3GPP TSG-RAN WG3 #107-e R3-201132

**E-meeting, 24th February – 6th March 2020**

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Title: Summary on CB: # 29\_Email029-RACHopt\_enhs

Agenda Item: 10.2.3.1

Document for: Discussion and decision

# Introduction

In last RAN WG1 meeting, a reply LS was sent toward RAN WG3, listing all the high-layer parameters which affecting the RACH configuration, albeit leave the flexibility that RAN WG3 could take the final decision on what parameter to be transferred over the interfaces, and how to transfer them [1]. Based on this LS, many discussion paper were raised in this RAN WG3 meeting, discussing what parameters and how to include into RAN WG3 specifications for PRACH coordination [2–6]. In this document, we briefly summarise all these discussions, and try to collect different companies’ understanding on several key issues.

Since this is the first time to discuss the PRACH configuration parameters, it may be controversial.

Companies are invited to include their comments in the present document if possible by **Tuesday, Feb. 26, 6 PM CET,**

Based on the comments collected, we could discuss on way forward before **Wednesday, Feb. 26, 6 PM CET.** After that, draft TPs could be prepared until the deadline of email discussion.

# Summarise of TDocs raised before meeting

## Where to include

There seems to be a consensus that the parameters provided in [1] should be included at least into the *Served Cell Information NR* IE in TS 38.423, the *Served NR Cell Information* IE in TS 36.423, and the *Served Cell Information* IE (delivered from the gNB-DU toward the gNB-CU) in TS 38.473.

In addition, One company also proposes that these parameters should also be included into the *Neighbour Information NR* IE in TS 38.423 and the *NR Neighbour Information* IE in TS 36.423 (see in Proposal 6 of [2]).

It was widely mentioned how a gNB-CU should deliver neighbour cells’ PRACH configuration toward the gNB-DU, but their opinions are very split:

* One company proposes to introduce a new F1AP procedure (see in Proposal 7 of [2]).
* One company proposes to include it into the current *Neighbour Cell Information List Item* IE with in the GNB-CU CONFIGURATION UPDATE message (see in §9.2.1.10 of [7]).
* One company proposes to include it into the *Cells to be Activated List Item* IE within the F1 SETUP RESPONSE message and the GNB-CU CONFIGURATION UPDATE message (see in Proposal 2 of [4]).
* One company proposes to include it into the F1 SETUP RESPONSE message and the GNB-DU CONFIGURATION UPDATE ACKNOWLEDGE message (see in Proposal 1 of [5]).

In addition, one company also propose to include a *NR PRACH configuration* IE into the *Cells to be Activated List Item* IE within the GNB-DU CONFIGURATION UPDATE ACKNOWLEDGE message (see in Proposal 1 of [5]), while the usage of this IE needs more clarification.

## How many to include

Different companies have different views on exchanging how many “PRACH configuration items” per cell (here a “PRACH configuration items” refers to a set of parameters which can determine a set of RACH occasions all of which can be used by **one** UE):

* One company thinks that we only need to exchange one “PRACH configuration item” per UL/SUL (see in Proposal 4 of [2]).
* One company thinks that the amount of “PRACH configuration item” can be multiple per UL/SUL (see in Proposal 1 of [3]).
* One company think that we need to exchange one “PRACH configuration item” per RACH type per UL/SUL (see in Proposal 3 and 5 of [4]).
* One company thinks that the amount of “PRACH configuration item” can be multiple per cell (see in §9.2.2.x of [8]).
* One company thinks that we only need to exchange one “PRACH configuration item” per cell (see in [6]).

## What to include

All companies agree that most of the IEs listed in [1] should be included, but some companies propose some adaption:

Two companies separate the IEs into two parts. One part of them (e.g. *scs-SpecificCarrierList*) are relatively “common” ones and should be delivered per UL/SUL, while the other part of them (e.g. *prach-ConfigurationIndex*) are relatively “dedicated” ones and should be delivered per “PRACH configuration item” [3, 4].

