3GPP TSG-RAN WG2 Meeting #113-e R2-21xxxxx

Online, Jan 25 – Feb 05 2021

**Agenda item: 8.3.3**

**Source: vivo**

**Title: [DRAFT] [post112-e][256][Multi-SIM] Network switching details (vivo)**

**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#112e:

* [Post112-e][256][Multi-SIM] Network switching details (vivo)

Discuss further details of network switching.

Intended outcome: Email 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) |
| Ericsson | lian.araujo@ericsson.com |
| Sharp | Fangying.xiao@cn.sharp.com |
| Oppo | fanjiangsheng@oppo.com |
| viivo | Kimba Dit Adamou, Boubacar <kimba@VIVO.COM> |
| Apple | Sethuraman Gurumoorthy, sethu@apple.com |
| Samsung | sy0123.jung@samsung.com |
| LG | hassium.kim@lge.com |
| ASUSTeK | Roger\_Guo@asus.com |
| Fraunhofer | nithin.srinivasan@hhi.fraunhofer.de |

## General

One of the objectives of MUSIM WID [1] is following:

|  |
| --- |
| 1. Specify mechanism for UE to notify Network A of its switch from Network A (for MUSIM purpose) [RAN2]:  * RAT Concurrency: Network A is NR. Network B can either be LTE or NR. * Applicable UE architecture: Single-Rx/Single-Tx, Dual-Rx/Single-Tx   NOTE 1: Single Rx allows MUSIM UE to receive traffic from only one network at one time, Dual Rx allows MUSIM UE to simultaneously receive traffic from two networks. Single Tx allows MUSIM UE to transmit traffic to one network at one time, dual Tx allows MUSIM UE to simultaneously Transmit traffic to two networks. (The terms Single Rx/Tx and Dual Rx/Tx do not refer to a device type. A single UE may, as an example, uses Dual Tx in some cases but Single Tx in other cases). |

In RAN2#112-e, the following network switching related agreements were made.

* RAN2 will continue to discuss RRC-based switching/leaving and returning procedure in 5GS/NR when UE is in RRC\_CONNECTED. There may be different mechanisms (short/long, leaving/returning, etc.).
* RAN2 will evaluate short/long time switching in this WI.
* From RAN2 point of view, it is feasible that the busy indication is sent as an RRC message with security for RRC\_INACTIVE. FFS how this works. FFS if/how to ensure UE doesn't disconnect from RRC\_CONNECTED during busy indication.

In this email discussion, we will focus on the above remaining issues.

**Short/long time switching:**

After the Multi-USIM UE sends RRC switching notification in network A and switches to network B, it is not clear what is difference between short and long switching. According to the contributions submitted in RAN2#112-e, the following RRC states difference after sending switching notification were discussed:

* RRC\_CONNECTED [5,6,7,8,9,10,11,15,18]
* RRC\_IDLE or RRC\_INACTIVE [4,5,6,7,11,13,14,15,16,17,18]

Based on contributions summaries, in the rapporteur's understanding, for the short-time switching, such as paging monitoring in network B, UE should be kept in the RRC\_CONNECTED in network A, to minimize the impact on the ongoing service in network A. While for the long-time switching, such as an initiated voice call in network B, it would be better to move the UE into RRC\_IDLE or RRC\_INACTIVE in network A instead of keeping in RRC\_ CONNECTED.

As captured in RAN2 agreements, there may be different mechanisms (short/long, leaving/returning, etc.). In the following sections, the term long-time switching procedure is used for the switching notification procedure which moves the UE to RRC\_IDLE/RRC\_INACTIVE in network A, while the term short-time switching procedure is used for the switching notification procedure which keeps the UE in RRC\_CONNECTED.

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

1. **Do companies agree with the assumption that the long-time switching procedure can be used for the switching notification procedure which moves the UE to RRC\_IDLE/RRC\_INACTIVE in network A, after sending switching notification to network A?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | No, but | We agree that the UE may end up in RRC\_IDLE/INACTIVE but this is ultimately a network decision. Hence, the current formulation may be misleading. It seems what we would want to state is actually “long-time switching procedure can be used to notify network A that the UE has a preference to leave RRC\_CONNECTED state in network A”. |
| Sharp | Agree with the intention, but | We prefer the wording from Ericsson that “long-time switching procedure can be used to notify network A that the UE has a preference to leave RRC\_CONNECTED state in network A”. |
| OPPO | Agree with the intention, but | No matter for short/long-time switching, which state the UE will be moved is more like a network implementation. It’s up to which type of info is added into switching notification message, so we should directly discuss which content is added into switching notification message instead of clarifying the possible network implementation.  More addition, we also think the UE may move to RRC\_IDLE/INACTIVE autonomously without waiting for network response for long-time switching, this methed should also be considered. |
| CATT | Agree with the intention, but | Agree with Ericsson that whether the UE could enter RRC\_IDLE/RRC\_INACTIVE is the network implementation, the wording could be improved. |
| vivo | Agree with the intention | Further, We agree with the wording of Ericsson: “The long-time switching procedure can be defined as the switching notification procedure which moves the UE to RRC\_IDLE/RRC\_INACTIVE in network A, after sending switching notification to network A” |
| Apple | Agree with the intention | From the UE perspective, we feel that the impending procedure on Network B should not be delayed inorder to allow for the Network A to signal a RRC Connection Release to the UE. In such cases, to avoid such delay, we agree with Ericsson wording that “long time switching procedure can be used to notify network A that the UE has a preference to leave RRC\_CONNECTED state in network A” and that network A on receipt of such a request would consider the UE to have moved out of RRC\_CONNECTED. This way, UE can autonomously trigger a local release of the RRC connection to handle the long time switching to Network B. |
| Samsung | Agree with the intention, but | We agree with the suggested re-wording from Ericsson. We think that which contents on UE’s preference to leave RRC\_CONNECTED state and when/how to move RRC\_IDLE/INACTIVE state can be further discussed in next questions. |
| LG | Agree with the intention | We also fine with Ericsson’s wording. This is definitely up to the network decision whether the UE moves to RRC\_IDLE/INACTIVE. |
| ASUSTeK | Agree with the intention | We agree with the wording proposed by Ericsson. |
| Fraunhofer | Agree with the intention | Agree with OPPO and Ericsson. The manifestation of both long and short-time switching should be dependent only on the content in the indication and not tied to RRC state. Ultimately for both long and short time switching, a common framework with should be defined. In which, the UE indicates to the network about the type of leaving. It is then upto network implementation to make decisions on RRC state, scheduling etc |

