**3GPP TSG-RAN WG2 Meeting #116e R2-21xxxxx**

Online, 1st – 12th November 2021

**Agenda item: 8.3.4**

**Source: Huawei/HiSilicon**

**Title: [Post115-e][236][MUSIM] Paging with service indication**

**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#115e:

* [Post115-e][236][MUSIM] Paging with service indication (Huawei)

Scope: Discuss remaining open issues for paging with service indication and try to have draft CRs to illustrate the necessary modifications to specifications. Can discuss which specifications are affected. Can also discuss AS/NAS interactions with paging cause.

Intended outcome: report + draft CRs

Deadline: Long

Rapporteur would like to organize the email discussion in two phases:

**Phase 1:** Companies are invited to provide comments to the questions by Sep 30th

**Phase 2:** Rapporteur provides the summary report + draft CRs by Oct 11th and companies can further comment by Oct 19th, 0900 UTC; Rapporteur will finalize the summary + the draft CRs to submit on 22nd Oct

Please provide your contact information when responding.

|  |  |
| --- | --- |
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# Discussion

SA2 raised the following issue in the LS [17]:

**Issue:** UE shall be able to discriminate the case where it is being paged for non-voice from the case where it is being paged (for any service) by a RAN node not supporting the Paging Cause, either because the RAN node does not support the Paging Cause feature, or because in case of RAN sharing it is configured to operate without the Paging Case feature for some of the connected CNs.

In RAN2#113bis-e, the following agreements were made:

* 1: RAN2 works to support the MUSIM paging cause feature that SA2 is working on and also addresses the paging cause issue raised by SA2 LS.
* 2: RAN2 attempts to reply LS to SA2 once we progress on solution and agree on CR(s) that support/address the above feature/issue.
* 5: If RAN2 agrees to add a paging cause value (or any other information that could lead to a specific paging cause) in Uu paging message, RAN2 specifies the relevant UE behavior (i.e. inform or passing to the upper layer) upon its reception in both LTE and NR specifications.
* RAN2 does not intend to introduce alternative paging IDs for MUSIM paging (unless requested by SA2).

There were several contributions in RAN2#115-e with proposals to introduce paging cause feature and address the issue raised in the SA2 LS. The email discussion attempts to collect views from companies on the issues for adding paging cause with service indication.

## Solution Direction

Based on the contributions in RAN2-115e, the proposals to add paging cause can be classified into two groups:

* Group A: Add paging cause to the legacy paging record [11][14]
* Group B: Extend ”nonCriticalExtension” and create a parallel list or separate list [1][2][3][4][5][7][8][9][10][12][13][15]

We would like to collect views from companies on which group they prefer to decide on the solution direction.

#### Q1. Of group A and B, which one do you prefer to add paging cause?

|  |  |  |
| --- | --- | --- |
| Company | Preferred Solution Group | Comments |
| vivo | Group B | The parallel list approach was adopted in LTE Rel-16 extension (*accessType, mt-EDT*) as it introduces lower overhead. Group A (using extension marker “…”) has higher signalling overhead a the bits for versions determination and the version’s length determination are required per each paging record. |
| Huawei/HiSilicon | Group B |  |
| OPPO | Group B |  |
| Qualcomm | A or B | Either can be made to work. |
| NEC | Group B |  |

**Summary:**

**Proposals:**

## Down selection of Solution Proposals

We discuss different proposals in each group and collect companies’ views on which solution they prefer. Different solution proposals in Group A are listed below along with the necessity of additional signalling to discriminate legacy paging from non-voice paging.

Table 1: Group A solutions

|  |  |
| --- | --- |
| Group A Solution | Details including ASN.1 code snippet and additional signalling requirements to address the issue described in SA2 LS [17] |
| A.1 | Define a new pagingCause IE with {voice, other} in the legacy Paging Record IE [11]; no additional signalling required to address the issue raised in SA2 LS [17]  PagingRecord ::= SEQUENCE {  ue-Identity PagingUE-Identity,  accessType ENUMERATED {non3GPP} OPTIONAL, -- Need N  ...,  [[  pagingCause-r17 ENUMERATED {voice, other} OPTIONAL, --Need N  ]]  } |
| A.2 | Define a new pagingCause IE with {nonVoice} in the legacy PagingRecord IE; Broadcast in system information if RAN supports paging cause or not [14] to address the issue raised in SA2 LS [17]  PagingRecord ::= SEQUENCE {  ue-Identity PagingUE-Identity,  accessType ENUMERATED {non3GPP} OPTIONAL, -- Need N  pagingCause-r17 ENUMERATED {nonVoice } OPTIONAL, --Need N  ...  } |

