**3GPP TSG-RAN WG2 Meeting #115e R2-21xxxxx**

Online, 9th –27th August 2021

**Agenda item: 8.3.3**

**Source: vivo**

**Title: [Post114-e][242][MUSIM] Switching message details**

**WID: LTE\_NR\_MUSIM-Core**

**Document for: Discussion and Decision**

# Introduction

This document aims to collect views from companies for the following email discussion agreed during RAN2#114e:

* [Post114-e][242][MUSIM] Switching message details (vivo)

Scope: Discuss message design (information to include, which messages, etc.).

Intended outcome: Discussion report

Deadline: Long

# Discussion

To make it easier to find the correct contact delegate in each company for potential follow-up questions, the rapporteur encourages the delegates who provide input to provide their contact information in this table:

|  |  |
| --- | --- |
| Company | Contact: Name (E-mail) |
| OPPO | fanjiangsheng@oppo.com |
| ASUSTeK | Roger\_Guo@asus.com |
| NEC | wang\_da@nec.cn |
| MediaTek | Chun-fan.tsai@mediatek.com |
| Lenovo, MotoM | Wulh5@lenovo.com |
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## General

In this email discussion, we will discuss the details of the network switching notification signaling, including the content of assistance information for switching notification, which message is used to deliver the assistance information, etc.

**Please note that gap handling details, e.g. gap configuration assistance information and gap configuration details would be discussed in [Post114-e][243][MUSIM] Gap handling (ZTE).**

According the previous discussion, at least RRC network switching notification for leaving RRC\_Connected state will be specified. In this email, we refer to RRC network switching notification for leaving RRC\_Connected state when network switching notification for leaving RRC\_Connected state is mentioned.

The previous agreements on network switching notification is copied in the Annex for your convenient.

## Network Switching Signaling

### **Assistance information for network switching notification**

According to the previous discussion, UE may provide the assistance information in switching notification message during the below procedures.

* Network switching for leaving RRC\_CONNECTED state(AS-based solution).
* Network switching without leaving RRC\_Connected state.

Here, we will discuss what assistance information is needed. Below assistance information contents in Table 1 are proposed in company contributions.

**Table 1: Assistance information content for switching notification**

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| --- | --- |
| **Procedure** | **Assistance information content** |
| Network switching for leaving RRC\_CONNECTED state (AS-based solution) | * *releasePreference,* including preferred RRC state [4, 5, 10] after network switching, such as RRC\_IDLE, RRC\_INACTIVE, outOfConnected. * NAS information[7,10,13]: e.g.   + MT restriction information[7,13], to temporarily restrict/filter MT data/signalling handling.   + Expected leaving time/duration [13], which is used to assist the network to decide the duration to block MT data/signaling for the UE. |
| Network switching without leaving RRC\_Connected state | * *releasePreference,* including preferred RRC state [10] after network switching, such as RRC\_CONNECTED. * Purpose of switching notification[7,22], such as TAU, RNAU, busy indication, etc.   **The assistant information for gap configuration would be discussed in [Post114-e][243][MUSIM] Gap handling (ZTE)** |

Companies are invited to express their view on the following questions.

1. **Which of the following assistance information need to be carried in the switching notification message?**

Option 1: *releasePreference,* including preferred RRC state, such as RRC\_IDLE, RRC\_INACTIVE, RRC\_CONNECTED，outOfConnected*.*

Option 2: NAS Container*,* including NAS information, such as MT restriction information*,* NAS information*,* expected leaving time/duration, etc*.* Details can be decided by other WGs.

Option 3: Purpose of switching notification, such as TAU, RNAU, busy indication in another network, etc.

Option4：Assistant information for gap configuration, details are discussed in [Post114-e][243][MUSIM] Gap handling (ZTE)

Option 5: Please comment.

