**3GPP TSG-WG2 Meeting #111-e *R2-2007567***

**17 – 28 August 2020**

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| *CR-Form-v12.0* |
| **CHANGE REQUEST** |
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|  | **04** | **CR** | **0810** | **rev** | **1** | **Current version:** |  |  |
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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:***  | Group WUS corrections |
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| ***Source to WG:*** | Qualcomm Incorporated, Nokia, Nokia Shanghai Bell, ZTE Corporation, Sanechips, Huawei, HiSilicon |
| ***Source to TSG:*** |   |
|  |  |
| ***Work item code:*** | LTE\_eMTC5-Core, NB\_IOTenh3-Core |  | ***Date:*** | 2020-08-18 |
|  |  |  |  |  |
| ***Category:*** | **F** |  | ***Release:*** | -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 canbe 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-12 (Release 12)**Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
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| ***Reason for change:*** | For the explanation of total weight W, only GWUS configuration is considered (e.g. UE GWUS capability is missing). In fact, UE not supporting GWUS, the W should be total weight of all NB-IoT paging carriers.Some aspects of group WUS description are difficult to follow. Structure of the conditional text is difficult to follow as well as text duplication. For GWUS alternation “div(x)” is used to indicate the maximal integer value less than or equal to x, which has multiple mathematical meaning (e.g. floor(), or divergence()), and is seldomly used in 3GPP. Instead, floor(x) is usually used to indicate the maximal integer value less than or equal to x in 3GPP. Furtheremore, div usage in the equeation is wrong, normaly it is ‘a div b’ and not ‘div(a/b)’. |
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| ***Summary of change:*** | Clairfy that ‘Total weight of all NB-IoT paging carriers configured with GWUS’ is only applicable to UE supporting GWUS.Change equation for GWUS hopping to use floor function instead of div.Change ‘time offset’ to ‘timeoffset’ to be consistent with legacy text.Remove unnecessary intermediate variable.Change ‘WUS resource’ to ‘WUS Resource’ when referring to a specific WUS resource. Change WG to WG’ to make it easier to distinguish from wg.Clean-up bullet text layout.**Impact analysis**Impacted functionality:Group WUSInter-operability:If the network is implemented according to the CR but UE is not, no interoperability problems are foreseen.If the UE is implemented according to the CR but UE is not, no interoperability problems are foreseen. |
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| ***Consequences if not approved:*** | Description of group WUS remains unclear. |
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| ***Clauses affected:*** | 7.1, 7.5.1, 7.5.2, 7.5.3, 7.5.4, 7.5.5 |
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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 ...  |
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| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

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| Start of 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, 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. UE specific DRX is not applicable for NB-IoT. In RRC\_INACTIVE state, if extended DRX is not configured by upper layers as defined in 7.3, T is determined by the shortest of the RAN paging cycle, the UE specific paging cycle, and the default paging cycle, if allocated by upper layers. Otherwise, in RRC\_INACTIVE state when extended DRX is configured by upper layers, T is determined by the shortest of the RAN paging cycle, the UE specific paging cycle, if allocated by upper layers and the default paging cycle during the PTW as defined in 7.3, and by the RAN paging cycle outside the PTW.

 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 supports GWUS and *gwus-Config* is present in system information:

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 supports GWUS and GWUS is configured, 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.

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| Start of next change |

### 7.5.1 General

When all of the following conditions are met then the UE shall monitor GWUS using the GWUS parameters provided in system information.

- the UE supports GWUS and GWUS configuration (*gwus-Config*) is provided in system information;

- and either:

- groupAlternation is present in *gwus-Config* and UE supports GWUS with group resource alternation; or

- groupAlternation is not present in *gwus-Config*.

A UE supporting GWUS can be configured to monitor a WUS group and a common WUS. Upon detecting either of them, UE shall monitor POs as defined in clause 7.4.

For NB-IoT, E-UTRAN may configure up to 2 WUS resources (numbered 0 and 1). The timeoffset, *g*0, from the end of WUS Resource 0 to the start of corresponding PO is determined as defined in clause 7.4. When both *wus-Config* and *gwus-Config* are present, WUS Resource 0 shares radio resources with *wus-Config*.The timeoffset from the end of WUS Resource 1 to the start of corresponding PO is sum of the timeoffset *g*0 and the maximum WUS duration.

After the UE has determined the applicable gap between end of WUS resource and associated PO as specified in clause 7.4, UE selects the WUS group set for the corresponding gap as specified in clause 7.5.2. From the selected WUS group set, UE selects one WUS group as defined in clause 7.5.3. If *groupAlternation* is not present in *gwus-Config*, the UE monitors the selected WUS group with the corresponding timeoffset for each PO. If *groupAlternation* is present in *gwus-Config* and UE supports GWUS with group resource alternation, the UE determines the WUS group to monitor for each PO and the corresponding timeoffset as specified in clause 7.5.4.

