**3GPP TSG RAN WG1 #114** **R1-230xxxx**

**Toulouse, France, August 21st – 25th, 2023**

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| *CR-Form-v12.2* |
| **DRAFT CHANGE REQUEST** |
|  |
|  | **38.213** | **CR** |  | **rev** |  | **Current version:** | **17.6.0** |  |
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| *For* [***HELP***](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 further NR coverage enhancements |
|  |  |
| ***Source to WG:*** | Samsung |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** | NR\_cov\_enh2-Core |  | ***Date:*** | 2023-09-01 |
|  |  |  |  |  |
| ***Category:*** | B |  | ***Release:*** | Rel-18 |
|  | *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-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | Introduction of further NR coverage enhancements. |
|  |  |
| ***Summary of change:*** |  Introduce support for further NR coverage enhancements.  |
|  |  |
| ***Consequences if not approved:*** | No support for further NR coverage enhancements. |
|  |  |
| ***Clauses affected:*** | 8.1, 8.2 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **x** |  |  Other core specifications  | TS 38.321, TS 38.331 |
| ***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 parts are omitted \*\*\*

## 8.1 Random access preamble

Physical random access procedure for a UE is triggered upon request of a PRACH transmission by higher layers or by a PDCCH order. A configuration by higher layers for a PRACH transmission includes the following:

- A configuration for PRACH transmission [4, TS 38.211].

- A preamble index, a preamble SCS, , a corresponding RA-RNTI, and a PRACH resource.

- A number of preamble repetitions for the PRACH transmission if the UE would transmit the PRACH with repetitions.

A PRACH is transmitted using the selected PRACH format with transmission power ,as described in clause 7.4, on the indicated PRACH resource.

For Type-1 random access procedure, a UE is provided a number of SS/PBCH block indexes associated with one PRACH occasion and a number of contention based preambles per SS/PBCH block index per valid PRACH occasion by *ssb-perRACH-OccasionAndCB-PreamblesPerSSB*.

For Type-2 random access procedure or for a Type-1 random access procedure with preamble repetitions with common configuration of PRACH occasions with Type-1 random access procedure without preamble repetitions, a UE is provided a number of SS/PBCH block indexes associated with one PRACH occasion by *ssb-perRACH-OccasionAndCB-PreamblesPerSSB* and a number of contention based preambles per SS/PBCH block index per valid PRACH occasion by *msgA-CB-PreamblesPerSSB-PerSharedRO*. The PRACH transmission can be on a subset of PRACH occasions associated with a same SS/PBCH block index within an SSB-RO mapping cycle for a UE provided with a PRACH mask index by *msgA-SSB-SharedRO-MaskIndex* according to [11, TS 38.321].

For Type-2 random access procedure or for a Type-1 random access procedure with preamble repetitions with separate configuration of PRACH occasions with Type-1 random access procedure without preamble repetitions, a UE is provided a number of SS/PBCH block indexes associated with one PRACH occasion and a number of contention based preambles per SS/PBCH block index per valid PRACH occasion by *msgA-SSB-PerRACH-OccasionAndCB-PreamblesPerSSB* when provided; otherwise, by *ssb-perRACH-OccasionAndCB-PreamblesPerSSB*.

For a random access procedure associated with a feature combination indicated by *FeatureCombinationPreambles*, a UE is provided a number of SS/PBCH block indexes associated with one PRACH occasion by *ssb-perRACH-OccasionAndCB-PreamblesPerSSB* or *msgA-SSB-PerRACH-OccasionAndCB-PreamblesPerSSB* when provided and a number of contention based preambles per SS/PBCH block index per valid PRACH occasion by *startPreambleForThisPartition* and *numberOfPreamblesPerSSB-ForThisPartition*. The PRACH transmission can be on a subset of PRACH occasions associated with a same SS/PBCH block index within an SSB-RO mapping cycle for a UE provided with a PRACH mask index by *ssb-SharedRO-MaskIndex* according to [11, TS 38.321].

For Type-1 random access procedure without preamble repetitions, and for Type-1 random access procedure with preamble repetitions or for Type-2 random access procedure with separate configuration of PRACH occasions from Type 1 random access procedure without preamble repetitions, if , one SS/PBCH block index is mapped to consecutive valid PRACH occasions and contention based preambles with consecutive indexes associated with the SS/PBCH block index per valid PRACH occasion start from preamble index 0. If , contention based preambles with consecutive indexes associated with SS/PBCH block index , , per valid PRACH occasion start from preamble index where is provided by *totalNumberOfRA-Preambles* for Type-1 random access procedure or by *msgA-TotalNumberOfRA-Preambles* for Type-2 random access procedure with separate configuration of PRACH occasions from a Type 1 random access procedure, and is an integer multiple of .

