**3GPP TSG-RAN WG2 Meeting #116 electronic R2-21xxxx**

**Online, 1 - 12 November 2021, 2021**

**Agenda Item: 8.9.3**

**Source: Xiaomi Communications (email discussion rapporteur)**

**Title: Summary of [AT116-e][045][ePowSav] Paging Subgrouping (Xiaomi)**

**Document for: Discussion and Decision**

# Introduction

This contribution provides a summary of the following email discussion:

* [AT116-e][045][ePowSav] Paging Subgrouping (Xiaomi)

 Scope: a) based on [R2-2109647](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2109647.zip), taking into account agreements above, for remaining proposals, collect one round of comments, attempt agreement offline,

 b) determine what configuration info need to broadcasted by gNB.

 Intended outcome: Report

 Deadline: Wed W2

Deadline for companies’ inputs:

For initial comments collection, before Nov 8th, 0900 UTC, Monday

For proposal checking and companies can further comment by Nov 9th,, 0900 UTC

# Contact information

|  |  |
| --- | --- |
| Company | Name and email address |
| Xiaomi | Li Yanhua; liyanhua1@xiaomi.com |
| Qualcomm | Linhai He (linhaihe@qti.qualcomm.com) |
| Ericsson | Martin van der Zee (martin.van.der.zee@ericsson.com) |
| Yunsong Yang | Yunsong Yang (yyang1@futurewei.com) |
| Sequans | Noam Cayron (noam.cayron@sequans.com) |

# Discussion

## 3.1 General

In the current RAN2 #116e meeting, the following agreements were made [1].

|  |
| --- |
| => Assume that one subgroup indication refer to either CN assigned subgroups or UE-ID based subgroup (no overlapping)=> Both UE ID based and CN based subgrouping can be supported simultaneously in a cell, it is allowed to just support one of them. => FFS if the total number of CN-assigned subgroups is OAM configured. Max would be 8 as this is what RAN support.  |

Following agreements were made in the previous RAN1 #106-bis meetings:

|  |
| --- |
| **From RAN1 #106-bis-e:**AgreementFor NR Rel-17, paging indications to UE subgroups are carried only in PEI.Agreement For PEI, a new DCI format is supported to include at least paging indications to UE group(s)/subgroups of the associated PO(s)* One bit in the DCI payload indicating one UE subgroup of a PO or one UE group/PO
* The maximum number of total bits for paging indication field in PEI DCI format is x
	+ One PEI can be configured to indicate up to 4 PO(s) in a PF
		- FFS whether to supporting map PEI to 3 POs in a PF
	+ FFS: 1 PEI for POs across multiple PFs
	+ FFS: value of x
 |

And on the draft RRC parameters list for R17 power saving in RAN1 [5], a new parameter, subgroupsNumPerPO, was introduced to indicate the “*Number of subgroups supported per PO in the cell, for UE to read the subgroup indication from physical layer signaling*”:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **WI code** | **Sub-feature group** | **RAN1 specification** | **Section** | **RAN2 Parent IE** | **RAN2 ASN.1 name** | **Parameter name in the spec** | **New or existing?** | **Parameter name in the text** | **Description** | **Value range** | **Default value aspect** | **Per (UE, cell, TRP, …)** | **UE-specific or Cell-specific** | **Specification** | **Comment** |
| **8.7.1.1 Paging Enh.** |
|  | Paging enhancement | 38.213 |   |  |   | subgroupsNumPerPO | new |   | Number of subgroups per Paging Occasion (PO) for UE to read subgroups indication from physical-layer singling | TBD with maximum of 8  |   | per cell | cell-specifc |   | Agreement:For UE subgroups indication in physical layer, maximum of 8 subgroups per PO is supported. |

And we also received the LS from SA2 with the following were captured in the cover sheet [3] (may be somewhat outdated, co-sourced by QC, MTK, Apple, Ericsson, HW):

|  |
| --- |
| Given the above, the following impacts to SA2 specification TS 23.501 are identified:1. UE may provide “UE paging probability” to aid AMF in decision for paging subgrouping.
2. AMF may assign a paging subgroup ID. If assigned it provides to RAN in N2 paging request.
3. Even if AMF does not assign, RAN needs to know UE supports paging subgrouping. Proposal: UE provides NR paging subgrouping information in registration request. AMF indicates NR paging subgrouping support to UE in Registration Accept and to NG-RAN in N2 paging request.
4. It is assumed that a UE that supports NR paging subgrouping support both 5GC assigned NR paging subgroup and NR paging subgroup by randomization, this simplifies the negotiation.
 |

## 3.2 RAN capability

This is mainly focusing on RAN capability for CN-assigned subgrouping and/or UE-ID based subgrouping. Since RAN1 decided the total number of L1 subgroups per PO (*subgroupsNumPerPO*), and we need to know how to split those L1 subgroups into the 2 methods.

