3GPP TSG-RAN WG2 Meeting #117 electronic R2-220xxxx

Online, Feb. 21 – March 3, 2022

Agenda Item: 8.9.3.1

Source: MediaTek Inc.

**Title: Report of [AT117-e][004][ePowSav] PEI and paging subgrouping**

Document for: Discussion and decision

# Introduction

This report is for the following offline discussion during RAN2#117-e:

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| --- |
| * [AT117-e][004][ePowSav] PEI and paging subgrouping (MediaTek)   Scope:  Following the on-line discussion on R2-2202769:  a) clarify details on UE behaviour for PEI in last cell, e.g. UE storing last cell info etc, and related TS impacts (can ask input on what need to be clarified).  b) whether we can assume that PEI with no subgrouping is implemented by using PEI + UEID subgrouping with one subgroup, or whether also other variants should be supported.  Treat R2-2203720 (taking into account on-line agreements).  Determine agreeable points, points for discussion if needed  Intended outcome: Report.  Deadline: In time for CB online W2 Tuesday |

In Week1, RAN2 made the following agreements, which should be taken into account in this discussion.

|  |
| --- |
| * PEI + UEID subgrouping is one capability * Network indicates whether UE monitors PEI in last used cell in system information. |

Rapporteur invites companies to provide their comments before **23:59 UTC, Feb. 27 (Sun)**, so as to allow some time report preparation.

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# Discussion

## UE behaviour for PEI in last cell

RAN2 just agreed that the network indicates whether UE monitors PEI in last used cell in system information. A rough description of UE behaviour could be as follows: When PEI-capable UE is released, it monitors the PEI in the same cell if PEI is broadcasted there. Once the UE moves and reselects to another cell, it checks the “last used cell” indication in the new cell, and monitors PEI only if the indication is negative (i.e., PEI is not restricted to the last used cell).

From the online and offline discussions, Rapporteur sees the following discussion points for UE behaviour:

* A UE may reselect to another cell and then reselect back to the last used cell, while keeping Idle/Inactive. Should UE store the “last used cell” information so that it can monitor PEI in the last used cell?
* If UE stores the “last used cell” information, will this information expire? (i.e., is there an associated timer?)
* Can one “last used cell only” indication be applied to all subgroups, or separate indication is needed for each subgroup?
* Do we need “no last cell update” in *RRCRelease* message for NR PEI (similar to *noLastCellUpdate* in *RRCConnectionRelease* for LTE WUS)?
* Implementation in TS: RRC CR rapporteur suggested that we make the “last used cell only” indication cell-specific and broadcast it along with PEI configuration, for example:

PEI-Config-r17 ::= SEQUENCE {

pei-SearchSpace-r17 SearchSpaceId,

po-NumPerPEI-r17 ENUMERATED {1, 2, 4, 8},

payloadSizeDCI-2-7-r17 INTEGER (1..maxDCI-2-7-Size-r17),

pei-FrameOffset-r17 FFS,

firstPDCCH-MonitoringOccasionOfPEI-O-r17 FFS,

subgroupConfig-r17 SubgroupConfig-r17 OPTIONAL, -- Need R

lastUsedCellOnly ENUMERATED {true} OPTIONAL,

...

}

The abovementioned discussion points are formulated into the questions below.

**Q1.1: Should a PEI-capable UE store the “last used cell” information?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| MediaTek | Y | If UE reselects back to the cell where it was released, it should be able to monitor PEI there even if a “last used cell only” indication is set. |
| Samsung | Y | Agree with MediaTek views. |
| Nokia | Y |  |
| Ericsson | Y |  |
| InterDigital | Y |  |
| Qualcomm | Y |  |
| Apple | Y | This aligns with the definition of “last used cell only” |
| ZTE | Y |  |
| DENSO | Y |  |
| OPPO | Y |  |
| LGE | Y | Agree with MediaTek. |
| CATT | Y or impl. | Network anyways behaves as if the UE didn’t reselect, i.e. it sends the PEI. But from UE perspective, it can actually be left to UE implementation. After all, if UE does not want to recall its last used cell to save complexity, it will not take profit of the PEI sent by the network when it comes back to its last used cell. So it can be viewed as a UE implementation tradeoff. |
| Intel | Yes | It should be “last connected cell” rather than the “last used cell”. Another thing is what is that information being stored by the UE? |
| Xiaomi | Yes, but | In my understanding, UE judges the last used cell by receiving a RRCRelease message (without ““no last cell update”).  If the question is for the case that the UE reselect to another cell and not performed a RRC release and then reselect back to the last used cell, I think UE still stores the original cell as the last used cell. If UE reselect to another cell and performed a RRC release and then reselect back to the original cell and performed a RRC release, I think UE still update the original cell as the last used cell.  UE should store the “last used cell” information after a successful RRCRelease. |
| CMCC | Yes | Also agree CATT about UE implement. |
| Huawei, HiSilicon | Y |  |
| vivo | See comments | From UE point of view, it should be up to UE implementation.  From NW point of view, NW should always assume UE stores the “last used cell” information.  Then, NW broadcasts PEI for the UE which has released from this cell. But from UE side, if UE has not performed cell selection/reselection, UE would use PEI for paging reception. If UE has reselected to another cell and reselected back to this cell, UE could either use PEI or not for paging reception.  Thus, there is no need to restrict UE behaviour on whether storing the “last used cell” information. |
| Sequans | Yes | Agree that in practice from UE PoV this is implementational but that is basically true of the entire feature, UE can always skip PEI occasion and just monitor paging directly. |
| Futurewei | Yes | NW, especially those cells that broadcasts the “last used cell only” indication, expects that a PEI-capable UE stores its “last used cell”. |

Summary

Totally 19 companies responded to this question, among them 18 agreed that UE stores “last used cell” information, while one company didn’t see the need of such a restriction for UE. 4 companies mentioned that from UE point of view, storing “last used cell” information may be up to UE implementation, that is, if UE does not want to recall its last used cell to save complexity, it will not take profit of the PEI sent by the network when it comes back to its last used cell. Two companies have concern on the meaning of “last used cell”, suggesting that it should be clarified as “last used cell after successful RRCRelease” or “last connected cell”.