As mentioned in Section 2.1, Group B solutions are based on extending “nonCriticalExtension”:

Paging ::= SEQUENCE {

pagingRecordList PagingRecordList OPTIONAL, -- Need N

lateNonCriticalExtension OCTET STRING OPTIONAL,

nonCriticalExtension Paging-v17xy-IEs OPTIONAL

}

Different solution proposals to add paging cause are listed below along with required additional signalling to discriminate legacy paging from non-voice paging.

Table 2: Group B solutions

|  |  |
| --- | --- |
| Group B Solutions | Details including ASN.1 code snippet and additional signalling requirement to address the issue described in SA2 LS [17] |
| B.1 | Parallel list with only one cause value; UE capability/CN support exchange between UE and CN on paging cause which was already agreed by SA2 [2][7][12][18][19] to address the issue raised in SA2 LS [17]  Paging-v17xy-IEs ::= SEQUENCE {  pagingRecordList-v17xy PagingRecordList-v17xy OPTIONAL, -- Need N  nonCriticalExtension SEQUENCE {} OPTIONAL  }  PagingRecordList ::= SEQUENCE (SIZE(1..maxNrofPageRec)) OF PagingRecord  PagingRecordList-v17xy ::= SEQUENCE (SIZE(1..maxNrofPageRec)) OF PagingRecord-v17xy  PagingRecord ::= SEQUENCE {  ue-Identity PagingUE-Identity,  accessType ENUMERATED {non3GPP} OPTIONAL, -- Need N  ...  }  PagingRecord-v17xy ::= SEQUENCE {  pagingCause-r17 ENUMERATED {voice} OPTIONAL -- Need N  } |
| B.2 | Parallel list with 2 cause values [2][3][5][9]; no additional signalling required to address the issue raised in SA2 LS [17]  Paging-v17xy-IEs ::= SEQUENCE {  pagingRecordList-v17xy PagingRecordList-v17xy OPTIONAL, -- Need N  nonCriticalExtension SEQUENCE {} OPTIONAL  }  PagingRecordList ::= SEQUENCE (SIZE(1..maxNrofPageRec)) OF PagingRecord  PagingRecordList-v17xy ::= SEQUENCE (SIZE(1..maxNrofPageRec)) OF PagingRecord-v17xy  PagingRecord ::= SEQUENCE {  ue-Identity PagingUE-Identity,  accessType ENUMERATED {non3GPP} OPTIONAL, -- Need N  ...  }  PagingRecord-v17xy ::= SEQUENCE {  pagingCause-r17 ENUMERATED {voice, other} OPTIONAL -- Need N  } |
| B.3 | Separate list of pagingrecords for MUSIM UEs paged for voice in paging message [13]. The contribution does not explain how to address the issue raised in SA2 LS [17]  Paging-v17xy-IEs ::=                SEQUENCE {      voicePagingRecordList-r17          VoicePagingRecordList-r17     OPTIONAL, -- Need N      nonCriticalExtension               SEQUENCE{}                OPTIONAL  }    PagingRecordList ::=                SEQUENCE (SIZE(1..maxNrofPageRec)) OF PagingRecord    VoicePagingRecordList-r17  ::=      SEQUENCE (SIZE(1..maxNrofPageRec)) OF PagingRecord    PagingRecord ::=                    SEQUENCE {      ue-Identity                         PagingUE-Identity,      accessType                          ENUMERATED {non3GPP}    OPTIONAL,   -- Need N  ...  } |
| B.4 | Separate list of pagingrecords for MUSIM UEs in paging message [8]. The contribution does not explain how to address the issue raised in SA2 LS [17]  Paging-v17xy-IEs ::=                SEQUENCE {      pagingRecordList2-r17             PagingRecordList2-r17     OPTIONAL, -- Need N      nonCriticalExtension               SEQUENCE{}                OPTIONAL  }    PagingRecordList ::=                SEQUENCE (SIZE(1..maxNrofPageRec)) OF PagingRecord    PagingRecordList2-r17  ::=         SEQUENCE (SIZE(1..maxNrofPageRec)) OF PagingRecord-r17    PagingRecord ::=                    SEQUENCE {      ue-Identity                         PagingUE-Identity,      accessType                          ENUMERATED {non3GPP}    OPTIONAL,   -- Need N      ...  }    PagingRecord-r17 ::=                SEQUENCE {      ue-Identity                         PagingUE-Identity,      accessType                          ENUMERATED {non3GPP}    OPTIONAL,   -- Need N  paginingCause-r17                   ENUMERATED  {voice}     OPTIONAL -- Need S  } |
| B.5 | Including the number of UEs paged for voice in paging message and place the paging records with voice paging cause at the beginning or at the end of the paging message. An indication from RAN node if it supports paging cause or not [4] to address the issue raised in SA2 LS [17]  Paging-v17xy-IEs ::= SEQUENCE {  numOfPagingCause INTEGER {1..maxNrofPageRec}  nonCriticalExtension SEQUENCE {} OPTIONAL  } |

