek | Support scenario 1 ,3  Comment for 2 | Both scenarios 1,2,3 are valid. Scenario 1 and 2 are for mobility case, scenario 1 should be the baseline, and scenario 2 behavior should be supplementary when PTM configuration is not available from MCCH of the re-selected cell.  However, based on previous discussion, the UE may not need to completely switch back to CONNECTED state to obtain the PTM configuration (e.g., by *RRCResume-RRCRelease*), so we think RAN2#119-e agreement is better for scenario 2:   * 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.   Scenario 3 is another issue when the reception quality is low in INACTIVE state, and it is natural that UE should switch back to CONNECTED for better QoS.  Meanwhile, some cases of service continuity are not listed, e.g., when network update the configuration. In this case, UE may obtain PTM configuration from MCCH but no need to acquire from the new SIB.  In fact, we prefer to discuss the following cases of service continuity separately to make it clearer. E.g.,   1. Mobility 2. When network changes the configuration 3. Except for the two above (the reception quality is below a configured threshold) |
| CATT | 1:acceptable  2:comments  3:comments | **1:**  Since we have agreed to introduce MCCH for inactive multicast, it is straightforward to reuse the similar principle as R17 MBS broadcast. It is not necessary to provide the PTM configuration of neighboring cells to UE in source cell.  **2:**  The question has dependency on the solution for session deactivation notification (as in Q9).In Q9, there is one option “Option 1. PTM config availability in MCCH.”, with this option, how can UE determine whether the session is active ifPTM configuration is not available in multicast MCCH?  **3:**  It is not essential but a optimization, can be discussed later |
| Qualcomm | Generally ok | We think the general intention of these bullets is fine. Specifics depend on conclusion of other discussion points below. |
| LGE | 1, 2 and 3: acceptable | 1: RAN2 already agreed serving cell will not provide the PTM configuration of neighbour cells from other gNBs, so UE should acquire new SIB and multicast MCCH to get PTM configuration after cell reselection in this case.  However, it is FFS whether the network can provide PTM configuration for intra-gNB cells. If UE can get the PTM configuration in advance, the UE doesn’t need to acquire new SIB and MCCH. The FFS should be discussed in RAN3.  2: ‘may’ can be removed. There is no other way to keep receiving the multicast.  3: It is essential to guarantee the QoS requirements of the multicast. |
| Nokia | 1, 2, 3 (but to be handled separately) and 4 (missing scenario) | Regarding 1: This should be the baseline behavior.  Additionally, we think both Multicast MCCH configuration (i.e., SIB) and PTM configuration of intra-gNB cells could be provided to the UE when released to RRC\_INACTIVE. In that scenario, UE can immediately try to decode the multicast transmission when reselecting an intra-gNB cell, and in parallel receive periodic MCCH to see if that was updated etc..  Regarding 2: Yes – In order to avoid UE returning to RRC\_CONNECTED state when the session is not active, UE should be informed of the session activation status.  Regarding 3: We support to have something like this, but this does not seem to be service continuity issue though so maybe it should be discussed separately.  We think we are missing a scenario from service continuity i.e., UE is receiving multicast in RRC\_CONNECTED in the serving cell. A handover is triggered to target cell which provides the service in RRC\_INACTIVE state. One should be able to send UE directly to RRC\_INACTIVE during handover in order to avoid delay of first completing handover and then releasing UE to INACTIVE state. |
| TD Tech, Chengdu TD Tech | 1: Acceptable  2: Acceptable with comments  3: Acceptable | For 2, if it’s difficult to exchange the availability of a multicast session in RRC\_INACTIVE state for inter-gNB case dynamically (for example, for a multicast session in RRC\_INACITVE state in the source cell, the availability of the multicast session in a neighbor cell is not known to the source cell for inter-gNB case), UE enters into RRC\_CONNECTED for the mobility for inter-gNB case. |
| Huawei, HiSilicon | 1. Support  2. Support with comments  3. Support | For 2, we tend to agree with NEC and MTK that the UE may not have to go into RRC\_CONNECTED to get the PTM configuration. If the NW can provide multicast for RRC\_INACTIVE, the NW should be able to use RRC release to configure the PTM configuration (already supported by signaling). There is no need to set a restriction that the UE must go into RRC\_CONNECTED as the NW may still have to release the UE after that.   * **2. When a UE enters to a cell for which PTM configuration is not available in multicast MCCH, the UE should resume to get the PTM configuration for an active multicast session, e.g., by entering RRC\_CONNECTED or via *RRCRelease* without entering RRC\_CONNECTED.** |