Rapporteur agrees that it is possible to allow UE implementation for storing “last used cell” information, i.e., UE stores “last used cell” information if it wants to monitor PEI when reselecting back to the last used cell. However, network has no idea about UE cell reselection, and as Futurewei commented, NW, especially those cells that broadcasts the “last used cell only” indication, expects that a PEI-capable UE stores its “last used cell”. Therefore, Rapporteur suggests that we follow majority view that a PEI-capable UE stores “last used cell” information. As for the meaning of “last used cell”, Rapporteur thinks the meaning is clear to all company, thus we can keep this term, and see if a better name is needed in running CR discussions.

**Proposal 1: (Easy agreement) [18/19] A PEI-capable UE stores its “last used cell” information.**

**Q1.2: If UE stores “last used cell” information, is there an associated timer for it?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| MediaTek | N | If a timer is introduced, the network and UE behaviors may be more complicated. |
| Samsung | N | Do not see any need to have timer. |
| Nokia | N |  |
| Ericsson | N |  |
| InterDigital | N |  |
| Qualcomm | N |  |
| Apple | N |  |
| ZTE | N |  |
| DENSO | N |  |
| OPPO | N |  |
| LGE | N |  |
| CATT | N |  |
| Intel | N | The UE should keep it to the next RRC connection |
| Xiaomi | N | Agree with intel. |
| CMCC | N |  |
| Huawei, HiSilicon | N | We do not see the need to have an associated timer. |
| vivo | N | See above. |
| Sequans | N |  |
| Futurewei | N |  |

Summary

All 19 companies responded to this question agreed that there is no need to have an associated timer for the “last used cell” information stored by UE.

**Proposal 2: (Easy agreement) [19/19] Do not introduce an associated timer for the “last used cell” information stored by UE.**

**Q3: Can one “last used cell only” indication be applied to all subgroups?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| MediaTek | Y | We do not see the need of finer granularity then cell-specific configuration. |
| Samsung | Y | Do not see any need to have this indication on subgroup level |
| Nokia | Y |  |
| Ericsson | Y |  |
| InterDigital | Y |  |
| Qualcomm | Y |  |
| Apple | Y |  |
| ZTE | Y | No introduce any complicate mechanism for ‘last used cell only’ |
| DENSO | Y |  |
| OPPO | Y |  |
| LGE | Y | No reason to support the finer granularity for this. |
| CATT | Y |  |
| Intel | Y |  |
| Xiaomi | Y |  |
| CMCC | Y |  |
| Huawei, HiSilicon | Y | We also do not see the need to have separate indication at the subgroup level |
| Vivo | Y | In our understanding, “last used cell only” indication is introduced per cell, but unnecessary to be per subgroup. |
| Sequans | Y |  |
| Futurewei | Y | Agree on no need of finer granularity than cell level configuration for this. |

Summary

All 19 companies responded to this question agreed that the “lastUsedCellOnly” indication is a cell-level configuration and there is no per-subgroup indication.

**Proposal 3: (Easy agreement) [19/19] The “lastUsedCellOnly” indication is a cell-level configuration and there is no per-subgroup indication.**

**Q1.4: Do we need “no last cell update” in *RRCRelease* message for NR PEI?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| MediaTek | Y | We can reuse the LTE mechanism. |
| Samsung | - | Not clear why this is needed. |
| Nokia | - | Not clear |
| Ericsson | Y | There needs to be a clear agreement between the UE and the NW what the “last used cell” means. There is a risk for mismatch in case the connection is setup and released without CN involvement. Such scenario was identified for NB-IoT/eMTC (R2-2005985). We also think that the same mechanism can be reused. |
| InterDigital | Y | Agree with Ericsson |
| Qualcomm | Y | We are fine with reusing the corresponding LTE mechanism |
| Apple | Y |  |
| ZTE | Y | As LTE, it is needed. |
| DENSO | Y |  |
| OPPO | No | We don’t understand why this needed. |
| LGE | N | Not needed in NR. UE can just follow the PEI-Config in SIB. |
| CATT | Y but | … we should clarify the interaction with *lastUsedCellOnly* e.g. it is our understanding that if “no last cell update” is present in the release message, UE uses *lastUsedCellOnly* normally i.e., when reselecting a new cell, to check from that cell, whether it should continue monitoring PEI. But if “no last cell update” is absent in the release message, UE monitor PEI neither in the cell where it is released nor in any other reselected cell, irrespective of *lastUsedCellOnly*, right? |
| Intel | N | We do not see the need of optimization. The UE should only keep the last used/connected cell to the next RRC connection. |
| Xiaomi | See comments | Agree with Ericsson that the IE is to solve the mismatch in case the connection is setup and released without CN involvement.  For UE in NR, I guess that issue still exist. Or it has been resolved by CN?  So maybe a LS is needed to ask CT1 to confirm that. |
| CMCC | Y |  |
| Huawei, HiSilicon | Y | We are ok to reuse the similar mechanism as in LTE |
| vivo | N and see comments | From our sides, we think there may be mismatch issue between UE and NW on the “last used cell”. But we do not agree to use the approach in LTE, as we have already agreed to broadcast the “last used cell only” indication in SI.  Maybe NW side solution could resolve this issue, e.g. some coordination between gNB and CN. |
| Sequans | Y | Agree with Ericsson |
| Futurewei | Y |  |

Summary

Totally 19 companies responded to this question, among them 11 agreed to introduce “no last cell update” indication in *RRCRelease* message for NR PEI, while others do not see or doubt the need of this. Rapporteur thinks that we may first need to check if in NR it is possible to have connection setup and release without CN involvement, causing mismatched network and UE understanding about last used cell. Therefore, we may postpone the discussion, until RAN2 has better knowledge on this. We may send LS to SA2/CT1 for clarification.