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| --- | --- | --- |
| **Company** | **Options (1, 2, 3, 4)** | **Comments** |
| OPPO | Option 1 and Option 4 | Option 1 is for leaving case while Option 4 is for without leaving case.  Regarding to Option 2, the requirement should come from SA2, RAN2 alone cannot make the decision.  As for Option 3, Option 4 is enough to reflect the requirement, no need to introduce another similar solution. |
| ASUSTeK | 1, 2, 3, 4 | Options 1, 2, and 3 could be used for the case to leave RRC\_CONNECTED.  Options 1, 3, and 4 could be used for the case without leaving RRC\_CONNECTED. |
| NEC | 1, 4 | For Option 2, it is up to SA2 decision, so we are open to it. |
| MediaTek | option 1 (simplified)  and option 4 (depends on #243) | For option 1, we think the UE could simply indicate whether it want to leave RRC Connected state. We have two kind of switching procedure (leaving or keep in RRC Connected), so it make sense have two kind of preference in the assistance information. We wonder how UE decide to stay in INACTIVE or IDLE for this switching. As in physical layer, INACTIVE and IDLE basically consume same resource. It does not impact the resource sharing to other SIM no matter the UE stay in IDLE or INACTIVE.  Option 2 should be decided by SA2.  Option 3 is not needed as we have option 4.  Option 4 depends on the result of e-mail discussion #243. |
| Lenovo | 1, 3, 4 | The option 2 can be up to SA2.  For option 4, the beginning time point and the length of gap should be provided to the network B. |
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**Summary:** TBD

### **message for network switching notification**

Regarding the message for sending network switching notification by the UE, *UEAssistanceInformation* has been proposed by some companies for both switching with leaving RRC\_CONNECTED (AS-based solution) and without leaving RRC\_CONNECTED, shown in Table 2:

**Table 2: Signalling message for switching notification**

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| **Procedure** | **Signaling message for switching notification** |
| Network switching for leaving RRC\_CONNECTED state (AS-based solution) | * *UEAssistanceInformation* [4,5,10,]. Reuse *UEAssistanceInformation* as switching notification. |
| Network switching without leaving RRC\_Connected state | * *UEAssistanceInformation* [14]. the *UEAssistanceInformation* message is used for switching procedure without leaving RRC\_CONNECTED state. |

Some of the identified potential assistance information, e.g. the preferred RRC state, is already specified UEAssistanceInformation in R16 NR UE Power Save. In the rapporteur’s understanding, for avoiding introduce duplication function in specification, it is natural to extend UEAssistanceInformation message for network switching procedures, with different assistance information included for switching with/without leaving RRC\_CONNECTED.

1. **Whether *UEAssistanceInformation* message can be extended and used for switching notification in both network switching procedures for leaving RRC\_CONNECTED state and without leaving RRC\_ CONNECTED state? If No, please specify**.

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes | This is a nature and simple way. |
| ASUSTeK | Yes | The same message could be used for both cases. |
| NEC | Yes |  |
| MediaTek | Yes, but | We are okay extend the *UEAssistanceInformation* to trigger the switching procedure. However, we would like to clarify that “assistance” information used in MUSIM is different from the one used in power saving purpose. For power saving, it would anyway up to network to do the corresponding configuration or not. For MUSIM, it is more like the UE has to leave even if the NW does not response to that.  Note that we think legacy notification (for power saving) could not be used without any extension. The network has to know the purpose of UE want to leave RRC Connected state since the response will be different. |
| Lenovo | Yes | Both switching with leaving RRC\_CONNECTED (AS-based solution) and without leaving RRC\_CONNECTED should use a single message. |
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**Summary:** TBD

### **Supporting of switching notification function**

In RAN2#114e, it was agreed that “*AS -based solution for network switching includes two steps: 1-) If configured, UE can send an RRC message to leave RRC\_CONNECTED for MUSIM purpose 2-) gNB may release the UE to Idle/Inactive.*”, which means, NW needs to inform the UE whether a network switching notification message for MUSIM purpose is supported or not before UE sending the network switching notification message.

According to the rapporteur’s understanding, one cell may support both or one of the two RRC network switching notifications. Hence, two separate indications should introduce to inform UE which network switching notifications are supported.

Companies are invited to express their view on the following question.

