**3GPP TSG-RAN2 Meeting #113bis-e *R2-21xxxxx***

**Online, April 12 – 20, 2021**

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| *CR-Form-v12.1* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **36.304** | **CR** |  | **rev** | **-** | **Current version:** | **16.3.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network | **x** | Core Network |  |

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| ***Title:*** | Correction on paging DRX cycle | | | | | | | | | |
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| ***Source to WG:*** | ZTE Corporation, Sanechips | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | LTE\_eMTC5-Core  LTE\_5GCN\_connect-Core | | | | |  | ***Date:*** | | | 2021-04-15 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **F** |  | | | | | ***Release:*** | | | Rel-16 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)* | |
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| ***Reason for change:*** | | 1. In the current specification, for DRX cycle determination in RRC\_INACTIVE, “if allocated by upper layers” is applied to the *default paging cycle.* But as the *default paging cycle* is always provided, and the *UE specific paging cycle* is optionally allocated by upper layers. “*if allocated by upper layers*” should apply to the *UE specific paging cycle* other than to *default paging cycle*.  2. In RRC\_IDLE, the half HSN value of the extended DRX cycle has special process, e.g., PTW would not be applied and T is always equals to 512. Such special process hasn’t been considered for the RRC\_INACTIVE case.  3. As determination rule of DRX cycle(T) for RRC\_IDLE is different from that for RRC\_INACTIVE, and as T is involved in the calculation of PNB, i\_s and wg, it’s possible that PNB, i\_s and wg calculation for RRC\_IDLE is different from PNB, i\_s and wg calculation for RRC\_INACTIVE if the T value are different. Such difference would cause determined paging resources for monitoring/sending CN paging are different for UE and network and further cause paging failure. | | | | | | | | |
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| ***Summary of change:*** | | 1. For DRX cycle determination in RRC\_INACTIVE, “*if allocated by upper layers*” is applied to the *UE specific paging cycle* other than to *default paging cycle*. 2. To add description that for UE in RRC\_INACTIVE, if extended DRX value of 512 radio frames is configured by upper layers according to 7.3, the Paging DRX cycle T in RRC\_INACTIVE should be determined by the shortest of the RAN paging cycle and 512 radio frames. 3. To separately describe DRX cycle T determination for PF calculation and for PNB, i\_s and wg calculation. The legacy description is still applicable to DRX cycle T determination for PF calculation. But for PNB, i\_s and wg calculation, the DRX cycle T determination should follow RRC\_IDLE mode rule.   **Impact Analysis**  Impacted functionality:  The changes only impacts paging DRX cycle determination for UE in RRC\_INACTIVE state.  Inter-operability:  If the UE is implemented according to this CR and the network is not, or vice versa, the UE and network would have inconsistence understanding on the DRX cycle(T). The CN paging might be lost. | | | | | | | | |
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| ***Consequences if not approved:*** | | 1. Without #2 change, the UE behaviour is unspecified if the UE specific extended DRX value is configured to 512 radio frames. 2. Without #3 change, Different paging narrowband, paging subframe and/or GWUS group index may be selected between UE and eNB in some scenarios and this may further lead to paging failure. | | | | | | | | |
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| ***Clauses affected:*** | | 7.1, 7.3 | | | | | | | | |
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|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **x** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **x** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
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| ***This CR's revision history:*** | |  | | | | | | | | |

**<Start of the first change>**

## 7.1 Discontinuous Reception for paging

The UE may use Discontinuous Reception (DRX) in idle mode in order to reduce power consumption. One Paging Occasion (PO) is a subframe where there may be P-RNTI transmitted on PDCCH or MPDCCH or, for NB-IoT on NPDCCH addressing the paging message. In P-RNTI transmitted on MPDCCH case, PO refers to the starting subframe of MPDCCH repetitions. In case of P-RNTI transmitted on NPDCCH, PO refers to the starting subframe of NPDCCH repetitions unless subframe determined by PO is not a valid NB-IoT downlink subframe then the first valid NB-IoT downlink subframe after PO is the starting subframe of the NPDCCH repetitions. The paging message is same for both RAN initiated paging and CN initiated paging.

The UE initiates RRC Connection Resume procedure upon receiving RAN paging. If the UE receives a CN initiated paging in RRC\_INACTIVE state, the UE moves to RRC\_IDLE and informs NAS.

One Paging Frame (PF) is one Radio Frame, which may contain one or multiple Paging Occasion(s). When DRX is used the UE needs only to monitor one PO per DRX cycle.

One Paging Narrowband (PNB) is one narrowband, on which the UE performs the paging message reception.

