**3GPP TSG-RAN WG2 Meeting #109bis-e *draft-*R2-2004042**

**Online, April 20th – April 30 2020**

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| *CR-Form-v12.0* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **36.304** | **CR** | **0783** | **rev** | **1** | **Current version:** | **16.0.0** |  |
|  | | | | | | | | |
| *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:*** | Introduction of Rel-16 NB-IoT enhancements | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Nokia | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NB-IoTenh3-Core | | | | |  |  | | | 2019-04-20 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***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-12 (Release 12)* *Rel-13 (Release 13) Rel-14 (Release 14) Rel-15 (Release 15) Rel-16 (Release 16)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | To capture the GWUS related agreements to specification | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | New section for GWUS group set selection, GWUS selection , WUS resource identification and WUS alternation related specifications. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Rel-16 NB-IoT enhancements for GWUS will not be supported . | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 7.5.1,7.5.2,7.5.3,7.5.x(new),7.5.x(new) | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **X** |  | Other core specifications | | | | TS 36.331 CR 4192 | | |
| ***affected:*** | | **X** |  | Test specifications | | | | TS 36.300 CR 1259 | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | |  | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |

|  |  |
| --- | --- |
| ***This CR's revision history:*** |  |

First Change

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 25.990: "Vocabulary for UTRAN".

[2] 3GPP TS 36.300: "E-UTRA and E-UTRAN Overall Description; Stage 2".

[3] 3GPP TS 36.331: "E-UTRA; Radio Resource Control (RRC) - Protocol Specification".

[4] 3GPP TS 22.011: "Service accessibility".

[5] 3GPP TS 23.122: "NAS functions related to Mobile Station (MS) in idle mode".

[6] 3GPP TS 36.213: "E-UTRA; Physical layer procedures".

[7] 3GPP TS 36.214: "E-UTRA; Physical layer; Measurements".

[8] 3GPP TS 25.304: "User Equipment (UE) procedures in idle mode and procedures for cell reselection in connected mode"

[9] 3GPP TS 43.022: "Functions related to Mobile Station in idle mode and group receive mode".

[10] 3GPP TS 36.133: "Requirements for Support of Radio Resource Management".

[11] void

[12] void

[13] void

[14] void

[15] void

[16] 3GPP TS 24.301: "Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3"

[17] 3GPP2 C.S0024-C v2.0: "cdma2000 High Rate Packet Data Air Interface Specification".

[18] 3GPP2 C.S0005-F v1.0: "Upper Layer (Layer 3) Signalling Standard for cdma2000 Spread Spectrum Systems".

[19] 3GPP TS 25.304: "User Equipment (UE) procedures in idle mode and procedures for cell reselection in connected mode".

[20] 3GPP TS 24.008: "Mobile Radio Interface Layer 3 specification; Core Network Protocols; Stage 3"

[21] 3GPP TS 37.320: "Universal Terrestrial Radio Access (UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRA); Radio measurement collection for Minimization of Drive Tests (MDT); Overall description; Stage 2".

[22] 3GPP TS 26.346: "Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs".

[23] 3GPP TS 23.401: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".

[24] 3GPP TS 23.682: "Architecture enhancements to facilitate communications with packet data networks and applications".

[25] 3GPP TS 23.402: "Architecture enhancements for non-3GPP accesses".

[26] IEEE 802.11, Part 11: "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, IEEE Std.".

[27] Wi-Fi Alliance Technical Committee, Hotspot 2.0 Technical Task Group: "Hotspot 2.0 (Release 2) Technical Specification".

[28] 3GPP TS 24.302: "Access to the 3GPP Evolved Packet Core (EPC) via non-3GPP access networks".

[29] 3GPP TS 23.303: "Proximity-based services (ProSe); Stage 2".

[30] 3GPP TS 36.321: "E-UTRA; Medium Access Control (MAC) protocol specification".

[31] 3GPP TS 24.105: "Application specific Congestion control for Data Communication (ACDC) Management Object (MO)".

[32] 3GPP TS 31.102: "Characteristics of the Universal Subscriber Identity Module (USIM) application".

[33] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception".

[34] Void

[35] 3GPP TS 23.003: "Numbering, addressing and identification".

[36] 3GPP TS 23.285: "Technical Specification Group Services and System Aspects; Architecture enhancements for V2X services".