**Summary:**

TBD.

1. **Do companies agree with the assumption that the short-time switching procedure can be used for the switching notification procedure which keeps the UE in RRC\_CONNECTED in network A, after sending switching notification to network A?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | No, but | We agree that the UE may stay in RRC\_CONNECTED but this is ultimately a network decision. Hence, the current formulation may be misleading. It seems what we would want to state is actually “short-time 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”. |
| Sharp | No | We think the state is incomplete for that the leaving behavior is not included. Currently, at least the periodic short-time switching should be supported for UE to perform paging reception on network B. Similar to measurement gap, periodic short-time should be configured by NW A without UE indication for each leaving to reduce signaling overhead. So “used to notify network A” from Ericsson’s state may be not suitable for periodic short-time switching. May be we can state it as “short-time switching procedure can be used for the switching notification procedure which keeps the UE in RRC\_CONNECTED in network A while temporarily switching to network B”. |
| OPPO | Agree with the intention, but | The similar comments as Q1 |
| CATT | Agree with the intention, but | The similar comments as Q1 |
| vivo | Agree with the intention | We agree with the wording of Ericsson. Furher a rewording can be: “Short-time 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 (periodically) switching to network B” |
| Apple | Agree | We would like to reduce as much as possible any potential RRC Connection Setup procedure again on network A, once the short switching procedure is completed on network B. We would prefer if NWs could distinguish the case of short Vs long switching to help UEs to stay in RRC CONNECTED for short switching cases atleast, and network A do not schedule any activity (both UL and DL) to the UE during these periods when UE does short switching to network B. |
| Samsung | Agree with the intention, but | We agree with the suggested re-wording from Ericsson. We think that which contents on UE’s preference to be kept in RRC\_CONNECTED state and how to stay in RRC\_CONNECTED while temporarily switching to network B can be further discussed in next questions. |
| LG | Yes with intention | However, considering that the scheduling gap is periodically working like the measurement gap, the wording of sending a notification to network A needs to be clarified more. This is because, if asking scheduling gap can be regarded as sending a notification, the UE may not ask the scheduling gap everytime after entering the scheduling gap. |
| ASUSTeK | Agree with the intention | We agree with the wording proposed by Ericsson. |
| Fraunhofer | Agree with the intention | Similar to Q1 |

**Summary:**

TBD.

## Long-time switching procedure

According to [4,5,6,7,11,12,13,14,15,16,17,18], the general framework of long-time switching procedure in network A can be given by Figure 1, which includes a Switching Notification message and optionally a Response message(i.e. RRCRelease). The procedure in Figure 1 does not exclude reusing existing message (e.g. UEAssistanceInformation with ReleasePreference) as Switching Notification message.



**Figure 1 RRC-based long-time switching procedure**

**Switching Notification message:**

Regarding the content of Switching Notification message, the below options are proposed in contributions:

* **A**: **Switching cause** [9,12,18], which is used to indicates the behavior in network B causing the switching, such as TAU, RNAU, busy indication, etc.
* **B**: **preferred RRC state** (RRC\_IDLE or RRC\_INACTIVE)[4,12,13,14,16], indicates the target RRC states in network A after switching.
* **C**: **Duration of switching** [12], e.g. could be the time expected by the UE that will be away from network A, or an indication to distinguish short-time and long-time switching.
* **D**: **Other info**, if any, please specify.

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

1. **What information (A, B, C, D) should the Switching Notification Message carry in case of the long-time switching?**

