**3GPP TSG RAN WG1 #118 R1-24xxxxx**

**Maastricht, Netherlands, August 19th – August 23rd, 2024**

**Source: Moderator (ZTE Corporation)**

**Title: [118-Pre-R18-NR] Summary of** **PEI for R17 UE power saving**

**Agenda item: 7**

**Document for:** **Discussion and Decision**

Introduction

In RAN1#118 meeting, one contribution [1, ZTE] is submitted to update the reference for PEI determination.

As guided by the Chairman, this contribution provides summary of the submitted contributions (Section 4), discussion points (Section 2), and possible RAN1 consensus during this meeting (Section 3).

**Rel-17 UE power savings**

R1-2406402 Correction on PEI for UE power saving ZTE Corporation, Sanechips.

Discussion

In [1, ZTE], it is mentioned that the terms of UE\_ID and $i\_{SG}$ are used for determination of PEI monitoring occasion. And the definitions of UE\_ID and $i\_{SG}$ refer to TS 38.304.

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| --------TS 38.213-ha0--------10.4A PDCCH monitoring for early indication of pagingA paging indication field of DCI format 2\_7 includes $N\_{PO}^{PEI}$ segments of $K$ bits, where $K=N\_{SG}^{PO}$. For a subgroup index $i\_{SG}$, $0\leq i\_{SG}<K$, a UE determines a value for the $\left(i\_{PO}⋅K+i\_{SG}\right)$ bit in the paging indication field, where $i\_{PO}=\left(\left(UE\\_IDmodN\right)⋅N\_{S}+i\\_s\right)modN\_{PO}^{PEI}$ is a paging occasion index, and $UE\\_ID$, $N$, $N\_{S}$, $i\_{SG}$, and $i\\_s$ are defined in [17, TS 38.304]. When the value is '1', the UE monitors a paging occasion determined according to [17, TS 38.304]; otherwise, the UE is not required to monitor the paging occasion.--------TS 38.213-ha0-------- |

## Issue #1: definition of UE ID

However, in TS 38.304, two different UE ID are defined.

In clause 7.1 of TS 38.304, UE ID, which is used for PO determination, is defined UE\_ID is defined as 5G-S-TMSI mod 4096 for UE operates in eDRX, otherwise, it is defined as 5G-S-TMSI mod 1024.

In clause 7.3.2 of TS 38.304, which is used for sub-group determination, the UE\_ID is defined as 5G-S-TMSI mod X, where X is 32768, if eDRX is applied; otherwise, X is 8192.

In [1, ZTE], it is pointed out that these two different the determination of UE\_ID is ambiguous without a specific subclause in reference.