### 3.2.1 Co-exist of CN-assigned subgrouping and UE-ID subgrouping

The network can broadcast its support for both CN assigned subgrouping and UE-ID based subgrouping. Since we have agreed the hard split between the 2 methods, we have to split the L1 subgroups for each separately. An example is there are two separate sets of subgroups at the same time, e.g., X (>=0) number of L1 subgroups for CN based subgroups and the rest are for UE-ID based subgrouping as show in the figure. Note X is less than *subgroupsNumPerPO.*



Figure 1: an example of Co-exist case

Q1: Do Companies agree that RAN indicates a parameter Nsg-CN to indicate how many L1 subgroups are used for CN-assigned subgrouping?

|  |  |  |
| --- | --- | --- |
| Company  | Yes/No | Comments |
| Qualcomm | See comment | If the number of CN-assigned subgroups Nsg-CN is predefined in the specs, since RAN2 have agreed that there is no remapping of subgroup assignment in RAN, the minimum value for *subgroupsNumPerPO* should be Nsg-CN. Then the number of UE-ID based subgroups equals *subgroupsNumPerPO* - Nsg-CN. Therefore, in this case there is no need for gNB to advertise how many L1 subgroups are used for CN-assigned subgrouping.If the number of CN-assigned subgroups is not predefined (e.g. configured by OAM), then UE which has a CN-assigned subgroup ID does not need to know how many subgroups gNB allocates for CN-assigned subgrouping, i.e. the simplest solution is to have one-to-one mapping between CN-assigned subgroup ID and L1 subgroup ID. Then for UEs supporting UE-ID based subgrouping, they need to know how many subgroups are assigned for them (Nsg-UEID). Whether Nsg-CN can be used to derive that number may depend on another issue, i.e. whether CN-assigned and UE-ID based should be separate capabilities or not. If they are separate capabilities, then it is a bit odd to require UEs which are only capable of UE-ID based subgrouping to understand and process Nsg-CN. |
| Intel | Yes to implicit;No to explicit | We think it is better that the number of subgroups for UEID based subgrouping is explicitly signalled by the network since it is needed by the UE to work out the subgroups for the UEID based subgrouping. In this case, the network does not need to indicate explicitly a parameter Nsg-CN. The following implicit indications are possible: a) PEI configuration with L1 subgrouping bits without UEID based subgrouping configuration (I.e. indicate the number of subgroups for UEID based subgrouping) indicates RAN support of CN based subgrouping only. b)  PEI configuration with L1 subgrouping bits with UEID based subgrouping configuration and not all L1 subgrouping bits are used by UEID based subgrouping configuration. This means that CN based subgrouping is supported and the remaining L1 subgrouping bits are for CN based subgrouping. Moreover, if all L1 subgrouping bits are used by UEID based subgrouping configuration means that CN based subgrouping is not supported in the cell.  |
| Ericsson | See comment | In our view RAN2 should wait for RAN1 agreement on the available bits for subgrouping and the 1:N PEI to PO mapping options. In our view it should be configurable if one or both subgrouping methods are used in the cell, and what the 1:N PEI to PO mapping (N=1, 2, 3 or 4) is. We would not configure both methods simultaneous in the cell, because we do not see the need for it and it requires more bits in the PEI, i.e. we rather use the PEI bits to enable a 1:N mapping and reduce the number of PEI transmissions. We hope that RAN1 agrees that the PEI DCI can support up to 32 bits, which would enable 8 subgroups with a 1:4 PEI to PO mapping (POs in the same PF). If only up to 16 bits are available then only 1:2 PEI to PO mapping can be configured. But we think that the CN should also be able to signal the number of subgroups it uses, i.e. in case the CN only uses 4 subgroups than RAN can configure 4 subgroups and a 1:4 mapping with a 16 bit DCI. RAN should not "remap" CN-assigned subgroups to save bits in the DCI, because the RAN may group them together in a wrong way. We also think there is no need for this now that RAN1 has agreed on DCI based PEI, i.e. not support sequence based PEI.  |
| Futurewei | No | It is not very useful to advertise the total number of CN-assigned subgroups to individual UEs, whether they have a CN-assigned subgroup ID or not. All a UE care is which method(s) is/are supported in the cell, whether the UE has a CN-assigned subgroup ID or not, and if the UE has no CN-assigned subgroup ID and UEID-based subgrouping is supported by the cell and the UE, how many UEID-based subgroup IDs are supported and where these subgroup IDs begin (assuming the CN-assigned subgroup IDs, if any, always begin from 0). So, the PEI configuration should include the total L1 subgrouping bits per PO (i.e., *subgroupsNumPerPO* or Nsg) and the total number of UEID-based subgroups per PO (i.e., Nsg-UEID). If Nsg-UEID = 0, only CN-assigned subgrouping is supported in the cell. * For a UE having a CN-assigned subgroup ID, the UE uses the CN-assigned subgroup ID as is when monitoring PEI.
* For a UE having no CN-assigned subgroup ID, the UE monitors its paging in the legacy way.