**Proposal 4: (For discussion) [11/19] Postpone the discussion of “no last cell update” indication in *RRCRelease*, until RAN2 knows whether network and UE may have mismatched understanding about last used cell.**

**Q1.5: Can we adopt the proposed RRC configuration for *lastUsedCellOnly*?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| MediaTek | Y |  |
| Samsung | Y |  |
| Nokia | Y |  |
| Ericsson | Y |  |
| InterDigital | Y | Can alternatively reverse the meaning (so true means UE can monitor in other cells reselection) but either way seems fine. |
| Qualcomm | Y |  |
| Apple | Y |  |
| ZTE | Y |  |
| DENSO | Y |  |
| OPPO | Y |  |
| LGE | Y |  |
| CATT | Y |  |
| Intel | Y |  |
| Xiaomi | - | Not quite understand the question.  If it is to ask whether we can accept ***lastUsedCellOnly in SIB,*** it is yes.  Ifit is to ask whether we can accept ***lastUsedCellOnly in RRC release,*** it is No, which has been option2 we have excluded. |
| CMCC | Y |  |
| Huawei, HiSilicon | Y |  |
| vivo | Y |  |
| Sequans | Y |  |
| Futurewei | Y |  |

Summary

Totally 19 companies responded to this question, among them 18 supported the proposed RRC configuration for lastUsedCellOnly, i.e., to introduce a one-bit indication of *lastUsedCellOnly* in *PEI-Config*. Rapporteur suggests that RAN2 adopt this.

**Proposal 5: (Easy agreement) [18/19] Introduce a one-bit indication of *lastUsedCellOnly* in *PEI-Config*.**

**Q1.6: Is there any other issue to be discussed for UE behaviors about “last used cell only”? Please also provide your preference or proposed solutions.**

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | We think we need to clarify the actual meaning of the ‘last used cell only’, because the current agreements can not reflect how to use the RRC configuration of ‘lastusedcellOnly’   * Network indicates whether UE monitors PEI in last used cell in system information.   To our understanding, there are two interpretation on this agreements:  1: Upon a cell configured with *lastUsedCellOnly,* it indicates whether all UE released by this cell can use the PEI after re-selection to other cells.  2: Upon a cell configured with *lastUsedCellOnly,* it indicates whether all foreign UEs can use the PEI to receive paging.  To our understanding, the second interpretation maybe majorities’ understanding, so we would like to suggest to reflect the actual intention of the *lastUsedCellOnly* in the following discussion |
| vivo | Regarding ZTE’s comments, we share the view on 2nd interpretation.  For UE in the cell last released, PEI would be always used if configured.  For UE in other cells, PEI could be used only if there is no “*lastUsedCellOnly*” configuration or “*lastUsedCellOnly*” is negative (i.e., PEI is not restricted to the last used cell). |
| Sequans | Agree with ZTE it would be better to confirm the correct interpretation (we share the view that it’s the second one) |
| Futurewei | “last used cell” is the lasted used cell of the UE, no matter whether the UE is released by the current cell or has reselected the current cell while in IDLE/INACTIVE. Therefore, only the second interpretation makes a sense to us. |

Summary

Totally 4 companies responded to this question. Companies mentioned that there may be different interpretations for the RAN2 agreement of “Network indicates whether UE monitors PEI in last used cell in system information”, although they all agree to the “2nd interpretation” by ZTE. To avoid future confusion, Rapporteur suggests that we clarify the meaning of “last used cell only”, that is, when a cell broadcasts “last used cell only”, a UE monitors PEI only if its last connection was released by this cell.

**Proposal 6: (Easy agreement) [4/4] RAN2 clarifies the meaning of “last used cell only”: When a cell broadcasts “last used cell only”, a UE monitors PEI only if its last connection was released by this cell.**

## Implementation of PEI with no subgrouping

RAN2 just agreed that “PEI + UEID subgrouping is one capability”. If PEI-capable Ues always support UEID-based subgrouping, it seems that “PEI without subgrouping” can be implemented by having PEI plus UEID subgrouping with one subgroup.

We may first confirm companies’ understanding about the RAN2 agreement of “PEI + UEID subgrouping is one capability”: Does it mean that a PEI-capable UE must support at least UEID-based subgrouping method?

**Q2.1: Do you agree that a PEI-capable UE must support at least UEID-based subgrouping method?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| MediaTek | Y | This is our understanding about the RAN2 agreement. |
| Samsung | Y |  |
| Nokia | Y |  |
| Ericsson | Y |  |
| InterDigital | Y | Agreement is already clear, the question seems redundant |
| Qualcomm | Y | “PEI-capable UE” could be interpreted in different ways. But it does simplify both UE and RAN implementation if UE must support at least UE-ID based subgrouping if it supports PEI. |
| Apple | Y | Our understanding based on the agreement is that PEI and UEID based subgrouping go together |
| ZTE | Y |  |
| DENSO | Y |  |
| OPPO | Y |  |
| LGE | Y |  |
| CATT | Y | Per agreement |
| Intel | Y | As per agreement. It has to be made clear in the proposal that the UEID based subgrouping is part of R1 29-1 capability (i.e. only 1 capability for R1 29-1 and UEID based subgrouping). |
| Xiaomi | Y | PEI and UEID based subgrouping go together.  **a** PEI-capable UE must support at least UEID-based subgrouping method; and a UE capable of UE-ID based subgrouping also is PEI capable. |
| CMCC | Y |  |
| Huawei, HiSilicon | Y |  |
| Vivo | Y |  |
| Sequans | Y |  |
| Futurewei | Y |  |

Summary

Totally 19 companies responded to this question. All companies agree that a PEI-capable UE must support at least UEID-based subgrouping method. Rapporteur suggests that RAN2 captures this agreement.

**Proposal 7: (Easy agreement) [19/19] A PEI-capable UE must support at least UEID-based subgrouping method.**

If the answer to Q2.1 is ‘yes’, we would like to know if network can implement “PEI without subgrouping” by configuring PEI plus UEID subgrouping with one subgroup (and no CN-assigned subgroups). That is, in *PEI-Config*, *subgroup-Config* is present, and Nsg-UEID = 1.

