**3GPP TSG RAN WG1 #106bis-e** **R1-210xxxx**

**e-Meeting, October 11th – 19th, 2021**

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| *CR-Form-v12.0* |
| **DRAFT CHANGE REQUEST** |
|  |
|  | **38.213** | **CR** |  | **rev** |  | **Current version:** | **16.7.0** |  |
|  |
| *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 UE power savings enhancements in NR |
|  |  |
| ***Source to WG:*** | Samsung |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** | NR\_UE\_pow\_sav\_enh-Core |  | ***Date:*** | 2021-11-01 |
|  |  |  |  |  |
| ***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-12 (Release 12)**Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
|  |  |
| ***Reason for change:*** | Introduction of UE power savings enhancements in NR. |
|  |  |
| ***Summary of change:*** | Add description for enhanced PDCCH monitoring and for enhanced paging procedure. |
|  |  |
| ***Consequences if not approved:*** | Incomplete support for UE power savings enhancements in NR. |
|  |  |
| ***Clauses affected:*** | 2, 3.3, 10.4, 10.4A (new) |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 38.211, TS 38.212, TS 38.214 |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

\*\*\* Unchanged text is omitted \*\*\*

# 2 References

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

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications"

[2] 3GPP TS 38.201: "NR; Physical Layer – General Description"

[3] 3GPP TS 38.202: "NR; Services provided by the physical layer"

[4] 3GPP TS 38.211: "NR; Physical channels and modulation"

[5] 3GPP TS 38.212: "NR; Multiplexing and channel coding"

[6] 3GPP TS 38.214: "NR; Physical layer procedures for data"

[7] 3GPP TS 38.215: "NR; Physical layer measurements"

[8-1] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone"

[8-2] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone"

[8-3] 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios"

[9] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception"

[10] 3GPP TS 38.133: "NR; Requirements for support of radio resource management"

[11] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification"

[12] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification"

[13] 3GPP TS 36.213: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures"

[14] 3GPP TS 36.321: "Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification"

[15] 3GPP TS 37.213: "Physical layer procedures for shared spectrum channel access"

[16] 3GPP TS 38.473: "F1 application protocol (F1AP)"

[17] 3GPP TS 38.304: "NR; User Equipment (UE) procedures in Idle mode and RRC Inactive state"

\*\*\* Unchanged text is omitted \*\*\*

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in [1, TR 21.905].