The table below lists the issues raised/expressed by companies in their contributions.

Table 3: Issues Raised for Group B Solutions

|  |  |
| --- | --- |
| Solution | Issues Raised by companies or not clear from the proponent’s contribution for the solution |
| B.1 | 1. Requires uniform support of the paging cause in the registration area [5][10][15]   **[vivo]**: In the registration area, RAN can, per cell, indicate whether the paging cause feature is supported via the precense of the parallel list. So, there is no such restriction on the deployment and upgrade of the network.  **[HW]**: Agree with Vivo. If ”pagingrecordlist-v17” is NOT included, it means that gNB does not support paging cause. If ”pagingrecordlist-v17” is included and paging cause present, it means that gNB supports paging cause and paged for voice. ”pagingrecordlist-v17” is included and paging cause absent, it means that gNB supports paging cause and paged for other.  **[OPPO]** We don’t think B.1 has this issue and share the similar understanding with vivo.   1. Service type should be identified by only Uu paging message to identify service type, that is, not combine Uu paging message and NAS indication to identify service type [3][15]   **[vivo]**: As SA2 has alreadly introduced the NAS indication and the combination seems not complicated, it is reasonable for RAN2 to consider this indication to avoid useless signalling overhead in Uu paging message.  **[HW]**: there is no separate NAS indication, here UE uses the MUSIM capability exchange etween the UE and the CN to address the issues mentioned in the SA2 LS.  **[OPPO]** why this cannot be solved by UE implementation? No big issue from our side.   1. Causes much signalling overhead compared to A.1[11]   **[vivo]:** see our comments in Q1.  **[HW]:** Signalling overhead is not an issue as analysed in our contribution [12]  **[OPPO]** we see no much difference from signalling overhead perspective, tend to have a easy ASN design.   1. Violates SA2’s agreement that paging cause indication should not be applied indiscriminately [11]   **[vivo]**: In case of incoming service is voice, the RAN will include the *pagingCause* IE for for MUSIM UE, while not include the *pagingCause* IE for non MUSIM UE. So, paging cause indication is not applied indiscriminately by the RAN.  **[HW]:** paging cause indication is applied only to Ues that support it so it does not violate SA2’s agreement.  **[OPPO]** we don’t think B.1 goes aganist any SA2 decision. |
| B.2 | 1. Introducing 2 values is not consistent with SA2’s conclusion [12][21] 2. Causes much signalling overhead compared to A.1[11] 3. Violates SA2’s agreement that paging cause indication should not be applied indiscriminately [11] |
| B.3 | 1. It is not clear from [13] how to address the issue raised in SA2 LS [17] |
| B.4 | 1. RAN node needs additional information from CN/RAN if the paging is for MUSIM or not so that RAN can page the UE via legacy or new paging record [12] 2. It is not clear from [8] how to address the issue raised in SA2 LS [17] |
| B.5 | 1. Restricts way of extension in future [7] |

