3GPP TSG-RAN WG2 Meeting #113-e R2-2101981

Online, Jan 25th – Feb 05th 2021

**Agenda item: 8.3.3**

**Source: vivo**

**Title: [AT113-e][242][NR][Multi-SIM] NAS vs. RRC signalling for paging collision and network switching (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#113e:

* [AT113-e][242][NR][Multi-SIM] NAS vs. RRC signalling for paging collision and network switching (vivo)

Scope:

* + - Collect views which companies support NAS or RRC signalling, including technical reasons **why** NAS/RRC should be used. Should consider contributions submitted to this meeting to highlight technical analysis.

Intended outcome:

* + - Discussion summary in [R2-2101981](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101981.zip) (by email rapporteur).

Deadline for providing comments, for rapporteur inputs, conclusions and CR finalization:

* + - Initial deadline (for companies' feedback): 2nd week Mon, UTC 1200
    - Initial deadline (for rapporteur's summary): 2nd week Tue, UTC 1200

# 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) |
| vivo | kimba@VIVO.COM |
| OPPO | fanjiangsheng@oppo.com |
| ZTE | li.wenting@zte.com.cn |
| Sony | Anders.Berggren@sony.com |
| CATT | [zhourui@catt.cn](mailto:zhourui@catt.cn) |
| Fraunhofer | nithin.srinivasan@hhi.fraunhofer.de |
| Google | nuggehalli@google.com |
|  |  |

## CN vs. RAN based solution for paging collision

During RAN2#113 online discussion, the following agreements have been made for paging collision objective.

|  |
| --- |
| * **There is support for solution 1 with something else, either solution 3 or 2b.** * **Option 2b is the preferred solution to address paging collision for “LTE + LTE”.** * **MUSIM UE determines potential paging collision on two networks and triggers actions on potential paging collision avoidance.** * **It is left to UE implementation as to how it selects one of the two RATs/networks for paging collision avoidance** * **FFS if we can make the UE behaviour predictable.** |

### 2.1.1 EPS

SA2 has already agreed to use Option 2b for solving the paging collision in EPS side.

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| 8.2 Conclusions for Key Issue #2: Enabling Paging Reception for Multi-USIM Device Editor's note: To be completed.  Based on the evaluation in clause 7.2 the following **interim** conclusions are agreed for the baseline functionality:  - For paging reception in EPS when the paging collision is detected, the following principles are agreed:  - Upon the UE detecting paging collisions between two networks, the UE initiates a TAU procedure to the MME of one network, to request an IMSI offset.  - UE may provide an IMSI offset to MME during TAU procedure.  NOTE: Details on the request e.g. offset range will be defined during the normative phase.  - The MME returns an IMSI offset to the UE in the TAU Accept.  - During CN paging delivery, the MME provides to the RAN the UE\_ID which is derived based on the IMSI and the IMSI offset. RAN and UE use the UE ID as the IMSI to calculate the PF/PO.  Editor's note: This conclusion needs to be confirmed in RAN plenary |

And the conclusion has been confirmed in RANP, as follows:

|  |
| --- |
| The detailed objectives of the Work Item are:   1. Specify, if necessary, enhancement(s) to address the collision due to reception of paging when the UE is in IDLE/INACTIVE mode in both the networks associated with respective SIMs [RAN2]    * RAT Concurrency: Network A can be NR or LTE. Network B can either be LTE or NR.    * Applicable UE architecture: Single-Rx/Single-Tx.   For objective 1, specification change should focus on NR side and the change on LTE side is only for IDLE mode (i.e. related to EPC enhancement in SA2)  <Omit> |

From RAN2 point of view, Option 2b is also agreed as the preferred solution to address paging collision for “LTE + LTE”. Thus, we think CN-based solution (Option2b) has already been agreed by SA2/RAN2 for solving paging collision issue in EPS side.

### 2.1.2 5GS

There is still no consensus on whether CN-based or RAN-based solution should be adopted to solve the paging collision issue in 5GS side, where CN-based or RAN-based solution here means that paging collision is solved by CN or RAN, respectively. In the companyies’ contributions [12]-[30], there are some support for both CN-based solutions and RAN-based solultions. The below Table summarizes the analysis given by the companyies’ contributions for the above solutions.