For Type-1 random access procedure with preamble repetitions or for Type-2 random access procedure with common configuration of PRACH occasions with Type-1 random access procedure without preamble repetitions, if , one SS/PBCH block index is mapped to consecutive valid PRACH occasions and contention based preambles with consecutive indexes associated with the SS/PBCH block index per valid PRACH occasion start from preamble index . If , contention based preambles with consecutive indexes associated with SS/PBCH block index , , per valid PRACH occasion start from preamble index , where is provided by *totalNumberOfRA-Preambles* for Type-1 random access procedure without preamble repetitions.

For link recovery, a UE is provided SS/PBCH block indexes associated with one PRACH occasion by *ssb-perRACH-Occasion* in *BeamFailureRecoveryConfig*. For a dedicated RACH configuration provided by *RACH-ConfigDedicated*, if *cfra* is provided, a UE is provided SS/PBCH block indexes associated with one PRACH occasion by *ssb-perRACH-Occasion* in *occasions*. If , one SS/PBCH block index is mapped to consecutive valid PRACH occasions. If , all consecutive SS/PBCH block indexes are associated with one PRACH occasion.

SS/PBCH block indexes provided by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon* are mapped to valid PRACH occasions in the following order where the parameters are described in [4, TS 38.211].

- First, in increasing order of preamble indexes within a single PRACH occasion

- Second, in increasing order of frequency resource indexes for frequency multiplexed PRACH occasions

- Third, in increasing order of time resource indexes for time multiplexed PRACH occasions within a PRACH slot

- Fourth, in increasing order of indexes for PRACH slots

For a PRACH transmission without preamble repetitions, an association period, starting from frame 0, for mapping SS/PBCH block indexes to PRACH occasions is the smallest value in the set determined by the PRACH configuration period according Table 8.1-1 such that SS/PBCH block indexes are mapped at least once to the PRACH occasions within the association period, where a UE obtains from the value of *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon*. If after an integer number of SS/PBCH block indexes to PRACH occasions mapping cycles within the association period there is a set of PRACH occasions or PRACH preambles that are not mapped to SS/PBCH block indexes, no SS/PBCH block indexes are mapped to the set of PRACH occasions or PRACH preambles. An association pattern period includes one or more association periods and is determined so that a pattern between PRACH occasions and SS/PBCH block indexes repeats at most every 160 msec. PRACH occasions not associated with SS/PBCH block indexes after an integer number of association periods, if any, are not used for PRACH transmissions.

For a PRACH transmission by a UE triggered by a PDCCH order, the PRACH mask index field [5, TS 38.212], if the value of the random access preamble index field is not zero, indicates the PRACH occasion for the PRACH transmission where the PRACH occasions are associated with the SS/PBCH block index indicated by the SS/PBCH block index field of the PDCCH order. If the UE is provided by *cellSpecificKoffset*, the PRACH occasion is after slot where is the slot of the UL BWP for the PRACH transmission that overlaps with the end of the PDCCH order reception assuming , and is the SCS configuration for the PRACH transmission. If the PDCCH reception for the PDCCH order includes two PDCCH candidates from two linked search space sets based on *searchSpaceLinkingId*, as described in clause 10.1, the last symbol of the PDCCH reception is the last symbol of the PDCCH candidate that ends later. The PDCCH reception includes the two PDCCH candidates also when the UE is not required to monitor one of the two PDCCH candidates as described in clauses 10 (except clause 10.4), 11.1, 11.1.1 and 17.2.

For a PRACH transmission triggered by higher layers, if *ssb-ResourceList* is provided, the PRACH mask index is indicated by *ra-ssb-OccasionMaskIndex* which indicates the PRACH occasions for the PRACH transmission where the PRACH occasions are associated with the selected SS/PBCH block index.

The PRACH occasions are mapped consecutively per corresponding SS/PBCH block index. The indexing of the PRACH occasion indicated by the mask index value is reset per mapping cycle of consecutive PRACH occasions per SS/PBCH block index. The UE selects for a PRACH transmission the PRACH occasion indicated by PRACH mask index value for the indicated SS/PBCH block index in the first available mapping cycle.