#### Q2: If Group A is your preferred direction, which solution do you prefer?

|  |  |  |
| --- | --- | --- |
| Company | Preferred Solution in Group A | Comments |
| Qualcomm | A.1 |  |
|  |  |  |

#### Q3: If Group B is your preferred direction, which solution do you prefer? Proponents are encouraged to address the issues mentioned in Table 3.

|  |  |  |
| --- | --- | --- |
| Company | Preferred Solutions in Group B | Comments |
| vivo | B.1 (proponents) | We provide our reply for the comments of the solution B.1 in Table 3.  Basically, we prefer B.1 due to its advantages of simplicity and readability, as it follows the extension method that was adopted in LTE. For solutions B.3~B.5: Solutions B.3 and B.4 have the same drawback as B.5. For example, if a new feature is introduced in the later release, the sorted-based or group-based solutions may introduce more complexity, because it is difficult to put one UE supporting both paging cause feature and the new feature in one proper position. |
| Huawei/HiSilicon | B.1 | Please see our answers for the comments of the solution B.1 in Table 3.  Of group B solutions, B.1 is the simplest solution, and with the SA2 agreement on MUSIM UE capabilities information exchange between UE and CN, the issue raised in SA2 LS [17] will be addressed. There is no need for 2 paging cause values as proposed in B.2 |
| OPPO | B.1 | Among solutions, B.1 is straightforward, we prefer to have a easy solution. |
| Qualcomm | B.2 or B.4 | It is not true that B.1 solves the problem of UE differentiating between legacy NW and Rel-17 supporting this indication. If the paging is due to non-voice, this new IE in B.1 (PagingRecord-v17xy) will not be included and thus the UE will only see the legacy paging record. In that case, the UE does not know whether this is a Rel-17 NW sending non-voice paging or legacy NW not supporting the paging indication. We need a way for the UE to differentiate these two cases so that the UE can, for example, decide to send busy indication for non-voice. Thus, we either add “other” as in B.2 or create a parallel list as in B.4 which is used instead of the legacy list for Rel-17 NW. |
| NEC | B.1 | Solution B.1 can address the SA2 issue and is also one straightforward solution. |

There was a proposal that RAN2 shall not add paging cause in RRC Paging message for EPS [6] hence we would like to collect your views if the solution proposal in NR can be applied to LTE to introduce paging cause. Please note that RAN2 has reached the following agreement in RAN2-113bis-e meeting.

* RAN2 does not intend to introduce alternative paging IDs for MUSIM paging (unless requested by SA2).

#### Q4: Can the solution proposal in NR to introduce paging cause be applied to LTE?

|  |  |  |
| --- | --- | --- |
| Company | Answer (Yes or No) | Comments |
| vivo | Yes |  |
| Huawei/HiSilicon | Yes |  |
| OPPO | Yes |  |
| Qualcomm | Yes |  |
| NEC | Yes |  |

#### Q5: If the answer to Q4 is No, then please give the solution proposed for LTE.

|  |  |
| --- | --- |
| Company | Proposed solution for LTE |
|  |  |
|  |  |

**Summary:**

**Proposals:**

## AS-NAS interaction

The following agreement was made in RAN2-113bis-e:

**If RAN2 agrees to add a paging cause value (or any other information that could lead to a specific paging cause) in Uu paging message, RAN2 specifies the relevant UE behavior (i.e. inform or passing to the upper layer) upon its reception in both LTE and NR specifications.**

There are two cases depending on the RRC state: CN paging and RAN paging that are described below. Please note that the description is based on NR specifications.

### CN paging

For paging reception in RRC\_IDLE, the current behaviour [20] is that UE’s RRC forwards the ue-Identity and accessType (if present) to NAS. Following this behaviour, it’s natural if UE’s RRC forwards the paging cause to NAS and let NAS decide what to do, i.e., accept the paging or reject the paging.

#### Q6: Do you agree that for paging reception in RRC\_IDLE, UE forwards the paging cause to NAS and it’s up to NAS to decide on what to do i.e., accept the paging or reject the paging?

|  |  |  |
| --- | --- | --- |
| Company | Answer (Yes or No) | Comments |
| vivo | Yes |  |
| Huawei/HiSilicon | Yes |  |
| OPPO | Yes |  |
| Qualcomm | Yes |  |
| NEC | Yes |  |

### RAN paging

For RAN paging reception in RRC\_INACTIVE, RAN2 has not discussed which layer (i.e. RRC or NAS) decides to accept/reject paging.