If Nsg-UEID = Nsg, only UEID-based subgrouping is supported in the cell.* For a UE capable of UEID-based subgrouping, the UE uses a subgroup ID equal to the hash output when monitoring PEI.
* For a UE incapable of UEID-based subgrouping, the UE monitors its paging in the legacy way.

If 0 < Nsg-UEID < Nsg, both CN-assigned and UEID-based subgrouping are supported in the cell.* For a UE having a CN-assigned subgroup ID, the UE uses the CN-assigned subgroup ID as is when monitoring PEI.
* For a UE having no CN-assigned subgroup ID and being capable of UEID-based subgrouping, the UE uses a subgroup ID equal to the sum of (Nsg - Nsg-UEID) and the hash output when monitoring PEI.

For a UE having no CN-assigned subgroup ID and being incapable of UEID-based subgrouping, the UE monitors its paging in the legacy way. |
| Sequans | See comments | It is too early to decide, it depends on both design decisions from RAN1 and RAN2, as highlighted by comments from QC and Ericsson. If the number is not specified, it still remains to be seen whether CN grouping and UE-ID grouping are independent capabilities or not. |
| Samsung | See comments | We can wait for RAN1 to complete its design |

For the co-exist case, we are not sure the total number of CN assigned subgroups the CN can assign and whether it can be bigger than the Nsg-CN L1 subgroups the RAN can support (More RAN1’s input is needed for the DCI size design). But before that we can consider to resolve the “FFS if the total number of CN-assigned subgroups is OAM configured” in this meeting first. And we will further consider if some N to 1 mapping from CN assigned subgroups to Nsg-CN L1 subgroups or remapping solutions will be needed in the next meeting.

* Option 1: The total number of CN-assigned subgroups is fixed and specified
* Option 2: No need to specify, e.g., by OAM
* Option 3: The total number of CN-assigned subgroups is decided by CN and informed to RAN (I still list it here)

Q2: Which option do companies prefer described above for the total number of CN-assigned subgroups?

|  |  |  |
| --- | --- | --- |
| Company  | Option1/2/3 | Comments |
| Qualcomm | Option 1 | Option 1 is the simplest. We can support Option 2 if it is supported by majority. |
| Intel | Option 2 |  |
| Ericsson | Option 3 (preferred) or 2 | We think that companies agree that more than 8 subgroups is not going to give much benefit. But using less than 8 subgroups (e.g 4) would still be effective and it would save bits in the PEI, i.e. reduce the PEI size (improve the power saving gains assuming that the DCI format size is configurable). Given that the number of subgroups in RAN is configurable, then the number of subgroups in the CN should obviously also not be fixed.  |
| Futurewei | Option 3 (preferred) or 2 | We prefer this number not being fixed by specification. Either option 2 or 3 can be used for configuring such number. From interoperability PoV, option 3 may be preferred. |
| Sequans | Option 3 (preferred) or 2 | Agree with Ericsson |
| Samsung | Option 2 or option 3 |  |

### 3.2.2 CN-assigned subgrouping only

The second question is how gNB informs the UE that it supports CN-assigned subgrouping only. A candidate solution would be network to configure the total Lay1 subgroups for CN based subgroups or 0 Lay1 subgroup for UE-ID based grouping.

Q3: Do Companies agree that RAN indicates a parameter Nsg-CN with a value equal to *subgroupsNumPerPO*  indicate all the L1 subgroups are used for CN-assigned subgrouping ? (or some other options, you can add)

|  |  |  |
| --- | --- | --- |
| Company  | Yes/No | Comments |
| Qualcomm | See comment | We think the answer to this question again depends on how the number of CN-assigned subgrouping is assigned (e.g. predefined, configured, signaled, etc). If the proposal in Q1 is agreed, then the answer is yes. Otherwise, gNB can signal a one-bit indication for whether CN-assigned subgrouping is supported or not. |
| Intel | See our comments to Q1  |  |
| Ericsson | See our comments to Q1 |  |
| Futurewei | No | We think RAN should advertise Nsg-UEID instead. And, when Nsg-UEID = 0, all the L1 subgroups are used for CN-assigned subgrouping. Please see our response to Q1.  |
| Sequans | See comments to Q1 |  |
| Samsung | No | Based on number of UE ID based subgroups and PEI bits, UE can know whether CN assigned subgrouping is supported or not. Alternate would be to have a 1 bit indication. |

### 3.2.3 UE-ID based subgrouping only

It is also possible for RAN to not spare any L1 subgroup used for CN assigned subgrouping which means all the RAN configured L1 subgroups per PO will be used by UE-ID assigned subgrouping by default.