BPRE Bits per resource element

BWP Bandwidth part

CB Code block

CBG Code block group

CBR Channel busy ratio

CCE Control channel element

CORESET Control resource set

CP Cyclic prefix

CRC Cyclic redundancy check

CSI Channel state information

CSS Common search space

DAI Downlink assignment index

DAPS Dual active protocol stack

DC Dual connectivity

DCI Downlink control information

DL Downlink

DL-SCH Downlink shared channel

EPRE Energy per resource element

EN-DC E-UTRA NR dual connectivity with MCG using E-UTRA and SCG using NR

FR1 Frequency range 1

FR2 Frequency range 2

GSCN Global synchronization channel number

HARQ-ACK Hybrid automatic repeat request acknowledgement

MCG Master cell group

MCS Modulation and coding scheme

NDI New Data Indicator

NE-DC E-UTRA NR dual connectivity with MCG using NR and SCG using E-UTRA

NR-DC NR NR dual connectivity

PBCH Physical broadcast channel

PCell Primary cell

PDCCH Physical downlink control channel

PDSCH Physical downlink shared channel

PRACH Physical random access channel

PRB Physical resource block

PRG Physical resource block group

PSCell Primary secondary cell

PSBCH Physical sidelink broadcast channel

PSCCH Physical sidelink control channel

PSFCH Physical sidelink feedback channel

PSS Primary synchronization signal

PSSCH Physical sidelink shared channel

PUCCH Physical uplink control channel

PUCCH-SCell PUCCH SCell

PUSCH Physical uplink shared channel

QCL Quasi co-location

PO Paging occasion

RB Resource block

RE Resource element

RLM Radio link monitoring

RRM Radio resource management

RS Reference signal

RSRP Reference signal received power

SCG Secondary cell group

SCI Sidelink control information

SCS Subcarrier spacing

SFCI Sidelink feedback control information

SFN System frame number

SL Sidelink

SLIV Start and length indicator value

SPS Semi-persistent scheduling

SR Scheduling request

SRI SRS resource indicator

SRS Sounding reference signal

SSS Secondary synchronization signal

SSSG Search space set group

TA Timing advance

TAG Timing advance group

TCI Transmission Configuration Indicator

UCI Uplink control information

UE User equipment

UL Uplink

UL-SCH Uplink shared channel

USS UE-specific search space

\*\*\* Unchanged text is omitted \*\*\*

## 10.4 Search space set group switching and skipping of PDCCH monitoring

A UE can be provided a group index for a respective Type3-PDCCH CSS set or USS set by *searchSpaceGroupIdList* for PDCCH monitoring on a serving cell. If the UE is not provided *searchSpaceGroupIdList* for a search space set, the following procedures are not applicable for PDCCH monitoring according to the search space set.

If a UE is provided *cellGroupsForSwitchList*, indicating one or more groups of serving cells, the following procedures apply to all serving cells within each group; otherwise, the following procedures apply only to a serving cell for which the UE is provided *searchSpaceGroupIdList*.

When a UE is provided *searchSpaceGroupIdList*, the UE resets PDCCH monitoring according to search space sets with group index 0, if provided by *searchSpaceGroupIdList*.

A UE can be provided by *searchSpaceSwitchDelay* a number of symbols $P\_{switch}$ where a minimum value of $P\_{switch}$ is provided in Table 10.4-1 for UE processing capability 1 and UE processing capability 2 and SCS configuration $μ$. UE processing capability 1 for SCS configuration $μ$ applies unless the UE indicates support for UE processing capability 2.

Table 10.4-1: Minimum value of $P\_{switch}$ [symbols]

|  |  |  |
| --- | --- | --- |
| $$μ$$ | Minimum $P\_{switch}$ value for UE processing capability 1 [symbols] | Minimum $P\_{switch}$ value for UE processing capability 2 [symbols] |
| 0 | 25 | 10 |
| 1 | 25 | 12 |
| 2 | 25 | 22 |

A UE can be provided, by *searchSpaceSwitchTimer*, a timer value for a serving cell that the UE is provided *searchSpaceGroupIdList* or, if provided, for a set of serving cells provided by *cellGroupsForSwitchList*. The UE decrements the timer value by one after each slot based on a reference SCS configuration that is the smallest SCS configuration $μ$ among all configured DL BWPs in the serving cell, or in the set of serving cells. The UE maintains the reference SCS configuration during the timer decrement procedure.

If a UE is provided by *SearchSpaceSwitchTrigger* a location of a search space set group switching flag field for a serving cell in a DCI format 2\_0, as described in clause 11.1.1;

- if the UE detects a DCI format 2\_0 and a value of the search space set group switching flag field in the DCI format 2\_0 is 0, the UE starts monitoring PDCCH according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, for the serving cell at a first slot that is at least $P\_{switch}$ symbols after the last symbol of the PDCCH with the DCI format 2\_0

- if the UE detects a DCI format 2\_0 and a value of the search space set group switching flag field in the DCI format 2\_0 is 1, the UE starts monitoring PDCCH according to search space sets with group index 1, and stops monitoring PDCCH according to search space sets with group index 0, for the serving cell at a first slot that is at least $P\_{switch}$ symbols after the last symbol of the PDCCH with the DCI format 2\_0, and the UE sets the timer value to the value provided by *searchSpaceSwitchTimer*

- if the UE monitors PDCCH for a serving cell according to search space sets with group index 1, the UE starts monitoring PDCCH for the serving cell according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, for the serving cell at the beginning of the first slot that is at least $P\_{switch}$ symbols after a slot where the timer expires or after a last symbol of a remaining channel occupancy duration for the serving cell if indicated by DCI format 2\_0