**Q2.2: If PEI-capable UEs always support UEID-based subgrouping, do you agree that “PEI without subgrouping” can be implemented by configuring PEI plus UEID subgrouping with one subgroup?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| MediaTek | Y | Then we need an additional rule: UEs with CN-assigned subgroup ID should derive UEID-based subgroup ID when monitoring PEI in a cell supporting only UEID-based subgrouping. |
| Samsung | Y |  |
| Nokia | Y | Agree with MediaTek. But it should be supported anyway for more than one subgroup case as well since it is possible that UE support CN assignment and UE-ID based while the cell support UE-ID only. |
| Ericsson | Y | We are fine with either this, or that the subgrouping configuration is absent. Note that for both of these cases (if NW uses either 0 or 1 group) RAN1 has already defined that that there will be one bit in PEI that the UEs follow, see highlighted below:   * The paging indication field of PEI DCI format comprises of *POnumPerPEI* segment(s) of *K* bit   + *K* = 1, if RAN2 is absent or set to 0 or 1,   + *K* = RAN2, if RAN2 is configured. |
| InterDigital | Y | Agree with Ericsson that either of those ways work fine. Also agree with Mediatek – if the cell configures only UE-ID based then this is what UE should use even if it has an assigned CN based subgroup. |
| Qualcomm | Y | Agree with both MediaTek and Ericsson. |
| Apple | Y | In this case, we understand that the specific bit corresponding to K=1 is used to carry the paging indication to that single (implicit) subgroup |
| ZTE | Y | With the agreement that there is only one capability for PEI and UE ID based subgrouping, it is for sure that there are two UE types:  1: PEI+UE ID based subgrouping  2: PEI+UE ID based subgrouping+CN assigned subgrouping  The main intention of ‘PEI configuration without subgoupConfig’ is to wake up all PEI capable UEs based on the assumption of separate capabilities of UE ID based subgrouping and CN assigned subgrouping. If CN assigned subgrouping capable UE must support UE ID based subgrouping, the PEI with out subgroupConfig become non-sense since PEI+ 1 UE ID subgroup can realize the intention. |
| DENSO | Y | And we think the NW can also configure PEI with one CN-assigned subgroup to implement “PEI without subgrouping”. That is, *subgroup-Config* is present and *subgroupsNumPerPO* = 1, but Nsg-UEID is absent in *PEI-Config*. |
| OPPO | Y |  |
| LGE | Y |  |
| CATT | Y | Agree with Ericsson and MediaTek. |
| Intel | Y | When UE is in a cell supporting only UEID-based subgrouping, it will perform UEID based subgrouping regardless of whether it is assigned a CN assigned subgroup. |
| Xiaomi | Y, but | We are fine with this.  And agree with Ericsson that the subgrouping configuration is absent or set to 0 should also be captured. Because RAN1 has decided this. If not, a LS should be sent to RAN1 to inform this.  The subgrouping configuration is absent also mean to wake up all PEI capable UEs, no matter it is:  1: PEI+UE ID based subgrouping  2: PEI+UE ID based subgrouping+CN assigned subgrouping  There is no contradiction here. |
| CMCC | Y | Agree with MTK and Ericsson. We think that all PEI-capable UEs should be woken up by the same 1-bit indication in the PEI. Besides, we agree with other companies that the UE capability of CN assigned subgrouping implicitly indicates that the UE is also capable of PEI+UEID subgrouping. |
| Huawei, HiSilicon | Y | In view of the current agreement we also think that “PEI without subgrouping” means that UEID subgrouping is supported with one subgroup |
| vivo | Y with comment | We agree it can be implemented. However, it also implicates that the RAN supports UEID subgrouping.  We share the same view as Ericsson, that another implementation is the subgrouping configuration is absent, as RAN1 has agreed and captured that K=1 if subgroupNumPerPO is absent or set to 0 or 1. With this understanding, there is no need to make restriction on the implementation. |
| Sequans | Y |  |
| Futurewei | Y with comment | Indeed, this can be the second way for indicating “PEI without subgrouping”. (The first being broadcasting PEI-Config-r17 without subgroupConfig-r17.) **However, it is insufficient by just saying that subgroupNumPerPO is present and Nsg-UEID equal to 1. Both subgroupNumPerPO and Nsg-UEID needs to be 1.**  We disagree with Denso’s suggestion that “PEI without subgrouping” can be implemented as configuring PEI with one CN-assigned subgroup only. There may be cases where the CN only care to protect (and therefore assign a CN-assigned subgroup ID to them) one type of UEs and the rest of the UEs are don’t care (therefore receiving no CN-assigned subgroup ID). If a cell is capable of supporting only one subgroup and the cell supports CN-assigned subgrouping, then that subgroup is used only for those UEs that has a CN-assigned subgroup ID. UEs having no CN-assigned subgroup ID would have to receive paging in the legacy way in this cell. So, this is different than “PEI without subgrouping”. |

Summary

Totally 19 companies responded to this question. All companies agreed that PEI without subgrouping” can be implemented by configuring PEI plus UEID subgrouping with one subgroup (i.e., both *subgroupNumPerPO* and Nsg-UEID are set to 1). Moreover, 7 companies mentioned that if this is agreed, a UE with CN-assigned subgroup ID should derive UEID-based subgroup in a cell supporting only UEID-based subgrouping (not limited to the “one subgroup” case). There are also comments about whether different configurations (e.g., having subgroup-Config absent) can also be used for PEI without subgrouping; this is actually discussed in the next question.

Rapporteur suggests that RAN2 confirm that “PEI without subgrouping” can be implemented by configuring PEI plus UEID-based subgrouping with one subgroup (i.e., both *subgroupNumPerPO* and Nsg-UEID are set to 1). Also, we may have some discussion to confirm that a UE with CN-assigned subgroup ID should derive UEID-based subgroup ID in a cell supporting only UEID-based subgrouping.

**Proposal 8: (Easy agreement) [19/19] RAN2 confirms that “PEI without subgrouping” can be implemented by configuring PEI plus UEID subgrouping with one subgroup.**

**Proposal 9: (For discussion) [7/19] A UE with CN-assigned subgroup ID should derive UEID-based subgroup ID in a cell supporting only UEID-based subgrouping.**

Another way to implement “PEI without subgrouping” is to have *subgroup-Config* absent in *PEI-Config*. If the answer to Q2.2 is ‘yes’, we will have two method for network to implement “PEI without subgrouping”.

