**3GPP TSG-RAN WG2 Meeting #114 electronic R2-210xxxx**

Online, May 19 – May 27, 2021

Agenda Item: 8.9.2

Source: MediaTek Inc.

**Title: Report of [AT114-e][025][ePowSav] Subgrouping network architecture**

Document for: Discussion and decision

# Introduction

In this offline discussion, we invite companies to share their views on further details about UE paging subgrouping for UE power saving, as described below.

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| * [AT114-e][025][ePowSav] Subgrouping network architecture (Mediatek)   Scope: Address whether CN or RAN shall be responsible for paging subgrouping based on UE characteristics. As this may be related to availability of information on UE characteristics in the CN or RAN network entity, can also discuss if needed provisioning of assistance information (e.g. between the network entities or from UE to the responsible network entity). The discussion shall be based on the contributions under 8.9.2.  Intended outcome: Report, with discussion, and presenting the main alternatives on the table with documented justifications, way forward.  Deadline: In time for CB online May 25 |

Please also kindly provide your contact information in the table below.

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| --- | --- | --- |
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# Discussions

## General issues of CN vs. RAN Assignment

In last meeting, we agreed that UE paging subgroups are assigned by the network based on UE characteristics. Companies provide contributions to this meeting about whether the subgroup assignment is done by CN or RAN. Companies’ views are summarized as follows:

* CN assignment (9): Qualcomm [1], Samsung [2], vivo [4], CATT [7], MediaTek [8], Nokia [10], Ericsson [11], CMCC [17], LG [18]
* RAN assignment (4): OPPO [3], Intel [5], Lenovo [14], Futurewei [16]
* CN or RAN assignment (for different RRC states or subgrouping solutions) (4): Apple [6], Xiaomi [9], HW [12], ZTE [15]

Which entity should assign UE subgroups?

First of all, we invite companies to express their view again on whether CN or RAN.

**Q1.1: Should UE grouping be considered as a kind of paging enhancement for UE power saving?**

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| **Company** | **Yes/No** | **Comments** |
| Ericsson | Yes | We also consider UE\_ID based grouping as a type of "RAN controlled grouping" |
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Subgroup IDs for UE in RRC\_IDLE and RRC\_INACTIVE

There are proposals (e.g. [9]) suggesting that a UE use one subgroup IDs when in RRC\_IDLE and another subgroup ID when in RRC\_INACTIVE, while other proposals suggest that the UE should use the same subgroup ID.

**Q1.2: Should UE use the same subgroup ID when in RRC\_IDLE and RRC\_INACTIVE?**

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| **Company** | **Yes/No** | **Comments** |
| Ericsson | Yes | We do not see why the UE subgroup should depend on the RRC state. If it would then it could impact monitoring CM-IDLE paging in Inactive like Xiaomi pointed out. |
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## CN-assigned UE subgroups

We now discuss the details if UE subgroups are assigned by CN. The network assigns UE subgroups, and may update the assignment from time to time. In each PO, a UE monitors the indication for its subgroup, and decode paging message if any UE in its subgroup is paged.

Subgroup assignment

**Q2.1: If UE subgroups are assigned by CN, how does network provide the initial assignment of subgroups to each UE?**

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| **Company** | **Comments** |
| Ericsson | During NAS registration procedure, i.e. in REGISTRATION ACCEPT (24.501). |
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**Q2.2: If UE subgroups are assigned by CN, how does network update the assignment of subgroups for each UE?**

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| **Company** | **Comments** |
| Ericsson | We should perhaps first discuss why there is a reason to update/change the grouping? The UE characteristics typically do not change e.g. RedCap, power sensitive? But the registration procedure in NR is used during initial registration but also during other periodic updates including mobility, i.e. updates are possible. |
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Assistance information from UE

Although UE subgroups are assigned by network, UE may provide assistance information (e.g. UE’s paging probability, power profile and mobility profile [1]) to assist subgroup assignment. There are also contributions suggesting that UE assistance is not needed [11]. If assistance information can be provided, we may want to know what attributes can be considered.

