**3GPP TSG-RAN WG4 Meeting # 111 R4-240xxxx**

**Fukuoka Meeting, May 20th – May 24th, 2024**

**Source: Skyworks, AT&T, Qualcomm, (...)**

**Title:** **WF on Harmonic MSD clean-up**

**Agenda item: 6.1.1.1**

**Document for: Approval**

1. Introduction

During RAN4#110bis, the principles of UL harmonic and Rx harmonic mixing MSD clean-ups were proposed in [1,2], followed by the agreed WF [3]. At RAN4#111, the leading companies provided companion CRs [4,5,6,7]. Comments were received that the impact on RAN5 should be carefully evaluated prior to agreeing these CRs. Also [8] pointed out that further corrections may be needed for UL band RB allocation parameter “Lcrb” and parameter “RBstart=0” to account for harmonic center frequency shift for non-fully allocated UL channels.

This WF captures options to ensure the necessary corrections can be implemented in Rel-18 at RAN4 meeting #112.

1. WF
   1. Handling RAN5 Concerns

Offline discussions were held with RAN5 this week. The proposed RAN4 changes may have big impact on RAN5 TS, and one possible way to handle such a large number of changes would be to clarify with RAN5 that the MSD requirements should be applicable only from Rel-18 and onward.

**<Way forward>**

* RAN4 CR cover page to clarify that the changes to UL harmonic and Rx harmonic MSD tables are applicable only from Rel-18 and onward to subsequent Releases.
  1. Handling UL RB configuration changes of [8]

Two types of UL band configuration corrections are proposed in [8]:

1. Ensure that the configured UL RB are centered in the middle of the UL channel.
2. Scale the number of configured UL RBs “Lcrb” with the UL harmonic order.

Note that CRs [4,6] have already proposed the Lcrb scaling concept.

Rationale for 1):

It was shown in [8] that the RBstart=0 configuration may create test conditions where the direct-hit harmonic collisions are no longer met. This is because RAN4 direct-hit test conditions are specified using equations in footnotes that define the relationship between the UL and the DL carrier center frequency. These equations do not define the relationship between the DL carrier center frequency and the UL harmonic center frequency. