TSG-RAN Working Group 4 (Radio) meeting #100-eR4-2115050

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**Source:** Ericsson, Apple

**Title:** TP to TR 38.844: Section 6.2 Overlapping UE Channel BWs

**Agenda item:** 10.2.3

**Document for:** Approval

# 1 Introduction

Revision of R4-2113949 based upon first round discussions.

# 3 Text Proposal

[Start of Changes]

6.2 Study of overlapping UE channel bandwidths

6.2.1 Overlapping UE CBW

6.2.1.1 General

One way to utilise the whole chunk of irregular spectrum of a particular size is to combine several overlapping channels of next lower standard channel bandwidth. As an example, Figure X-1 shows a case when two overlapping 10MHz carriers cover 13MHz channel bandwidth. From an individual UE perspective, each UE is configured with existing immediately lower channel bandwidth following legacy procedures and signalling: one UE can use the first 10MHz carrier, while another UE can use another carrier. In fact, both UEs can use overlapping part of the spectrum provided that the BS takes care that the overlapping region is allocated to one particular carrier at a time. It should be also noted that from the UE perspective, an existing immediately lower channel bandwidth will be always used, either for initial access (as the channel bandwidth advertised by the network) or as a dedicated channel bandwidth configured by RRC. From the network perspective, the BS will/can use the whole irregular channel bandwidth.



**Figure 6.2.1.1-1: Using overlapping carriers (example for 13MHz).**

It is worth noting that overall capacity of the cell will be according to the irregular channel bandwidth because the BS can use the full bandwidth. However, since a particular UE will use only one carrier of a smaller bandwidth within the irregular channel bandwidth, the maximum throughput for a single UE will be less than the theoretically possible within the spectrum in case there is only a single UE in the cell. Nevertheless, since there will be multiple Ues in the cell the overall system throughput will not decrease.

6.2.1.2 Detailed description

One of the challenges associated with configuring overlapping carriers for the same spectrum is that both carriers should have aligned grid so that the BS can perform same FFT and schedule resources in the overlapping region. Moreover for alignment the initial BWP would be beneficial from BS coordination efforts to keep aligned between the UE dedicated channel bandwidth.



**Figure 6.2.1.2-1: Using overlapping carriers with single overlapping SSB (example for 13MHz).**

Another challenge while aligning RB grids is not an issue for bands above 3GHz that have the SCS based raster, it becomes more challenging for the sub-3GHz band that have 100kHz raster. As a result, carriers can be configured on raster points that correspond to the least common multiple of the channel raster and the RB size. As an example, the least common multiple will be 900kHz in case of the 15kHz SCS, which corresponds to 5RBs. It effectively means that overlapping carriers will not be able to address efficiently any irregular spectrum size and in some case maybe will not be applicable at all. Of course one way to improve spectrum utilisation is to allow shifting carriers in multiples of 1RB, but that will require introduction of new raster points, which will not be supported by legacy Ues.

Figure 6.2.1.2-2 presents an example for the 6MHz channel comprising two 5MHz channels. As can be seen from the figure, centre frequency distance between carriers is 900kHz, which is a multiple of 100kHz channel raster and 180kHz RB size. From an individual UE perspective, it is just a normal 5MHz carrier comprising 25RBs and having the 5MHz channel guard bands. From the BS perspective, it is a 6MHz channel with 30RBs. Figure 6.2.1.2-3 exemplifies how this approach can be used to support the 7MHz irregular channel bandwidth, in which the distance between the carriers is 2RBs i.e. 1800kHz. Finally, Figure 6.2.1.2-4 shows the 11MHz channel that is supported with two 10MHz channels.Referring to Figure 6.2.1.2-2, 6.2.1.2-3 and 6.2.1.2-4, it should be noted that guard bands will not necessarily be symmetrical and the exact guard band size will depend on a particular spectrum allocation, its size, and how the overlapping channels are placed.



**Figure 6.2.1.2-2: Detailed overview of overlapping carriers (6MHz channel with 5MHz carriers).**



**Figure 6.2.1.2-3: Detailed overview of overlapping carriers (7MHz channel with 5MHz carriers).**

**Figure 6.2.1.2-4: Detailed overview of overlapping carriers (11MHz channel with 10MHz carriers).**

Table 6.2.1.2-1 below summarises potential number of schedulable RBs for a scenario when the next smaller overlapping channels are used. To calculate them, it is assumed that distance between individual carriers is a multiple of 900kHz and that the resulting guard bands must meet at least next smaller channel requirements. So, “Channel Nrb”, “Channel guard bands”, and “Utilisation” represent the network view, while from the UE perspective all the parameters are the same as for the next smaller channel.