**Q2.3: Should we allow multiple methods for network to implement “PEI without subgrouping”?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| MediaTek | N | We’d like to keep things simple. In RAN1 discussion of (PDCCH-based) PEI format, RAN1 implicitly assumed that every UE has a subgroup ID, and a corresponding bit is used for paging indication. What described in Q2.2 can be considered as the only implementation for “PEI without subgrouping”. Then *subgroup-Config* must present in *PEI-Config*. |
| Samsung | N |  |
| Nokia | N | Depends on the result of Q2.1. and Q2.2 whether *subgroup-Config* absent in *PEI-Config* needs to be supported. |
| Ericsson | N | One method is enough. However, we are fine with any of the two methods discussed. None of these methods have impact on RAN1 either as indicated by us in Q2.2. |
| InterDigital | N |  |
| Qualcomm | N | We have the same comment as Ericsson |
| Apple | N | In the interest of keeping it simple, this one method is enough |
| ZTE | N |  |
| DENSO | N |  |
| OPPO | Y | Why do we need to restrict network’s implementation if both methods work and have no impact on RAN1. |
| LGE | N |  |
| CATT | N | We also prefer to keep things simple. We would then have a slight preference for the method of Q2.2 (*PEI-Config*, *subgroup-Config* is present, and Nsg-UEID = 1). |
| Intel | N | We also prefer one configuration for the network to support “PEI without subgrouping” |
| Xiaomi | Y | See comments to Q.2.2  If both methods work and have no impact on RAN1, we are fine. |
| CMCC | N |  |
| Huawei, HiSilicon | N | The interpretation for Q2.2 for “PEI without subgrouping” is simple and straightforward. We need not have other method to implement this. |
| vivo | Y | Is there any problem if we allow multiple methods for NW implementation?  Otherwise, we should not restrict the network flexibility. |
| Sequans | N | Agree with Ericsson |
| Futurewei | N | We are fine to down-select either of the two valid ways. |

Summary

Totally 19 companies responded to this question, among them 16 did not want to have multiple methods to configure “PEI without subgrouping”, while 3 think this should be allowed. Rapporteur suggests that we follow majority to have only one method to configured “PEI without subgrouping”. If Proposal 8 is agreed, “PEI without subgrouping” will be configured by PEI with one UEID-based subgroup. Moreover, Rapporteur would like to clarify that the RAN1 agreement of “K = 1, if *subgroupNumPerPO* is absent or set to 0 or 1” was made then because RAN1 was not sure how RAN2 would design the configurations, and this does not imply that RAN2 needs to support all 3 cases.

**Proposal 10: (Easy agreement) [16/19] “PEI without subgrouping” can be configured by only one method.**

## Proposals in R2-2203720 (AI summary)

AI summary for 8.9.3.2.1 is provided in [1], where we have the following proposals:

|  |
| --- |
| Easy agreements  **Proposal 1: When PEI is applied with eDRX, the UEID for UEID-based subgrouping is determined by 5G-S-TMSI mod 32768.**  **Proposal 2: No special handling or configuration is introduced for PEI monitoring with PTW (i.e., PEI is applicable to each PO within PTW)**  **Proposal 4: No additional handling for PEI and PO monitoring is introduced, even if certain gNB within a RNA does not support CN controlled subgrouping.**  **Proposal 5: UE PHY processing for DCI format 2\_7 is the same for PEI without subgrouping and PEI with one subgroup if UE monitors PEI.**  For discussion  **Proposal 3: RAN2 to check PEI-related ignalling between AMF and UE, between AMF and gNB, and between gNBs, and decide if LS to SA2/CT1/RAN3 is still needed.**  **Proposal 6: RAN2 to confirm the configurations and PEI/PO monitoring for different cases with “K=1”.**  **Proposal 7: RAN2 discuss the following proposals about PEI configurations:**   * + **(a) PEI configuration is included in SIBx currently proposed for TRS resource configuration.**   + **(b) CN informs RAN about the number of *subgroupsNumPerPO* to use for the CN-assigned subgrouping.**   + **(c) Network can optionally configure a separate set of PO(s) dedicated to Rel-17 Ues with new paging capabilities.**   + **(d) Network can configure dedicated Pos for Ues supporting PEI and K0>0 via a second set of ns, and/or *nAndPagingFrameOffset* and/or *firstPDCCH-MonitoringOccasionOfPO* parameters.**   + **(e) If configured by the NW, UE indicates whether PEI is currently useful for the UE.** |

First, we would like to know if the “easy agreements” in [1] can be accepted.