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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. |
| Samsung | Yes | It is preferable to have frequency based prioritization as well as de-prioritization (e.g. dispersing UEs from loaded frequency/cell) |
| MediaTek | Yes |  |
| CATT | Yes | We think the general principle is we need a solution to enable UE receiving multicast in INACTIVE to reselect to a multicast cell as much as possible.  Even though multicast service is not deployed in a static large area as broadcast, but it is very likely the multicast service are only provide on cells of certain frequency at certain place, so multicast frequency prioritization may be not perfect but still makes sense to enable UE to reselect to a multicast cell as much as possible. |
| Qualcomm | Yes | We understand this question is about per frequency (and not per cell covered in Q3) |
| LGE | Yes | Though broadcast is not based on MBSFN, the frequency prioritization help UE move to a cell providing the same broadcast session. It would be also useful for multicast continuity in RRC\_INACTIVE. |
| Nokia | Yes | Based on previous RAN2 agreement, a Rel-18 UE in RRC\_INACTIVE state should be able to move without going to connected state among the cells in the RNA. RAN2 should define a mechanism to guide the UE to a frequency/cell that provides the multicast service for service continuity purposes, similar to Rel-17 broadcast frequency prioritization feature. Otherwise, the UE may end up camping in a cell that does not provide the multicast service, e.g., out of the service area.  In our view, concerns are not relevant:  There is no such requirement for broadcast to be deployed per frequency either.The goal is to be able to guide the RRC\_INACTIVE/IDLE UEs to a cell where the session is provided rather than a cell that does not. Similar achievement is needed for multicast for UEs in RRC\_INACTIVE. Note that [3] considers only public safety scenarios, which is not the only objective of WID.  Rather than USD, it is about service announcement, if FSAI based mechanism is to be reused.(which is the easiest and leanest approach in our view). It could easily be introduced via SA2 – we would just include FSAI multicast information into SIB. |
| TD Tech, Chengdu TD Tech | Yes | A frequency prioritization/de-prioritization mechanism is optional for multicast sessions in RRC\_INACTIVE state. In other words, a new SIB like SIB21 can be introduced for multicast reception in RRC\_INACTIVE state.  If the multicast sessions in the current cell are not provided on a same frequency, no SIB21-like SIB is used in the current cell. |
| Huawei, HiSilicon | Yes with comments | The frequency prioritization mechanism is beneficial for multicast reception in RRC\_INACTVIE at least for the scenario where a multicast service is provided on the same frequency. But different from broadcast, there is no pre-planned area for multicast in RRC\_INACTIVE, thus it is not possible to use FSAI based solution as MBS broadcast. We think dedicated frequency priority can be used as baseline for frequency prioritization if needed. |
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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. |
| Samsung | No | We prefer frequency prioritization based mechanism. Agree with NEC that NCL can help UE about cell level information. |
| MediaTek | No | Shared the same view with NEC |
| CATT | No | See answer to Q2.and we understand there should be only on prioritization solution, so Q3 and Q2 are exclusive. |
| Qualcomm | No | Agree with companies’ comments above. Per frequency prioritization is useful, but per cell mechanism can be complicated. Existing Qoffset can be used, no overoptimization is needed (to keep it simple). |
| LGE | No |  |
| Nokia | No | UE should camp on best cell on frequency as has been done always in NR (and LTE). Otherwise once UE starts connection there will be unwanted interference to cell that is “closer” to the UE. |
| TD Tech, Chengdu TD Tech | No |  |
| Huawei, HiSilicon | No | Frequency prioritization mechanism is sufficient. |
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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. |
| Samsung | Yes | It is straight-forward to re-use the NCL approach of broadcast also for multicast reception in RRC\_INACTIVE. As asked in the question, this is only about the multicast session availability on the neighboring cells and UE can resume RRC connection at earliest if session is not available on re-selected cell for seamless service continuity i.e., avoiding interruption due to time taken for reading multicast MCCH in the re-selected cell. |
| MediaTek | Yes, but | The signaling design for multicast NCL may be a little different since the multicast service are not open to all UEs (only authorized UEs). We can further discuss whether multicast NCL information can be included in multicast MCCH at service level only. |
