3GPP TSG-RAN WG2 Meeting #112-e R2-20xxxxx

Online, 2nd – 13th November 2020

Agenda Item: x.x.x

Source: MediaTek Inc.

**Title: [DRAFT] Report of email discussion [Post111-e][907][ePowSav] UE grouping**

Document for: Discussion and decision

# Introduction

During the RAN2#111-e meeting, RAN2 had online discussions about paging enhancements for UE power saving. Since the UE grouping method is mentioned in the contributions from many companies, RAN2 set up the following email discussion:

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| * [Post111-e][907][ePowSav] UE grouping (Mediatek)

 Scope: UE grouping, put solutions on the table, describe intentions / how they work (high level), and their potential to save power. Possibly take into account R1 evaluation methodology (if they have agreements on the evaluation parameters). Intended outcome: Report Deadline: Long |

In this email discussion, we invite companies to share their views on further details about UE grouping as a paging enhancement method for UE power saving. Moreover, since we received RAN1 LS [1] about the evaluation methodology, the models from RAN1 may be taken into account.

# Discussions

## Paging enhancement with UE grouping

The idea of paging enhancement by UE grouping is to reduce the probability that a UE decodes paging message and realizes that itself is not paged (i.e. the “false alarm” rate), using some kind of sub-group paging indication. Among to the contributions submitted to RAN2#111-e, 14 companies mentioned UE grouping as paging enhancement: Qualcomm [2], vivo [4], Xiaomi [6], Samsung [7], OPPO [8], ZTE [9], CATT [10], SONY [13], MediaTek [14], ITRI [15], CMCC [18], Huawei [19], Lenovo [20], and LG [23]. Therefore, we first discuss whether UE grouping should be considered as a kind of paging enhancement for UE power saving.

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

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| **Company name** | **Yes/No** | **Comments** |
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## Paging for UE subgroups

If UE grouping is considered as a kind of paging enhancement for UE power saving, UEs monitoring the same paging occasion (PO) are divided into subgroups, and the network needs to indicate whether a subgroup of UEs need to monitor paging message. Some contributions in RAN2#111-e provided more details about how to indicate paging for UE subgroups, for example

* Paging for UE subgroups using multiple P-RNTI:
	+ Additional P-RNTI(s) are introduced.
	+ Different UE subgroups monitor paging PDCCHs with CRCs scrambled different P-RNTIs.
	+ Supporting company: Qualcomm [2] **(1)**
* Paging for UE subgroups using different time/frequency resources:
	+ The paging message of different UE subgroups are transmitted on different time/frequency resources.
	+ Supporting company: OPPO [8] **(1)**
* Paging indication for UE subgroups using paging DCI:
	+ In paging DCI, network indicates whether each subgroup of UEs needs to monitor the corresponding paging PDSCH.
	+ Spare bits in paging DCI may be used, or we can define new DCI format.
	+ Supporting companies: vivo [4], Xiaomi [6], Samsung [7], OPPO [8], ZTE [9] **(5)**
* Paging early indication or wake-up signal (WUS) for UE subgroups:
	+ Transmit early indication or wake-up signal before paging occasion. The indication or WUS may apply to a subgroup of UEs.
	+ UE needs not to monitor PO in case of negative indication.
	+ Supporting companies: Xiaomi [6], MediaTek [14], ITRI [15], Huawei [19], LG [23] **(5)**

Note: This email discussion focus on UE grouping, and thus other proposals not related to UE grouping are not shown in the above list.

Although many details of this topic require RAN1 involvement, we think that RAN2 may list candidate solutions, and then inform RAN1 to continue the detailed designs. In the following discussions, we invite companies to share their views about the candidate solutions, and analyse what part of the power consumption can be saved with each solution. Initial justifications, e.g., power saving gain, may also be provided, if available. For both qualitative and quantitative analyses, please take in to account the evaluation methodology from RAN1 [1]. Please also specify your own assumptions beyond what RAN1 suggests.