1. **Whether switching notification for leaving RRC\_CONNECTED state and without leaving RRC\_CONNECTED state should be enabled separately?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes but with comments | For leaving case, the legacy signaling can be reused, i.e. reuse *releasePreference* introduced in R16 PS, so the legacy indication can be reused also for leaving case, no more enhancement is needed.  As for without leaving case, we’re open to discuss whether to reuse a existing indicator or introduce a new indicator to enable the capability. |
| ASUSTeK | No | Unless the need of such flexibility is identified, support/enable of the two cases could be bundled. |
| NEC | No | UE sends assistance information to the network, but whether to leave RRC Connected state or use scheduling gap is up to network decision, it seems no strong need for the case that the network only support one of the two RRC network switching notifications. |
| MediaTek | See Comment | It is not so clear on the question. There are several aspects on the granularity of switching control.  UE capability – It could be further discussed whether UE capability separation is needed. We are okay for UE to support both kind of network notification (leaving connected or not) together but trigger which kind of notification should be up to UE.  NW configuration – We would like to understand (from NW vendors) that whether this kind of flexibility is needed.  UE switching notification – It should be up to UE implementation (depends on the purpose of other SIM) to indicate whether it want to leave RRC Connect or not. If the UE want to leave RRC Connected state to perform some network B activities but the Network A does not enabled this, the UE has to fallback to legacy behavior (i.e. leave network A without notification). |
| Lenovo | No | We don’t see the use case to have the separate ‘enabled’. |
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**Summary:** TBD

1. **How to inform UE that RRC based switching notification function is supported by NW?**

Option 1: Extend the existing configuration mechanism of UE assistance information, to inform UE that RRC based switching notification message is supported by NW in *otherConfig* of *RRCReconfiguration* message*.*

Option 2: please specify if any new methods

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| **Company** | **Option (1, 2)** | **Comments** |
| OPPO | Prefer Option 1 | But we think we should reuse the existing indicator as much as possible, just like the comments in Q3. |
| ASUSTeK | 1 | Current mechanism could be reused. |
| NEC | Option 1 | Reusing existing mechanism is sufficient. |
| MediaTek | FFS | We are fine to put this network configuration in *otherConfig* of *RRCReconfiguration*. We however want to clarify that only MN should enable this feature. Note that for power saving, the assistance information could be enabled by MN or SN independently.  Another alternative is to just put this configuration in first level of RRC Reconfiguration (e.g. in *RRCReconfiguration-v1710-IEs*). It seems no urgent to conclude this detail ASN.1 at this moment. |
| Lenovo | Option 1 | Reusing the existing otherconfig IE. |
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**Summary:** TBD

### **Configuration for autonomous switching**

The agreement has been achieved that “*During switching procedure for leaving RRC\_CONNECTED state, UE is allowed to enter RRC\_IDLE state if it does not receive response message from network within a certain configured time period. FFS for RRC\_INACTIVE state.*”

Regarding to whether UE is allowed to enter RRC\_INACTIVE state if not receive NW response message within a certain configured time period, views are summarized based on company contributions:

* **Allowed:**[2, 5, 11, 18]
  + The UE is allowed to enter Inactive state assuming this was the UE preference[2].
  + UE is allowed to configure the RRC state to transit in advance of triggering the switching procedure with leaving RRC\_CONNECTD for some specific scenarios(FFS: what scenarios to make configurable), to avoid mismatch of the RRC state transition between the UE and network A [8].
  + The RRC state to which the UE should be transferred to can be preconfigured via RRC signalling procedure. The pre-configuration can also include the state transition information depending on the time of return. This preconfigured return behavior enables the UE to leave NTWK-A without waiting for the network response.[11]
* **Not Allowed:**[4, 8, 14, 21, 24]
  + It's not feasible as RRC\_INACITVE state is associated to a RAN-based notification area which is configured by network [8]
  + The RRC state mismatch issue may happen between network A and UE if UE autonomously leaves network A. [4]
  + It is not practical to pre-configure the *suspendConfig* to the UE. It consumes RNTI resources as if *fullI-RNTI* and *shortI-RNTI* is pre-configured to a UE, it cannot be used by other UEs which are actually in the RRC\_INACTIVE state. Moreover, as it is unpredictable whether/when a UE will request to leave RRC\_CONNECTED state, the pre-configured *suspendConfig* may never be used which just wastes RNTI resources.[21]
  + The network should maintain the suspend configuration for the UE until performing the long-term SIM switching. The problem is that the network doesn’t know when the UE would perform the long-term SIM switching. Thus, supporting timer-based leaving in RRC INACTIVE will decrease the network performance from the resource handling point of view because the network may not handle promptly to the other UEs which require RRC\_INACTIVE.[24]
  + There is no real to support autonomous transition from RRC\_CONNECTED state to RRC\_INACTIVE state. The concerned scenario is rare so it merely entails specification complexity with marginal benefit.[14]