**Q3.1: Can we accept the “easy agreements” in [1]?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| MediaTek | Y |  |
| Samsung | Y |  |
| Nokia | Y | Proposal 5 depends on the discussion whether we have the case of PEI without subgrouping in Q2.3 for P5. We might not need PEI without subgrouping if all the PEI Ues supports at least UE-ID based |
| Ericsson | Y |  |
| InterDigital | Y | For p5, it is true that both approaches are equivalent, but the proposal is redundant if we solve Q2.2/2.3 |
| Qualcomm | Y |  |
| Apple | Y |  |
| ZTE | Y |  |
| DENSO | - | P4: If the anchor gNB does not support CN controlled subgrouping but the current gNB and UE does, additional handling for PEI and PO monitoring may need to be introduced. If this case is valid, the anchor gNB doesn’t transmit CN-assigned ID via Xn interface, so UE cannot use PEI with CN controlled subgrouping in RAN paging. On the other hand, considering CN paging includes CN-assigned ID, it is necessary to clarify which subgroup ID in PEI field the UE should monitor.  If the configuration for supporting CN controlled subgrouping is the same in all cells within RNA, P4 is fine. |
| OPPO | Y |  |
| LGE | Y |  |
| CATT | Y | Agree with Nokia. P5 may no longer matter. |
| Intel | Partly | All proposals are fine with us except Proposal 4.  For Proposal 4, the issue is when the source gNB does not support CN assigned subgrouping (e.g. legacy gNB) while the target gNB supports CN assigned subgrouping. UE is provided CN subgroup ID from NAS. During RAN paging, as the source gNB that does not support CN assigned subgrouping will not forward the CN subgroup ID to the target gNB; there will be a mismatch between the target gNB and the UE which is expecting CN assigned subgrouping paging while the target gNB does not know that the UE supports it and will not use PEI.  The only simple solution to avoid a mismatch between the target gNB and UE is to assume that the CN assigned subgrouping is uniformly supported within a RNA.  Actually, similar issue also occurs for UEID based subgrouping as well.  Hence we think network support of PEI (i.e,, network has to support at least one of the sub-grouping methods) has to be uniform across the paging area and the scenario in proposal 4 (certain gNB within a RNA does not support CN controlled subgrouping) should not be supported. So we think it is better to capture it as  **Alternative proposal 4:**  **Network support of PEI (i.e, network has to support at least one of the sub-grouping methods) has to be uniform across the paging area.**  If this suggestion is not acceptable, the current proposal 4 is also acceptable to us, with the understanding that it implies that non-uniform support across the paging area does not work. Proposal 4 should still be generalized to cover both subgrouping methods:  **Generalised proposal 4:**  **No additional handling for PEI and PO monitoring introduced, even if certain gNB within a Paging area does not support PEI.** |
| Xiaomi | Partly | For P1, and P2:  Do we need to configure a separate PEI offset for e-DRX UEs?  P5 depends on Q.2.2 and Q2.3 |
| CMCC | Y |  |
| Huawei, HiSilicon | Partly | For P4 we think that certain gNB within an RNA not supporting CN controlled subgrouping is a valid scenario and needs to be addressed.  For the CN controlled subgrouping, if the anchor gNB does not support this type of subgrouping, it would not be able to transfer such information, which means that the CN controlled subgrouping based RAN paging cannot be used within the corresponding RNA. Thus, for RRC\_INACTIVE UEs supporting CN controlled subgrouping, to determine whether the CN controlled subgrouping can be used for RAN paging in a cell, it depends on both the support/use of CN controlled subgrouping of the anchor gNB and the current gNB.  There are to possible options to address this.  Option 1- The UE stores the information that whether the CN controlled subgrouping is used or not based on system information broadcast in anchor gNB  Option 2- The anchor gNB explicitly configures whether the UE can use CN controlled subgrouping in RRC\_INACTIVE, e.g. via RRCRelease message.  We think Option 2 is simple and straight forward way of addressing this.  Further analysis can be found in R2-2203229. |
| vivo | Y, but | Regarding P5, the understanding of “PEI without subgrouping” is relying on the conclusion of question 2.2 & 2.3 |
| Sequans | Partly | Agree with issue raised above about P4 (and prefer solution 1 from HW).  Agree that P5 will be redundant based on resolution of Q2.2, Q2.3 |
| Futurewei | Y | But agree that we may not need P5 anymore once Q2.2/2.3 is resolved. |

Summary

Totally 19 companies responded to this question, among them 11 think all 4 proposals can be agreed. 1 company doubted if we need to support PEI with eDRX. 4 companies raised concern about “Proposal 4”. 6 companies mentioned that “Proposal 5” may not be needed after conclusion of Q2.2 & Q2.3.

Rapporteur suggests that RAN2 confirm “Proposal 1” and “Proposal 2” in [1]. Then for “Proposal 4”, Rapporteur agrees with Intel’s explanation that in RAN paging, if the source gNB does not support CN-assigned subgoruping, it is possible that UE expects CN assigned subgrouping paging, while target gNB does not know that the UE supports it. Rapporteur suggests that we have a discussion between the two methods (proposed by Intel and Huawei, respectively) to handle this issue:

1. Network support of PEI (i.e, network has to support at least one of the sub-grouping methods) has to be uniform across the paging area.
2. The anchor gNB explicitly configures whether the UE can use CN controlled subgrouping in RRC\_INACTIVE, e.g. via *RRCRelease* message.

We can ignore “Proposal 5” as the issue will be concluded by other questions.

Therefore, we have the following proposals.

**Proposal 11: (Easy agreement) [18/19] When PEI is applied with eDRX, the UEID for UEID-based subgrouping is determined by 5G-S-TMSI mod 32768.**

**Proposal 12: (Easy agreement) [18/19] No special handling or configuration is introduced for PEI monitoring with PTW (i.e., PEI is applicable to each PO within PTW)**

**Proposal 13: (For discussion) [4/19] To handle the situation where some gNBs within an RNA does not support CN-assigned subgrouping, RAN2 to choose between the two methods:**

1. **Network support of PEI (i.e, network has to support at least one of the sub-grouping methods) has to be uniform across the paging area.**
2. **The anchor gNB explicitly configures whether the UE can use CN controlled subgrouping in RRC\_INACTIVE, e.g. via RRCRelease message.**

Then regarding the “for discussion” proposals in [1], rapporteur thinks that

* “Proposal 3”: We may discuss here is LS to RAN3/SA2/CT1 is need.
* “Proposal 6”: This overlaps with the “PEI without subgrouping” discussion above, so it can be skipped.
* “Proposal 7”: These are proposals extracted from [2]. It may be a bit late to discuss them, but we may still consider some of them if we see a good support.

**Q3.2: Do we need to send LS to RAN3/SA2/CT1?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| MediaTek | Y | We believe that at least they need to know RAN2 agreements about UE capability. We can send a copy of RAN2 agreements after this meeting and let them check if any work is needed. |
| Samsung | Y |  |
| Nokia | Y |  |
| Ericsson | Y |  |
| InterDigital | Y | Seems fine to send informative LS on the agreements |
| Qualcomm | Y |  |
| Apple | Y | At least the other groups should be informed about the agreements and the capability aspects that were agreed |
| ZTE | Y |  |
| DENSO | Y |  |
| OPPO | Y |  |
| LGE | Y | Same view as MediaTek. |
| CATT | Y |  |
| Intel | Y |  |
| Xiaomi | Y |  |
| CMCC | Y |  |
| Huawei, HiSilicon | Y |  |
| vivo | Y |  |
| Sequans | Y | Agree with MediaTek |
| Futurewei | Y |  |

Summary

Totally 19 companies responded to this question, and all agreed that we can LS to RAN3/SA2/CT1. Rapporteur suggests that we send an LS for RAN2 agreements. The LS may also ask questions about mismatched understanding of “last cell” between network and UE (i.e., the issue in Proposal 4).