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| ------TS 38.304-h90-----7 Paging7.1 Discontinuous Reception for pagingThe PF and PO for paging are determined by the following formulae: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-----omitted part-----N: number of total paging frames in TNs: number of paging occasions for a PFPF\_offset: offset used for PF determinationUE\_ID:If the UE operates in eDRX as specified in clause 7.4:- 5G-S-TMSI mod 4096else:- 5G-S-TMSI mod 1024Parameters *Ns*, *nAndPagingFrameOffset*, *nrofPDCCH-MonitoringOccasionPerSSB-InPO*, and the length of default DRX Cycle are signaled in *SIB1*. The values of N and PF\_offset are derived from the parameter *nAndPagingFrameOffset* as defined in TS 38.331 [3]. The parameter *firstPDCCH-MonitoringOccasionOfPO* is signalled in *SIB1* for paging in the BWP configured by *initialDownlinkBWP*.For paging in a DL BWP other than the BWP configured by *initialDownlinkBWP*, the parameter *first-PDCCH-MonitoringOccasionOfPO* is signaled in the corresponding BWP configuration.If the UE has no 5G-S-TMSI, for instance when the UE has not yet registered onto the network, the UE shall use as default identity UE\_ID = 0 in the PF and i\_s formulas above.5G-S-TMSI is a 48 bit long bit string as defined in TS 23.501 [10]. 5G-S-TMSI shall in the formulae above be interpreted as a binary number where the left most bit represents the most significant bit.-----omitted part-----7.3 Subgrouping7.3.0 GeneralIf PEI and subgrouping are configured, UEs monitoring the same PO can be divided into one or more subgroups. With subgrouping, the UE monitors the associated PO if the corresponding bit for subgroup the UE belongs to is indicated as 1 by PEI corresponding to its PO, as specified in clause 10.4a in TS 38.213 [4].UE's subgroup can be either assigned by CN as specified in clause 7.3.1 or formed based on UE\_ID as specified in clause 7.3.2:- If *subgroupsNumForUEID* is absent in *subgroupConfig*, the subgroup ID based on CN assigned subgrouping as specified in clause 7.3.1, if available for the UE, is used in the cell.- If both *subgroupsNumPerPO* and *subgroupsNumForUEID* are configured, and *subgroupsNumForUEID* has the same value as *subgroupsNumPerPO*, the subgroup ID based on UE\_ID based subgrouping as specified in clause 7.3.2 is used in the cell.- If both *subgroupsNumPerPO* and *subgroupsNumForUEID* are configured, and *subgroupsNumForUEID* < *subgroupsNumPerPO*:- The subgroup ID based on CN assigned subgrouping as specified in clause 7.3.1, if available for the UE, is used in the cell;- Otherwise, the subgroup ID based on UE\_ID based subgrouping as specified in clause 7.3.2 is used in the cell.If a UE has no CN assigned subgroup ID or does not support CN assigned subgrouping, and there is no configuration for *subgroupsNumForUEID*, the UE monitors the associated PO according to clause 7.1.-----omitted part-----7.3.1 CN assigned subgroupingPaging with CN assigned subgrouping is used in the cell which supports CN assigned subgrouping, as described in clause 7.3.0. A UE supporting CN assigned subgrouping in RRC\_IDLE or RRC\_INACTIVE state can be assigned a subgroup ID (between 0 to 7) by AMF through NAS signalling. The UE belonging to the assigned subgroup ID monitors its associated PEI which indicates the paged subgroup(s) as specified in clause 7.2.7.3.2 UE\_ID based subgroupingPaging with UE\_ID based subgrouping is used in the cell which supports UE\_ID based subgrouping, as described in clause 7.3.0.If the UE is not configured with a CN assigned subgroup ID, or if the UE configured with a CN assigned subgroup ID is in a cell supporting only UE\_ID based subgrouping, the subgroup ID of the UE is determined by the formula below:SubgroupID = (floor(UE\_ID/(N\*Ns)) mod subgroupsNumForUEID) + (subgroupsNumPerPO - subgroupsNumForUEID),where:N: number of total paging frames in T, which is the DRX cycle of RRC\_IDLE state as specified in clause 7.1Ns: number of paging occasions for a PFUE\_ID: 5G-S-TMSI mod X, where X is 32768, if eDRX is applied; otherwise, X is 8192subgroupsNumForUEID: number of subgroups for UE\_ID based subgrouping in a PO, which is broadcasted in system informationIn RRC\_INACTIVE state with CN configured PTW the SubgroupID used outside CN PTW is the same as the SubgroupID used inside CN PTW.The UE belonging to the SubgroupID monitors its associated PEI which indicates the paged subgroup(s) as specified in clause 7.2. |

Since the original intention of PEI determination in TS38.213 is to use the similar mechanism of PO determination and associate the PEI occasion with PO, it is suggested to refer clause 7.1 of TS 38.304 for PEI occasion determination in [1].

**Question 1:**

**To your understanding, which is the interpretation of the UE ID for PEI determination?**

**Interpretation 1 (definition in clause 7.1 in TS 38.304):** the UE\_ID is defined as 5G-S-TMSI mod 4096 for UE operates in eDRX, otherwise, it is defined as 5G-S-TMSI mod 1024.

**Interpretation 2** **(definition in clause 7.3.2 in TS 38.304):**  the UE\_ID is defined as 5G-S-TMSI mod X, where X is 32768, if eDRX is applied; otherwise, X is 8192.