|  |  |  |
| --- | --- | --- |
| **Company** | **A/B/C/D/E** | **Comments** |
| Ericsson | C | Besides the information already agreed in SA2, a long-time switching notification could contain information about the switching duration, e.g. it could indicate whether the switching is for a *limited* or *extended* duration (maybe better to not refer to the indication in C as short-time and long-time duration to avoid confusion with the long-time and short-time switching we have in sections 2.2 and 2.3). Moreover, we have to further discuss later whether this information should be carried over NAS or RRC. |
| Sharp | B | For MUSIM UE, we think it is the baseline that if UE dicided to switch from NW A to NW B, NW A should follow UE’s indication. So, what UE needs to do may be just indicate its preferred RRC state. But it should be up to NW about whether release UE to INACTINVE or IDLE. |
| Oppo | B | Option B can be the baseline and further optimization can be considered if needed, e.g. UE may move to RRC\_IDLE/INACTIVE autonomously without waiting for network response. |
| CATT | B | The UE could request for the preferred state to the network, but the network could have its own decision about whether to release the UE to INACTIVE or to IDLE.  To choose this option, maybe specific procedure is not needed. IE “*releasePreference”* in message *UEAssistanceInformation* could be reused. |
| vivo | A or A+B | As mentioned in Q1, UE indicates its preference to leave from connected state in netowrk A with long-time switching procedure and the network A can make the final decision. Hence, the network A needs some information, e.g. switching cause (Option A), to determine whether the UE should be released.  In addition, preferred RRC state (Option B) stands for the UE’s expectation, it may be useful for network A to determine UE’s state.  Considering it is relatively difficult for UE to estimate an exact duration of switching. Option C is not preferred |
| Apple | C/B/A | We feel that all the three options would work, and can be candidate solutions. For example, Option C would be the most straightforward to allow the UE to resume back within a given negotiated time duration for long-time switching if UEs would like to avoid immediately being moved to RRC IDLE or RRC INACTIVE states as part of a long-time switching. Option B is preferred if UE is not able to deterministically estimate the duration of the long-time switching, and hence would request for a transition to either RRC IDLE or RRC INACTIVE states. Option A would leave the NW to drive the susbquent course of action, based on the switching cause indicated by UE. |
| Samsung | B with comments | We understand that SA2 has discussed NAS based solution for long-time switching procedure, thus it would be good to first discuss whether RRC or NAS based solution is used for long-time switching procedure. This could avoid back and forth discussion between RAN2 and SA2, which is time consuming. Even though both solutions are more or less the same except which signalling is used, NAS may be in a better position to judge whether to trigger long-time switching procedure with more detailed information.  If RRC signalling is used for long-time switching procedure, we think the preferred RRC state is enough. We also would like to point out that the preferred RRC state for long-time switching procedure (if introduced) and legacy one for power saving are independent features e.g. UE may implement only one feature so new IE needs to be defined. |
| LG | B, C | Duration of switching helps efficiency for data scheduling because the network can expect when the UE will come back.  We think, even in the case of long time switching, the network may decide to keep RRC state as RRC\_CONNECTED if the UE’s expected duration of switching isn’t too long in the network perspective. Thus, we think the UE needs to indicate not only the duration of switching but also the preferred RRC state to keep RRC\_CONNECTED state. |
| ASUSTeK | C | According to the conclusion made by SA2, the switching notification message should provide information to assist network to block paging to the UE during the UE leaving. Therefore, information to help network to decide duration of the blocking is needed and the network could make the decision based on option C. |
| Fraunhofer | A, B  C => with comments | Option A, we agree with Apple. This might be a useful feature to inform the incumbent network about scheduling decisions and help improve network statistics.  For Option B, we agree with Sharp and CATT  For Option C, as Ericsson pointed out, depending on the type of the indication i.e., RRC or NAS, this might need to be coordinated with SA2. As in the SA2 solution using NAS indication, in addition to duration, the UE can also indicate the preferred (or not-preferred) MT PDU sessions |

**Summary:**

TBD.

**Response message:**

After sending the Switching Notification Message in network A, there are different understandings on whether the RRCRelease message is mandatory for the UE to switch to network B.

Some papers [7, 15] propose the UE switches only after receiving a network response for Switching Notification Message, to ensure full control of network and allows the network A to release the multi-SIM UE to RRC\_INACTIVE if needed.

Autonomously/local release of the RRC connection after sending switching notification is proposed in [4, 18]. The argument is in Multi-USIM scenario if the UE decides to leave network A, it is better to leave and initiate the setup with network B as soon as possible to initiate the intended service. In this case, requiring the UE to wait for the RRC release message from network A seems not practical, especially considering that network A may decide not to give any response to the UE. Hence, allowing the UE to autonomously release RRC connection may be more appropriate for Multi-USIM device.

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

1. **After sending switching notification message, whether UE is allowed to perform switching without the reception of RRCRelease message?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | No | If the UE is in RRC\_CONNECTED in Network A it may have data scheduled in Network A, hence the UE cannot judge alone on whether to leave Network A or not and should wait for a decision from Network A. The network may also decide to move the UE to RRC\_INACTIVE instead of RRC\_IDLE, but such decision must be conveyed in the *RRCRelease* message. Even in the case where the UE would always be moved to RRC\_IDLE in Network A, it may lead to state mismatch between the UE and the network if the UE performs this action without an *RRCRelease* message. |
| Sharp |  | For MUSIM UE, we think it is the baseline that if UE dicided to switch from NW A to NW B, NW A should follow UE’s indication. The case that UE sends an indication but no response received could be considered as an exception, what should UE do in such case may left for UE implementation. |
| Oppo | Yes within a timer | After sending switching notification message, it’s more flexible to leave it to UE implementation whether it’s needed to wait for RRC release message; but from network perspective, it’s more desirable to control UE in a predictable way, so to balance the requirements between UE and network, UE can wait in network A for Response Message within a certain time, after that, UE behaviour is up to implementation. |
| CATT | Yes | It could be more a UE’s preference about whether to leave the network A and connect to the network B. So based on Q3, if option B could be agreed, the UE could perform switching without the reception of RRCRelease message. |
| vivo | Yes | UE should be allowed to perform switching without the reception of *RRCRelease* message.  For example, if the UE is performing ftp downloading in NW A when a voice call occurs in NW B. Considering the voice call is more delay-sensitive and has higher priority than the ftp downloading, it is better for the UE to leave NW A and initiate the connection setup with NW B ASAP. Thus, the reception of *RRCRelease* message should not be be mandatory on the UE switching. |
| Apple | Yes (with a Timer if needed) | Agree that having a RRCRelease message would ensure a clean switch from Network A to Network B. But the question is what if there is a delay from Network A to indicate the RRCRelease ? From a MUSIM UE perspective, it would be reasonable for the UE to expect that NW is always going to agree to the UE request to switch. If the concern is about state mismatch as Ericsson has indicated, some protocol behavior can be mandated in UE side to ensure RRC state sync between UE and NW. One option is to have a timer based implementation limiting the maximum waiting time for receiving the RRCRelease message, and if none is received withing timer expiry, UE proceeds to switch to Network B. |
| Samsung | No | Agree with Ericsson. |
| LG | No | Agree with Ericsson |
| ASUSTeK | Yes | Local release of the RRC connection should be supported, especially when the switching is due to delay-sensitive service. |
| Fraunhofer | No | In general, the MUSIM UE connected to network A should not be switch without a response. Depending on the operation that needs to be performed in network B, the MUSIM UE might be forced to switch. This can however be based on implementation and need not be specified. |

**Summary:**

TBD.

