3GPP TSG-RAN WG2 Meeting #114-e R2-21xxxxx

Online, 19 – 27th of May 2021

**Agenda item: 5.4.4**

**Source: ZTE corporation, Sanechips**

**Title: Report of [AT114-e] [013] [NR15] Idle Inactive mode (ZTE)**

**Document for: Discussion and Decision**

# Introduction

This document reflects the content and outcome of the following email discussion:

* [AT114-e] [013][NR15] Idle Inactive mode (ZTE)

Scope: Treat R2-2105751, R2-2105744, R2-2105745, R2-2105752, R2-2105753, R2-2105754, R2-2105755, R2-2106196,

Phase 1, determine agreeable parts, Phase 2, for agreeable parts Work on CRs.

Intended outcome: Report and Agreed CRs.

Deadline: Schedule A

[R2-2105751](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105751.zip) Discussion on PO determination for UE in inactive state ZTE corporation, Sanechips, Ericsson discussion Rel-15 NR\_newRAT-Core

[R2-2105744](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105744.zip) Correction on PO determination for UE in inactive state-38.304 ZTE corporation, Sanechips, Ericsson CR Rel-16 38.304 16.4.0 0208 - F NR\_newRAT-Core

[R2-2105745](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105745.zip) Correction on PO determination for UE in inactive state-38.306 ZTE corporation, Sanechips, Ericsson CR Rel-16 38.306 16.4.0 0592 - F NR\_newRAT-Core

[R2-2105752](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105752.zip) Correction on PO determination for UE in inactive state-38.331 ZTE corporation, Sanechips, Ericsson CR Rel-16 38.331 16.4.1 2646 - F NR\_newRAT-Core

[R2-2105753](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105753.zip) Correction on PO determination for UE in inactive state-36.331 ZTE corporation, Sanechips, Ericsson CR Rel-16 36.331 16.4.0 4663 - F LTE\_5GCN\_connect-Core

[R2-2105754](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105754.zip) Correction on PO determination for UE in inactive state-36.304 ZTE corporation, Sanechips, Ericsson CR Rel-16 36.304 16.3.0 0826 - F LTE\_5GCN\_connect-Core

[R2-2105755](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105755.zip) Correction on PO determination for UE in inactive state-36.306 ZTE corporation, Sanechips, Ericsson CR Rel-16 36.306 16.4.0 1815 - F LTE\_5GCN\_connect-Core

[R2-2106196](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2106196.zip) Discussion on PO misalignment for INACTVIE and IDLE states Huawei, HiSilicon discussion Rel-15 NR\_newRAT-Core

[R2-2104907](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2104907.zip) Discussion on paging DRX cycle determination for inactive mode vivo discussion Rel-15 NR\_newRAT-Core Late

# 2 Discussion

## 2.1 PO misalignment for RAN paging and CN paging

The following agreements have been reached in RAN2 NR Adhoc 201701:

Agreements:

1 A UE in INACTIVE is reachable via RAN-initiated notification and CN-initiated Paging. RAN and CN paging occasions overlap and same paging/notification mechanism used.

2 A RAN node can configure a UE in INACTIVE with a RAN configured paging DRX cycle (which could be UE specific configuration).

UE in inactive state has to monitor both CN-initiated paging and RAN-initiated paging and it has been expected in 38.300 that *“The POs of a UE for CN-initiated and RAN-initiated paging are based on the same UE ID, resulting in overlapping POs for both.”* so that UE in inactive can monitor CN-initiated paging and RAN-initiated paging in the overlapping POs.

However, the actual situation does not meet our expectations and it is possible that NW send CN paging and RAN paging in different POs and UE in active state may only monitor the PO calculated for RAN paging and miss CN paging.

The PF and PO for paging are determined by the following formula [1]:

SFN for the PF is determined by:

(SFN + PF\_offset) mod T = (T div N) \* (UE\_ID mod N)

Index (i\_s), indicating the index of the PO is determined by:

i\_s = floor (UE\_ID/N) mod Ns

The following parameters are used for the calculation of PF and i\_s above:

T: DRX cycle of the UE (T is determined by the shortest of the UE specific DRX value(s), if configured by RRC and/or upper layers, and a default DRX value broadcast in system information. In RRC\_IDLE state, if UE specific DRX is not configured by upper layers, the default value is applied).