| CATT | Yes | It is straightforward to reuse the mechanism in R17 broadcast as the similar motivation exists. But it is worth to mention that NCL is optional and if NCL is not present, UE still needs to read new multicast SIB/MCCH of target cell to determine whether need to resume the RRC connection. |
| Qualcomm | Yes | It is beneficial for the UE if it is possible to know whether service is available in the neighbor cell without having to attempt to read MCCH. |
| LGE |  | The NCL would be useful for multicast reception also, but such UE behavior doesn’t need to be specified and can be up to UE implementation. |
| Nokia | No | There is no mandate as such in the current specifications where the UE skips reading MCCH in the re-selected cell. In fact, the UE must read the SIB and MCCH in the re-selected cell. However, the NCL mechanism for broadcast is an optimization and there is also an open issue in Rel-17 about whether the UE requests unicast service in the source or target cell which needs to be resolved first. Our view is the UE can request the unicast transmission in the source cell before going into a neighbor cell as this minimizes the service interruption. |
| TD Tech, Chengdu TD Tech | Yes with comments | We think the NCL mechanism shall be enhanced to further indicate whether or not a same PTM configuration is applied in a neighbor cell. |
| Huawei, HiSilicon | Yes | Agree with Samsung and QC.  A similar mechanism can be introduced for multicast in RRC\_INACTVE for service continuity, which is supported for broadcast already. It is even more useful in multicast considering that the multicast UE is always required by AS layer itself to return RRC\_CONNECTED in case PTM configuration is available (for MBS broadcast the UE may only trigger unicast in case it is required by application layer). |
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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.**

|  |  |  |  |
| --- | --- | --- | --- |
| **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.

|  |
| --- |
| * **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.)?**

|  |  |  |
| --- | --- | --- |
| 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. |
| Samsung | Yes (only for PTM config) | Agree with NEC, presence/absence of PTM config in RRC Release with suspendConfig is sufficient indication for UE to continue the relevant multicast session in RRC\_INACTIVE. In general, the session may be in activated or deactivated state while the UE is released to RRC\_INACTIVE. We understand the main reason for the gNB is to alleviate congestion by reducing the number of RRC\_CONNECTED UEs and UEs may be released irrespective of multicast session state. |
| MediaTek | Yes (only for PTM config) | Agree with Samsung and NEC. Meanwhile we want to clarify the valid PTM configuration is obtained via RRCRelease message (not via SIB-MCCH) |
| CATT | No | For valid PTM configuration(Ii.e. the one preconfigured via dedidated RRC signalling), according to the previous agreement it can be optionally provided via dedicated RRC signaling, but it is not mandatorily provided.  For the indication that allows one UE to receive multicast data in RRC\_INACTIVE, if it is about 5GC UE level MBS assistance information(i.e.UE is preferred to be kept in the RRC Connected state) ,that seems a upper layer information and optional and only be available for some UEs |
| Qualcomm | Yes, if (1) UE has already joined the session; and (2) there is valid PTM config; and (3) network doesn’t indicate the UE to go back to CONNECTED (or indicate to receive multicast in INACTIVE) | All 3 conditions need to satisfy (i.e., it is AND, not OR) |
| LGE |  | When RRC connection is suspended, NW should indicate whether the UE is allowed to receive the multicast in RRC\_INACTIVE or not. Though UE can acquire PTM configuration via MCCH, if NW doesn’t allow the UE to receive the multicast in RRC\_INACTIVE, the UE should resume RRC connection upon session activation. |
| Nokia | No | We do not really see motivation to require pre-configuration for UE to stay in RRC\_INACTIVE. In the discussion above, PTM configuration is mentioned as an example pre-configuration information, but it is obvious that a UE must have valid PTM configuration for multicast reception in RRC\_INACTIVE but we must have some other criteria in addition to having a valid PTM configuration for UE to decide whether it can stay in RRC\_INACTIVE or moves to RRC\_CONNECTED. Something with explicit network control. Also, whether to keep the UE in RRC\_INACTIVE or not is a “cell-based” decision. A UE in RRC\_INACTIVE state may reselect to another cell and that cell may decide differently than the source cell.  Therefore, we should have explicit information (e.g. in paging message) to determine whether a UE stays in RRC\_INACTIVE or comes back to RRC\_CONNECTED. For some special UEs, such pre-configuration could make sense, as this is not a cell-level decision but common throughout the network for the UE. However, such pre-configuration should be something other than a valid PTM configuration, e.g., explicit signalling that UE always comes back to RRC\_CONNECTED. Such a UE should always move to CONNECTED to receive multicast. |