Two companies figure out that the information of *absoluteFrequencyPointA* and *freqBandIndicatorNR* is already included within the “Served Cell Information” IEs, and thus no need to duplicate them (see in Proposal 1 of [2] and [3]).

One company thinks that the information of *tdd-UL-DL-ConfigurationCommon* should be included (see in Proposal 3 of [2]), but another company thinks that the existing *Intended TDD DL-UL Configuration NR* field can be reused directly [3].

One company thinks that the IEs related to BWP (i.e. *locationAndBandwidth* and *msg1-FrequencyStart*) are not suitable to include, and thus proposes a method to “bypass” the two IEs (see in Proposal 3 and 4 of [3]).

One company thinks that the IEs related to SSB do not cover RACH type of BFR, and propose not to include them in Rel-16 and to discuss them in later release (see in Proposal 5 of [3]).

One company thinks that the timing offset between cells should also be deliverd over interfaces (see in Proposal 7 of [4]), even if it is not mentioned in [1].

# Questions

Based on abovementioned summaries, we raised following questions. Companies are welcome to provide any feedback.

## Question 1-1: A gNB-CU should be possible to inform a gNB-DU about the PRACH configuration of the latter’s neighbour cells. Within what IE (or message) to include it?

| **Company** | **Place to include** | **Reason (if any)** |
| --- | --- | --- |
| CATT | *Neighbour Cell Information List Item* within the GNB-CU CONFIGURATION UPDATE message | This IE is already used for inter-gNB-DU low layer coordination, i.e. deliver the *Intended TDD DL-UL Configuration NR* of the neighbour cell. |
| China Telecom | To introduce a new F1AP procedure | 1. In TS38.473 clauses 8.2.5.2, the purpose of gNB-CU Configuration Update is to transfer the updated information to DU. From the CU side, it just forward the PRACH Configuration from neighbour node to DU rather than inform DU of the configuration update for neighbour node and/or CU
2. Moreover, the gNB-DU use The *Neighbour Cell Information List* IE only for Cross Link Interference management rather than SON purpose.(see in TS38.473 clauses 8.2.5.2)
 |

## Question 1-2: Is it necessary to include PRACH configuration IE into the *Neighbour Information NR* IE in TS 38.423 and the *NR Neighbour Information* IE in TS 36.423?

The major motivation of this proposal is to facilitate PRACH coordination between RAN nodes serving as SNs in DC.

| **Company** | **Opinion (e.g. yes or no)** | **Reason (if any)** |
| --- | --- | --- |
| CATT | Yes for EN-DC | It could be used to make the two neighbour gNB which does not have Xn interface know the PRACH configuration of each other |
| China Telecom | Yes for EN-DC | For the RACH configuration, a set of physical layer parameters, there is no obvious difference between SA mode and NSA mode. And the appropriate RACH configuration in both SA and NSA network can achieve the same targets |

## Question 2-1: For a given cell, should the PRACH configuration be delivered separately per UL/SUL?

NOTE: PRACH is entirely a uplink physical channel used to send RACH preamble (i.e. MSG1). Any other information exchanging over Uu during a RACH procedure does not use PRACH.

| **Company** | **Opinion (e.g. yes or no)** | **Reason (if any)** |
| --- | --- | --- |
| CATT | Yes |  |
| China Telecom | Yes | In NR system, one cell can support two uplink cells, one is NUL and another is SUL. Thus the PRACH configuration shall be delivered separately per NUL/SUL.  |

## Question 2-2: Is it necessary to exchange multiple “PRACH configuration items” per UL/SUL or per cell?

Here a “PRACH configuration item” refers to a set of parameters which can determine a set of RACH occasions Comparing to LTE, one main difference in NR is the introduction of multiple BWPs, and thus PRACH resources could be configured in both initial BWP and other active BWPs. According to the LS from RAN1, PRACH resources used for BFR should also be coordinated between neighbour node which would mostly be configured in active BWPs. Therefore, it seems necessary to exchange multiple PRACH configuration items to aviod PRACH configuration confliction in NR.