N: number of total paging frames in T(configured by nAndPagingFrameOffset with value T, T/2, T/4, T/8, or T/16)

Ns: number of paging occasions for a PF

PF\_offset: offset used for PF determination

UE\_ID: 5G-S-TMSI mod 1024

|  |  |
| --- | --- |
| Example of configuration | RAN paging cycle: 32rf  Default paging cycle: 64rf  N: T/16  Ns: 4  PF\_offset: 14  UE\_ID:5G-S-TMSI mod 1024 = 3 |
| RRC\_INACTIVE | PF:2 34 66 98130 162 194 226 258 290 322 354 386 418 450 |
| i\_s =1 |
| RRC\_IDLE | PF:34 98 162 226 290 354 418 |
| i\_s=0 |

For a UE with same UE ID, as shown in the above example, it is possible that the T used in inactive state is different from the T used in idle mode as NW is allowed to configure a RAN paging cycle different from the UE specific paging cycle configured by upper layer or the default value in system information while the N used in calculation is still the one broadcast in SIB1 with value T, T/2, T/4, T/8, or T/16 and will turn into different values when the T changes.

As a result, the index of the PO (i.e. the i\_s) would be different for inactive state and idle state as the N is a value related to the T while the T has different value in idle and inactive state, which deviates from the intention that the POs of a UE for CN-initiated and RAN-initiated paging should be overlapped and inactive UE can monitor CN paging and RAN paging in the overlapped POs. Under this circumstance, it is worth considering what is the expected UE behavior for UE in RRC\_INACTIVE. If UE in RRC\_INACTIVE only monitors the RAN paging PO, CN paging failure would happen.

**Question 1: Do companies agree with the observation that “*For a UE, the index of the PO calculated based on the same UE ID may be different in inactive state and idle state. If a UE in inactive state only monitors the PO derived for inactive state, CN paging failure would happen in both NR and eLTE*”?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes |  |
| Nokia | Yes |  |
| MediaTek | Yes |  |
| LGE | Yes |  |
| OPPO | Yes |  |
| ZTE | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Apple | Yes |  |
| Ericsson | Yes |  |
| Intel | Yes |  |
| vivo | Yes | The T i.e. DRX cycle of UE related to the calculation of i\_s are different in idle and inactive when RAN paging cycle is shorter than UE specific DRX cycle configured by upper layer and default paging cycle, and in this case the index of PO may be different between inactive and idle for some UEs. |

## 2.2 Potential Solutions

The following solutions can be considered to address the issue described above:

* Solution 1: It is up to NW implementation to ensure RAN and CN paging occasions overlap.
* Solution 2: UE in RRC\_INACTIVE shall monitor both RAN and CN PO, in case RAN and CN PO are not overlapped.
* Solution 3: UE in RRC\_INACTIVE should use the same i\_s to determine PO as for RRC\_IDLE and both CN paging and RAN paging will be sent on such POs.