Companies are invited to express their view on the following questions.

1. **Is UE allowed to enter RRC\_INACTIVE state if no NW response message is received within a certain configured time period after the network switching notification message is sent?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | No | As analyzed above, the drawback is quite obvious but the benefit is not significant. More addition, to simplify our work, ‘Not allowed’ has less spec impact, so we prefer to say ‘No’. |
| ASUSTeK | No | Entering RRC\_INACTIVE autonomously may be considered in general (not only for this case) in later release. |
| NEC | No | Entering RRC\_IDLE autonomously is sufficient. Entering RRC\_INACTIVE requires big specification impact, however brings small benefit. |
| MediaTek | No | In INACTIVE mode, UE and NW should have common understanding on the UE Inactive context. So, autonomously transit to INACTIVE mode does not work, it will create lots of problem. |
| Lenovo | No | Entering RRC\_Inactive autonomously will result in mismatching between UE and network. In addition, UE has no I-RNTI for inactive state. |
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**Summary:** TBD

During switching procedure for leaving RRC\_CONNECTED state, UE is allowed to enter RRC\_IDLE state if it does not receive response message from network within a certain configured time period. The agreement has been achieved that “*The ‘configured time’ for AS-based solution for the UE to leave RRC\_CONNECTED without a response is configured by the gNB.*”

Regarding how to provide the “configured time” by the NW, [14] points out that it seems sufficient to re-use existing *dataInactivityTimer* i.e. UE enters RRC\_IDLE state autonomously upon the expiry of *dataInactivityTimer* during switching procedure for leaving RRC\_CONNECTED state, and suggests RAN2 to discuss whether to introduce new timer for autonomous UE state transition during switching procedure for leaving RRC\_CONNECTED state.

In rapporteur’s understanding, as discussed in Question 3, another possible method is to provide the “configured time” in the RRCReconfiguration message which enables network switching notification message sending.

Companies are invited to express their view on the following questions.

1. **How to provide the “configured time” by the NW which is used for the UE to leave RRC\_CONNECTED without a response?**

Option 1: Introduce a new timer for the “configured time”, provided in the RRCReconfiguration message which enables network switching notification message sending.

Option 2: Reuse the existing timer for the “configured time”. Please specify which existing timer can be reused, e.g. *dataInactivityTimer*.

Option 3: Please comment.

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| **Company** | **Option (1/2/3)** | **Comments** |
| OPPO | Option2 | We slightly prefer to reuse the legacy timer. |
| ASUSTeK | 1 | It is more straightforward to introduce a new timer. |
| NEC | Option 1 | New timer is better. Mixing with existing timers requires additional efforts, for example dataInactivityTimer is a MAC layer timer, while here we are expecting a RRC layer time. |
| MediaTek | Option 1 | New timer is preferred. The purpose of *dataInactivityTimer* and this MUSIM guard timer is different. It is easier to keep two independent timer. |
| Lenovo | Option 2 | *dataInactivityTimer* can be reused. |
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**Summary:** TBD

[8] thought, switching without the response from network for a certain time is also valid for switching procedure without leaving RRC\_CONNECTED state. i.e. during switching procedure without leaving RRC\_CONNECTED state, UE is allowed to perform switching without the response from network for a certain time.