In addition, CT1 has sent reply LS on NAS-based busy indication and provided two options for AS-NAS interaction for RAN paging [16]. Both of them (Option 1 & 2) are listed below along with other possible options. CT1 also asked RAN2 if a paging cause, if any, indicated together with indication about RAN paging from AS layer to NAS layer.

**Option 1: the AS layer resumes the RRC connection upon receipt of RAN paging and then the AS layer informs the NAS layer an indication that the UE has transitioned to RRC\_CONNECTED state and indication about the RAN paging;**

**Option 2: the AS layer informs the NAS layer an indication about the RAN paging and the AS layer resumes the RRC connection based on a request from the NAS layer to the AS layer to transition to RRC\_CONNECTED state (the request from NAS layer is triggered by acceptance of RAN paging or the SERVICE REQUEST message containing the “NAS signalling connection release" indication);**

**Option 3: No need to specify AS-NAS interaction, up to UE implementation;**

**Option 4: Others, please give details if chosen this option.**

Considering the AS-NAS interaction options provided above and the open issue of which layer decides to accept/reject paging, we can discuss the AS-NAS interaction modelling for RAN paging.

#### Q7: For the AS-NAS interaction for paging reception in RRC\_INACTIVE, which of the above options do you prefer?

|  |  |  |
| --- | --- | --- |
| Company | Answer | Comments |
| vivo | Option 2 | NAS layer may decide not to send NAS busy indication if it judges the UE cannot do this, e.g., upper layer knows the service in another network is delay sensitive. And for this reason, the RRC resume procedure should not be initiated before NAS determination.  And option 2 can enable an uniform UE behaviour when receiving RAN paging and CN paging. |
| Huawei/HiSilicon | Option 4.  We would like to keep the legacy behaviour for RAN paging (i.e., RRC layer initiating RRC connection resume procedure when paging is received in RRC\_INACTIVE) as much as possible and hence provide a different solution. please see comments | AS layer decides whether to accept the paging or not. If AS layer rejects paging, it’s also up to AS layer to judge whether it can send busy indication or not. How the AS layer can judge whether it can send busy indication or not is up to UE implementation   * + If AS layer accepts paging, it follows the legacy procedure to initiate RRC connection resume procedure and there is no need to send indication to NAS.   + If AS layer rejects paging and decides NOT to send busy indication, then there is no need to initiate RRC connection resume procedure and no need to send indication to NAS.   + If AS layer rejects paging and decides to send busy indication, it follows the legacy procedure to initiate RRC connection resume procedure and sends indication to NAS to trigger the SR procedure for busy indication. |
| OPPO | Prefer Option3 but can accept Option1 with modification | RAN paging indication from AS is just one trigger for NAS busy indication, some other trigger like application layer may also trigger NAS busy indication, we don’t find big issue to leave this to UE implementation, so we slightly prefer Option3.  As for Option1 and Option2, Option2 has more spec effort than Option1. More addition, Option2 has no more benefit compared to Option1 from saving signalling perspective.  But for Option1, we think RAN paging cause should also be forward to NAS if provided in paging message, so propose the following version:  **Option 1: the AS layer resumes the RRC connection upon receipt of RAN paging and then the AS layer informs the NAS layer an indication that the UE has transitioned to RRC\_CONNECTED state and indication about the RAN paging and RAN paging cause if provided.** |
| Qualcomm | Option 2 or 3 | Since we only have NAS based busy indication in RRC Inactive, it would be cleaner if all the action in response to paging, whether RAN or CN-based paging, is done by the NAS. Then, all we need for AS is to pass the paging indication to the NAS. So, Option 2 is acceptable. It is also fine not to specify the AS-NAS interaction and leave it up to the UE implementation. |
| NEC | Option 4 (otherwise, Option 2) | For Option 1, our concern is that it is not aligned with the CR provided in the LS from SA2 R2-2106970, as the UE has already transitioned to CONNECTED state.  For Option 2, we think it is workable, although it is change the current UE behaviour upon reception of RAN paging. One aspect is that if the upper layer decides **not to** send busy indication, SA2/CT1 also need to specify UE behaviour that NAS shall initiate RRC Connection resume for INACTVE UE in case of paging reception.  As another alternative, it is also possible to indicate the paging cause to the NAS layer at the same time when initiating RRC Resume procedure:  **Option 4: Upon receipt of RAN paging, the AS layer resumes the RRC connection and informs the NAS layer the indication (paging cause) about the RAN paging.**  For this option, if the upper layer decides to send busy indication, the NAS layer can generate Service Request NAS message for busy indication, which can be transmitted when UE enters CONNECTED state later. And if the NAS or higher layer decides not to generate busy indication, then the NAS layer doesn’t have to response anything to AS layer. Note that we will not specify detail UE behaviour (e.g. cancelling/stopping resume procedure) when NAS layer generates Service Request message while AS layer is performing RRC Resume procedure. |