For BL UEs and UEs in enhanced coverage, E-UTRAN may configure up to 4 WUS resources. The resource number, time and frequency location of these resources is determined as specified in clause 7.5.5.

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| Start of next change |

### 7.5.2 WUS group sets selection

The total number of WUS groups, maxWG, configured for a gap is determined with the following equation:

where:

* maxWR is the total number of WUS resources configured for the gap.
* *numGroupsList*[i] is the number of WUS groups configured for WUS Resource i, provided in *gwus-Config*, for the gap.

Using *numGroupsList* for the gap*,* the UE builds the list of WUS groups as an ordered list of pairs (, ) where the first entry corresponds to the first WUS group on the first configured WUS resource and the last entry corresponds to the last WUS group on the last configured WUS resource.

For a NB-IoT UE, if *resourcePosition* provided in *gwus-Config* is set to *secondary,*  = 0 is not used and the first entry in the list corresponds to = 1. Otherwise, is the index of the WUS resources in *numGroupsList*.

For a BL UE or UE in enhanced coverage, UE determines of the configured resources as specified in clause 7.5.4.

If *probThreshList* is present in *gwus-Config*, UE determines the WUS group sets as defined in Table 7.5.2.1. The total number of WUS group sets is equal to the number of entries in *probThreshList* + 1. The WUS groups are first assigned to WUS group set 1, followed by WUS group set 2, and so on. The UE determines the WUS group set corresponding to its probability PNAS, if configured, as defined in Table 7.5.2-1. If PNAS is not configured UE selects the WUS group set with highest index that has at least one WUS group (i.e. Upper bound – Lower bound > 0).

Table 7.5.2-1: WUS group set definition when *probThreshList* is configured

|  |  |  |
| --- | --- | --- |
| WUS group set | *probThreshList* | WUS group index in WUS groups list |
| Lower bound | Upper bound |
| 1 | PNAS ≤ Thresh1 | 0 | Nth1 -1 |
| 2 | Thresh1 < PNAS ≤ Thresh2 (Note) | Nth1 | Nth1 + Nth2 -1 |
| 3 | Thresh2 < PNAS ≤ Thresh3 (Note) | Nth1 + Nth2 | Nth1 +Nth2 + Nth3 -1 |
| 4 | PNAS > Thresh3 | Nth1 +Nth2 + Nth3 | maxWG-1 |
| where Threshi is the value signalled in the ith entry of *probThreshList* Nthi is the value signalled in the ith entry of *groupsForServiceList*Note: When the total number of WUS group sets is less than 4, the upper bound for the WUS group set with highest index is maxWG-1. |

If *probThreshList* is not present in *gwus-Config*, there is only one WUS group set containing all the WUS groups configured in *numGroupsList*. The total number of WUS groups is maxWG.

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| Start of next change |

### 7.5.3 WUS group selection

After selection of the WUS group set as specified in clause 7.5.2, the UE selects the WUS group to monitor as below.

For BL UE or UE in enhanced coverage, the UE determines wg with following equation:

For NB-IoT, the UE determines wg with following equation:

where:

* UE\_ID, N, Ns, Nn and W are defined in clause 7.1.
* Nw is the number of WUS groups in the selected WUS group set.
* wg is the index of the WUS group in the selected WUS group set.

If *probThreshList* is not present (i.e. in this case all WUS groups belong to the same WUS group set) then:

WG’ = wg

If *probThreshList* is present, the UE determines WG’, the index of the corresponding WUS group within the WUS groups list of the selected WUS group set, as defined in Table 7.5.3-1.

Table 7.5.3-1: Index of the WUS group to monitor

|  |  |
| --- | --- |
| Selected WUS group set | WG’ |
| 1 | wg |
| 2 | wg + Nth1 |
| 3 | wg + Nth1 + Nth2 |
| 4 | wg + Nth1 + Nth2 + Nth3 |
| Where Nthi is defined in table 7.5.1  |

The entry corresponding to WG’in theWUS groups list defined in clause 7.5.2 provides (, as specified in TS 36.213 [6].

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| Start of next change |

### 7.5.4 WUS Group Alternation

When WUS group alternation is used in the cell then one of two schemes for WUS group alternation is used depending on *gwus-Config* configuration. In the first scheme a subset of WUS groups alternate togher at each PO; while in the second scheme all WUS groups in a WUS resource alternate at each PO.