PF, PO, and PNB are determined by following formulae using the DRX parameters provided in System Information:

PF is given by following equation:

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

Index i\_s pointing to PO from subframe pattern defined in 7.2 will be derived from following calculation:

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

If P-RNTI is monitored on MPDCCH, the PNB is determined by the following equation:

PNB = floor(UE\_ID/(N\*Ns)) mod Nn

If P-RNTI is monitored on NPDCCH and the UE supports paging on a non-anchor carrier, and if paging configuration for non-anchor carrier is provided in system information, then the paging carrier is determined by the paging carrier with smallest index n (0 ≤ n ≤ Nn-1) fulfilling the following equation:

floor(UE\_ID/(N\*Ns)) mod W < W(0) + W(1) + … + W(n)

System Information DRX parameters stored in the UE shall be updated locally in the UE whenever the DRX parameter values are changed in SI. If the UE has no IMSI, for instance when making an emergency call without USIM, the UE shall use as default identity UE\_ID = 0 in the PF, i\_s, and PNB formulas above. 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.

The following Parameters are used for the calculation of the PF, i\_s, PNB, wg, and the NB-IoT paging carrier:

- T: DRX cycle of the UE.

Except for NB-IoT: If a UE specific extended DRX value of 512 radio frames is configured by upper layers according to 7.3, T =512. Otherwise, T is determined by the shortest of the UE specific DRX value, if allocated by upper layers, and a default DRX value broadcast in system information. If UE specific DRX is not configured by upper layers, the default value is applied.

In RRC\_INACTIVE state, if extended DRX is not configured by upper layers as defined in 7.3:

* For PF calculation, T is determined by the shortest of the RAN paging cycle if configured, the UE specific paging cycle, if allocated by upper layers, and the default paging cycle.
* For i\_s, PNB and wg calculation, T is determined by the shortest of the UE specific paging cycle, if allocated by upper layers, and the default paging cycle.

In RRC\_INACTIVE state, when extended DRX value of 512 radio frames is configured by upper layers according to 7.3:

* For PF calculation, T is determined by the shortest of the RAN paging cycle if configured, and 512 radio frames.
* For i\_s, PNB and wg calculation, T is 512 radio frames.

In RRC\_INACTIVE state, when extended DRX is configured by upper layers according to 7.3 and it’s not 512 radio frames:

* For PF calculation during the PTW as defined in 7.3, T is determined by the shortest of the RAN paging cycle if configured, the UE specific paging cycle, if allocated by upper layers and the default paging cycle. For PF calculation outside the PTW, T is determined by the RAN paging cycleif configured, otherwise, by the shortest of the UE specific paging cycle, if allocated by upper layers, and the default paging cycle.
* For i\_s, PNB and wg calculation during the PTW as defined in 7.3, T is determined by the shortest of the UE specific paging cycle, if allocated by upper layers, and the default paging cycle. For i\_s, PNB and wg calculation outside the PTW, T is determined by the RAN paging cycle if configured, otherwise, by the shortest of the UE specific paging cycle, if allocated by upper layers, and the default paging cycle.

For NB-IoT: If UE specific DRX value is allocated by upper layers and minimum UE specific DRX value is broadcast in system information, T = min (default DRX value, max (UE specific DRX value, minimum UE specific DRX value broadcast in system information)). If UE specific DRX is not configured by upper layers or if the minimum UE specific DRX value is not broadcast in system information, the default DRX value is applied.

- nB: 4T, 2T, T, T/2, T/4, T/8, T/16, T/32, T/64, T/128, and T/256, and for NB-IoT also T/512, and T/1024.

- N: min(T,nB)

- Ns: max(1,nB/T)

- Nn: number of paging narrowbands (for P-RNTI monitored on MPDCCH) or paging carriers (for P-RNTI monitored on NPDCCH) determined as follows:

If UE monitors GWUS according to clause 7.5.1:

this is the number of paging narrowbands (paging carriers) that are configured with GWUS.

else:

this is the number of paging narrowbands (paging carriers) provided in system information.

- UE\_ID:

If the UE supports E-UTRA connected to 5GC and NAS indicated to use 5GC for the selected cell:

5G-S-TMSI mod 1024, if P-RNTI is monitored on PDCCH.

5G-S-TMSI mod 16384, if P-RNTI is monitored on NPDCCH or MPDCCH.

else

IMSI mod 1024, if P-RNTI is monitored on PDCCH.

IMSI mod 4096, if P-RNTI is monitored on NPDCCH.

IMSI mod 16384, if P-RNTI is monitored on MPDCCH or if P-RNTI is monitored on NPDCCH and the UE supports paging on a non-anchor carrier, and if paging configuration for non-anchor carrier is provided in system information.

- W(i): Weight for NB-IoT paging carrier i.

- W: Total weight of all NB-IoT paging carriers, i.e. W = W(0) + W(1) + … + W(Nn-1). If UE monitors GWUS according to clause 7.5.1, Total weight of all NB-IoT paging carriers configured with GWUS.