**Table 1: Summary of analysis of solutions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Solutions** | | **Whether paging collision can be totally solved?** | **The increased signal overhead on Uu** | **Impact analysis** |
| CN-based solution | 1 | No  Paging collisions may reoccur due to the following reasons, leading to the UE has to request again:  - after cell reselection;  - 5G-GUTI is reassigned again by other legacy SA2 procedures;  - the identity used for CN paging in NR has to be refreshed after every paging message for better security. | No extra paging overhead | / |
| 2a | No  Paging collisions may reoccur after cell reselection, leading to the UE has to request again. | Impact on Uu, NG. |
| 2b | No  Same with Option 1 | Impact on Uu, NG. |
| RAN-based solution | 3 | Yes | The paging overhead is at least doubled. | Impact on Uu at least. |

Hence, companies are invited to provide their inputs for the following questions.

1. **Do you think which one should be supported for solving paging collision in 5GS side?** 
   * + **A: CN-based solution**
     + **B: RAN-based solution**

|  |  |  |
| --- | --- | --- |
| **Company** | **A or B** | **Technical reasons** |
| vivo | A | Considering the probability of paging collision reoccur after cell reselection is low, solutions 1/2a/2b may work well in most cases, and solution 1 is the simplest. |
| OPPO | A | Share similar view with vivo, anyway paging collision is not a big issue, many UE vendors have solved this issue by implementation for a long time, so it’s not worth to have a complex solution. Solution1 is sufficient. |
| ZTE | A | Share the same view as Vivo |
| Sony | A | The CN based solutions solves the problem with paging collisions by moving one of the paging occasions. The paging occasions can, with UE assistance be moved to a UE preferred position, e.g. it can minimize the power consumption of the UE by having the paging occasions not colliding but aligned. With 2a the position of the paging occasion can be set as not depending on the 5G-GUTI and thereby not risk paging collision when the GUTI is reassigned. |
| CATT | A | Agree with vivo and OPPO |
| Fraunhofer | A | Same view as Vivo |
| Google | A | Agree with Vivo and OPPO that paging collision probability is quite low. We think there is no need for either CN or RAN based solution, but if we have to standardize something, then CN based solution is good enough. |
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**Summary:**

TBD.

1. **For the selected solution in Q1, do you think whether assistant information is needed?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Technical reasons** |
| vivo | Yes | It is benefit if the UE is allowed to provide assistant information to help the network to decide the new ones. Since the UE knows the POs in multiple USIM precisely and then decide the new 5G-S-TMSI more properly, to avoid requesting multiple times. On top of this, providing the assistant information may enable the UE to wake up once but can monitor the POs for multiple SIM cards. Moreover, if the UE has multiple USIM cards, it is more suitable to determine the PO offset to be switched at the UE side instead of NW side, since the change of 5G-S-TMSI may solve the PO collision between USIM 1 and 2, but bring PO collision between USIM 1 and 3. |
| OPPO |  | If Option A is preferred by companies in Q1, we think the necessity of assistant info can be addressed by NAS. |
| ZTE | No | We under stand the intention on the assistance information. However, to solve re-collision issue, besides sending the assistance information to the Network, it can also be solved without assistance information for that the PO is periodically distributed and the possible paging cycle is specified to be {rf32, rf64, rf128, rf256}.  Take the Fig 1 as an example, the network B can have the same (network B2) or different (network B1) paging cycle from the network A, once the collision happened, the network B can shift the PO to the position of original PO+16rf, then the AMF select a 5G-STMSI that can derive a PO next or equal to the original PO+16rf.  (We just give a solution example that without assistance information, it doesn’t mean the network must take this method, the detail can be left to the network implementation.)    **Fig 1: PO collision**  For the benefit propose by vivo above (e.g. wake up one time for the same operator, avoid collision for more than 2 Usims), we think it’s just an enhancement for some corner cases. |
| Sony | Yes | See answer in Q1) |
| CATT | No | no need to send such assistant information,  1. if the old 5G-S-TMSI causes collision, then in principle a new 5G-S-TMSI will avoid the collision at least in the current cell.  2. probability of paging collision would be very low after the 5G-GUTI reallocation. |
| Fraunhofer | Yes | Providing the assistance information can help the network make more informed updates thereby reducing the number of requests to resolve the PO collision. Also as pointed out by Sony, can better accommodate UE preferences. |
| Google | No | Since we are of the view that paging collision is quite rare, we are reluctant to over-engineer the proposed solution. In the unlikely event of a paging collision, the UE can awlays request a further reassignment. |
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**Summary:**

TBD.