**Proposal 14: (Easy agreement) [19/19] Send an informative LS to RAN3/SA2/CT1 for RAN2 agreements about PEI and paging subgrouping and ask question about mismatched understanding of “last cell” between network and UE.**

**Q3.3: Should we agree to any items in “Proposal 7” in [1]?**

|  |  |  |
| --- | --- | --- |
| Company | Items (a)-(e) | Comment |
| MediaTek | (b) | It seems that this has been implemented by RAN3 |
| Samsung | (b) |  |
| Nokia | (a), (b) | For (a), PEI does not need to be in SIB1 since they are only needed for PEI capable UEs and not urgent. RAN2 already agreed segmentation for SIBX, so size should not be a concern.  For (b) it could be useful information for RAN to take into account for the subgroup configurations. |
| Ericsson | (a), (b), (c), (d), (e) | (a) unnecessary to pollute SIB1 with high-rate transmission with non-essential PEI configuration  (c)/(d) important for the NW to be able to concentrate PEI capable UEs to same POs. Benefit for the NW is less PEI transmissions (only PEI transmission for Pos with PEI capable UEs), benefit for legacy UEs is that there will be less false paging messages for them if they are in separate POs.  (e) As indicated similarly for TRS in the meeting, we don’t want to implement features that are not used by the UEs. Even if UEs indicate that they are capable of PEI, it does not mean that they are actually using them. For example, if they are in sufficiently good coverage, they will most probably not use PEI (this has clearly been indicated by UE vendors). We don’t want to transmit PEI in vain, we could introduce a very light weight mechanism with piggybacking on existing signaling, e.g. in a paging response whether UE is using PEI. |
| InterDigital | (b)  Maybe (c), (d) | For, (a) we do have sympathy with the comments from Nokia and Ericsson, the information is not essential for access. However, this is logically part of the paging common configuration, and also putting it into the new SIB means the UE has to acquire potentially large amount of information even if it does not support the TRS resource config creating a feature dependency.  For (c)+(d) this may allow NW to more efficiently manage the paging resources and it seems not much effort to implement the signalling, however it seems not essential and does introduce additional broadcast overhead, if configured. It would be fine if we do also have (a) but otherwise maybe not.  For (e) we would assume PEI is always useful if it is supported, in idle mode the UE moves between better and worse coverage without sending any indication so it is not clear how this helps the network decide whether to use PEI. The example given by Ericsson in paging response sounds like a SON/MDT enhancement, maybe it could be considered later. |
| Qualcomm | (b) and (d) | (b) can be useful for RAN in its configuration of paging subgroups.  (d) helps enable cross-slot scheduling for paging message, which can help UE save more power in paging reception. Although CSS for paging is a mandatory feature since R15 but it can’t be used in practice because it is mandatory with capability signaling. |
| Apple | 1. and (b) | For (a) with SIB segmentation, sizing restriction is not an issue  For (b) it would be useful for gNB to have this information |
| ZTE | b | Seems only B is needed according to the current situation |
| DENSO | (b) |  |
| OPPO | None | We don’t think (b) is needed. subgroupsNumPerPO is configured by RAN. How can CN inform RAN of this? |
| LGE | b |  |
| CATT | None | (a): SIB1 contains some important and necessary info, e.g. info for initial access, scheduling info of other SIB, info for paging reception and so on. PEI doesn’t change frequently. And overhead of PEI is small. There is no motivation to broadcast it with on-demand. But if it is included in SIB-X, PEI feature will be impacted by the update of TRS configuration, which can be frequent because TRS is shared with Connected UEs. For example: If TRS configuration needs to be updated while PEI configuration is unchanged, PEI feature cannot be used until SIB-X is received successfully. So if PEI configuration is included in SIB-X, it will impact the effectiveness of PEI feature.  (b): Agree with MediaTek  (c) (d) (e): non-essential optimizations at this late stage. |
| Intel | None |  |
| Xiaomi | None |  |
| CMCC | None | 1. seems reasonable, but no further proposal is need based on the current implementation in SA2. |
| Huawei, HiSilicon | None | For (b) we think it is only needed if OAM based solution is not agreed in RAN 3 as baseline. We should let RAN 3 decide about this. |
| vivo | b | (6) anyway needs a solution. |
| Sequans | (b), (c), (d)  not (a), (e) | (a) we agree this is not essential to have in SIB1, but putting it SIBX for TRS is worse as it would increase the chances for segmentation and require UEs that do not support TRS to read a huge SIB for very little information, and which additionally may change more frequently than it would if it was SIB1 or PEI only.  (b) seems useful for RAN, but we are fine to wait to see if OAM solution is preferred in RAN3  (c) could be beneficial to NW to send less PEI, beneficial for legacy UEs who will receive less false paging, and is needed for (d)  (d) it is very useful for power consumption if UE can assume K0>0.  (e) while we could support an indication for TRS which is very resource heavy, we think for PEI it is even less useful – since coverage can change drastically, most UEs will anyway not know in advance if they will use PEI or not. |
| Futurewei | None |  |

Summary

Totally 19 companies responded to this question. The number of supporting companies for each item is shown below:

(a): 3 companies

(b): 12 companies

(c): 3 companies

(d): 4 companies

(e): 1 company

Only item (b) gets a good support. However, this is a RAN3 issue, and we can trigger RAN3 works by LS (if they haven’t done the signaling design). Therefore, Rapporteur suggest that we do not need any proposal for this question.