**Question 2: Which solution do companies prefer to address the PO misalignment issue?**

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| --- | --- | --- |
| **Company** | **Preferred Solution** | **Comments** |
| Samsung | Solution 1 | We think that it is a corner case i.e. to be paged by CN paging for RRC\_INACTIVE state due to RNAU. Besides, the concerned scenario seems only valid in case the value of RAN paging cycle is less than that of CN paging cycle.  If any solution is required other than Solution 1, we prefer to go for Solution 3 from Rel-17. |
| Nokia | Solution 1 | Any other solution is not feasible in release 15 and having other solutions in later releases does not help too much as anyway UEs not supporting this would require to follow legacy paging procedure. |
| MediaTek | Solution 1 | As indicated by Samsung, this is a corner case. The paging for UE in INACTIVE mode is mainly from RAN paging. Monitoring CN paging in INACTIVE mode is something like error handling (Note that UE will transit to IDLE while receiving CN paging). So, hope that no CN paging reception is needed in most case. Considering that, we would prefer to have solution 1 in R15/R16. The simple way of solution 1 is to have same paging cycle for both CN and RAN paging.  If anything is needed, we also prefer solution 3 from Rel-17. |
| LGE | Solution 1 | We do not support Sol 2. because it requires additional power consumption..  NW should ensure RAN and CN paging occasions overlap. If not, legacy UEs may miss the CN paging in INACIVE. |
| OPPO | Solution 1 | For R15/R16, no much benefit we can get, so solution1 is sufficient.  For R17, we can consider both solution1 and solution3. |
| ZTE | Solution 3 and agree on R16 CRs with magic sentence to support early implementation | This is a broken part of the spec we need to fix as it deviates from the original design for CN paging and RAN paging.  - From NW’s perspective, supporting solution 1 is not easy as we need to configure same RAN paging cycle and CN paing cycle. Sometimes the CN paging cycle is quite large, e.g. 128rf, as required by the operators. Having the RAN paging cycle with such a large value would definitely impact the QoS.  - Solution 2 would be too demanding to UE considering the power consumption and we do not want to put so much pressure on UE side, either.  So solution 3 is actually a compromise which requires changes in both UE and NW sides but would not be too demanding to both. Hope our painstaking efforts can be understood. |
| Huawei, HiSilicon | Solution 1 | This is a corner case and can be handled by network implementation for Rel-15 and Rel-16.  For Rel-17, we are fine to look at a solution under TEI7. We should not decide a solution now but wait for more companies’ inputs. |
| Apple | Solution 1 | We think this can be solved in NW implementation. Even for R17, this can still be left to UE implementation and no other solution is needed. |
| Ericsson | Solution 3 | As co-proponent company, we support introduction of Solution 3 into specifications as soon as possible. Overlapping CN and RAN paging is the tool that recover from state inconsistency. It is probably true this happens only in corner cases, but for the individual UE, this is more critical.  True is also this can be avoided with Solution 1 (e.g. RAN and CN paging uses same DRX cycle, or “i\_s = 1” (one PO in a PF). But this also means certain configurations/scenarios might be used as was intended (e.g. short DRX cycles in RRC\_Inactive). |
| Intel | Solution 1 for Rel-15 | Solution 3 for later release – open to Rle-16/17. |
| vivo | Solution1 for existing UEs and  Solution3 for future UEs | For existing UEs which can’t be upgraded, the solution1 is the only choice. But solution 1 introduce a strong restriction on the network implementation, e.g. gNB may has to set Ran Paging Cycle bigger than DRX cycle configured by upper layer.  Solution2 should be avoided since it requires UE to monitoring additional PO which may increase the inactive UEs’ power consumption. It is not the design principle for inactive paging.  Solution3 reflects the original intention of the design principle of PO monitoring per TS38.300 with limited impact on specification.  There is a description in TS 38.300:  “*The POs of a UE for CN-initiated and RAN-initiated paging are based on the same UE ID, resulting in overlapping POs for both.”*  It can be observed that the intention of PO calculation is to guarantee the PO of RAN-initiated paging to overlap with the PO of CN-initiated paging in the overlapped PF. And solution 3 can keep the intention with minimal specification correction. |

### Further details for solution 1

**Question 2-1: If solution 1 is selected, is there a need to capture anything, e.g. *It is up to NW implementation to ensure RAN and CN paging occasions overlap*, in specs to reflect the agreement?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | No | We think capturing it in the minutes seems enough. |
| Nokia | No | Same as Samsung |
| MediaTek | No | Same view as Samsung |
| LGE | No | Same as Samsung |
| OPPO | No | Same as Samsung |
| Huawei, HiSilicon | No |  |
| Apple | No |  |
| Ericsson | Yes/no | Normally, we agree there is no need to capture nw settings in the spec. But since this “error” is not so obvious, a note could be considered. |
| Intel | No strong view | Between chair’s notes or a NOTE in spec. |
| vivo | No | According to TS 38.300：  “*The POs of a UE for CN-initiated and RAN-initiated paging are based on the same UE ID, resulting in overlapping POs for both.”*  Based on the above description, it is our understanding that UE could assume that the NW ensures RAN and CN paging occasions overlap. Nothing more needs to be captured. |

### Further details for solution 2

**Question 2-2: If solution 2 is selected, is there a need to capture anything, e.g. *UE in RRC\_INACTIVE shall monitor both RAN and CN PO, in case RAN and CN PO are not overlapped*, in specs to reflect the agreement?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| LGE |  | We don’t support sol. 2, but if this solution is agreed, it can be specified like “***UE in RRC\_INACTIVE shall monitor both RAN and CN PO”.*** |
| vivo |  | We don’t support solution2. It is clearly mentioned in TS38.304: *The UE monitors one paging occasion (PO) per DRX cycle.*  In our understanding, the sentence needs to be removed to reflect the solution2. An NBC issue could be foreseen. |
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### Further details for solution 3

If solution 3 is selected, a UE capability should be introduced to indicate UE support for using the same i\_s in PO determination in RRC\_INACTIVE state as in RRC\_IDLE state so that NW can identify such UE and send both CN paging and RAN paging in the same POs.