**Please to elaborate on the reasoning of your answer if possible.**

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| **Company** | **Comment** |
| Nokia1 | In my understanding the UE\_ID based subgrouping is defined by RAN2 in Section 7.3.2. Hence interpretation 2 would be correct in my view. This should be rather clear.  |
| Huawei, HiSilicon | It is clearly should be the interpretation 1. The equation in TS 38.213 is used to calculate the iPO, which is clearly stated as “is a paging occasion index”. Therefore, the calculation of course should refer to the section 7.1 which is the section to define PO. Therefore, the interpretation 1 is the correct understanding. |
| Samsung | We tend to agree with Nokia. But, it is open to further discuss. |
| ZTE, Sanechips | In our understanding, the a paging occasion index $i\_{PO}$ is used to one-to-one map the PEI bit field and PO. From this perspective, we think the UE ID in TS 38.213 is the definition in clause 7.1 in TS 38.304, which is also used for PO determination, otherwise, the mapping between the PEI bit and PO will disorder, i.e., UE monitors PEI information for other POs.For the UE ID used in clause 7.3.2 in TS 38.304, it is for the sub-group index ($i\_{SG}$) determination instead.

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| ---TS 38.213---A paging indication field of DCI format 2\_7 includes $N\_{PO}^{PEI}$ segments of $K$ bits, where $K=N\_{SG}^{PO}$. For a subgroup index $i\_{SG}$, $0\leq i\_{SG}<K$, a UE determines a value for the $\left(i\_{PO}⋅K+i\_{SG}\right)$ bit in the paging indication field, where $i\_{PO}=\left(\left(UE\\_IDmodN\right)⋅N\_{S}+i\\_s\right)modN\_{PO}^{PEI}$ is a paging occasion index, and $UE\\_ID$, $N$, $N\_{S}$, $i\_{SG}$, and $i\\_s$ are defined in [17, TS 38.304]. When the value is '1', the UE monitors a paging occasion determined according to [17, TS 38.304]; otherwise, the UE is not required to monitor the paging occasion. |
| 7 Paging7.1 Discontinuous Reception for pagingThe PF and PO for paging are determined by the following formulae: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-----omitted part-----N: number of total paging frames in TNs: number of paging occasions for a PFPF\_offset: offset used for PF determinationUE\_ID:If the UE operates in eDRX as specified in clause 7.4:- 5G-S-TMSI mod 4096else:- 5G-S-TMSI mod 1024 |

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| Moderator | **Interpretation of the UE ID for PEI determination:****Interpretation 1 (definition in clause 7.1 in TS 38.304):** the UE\_ID is defined as 5G-S-TMSI mod 4096 for UE operates in eDRX, otherwise, it is defined as 5G-S-TMSI mod 1024.Supported by: Huawei/HiSilicon, ZTE/Sanechips**Interpretation 2** **(definition in clause 7.3.2 in TS 38.304):**  the UE\_ID is defined as 5G-S-TMSI mod X, where X is 32768, if eDRX is applied; otherwise, X is 8192.Supported by: Nokia, Samsung |

**Question 2:**

**Do you agree to update the reference of UE ID determination in clause 10.4A of TS 38.213?**

**Please assist to elaborate on the reasoning of your answer if possible.**

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| **Company** | **Yes or No** | **Comment** |
| Nokia1 |  | Not sure if this is needed as it should be clear from TS38.304, but if companies feel it is needed can be considered. |
| Huawei, HiSilicon | No | This is already clear. The existing spec in 213 already clearly says *i*PO is a paging occasion index. So, it is very straight forward to refer to clause 7.1 in 38.304 where the PO is defined.There is no spec change needed. |
| Samsung |  | It is not clear yet. It may depend on the outcome of Question 1. |
| Moderator |  | Depends on the outcome of Question 1. |

## Issue #2: definition of $i\_{SG}$

The subgroup index $i\_{SG}$ is defined in clause 7.3 of TS38.304 as below. However, there is no abbreviation *iSG* in 38.304. it is pointed out in [1] that it is necessary to refer *iSG* to the subgroup ID in 38.304. Moreover, if the specific clause reference is used for UE ID determination, the reference of subgroup index definition may also need to be updated since different clauses they may refer to.