1. **Is UE allowed to perform switching without the response from network for a configured time during switching procedure without leaving RRC\_CONNECTED state?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Maybe No | If the task in network B can be done within the existing gap duration configured in network A, UE does not have to wait a configured timer. In this case, UE network switching is invisible to network A, no spec work is identified.  As for second case, i.e. a new gap configuration is needed for UE from network A to complete the task in network B, in this case, we think UE should wait the response from network A to at least get the new gap configuration, otherwise, the resource scheduling misalignment will happen between UE and network A. In short, UE should wait the response from network A for the second case. |
| ASUSTeK | No | Agree with OPPO. |
| NEC | Maybe No | Agree with OPPO |
| MediaTek | No | It seems complicate and not so useful to specify this kind of behavior in SPEC. If the UE request some kind of gap for MUSIM purpose and the NW does not configure suitable one, the UE will fall back to “legacy” behavior. The UE will try to continue the connection in network A and may use autonomous gap if the network B activity indeed has higher priority. We can leave this to UE implementation. |
| Lenovo | No | Agree with Oppo. |
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**Summary:** TBD

### **Early Return during switching procedure without leaving RRC\_CONNECTED state**

Some companies discussed whether early return is allowed during switching procedure without leaving RRC\_CONNECTED state.

[11] proposed RAN2 to provide signalling mechanisms to allow the UE’s early return and NW-A possibility to schedule traffic in the remaining (non-used) part of the gap. For example, the UE has to monitor for paging in all PO locations in NW-B for which it has required a periodic gap from NW-A. However, in majority of occasions the UE may not find any paging addressed to it and may identify it quite early if an early paging indication is applied. The remaining time can be used by NW-A to reduce the impact due to interruption in data traffic.

[2] thought RAN2 can consider enhancements to optimize the switching operation such as early termination or extension of the gap via MAC signaling. The potential enhancement is for the UE to inform the NW when it returns from the switch. This can be especially useful for relatively longer duration aperiodic switching if the UE is able to return faster.

[7] thought that a return message from the UE to the network is not needed for one-shot short-time switching in case of the early return.

1. **Whether early return is allowed during switching procedure without leaving RRC\_CONNECTED state? If Yes, what’s the signalling for early return?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | No | Usually, the gap duration is not too long, i.e. several milliseconds and the service QoS in network A can still be maintained, the benefit for early return is not significant considering limited remaining gap duration, more addition,  early return will also make the network A resource scheduling more complex, so the benefit is not clear.  If companies want to introduce larger gap duration, this may impact other group, e.g. RAN4/CT1, RAN2 alone can not assume any enhancement at this stage. More details can be discussed in email#243. |
| ASUSTeK | Yes | The same RRC message used to request the gap can be used to modify or cancel the gap. |
| NEC | No | Considering the length of the gap, there is limited benefit for the early return. And as there is no UL grant scheduled during the gap, the early return indication can only be relied on some pre-configured UL resources, for example SR and RA resource, which requires some specification efforts. Therefore, we don’t support the idea of early return indication. |
| MediaTek | Maybe not | For one-shot gap, it is not necessary as the duration is usually short, also the UL grant issue (mentioned by NEC) should be considered.  For periodical gap, it maybe ok for UE to indicate this gap is not needed anymore. This depends on the result of e-mail discussion #243, so we could keep it FFS for now. |
| Lenovo | Yes | The same RRC message as the request message e.g UEAssistanceInformation message can be reused to notified. |
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**Summary:** TBD

## Other Comments

Companies are invited to express their view if any other comments or suggestions on the switching message details.

1. **Any other comments or suggestions on the switching message details?**

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| **Company** | **Comments** |
| Lenovo | After UE returns to the network A at the end of the gap, what information is sent by UE first? For example, if TAT expires at the end of the gap, random access should be performed first. |
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**Summary:**

TBD.

# Conclusions

TBD.