**Question 2-3-1: If solution 3 is selected, is there a need to introduce a UE capability to indicate UE support for using the same i\_s in PO determination in RRC\_INACTIVE state as in RRC\_IDLE state?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes | Without a UE capability, NW has no idea whether UE can support it. |
| MediaTek | Yes |  |
| LGE | Yes |  |
| OPPO | Yes |  |
| ZTE | Yes |  |
| Ericsson | Yes |  |
| Intel | Yes |  |
| vivo | Yes | In current deployment, there are already many Rel-15 (and maybe Rel-16) devices in RRC\_INACTIVE monitors paging according to the DRX cycle in RRC\_INACTIVE, and if we want to adopt the new calculation of PO index according to the DRX cycle in RRC\_IDLE, it’s better to introduce a new UE capability to indicate whether supporting the modified formula for PO calculation. Otherwise, network cannot differentiate the legacy UEs not supporting this feature and new UEs supporting this feature. Only after the network knows such capability of UEs, it could send the RAN-initiated paging of the UE according to the modified formula for PO calculation. |

For solution 3, the following options can be considered on the signaling details:

* Option 1: If UE indicates support for such behaviour, NW send an indication (e.g. *useIdlePO*) in RRCRelease message when release UE from RRC\_CONNECTED to RRC\_INACTIVE state and ensure that both CN paging and RAN paging will be sent in the same POs (i.e. the idle POs) within the configured RNA.

- The *useIdlePO* in RRCRelease message can only be configured when all the gNBs within the RNA support to send both CN paging and RAN paging in the same POs, i.e. the idle POs.

- The indication (e.g. *useIdlePO*) is also sent to the neighbour RAN nodes for Xn-paging.

* Option 2: Broadcast an indication (e.g. *ranPagingInIdlePO*) in system information to show if network supports to send both CN paging and RAN paging in the idle POs.

- UE monitor CN paging and RAN paging in idle POs when both of the anchor cell and serving cell broadcast *ranPagingInIdlePO*.

- To assist Xn-paging, the UE capability for using the same i\_s in PO determination in RRC\_INACTIVE state as in RRC\_IDLE state will be sent to neighbour RAN nodes.

**Question 2-3-2: If solution 3 is selected, which option do companies prefer on the signaling details?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Comments** |
| Samsung | Option 1 |  |
| MediaTek | Option 1 |  |
| LGE | Option 2 |  |
| OPPO | either |  |
| ZTE | either |  |
| Huawei, HiSilicon |  | We think that any details of a solution can be discussed in TEI17 based on company input, it is too early to decide the solution details. |
| Ericsson | Option 2 |  |
| Intel | Option 1 | Since this is only needed when RAN paging is possible, and UE is configured with INACTIVE, we think dedicated signalling should be used. |
| vivo | Option 2 | Either solution works, but we prefer option 2. As mentioned rapporteur, option1 requires all the gNBs within the RNA supporting to send both CN paging and RAN paging in the same POs, while option2 has no such restriction. Hence, option2 allows more flexible network upgrading.  The indication is delivered via dedicated signaling in optoin1 and system information in option2, it is hard to say which one is more efficient regarding signaling overhead. |

**Question 2-3-3: Which option do companies prefer to reflect the changes needed for solution 3?**

* **Option 1: Support solution 3 since Rel-16 and agree on Rel-16 CRs with magic sentence to support early implementation.**
* **Option 2: Support solution 3 since Rel-17.**

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| **Company** | **Option** | **Comments** |
| Samsung | Option 2 | See our previous comments on Question 2. |
| MediaTek | Option 2 |  |
| LGE | Option 2 |  |
| OPPO | Option 2 |  |
| ZTE | Option 1 |  |
| Ericsson | Option 1 | We can postpone the topic to next meeting to give companies more time. |
| Intel | No strong view |  |
| vivo | Option 1 | he earlier the better, to reduce the restriction to the network implementation.  If a capability for *useIdlePO* is agreed to be introduced, we see no issue to have early implementation from Rel-15. |

# 3 Conclusions

Based on the views expressed in the previous sections, we propose the following:

*To be added*

# Contact information

|  |  |
| --- | --- |
| Company | Delegate contact |
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