| TD Tech, Chengdu TD Tech |  | We think the availability of a preconfiguration is just one case. There are other cases. For example, a preconfiguration and an UE ID list are used together to decide which UEs can receive in RRC\_INACTIVE state. |
| Huawei, HiSilicon | Yes (only for PTM config) | It is a simple way to indicate whether the UE is required to enter RRC\_CONNECTED for multicast reception which is aligned with SA2 and RAN3 conclusion on the per UE MBS assistance information.  Regarding the indication, it is a stage3 issue. Probably there is no need for an extra indication other than the valid PTM configuration (at least a list of TMGIs for inactive reception is required, the exact PTM configuration may be optional) for this purpose. Besides, the indication mechanism cannot always work as the UE may not be able to receive the multicast in RRC\_INACTIVE without resume after mobility, even if the indication says so. |
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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.**
* **Option 4. Explicit indication in RRC release with suspend config (the UE specific configuration doesn’t need to be changed when multicast is activated).**
* **Others. Please elaborate the details in comment.**

|  |  |  |
| --- | --- | --- |
| 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. |
| Samsung | Option 2 | Paging is always read by UEs. Group paging for activation is existing Rel-17 mechanism and it is natural and quite simpler to extend this also for Rel-18 multicast reception. Enhancement required could be to indicate UE to stay in RRC\_INACTIVE state, as Rel-17 Group paging implies transiting to RRC\_CONNECTED by default. Adding another mechanism based on MCCH reading for this is not only redundant but is also complex and power inefficient. |
| MediaTek | Option 2 (without enhancement) | We think group paging can be used for session activate without enhancement. If we agree in Q5 that UE can stay in RRC INACTIVE and receive multicast when session activate only if it has valid configuration, the simplest and most compatible way is to reused group paging so that the UEs which have PTM configuration can receive multicast in RRC INACTIVE while Rel-17 UE/Rel-18 UE which does not have PTM configuration will resume RRC Connection.  The variety of e.g., cell load or congestion level may not be an issue since the load of a cell is mainly determined by the UE in RRC CONNECTED state. Pre-configuring UEs is to make them not resume to RRC CONNECTED, which will not aggravate the cell load, and even the opposite. |
| CATT | Option 2 | It is straightforward to further enhance based on group paging as group paging is already used for session activation notification. And it enables gNB to control the inactive reception dynamically. And if MCCH-like solution is used, it will cause a lot of extra MCCH changes and increase the UE power consumption.  And for the detailed solution, UE needs to be indicated whether it can receive the multicast session in RRC\_INACTIVE or not as dynamic control is one of the major reason for choosing group paging solution. |
| Qualcomm | Option 2 | A single flag per TMGI should be enough in Rel-18 group paging to indicate whether all the UEs receiving the service with a given TMGI should stay in RRC\_INACTIVE and continue to receive the service, or all the UEs receiving the service with a given TMGI should move to RRC\_CONNECTED.  However, to move a selected subset of UEs, the specific UEs need to be notified, which can be done using legacy paging. UE-specific paging (i.e. PagingRecordList) can be (re)used to move specific UE(s) to RRC\_CONNECTED. This overrides the per-TMGI flag in the group paging for the specific UE(s).  Specifically, regarding Option 1, there is additional issue on top of what moderator listed above with using PTM config availability as an implicit indication. Considering the discussion about temporary data stop/deactivation (in later sections) – this would imply that in deactivation case the PTM config must be made non-available. That is not a good approach. |
| LGE | Option 4 | RAN2 agreed the network can choose which UEs receive in RRC INACTIVE and which in RRC Connected and can move UEs between the states for Multicast service reception. It should be configured via dedicated signalling per UE whether UE can receive multicast in RRC\_INACTIVE, and the UE specific configuration doesn’t need to be changed when multicast is activated.  Since the PTM configuration can be provided via MCCH, all R18 UEs can acquire the TPM configuration. Even though UE acquires PTM configuration via MCCH, if the UE is not allowed to receive the multicast in RRC\_INACTIVE, the UE should resume RRC connection upon session activation. |