**Q2.3: If UE subgroups are assigned by CN, can UE provide assistance information for subgroup assignment? What are the attributes to be considered?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | No | We do not see the need for UE assistance, i.e. the network has the information it needs to do grouping (e.g. subscription info, paging probability). And in case the NW uses the UE preference, then practically the grouping is controlled by the UE, unless the NW checks if the UE is reporting correctly, e.g. indicates the correct paging probability or checks if is it power sensitive. Such checks are complicated to implement, and typically the NW does not do that.  But our main concern is that the group assignment should be left to NW implementation. This does not only mean that the NW should be able to ignore the "preference" indicated by the UE, but also that the UE assistance does not lead to pre-defined groups, e.g. "paging probability group", "power sensitive group", etc. Because in such case the grouping is not left completely to the NW implementation, but it is partially controlled by the UE assistance.  In case the UE assistance does not lead to pre-defined groups, and leaves the group assignment to the NW implementation (e.g. the NW just assigns a group number), then UE assistance would be acceptable. |
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Assistance information between network entities

Network entities may also provide assistance information to each other. For example, RAN may provide information to help subgrouping by CN (e.g. last used cell [13]), and CN may inform RAN of the subgroup assignment.

**Q2.4: If UE subgroups are assigned by CN, can network provide assistance information to each other? What are the attributes to be considered?**

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| **Company** | **Yes/No** | **Comments** |
| Ericsson | Yes | We understand that the assigned group should be included in the INITIAL CONTEXT SETUP REQUEST in the *Core Network Assistance Information for RRC INACTIVE* IE to enable the use of group info during RAN paging. For CM\_IDLE paging the assigned group needs to be included in the PAGING message to the gNB.  We also think that PEI, similar as WUS in LTE, should only be used in "last used" cell, see [13] ([R2-2105736](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_114-e/Docs/R2-2105736.zip)). Because paging due to mobility may cause the PEI to be triggered frequently which nullifies the power gains with PEI, and paging due to mobility may cause of lot of PEI transmissions while the UE only replies in a single cell within the TA. In case PEI is only used in the last used cell, then this information needs to be exchanged between RAN and CN (e.g. in *Information on Recommended Cells and RAN Nodes for Paging* in UE CONTEXT RELEASE COMPLETE from gNB to AMF, and in *Assistance Data for Recommended Cells* IE in PAGING message).  Furthermore the PEI UE capability need to be added to the UE capabilities, i.e. signalled between UE and gNB. The gNB needs to send these UE radio paging capabilities (UCRP) to the CN, such that the CN can include them as the UE radio paging capabilities in the PAGING message to the gNB. In case PEI is added to the UERadioPagingInformation message in Rel-17, then we should also add *ue-RadioPagingInfo* IE in the *UECapabilityInformation*, similar as already has been done for LTE, such that the gNB can just copy it, and does not need to extract it from the reported UE capabilities. Also see also current RAN3 discussion on use of URCP in case of RAN paging in [R3-211621](https://protect2.fireeye.com/v1/url?k=750797bf-2a9caef2-7507d724-86b568293eb5-3cfbb9a53e1c3194&q=1&e=06aac426-6f8d-4ed9-92b8-0f545c69ec20&u=https%3A%2F%2Fwww.3gpp.org%2Fftp%2FTSG_RAN%2FWG3_Iu%2FTSGR3_112-e%2FDocs%2FR3-211621.zip) . We propose to send an LS to RAN3/SA2 about this. |
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## RAN-assigned UE subgroups

An alternative is to have UE subgroups assigned by RAN. We now discuss the details in a similar way.

Subgroup assignment

**Q3.1: If UE subgroups are assigned by RAN, how does network provide the initial assignment of subgroups to each UE?**

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| **Company** | **Comments** |
| Ericsson | We think that the UE\_ID can be used as a "RAN controlled" grouping mechanism. |
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**Q3.2: If UE subgroups are assigned by RAN, how does network update the assignment of subgroups for each UE?**

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| **Company** | **Comments** |
| Ericsson | The UE\_ID based grouping is controlled via parameters configured in System Information e.g. *Ng: Total number of groups*. |
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Cell reselection

When in IDLE or INACTIVE mode, UE may move to the coverage of another cell without notifying the network. Paging message is sent from multiple cells in the same tracking area or RAN notification area. If UE subgroup is assigned by one RAN node, we need to discuss how other RAN nodes know the subgroups of UEs to be paged.