[37] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[38] 3GPP TS 38.304: "New Generation Radio Access Network; User Equipment (UE) procedures in Idle mode and RRC Inactive state".

[39] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[40] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[xx] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation".

next 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.

- 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-r16* is present in system information:

this is the number of paging narrowbands (paging carriers) that is configured with WUS groups

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 GWUS is configured, Total weight of all NB-IoT paging carriers supporting 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.

Next Change

## 7.5 Paging with Group Wake Up Signal

### 7.5.1 General

When the UE supports GWUS and GWUS configuration (*gwus-Config*) is provided in system information, the UE shall monitor GWUS using the GWUS parameters provided in System Information.

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 time offset, *g*0, from the end of WUS resource 0 to the start of corresponding PO is determined as defined in subclause 7.4. When both *wus-Config* and g*wus-Config* are present, WUS resource 0 shares radio resources with *wus-Config.*The time offset from the end of WUS resource 1 to the start of corresponding PO is sum of the time offset *g*0 and the maximum WUS duration (TS 36.331 [3]).

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 subclause 7.5..

After the UE has determined the applicable gap between end of WUS resource and associated PO as specified in subclause 7.4, UE selects the WUS group set for the corresponding gap as specified in subclause 7.5.2. From the selected WUS group set, UE selects one WUS group as defined in subclause 7.5.3. If *gwus-GroupAlternation* is not present in *gwus-Config*, the UE monitors the selected the WUS group for each PO. Otherwise, the UE determines the WUS group to monitor for each PO as specified in subclause 7.5.5.

### 7.5.2 WUS group set selection

The total number of WUS groups configured for a gap is given by:

Where:

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

*maxWG[i]* is the value of *gwus-NumGroupsList[i]* provided in *gwus-Config* for the gap.

Using *gwus-NumGroupsList* for the gap*,* the UE builds the list of WUS groups as an ordered list of pairs (, ) where the first entry (*WUS Index*= 0) corresponds to the first WUS group on the first configured WUS resource and the last entry (*WUS Index*= *maxWG* - 1) corresponds to the last WUS group on the last configured WUS resource. The total number of entries in the list is *maxWG*, , configured WUS resource number, has value 0, 1 2 or 3 and , the WUS group number within a configured WUS resource, has value 0, 1, …, 7.



For a NB-IoT UE, if *gwus-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 *gwus- NumGroupsList*.

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

If g*wus-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 set is equal to the number of entries in g*wus-ProbThreshList* + 1. The WUS groups are first assigned to WUS group set 1, followed by WUS group set 2, and so on. If g*wus-ProbThreshList* is not present in *gwus-Config*, then WUS group set 1, 2 & 3 are all empty and all WUS groups belong to WUS group set 4.

The UE determines the WUS group set corresponding to its probability PNAS, if configured, as defined in Table 7.5.2-1. If the WUS group set corresponding to the configured probability PNAS is empty, then UE selects the next non-empty WUS group set.

Table 7.5.2-: WUS group set definition when g*wus-ProbThreshList* is configured

|  |  |  |  |
| --- | --- | --- | --- |
| ***WUS group set*** | ***gwus-ProbThreshList*** | ***WUS group index in WUS groups list*** | |
| *Lower bound* | *Upper bound* |
| 1 | PNAS ≤ Thresh1 (Note) | 0 | min (Nth1 -1, maxWG) |
| 2 | Thresh1 < PNAS ≤ Thresh2 (Note) | min (Nth1, maxWG) | min (Nth1 + Nth2 -1, maxWG) |
| 3 | Thresh2 < PNAS ≤ Thresh3 (Note) | min (Nth1 + Nth2, maxWG) | min (Nth1 +Nth2 + Nth3 -1, maxWG) |
| 4 | PNAS > Thresh3 or PNAS not configured | min (Nth1 +Nth2 + Nth3, maxWG) | maxWG |
| where  Threshi is the value signalled in the ith entry of g*wus-ProbThreshList*  Nthi is the values signalled in the ith entry of *gwus-GroupsForServiceList*  Note: If Threshx is configured, otherwise this set is empty. | | | |
|  | | | | |

### 7.5.3 WUS group selection

After selection of the WUS group set as specified in subclause 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 Ware definedin subclause7.1

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, determined as defined in subclause 7.5.2, 0 .. Nw-1

If *probThreshList* is not present in *gwus-Config*, UE selects WUS group from all the WUG Groups configured in numGroupsList. And Nw =maxWG in this case.