| Nokia | 2, 3 | Regarding 1- Please see our answer above. PTM configuration in dedicated signalling is only for the  current cell, but not the neighboring gNBs. It is FFS whether it could also comprise intra-gNB neighbor cells.As indicated in previous question the decision to move/provide service in INACTIVE is cell level decision and UE may reselect to another cell and that cell may decide differently than the source cell. Such one should be providing the information in the new cell to the UE e.g. via paging message whether UE should receive the service in INACTIVE or CONNECTED.  A cell can provide the PTM configuration in MCCH already before multicast session activation. However, this does not mean that the service is active. It can only help UE to immediately receive multicast once receiving the group-paging.  Regarding 3- a UE in RRC\_INACTIVE state may be out of the service area of the multicast session initially, but then may go into a cell within the service area. This UE may have missed the group paging performed by the gNB (as above). Unless we would like to have some periodic group paging at the cell, we need an indication in SIB/MCCH that the session is active/deactive.  As stated above, a valid PTM configuration alone cannot determine whether the session is active/deactive. As the UE would read SIB initially, it would be better if we provide the session activation status ALSO in the new SIB to be defined for multicast. Otherwise, the UE would need to wait longer to see if the session is active or deactive until it has received MCCH information. Note that if the status is only provided in SIB, but not MCCH, “deactivation” may become problematic. |
| TD Tech, Chengdu TD Tech | Option 2 | The information includes: (1) an indicator for multicast reception in RRC\_INACTIVE state (2) UE ID list if needed (3) updated PTM configuration if needed |
| Huawei, HiSilicon | Option 2 | To us, the UE doesn’t need to monitor MCCH during session deactivation, which is beneficial for UE power saving. In this case, the MCCH based solution will lead to the following problems:  1) Upon reception of paging, the UE has to additionally acquire the MCCH before it decides whether to resume, leading to extra delay.  2) Even though the UEs receive paging in different POs, they have to wait for the same MCCH transmission occasion to check whether to resume. This might cause RACH congestion due to many UEs resuming simultaneously, if the PTM configuration is absent in MCCH for the concerned service. |
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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?**

|  |  |  |
| --- | --- | --- |
| 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. |
| Samsung | Yes | If there is no PTM configuration available to UE, that implies the cell does not support the session in RRC\_INACTIVE (with no config in MCCH) but the session is still available in RRC\_CONNECTED (as group paging indicates activation). This is same as Rel-17 behaviour. |
| MediaTek | Yes, but | This behavior may be similar to the answer in Q1. I.e., UE may not need to fully resume to RRC CONNECTED state, but to obtain the PTM configuration by *RRCResume—RRCRelease* way (as we agreed) and then receive multicast service in RRC INACTIVE. This can help to alleviate the system load in congestion scenario. |
| CATT | Yes | But The Question is not clear. The intention should for multicast session that is allowed to be received in INACTIVE, but cannot read it from the question itself. If the session can only be received in CONNECTED state, of course UE in INACTIVE cannot get PTM configuration and need to resume RRC connection. |
| Qualcomm | Yes, see comment | The question should also include the case if UE has not joined the multicast session.  Group paging can be used to indicate activation/data transmission resumed. Upon such indication, UEs in RRC\_INACTIVE that have not joined the multicast session but interested to receive it need to move to RRC\_CONNECTED (i.e. similar to Rel-17). |
| LGE |  | The presence or absence of the PTM configuration should not be used as a condition to decide whether to resume RRC connection, because all R18 UE can acquire the PTM configuration via MCCH. When multicast is activated, UE only needs to consider whether it is configured to receive the multicast in RRC\_INACTIVE by network or not. |
| Nokia | Depends | If the UE receives group-paging without new indication telling UE to stay in RRC\_INACTIVE, the UE would go to RRC\_CONNECTED. If the UE receives group-paging with new indication telling UE to stay in RRC\_INACTIVE, it would stay in RRC\_INACTIVE. We do not believe that the gNB would send such indication and not include PTM configuration in MCCH. No need to specify such behavior. It can be left to UE implementation to reconnect. |
| TD Tech, Chengdu TD Tech | Yes |  |
| Huawei, HiSilicon | Yes with comments | Similar with our comments on Q1: UE should resume but not necessarily enter RRC\_CONNECTED as long as it can get valid PTM configuration. |
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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.

