3GPP TSG-RAN WG4 Meeting # 100-e R4-2115052

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Agenda item: 10.3.5

Source: Huawei, HiSilicon

Title: TP on the rules of NE-DC with contiguous intra-band NR and LTE carriers

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# 1 Introduction

RAN4 had discussed the simplification of band combination tables in the 38.101 specifications over a number of meetings in a special agenda item. One aspect of these discussions is the notation of CA/DC band configurations in the specification and in the request sheets, as was highlighted in [1]. During the RAN4 #97e meeting RAN4 captured a set of agreements related to the notation of CA/DC band configurations in [2]. During the RAN4 #98bis-e meeting RAN4 captured another set of agreements related to the notation of CA/DC band configurations in [3]. As is mentioned in [4] RAN4 didn’t clarify the rules of NE-DC with contiguous intra-band NR and LTE carriers. During the RAN4#99e meeting, RAN4 get the agreement that DC\_x(n)AA is the naming convention (x is band number) for intraband contiguous NEDC combinations in [5].

As a result, an internal TR will be used to capture the agreement. This contribution provides the rules on request sheet and notations for NE-DC with contiguous intra-band NR and LTE carriers as a text proposal to the new TR.

# 2 Discussion

The text proposal in this contribution has been prepared by combining the agreed rules in [4] and [2] with further background information in [1].

Proposal 1: It is proposed to approve the text proposal provided in this contribution.

# 3 References

1. R4-2016297, “CA/DC Band configurations notations and usage in 3GPP,” Apple, 3GPP RAN4 #97e, November 2020
2. R4-2016935, “WF on rules on request sheet and notations of CA/DC configurations,” Apple, 3GPP RAN4 #97e, November 2020
3. R4-2105430, “TP on rules and guidelines for specifying band combinations, RP-210773,” Apple, 3GPP RAN4 #98bis-e, April 2021
4. R4-2110080, “Discussion on the rules of NE-DC with contiguous intra-band NR and LTE carriers”, Huawei, HiSilicon , 3GPP RAN4#99-e, May 2021
5. R4-2107926, “Draft Final Email summary for [99-e][116] NR\_Baskets\_Part\_1” , Skyworks Solutions Inc., 3GPP RAN4#99-e, May 2021

# Text Proposal

<< start of text proposal 1 >>

# 5 Rules and guidelines of specifying band combinations

## 5.1 General

The notation of the band combinations in the 38.101 specifications as well as the combination request lists by the operators and the basket WIDs can have significant impact, as it can become unclear what combination is really meant in the request or specification in cases of errors. Then the combination may be misinterpreted, not taken into account when implementing combinations in BS or UEs or even removed from specs or requests. Also automated processing of the tables will become difficult with too many bugs.

Generally the notation of band combinations starts with the type of the configuration (mainly CA or DC), followed by one list (either LTE or NR) or two lists (first LTE, then NR) of bands with bandwidths. The following types of band combinations are defined in 3GPP specifications:

Carrier Aggregation: Starts with “CA\_” as the first three characters. Then either a list of LTE or NR carriers is following, where the carriers or bands are always separated by “-“. LTE and NR carriers cannot be combined, that would be a DC combination. Examples:

- CA\_1A-2A (LTE)

- CA\_n1A-n2A (NR)

- Examples for wrong notations: CA\_1A\_2A (“\_” instead of “-“ between the carriers/bands), CA-1A-2A (no “\_” but “-“ after “CA”, CA\_1A\_n2A (this would need to be a DC combination)

- NOTE: LTE examples are provided for information only

Dual Connectivity: Starts with “DC\_” as the first three characters, then for EN-DC configurations followed by the list of LTE carriers, a “\_” as separation between the LTE and NR carriers and then the list of NR carriers. For NE-DC configurations the list begins with NR carriers, a “\_” as separation between the NR and LTE carriers, and then the list of LTE carriers. There are exceptions for SUL EN-DC combinations, which separate the LTE and NR carriers by “\_SUL\_” instead of “\_”, and contiguous intra-band EN-DC combinations using “(n)” instead of “\_” and the “n” of the first NR band in the list. DC configurations within LTE or NR just list the carriers after “DC\_”. For EN-DC combinations for V2X the “DC\_” at the beginning is replaced by V2X\_”, even if it is still a EN-DC combination. Examples:

- DC\_1A\_n2A (EN-DC)

- DC\_1A-2A (LTE-DC)

- DC\_n1A-n2A (NR-DC)

- DC\_(n)1AA (EN-DC with contiguous intra-band LTE and NR carriers)

- DC\_1(n)AA (NE-DC with contiguous intra-band NR and LTE carriers)

- DC\_1A-(n)2AA (EN-DC with one LTE carrier followed by contiguous intra-band LTE and NR carriers)