A candidate solution would be network to configure Nsg-CN to 0 or the absence of Nsg-CN can indicate implicitly that the total Lay1 subgroups are for UE-ID based grouping.

* Option 1: Explicitly, by configuring Nsg-CN =0
* Option 2: Implicitly way, by absence of Nsg-CN

Q4: Which option do companies prefer described above for RAN indicating only support UE-ID based subgrouping?

|  |  |  |
| --- | --- | --- |
| Company  | Option1/2 | Comments |
| Qualcomm | See comment | For UE which has a CN-assigned subgroup ID, designs discussed in Q1~3 will allow them to determine whether CN-assigned subgrouping is supported by the cell or not. This also includes UEs which support both types of subgrouping, as we have agreed that CN-based subgrouping always has higher priority than UE-ID based subgrouping. For UE which can only support UE-ID based subgrouping, they do not need to know if only UE-ID based subgrouping is supported. They only need to know how many such subgroups are configured for them to use. Therefore, we are not sure if this issue needs to be discussed.  |
| Intel | See our comments to Q1  |  |
| Ericsson | See our comments to Q1 |  |
| Futurewei | No | We think RAN should advertise Nsg-UEID instead. And, when Nsg-UEID = Nsg, all the L1 subgroups are used for UEID-based subgrouping. Please see our response to Q1.  |
| Sequans | See comments to Q1 |  |
| Samsung | No | In RAN2#115 following was agreed* At least for UEID-based subgroup method the total number, Nsg, of supported subgroups by the network is decided by RAN and broadcasted in System Information

This is sufficient. If network supports UEID-based subgrouping, it will broadcast number of UE ID based subgroups, otherwise not. |

### 3.2.4 Not support any of them

Q5: Do companies agree that RAN indicates not support any of them by not giving the supported L1 subgroups for subgrouping (e.g., no PEI subgrouping configuration)?

|  |  |  |
| --- | --- | --- |
| Company  | Yes/No | Comments |
| Qualcomm | Yes | gNB support for subgrouping is optional. |
| Intel | See comments | Subgrouping support is an integral part of the PEI and vice versa. Hence this will mean that no PEI configuration is provided in the cell (i.e. not just no subgrouping configuration in the PEI configuration) |
| Ericsson | Yes | In addition to the comments provided by QC and Intel above:* CN subgrouping, UE-ID subgrouping and PEI (without subgrouping) are optional for gNB to support/configure
* If subgrouping is configured, PEI shall also be configured
* gNB may configure CN-subgrouping without UE-ID (and vice versa) or both
 |
| Futurewei | Yes | As an optional feature, no configuration, no support. |
| Sequans | Yes |  |
| Samsung | See comments | Same view as intel |

## 3.3 issues related to other WG

This session relates to issues related to other WG.

We only capture the results of UE capability. UE assistance information is currently discussed in a separate email (CMCC) and the proponent company will treat RAN paging in another email (Ericsson, 046).

Note other issues discussed in [4] (e.g., negotiations between CN and gNBs) are currently dropped here since people show not much interest.

### 3.3.1 UE capability

Q6 is about the UE capability.

20 companies provide inputs for this question in [3].

* 12/19 companies support (option 1) that introduce common UE capability for UE-ID based subgrouping and network-assigned subgrouping in CN and RAN. With key argument is that option 1 is a simple scheme and from UE perspective there is no too much difference.
* 8/19 companies support option 2:
	+ 5 companies support (option 2a) that RAN only needs to care about UE’s capability of supporting the UE ID based subgrouping while UE’s capability of supporting the CN-assigned subgrouping is handled in NAS.
	+ 3 companies support (option 2b) that both capabilities are reported to CN by NAS signalling and CN forwards both to RAN in paging message. Futurewei brings a point that we need to transfer UE’s AS capability when escalating CN-initiated paging to support 2b.