For the indicated preamble index, the ordering of the PRACH occasions is

- First, in increasing order of frequency resource indexes for frequency multiplexed PRACH occasions

- Second, in increasing order of time resource indexes for time multiplexed PRACH occasions within a PRACH slot

- Third, in increasing order of indexes for PRACH slots

A time period, starting from frame 0, for determining [RO groups] for PRACH transmission with repetitions, is the smallest number of SS/PBCH block to PRACH occasion association pattern period(s) such that at least one RO group is determined for all configured and the determined [RO group pattern] repeats at every such time period.

For a PRACH transmission with preamble repetitions, a time period, starting from frame 0, for mapping an SS/PBCH block index to PRACH occasions is the smallest value of SS/PBCH block to PRACH occasion association pattern periods such that the SS/PBCH block index is mapped at least once to PRACH occasions within the time period for each configured number of preamble repetitions. A time period pattern for PRACH occasions includes one or more time periods and is determined so that a pattern between the PRACH occasions and the SS/PBCH block index repeats in time.

For a PRACH transmission with preamble repetitions within a time period, a first valid PRACH occasion is determined according to the ordering of PRACH occasions and is after consecutive valid PRACH occasions in time from a last valid PRACH occasion corresponding to previous preamble repetitions, if any, where is the value of *TimeOffsetBetweenStartingRO*, if provided; otherwise, .

For a PRACH transmission with preamble repetitions within a time period, the first valid PRACH occasion of the first preamble repetitions associated with an SS/PBCH block is the first valid PRACH occasion associated with the SS/PBCH block in the association period for preamble repetitions. The first valid PRACH occasion of subsequent preamble repetitions associated with the SS/PBCH block in the time period, if any, is determined according to an ordering of PRACH occasions

- First, in increasing order of frequency resource indexes for frequency multiplexed PRACH occasions

- Second, in increasing order of time resource indexes for time multiplexed PRACH occasions after consecutive valid PRACH occasions in time from a last valid PRACH occasion corresponding to previous preamble repetitions with same frequency location, if any, for the SS/PBCH block

For a PRACH transmission with preamble repetitions, all respective valid PRACH occasions are consecutive in time and use same frequency resources and are associated with a same SS/PBCH block index.

For a PRACH transmission triggered upon request by higher layers, a value of *ra-OccasionList* [12, TS 38.331], if *csirs-ResourceList* is provided, indicates a list of PRACH occasions for the PRACH transmission where the PRACH occasions are associated with the selected CSI-RS index indicated by *csi-RS*. The indexing of the PRACH occasions indicated by *ra-OccasionList* is reset per association pattern period.

Table 8.1-1: Mapping between PRACH configuration period and SS/PBCH block to PRACH occasion association period

|  |  |
| --- | --- |
| PRACH configuration period (msec) | Association period (number of PRACH configuration periods) |
| 10 | {1, 2, 4, 8, 16} |
| 20 | {1, 2, 4, 8} |
| 40 | {1, 2, 4} |
| 80 | {1, 2} |
| 160 | {1} |

For paired spectrum or supplementary uplink band all PRACH occasions are valid.

For unpaired spectrum,

- if a UE is not provided *tdd-UL-DL-ConfigurationCommon*, a PRACH occasion in a PRACH slot is valid if it does not precede a SS/PBCH block in the PRACH slot and starts at least symbols after a last SS/PBCH block reception symbol, where is provided in Table 8.1-2 and, if *channelAccessMode* = "*semiStatic*" is provided, does not overlap with a set of consecutive symbols before the start of a next channel occupancy time where the UE does not transmit [15, TS 37.213].

- the candidate SS/PBCH block index of the SS/PBCH block corresponds to the SS/PBCH block index provided by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon* , as described in clause 4.1

- If a UE is provided *tdd-UL-DL-ConfigurationCommon*, a PRACH occasion in a PRACH slot is valid if

- it is within UL symbols, or

- it does not precede a SS/PBCH block in the PRACH slot and starts at least symbols after a last downlink symbol and at least symbols after a last SS/PBCH block symbol, where is provided in Table 8.1-2, and if *channelAccessMode* = "*semiStatic*" is provided, does not overlap with a set of consecutive symbols before the start of a next channel occupancy time where there shall not be any transmissions, as described in [15, TS 37.213]

- the candidate SS/PBCH block index of the SS/PBCH block corresponds to the SS/PBCH block index provided by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon*, as described in clause 4.1.