If a UE is not provided *SearchSpaceSwitchTrigger* for a serving cell,

- if the UE detects a DCI format by monitoring PDCCH according to a search space set with group index 0, the UE starts monitoring PDCCH according to search space sets with group index 1, and stops monitoring PDCCH according to search space sets with group index 0, for the serving cell at a first slot that is at least $P\_{switch}$ symbols after the last symbol of the PDCCH with the DCI format, the UE sets the timer value to the value provided by *searchSpaceSwitchTimer* if the UE detects a DCI format by monitoring PDCCH in any search space set

- if the UE monitors PDCCH for a serving cell according to search space sets with group index 1, the UE starts monitoring PDCCH for the serving cell according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, for the serving cell at the beginning of the first slot that is at least $P\_{switch}$ symbols after a slot where the timer expires or, if the UE is provided a search space set to monitor PDCCH for detecting a DCI format 2\_0, after a last symbol of a remaining channel occupancy duration for the serving cell if indicated by DCI format 2\_0

A UE determines a slot and a symbol in the slot to start or stop PDCCH monitoring according to search space sets for a serving cell that the UE is provided *searchSpaceGroupIdList* or, if *cellGroupsForSwitchList* is provided, for a set of serving cells, based on the smallest SCS configuration $μ$ among all configured DL BWPs in the serving cell or in the set of serving cells and, if any, in the serving cell where the UE receives a PDCCH and detects a corresponding DCI format 2\_0 triggering the start or stop of PDCCH monitoring according to search space sets.

A UE can be provided a set of durations by *PDCCHSkippingDurationList* for PDCCH monitoring on a serving cell and, if the UE is not provided *searchSpaceGroupIdList-r17*, a DCI format 0\_1, and/or DCI format 1\_1, and/or DCI format 0\_2, and/or DCI format 1\_2 that schedules a PUSCH transmission or a PDSCH reception can include a PDCCH monitoring adaptation field of 1 bit or of 2 bits.

If the field has 1 bit and for PDCCH monitoring according to Type3-PDCCH CSS sets or USS sets on the serving cell

- a '0' value for the bit indicates no skipping in PDCCH monitoring

- a '1' value for the bit indicates skipping PDCCH monitoring for a duration provided by the first value in the set of durations

If the field has 2 bits and for PDCCH monitoring according to Type3-PDCCH CSS sets or USS sets on a serving cell

- a '00' value for the bits indicates no skipping in PDCCH monitoring

- a '01' value for the bits indicates skipping PDCCH monitoring for a duration provided by the first value in the set of durations

- a '10' value for the bits indicates skipping PDCCH monitoring for a duration provided by the second value in the set of durations

- a '11' value for the bits indicates skipping PDCCH monitoring for a duration provided by the third value in the set of durations, if any; otherwise, if the set of durations includes two values, a use of the ‘11’ value is reserved

A UE can be provided group indexes for a Type3-PDCCH CSS set or USS set by *searchSpaceGroupIdList-r17* for PDCCH monitoring on a serving cell and, if the UE is not provided *PDCCHSkippingDurationList*, DCI format 0\_1, or DCI format 1\_1, or DCI format 0\_2, or DCI format 1\_2 that schedules a PUSCH transmission or a PDSCH reception can include a PDCCH monitoring adaptation field of 1 bit or of 2 bits.

If the field has 1 bit and for PDCCH monitoring according to Type3-PDCCH CSS sets or USS sets on the serving cell

- a '0' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 0 and stop of PDCCH monitoring according to search space sets with other group indexes, if any

- a '1' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 1 and stop of PDCCH monitoring according to search space sets with other group indexes, if any

If the field has 2 bits and for PDCCH monitoring according to Type3-PDCCH CSS sets or USS sets on the serving cell

- a '00' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 0 and stop of PDCCH monitoring according to search space sets with other group indexes, if any

- a '01' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 1 and stop of PDCCH monitoring according to search space sets with other group indexes, if any

- a '10' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 2 and stop of PDCCH monitoring according to search space sets with other group indexes, if any