| **Company** | **Opinion (e.g. yes or no)** | **Reason (if any)** |
| --- | --- | --- |
| CATT | Yes | For one cell, different UEs can be configured with different active BWPs with corresponding PRACH configuration parameters. |
| China Telecom | No | As we know, the PRACH resource are usually used in initial access procedure. Thus, the PRACH configuration is mandatory for initial BWP but not for other dedicated BWP. And all UEs within different BWP can share the same PRACH resource of initial BWP. Moreover, we don’t see the need to configure multiple PRACH resources in one cell. Because it will markedly increase the overhead for uplink direction.  |
|  |  |  |

For the parameters that should be introduced, we list all the parameters listed in RAN1 LS as below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Parameter | Granularity | Presence in current spec | Note |
| PRACH preamble sequences and formats | *prach-ConfigurationIndex* | Per PRACH configuration item | no |  |
| *prach-RootSequenceIndex* | Per PRACH configuration item | no |  |
| *restrictedSetConfig* | Per PRACH configuration item | no |  |
| *zeroCorrelationZoneConfig* | Per PRACH configuration item | no |  |
| *msg1-SubcarrierSpacing* | Per PRACH configuration item | no |  |
| *rootSequenceIndex-BFR* | Per PRACH configuration item | no |  |
| Time domain parameters | *prach-ConfigurationIndex* | Per PRACH configuration item | no |  |
| *msg1-SubcarrierSpacing* | Per PRACH configuration item | no |  |
| Frequency domain | *absoluteFrequencyPointA* | Per UL/SUL | *NR ARFCN* |  |
| *scs-SpecificCarrierList* | Per UL/SUL | *Transmission Bandwidth* | Only one SCS and bandwidth is provided in the current RAN3 specs, which should be updated as a list |
| *freqBandIndicatorNR* | Per UL/SUL | *NR Frequency Band List* |  |
| *frequencyShift7p5khz* | Per UL/SUL | no | Should be introduced in *Serving cell information* IE |
| *msg1-FDM* | Per PRACH configuration item | no |  |
| *msg1-FrequencyStart* | Per PRACH configuration item(but related to BWP) | no |  |
| *msg1-SubcarrierSpacing* | Per PRACH configuration item | no |  |
| *locationAndBandwidth* | Per BWP | no |  |
| *subcarrierSpacing* | Per PRACH configuration item (Used to find the SCS specific *offset to carrier* ) | no |  |
| SSB | *ssb-PositionsInBurst* | Per cell | no |  |
| *ssb-perRACH-OccasionAndCB-PreamblesPerSSB* | Per cell | no |  |
| *tdd-UL-DL-ConfigurationCommon* | Per cell | *Intended TDD DL-UL Configuration NR* |  |

According to above table, there are three types of the parameters i.e. per-cell/UL/SUL level, per-BWP level and per-PRACH-configuration-item level.

For per-cell/UL/SUL level parameters, as noted in above table, *absoluteFrequencyPointA*, *freqBandIndicatorNR* and *tdd-UL-DL-ConfigurationCommon* are already included in the serving cell information IE. So, for the cell/UL/SUL specific parameters, it is only proposed to introduce *NR Carrier List* and *frequencyShift7p5khz* in serving cell information.

## Question 3-1: Do you agree with the proposal above, i.e. for the cell/UL/SUL specific parameters listed in RAN1’s LS, only the *NR Carrier List* and the *frequencyShift7p5khz* should be included?

| **Company** | **Opinion** | **Reason (if any)** |
| --- | --- | --- |
| CATT | Yes |  |
| China Telecom | Yes for *frequencyShift7p5khz* | *frequencyShift7p5khz* shall be contained in Dynamic Spectrum Sharing and SUL  |

## Question 3-2: Is the timing offset between cells necessary to exchange?

| **Company** | **Opinion (e.g. yes or no)** | **Reason (if any)** |
| --- | --- | --- |
| CATT | No strong opinion |  |
| China Telecom | No  | In 4G era, timing offset is not exchanged between eNBs. For NR system, we do not see the need to introduce this information for Xn interface as well.  |

