**3GPP TSG-RAN WG2 Meeting #116bis-e *R2-2201791***

 **Online, 17 - 25 Jan 2022**

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| *CR-Form-v12.1* |
| **CHANGE REQUEST** |
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|  | **36.304** | **CR** | - | **rev** | **-** | **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:***  | [Running CR] Introduction of additional 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:*** | 2021-12-21 |
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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
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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 |
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|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 36.300 CR xxxx, TS 36.304 CR xxxx, TS 36.306 CR xxxx, TS 36.321 CR xxxx  |
| ***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 – V1 |

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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 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.

 Editor Note: FFS whether and how to update T calculation if coverage/carrier specific DRX cycle is supported.

- 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. FFS the value of nB if coverage/carrier specific nB value is supported.

- 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 carrier selection (for P-RNTI monitored on NPDCCH) or paging carriers configured with coverage-based carrier selection according to clause 7.X. (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.

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| Next Change |

## 7.6 NRS presence on non-anchor paging carrier in NB-IoT

For FDD, when *nrs-NonAnchorConfig* is signalled in system information, the POs with associated NRS are determined using the DRX parameters broadcast in *systeminformationBlockType2-NB*:

- T is the value of *defaultPagingCycle* broadcast in system information.

- nB is the value corresponding to *nB* broadcast in system information: 4T, 2T, T, T/2, T/4, T/8, T/16, T/32, T/64, T/128, T/256, T/512, and T/1024.

The POs are determined by:

- Paging Frame (PF) given by: SFN mod T= (T div N) \* k

where:

- N: min(T, nB)

- k: 0, 1, .., N-1

- Paging subframe given by index i\_s

where:

- Index i\_s: values pointing to a subframe for which a PO is defined in the row referenced by Ns in clause 7.2.

- Ns: max(1, nB/T)

The POs with associated NRS are determined as follows:

- if nB is equal to 4T, 2T, T or T/2:

POs for which R = 1 have associated NRS

where:

R = (PO\_Index+ Offset) mod 2

where:

- PO\_Index = (SFN \* nB/T + i\_s) mod nB

- Offset = (FLOOR ((SFN + 1024\*H-SFN) / T)) mod 2

- SFN is the SFN corresponding to the PO

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

- i\_s is the index i\_s corresponding to the PO

- else:

all POs have associated NRS.

## 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

- reception of *RRCConnectionRelease* not including *noLastCellUpdate*; or

- reception of *RRCConnectionRelease* including *noLastCellUpdate* and the UE was using coverage based paging carrier in this cell prior to this RRC connection attempt.

When all of the following conditions are met then UE shall select the paging carrier based on coverage level

* The UE is in RRC-IDLE
* The UE supports coverage-based carrier selection
* One or more non-anchor carriers are configured for coverage-based carrier selection in system information.
* UE has received the index of coverage group at the time of RRC connection release

A UE supporting coverage-based carrier selection selects the set of non-anchor carriers for coverage-based carrier selection

If the persistent-timer for paging carrier is not running or UE is outside the PTW and

If the following conditions is met for the serving cell measurements

N-RSRP (Serving cell) > N-RSRP-Threshold of the carrier group assigned to UE.

If *hysteresis (Timer)* is configured for paging carrier selection, UE estimates N-RSRP value based on the measurements carried over this duration.

selects one of the carriers from the carrier group for paging reception as specified in clause 7.1 and persistent timer for selected paging carrier is started.

 Else

The UE uses the list of carriers including anchor carrier not configured with NRSRP-Range and selection one of the carriers from this list for paging reception as specified in clause 7.1