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:

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| --- | --- |
| Company | Contact: Name (E-mail) |
| Ericsson | lian.araujo@ericsson.com |
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## General

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

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| 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?**

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| --- | --- | --- |
| **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”. |
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**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?**

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| **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”. |
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**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?**

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| **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. |
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**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?**

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

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| **Company** | **Option 1/2** | **Comments** |
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**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?**

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| **Company** | **Comments** |
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**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?**

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

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

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| **Company** | **Comments** |
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**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?**

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

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

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| **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.  |
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**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?**

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| **Company** | **Comments** |
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**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?**

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

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| --- |
| - 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?**

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

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

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