For CN-based solutions, according to the detailed procedure and descriptions for option 1/2a/2b (referred to Sol#14, #15, #16) in TR 23.761, the UE can trigger paging collision avoidance and provide assistant info to AMF. Thus, companies are invited to provide their inputs for the following question.

1. **If CN-based solution is supported, do you agree that paging collision avoidance and/or the assistant info (if needed) should be indicated to AMF?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Technical reasons** |
| vivo | Yes | For each CN-based solution, paging collision avoidance shall be triggered by the UE side and indicated to the AMF. |
| OPPO |  | See Q2 |
| ZTE | Yes(but no assistance information) | For CN-based solution, paging collision avoidance shall be triggered by the UE side and indicated to the AMF. |
| Sony | Yes | Thereby the CN can assign a UE\_ID which is at a good non-colliding position. |
| CATT | Yes(but no assistance information) |  |
| Fraunhofer | Yes | Both collision avoidance and assistance information |
| Google | Yes but no assistance information |  |
|  |  |  |

**Summary:**

TBD.

For RAN-based solution, it is feasible for the UE to trigger paging collision avoidance and provide the assistant information to AMF or gNB. Thus, companies are invited to provide their inputs for the following question.

1. **If RAN-based solution is supported, do you think whether the UE need to indicate paging collision avoidance and/or the assistant info (if needed) to the network? And if yes, to which network node, i.e., AMF, gNB?**

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| --- | --- | --- |
| **Company** | **Yes or No** | **Technical reasons** |
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**Summary:**

TBD.

## NAS vs. RRC signalling for network switching

During RAN2#113 online discussion, the following agreements have been made for network switching objective.

**Agreements**

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.

In the subsequent section, the NAS vs. RRC signalling for supporting the above two network switching procedures are discussed. The available technical analysis based on the contributions [2]-[11] will be provided. It would be good that companies can share views to support NAS or RRC signalling, including technical reasons whyNAS/RRC should be used.

To facilitate the discussion, the following terms are used in the discussion:

* switching procedure for keeping in RRC\_CONNECTED: is used as short term for the switching procedure which is 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
* switching procedure for leaving RRC\_CONNECTED: is used as short term for the switching procedure which is used to notify network A that the UE has a preference to leave RRC\_CONNECTED state in network A

### 2.2.1 Switching procedure for keping in RRC\_CONNECTED

When UE wants to perform some short time activities in network B, e.g. paging reception, measurements, UE has a preference to be kept in RRC\_CONNECTED state in network A while temporarily switching to network B. These activities in network B are periodical and have deterministic upper bounds, and consequently can be regarded as some sort of short-term switching [3]. UE may use the existing gaps configured by network A to perform the activities. If the existing gaps cannot meet the Multi-SIM network switching requirement, a switching procedure is needed for UE to request gaps.

Considering the gap scheduling is invisible at CN while has been widely utilized at RAN, and SA2 has not concluded any NAS solution related to gap, thus AS level signalling is needed and feasible for requesting gap.

Technical analysis of AS level solutions, e.g. gap pattern, has been further discussed in contributions[2, 4, 5, 6, 10]. [2][10] thought UE can be configured with multiple gap patterns. [4][6] thought that existing measurement gap pattern may be not suitable, thus dedicated scheduling gap should be supported for multi-SIM purpose. [5] proposed that a UE may be configured with multiple measurement gaps with various attributes.

In addition, contributions [3, 5, 10] further discussed which AS layers will be impacted. [10] proposed that both RRC and MAC procedure are considered for Scenario 1 (Leaving for short-time periodic activities in USIM B). [5] thought that each measurement gap may be activated/activated via MAC CE. [3] proposed to further discuss whether to use RRC, MAC, or a combination for signaling.

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

1. **Which level signalling(i.e. AS or NAS) is suitable to support the switching procedure indicating UE has a preference to be kept in RRC\_CONNECTED state?**

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| --- | --- | --- |
| **Company** | **AS or NAS** | **Technical reasons** |
| vivo | AS | Gap is invisible for Core Network while has been widely utilized at RAN, hence AS level signalling is more suitable. |
| OPPO | AS | For this case, AS based method has less delay, which is more suitable to keep UE in connected mode in another network. |
| ZTE | AS |  |
| Sony | AS | The gap configuration,when still in connected mode is handled in AS. |
| CATT | AS | RRC based switching has Low latency, and extra effort can be avoided by using common procedure as long time switching |
| Fraunhofer | AS | Gap configurations in connected mode should be under AS control |
| Google | AS |  |
|  |  |  |

**Summary:**

TBD.