- DC\_2(n)AA-1A (NE-DC with one LTE carrier followed by contiguous intra-band NR and LTE carriers)

- DC\_n78A\_1A-3A (NE-DC)

- Examples for wrong notations: DC\_1A-n2A (“-” instead of “\_“ between the LTE and NR carriers/bands for EN-DC combinations), DC-1A-2A (no “\_” but “-“ after “DC”, DC\_n1A\_n2A (“\_” instead of “-“ between the NR carriers/bands for NR-DC combinations)

Supplementary UL: NR SA configurations start with SUL\_ as the first four characters, as it is only NR without LTE, if it is within an EN-DC combination there is a \_SUL\_ between the LTE and the NR part instead of the “SUL\_” at the beginning, using the usual “DC\_” as the first characters. Examples:

- SUL\_n2A-n80A (n80 being the SUL band)

- DC\_1A\_SUL\_n2A-n80A (n80 being the SUL band)

In summary the following types and notations are defined:

- CA\_ …: A Carrier Aggregation configuration followed by the list of either LTE or NR carriers

- DC\_ …: A Dual Connectivity configuration followed by the list of either LTE carriers for LTE-DC or NR carriers for NR-DC or for EN-DC first LTE carriers, then “\_” and the NR carriers. In case of a DC combination for V2X, the “DC\_” is replaced with “V2X\_”.

- SUL\_ …: A Carrier Aggregation configuration including one SUL band followed by the list of NR carriers, one of them being a SUL carrier. In case of a DC configuration with SUL, the “SUL\_” is shifted behind the “\_” separating the LTE and NR carriers and the configuration starts with “DC\_” as usual for DC configurations

## 5.2 Notation of lists of bands and bandwidths within a configuration

### 5.2.1 Band numbers

A list of LTE or NR carriers within a CA or DC configuration is a either a single or multiple LTE or NR carriers. The simplest one is just a single carrier. It consists of the band number followed by the bandwidth class, which is “A” for a single carrier. For LTE the band number is just the number of the band, for NR carriers the numerical part of the band notation is preceded by a “n”, indicating this is a NR band, not a LTE band. NR bands above n256 are FR2 bands, below n256 are FR1 bands. The band number is always followed by the bandwidth class, which can be quite complicated for NR combinations with intra-band CA. Bandwidth classes other than “A” indicate multiple carriers in that band. In the list there can be multiple entries for inter-band CA configurations (in LTE also intra-band non-contiguous CA), which are always separated by “-“. The band numbers are sorted in increasing numbers. LTE and NR bands in the same frequency range usually have the same band number. Examples:

- Notation of a single LTE carrier: 1A, 2A, 3A etc.

- Notation of a single NR carrier: n1A, n2A, n3A etc.

- List of multiple LTE carriers on different bands: 1A-2A-3A

- List of multiple NR carriers on different bands: n1A-n2A-n3A

### 5.2.2 Bandwidth classes

#### 5.2.2.1 Bandwidth classes for LTE

An entry within the list of carriers always starts with the band number followed by the bandwidth class. In LTE the bandwidth classes (if not “A”) mean this is a contiguous CA configuration with multiple carriers. They are specified in table 5.6A-1 in 36.101 and can range from “A” for a single carrier up to F for 5 carriers. BW class I is specified for 8 carriers, but is not used. Non-contiguous CA combinations are just listing multiple sub-blocks separated by “-“. Examples:

- CA\_1B: Two contiguously aggregated LTE carriers with 20MHz or less in band 1.

- CA\_2F: Five contiguously aggregated LTE carriers with up to 100MHz in band 2.

- CA\_3A-3A: Two non-contiguously aggregated LTE carriers in band 3

- CA\_4A-4E: A single carrier followed by a gap and then followed by four contiguously aggregated carriers with up to 80MHz

- A single carrier is no CA configuration as there is nothing aggregated, so there is no CA\_5A, this is just 5A.

#### 5.2.2.2 Bandwidth classes for NR

NR bandwidth classes are much more complicated. Also here an entry within the list of carriers always starts with the band number followed by the bandwidth class. But in NR the bandwidth class includes contiguous and non-contiguous CA and a mixture of contiguous and non-contiguous CA. For contiguous CA the bandwidth classes are specified similar to LTE, but separate for FR1 and FR2. For FR1 contiguous CA BW classes are specified in table 5.3A.5-1 in 38.101-1 ranging from A to O, for FR2 in 5.3A.4-1 in 38.101-2 ranging from A to Q.