#### Q8: Can the above AS-NAS interaction principles for NR be applied to LTE?

|  |  |  |
| --- | --- | --- |
| Company | Answer (Yes or No) | Comments |
| vivo | Yes |  |
| Huawei/HiSilicon | Yes |  |
| OPPO | Yes |  |
| Qualcomm | Yes |  |
| NEC | Yes |  |

**Summary:**

**Proposals:**

## Specification Impact

The rapporteur understands that paging cause solution will impact 38.331 and potentially 36.331 (depending on the conclusion of Q4). In addition to the two specifications, do you think any other specs are impacted? If yes, please provide the specs.

#### Q9: In addition to the above specifications, do you think any other RAN2 specs are impacted? If yes, please provide the specs.

|  |  |  |
| --- | --- | --- |
| Company | Answer (Yes or No) | Comments |
| vivo | Maybe TS36.300 and/or TS38.300 |  |
| Huawei/HiSilicon | No | Introduction of service indication in paging message is a Stage 3 design and thus there is no need to capture it in Stage 2 specs. |
| OPPO | No | 38.331 is enough. |
| Qualcomm | Maybe stage 2 | If busy indication is captured in stage-2, service indication should also be included for coherent handling. |
| NEC | Maybe stage-2 specs as it is related to busy indication |  |

**Summary:**

**Proposals:**

## Other Comments

#### Q10: If there are any other issues for paging cause with service indication that rapporteur missed, please provide them below.

|  |  |
| --- | --- |
| Company | Comments |
| OPPO | For Q7, RAN paging cause delivery to NAS should also be considered. |
|  |  |

**Summary:**

**Proposals:**

# Conclusions

Based on the inputs from companies, the following proposals are made:

# References

1. R2-2107028 Paging with Service Indication, Oppo
2. R2-2107180 Further discussion on introduction of paging cause, China Telecom
3. R2-2107298 Solution analysis for supporting Multi-SIM paging cause, Intel
4. R2-2107349 Discussion on the transmission of paging cause, Spreadtrum
5. R2-2107379 Paging Prioritization, Qualcomm
6. R2-2107809 On remaining issues for Service type indication in paging message and busy indication procedure, Nokia
7. R2-2107858 Introduction of Paging Cause, Vivo
8. R2-2107928 Discussion on support of paging cause for Multi-USIM devices, Samsung
9. R2-2107976 Introduction of a Paging cause indication, Ericsson
10. R2-2108074 Consideration on the Service Indication, ZTE
11. R2-2108101 Detailed methods of the paging cause support for MUSIM, Xiaomi
12. R2-2108122 Discussion on the pagigng with service indication, Huawei/HiSilicon
13. R2-2108549 Discussion on paging service indication for MUSIM, Futurewei
14. R2-2108727 Support of Paging Cause, LG
15. R2-2108738 Paging with service indication, MediaTek
16. C1-214917 Reply LS on NAS-based busy indication
17. R2-2102664 LS on System support for Multi-USIM devices
18. S2-2105117 Introduction of MUSIM capability exchange
19. 3GPP TS 23.501 v17.1.1 (2021-06) System architecture for the 5G System (5GS); Stage 2 (Release 17)
20. 3GPP TS 38.331 v16.1.0 (2021-07) Radio Resource Control (RRC) protocol specification
21. R2-2105271 Introduction of Paging Service Indication for MUSIM, vivo