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| ------TS 38.304-h90-----7.3 Subgrouping7.3.0 GeneralIf PEI and subgrouping are configured, UEs monitoring the same PO can be divided into one or more subgroups. With subgrouping, the UE monitors the associated PO if the corresponding bit for subgroup the UE belongs to is indicated as 1 by PEI corresponding to its PO, as specified in clause 10.4a in TS 38.213 [4].The following parameters are used for the determination of subgroup ID:- *subgroupsNumPerPO*: total number of subgroups for both CN assigned subgrouping (if any) and UE\_ID based subgrouping (if any) in a PO, which is broadcasted in system information;- *subgroupsNumForUEID*: number of subgroups for UE\_ID based subgrouping in a PO, which is broadcasted in system information.------omitted part-----If a UE has no CN assigned subgroup ID or does not support CN assigned subgrouping, and there is no configuration for *subgroupsNumForUEID*, the UE monitors the associated PO according to clause 7.1. |

**Question 3:**

**Do you agree with [1] to update the reference for subgroup index definition as below?**

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|  $i\_{SG}$ is the subgroup ID defined in clause 7.3 of [17, TS 38.304] |

**Please to elaborate on the reasoning of your answer if possible.**

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| **Company** | **Comment** |
| Nokia1 | Could be considered if companies feel strongly that this is not clear from TS38.304. |
| Huawei | It is already described in the existing spec that “for a subgroup index *i*SG”, therefore the meaning is already crystal clear. People can know using clause 7.3 of 304 to define *i*SG, because the clause 7.3 is the section for defining subgroup. |
| Samsung | Similar view as HW but OK with the update if majority wants it. |
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Resulted RAN1 conclusion/agreement

TBD.

Summary of contribution inputs

**Summary for [1, ZTE]:**

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| **Reason for change**1. UE\_ID used for the determination of PO associated with PEI indication, refers to TS 38.304. While, in clause 7.1 of TS 38.304, the UE\_ID is defined as 5G-S-TMSI mod 4096 for UE operates in eDRX, otherwise, it is defined as 5G-S-TMSI mod 1024. In clause 7.3.2 of TS 38.304, the UE\_ID is defined as 5G-S-TMSI mod X, where X is 32768, if eDRX is applied; otherwise, X is 8192. That is, two different definitions are provided in TS 38.304, resulting the determination of UE\_ID is ambiguous without a specific reference. Therefore, an accurate reference relationship should be provided.
2. The definition and the determination of subgroup index *iSG* are provided in 38.304. However, there is no abbreviation *iSG* in 38.304. Therefore, it is necessary to refer *iSG* to the subgroup ID in 38.304.
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| 10.4A PDCCH monitoring for early indication of paging**<Unchanged parts are omitted>**A paging indication field of DCI format 2\_7 includes $N\_{PO}^{PEI}$ segments of $K$ bits, where $K=N\_{SG}^{PO}$. For a subgroup index $i\_{SG}$, $0\leq i\_{SG}<K$, a UE determines a value for the $\left(i\_{PO}⋅K+i\_{SG}\right)$ bit in the paging indication field, where $i\_{PO}=\left(\left(UE\\_IDmodN\right)⋅N\_{S}+i\\_s\right)modN\_{PO}^{PEI}$ is a paging occasion index, and $UE\\_ID$, $N$, $N\_{S}$, $i\_{SG}$~~,~~ and $i\\_s$ are defined in clause 7.1 of [17, TS 38.304], $i\_{SG}$ is the subgroup ID defined in clause 7.3 of [17, TS 38.304]. When the value is '1', the UE monitors a paging occasion determined according to [17, TS 38.304]; otherwise, the UE is not required to monitor the paging occasion.**<Unchanged parts are omitted>** |

References

[1] R1-2406402, “Correction on PEI for UE power saving”, ZTE Corporation, Sanechips., RAN1 #118