**3GPP TSG-RAN WG2 Meeting #116bis-e *draft-R2-2203581***

 **Online, 17 - 25 Jan 2022**

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| *CR-Form-v12.1* |
| **CHANGE REQUEST** |
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|  | **36.304** | **CR** | **0844** | **rev** | **1** | **Current version:** | **16.5.0** |  |
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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:***  | Introduction of Enhancements for NB-IoT/eMTC |
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| ***Source to WG:*** | Nokia  |
| ***Source to TSG:*** | RAN2 |
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| ***Work item code:*** | NB\_IOTenh4\_LTE\_eMTC6-Core  |  | ***Date:*** | 2022-02-22 |
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| ***Category:*** | **B** |  | ***Release:*** | Rel-17 |
|  | *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-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)* |
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| ***Reason for change:*** | Introduce Release 17 enhancements for NB-IoT and eMTC |
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| ***Summary of change:*** | The running CR captures the agreements to support enhancements for NB-IoT/eMTC up to and including RAN2 #116-bis-e meeting applicable for paging reception. **RAN2-116-bis-e*** UE can be enabled/disabled coverage-based paging carrier selection via dedicated signalling. Presence or absence of the coverage information can be implicit enable/disable indication.
* In SIB, the value range for Rmax (npdcch-NumRepetitionPaging) in R17 paging carrier (list) configuration can be ENUMERATED {r1, r2, r4, r8, r16, r32, r64, r128}.
* In SIB, coverage specific nB is supported, e.g., a common nB value is configured for the R17 paging carrier(s) with same Rmax (npdcch-NumRepetitionPaging).
* Coverage-specific default DRX cycle is not supported.
* Working assumption: In SIB, coverage specific ue-SpecificDRX-CycleMin is supported, e.g., a common ue-SpecificDRX-CycleMin value is configured for the R17 paging carrier(s) with same Rmax (npdcch-NumRepetitionPaging).
* (FFS check whether there are any issues with the UE specific minimum DRX cycle per coverage level, can confirm WA if no issues.)
* Paging weight can still be used in coverage-based paging carrier selection.
* In SIB, both non-mixed operation mode and mixed operation mode can be supported in R17 paging carrier list configuration. They can be configured separately (as legacy).
* The extension in SIB22-NB can be used for providing R17 paging carrier list configuration.
* No “offset” (headroom) would be introduced for the configured NRSRP threshold.
* A configurable cell specific timer period can be applied when UE compares its serving cell NRSRP with the NRSRP threshold. FFS how to signal and value range.
* It’s specified that UE does not switch paging carrier if it has stayed less than [xx] seconds on the carrier or within a PTW. FFS value of [xx] seconds
* Coverage based paging carrier selection is enabled implicitly, i.e., when relevant parameters are provided to the UE during release.
* The Rel-17 paging carriers can also be used as the DL carriers for random access.
* No need to introduce a subgroup of paging carriers for the more easily changed CE level.
* In SIB, at most 2 coverage levels can be configured in R17 paging carrier list, each coverage level has one NRSRP threshold
* Rmax may be configured per carrier or per carrier group (coverage level).
* A paging carrier group index, e.g., the index to one of the two lists which correspond to the 2 coverage levels in SIB, is provided to the UE in dedicated signaling (when UE is released to idle).
* UE measured NRSRP can be reported to network for assisting the network to provide suitable coverage level related information. FFS how.
* FFS whether to introduce a new paging carrier list, e.g., DL-ConfigCommon-NB-r17, or just to extend PCCH-ConfigList-NB.

**Upto RAN2-116-e*** Rel-17 paging carriers and the legacy paging carriers should be exclusive.
* Rel-17 paging carrier configuration is provided in broadcast signalling.
* Whenever the R17 coverage-based carrier criteria is met, UE uses the R17 coverage based carrier, otherwise UE should use the fallback mechanism
* For both options, fall back carrier is legacy paging carrier based on UE\_ID.
* Support coverage or carrier specific DRX configurations, FFS details.
* UE metric for determining carrier suitability and selection is based on NRSRP.
* Use a hysteresis/longer averaging/timer for UE metric based on NRSRP.
* DRX is not used a criterion that needs to be explicitly considered for paging carrier selection.
* Option 1c with Alt2 (fallback when cell change) is supported.
	+ - Option 1c: Network enables UE to select a Rel-17 paging carrier by providing the coverage information (CEL/Rmax) for the carrier selection to the UE in dedicated signalling