For the BWP related parameters(i.e. *locationAndBandwidth* and *msg1-FrequencyStart*),in Uu interface, it is configured to UE via dedicated signalling and is not suitable to be copied and exchanged over Xn interfaces. A “decoupled” IE, namely e.g. *MSG1 Frequency Start from Carrier*, shall be used instead of the two IEs related with BWP. Three reasons are raised:

One reason is that the BWP is usually allocated dynamically in a per-UE manner, and thus parameters related to the BWP are not suitable to be included in non-UE-associated signalling.

Another reason is that from the perspective of network, PRACH resources are naturally decoupled with BWP, which means that multiple BWPs of different UEs may share the same PRACH resources.

The last reason is that “decoupled” solution costs only 9 bits, but the *locationAndBandwidth* and *msg1-FrequencyStart* cost 25 bits in combination—16 bits are wasted for each PRACH configuration item. (Such waste does not exist over Uu, since every UE are configured with a BWP either by dedicated signalling or by broadcast, which means that the *locationAndBandwidth* IE is anyhow necessary to be deliverd.)



Figure 1: Different BWPs sharing the same set of PRACH resources, and the way to bypass them.

## Question 3-3: Based on above analysis, shall we include *MSG1 Frequency Start from Carrier* instead of *locationAndBandwidth* and *msg1-FrequencyStart*?

| **Company** | **Opinion (e.g. yes or no)** | **Reason (if any)** |
| --- | --- | --- |
| CATT | Yes |  |
| China Telecom | No  | We agree to remove *LocationAndBandwidth* but suggest to keep *msg1-FrequencyStart* |

Among per PRACH configuration related parameters, *rootSequenceIndex-BFR* is just the root sequence index for the Prach configuration set used in BFR procedure, so it is not needed to be introduced since *prach-RootSequenceIndex* would be included. Other per-PRACH-configuration-item parameter proposed by RAN1, it should be included in PRACH Configuration.

## Question 3-4: Do you agree with the proposal above, i.e. for the per-PRACH-configuration-item parameters listed in RAN1’s LS, all of them except the *rootSequenceIndex-BFR* should be included?

| **Company** | **Opinion** | **Reason (if any)** |
| --- | --- | --- |
| CATT | Yes |  |
| China Telecom | No  | In our understanding, the NW can adjust this parameter to optimize the access performance in BFR |

## Question 3-5: Considering the limited time and we are not clear on the benefit of exchanging beam-related parameters, for the issue on whether and how to include the beam-related parameters, shall we delay it to later release, e.g. Rel-17?

| **Company** | **Opinion (e.g. yes or no)** | **Reason (if any)** |
| --- | --- | --- |
| CATT | Yes |  |
| China Telecom | No | In order to minimize access delays for the UEs under the coverage of popular SSBs, per beam level optimization need to be considered in NR network. Therefore, *ssb-perRACH-OccasionAndCB-PreamblesPerSSB* IE shall be exchanged between nodes. Based on this parameter, the neighbour node can derive the association pattern period which indicates PRACH occasions and SS/PBCH blocks repeats at most every 160 msec. |

# Conclusion

TBD.

# Reference

[1] R1-1913578; Reply LS on PRACH configuration conflict detection.

[2] R3-200164; RACH Optimization Enhancement for NR; China Telecom.

[3] R3-200437; Discussion on PRACH coordination; CATT.

[4] R3-200494; (TP for SON BL CR for TS 38.423): PRACH configuration exchange; Huawei, CMCC.

[5] R3-200625; Left issue for NR RACH OPTIMIZATION; ZTE.

[6] R3-200959; Solution for RACH Optimisation over the Xn; Ericsson.

[7] R3-200440; (TP for SON BL CR for TS 38.473) Addition of PRACH Coordination; CATT.

[8] R3-200627; (TP for [NR\_SON\_MDT] BL CR for TS 38.423)Addition of RACH OPTIMIZATION; ZTE.