|  |
| --- |
| * 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?**

|  |  |  |
| --- | --- | --- |
| 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. |
| Samsung | Yes | For power efficiency, UE need not monitor corresponding G-RNTI upon session deactivation, while in RRC\_INACTIVE. There is also no reason to change RRC state when session is deactivated, so UE should continue in RRC\_INACTIVE, until network explicitly asks UE to move to RRC\_CONNECTED.  Agree with Ericsson there may not be notification from gNB for temporary no data. However, we think UE needs to consider some limit to data inactivity. There is an existing mechanism for data inactivity for multicast reception in RRC\_CONNECTED. UE transits to RRC\_IDLE if multicast data is not received for a defined time (dataInactivityTimer). Same situation is relevant for multicast reception in RRC\_INACTIVE. UE may not receive multicast data for long (e.g. due to data inactivity or session release not informed to RRC\_INACTIVE UE etc.) and it may unnecessary monitor for multicast channel and consume power. Therefore, extending data inactivity mechanism of RRC\_CONNECTED also to RRC\_INACTIVE seems reasonable. |
| MediaTek | Yes | It is beneficial for both UE power saving and system load. |
| CATT | Yes | It is straightforward as we have agreed that the UE may be notified when the multicast session is deactivated, or such notification makes no sense. |
| Qualcomm | Yes |  |
| LGE | Yes |  |
| Nokia | Yes | MCCH can include a flag to indicate session deactivation. After seeing such flag, the UE can stop decoding G-RNTI until UE receives activation indication. |
| TD Tech, Chengdu TD Tech | Yes |  |
|  |  |  |
| Huawei, HiSilicon | Yes with comments | The UE doesn’t need to monitor MCCH-RNTI either during session deactivation, which is beneficial for UE power saving. There is no benefit monitoring the MCCH-RNTI during session deactivation. |
|  |  |  |

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.**

|  |  |  |
| --- | --- | --- |
| 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. |
| Samsung | Option 2 | Agree with NEC. Group Paging mechanism is already available for per-TMGI group notification and can be enhanced to also indicate the cause (e.g. session deactivation). On contrary, newer approaches for enhanced MCCH and MAC CE are too complex, involves large standards impact and also redundant. We prefer not to complicate with making 2 different approaches for a single purpose. |
| MediaTek | Option 3 | The MCCH can be enhanced to carry the information for session deactivation. UE may not need to always monitor MCCH, but notified by DCI that something is changed.  Some options are also relate to the other email discussion which discussing the DCI format for multicast in INACTIVE. |
| CATT | Option 2 | We agree with the point from Ericsson that activation and deactivation should not be discussed separately.  Group paging is already used for session activation notification, so it is natural to also use it for session deactivation notification. furthermore, as we mentioned in Q6, if MCCH-like solution is used, it will cause a lot of extra MCCH changes and increase the UE power consumption. |
| Qualcomm | Option 3 | While both group paging and MCCH-based options are possible to indicate deactivation of multicast session while UE is in RRC\_INACTIVE. Since RAN2 previously agreed that MCCH is used to indicate PTM configuration change while the UE is in RRC\_INACTIVE, similarly, deactivation of the session can be indicated by MCCH. |
| LGE | Option 2 | We also prefer to use the same message to notify the session activation and de-activation. |
| Nokia | 3 | Regarding 1-. A cell can provide the PTM configuration in MCCH already before multicast session activation. However, this does not mean that the service is active/deactive. It can only help UE to immediately receive multicast once receiving the group-paging.  Regarding 2- No need to enhance the paging to indicate deactivation. The UE anyway reads MCCH, and deactivation is not as urgent as activation, so no paging is needed and MCCH can be relied on.  Regarding 3- It is simple to include the deactivation status of the multicast session on MCCH. In addition, for a UE that comes newly to a cell in RRC\_INACTIVE, it would be good to optionally be able to include deactivation status ALSO in SIB.  Regarding 4/5- In our view, such options does not have any benefits compared to 3. Also, it is not clear yet which DCI is to be used for scheduling INACTIVE UEs. It is also not clear why there would be power saving gain compared to MCCH and why delay is critical for deactivation. |
| TD Tech, Chengdu TD Tech | Option 3 |  |
| Huawei, HiSilicon | Option 3 | Agree with QC and Nokia.  The UE will anyway monitor MCCH-RNTI during an active session so the deactivation can be indicated via MCCH, which is similar to the R17 mechanism when the MBS broadcast stops.  For option 2, to avoid the impacts to the legacy R17 UEs, a new TMGI list to deactivate MBS services has to be introduced in the paging message. This will further increase the load of paging which can be avoided by option3. Besides, the UE may miss this notification in paging message in some cases such as during cell reselection and will not know the session has been deactivated. |