RAN2-117e* RAN2 introduces a new ue-SpecificDRX-CycleMin parameter which is configured per coverage level.
* Same rules, e.g., to wait a certain period of time or avoid paging carrier switching in PTW would be applied no matter UE selects legacy paging carrier or coverage-based paging carrier.
* RAN2 use the way of extending PCCH-Config-NB to provide the R17 paging carrier list configuration in SIB.
* It’s RAN2 assumption that the assigned information to UE in dedicated signaling also need to be delivered to core network and sent back to eNB in next paging.
* UEPagingCoverageInformation RRC container is used to deliver the assigned information to UE in dedicated signaling to core network and sent back to eNB. A response LS to RAN3 would be sent as early as possible.
* Only one timer is specified to reduce paging carrier switching, regardless of whether UE is in PTW and regardless of the currently selected carrier.
* The timer is started after UE selects/switches between coverage based/non-coverage based carrier. When the timer is running, UE does not switch its current paging carrier. When timer expires, UE is allowed to switch its paging carrier based on its coverage status with respect to what was configured by the network.
* The timer is configured in SIB with a cell-specific value.
* The unit of the timer is second, from 2.56s up to 40s (maximum 8 values)
	+ FFS Exact value range and whether infinity is possible [CB]
* Previous agreement can be refined as below:
	+ In SIB, coverage specific nB is supported, e.g., a common nB value is configured for the R17 paging carrier(s) with same coverage level.
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| ***Consequences if not approved:*** | Release 17 enhancements for NB-IoT and eMTC will not be supported. |
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| ***Clauses affected:*** | 7.1, 7.X (New) |
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|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 36.300 CR 1354, TS 36.306 CR 1841, TS 36.321 CR xxxx,TS 36.331 CR 4760  |
| ***affected:*** |  |  |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
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| ***Other comments:*** |  |
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| ***This CR's revision history:*** | R2-2200058 – Initial version.R2-2201791 – V1R2-2203756 –Incorporation of further comments until RAN2-117e (not endorsed) |

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| Start of first change |

# 7 Paging

## 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:

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.

In RRC\_IDLE state:

- 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:

- 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.

In RRC\_INACTIVE state if extended DRX is configured by upper layers according to 7.3:

- If a UE specific extended DRX value of 512 radio frames is configured, T is determined by the shortest of the RAN paging cycle, if configured, and 512 radio frames.

- If a UE specific extended DRX value other than 512 radio frames is configured:

- During the PTW, 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. Outside the PTW, T is determined by the RAN paging cycle, if configured.

 In RRC\_INACTIVE state, a BL UE or a UE in enhanced coverage uses the T value applicable for RRC\_IDLE state for the determination of PNB and i\_s.

 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 the UE has selected paging carrier with coverage-based paging group and UE specific DRX value is allocated by upper layers T = min (default DRX value, max (UE specific DRX value, minimum UE specific DRX value configured in the coverage-based paging group)). 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. If the UE has selected paging carrier configured with coverage-based paging group, it is nB value configured for the coverage-based paging group.

- N: min(T,nB)

- Ns: max(1,nB/T)

- Nn: number of paging narrowbands (for P-RNTI monitored on MPDCCH) or paging carriers configured without coverage-based paging carrier selection (for P-RNTI monitored on NPDCCH) if the UE is not configured for coverage-based paging carrier selection . If the UE is configured for coverage-based paging carrier selection, it is the number of paging carriers determined according to clause 7.X.

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.

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| Next Change |

## 7.X Coverage based paging carrier selection

Coverage-based paging carrier selection is only used in the cell in which the UE most recently entered RRC-IDLE triggered by:

- reception of *RRCEarlyDataComplete* or *RRCConnectionRelease*.

- and the message includes *coverageBasedPCG*

The UE shall select the paging carrier based on coverage level in cell if one or more non-anchor carriers are configured with *cbpcg-Index* in system information.

The UE configured with *cbpcg-Index* shall select a paging carriers as described in clause 7.1 fromthe list of carriers configured with *cbpcg-Index* for the corresponding paging carrier group, when following conditions are met

 -*cbpc-HystTimer* for paging carrier is not running and

- Srxlev  > *cbpcg-Threshold* of the coverage-based paging group indicated by *cbpc-Config*.

Whenever UE switches between paging carrier configured with *cbpcg-index* and carrier not configured with *cbpcg-index*  UE starts *cbpc-HystTimer*.

While *cpbc-HystTimer* is running, UE continues to use the previously selected paging carrier.

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| End of Changes |