# References

1. R2-2100474 report on e-mail discussion [post112-e][256][Multi-SIM] Network switching details, vivo
2. R2-2105257 Network switching procedures for Multi-SIM Qualcomm Incorporated
3. R2-2105900 Network Switching Solutions for Multi-SIM Charter Communications, Inc
4. R2-2104765 UE Notification on Network Switching for Multi-SIM OPPO
5. R2-2105085 MUSIM Network Switching Apple
6. R2-2105086 MUSIM Band Conflict and RRC Processing Delay Requirements Apple
7. R2-2105165 Consideration on the Switching Notification Procedure ZTE Corporation, Sanechips
8. R2-2105195 Further Consideration on Network Switching CATT
9. R2-2105196 Analysis on UE switching without leaving RRC\_CONNECTED state China Telecommunications
10. R2-2105201 Network switching consideration of Multi-SIM China Telecommunication
11. R2-2105226 Scenarios and Requirements for switching notification procedure Nokia, Nokia Shanghai Bells
12. R2-2105270 Open Issues on Switching Notification vivo
13. R2-2105375 MUSIM Release Assistance Info for network switching ASUSTeK
14. R2-2105437 Open issues on network switching for Multi-USIM devices Samsung Electronics Co., Ltd
15. R2-2105442 Signalling design on short time switching procedure DENSO CORPORATION
16. R2-2105445 Procedures for MSIM UE notification on network switching Futurewei Technologies
17. R2-2105449 UE notification procedure for short time switching NEC
18. R2-2105450 Open issues on network switching procedures DENSO CORPORATION
19. R2-2105683 Discussion on Busy Indication in Inactive State Sony
20. R2-2105684 Discussion on Leaving in MultiSIM Sony
21. R2-2105719 On coordinated switch from NW for MUSIM device Huawei, HiSilicon
22. R2-2105823 Switching notification and busy indication Lenovo, Motorola Mobility
23. R2-2105977 Discussion on switching mechanisms for a Multi-USIM device Ericsson
24. R2-2106110 Considerations on SIM Swithcing LG Electronics
25. R2-2106212 RRC based Switching Notification for leaving RRC\_CONNECTED Sharp
26. R2-2106215 RNAU Handling in MUSIM Sharp
27. R2-2106351 Network switching behavior for MUSIM device MediaTek Inc.
28. R2-2106399 Discussion of the UE notification on network switching for multi-SIM Xiaomi Communications

# Annex

The following network switching related agreements were made in previous meetings.

RAN2#114-e:

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| --- |
| * 1: RRC signaling for network switching without leaving RRC\_Connected state should allow multiple configurations of periodic “gaps” with different parameters (e.g. periodicities and durations). FFS is multiple can be active at the same time. FFS if multiple aperiodic gaps are supported. * 4: UE provides assistance information to the gNB of NW A in Connected state based on the configuration of USIM of NW B for the gNB to determine the necessary switching parameters. Up to network what is the action based on UE assistance information. FFS what assistance information is needed. * We support at least AS-based solution (with AS-based response) for network switching while leaving RRC\_Connected state in NW A. FFS if this may include NAS information * 1: AS -based solution for network switching includes two steps: 1-) If configured, UE can send an RRC message to leave RRC\_CONNECTED for MUSIM purpose 2-) gNB may release the UE to Idle/Inactive. * 2: Include the following RAN2#113bis-e agreement in the LS:   During switching procedure for leaving RRC\_CONNECTED state, UE is allowed to enter RRC\_IDLE state if it does not receive response message from network within a certain configured time period. FFS for RRC\_INACTIVE state   * 3: The “configured time” for AS-based solution for the UE to leave RRC\_CONNECTED without a response is configured by the gNB. Indicate RAN2 is still discussing this for AS-based solution in the LS. * 4: Indicate that RAN2 has not discussed the interaction between AS-based solution and any SA2 agreement on NAS messages or NAS-based solution for network switching. |

RAN2#113bis-e:

1 RRC signalling is used for switching procedure without leaving RRC\_CONNECTED state in network A for UE temporarily switching to network B as a baseline. FFS on additional need of MAC signalling.

2 During switching procedure for leaving RRC\_CONNECTED state, UE is allowed to enter RRC\_IDLE state if it does not receive response message from network within a certain configured time period. FFS for RRC\_INACTIVE state.

RAN2#113-e:

1 Switching procedure can be used to notify network A that the UE has a preference to leave RRC\_CONNECTED state in network A.

2 The switching procedure can be used to notify network A that the UE has a preference to be kept in RRC\_CONNECTED state in network A while temporarily switching to network B.