**Q2: Should we consider “paging for UE subgroups using multiple P-RNTI” as a candidate solution? What part of power can be saved with this method? Please provide initial justifications, if available.**

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| **Company name** | **Yes/No** | **Comments** |
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**Q3: Should we consider “paging for UE subgroups using different time/frequency resources” as a candidate solution? What part of power can be saved with this method? Please provide initial justifications, if available.**

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| **Company name** | **Yes/No** | **Comments** |
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**Q4: Should we consider “paging indication for UE subgroups using paging DCI” as a candidate solution? What part of power can be saved with this method? Please provide initial justifications, if available.**

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| **Company name** | **Yes/No** | **Comments** |
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**Q5: Should we consider “paging early indication or wake-up signal (WUS) for UE subgroups” as a candidate solution? What part of power can be saved with this method? Please provide initial justifications, if available.**

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| **Company name** | **Yes/No** | **Comments** |
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**Q6: Should we consider any other candidate solution(s) for paging for UE subgroups? What part of power can be saved with the method(s)? Please provide initial justifications, if available.**

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| **Company name** | **Yes/No** | **Comments** |
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## How to group UEs

If UE grouping is applied, we need to find the methods to divide UEs into subgroups. One prior example of UE-group paging is the Group Wake Up Signal (GWUS) introduced in Rel-16, where a UE selects one WUS group based on its UE paging probability information and /or its UE NAS identity (UE ID). For UE grouping in Rel-17, we may start from these methods.

**Q7: Do you support UE grouping based on UE paging probability information?**

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| **Company name** | **Yes/No** | **Comments** |
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**Q8: Do you support UE grouping based on UE ID?**

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| **Company name** | **Yes/No** | **Comments** |
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**Q9: Do you support UE grouping based on any other methods?**

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| **Company name** | **Yes/No** | **Comments** |
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**Q10: Do you think UE grouping can be based on multiple methods? If yes, what methods should be supported?**

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| **Company name** | **Yes/No** | **Comments** |
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## Performance metrics

The purpose of paging enhancements in this WI is to reduce UE power consumption. Therefore, one major performance metric is the power saving gain (PSG), which can be calculated as:

$$PSG=\left(1-\frac{P\_{enh}}{P\_{base}}\right)×100\%$$

where *Pbase* and *Penh* denote the average power consumption of baseline and the enhanced methods, respectively.

In addition to power saving gain, there may be other performance metrics for us to evaluate potential solutions.

**Q11: In addition to power saving gain, what are the performance metrics for us to evaluate potential solutions?**

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| **Company name** | **Comments** |
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## Other issues

Both RAN1 and RAN2 are working on the paging enhancement topic. Based on our discussion above, we may need to send some information to RAN1.

**Q12: Based on RAN2 discussions, what information about UE grouping do we need to send to RAN1?**

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| **Company name** | **Comments** |
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Finally, please let us know if there is any other issue to be discussed.

**Q13: Is there any other issue about UE grouping to be discussed?**

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| **Company name** | **Comments** |
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# Conclusion

# Reference

1. R1-2007425 LS on evaluation methodology for UE power saving enhancements, RAN1
2. R2-2006608 Power saving enhancements for paging reception Qualcomm Inc
3. R2-2006654 UE power saving for paging procedures ETRI
4. R2-2006690 Paging enhancement in idle inactive mode for power saving vivo
5. R2-2006720 Paging enhancements to reduce UE power consumption Intel Corporation
6. R2-2006729 Discussion on UE Power saving for RRC-IDLE and RRC-INACTIVE State Xiaomi Communications
7. R2-2006774 Paging Enhancements to Reduce Unnecessary Paging receptions Samsung Electronics Co., Ltd
8. R2-2006790 Paging enhancement for power saving OPPO
9. R2-2006874 Solutions to reduce unnecessary paging reception ZTE corporation, Sanechips
10. R2-2006990 Considerations on paging enhancements for Power saving CATT
11. R2-2007115 False Paging Mitigation Apple
12. R2-2007116 Wakeup and Paging Reception Apple
13. R2-2007182 Discussion on reduction unnecessary UE paging receptions Sony
14. R2-2008361 Paging Enhancements for UE Power Saving in NR MediaTek Inc.
15. R2-2007249 Discussion on the UE grouping based solution for idle/inactive-mode UE power saving ITRI
16. R2-2007260 Paging enhancement to reduce unnecessary UE paging receptions Ericsson
17. R2-2007261 Exposure of connected mode TRS occasions to Idle and Inactive mode Ericsson
18. R2-2007437 Paging enhancement for idle inactive-mode UE power saving CMCC
19. R2-2007441 Discussion on paging enhancements Huawei, HiSilicon
20. R2-2007468 Consideration on Idle/inactive-mode UE power saving Lenovo, Motorola Mobility
21. R2-2007562 Potential TRS/CSI-RS occasion(s) Nokia, Nokia Shanghai Bell
22. R2-2007563 IDLE / INACTIVE mode UE power saving Nokia, Nokia Shanghai Bell
23. R2-2007990 Paging enhancement for power saving LG Electronics Inc.