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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.* |
| Samsung | Yes | Objectives should be two-fold for multicast session release:   1. All the UEs should not transition to RRC\_CONNECTED at once due to session release 2. UEs should not monitor multicast channel further for the session which is already released.   Therefore, we think UE can be notified about session release in group paging and UE may stay in RRC\_INACTIVE with no need to indefinitely monitor for a released session and can complete the NAS signaling when it reconnects to RRC\_CONNECTED. |
| MediaTek | No strong view | The intention is good, but it seems the benefit is small compared with its complexity, since session release may not happen very often.  We may need a LS to check whether it is acceptable if we want to support this feature. |
| CATT | No | R17 group paging is sufficient to move UE to CONNECTED for session release,which was already supported in R17 MBS. And we agree with Ericsson that NW can chose to inform UE later if congestion exists. |
| Qualcomm | Yes | The question is not very clear. Agree with Ericsson’s comment but that would mean ‘yes’ to the question: one UE already in RRC\_INACTIVE, it can stay in RRC\_INACTIVE and stop monitoring corresponding G-RNTI upon session release *until the SMF initiates PDU session modification to inform the UE of the MBS session release* (but not indefinitely). |
| LGE |  | Same view as Ericsson. |
| Nokia | No | If the UE is indicated that the session is deactive, the UE can immediately stop monitoring G-RNTI. Note that Rel-17 mechanism allows indication of session deactivation to the gNB by the core network, once release is triggered. Rel-17 specifications also allow the network/gNB to not page the UEs to ALWAYS come to CONNECTED as soon as release is triggered in the core network. Rather, network can wait that the UE comes back to RRC\_CONNECTED for other purposes, and then the session would be released for the UE. We do not think that there are any drawbacks of this operation, which does not require any enhancements. |
| TD Tech, Chengdu TD Tech | Yes |  |
| Huawei, HiSilicon | No | We think Rel-17 mechanism should be reused: tither the NW invoke the UEs by group paging and send session release to the UE; or the group paging is not sent and the UE still monitors the G-RNTI in RRC\_INACTIVE.  There shouldn’t be a case where UE stay in RRC\_INACTIVE and stops the G-RNTI monitoring. |
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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. |
| Samsung | Option 2 | Group paging with indication for session release can avoid massive transition of all the UEs  to RRC\_CONNECTED at once and also avoids unnecessary monitoring for a released session  in RRC\_INACTIVE |
| MediaTek | Option 1 |  |
| CATT | Option 1 |  |
| Qualcomm | Option 1 | Similar comment as Ericsson, there is no need to notify the UE about session state (activation,  deactivation, temporary data, temporary no data, session release) as long as when to start / stop  monitoring for a G-RNTI is clearly indicated to the UE. |
| LGE | Option 1 |  |
| Nokia | 1 | Please see our reply above. No need to make any enhancements if deactivation is communicated  to the UE. |
| TD Tech, Chengdu TD Tech | Option 1 |  |
| Huawei, HiSilicon | Option 1 | See comments above. |
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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.**
* **Option 4: Legacy UE-specific paging.**
* **Option 5: Enhanced group paging to indicate transition to RRC\_CONNECTED though the UE is configured to receive multicast in RRC\_INACTIVE.**
* **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, using 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. |
| Samsung | Option 1 | Rel-17 Group paging is sufficient to transition UE to RRC\_CONNECTED state by default i.e. Group paging with no enhancement is an obvious approach. Only to keep the UE in RRC\_INACTIVE, enhancement for Group Paging is needed as commented in Q6 |
| MediaTek | Option 1 and option4 | This question can be discussed in different cases:  Case 1: Network intends to indicate all UEs to switch to RRC CONNECTED state.  This may be used when the congestion alleviate and the network decide to switch off the multicast in INACTIVE. In this case, the group paging can be reused with no enhancement.  Case 2: Network select a subset of UEs to switch to RRC CONNECTED state.  In this case, there is no benefit for enhancing group paging compared with unicast paging. Also it may introduce extra UE power consumption since other UEs need to check for unnecessary information. |
| CATT | Option 1 and Option 4 | It is workable to reuse R17 group paging. The expected behavior of R18 UE when it is paged for transiting to CONNECTED to continue the multicast reception is same as that for R17 UE, so the R17 group paging can be reused without enhancement. And if gNB only wants to address a subset of all the Ues,it can chose to send the group paging message on subset of the available POs.  Besides, legacy individual paging can also be used to move certain multicast receiving UE(s) from RRC\_INACTIVE to RRC\_CONNECTED. |
