3GPP TSG RAN WG1 Meeting #118bis R1-240xxxx

**Hefei, China, October 14th – 18th, 2024**

Source: Moderator (ZTE)

Title: Summary of QCL relationship of SSBs transmitted with the same block index

Agenda Item: 7

**Document for: Discussion and Decision**

# Introduction

In this contribution, we provide the summary of discussion on QCL relationship of SSBs transmitted with the same block index as per the following draft CR provided in [1].

* **TS 38.211-h90**

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| 7.4.3.1 Time-frequency structure of an SS/PBCH block<Unrelated parts are omitted>The UE may assume that SS/PBCH blocks transmitted with the same block index and associated to the same physical cell ID on the same center frequency location are quasi co-located with respect to Doppler spread, Doppler shift, average gain, average delay, delay spread, and, when applicable, spatial Rx parameters. The UE shall not assume quasi co-location for any other SS/PBCH block transmissions other than what is specified in [5, TS 38.213].<Unrelated parts are omitted> |

# Discussion

According to the following highlighted excerpt in TS 38.211-h90, SSBs transmitted with the same index on the same center frequency location are assumed to be quasi co-located.

* **TS 38.211-h90**

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| 7.4.3.1 Time-frequency structure of an SS/PBCH block<Irrelevant parts are omitted>The UE may assume that SS/PBCH blocks transmitted with the same block index on the same center frequency location are quasi co-located with respect to Doppler spread, Doppler shift, average gain, average delay, delay spread, and, when applicable, spatial Rx parameters. The UE shall not assume quasi co-location for any other SS/PBCH block transmissions other than what is specified in [5, TS 38.213].<Irrelevant parts are omitted> |

On the other hand, as per the following highlighted excerpt in TS 38.213-hb0, it can be existed the index of SSBs associated with different physical cell IDs are the same, no matter within the same half frame or across different half frames.

* **TS 38.213-hb0**

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| 4.1 Cell search<Irrelevant parts are omitted>The candidate SS/PBCH blocks in a half frame are indexed in an ascending order in time from 0 to $\overline{L}\_{max}−1$, where $\overline{L}\_{max}$ is determined according to SS/PBCH block patterns for Cases A through G. $L\_{max}$ is a maximum number of SS/PBCH block indexes in a cell, and the maximum number of transmitted SS/PBCH blocks within a half frame is $L\_{max}$.- For operation without shared spectrum channel access in FR1 and FR2, and for operation with shared spectrum channel access in FR2-2, $L\_{max}=\overline{L}\_{max}$- For operation with shared spectrum channel access in FR1, $L\_{max}=8$ for $\overline{L}\_{max}=10$ and 15 kHz SCS of SS/PBCH blocks and for $\overline{L}\_{max}=20$ and 30 kHz SCS of SS/PBCH blocks <Irrelevant parts are omitted> |

Subsequently, it may wrongly lead to that SS/PBCH blocks transmitted with the same block index on the same center frequency but associated with different physical cell IDs (i.e., in case of inter-cell MTRP operation or inter-cell beam management) are quasi co-located. Consequently, the following two cases are provided for elaborations:

* Case-1: Within a same half frame, an SSB associated with a PCI of the serving cell and another SSB associated with an additional PCI different the PCI of the serving cell are transmitted in the same time domain, then the two SSBs are corresponding to the same SSB index. Although the two SSBs are transmitted on the same center frequency, it does not make sense to assume the SSB associated with the PCI of the serving cell is quasi co-located with the SSB associated with the additional PCI.
* Case-2: Among different half frames, an SSB associated with a PCI of the serving cell and another SSB associated with an additional PCI different the PCI of the serving cell are corresponding to the same SSB index and transmitted on the same center frequency, it does not make sense to assume the SSB associated with the PCI of the serving cell is quasi co-located with the SSB associated with the additional PCI.

To address this issue, it needs to be correctly captured in TS 38.211 that SS/PBCH blocks transmitted with the same block index on the same center frequency location are quasi co-located only if the SS/PBCH blocks associated with the same physical cell ID.

Companies are welcome to provide comments of the following questions in the table below.