If a UE is provided group indexes for a Type3-PDCCH CSS set or a USS set by *searchSpaceGroupIdList-r17* and a timer value by *searchSpaceSwitchTimer* for PDCCH monitoring on a serving cell and the timer is running, the UE

- decrements the timer after a slot of an active DL BWP of the serving cell when the UE does not detect a DCI format in a PDCCH reception in the slot for the Type3-PDCCH CSS set or the USS set with group index of either 1 or 2

- resets the timer after a slot of the active DL BWP of the serving cell when the UE detects a DCI format in a PDCCH reception in the slot for the Type3-PDCCH CSS set or the USS set with group index of either 1 or 2

When the timer expires, the UE monitors PDCCH on the serving cell according to search space sets with group index 0.

## 10.4A PDCCH monitoring for advanced paging indication

A UE can be provided the following for detection of a DCI format X in RRC\_IDLE state or in RRC\_INACTIVE state [12, TS 38.331]

- a search space set, by *peiSearchSpace*, to monitor PDCCH for detection of DCI format X according to a common search space as described in clause 10.1

- the DCI format X includes a number of bits for a number of POs provided by *number-of-PO*

- if *subgroupsNumPerPO* is provided, a bit maps to a UE subgroup associated with a PO from the number of POs; otherwise, a bit maps to a PO from the number of POs

- a '0' value for the bit indicates to not monitor PDCCH according to *pagingSearchSpace* for a UE subgroup or a UE group [17, TS 38.304]

- a '1' value for the bit indicates to monitor PDCCH according to *pagingSearchSpace* for a UE subgroup or a UE group

## 10.5 HARQ-ACK information for PUSCH transmissions

A UE can be configured a number of search space sets to monitor PDCCH for detecting a DCI format 0\_1 with a DFI flag field and CRC scrambled with a CS-RNTI provided by *cs-RNTI*. The UE determines that the DCI format provides HARQ-ACK information for PUSCH transmissions based on when a DFI flag field value is set to '1', if a PUSCH transmission is configured by *ConfiguredGrantConfig*.

The HARQ-ACK information corresponds to transport blocks in PUSCH transmissions for all HARQ processes for a serving cell of a PDCCH reception that provides DCI format 0\_1 or, if DCI format 0\_1 includes a carrier indicator field, for a serving cell indicated by a value of the carrier indicator field.

For a PUSCH transmission configured by *ConfiguredGrantConfig*, HARQ-ACK information for a transport block of a corresponding HARQ process number is valid if a first symbol of the PDCCH reception is after a last symbol of the PUSCH transmission, or of any repetition of the PUSCH transmission, by a number of symbols provided by *cg-minDFI-Delay*.

For an initial transmission by a UE of a transport block in a PUSCH configured by *ConfiguredGrantConfig*, if the UE receives a CG-DFI that provides HARQ-ACK information for the transport block, the UE assumes that the transport block was correctly decoded if the HARQ-ACK information value is ACK; otherwise, the UE assumes that the transport block was not correctly decoded.

For a PUSCH transmission scheduled by a DCI format, if the UE receives a CG-DFI that provides HARQ-ACK information for the transport block, the UE assumes that the transport block was correctly decoded if the HARQ-ACK information value is ACK; otherwise, the UE assumes that the transport block was not correctly decoded.

For a PUSCH transmission scheduled by a DCI format, HARQ-ACK information for a transport block of a corresponding HARQ process number is valid if a first symbol of the PDCCH reception is after a last symbol of the PUSCH transmission by a number of symbols provided by *cg-minDFI-Delay* or, if the PUSCH transmission is over multiple slots,

- after a last symbol of the PUSCH transmission in a first slot from the multiple slots by a number of symbols provided by *cg-minDFI-Delay*, if a value of the HARQ-ACK information is ACK.

- after a last symbol of the PUSCH transmission in a last slot from the multiple slots by a number of symbols provided by *cg-minDFI-Delay*, if a value of the HARQ-ACK information is NACK.

UE does not expect to be configured with different *cg-minDFI-Delay-r16* among multiple *ConfiguredGrantConfig* in one BWP.