UE may fail to receive the Response Message in some cases, e.g. due to bad link quality or network A decides not to give any response to the UE. To handle the Response Message missing case, timer-based RRC release is discussed in [14,17]. In this solution, UE starts a timer while sending the Switching Notification Message in network A, and initiates a local RRC connection release procedure upon the timer expires if no response is received from network A.

If **Yes** is selected for **Q4**, please further indicates which of the following is preferred.

**Option1: UE waits in network A for Response Message within a certain time**

**Option2: UE performs local release immediately after sending the switching notification message**

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

1. **If the ANS to Q4 is Yes, which detailed option is preferred?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1/2** | **Comments** |
| Oppo | Op1 | See the answer in Q4 |
| CATT | Op1 | A timer could be used to allow the UE to receive the RRCRelease message, but if the timer is expired, the UE could directly switch to network B. |
| vivo | Option 1 | The below factors need to be balanced:   * UE needs to perform the switching to NW B ASAP in case of latency-sensitive services(e.g. voice call); * UE needs to stay in NW A as long as possible to ensure the reception of *RRCRelease* to keep state match between UE and NW A.   Therefore, we suggest that UE performs local release if UE cannot receive the NW response in a certain duration after sending the switching notification message. We can further discuss whether a timer needs to be specified/configured later. |
| Apple | Option 1 | See answer to Q4 above. |
| ASUSTeK | Option 1 | We are fine with option 1. Regarding option 2, it depends on whether the timer is configurable. If the timer could be set to 0, option 2 is supported as well. |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

**Summary:**

TBD.

Companies are invited to express their view if any other comments or suggestions on the solutions for long-time switching procedure.

1. **Any comments or suggestions on the solution for long-time switching procedure?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | Even though the UE thinks a long time switching procedure is required, the network may think differently and can configure the scheduling gap for the switching procedure maintaining RRC Connection. Thus, even in a long time switching procedure, we think RAN2 needs to consider whether the RRC Connection can be maintained. |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

**Summary:**

TBD.

## Short-time switching procedure

Short-time switching procedure can be used for short time activities in network B, includes paging reception, measurements, TAU, RNAU, etc. To facilitate the detailed solution discussion, we can further categorize the short-time switching scenario based on whether the activity which triggers the switching is a periodic event or not, as below.

**1. Periodic Short-time Switching**

The periodic short-time switching is triggered by some periodic activities on network B, such as paging reception, Measurements performing.

**2. One-shot Short-time Switching**

The one-shot switching is triggered by one-shot activities on network B, which may include reception and/or transmission, such as measurement for cell reselection, system information acquisition, etc.

To support the above 2 types of switching, both periodic short-time switching and one-shot short-time switching are proposed. The two procedures will be discussed in the following sections.

## Periodic short-time switching procedure

When UE is in RRC\_CONNECTED state on network A, the periodic short-time switching is triggered by the periodic activities on network B, including paging reception, measurements, etc.

Some companies discussed potential solutions for periodic short-time switching. [4] pointed out that the UE does not have to send the switch notification every time for the periodic event. [5] thought that the periodical duration for the periodical leaving can be considered.

[6, 7, 9, 10, 11] proposed mechanism of scheduling gap. In [9], it was proposed that a short gap (like in legacy measurement gap) can be applied to paging reception. The mechanism of scheduling gap could contain gap negotiation and gap configuration.

The following Figure 2 shows a candidate general framework of periodic gap negotiation and configuration.

1. UE sends short-time switching notification to request gap for multi-SIM purpose.
2. The network provides the gap configuration via RRCReconfiguration message.
3. UE sends RRCRecnfigurationComplete.



**Figure 2 Periodic short-time switching procedure**

Note: The Switching Notification in Figure1/2/3 may be the same or different RRC messages. The details of which RRC message to be used for switching notification can be discussed later.

1. **Do companies think the procedure in Figure2 is suitable for periodic short-time switching, which contains the switching notification message and RRC Reconfiguration procedure to configure gap?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | No | There may not be a need for a short-time switching procedure in case the UE can perform such short time activities within the gaps that the network may already have configured. In case such short-time switching mechanism is really needed, the overall description above would be ok, i.e. the UE may indicate preference for certain gaps and the network may reconfigure the UE based on this. |
| Sharp |  | We agree with Ericsson that configuration of periodic short-time switching should be based on UE’s request. So, it could be a 2-step procedure, i.e., UE request a expected shechduling gap and NW configure the shechduling gap. |
| Oppo | Yes | We agree the signalling flow in general, but this does not imply that any enhancement is needed for step 2/3. Maybe the exsisting mechanism can be reused for step 2/3. |
| CATT | Yes,but | But  1.maybe UE does not need to initiate the short-time switching procedure every time for the periodic event.We agree with Ericssion that it is feasible that a scheduling gap maybe configured upon UE enters connected mode,then the scheduling gap can be used for each periodic event.‎  2.The procedure in Figure 2 does not imply any new messages is necessary.reusing or enhancement to the existing messages could be possible. |
| vivo | Yes | The already configured gap cannot always meet the gap requirement for MUSIM purpose, e.g. the paging reception on network B may need a gap with different start time and/or repetition period. In this case, the above procedure in Figure 2 is needed for the UE to report the preference of the gap pattern for MUSIM purpose. |
| Apple | Yes | Agree witht the overall short time switching procedure |
| Samsung | Yes with comments | We agree with the proposed signalling flow, except that the UE needs to request its preferred periodic gap configuration in step 1 as NW has no idea how to configure it.  In addition, we think that the configured periodic gap at certain times may not be needed anymore. Thus, we are open to discuss whether the UE is allowed to request the release of configured periodic gap. |
| LG | Yes | We agree with the procedure generally but the legacy procedures can be reused to configure the gap period. |
| ASUSTeK | Yes | The UE could perform the request when necessary. |
| Fraunhofer | Maybe | Agree with Ericsson. However, the switching notification can be an optional feature to update for e.g., the gap configuration |