A special kind or BW class specification is when there are intra-band contiguous LTE and NR carriers within a DC combination like DC\_(n)1AA. In this case the LTE and NR carriers within that band are combined to a single entry of the list of carriers starting with (n) indicating that it can be “n” for the NR carrier, or no “n” for the LTE carrier. This is followed by the numerical value of the band (here “1”) and then the contiguous BW class for the LTE part and the contiguous BW class for the NR part. So DC\_(n)1AA means that there is a single carrier for LTE and a single carrier for NR side-by-side contiguously aggregated in band 1. This can be extended by more contiguous carriers on the LTE or NR side or both, for example DC\_(n)41DA means three contiguous carriers for LTE besides a single carrier for NR. This can be extended by other LTE carriers in front of the combination of carriers with (n) or with other NR carriers behind the (n) part, for example DC\_1A-(n)2AA or DC\_(n)2AA-n3A. The (n) part is considered as the last LTE combination in the list or the first NR combination in the list, therefore adding it with a “-“ instead of a “\_”.

However, the BW class part of a NR configuration also includes non-contiguous intra-band CA. For a combination containing any non-contiguous CA, i.e. a gap between any aggregated carriers, each block of single or contiguously aggregated carriers is called a sub-block, where a sub-block can also consist of the contiguously aggregated carriers as stated above. While in LTE single non-contiguously aggregated carriers are just duplicated like CA\_1A-1A, in NR the number of non-contiguous carriers of a BW class is counted and put in parenthesis with the number of subblocks of this type preceding the bandwidth class. Therefore a configuration with two non-contiguous carriers will have a BW class (2A) in NR, so the combination will be named CA\_n1(2A), meaning there are two non-contiguous carriers with BW class A in band n1.

However, there can also be the combination of contiguous and non-contiguous intra-band CA in NR. In. this case the sub-blocks of each BW class are separately counted and added within the brackets. For example if there are in a n260 FR2 CA combination two sub-blocks of BW class “A” (single carriers), three of BW class “G” (two contiguous carriers up to 100MHz) and one of BW class O (two carriers with 50 or 100MHz), the full combination will be named CA\_n260(2A-3G-Q), having 6 sub-blocks with in total 10 carriers. Examples:

- CA\_n1B: Two contiguously aggregated NR carriers with 100MHz or less in band n1 (FR1).

- CA\_n2D: Three contiguously aggregated NR carriers with up to 300MHz in band n2.

- CA\_n3(2A): Two non-contiguously aggregated NR carriers in band n3

- CA\_n260G: Two contiguously aggregated NR carriers with 150 or 200MHz in band n260 (FR2).

- CA\_n260M: Eight contiguously aggregated NR carriers with 750 or 800MHz in band n260 (FR2).

- CA\_n260(2A): Two non-contiguously aggregated NR carriers in band n260 with up to 800MHz (2x400MHz)

- CA\_n260(A-M): A single carrier followed by a gap and then followed by eight contiguously aggregated carriers with up to 100MHz each

- CA\_n260(2A-3G-Q): Two single carriers up to 400MNHz each, three sub-blocks with two carriers each of 150 or 200MHz per sub-block followed by another subblock with two carriers of 50 or 100MHz each

## 5.3 Rules to be used for the notation of CA or DC configurations

The following are the rules for generating the configuration notations:

- Each configuration needs to start with “CA\_”, “DC\_”, “SUL\_” or “V2X\_”

- DC combinations include a list of LTE carriers first, followed by the list of NR carriers

- Entries within a list of either LTE carriers or NR carriers need to be separated by “-“, not “\_”

- The list of LTE carriers and the list of NR carriers within an EN\_DC combination need to be separated by “\_”, for contiguous intra-band EN-DC the two lists are connected with the (n)xxAA like notation, not “\_” (xx is the band number), for contiguous intra-band NE-DC the two lists are connected with the xx(n)AA like notation, not “\_” (xx is the band number). In specific cases “\_SUL\_” connects the two lists.

- Contiguous LTE+NR intra-band carriers within a DC combination are using the notation (n)xxAA (xx is the band number), Contiguous NR+LTE intra-band carriers within a DC combination are using the notation xx(n)AA (xx is the band number)

- No other characters than “A” to “Z”, “0” to “9”, “(“, “)”, “-“ “\_” and “n” are allowed within the notation, especially no spaces “ “, “/”, “.”, “.”, LineFeed, CR, other special characters

- Entries within the list of carriers need to be sorted in numerical order, i.e. first band n1, then n2, then n3, then n260, i.e. CA\_1A-2A, not CA\_2A-1A, but LTE and NR combinations are separately sorted, i.e. DC\_2A\_n1A, entries with (n) are always between the LTE and NR lists.

- Bandwidth notations are either a single character according to the BW class lists of contiguously aggregated carriers, two of these characters in case of combinations with (n) or for NR non-contiguous intra-band combinations specific expressions listing multiple carriers within “()”

- Within the “()” of non-contiguous NR combinations there will only be BW class letters for the BW class of contiguous sub-blocks preceded by a number indicating the number of sub-blocks of this BW class, if there are multiple different BW classes they are listed in ascending BW class order separated by “-“

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