**Table 6.2.1.2-1: Exemplary number of RBs based on the next smaller overlapping channel (15kHz SCS).**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Channel (MHz)** | **Next smaller channel (MHz)** | **Next smaller channel guard band (kHz)** | **Next smaller channel Nrb** | **Channel Nrb** | **Utilisation (%)** |
| 6 | 5 | 242,5 | 25 | 30 | 90 |
| 7 | 5 | 242,5 | 25 | 35 | 90 |
| 11 | 10 | 312,5 | 52 | 57 | 93,3 |
| 12 | 10 | 312,5 | 52 | 62 | 93 |
| 13 | 10 | 312,5 | 52 | 67 | 92,8 |

Table 6.2.1.2-2 presents similar calculations for the number of available RBs with overlapping carriers, but for the 30kHz SCS. As can be seen from the table, a solution based on the 30kHz SCS overlapping carriers does not provide a good spectral utilisation for certain non-standard channel bandwidths due to the reason that the “distance” between carriers must be a multiple of 1800kHz. Because of that, channel bandwidths such as 7 and 12MHz have more or less good utilisation, whereas 6 and 11MHz do not provide any benefit at all.

**Table 6.2.1.2-2: Exemplary number of RBs based on the next smaller overlapping channel (30kHz SCS).**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Channel (MHz)** | **Next smaller channel (MHz)** | **Next smaller channel guard band (kHz)** | **Next smaller channel Nrb** | **Channel Nrb** | **Utilisation (%)** |
| 6 | 5 | 505 | 11 | 11 | 66 |
| 7 | 5 | 505 | 11 | 16 | 82,3 |
| 11 | 10 | 665 | 24 | 24 | 78,5 |
| 12 | 10 | 665 | 24 | 29 | 87 |
| 13 | 10 | 665 | 24 | 29 | 80,3 |

To suppport two overlapping carriers, the network can consider using one or two SSBs. To be more precise, since the the SSB bandwidth is 3.6MHz and the CORESET#0 bandwidth is 4.32MHz, a single SSB/CORESET#0 can be placed into a common part between two overlapping channels. However, this approach works only if the overlapping part is at least 4.32MHz, e.g. it is not applicable to 7MHz irregular channels. So, some irregular channel bandwidth will needed two SSB/CORESET#0. In this case, at least for irregular channel bandwidths <10MHz the network broadcasts two separate SSBs, one for each overlapping regular carrier. In case of irregular channels of a small size, e.g. less than 10MHz, it may create the challenge of aligning SSBs in the time and frequency domain so that they do not overlap thus complicating the gNB scheduling. i.e. for this approach complexity increases to coordinate the overlapping SSB for different Ues. As an example, if a particular irregular channel bandwidth does not allow for placing two SSBs in the same time slots, then the network will have two ensure that they are “multiplexed” accordingly in the time domain.

**Table 6.2.1.2-3: Summary of how many SSB/CORESET#0 needed for different channel bandwidths.**

|  |  |  |
| --- | --- | --- |
| **Channel (MHz)** | **Number of SSB** | **Time multiplexing for 2 SSBs is needed** |
| 6 | 1 or 2 | yes |
| 7 | 2 | yes |
| 11 | 1 or 2 | no |
| 12 | 1 or 2 | no |
| 13 | 1 or 2 | no |

This approach works with all the legacy Ues. As mentioned earlier, from an individual UE perspective, this is just a standard Rel-15 channel and no special UE side enhancements are needed. Thus an operator can use this solution with the whole ecosystem of available devices.

6.2.1.3 Configuration and signalling aspects

Since from an individual UE perspective each overlapping carrier is just a legacy carrier, the existing signalling applies. As an example, for the 7MHz allocation the UE can be configured with the 5MHz channel bandwidth, and the initial bandwidth part can be also 5MHz.

- SIB1-> servingCellConfigCommon-> downlinkConfigCommon-> frequencyInfoDL-> scs-SpecificCarrierList-> carrierBandwidth = 25 PRBs / subcarrierSpacing = 15 kHz

- SIB1-> servingCellConfigCommon-> downlinkConfigCommon-> initialDownlinkBWP-> genericParameters-> locationAndBandwidth = 25 PRBs

*Editor’s note: Signalling aspects to be updated once LS from RAN1/2 is received. The text above is current RAN4 understanding.*

[Unchnaged Sections]

6.3 Complexity and efficiency study

6.3.x Overlapping UE CBW

6.4 Generic solutions guidance

NOTE: The 6th objective is not an analysis/study but a guidance on solutions. A comparison of the proposed solutions with respect to the criteria in the 6th objective should be included in this clause.

6.4.x Overlapping UE CBW

This approach can be also be applied to all irregular channel bandwidths with only consideration of different spectral utilization considerations. However the single CORESET#0 and SSB is only applicable for bandwidths greater than 10 MHz. All irregular channel bandwidths two SSBs can be used (irregular channel bandwidths < 10 MHz SSB can be TDM). .

[Unchnaged Sections]

6.6 Legacy UE impact

NOTE: The 8th objective is not an analysis/study but a guidance on solutions

6.6.x Overlapping UE CBW

This approach works with all the legacy UEs and thus an operator can use this solution with the whole ecosystem of available devices.

[End of Changes]

# 5 References

1. R4-2101558, “Overlapping Channel Bandwidth Approach from BS Perspective”, Ericsson