### 2.2.2 Switching procedure for leaving RRC\_CONNECTED

Both NAS and RRC based signaling are proposed to support the switching procedure to leave RRC\_CONNECTED state in some contributions.

Contributions [4, 8] propose to use RRC based signaling for the following reasons:

* [4] thought that RRC-based solution is beneficial to fast switching for delay-sensitive activities, which ensures the user experience. NAS-based solution involves AMF and requires a long time, it is not suitable for the case of switching for delay-sensitive activities (e.g. MO VoNR) on another network.
* [8] proposed to reuse the existing RRC-based UE Assistance Information procedure to solve the UE switching problem for all types of switch procedures.

Contributions [2, 5, 7, 9, 10] propose to use NAS based signaling for the following reasons:

* SA2 group agreed to use NAS-level leaving procedure for the E-UTRA/EPS scenario, then it is reasonable to use the same procedure for the other scenarios as well (NR/5GS and E-UTRA/5GS), to keep the specification complexity on reasonable level [7, 9,10]. In addition, it is highlighted that assistance information regarding MT data/signalling handling defined in NAS switching procedure for EPS is also useful for the NR/5GS and E-UTRA/5GS cases as well[2][5][10].
* NAS is currently used for delay-sensitive services like “emergency fallback”, so no issue is expected from timing/delay point of view [7][9].
* Limited RAN impacts and no RAN2 specs impact are expected if the UE uses NAS signaling [9].

Contributions [31] proposed RAN2 to discuss a combination of RRC and NAS-based signalling. It is pointed out that If the UE is configured with NAS level leave indication, the NAS level leave indication can also be included in the RRC message which indicates the leave at AS level, and proposed RAN2 to further discuss the RAN impacts of supporting NAS level Leave indication procedure including the impact of delay in switching to another network.

Regarding the Pros/Cons, they can be summarized as follows based on companies’ contributions:

**Table 2: summary of Pros/Cons of NAS based and RRC based solution**

|  |  |  |
| --- | --- | --- |
| **Signaling Level** | **Pros** | **Cons** |
| **NAS based signaling** | 1. Allow common switching procedure for EPS as well as NR/5GS and E-UTRA/5GS, and assistance information defined for EPS can be reused in NR/5GS and E-UTRA/5GS.  2. Limited RAN impacts and no RAN2 specs impact are expected | NAS based signaling procedure leads to long latency than RRC based signaling. |
| **RRC based signalling** | 1. Allow UE to perform fast switching towards network B for delay-sensitive activities;  2. Existing RRC-based UE Assistance Information can be reused for switching. | Different switching procedures for EPS, NR/5GS and E-UTRA/5GS. |

Companies are invited to provide their inputs for the following questions.

1. **Do companies support NAS signaling and/or RRC signlling for the NR switching procedure with a preference to leave RRC\_CONNECTED state?**