**Summary:**

TBD.

Moreover, [11] proposed RAN2 to discuss the support of UE reporting pattern of availability and also the configuration of gaps for switching scenarios for the basic idle mode operation. [7] thought that AS based negotiated short time gaps are needed to support short time switching for multi-SIM purpose. Multi-SIM UE can request its preferred short time gap configuration to current network for short time activities on other network, and current network confirms/ configures it accordingly.

Considering UE performs paging reception on network B within the scheduled gap, and the paging receptions are periodic behaviors with fixed time positions, the assigned gap shall cover the paging reception at least. Hence, during gap requesting, UE can provide necessary gap requirement information to network A, such as the below contents:

1. Indication of Need for Gap e.g. UE may need for gap, or disable the need for gap (e.g. if the other SIM is disabled).
2. Gap pattern request, e.g. gap start time, gap repetition period, etc;
3. Others, if any, please comment.
4. **What content should the switching notification message carry for periodic short-time switching?**

|  |  |  |
| --- | --- | --- |
| **Company** | **A/B/C** | **Comments** |
| Ericsson | C | See comments on Q7. But if ever needed to introduce such short-time methods, one may use power saving framework for DRX assistance info for it. |
| Sharp | B | Without changing the paging mechanism, for the gap used by UE performs paging reception on network B, the paging patteren information in NW B should be indicate to NW A. Otherwise, the gap configured by NW A may not align with the paging occation in NW B. |
| Oppo | C | We slightly prefer to leave this periodic short time to UE implementation. For instance, RRM measurement gap /DRX off duration in network A. |
| CATT | B | The information of requesting gap pattern is needed, and the network could configure the gap for short time switching different from the gap configured for RRM measurement. |
| vivo | A, B | As answered to Q7, the already configured gap may not be suitable for MUSIM purpose. For example, paging reception in network B requires UE to switch away from the network A for a certain time from a strict timepoint periodically. If the already configured gap in NW A cannot cover the the interval required for paging reception, the paging reception in NW B cannot be performed with the already configured gap. In this case, the information of gap pattern for paging reception in NW B should be indicated to NW A.  In addition to request for a gap for MUSIM purpose, in some cases, a UE configured with gap for MUSIM purpose may want to release the gap pattern. For example, the user may disable a second USIM, e.g. to reduce the power consumption. In this case, a request to disable the need for gap is necessary. |
| Apple | B | Eventhough option A would also work, we feel option B provides more granularity in to the exact gap patterns. |
| Samsung | B, C | We think that the purpose of periodic gap configuration is not the same as legacy measurement gap i.e. the former one is for other network while the latter one is for current network. Introducing new gap configuration for periodic short-time switching is a cleaner approach while keeping the principle aligned to that of legacy measurement gap. Thus, at least the following contents can be considered i.e.   * gap offset * gap length * gap repetition period   We also think multiple periodic gap configuration are needed i.e. a single gap configuration may not be efficient to handle all fixed/semi-static idle mode operations in other network e.g. SIB, paging, or RRM measurements etc.  As commented in Q7, configured gap pattern release can be requested to network by UE. |
| LG | A, B | The UE may indicate that gap is needed for MUSIM operation including the preferred gap period and pattern for paging information in other SIM |
| ASUSTeK | C | The paging/measurement activity information in NW B should be indicate to NW A. How to indicate such information could be FFS. |
| Fraunhofer | A, B | Option A and Option B can also be combined to provide more information to network A thereby as mentioned before improving network statistics. |

**Summary:**

TBD.

Companies are invited to express their view if any comments or suggestions on the mechanism of periodic short-time switching.

1. **Any other comments or suggestions on the mechanism for periodic short-time switching?**

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

**Summary:**

TBD.

## One-shot short-time switching procedure

[5, 8, 11] proposed the mechanism of one-shot short-time switching. [11] thought that Cell Reselection and System Information monitoring in network B would require longer gaps than the gaps applicable for idle mode paging monitoring and serving cell measurements, and proposed that one way switching notification with the cause value at RRC or lower layers can be configured for leaving the network for extended idle mode monitoring in network B. [8] discussed that additional enhancements may be needed for example to handle aperiodic events such as paging response or TAU/RNAU based on the scheduling gap mechanism. [5] thought that one-shot leaving duration based on UE request would be supported.

The following Figure 3 shows a general framework of one-shot short-time switching. We will discuss it step by step.

1. UE sends one-shot short-time switching notification.
2. The network sends the switching response message, if needed.
3. UE sends a return message, if needed.



**Figure 3 one-shot short-time switching procedure**

During one-shot gap requesting, UE may provide necessary gap requirement information to network A, such as:

1. Gap pattern requested, e.g. gap length, gap start time.
2. Gap request cause, e.g. Cell Reselection or System Information, etc.
3. Others, if any.