For preamble format B4 [4, TS 38.211], .

Table 8.1-2: values for different preamble SCS

|  |  |
| --- | --- |
| Preamble SCS |  |
| 1.25 kHz or 5 kHz | 0 |
| 15 kHz or 30 kHz or 60 kHz or 120 kHz | 2 |
| 480 kHz | 8 |
| 960 kHz | 16 |

If a random access procedure is initiated by a PDCCH order, the UE, if requested by higher layers, transmits a PRACH in the selected PRACH occasion, as described in [11, TS 38.321], for which a time between the last symbol of the PDCCH order reception and the first symbol of the PRACH transmission is larger than or equal to msec, where

- is a time duration of symbols corresponding to a PUSCH preparation time for UE processing capability 1 [6, TS 38.214] assuming corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH order and the SCS configuration of the corresponding PRACH transmission

- if the active UL BWP does not change and is defined in [10, TS 38.133] otherwise

- msec for FR1 and msec for FR2

- is a switching gap duration as defined in [6, TS 38.214]

For a PRACH transmission using 1.25 kHz or 5 kHz SCS, the UE determines assuming SCS configuration .

For single cell operation or for operation with contiguous carrier aggregation in a same frequency band or for operation with non-contiguous carrier aggregation in a same frequency band if the UE is not provided with *intraBandNC-PRACH-simulTx-r17*, a UE does not transmit PRACH and PUSCH/PUCCH/SRS in a same slot with respect to the smallest SCS configuration between the SCS configuration for the UL BWP with the PRACH and the SCS configuration for the UL BWP with the PUSCH/PUCCH/SRS transmissions or when a gap between the first or last symbol of a PRACH transmission in a first slot is separated by less than symbols from the last or first symbol, respectively, of a PUSCH/PUCCH/SRS transmission in a second slot where for or 1, for or , for , for , and is the smallest SCS configuration between the SCS configuration for the UL BWP with the PRACH and the SCS configuration for the UL BWP with the PUSCH/PUCCH/SRS transmissions. For a PUSCH transmission with repetition Type B, this applies to each actual repetition for PUSCH transmission [6, TS 38.214].

\*\*\* Unchanged parts are omitted \*\*\*

## 8.2 Random access response - Type-1 random access procedure

In response to a PRACH transmission, a UE attempts to detect a DCI format 1\_0 with CRC scrambled by a corresponding RA-RNTI during a window controlled by higher layers [11, TS 38.321]. The window starts at the first symbol of the earliest CORESET the UE is configured to receive PDCCH for Type1-PDCCH CSS set, as defined in clause 10.1, that is at least one symbol, after the last symbol of the last PRACH occasion corresponding to the PRACH transmission, where the symbol duration corresponds to the SCS for Type1-PDCCH CSS set as defined in clause 10.1. Ifor, as defined in [4, TS 38.211], is not zero, the window starts after an additional msec where is defined in [4, TS 38.211] and is provided by *kmac* or if *kmac* is not provided. The length of the window in number of slots, based on the SCS for Type1-PDCCH CSS set, is provided by *ra-ResponseWindow*.

If the UE detects the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI and LSBs of a SFN field in the DCI format 1\_0, if included and applicable, are same as corresponding LSBs of the SFN where the UE transmitted PRACH, and the UE receives a transport block in a corresponding PDSCH within the window, the UE passes the transport block to higher layers. The higher layers parse the transport block for a random access preamble identity (RAPID) associated with the PRACH transmission. If the higher layers identify the RAPID in RAR message(s) of the transport block, the higher layers indicate an uplink grant to the physical layer. This is referred to as random access response (RAR) UL grant in the physical layer.

If the UE does not detect the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI within the window, or if the UE detects the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI within the window and LSBs of a SFN field in the DCI format 1\_0, if included and applicable, are not same as corresponding LSBs of the SFN where the UE transmitted PRACH, or if the UE does not correctly receive the transport block in the corresponding PDSCH within the window, or if the higher layers do not identify the RAPID associated with the PRACH transmission from the UE, the higher layers can indicate to the physical layer to transmit a PRACH. If requested by higher layers, the UE shall be ready to transmit a PRACH no later than msec after the last symbol of the window, or the last symbol of the PDSCH reception, where is a time duration of symbols corresponding to a PDSCH processing time for UE processing capability 1 assuming  corresponds to the smallest SCS configuration among the SCS configurations for the PDCCH carrying the DCI format 1\_0, the corresponding PDSCH when additional PDSCH DM-RS is configured, and the corresponding PRACH. For , the UE assumes [6, TS 38.214]. For a PRACH transmission using 1.25 kHz or 5 kHz SCS, the UE determines assuming SCS configuration .