|  |  |  |
| --- | --- | --- |
| **Company** | **NAS and/or RRC** | **Technical reasons, including comment on Table 2.** |
| vivo | RRC | As it has been agreed in RAN#90 that E-UTRAN is not impacted for switching notification, NAS based switching is the only choice for the E-UTRAN/5GS case. Naturally, the NAS based switching can be reused for NR/5GS.  However, for the *switching procedure for keep in RRC\_Connected* case, no paper submitted has proposed to use the NAS based signalling. We assume RRC based signalling is preferred.  Then there will be anyway two switching procedure options for NR/5GS:   * RRC based signalling for the switching procedure for keeping in RRC\_Connected case; and * NAS based signalling for the switching procedure for leaving RRC\_Connected case   The question is whether we need to support RRC based signalling for switching procedure for leaving RRC\_Connected.  Our answer is yes. On top of the advantages listed in the Table 2, we also observe other benefits.  Firstly, we think it can provide flexbile to network deployment. For a operator which wants to support both switching procedure for keeping in RRC\_Connected and leaving RRC\_Connected, it can choose RRC signalling based solution, which means NO CN upgrade is needed for NR/5GS.  Secondly, we think the switching procedure can reuse the RRC based signalling for switching procedure for keep in RRC\_Connected case with limited enhancement, so no big impact is foreseen. |
| OPPO | NAS | When UE has a preference to leave connected mode, it’s quite strange to leave NAS behind, no much benefit we can get by RRC based solution, anyway NAS based solution can work, one single solution is more desirable. |
| ZTE | NAS | SA2 has defined some assistance information for the MT restriction, for the NR switching procedure with a preference to leave RRC\_CONNECTED state, the UE would bring assistance information for the MT restriction.  If adopt RRC based signaling, the AS signaling should include a NAS message container to include the MT restriction information, which would be similar to a NAS signaling based scheme but increase the complexity significantly, e.g. introduce more interaction between UE AS and NAS , also between CN and RAN.  With NAS signaling, it has less impact to the RAN and we also don’t see the see the motivation to adopt the same message for the “*long leaving”(leave connected state)* and “*short leaving” (keep at connected state)*, for that different procedures would be adopted for the *long leaving and short leaving*  About the delay, the CN and the Ran node will interact only one time, we think compared with the air interface, the delay of the NG can be ignored, and for the LTE when leaving to the idle state, it has been agreed to adopt NAS based procedure.  Thus, we think it’s better to adopt a NAS based signaling for the NR switching procedure with a preference to leave RRC\_CONNECTED state. |
| Sony | NAS | When leaving connected mode it is not time critical so simplest to use same procedure in EPS |
| CATT | RRC | A unified procedure for both long time switching and short time switching in 5GS is preferred. |
| Fraunhofer | NAS | Agree with ZTE |
| Google | NAS | We think the CN anyway needs to be informed if UE is switching away. Of course, this can be done by either the UE or the gNB. But we think it is more straightforward to be done by the UE. The RRC based method may be a bit faster but seems more like an optimization. |
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**Summary:**

TBD.

## Other Comments

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

1. **Any other comments or suggestions?**

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| --- | --- |
| **Company** | **Comments** |
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**Summary:**

TBD.

# Conclusions

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

TBD

# References

1. Summary of [Post112-e][256][Multi-SIM] Network switching details (vivo)
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4. [R2-2100475](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100475.zip) Discussion on Switching Notification Procedure vivo
5. [R2-2100725](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100725.zip) Network Switching for Multi-SIM UEs Charter Communications, Inc
6. R2-2100750 UE notification procedure for short time switching NEC
7. R2-2100901 Discussion on Busy Indication and Leaving in Multi-SIM Sony
8. R2-2101305 Discussion of the UE notification on network switching for multi-SIM Xiaomi Communications
9. R2-2101427 Graceful leaving for a MultiSIM device Ericsson
10. R2-2101780 Analysis on various scenarios of UE switching China Telecomunication Corp.
11. R2-2101937 Considerations for MSIM UE notification on network switching Futurewei Technologies
12. R2-2100244 Paging collision avoidance OPPO discussion Rel-17 LTE\_NR\_MUSIM-Core
13. R2-2100280 Further Consideration on Paging Collision Avoidance CATT discussion Rel-17 LTE\_NR\_MUSIM-Core
14. R2-2100428 Consideration on the Paging Collision ZTE Corporation, Sanechips discussion Rel-17 LTE\_NR\_MUSIM-Core
15. R2-2100434 Paging Collision Avoidance for Multi-RAT MUSIM UE Samsung discussion
16. R2-2100445 Solutions for paging collisions Qualcomm Incorporated discussion
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19. R2-2100724 Considerations for Paging Collision for Multi-SIM UEs Charter Communications, Inc discussion
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24. R2-2101222 Definition and solution for paging collision, RRC Inactive, SI change Lenovo, Motorola Mobility discussion LTE\_NR\_MUSIM-Core
25. R2-2101296 Multi-SIM Paging Collision Solution MITRE Corporation discussion R2-2100250
26. R2-2101304 Discussion of the paging collision problem Xiaomi Communications discussion
27. R2-2101428 Paging collision avoidance Ericsson discussion
28. R2-2101536 Multi-SIM Devices - Paging Collision MediaTek Inc. discussion
29. R2-2101543 “Effective” solution for paging collision avoidance for 5GS Intel Corporation discussion
30. R2-2101748 UE indication of paging collision for Multi-SIM ASUSTeK discussion Rel-17 LTE\_NR\_MUSIM-Core
31. R2-2100508 Switching notification procedure for basic switching scenarios for Single RX UE Nokia, Nokia Shanghai Bell