Then, the UE determines WG, the index of the corresponding WUS group within the WUS groups list, as below:

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

|  |  |
| --- | --- |
| ***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.x.1 | |

The entry corresponding to WGin theWUS groups list defined in subclause 7.5.2 provides (, as specified in TS 36.211 [xx].

### 7.5.4 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 *FreqLocation* parameter in *wus-Config*, if present, otherwise based on *gwus-FreqLocation* parameter in *gwus-Config*. *FreqLocation* or *gwus-FreqLocation* parameter indicates the frequency location of WUS Resource ID 0 (. Frequency location of other WUS Resources (Resource ID 1, 2, 3) based on the frequency location of WUS Resource ID 0 is given in Table 7.5.4-1. The resource pattern which indicates the WUS Resources applicable for WUS Groups is signalled either by *gwus-ResourceMappingPattern* or *gwus-ResourceMappingPatternWithoutLegacy*.

Table 7.5.4-1: WUS Resource frequency location

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***WUS Resource***  ***()*** | ***Frequency location of WUS Resource ID 0*** | | | | | |
| ***NB below centre frequency*** | | | ***NB above centre frequency*** | | |
| ***n0*** | ***n2*** | ***n4 (Note 1)*** | ***n0*** | ***n2*** | ***n4 (Note 1)*** |
| WUS Resource 1 | n2 | n0 | n2 | n2 | n4 | n2 |
| WUS Resource 2 | n0 | n2 | n4 | n0 | n2 | n4 |
| WUS Resource 2  (Note 2) | n4 | n4 | n0 | n4 | n0 | n0 |
| WUS Resource 3 | n2 | n0 | n2 | n2 | n4 | n2 |
| Note 1: This column is applicable if wus-Config is present.  Note 2: This row is applicable for the resource pattern ID 7 | | | | | | |

The time offset, *g*0, from the end of WUS Resource 0 and WUS Resource 1 to the start of corresponding PO is determined as defined in subclause 7.4. The time offset from the end of WUS Resource 2 and WUS Resource 3 to the start of corresponding PO is sum of the time offset *g*0 and the maximum WUS duration for all values of ResourcePatterns except Resource-Pattern-ID-7. For ResourcePattern ID 7, the time offset, *g*0, from the end of WUS Resource 0, WUS Resource 1 and WUS Resource 2 to the start of corresponding PO is the same and is determined as defined in subclause 7.4.

The WUS Resource ID for the selected WUS Groups is selected according to Table 7.5.4-2.

Table 7.5.4-2: 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 |  |
| ***Number of***  ***WUS Resources*** | | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 3 |

If = 0 is not used for WUS Groups the first entry in the *gwus- NumGroupsList*. corresponds to = 1. Otherwise, is the index of the WUS resources in *gwus-NumGroupsList*.

### 7.5.5 WUS Group Alternation

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

- if *gwus-ProbThreshList* is not present in *gwus-Config* and *gwus-CommonSequence* is set to *legacyWUS*, the UE determines the WUS group to monitor for the current PO as follows:

where:

Tcell is the default DRX cycle for the cell.

maxWG is the total number of WUS group configured in *gwus-NumGroupsList* for the gap.

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

WGcurrent is the index of the WUS Group to monitor for the current PO.

WGinitial is the index, WG, of the WUS Group determined in subclause 7.5.3

The entry corresponding to WGcurrent in the WUS groups list defined in subclause 7.5.2 provides (, as specified in TS 36.211 [xx].

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

where:

Tcell is the default DRX cycle for the cell.

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

minitial:

For a NB-IoT UE :in the entry corresponding to the index WG determined in subclause 7.5.3 .

For a BL UE or UE in enhanced coverage:

if = 0 is configured:

- 1, where is given in the entry corresponding to the index WG determined in subclause 7.5.3

else:

, where is given in the entry corresponding to the index WG determined in subclause 7.5.3

mcurrent is used to determine of the WUS group to monitor for the current PO

For a NB-IoT UE := mcurrent

For a BL UE or UE in enhanced coverage:

if is configured:

= 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 subclause 7.5.3

End of Changes