## Other comments

**Q4.1: Please provide your comments here.**

|  |  |
| --- | --- |
| Company | Comment |
| MediaTek | By confirming that a PEI-capable UE must support at least UEID-based subgrouping, we can eliminate many cases of “RAN-UE mismatch”. If UE still cannot find its subgroup ID (e.g., UE supports UEID-based subgrouping only, but RAN configures CN-assigned subgrouping only), we suggest that RAN2 confirm that UE monitors legacy paging. |
| Samsung | Agree with MediaTek |
| Nokia | Assuming same number of CN assignment subgroups for all the cells seems to put too much restrictions to the NW since it has been agreed each cell can decide its own configuration. As long as we define the behavior that the UE monitors legacy if the UE cannot find corresponding bit in PEI, it covers already the case of if the bit allocated for CN is less than the CN assigned ID of the UE without remapping. |
| Ericsson | Agree with Mediatek |
| InterDigital | Agree with Mediatek |
| Qualcomm | We are fine with MediaTek’s proposal, |
| Apple | Agree with Mediatek, that in case of any mismatch UE falls back to legacy paging monitoring. This is also in line with one of RAN2 earlier agreement on this topic |
| ZTE | Fine with MTK’s proposal. |
| DENSO | Agree with MediaTek. |
| LGE | Agree with MediaTek |
| CATT | We agree that only Case 3 from OI 1.2 is left after the capability agreement, i.e. when a cell only supports CN-assigned subgrouping.  However, here again, we would prefer a solution where the UE can benefit from the PEI, rather than the legacy fallback. So we would suggest 2 possibilities:  - Option 1: Same as for the UE cap: if RAN supports PEI, it also supports at least UEID-based subgrouping (if we were able to agree this for a UE, it should then be straightforward for the network)  Or:  - Option 2: UE falls back to only monitoring its PO by e.g. using 1st subgroup of the bitmap (i.e. it uses *iSG* = 0) which requires no RAN1 specification change and can be captured in 38.304.  Proactively addressing comments on option 2:  - It does not require transmitting multiple PEIs (PEI for “fallback” UEs and PEI for CN-assigned UEs) since a single PEI can anyways indicate different subgroups of the same PO via setting different bits of the bitmap.  - It does not disturb the CN-assigned subgroups if CN implementation chooses to allocate CN-assigned UEs in subgroups starting with *iSG* = 1 onwards. Alternately, CN implementation may choose to also allocate *iSG* = 1 to UEs not meeting any of its classification criteria, kind of “default” bin (as an example). |
| Intel | Agree with MediaTek. No further optimization. |
| CMCC | Agree with MediaTek. |
| Huawei, HiSilicon | We think the UE behavior with regards to how it carries forward and applies the “last used cell only” indication from its last serving cell needs to be clarified.  We think there are two possible options  Option 1 is that the UE applies the indication broadcast by the cell where the UE leaves connected state. After the UE re-selects to other cells, the indication broadcast by other cells is not valid for this UE. For instance, the UE leaves connected state in cell 1 and cell 1 broadcasts the last cell restriction, then the UE will not use PEI once it leaves cell 1, regardless of what other cells broadcast.  Option 2 is that the UE applies the indication broadcast by the cell where the UE camps. For instance, the UE leaves connected state in cell 1 and cell 1 broadcasts the last cell restriction, then the UE can use PEI in cell 1. Later if the UE re-selects to cell 2 and cell 2 does not broadcast the restriction, then the UE can also use PEI in cell 2; if the UE re-selects to cell 3 and cell 3 broadcasts the restriction, then the UE cannot use PEI in cell 3.  Comparing the two options, we think option 2 is simple for both the UE and the network and can be adopted |
| Sequans | Agree with MediaTek |

Summary

Totally 15 companies responded to this question.

14 Companies mentioned the situation where UE cannot find its subgroup ID with the PEI configurations in a cell, and among them 13 companies think that UE simply monitors legacy paging in this case, while one company prefer a solution where the UE can benefit from the PEI. Rapporteur suggests that RAN2 adopt this simple solution.

One company has concern about the UE behavior with regards to how it carries forward and applies the “last used cell only” indication from its last serving cell. Rapporteur suggests that this can be clarified with the discussions in Section 2.1.

**Proposal 15: (Easy agreement) [13/14] If a UE cannot find its subgroup ID with the PEI configurations in a cell, it monitors legacy paging.**

# Conclusion

It is proposed to discuss and decide on the following proposals:

Easy agreements

**Proposal 1: (Easy agreement) [18/19] A PEI-capable UE stores its “last used cell” information.**

**Proposal 2: (Easy agreement) [19/19] Do not introduce an associated timer for the “last used cell” information stored by UE.**

**Proposal 3: (Easy agreement) [19/19] The “lastUsedCellOnly” indication is a cell-level configuration and there is no per-subgroup indication.**

**Proposal 5: (Easy agreement) [18/19] Introduce a one-bit indication of *lastUsedCellOnly* in *PEI-Config*.**

**Proposal 6: (Easy agreement) [4/4] RAN2 clarifies the meaning of “last used cell only”: When a cell broadcasts “last used cell only”, a UE monitors PEI only if its last connection was released by this cell.**

**Proposal 7: (Easy agreement) [19/19] A PEI-capable UE must support at least UEID-based subgrouping method.**

**Proposal 8: (Easy agreement) [19/19] RAN2 confirms that “PEI without subgrouping” can be implemented by configuring PEI plus UEID subgrouping with one subgroup.**

**Proposal 10: (Easy agreement) [16/19] “PEI without subgrouping” can be configured by only one method.**

**Proposal 11: (Easy agreement) [18/19] When PEI is applied with eDRX, the UEID for UEID-based subgrouping is determined by 5G-S-TMSI mod 32768.**

**Proposal 12: (Easy agreement) [18/19] No special handling or configuration is introduced for PEI monitoring with PTW (i.e., PEI is applicable to each PO within PTW)**

**Proposal 14: (Easy agreement) [19/19] Send an informative LS to RAN3/SA2/CT1 for RAN2 agreements about PEI and paging subgrouping and ask question about mismatched understanding of “last cell” between network and UE.**

**Proposal 15: (Easy agreement) [13/14] If a UE cannot find its subgroup ID with the PEI configurations in a cell, it monitors legacy paging.**

For discussion

**Proposal 4: (For discussion) [11/19] Postpone the discussion of “no last cell update” indication in *RRCRelease*, until RAN2 knows whether network and UE may have mismatched understanding about last used cell.**

**Proposal 9: (For discussion) [7/19] A UE with CN-assigned subgroup ID should derive UEID-based subgroup ID in a cell supporting only UEID-based subgrouping.**

**Proposal 13: (For discussion) [4/19] To handle the situation where some gNBs within an RNA does not support CN-assigned subgrouping, RAN2 to choose between the two methods:**

1. **Network support of PEI (i.e, network has to support at least one of the sub-grouping methods) has to be uniform across the paging area.**
2. **The anchor gNB explicitly configures whether the UE can use CN controlled subgrouping in RRC\_INACTIVE, e.g. via RRCRelease message.**

# Reference

1. R2-2203720, “Summary of 8.9.3.2.1 PEI and Paging Subgrouping,” MediaTek
2. R2-2203252, “PEI and paging subgrouping,” Ericsson