* Q1: Do you agree this issue is valid? If not, please provide your understanding of the current spec for clarification.
* Q2: If your answer to Q1 is yes, do you agree with the draft CR provided in [1]? If not, please suggest anything else (e.g., modification or different draft CR) to address this issue properly.

**Companies’ views**

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| **Company** | **Comments** |
| NEC | Q1: We can see the intention for this issue. While we think current spec may already reflect it, we don’t need to emphasize the special wording. In same TS 38.211 section 4.5, it says:

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| 4.5 Carrier aggregationTransmissions in multiple cells can be aggregated. Unless otherwise noted, the description in this specification applies to each of the serving cells.  |

In our understanding, the SSB mentioned in section 7.4.3.1 also needs to follow the general description, so it’s clear that “SS/PBCH blocks transmitted with the same block index” are associated with one serving cell.Q2: As discussed in Q1, so we think current spec is clear, no need of additional update.Mod: As per the following conclusion reached in RAN1#112, it should be noticed that inter-cell MTRP (which is in scope of MDCI MTRP) and CA cannot be existed at the same time. In this sense, the excerpt you referred above cannot be feasible to the case of this issue. More precisely, for inter-cell MTRP operation in a single carrier, the current spec still wrongly lead to SSB associated with different physical cell id (e.g., serving cell id and additional PCI id) is assumed to be QCLed. Hope that clarifies.**Conclusion**It is RAN1 understanding that any combination of Rel-16 MDCI MTRP PDSCH/PUSCH operation and cross-carrier scheduling is not supported. |
| MTK | Q1: YesQ2: YesWe tend to think the proposal makes current spec more clear. If hard to achieve consensus on the spec change, we think at least a conclusion can be helpful to record that this is common RAN1 understanding.Mod: A conclusion means there is no spec hole to my understanding, but the fact is opposite per companies understanding includes you. |
| Apple | Q1: No, there could be no other interpretation (SSB index of the same PCI are QCLed). The proposed CR is not needed, as it has been UE’s understanding since R15 (when additional PCI was not even introduced in R17).Mod: For Rel-15/16 UE behavior (i.e., not the case that SSB can be associated with additional PCI), the current description in TS 38.211 is clear. However, it cannot be feasible to the case that SSB associated with different physical cell id (e.g., serving cell id and additional PCI id) is assumed to be QCLed. If not, how to intepret the assumption of QCL relation for SSBs associated with different physical cell id as per the current TS 38.211 from Rel-17? |
| Ericsson | Q1: Yes. When the specification was written, each serving cell was only associated with one PCI. This is not true anymore.Q2: Yes |
| Huawei, HiSilicon | Q1: The spec is written in the logic that they are specified for the serving cell for the UE. Otherwise, it will be explicitly stated in the spec. The proposed change will introduce further confusion to other parts of the spec. For example, the following part does not need to explicitly state they are for the same PCell ID either.*offsetToPointA* for a PCell downlink where *offsetToPointA* represents the frequency offset between point A and the lowest subcarrier of the lowest resource block, which overlaps with the SS/PBCH block, or the SS/PBCH block after puncturing if applicable, used by the UE for initial cell selection, expressed in units of resource blocks assuming 15 kHz subcarrier spacing for FR1 and 60 kHz subcarrier spacing for FR2;Mod: Please see my response to NEC, this is for the case of inter-cell MTRP operation in a single carrier, rather than CA scenario. |
| OPPO | Q1: No. We have similar view as Huawei. Otherwise, we may need CR for each part in spec. with SS/PBCH block.Mod: Please see my response to NEC and HW. |
| Samsung | Q1: Yes. Q2: We thinks no other interpretation exists. If the CR is taken, we may need to check all SSB related descriptions for consistency. So, we can make a conclusion on that. Mod: Please see my response to HW. For clarification, other interpretation of the current TS 38.211 from Rel-17 is that SSBs associated with different physical cell id are assumed to be QCLed, which was also mentioned by other companies. |

# Conclusion

[TBD]

# References

1. R1-2407786, Draft CR on QCL relationship of SSBs transmitted with the same block index in TS 38.211, ZTE Corporation, Sanechips