**Proposal: No consensus on whether subgrouping capability is common or separate.**

* Option 1: introduce common UE capability (i.e., only one UE capability reported to RAN or CN by NAS);
* Option 2: introduce separate UE capabilities;
* Option 2a: UE’s capability of supporting the UE ID based subgrouping is reported to RAN by AS UE capability signalling while UE’s capability of supporting the CN-assigned subgrouping is reported to CN by NAS signalling).
* Option2b: both capabilities are reported to CN by NAS signalling and CN forwards both to RAN in paging message

And a question is asked to people: can companies accept what is captured in [3]? If not, we will further discuss in RAN2.

Q6: Can companies accept what is captured in [3]? If not, we will further discuss in RAN2.

|  |  |  |
| --- | --- | --- |
| Company  | Yes/No | Comments |
| Qualcomm | No | First, SA2 did not state in their LS (S2-2107856/R2-2111234) that UE capability for those two types of subgroups must be common. Even if the text provided by the rapporteur is some agreement made by SA2, it is only an assumption they prefer, from SA2’s perspective. From UE’s perspective, support for CN-assigned subgrouping is a core network capability and should be reported to CN via NAS signaling. UE-ID based subgrouping, which does not involve CN at all, should be a RAN paging capability and be reported to RAN by RRC signaling in UE Radio Paging Information. From implementation point of view, because CN-assigned subgrouping involves updates to both CN and RAN, one can expect that UE-ID based subgrouping likely will be deployed earlier than CN-based subgrouping. In that case, having separate capabilities for different types of subgrouping can help reduce implementation complexity and effort. |
| Intel | No (but see comments) | While we think option 1 (i.e. “*introduce common UE capability*” and in SA2 LS [3] via NAS) is sufficient from UE implementation point of view, we need a bit in the UE AS capability at least for inter-operability testing perspective. Further, the UE ID based subgrouping is reported to RAN by AS UE capability signalling is the normal way (i.e. consistent) in which UE provides UE RAN capability as this information is required by gNB for paging. Hence we think UEID based subgrouping as a UE AS capability bit is better (i.e. we support option 2 “*introduce separate UE capabilities*”).  We understand that CN needs to know whether the UE supports CN based subgrouping.  Hence we suggest first agreeing that UE supports CN based subgrouping is provided via NAS.  |
| Ericsson | See comments | In our view the RAN may configure UE-ID, CN-assigned, or both. From this perspective, we think that the UE may support UE-ID based only. Because we will not provide IOT test opportunity for CN-based subgrouping in case we only want to deploy UE-ID based RAN subgrouping. It can be discussed further if a UE that supports CN-assigned, shall also support UE-ID based subgrouping.  |
| Futurewei | No | We supported option 2b in the original discussion, because when the CN escalates or floods the paging for a UE, some gNBs supporting only the UEID-based subgrouping may not have the UE’s capability regarding the UE’s support of UEID-based subgrouping and need to know it from the CN. |
| Sequans | Yes? | It seems to us that the question is asking whether one of the three options in [4] is acceptable, in which case the answer is yes. If the question is about the LS we are not sure what it is expected of us to agree or not to, it is statements by SA2.  |
| Samsung |  | We support option 1 |

### 3.3.2 LS to CT1/SA2

Rapporteur thinks at least the progress or decisions on the following topics made by RAN2 should be informed to CT1/SA2.

* The total number of CN-assigned subgroups CN can assign in Q2;
* UE capability in Q6.

Q7: Can companies agree that a LS should be sent to CT1/SA2 to capture the progress of RAN2?

|  |  |  |
| --- | --- | --- |
| Company  | Yes/No | Comments |
| Qualcomm | Yes |  |
| Intel | Yes. LS should also include RAN3 | Agree with the rapporteur, LS needs to be sent to CT1, ~~/~~SA2 and RAN3 for the above topics   |
| Futurewei | Yes |  |
| Sequans | Maybe | Depends on the actual progress, but yes in principle |
| Samsung | May be |  |

## 3.4 Other

Q8: Any other relevant issue to discuss (Only limits to paging subgrouping)?

|  |  |
| --- | --- |
| Company | Issue description  |
|  |  |
|  |  |

Summary:

# Conclusions

Based on companies’ inputs to this email discussion, the following proposals are listed for agreement:

# References

1. RAN2 #116-e Meeting minutes
2. R2-2108917, LS on UE Power Saving, MTK
3. [R2-2111234](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_116-e/Docs/R2-2111234.zip) LS Reply on UE Power Saving (S2-2107856)
4. [R2-2109647](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2109647.zip) Summary of [Post115-e][089][ePowSav] Paging Subgrouping, xiaomi
5. [R2-2111246](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2111246.zip) LS on Re-17 LTE and NR higher-layers parameter list (R1-2110575; contact: Ericsson)