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

1. **What content should the switching notification message carry for one-shot short-time switching?**

|  |  |  |
| --- | --- | --- |
| **Company** | **A/B/C** | **Comments** |
| Ericsson | C (same information used for periodic short-time switching) | Since those one-shot short-time operations should not be time critical, we see no need to differentiate between one-shot and periodic short-time switching. If one defines a periodic switching it may as well be used for one-shot short-time switching. The UE can wait for the short-time switching configuration for periodic events. |
| Sharp | A | The procedure used for one-shot short-time switching should be same as periodic short-time switching. |
| Oppo | A |  |
| CATT | A | Network A do not need to know the detailed gap request cause.  Moreover,the procedure for one-shot short-time switching and Periodic short-time switching can be unified to one procedure. |
| vivo | A |  |
| Apple | A | Similar to Option B for Question 8 |
| Samsung | A | We think that same contents in Q8 can be considered without gap repetition period for one-shot short-time switching procedure. |
| LG | C | Same information like our response to Q8. We think a common procedure can be used regardless of the one-shot short time or periodic switching. This is because, even in the case of one-shot switching, the UE anyway need to perfrom periodical short time switching procedure to monitor paging later. |
| ASUSTeK | C | We agree with Ericsson’s comment. |
| Fraunhofer | A, B | Similar to Q8 |

**Summary:**

TBD.

Regarding the switching response message in one-shot short-time procedure, In [18], If the UE has to receive the switching notification response message before the switching, the activity on network B may be delayed. Thus, the reception of the switching response message could be optional. There could be several options:

* **Option 1: Perform switching only after the reception of the Switching Response Message**. The network acknowledges the switching notification message via the switching response message. And UE switches after receiving the switching response message.
* **Option 2: Perform switching without Switching Response Message**. UE requests for the switching and is allowed to perform autonomous switching without the reception of Response Message.
* **Option3: Others**, if any, please comment.

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

1. **Whether should UE wait for the Response Message for one-shot short-time switching?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option1/2/3** | **Comments** |
| Ericsson | 3 | If there would be a need for the UE to have a specific handling for one-shot short-time switching, then option 1 would be needed. But as said for Q10, there is no need for a specific handling of one-shot short time switching. The UE can leave for one short-time switching during the periodic interruptions that the network may have configured. |
| Sharp | 3 | Agree with Ericsson. |
| Oppo | 2 | Unlike long-time switching, the consequence caused by short-time switching is not so big even performing switching without Switching Response Message |
| CATT | 2 | Whether perform the switching in case Switching Response Message is not received in a certain period could be up to UE implementation. |
| vivo | 3 | First, considering some one-shot short-time activities are flexible to perform (i.e. can allow some delay before being initiated), UE may wait for the response message, which is beneficial to keep UE behavior consistent with network A.  However, anyway this should not require the UE to perform switching only after receiving the response, since that network A may decide not to give any response to the UE, at all.  UE may wait in network A for Response Message within a certain time, similar to the long-time switching procedure. |
| Apple | 3 | Choice of Option 1 or Option 2 would depend upon the maximum delay incurred in waiting for the switching response message. In the worst case, we can have a timer based mechanism which determines when the UE can autonomously switch without waiting for the switching response message. |
| Samsung | 1 | If gap pattern for one-shot short-time switching can be requested as it does for periodic short-time switching, it should be up to a network decision whether a UE is allowed to temporarily switch to other network i.e. within the configured/confirmed one-shop gap from the current network. Thus, we do not see any need to have different solutions for periodic and one-shot short-time switching procedures.  Of course, it can be up to UE implementation whether to temporarily switch to other network for one-shot short-time switching activity within the configured periodic gap. |
| LG | 3 | Agree with Ericsson |
| ASUSTeK | 3 | We agree with Ericsson’s comment. |
| Fraunhofer | 1 | Agree with Samsung |

**Summary:**

TBD.

As captured in RAN2 agreements, there may be different mechanisms (short/long, leaving/returning, etc.). A Return message could be required in one-shot short-time switching in the following cases.

* It is hard to decide the exact length for one-shot short-time switching in many cases. If the gap length allocated is longer than required, UE will prematurely return to network A before the gap expires, in such case a UE return message to notify network A may be useful.
* If a gap length is not provided(e.g. UE switches without the reception of switching response), a return message is required for UE to notify the network.

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

1. **Whether a Return message is needed for one-shot short-time switching?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | No | Similar comments as Q11. If we are using the periodic short time switching defined, there will be no need for a return message. |
| Oppo | Yes | For one-shot short-time switching case, UE is still in connected mode in network A. It’s benefitial to achieve timing synchronization between UE and network A if UE returns from resources efficiency perspective, so it’s a good way to have Return message. |
| CATT | No | It will work well without a return message.We can keep the solution as much as simple. |
| vivo | Yes | A return message is needed for the below two cases:  1. UE returns before the configured gap length expires; UE may send a return message to network A, e.g. to resume the DL data transfer.  2. If UE is permitted to switch without the reception of response message, the gap length may not be configured to the UE. In this case, UE needs to send a return message when it returns back to network A. |
| Apple | No | This would depend upon the outcome of Q11. If there is no response message being waited for, then the need for Return message does not arise. Also, we need to ensure that the overhead of this short switching is not more than that the short switching duration itself. |
| Samsung | No | We think it is a minor optimization issue. |
| LG | No | We think a common procedure is enough to perform short time switching. The UE can request to update the scheduling gaps to the network whenever the gap information needs to be newly required. |
| ASUSTeK | No | A common procedure could be used for both one shot/periodic short-time switching. |
| Fraunhofer | Maybe | Depends on the design of the one-shot switching procedure |
|  |  |  |

**Summary:**

TBD.