If *groupAlternation* is present in *gwus-Config*:

- if *probThreshList* is not present in *gwus-Config* and *commonSequence* is set to *g*0*,* the UE determines the WUS group to monitor for the current PO as follows:

WGcurrent = (WGinitial + Gmin · floor()) mod maxWG

- else, the UE determines the WUS group to monitor for the current PO as follows:

mcurrent = (minitial + floor()) mod maxWR

where:

- Tcell is the default DRX cycle for the cell.

- SFN is the SFN corresponding to the PO.

- H-SFN is the H-SFN corresponding to the PO.

- maxWR is the total number of WUS resources configured in *numGroupsList* for the gap.

- Gmin is the lowest number of WUS groups configured amongst all WUS resources for the gap.

- WGcurrent is the index of the WUS group to monitor for the current PO. The entry corresponding to WGcurrent in the WUS groups list defined in clause 7.5.2 provides (, as specified in TS 36.213 [6].

- WGinitial is the index, WG’, of the WUS group determined in clause 7.5.3.

- minitial is defined based on given in the entry corresponding to the index WG’ determined in clause 7.5.3:

- For a NB-IoT UE : minitial

- For a BL UE or UE in enhanced coverage:

- if = 0 is configured to be used for GWUS:

 - minitial - 1.

- else:

 - minitial.

- mcurrent is used to determine of the WUS group to monitor for the current PO as follows:

- For a NB-IoT UE := mcurrent.

- For a BL UE or UE in enhanced coverage:

- if is configured to be used for GWUS:

- = mcurrent.

- else:

- = mcurrent +1.

 of the WUS group to monitor for the current PO is given in the entry corresponding to the index WG’ determined in clause 7.5.3.

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| Start of next change |

### 7.5.5 WUS Resource Location for BL UEs and UEs in Enhanced coverage

A BL UE or UE in enhanced coverage determines the time/frequency location of WUS resources based on the number of configured WUS resources and the frequency location of WUS Resource 0 (. If *wus-Config* is present, frequency location for WUS Resource 0 is defined by *frequencyLocation* parameter in *wus-Config*. Otherwise, frequency location for WUS Resource 0 is defined by *resourceLocationWithoutWUS* in *gwus-Config*. The frequency location of other WUS resources (i.e., WUS Resource 1, 2, 3), based on frequency location of WUS Resource 0, is given in Table 7.5.5-1.

Table 7.5.5-1: WUS Resource frequency location

|  |  |
| --- | --- |
| WUS Resource() | Frequency location of WUS Resource ID 0 |
| n0 | n2  | n4 (NOTE 1) |
| NB frequency < centre frequency | NB frequency > centre frequency  |
| WUS Resource 1,3 | n2 | n4 | n0 | n2 |
| WUS Resource 2 | n0 | n2 | n2 | n4 |
| WUS Resource 2(NOTE 2) | n4 | n0 | n4 | n0 |
| NOTE 1: This column is applicable if *wus-Config* is present.NOTE 2: This row is applicable if *resourceLocationWithWUS* is *primary3FDM*. |

The timeoffset, *g*0, from the end of WUS Resource 0 and WUS Resource 1 to the start of corresponding PO is determined as defined in clause 7.4. Except when *resourceLocationWithWUS* is set to *primary3FDM* , the timeoffset from the end of WUS Resource 2 and WUS Resource 3 to the start of corresponding PO is sum of the timeoffset *g*0 and the maximum WUS duration. When *resourceLocationWithWUS* is set to *primary3FDM*, the timeoffset for WUS Resource 2 is same as WUS Resource 0 and 1.

The resource pattern ID (rp-ID) which indicates the WUS Resources applicable for GWUS is derived based on *resourceMappingPattern* and the configured number of WUS resources as follows:

If *resourceLocationWithWUS* is configured:

rp-ID = 2\*(maxWR -– 1) if *resourceLocationWithWUS* is set to *primary*.

rp-ID = 2\*maxWR - 1 if *resourceLocationWithWUS* is set to *secondary*.

rp-ID = 7 if *resourceLocationWithWUS* is set to *primary3FDM*.

If *resourceLocationWithoutWUS* is configured:

rp-ID = 2\*(maxWR - 1)

where maxWR is the total number of WUS resources configured in *numGroupsList* for the gap.

The WUS resource IDs corresponding to the resource pattern ID are determined as defined in Table 7.5.5-2.

Table 7.5.5-2: WUS Resources applicable for Resource Pattern

|  |  |
| --- | --- |
|  | Resource Pattern ID |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| WUS Resource*()* | 0 | X |  | X |  | X |  | X | X |
| 1 |  | X | X | X | X | X | X | X |
| 2 |  |  |  | X | X | X | X | X |
| 3 |  |  |  |  |  | X | X |  |

If = 0 is not used, the first entry in the *numGroupsList* corresponds to = 1. Otherwise, is the index of the WUS resources in *numGroupsList*.

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| End of change |