If the UE detects a DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI and LSBs of a SFN field in the DCI format 1\_0, if included and applicable, are same as corresponding LSBs of the SFN where the UE transmitted the PRACH, and the UE receives a transport block in a corresponding PDSCH, the UE may assume same DM-RS antenna port quasi co-location properties, as described in [6, TS 38.214], as for a SS/PBCH block or a CSI-RS resource the UE used for PRACH association, as described in clause 8.1, regardless of whether or not the UE is provided *TCI-State* for the CORESET where the UE receives the PDCCH with the DCI format 1\_0.

If the UE attempts to detect the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI in response to a PRACH transmission initiated by a PDCCH order that triggers a contention-free random access procedure for the SpCell [11, TS 38.321], the UE may assume that the PDCCH that includes the DCI format 1\_0 and the PDCCH order have same DM-RS antenna port quasi co-location properties. If the UE attempts to detect the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI in response to a PRACH transmission initiated by a PDCCH order that triggers a contention-free random access procedure for a secondary cell, the UE may assume the DM-RS antenna port quasi co-location properties of the CORESET associated with the Type1-PDCCH CSS set for receiving the PDCCH that includes the DCI format 1\_0.

A RAR UL grant schedules a PUSCH transmission from the UE. The contents of the RAR UL grant, starting with the MSB and ending with the LSB, are given in Table 8.2-1.

If the value of the frequency hopping flag is 0, the UE transmits the PUSCH without frequency hopping; otherwise, the UE transmits the PUSCH with frequency hopping.

The UE determines the MCS of the PUSCH transmission from the first sixteen indexes of the applicable MCS index table for PUSCH as described in [6, TS 38.214].

The TPC command value is used for setting the power of the PUSCH transmission, as described in clause 7.1.1, and is interpreted according to Table 8.2-2.

The CSI request field is reserved.

The ChannelAccess-CPext field indicates a channel access type and CP extension for operation with shared spectrum channel access [15, TS 37.213] in FR1 as defined in Table 7.3.1.1.1-4 in [5, TS 38.212] or Table 7.3.1.1.1-4A in [5, TS 38.212] if *channelAccessMode* = "*semiStatic*" is provided. The ChannelAccess-CPext field indicates a channel access type for operation with shared spectrum channel access [15, TS 37.213] in FR2-2 as defined in Table 7.3.1.1.1-4B in [5, TS 38.212] if *ChannelAccessMode2-r17* is provided.

Table 8.2-1: Random Access Response Grant Content field size

|  |  |
| --- | --- |
| RAR grant field | Number of bits |
| Frequency hopping flag | 1 |
| PUSCH frequency resource allocation | 12, for operation with shared spectrum channel access in FR1 or for FR2-2 when *ChannelAccessMode2-r17* is provided14, otherwise |
| PUSCH time resource allocation | 4 |
| MCS | 4 |
| TPC command for PUSCH | 3 |
| CSI request | 1 |
| ChannelAccess-CPext | 2, for operation with shared spectrum channel access in FR1 or for FR2-2 when *ChannelAccessMode2-r17* is provided0, otherwise |

Table 8.2-2: TPC Command for PUSCH

|  |  |
| --- | --- |
| TPC Command | Value (in dB) |
| 0 | -6 |
| 1 | -4 |
| 2 | -2 |
| 3 | 0 |
| 4 | 2 |
| 5 | 4 |
| 6 | 6 |
| 7 | 8 |

Unless the UE is configured a SCS, the UE receives subsequent PDSCH using same SCS as for the PDSCH reception providing the RAR message.

If the UE does not detect the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI within the window, or if the UE detects the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI within the window and the LSBs of a SFN field in the DCI format 1\_0, if included and applicable, are not same as corresponding LSBs of the SFN where the UE transmitted the PRACH, or the UE does not correctly receive a corresponding transport block within the window, the UE procedure is as described in [11, TS 38.321].