**Q3.3: If UE subgroups are assigned by RAN, how do RAN nodes know the subgroups of UEs to be paged, if assigned by other RAN nodes?**

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| **Company** | **Comments** |
| Ericsson | The UE-ID based RAN group is cell specific. |
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If UE subgroups assigned by RAN, each RAN nodes may have its own subgroup management. For example, the number of subgroups may be different across cells. We need to discuss whether and how a RAN node can accept the subgroup assigned by other RAN nodes.

**Q3.4: If UE subgroups are assigned by RAN, can a RAN node accept the UE subgroups assigned by other RAN nodes?**

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| **Company** | **Yes/No** | **Comments** |
| Ericsson | No |  |
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Assistance information from UE

**Q3.5: If UE subgroups are assigned by RAN, can UE provide assistance information for subgroup assignment? What are the attributes to be considered?**

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| **Company** | **Yes/No** | **Comments** |
| Ericsson | No | The UE-ID is for RAN paging is known by UE and RAN, i.e. no UE assistance is needed. |
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Assistance information between network entities

**Q3.6: If UE subgroups are assigned by RAN, can network entities provide assistance information to each other? What are the attributes to be considered?**

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| **Company** | **Yes/No** | **Comments** |
| Ericsson | Yes | In case of RAN paging the UE radio paging capabilities need to be exchanged on Xn interface in RAN PAGING message in case of paging escalation, i.e. UE is not found on "last used" cell. |
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## Other issues

We prepared this material following the scope announced by Chairman. However, companies may find other issues that require RAN2 discussions.

**Q4.1: Are there any other issues about UE paging subgroups that require RAN2 discussion?**

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| **Company name** | **Comments** |
| Ericsson | As explained with Q2.4 RAN2 needs to discuss whether PEI, similar as WUS in LTE, should only be used in "last used" cell, see [13] ([R2-2105736](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_114-e/Docs/R2-2105736.zip)). Because paging due to mobility may cause the PEI to be triggered frequently nullifies the power gains with PEI, and paging due to mobility may cause of lot of PEI transmissions while the UE only replies in a single cell. We also think that RAN3 and SA2 should be involved in this discussion, similar as during the LTE time frame. |
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# Conclusion

# Reference

1. R2-2104773 Paging subgroup assignment Qualcomm Incorporated discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
2. R2-2104783 Paging Enhancements\_UE Grouping Samsung Electronics Co., Ltd discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
3. R2-2104807 Discussion on grouping-based paging OPPO discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
4. R2-2104909 UE sub-grouping for paging enhancement vivo discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
5. R2-2105021 Further considerations of network assigned subgrouping Intel Corporation discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
6. R2-2105087 NR UE Power Save IDLE/INACTIVE Paging Grouping Schemes Apple discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
7. R2-2105283 UE subgrouping schemes with paging enhancement CATT discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
8. R2-2105293 UE Paging Subgroup Assignment for Power Saving MediaTek Inc. discussion
9. R2-2105295 Discussion on idle\_inactive\_mode UE power saving Xiaomi Communications discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
10. R2-2105411 Details on paging subgrouping determination and indication Nokia, Nokia Shanghai Bell discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
11. R2-2105656 Grouping methods for Paging Ericsson discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
12. R2-2105718 Discussion on the control node for UE grouping Huawei, HiSilicon discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
13. R2-2105736 PEI monitoring in NR: CN and System level impacts VODAFONE Group Plc discussion
14. R2-2105809 Consideration on Idle/inactive-mode UE power saving Lenovo, Motorola Mobility discussion Rel-17
15. R2-2105855 Further Consideration on UE Grouping ZTE, Sanechips discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
16. R2-2105956 Discussion on UE grouping control entity Futurewei Technologies discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
17. R2-2106257 Considerations on paging subgrouping CMCC discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core
18. R2-2106349 UE subgrouping for paging enhancement LG Electronics Inc. discussion Rel-17 NR\_UE\_pow\_sav\_enh-Core