Companies are invited to express their view if any other comments or suggestions.

1. **Any other comments or suggestions on the solution for one-shot short-time switching?**

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

**Summary:**

TBD.

## Busy Indication

In RAN2#112e, the following busy indication related agreements were made.

* From RAN2 point of view, it is feasible that the busy indication is sent as an RRC message with security for RRC\_INACTIVE. FFS how this works.

**=> FFS if/how to ensure UE doesn't disconnect from RRC\_CONNECTED during busy indication**

We will discuss the above open issues in this section.

## **How to send the RRC busy indication in RRC\_INACTIVE**

For RRC inactive UE, [5,19] mentioned that the UE can include the busy indication in the RRC connection resume request message. The network can confirm the busy indication via RRCRelease.



**Figure 4 Busy Indication in RRC\_INACTIVE**

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

1. **Do companies agree with the general RRC procedure of sending Busy Indication in RRC\_INACTIVE state, i.e. UE sends busy indication in the RRC connection resume request message, and the network confirms the busy indication via RRCRelease?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | No, but | Even though we can say it is feasible to include it in the RRC Resume Request message, it should be noted that there are few spare values that are too costly to use for the sake of busy indication. An alternative approach would be to include the busy indication into the RRC Resume Complete message. |
| Sharp | Yes |  |
| Oppo | Agree if the security issue is resolved | Busy indication in the RRC connection resume request message has no integrity protection and ciphering, so this info may be changed by a third party, it’s better to enhance step 2 in figure 4 to let UE double check the integrity of busy indication. |
| CATT | Yes, but | The mentioned procedure is feasible. But we think a unified solution(RRC based or NAS based) for both RRC\_INACTIVE and RRC\_IDLE would be better. |
| vivo | Yes | Agree with the general RRC procedure of sending Busy Indication in RRC\_INACTIVE state. There are five spare codepoints for *ResumeCause* and one can be used for busy indication. Upon the reception of *RRCResumeReq* with *ResumeCause* “busyindication”, the network B can respond to the busy indication via *RRCRelease*. In this way, the shortest time required for UE to send a busy indication can be achieved. |
| Apple | Agree if security aspects are resolved | Same comment as Oppo. Also in favor of an unified solution for RRC\_IDLE and RRC\_INACTIVE as CATT had indicated. |
| Samsung | May be | It would be good to first discuss whether busy indication itself is needed or not as it might be merely used by network to verify whether UE receives paging message correctly. In order to send busy indication in response to paging, the UE needs to suspend on-going data transmission in current network. Even though the UE just ignores the paging, the UE may respond to it later as repetitive paging transmission is allowed from network.  If busy indication is agreed to be supported, then we agree with Figure 4 i.e. new resume cause value for busy indication in resume request message can be defined. We have some sympathy that new cause value may be costly, but negative impact on ongoing service in current network could be minimized with new cause value without entering RRC\_CONNECTED. |
| LG | Yes | It is feasible to send a busy indication when sending RRC Resume Request message. But if there is a size issue, RRC Resume Complete message is also a feasible way to send a busy indication w/o RRC Connection. |
| ASUSTeK | Yes | We agree with Samsung’s comment. |
| Fraunhofer | Maybe | Agree with Samsung |

**Summary:**

TBD.

## **If/How to ensure UE does** **n**o**t disconnect in network A**

When the UE has an ongoing service in network A, a busy indication is triggered that towards to network B if the UE decides not to respond to paging in network B. Hence, UE sends busy indication to network B which implies it wants to keep the connection/ongoing service in network A. With this in mind, the rapporteur thinks it should be ensured that UE does not disconnect in network A while sending busy indication in network B.

What’s more, SA2 has achieved the below conclusions for busy indication.

|  |
| --- |
| - If Multi-USIM device received paging by Network-A in RRC\_Idle mode and the device decides to accept the paging, UE shall perform as existing procedure (send the Service Request message).  - If Multi-USIM device received paging by Network-A in RRC\_Idle mode and the device decides not to accept the paging, a UE supporting NAS BUSY indication attempts to send a BUSY Indication via NAS message to network unless it is unable to do so e.g. due to UE implementation constraints.   NOTE X1: Whether Busy indication is supported for RRC\_Inactive case is up to RAN decision. |

According to the discussion in SA2, the UE implementation constraints rely on the connectivity and services in another network, e.g. SA2 assumes for some services, keeping the service ongoing without impacts in network A and sending NAS busy indication to network B cannot be performed simultaneously(e.g. sending busy indication may cause the QoS of the ongoing service cannot be ensured), the busy indication sending can be omitted in these cases. Similar principle may be consided in RAN2.

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

1. **Do companies agree to ensure UE keeps RRC\_CONNECTED in network A during sending busy indication in network B?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | No, but | Similar as what we said for 2.3.2, busy indication would be a one time indication that one could do within the time of other interruptions already configured by the network. |
| Oppo | Maybe | At least in the negotiated gap duration, the connected state in network A can be guaranteed; otherwise, more like a network A implementation. |
| CATT | Yes, but | We agree with rapporteur that “UE sends busy indication to network B which implies it wants to keep the connection/ongoing service in network A.” But whether the connected state could be kept is network A implementation. |
| vivo | Yes | Agree with the comment from CATT.  We think a smart network implemation should avoid to release UE during the UE sending busy indication in another network and the UE should not initiate a long-time switching in NW A for the sending of busy indication in NW B. |
| Apple | Yes | Since the reason as to why the UE is sending busy indication in network B is to continue with its ongoing activity in network A (and connected state thereof). |
| Samsung | Yes | We do not see any need for network A to move UE to RRC\_IDLE/RRC\_INACTIVE from RRC\_CONNECTED during sending busy indication in network B. |
| LG | Yes | If a scheduling gap is used, it is possible that the UE keeps RRC\_CONNECTED on network A while sending a busy indication to network B. This is because we think a scheduling gap can be a common procedure not only for one-shot switching but for periodic switching. |
| ASUSTeK | Yes | We agree with CATT’s comment. |
| Fraunhofer | Yes |  |
|  |  |  |

**Summary:**

TBD.