| Qualcomm | Option 4 | See Q6 also.  Group paging can indicate whether ALL the UEs should stay in INACTIVE or move ALL the UEs to CONNECTED. Legacy paging can be used to move selected UEs to CONNECTED (overriding the group paging indication). |
| LGE | Option 5 | The multicast list in the existing group paging only can indicate the session is activated. When the existing group paging is received, R18 UE decides whether to initiate RRC Resume to receive the multicast in RRC\_CONN or stay RRC\_INACTIVE based on the UE-specific network configuration. Therefore, network cannot indicate UE which is allowed to receive the multicast in RRC\_INACTIVE to transition to RRC\_CONN using the existing multicast list in the group paging. |
| Nokia | Option 1 | Option 2 simply would mean if no other flag is transmitted within Rel-17 group paging, UE would come back to RRC\_CONNECTED; and if enhancements are done (as proposed for activation) to keep UEs in RRC\_INACTIVE, the UE would not come back.  Regarding Option 3- No need to enhance MCCH to indicate the state. If the UE sees that the session is active (via activation flag in MCCH that we propose above) and if the UE cannot find PTM configuration in MCCH, the UE would directly understand that it should reconnect. |
| TD Tech, Chengdu TD Tech | Option 3 |  |
| Huawei, HiSilicon | Option 1 and Option 4 | Legacy group paging can be reused to invoke the UEs from RRC\_INACTIVE to RRC\_CONNECTED.  If the NW wants to invoke only some of the UEs, the group paging can be sent on a subset of POs or unicast paging can be used. Or in another way, the NW can use UAC mechanism to prevent too many UEs from going to RRC\_CONNECTED. |
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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.  [NEC] This is also an optional solution (i.e., SIB-controlled MCCH transmission), however we are concerning:  **1.** If we are putting session notification (e.g., activation/deactivation) into MCCH, I am afraid the frequency of MCCH monitoring may not be a “seldom”;  **2.** If PTM config of neighbor cell is provided in MCCH instead of dedicated RRC, a UE who re-select to a new cell should acquire PTM config by MCCH. In this case, SIB-controlled MCCH transmission could not work well;  **3.** The legacy Rel-17 MCCH could include multiple sessions which means any one of PTM reconfiguration means MCCN change notification, currently I am not sure whether the “false alarm” issue boost the frequency of MCCH monitoring. |
| Samsung | As also stated in comment for Q8:  There is an existing mechanism for data inactivity for multicast reception in RRC\_CONNECTED. UE transits to RRC\_IDLE if multicast data is not received for a defined time (dataInactivityTimer). Same situation is relevant for multicast reception in RRC\_INACTIVE. UE may not receive multicast data for long (e.g. due to data inactivity or session release not informed to RRC\_INACTIVE UE etc.) and it may unnecessary monitor for multicast channel and consume power. Therefore, extending data inactivity mechanism of RRC\_CONNECTED also to RRC\_INACTIVE seems reasonable. |
| MediaTek | We may need to discuss the notification when network update the configuration and check whether to reuse R17 mechanism (MCCH change notification)  [Qualcomm] Similar view. |
| Nokia | **Counting:**  Rel-17 multicast delivery mode provides significant benefits to the UE compared to reception of multicast in RRC\_INACTIVE state, as it offers HARQ feedback that can feed MCS selection and enable retransmissions. If the reception of a multicast session by the UEs in RRC\_INACTIVE is enabled, the gNB should transmit the data in all beams, as the gNB would not be aware under which beam the UE is located, which may decrease spectral efficiency compared to Rel-17 mechanism where the gNB is aware of the location of the UE (and not transmit data multiple times in different beams). In our view, for deciding on whether to provide a multicast session to UEs in RRC\_INACTIVE state, a gNB that uses delivery of multicast session to the UEs in RRC\_INACTIVE state should estimate periodically the number of UEs in RRC\_INACTIVE state in the cell that are receiving a multicast session, if the multicast session is active. Therefore, some sort of mechanism is required to evaluate the number of UEs receiving a multicast session in RRC\_INACTIVE state in a cell.  **Q1:** Scenario 4 mentioned in the Q1 in our comment |
| TD Tech, Chengdu TD Tech | The following two issues are related to service continuity.   1. MCCH configuration can be area specific. In other words, the new SIB for multicast MCCH can be area specific just as an existing SIB can be area specific. 2. The PTM configuration of a multicast session can be applied to the cells of a same gNB. In other words, the sane PTM configuration can be applied to intra-gNB case. |
| Huawei, HiSilicon | We should discuss whether the UE needs to monitor the MCCH-RNTI besides G-RNTI during the session deactivation. |
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# 6 Conclusions

TBD

# 7 Reference

*# PTM config and mobility*

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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
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*# notification*

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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
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