IMSI is given as sequence of digits of type Integer (0..9), IMSI shall in the formulae above be interpreted as a decimal integer number, where the first digit given in the sequence represents the highest order digit.

For example:

IMSI = 12 (digit1=1, digit2=2)

In the calculations, this shall be interpreted as the decimal integer "12", not "1x16+2 = 18".

5G-S-TMSI is a 48 bit long bit string as defined in TS 23.501 [39]. 5G-S-TMSI shall in the PF and i\_s formulae above be interpreted as a binary number where the left most bit represents the most significant bit.

**<End of the first change>**

**<Start of the second change>**

## 7.3 Paging in extended DRX

The UE may be configured by upper layers with an extended DRX (eDRX) cycle TeDRX. Except for NB-IoT, the UE may operate in extended DRX only if the UE is configured by upper layers and the cell indicates support for eDRX in System Information. For NB-IoT, the UE may operate in extended DRX only if the UE is configured by upper layers.

For UE in RRC\_IDLE state, If the UE is configured with a TeDRX cycle of 512 radio frames, it monitors POs as defined in 7.1 with parameter T = 512. Otherwise, a UE configured with eDRX monitors POs as defined in 7.1 (i.e, based on the upper layer configured DRX value and a default DRX value determined in 7.1, during a periodic Paging Time Window (PTW) configured for the UE or until a paging message including the UE's NAS identity is received for the UE during the PTW, whichever is earlier.

For UE in RRC\_RRCINACTIVE state, the UE monitors POs as defined in 7.1 (i.e, based on the upper layer configured DRX value, default DRX cycle and RAN paging cycle determined in 7.1), until a paging message including the UE's NAS identity or AS identity is received for the UE.

The PTW is UE-specific and is determined by a Paging Hyperframe (PH), a starting position within the PH (PTW\_start) and an ending position (PTW\_end). PH, PTW\_start and PTW\_end are given by the following formulae:

The PH is the H-SFN satisfying the following equation:

H-SFN mod TeDRX,H= (UE\_ID\_H mod TeDRX,H), where

- UE\_ID\_H:

- 10 most significant bits of the Hashed ID, if P-RNTI is monitored on PDCCH or MPDCCH

- 12 most significant bits of the Hashed ID, if P-RNTI is monitored on NPDCCH

- T eDRX,H : eDRX cycle of the UE in Hyper-frames, (TeDRX,H =1, 2, …, 256 Hyper-frames) (for NB-IoT, TeDRX,H =2, …, 1024 Hyper-frames) and configured by upper layers.

PTW\_start denotes the first radio frame of the PH that is part of the PTW and has SFN satisfying the following equation:

SFN = 256\* ieDRX, where

- ieDRX = floor(UE\_ID\_H /TeDRX,H) mod 4

PTW\_end is the last radio frame of the PTW and has SFN satisfying the following equation:

SFN = (PTW\_start + L\*100 - 1) mod 1024, where

- L = Paging Time Window length (in seconds) configured by upper layers

Hashed ID is defined as follows:

Hashed\_ID is Frame Check Sequence (FCS) for the bits b31, b30…, b0 of S-TMSI or 5G-S-TMSI. 5G-S-TMSI is used for Hashed-ID if the UE supports connection to 5GC and NAS indicated to use 5GC for the selected cell.

S-TMSI = <b39, b38, …, b0> as defined in TS 23.003 [35]

5G-S-TMSI = <b47, b46, …, b0> as defined in TS 23.003 [35].

The 32-bit FCS shall be the ones complement of the sum (modulo 2) of Y1 and Y2, where

- Y1 is the remainder of xk (x31 + x30 + x29 + x28 + x27 + x26 + x25 + x24 + x23 + x22 + x21 + x20 + x19 + x18 + x17 + x16 + x15 + x14 + x13 + x12 + x11 + x10 + x9 + x8 + x7 + x6 + x5 + x4 + x3 + x2 + x1 + 1) divided (modulo 2) by the generator polynomial x32 + x26 + x23 + x22 + x16 + x12 + x11 + x10 + x8 + x7 + x5 + x4 + x2 + x + 1, where k is 32; and

- Y2 is the remainder of Y3 divided (modulo 2) by the generator polynomial x32 + x26 + x23 + x22 + x16 + x12 + x11 + x10 + x8 + x7 + x5 + x4 + x2 + x + 1, where Y3 is the product of x32 by "b31, b30…, b0 of S-TMSI or 5G-S-TMSI", i.e., Y3 is the generator polynomial x32 (b31\*x31 + b30\*x30 + … + b0\*1).

NOTE: The Y1 is 0xC704DD7B for any S-TMSI or 5G-S-TMSI value. An example of hashed ID calculation is in Annex B.

**<End of the second change>**