As shown in Figure 4, the procedure for paging reception and busy indication sending includes a periodic short-time activity(paging reception) and a one-shot short-time activity (busy indication sending). And, these two activities are normally continuously performed by UE.

Based on the above discussion for periodic/one-shot short-time switching, there could be several options to support paging reception and sending busy indication.

* **Option 1: One-step switching with long gap,** i.e. the gap allocated for the switching is long enough for UE to perform both paging reception and busy indication sending. UE sends busy indication during the gap when necessary.
* **Option2: Two-step switching,** i.e. a first gap allocated for the first switching is only enough for UE to perform paging reception. If the UE decides to send busy indication after paging reception in network B, it goes back to network A and asks for a second switching for busy indication sending.
* **Option3**: **Others,** if any, please comment.

Note: Solutions that allow the UE to send busy indication by extending the gap without informing the network A are not listed here. These solutions may result in network A releasing the UE while the UE doesn’t come back as expected.

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

1. **Which option is suitable for sending busy indication?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1/2/3** | **Comments** |
| Ericsson | 3 (up to UE implementation) | In a first periodic interruption the UE can perform paging reception, while in a second periodic interruption the UE may send the busy indication. If the NW configures a periodic interruption for the UE that is long enough, the UE may also be able to perform both activities within a single interruption (option 1 above), but it depends on how large those interruptions would be – there is no need to define a strict handling as option 1 and 2, it can be left up to UE implementation. |
| Oppo | 3 (up to UE implementation) | The same view with Ericsson |
| CATT | 3 (up to UE implementation) | Agree with Ericsson. |
| vivo | 3 (up to UE implementation) | Whether and how UE sends busy indication is up to gap pattern. If the configured gap length is long enough to complete sending the busy indication, UE can send busy indication within the configured gap (option 1).  As per SA2 conclusion, sending the busy indication can be omitted due to UE implementation constraints. Therefore, UE may send the busy indication as best effort action. If the assigned gap is not long enough to complete sending the busy indication, sending the busy indication can be omitted. |
| Apple | 3 | This is a function of how long the initial switching gap is configured as. If the gap is long enough in the first place, then both paing decode and sending of busy indication can be done together. |
| Samsung | 3 (up to UE implementation) | We think it is not preknown to UE whether busy indication is also to be sent and/or periodic gap can accomodate busy indication always. It seems better to leave it to UE implemention to perform this in either in 1-step when feasible or 2-steps when needed. |
| LG |  | We don’t think only one option should be chosen. If the UE can send the busy indication within the gap period, then there is no need to consider a two-step switching procedure. Otherwise, i.e. additional gap period is required in the UE perspective, the UE may ask for additional gap configuration to the network for sending the busy indication for the next gap duration. |
| ASUSTeK | 3 | It can be left up to UE implementation. |
| Fraunhofer | 3 | Upto implementation. A UE can make a fair judgement of the required time to perform the two procedures in tandem. Though it would be efficient to have only one gap, this should be left to implementation. |
|  |  |  |

**Summary:**

TBD.

## Other Comments

Companies are invited to express their view if any other overall comments or suggestions on the solutions of network switching.

1. **Any other comments or suggestions on the solutions of network switching?**

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

**Summary:**

TBD

# Conclusions

Based on the email discussion, we give the below proposals and observations.

**TBD**

# References

1. RP-202895 Support for Multi-SIM devices for LTE/NR vivo, China Telecom, China Unicom
2. R2-2009325 Summary of [Post111-e][917][Multi-SIM] Multi-Sim vivo
3. R2-2010739 Summary of [AT112-e][241][Multi-SIM] Network switching scenarios(vivo)
4. R2-2010246 On coordinated switch from NW for MUSIM device Huawei, HiSilicon
5. R2-2008872 Discussion on graceful leaving and busy indication OPPO
6. R2-2008956 Discussion on UE Notification on Network Switching CATT
7. R2-2010350 Discussion on switching mechanism for multi-SIM Samsung Electronics Co., Ltd
8. R2-2009557 Switching between two links for Multi-SIM Qualcomm Incorporated
9. R2-2009856 Switching Notification in MUSIM Lenovo, Motorola Mobility
10. R2-2010477 Network Switching for Multi-SIM UEs Charter Communications, Inc
11. R2-2009265 Scenarios and Impact analysis for Switching Notification Nokia, Nokia Shanghai Bell
12. R2-2009506 MUSIM Network Switching Apple
13. R2-2010428 Mechanism for UE to notify network switching ASUSTeK
14. R2-2009658 RRC-based coordinated switch for multi-USIM UE NEC
15. R2-2010286 SIM Switching Handling in MUSIM LG Electronics
16. R2-2009781 Discussion of the UE switching problem Xiaomi
17. R2-2009787 Support for Multi-SIM Devices - Notification upon Network Switching MediaTek Inc.
18. R2-2009327 UE notification on network switching for multi-SIM vivo
19. R2-2009328 Discussion on Busy Indication Procedure vivo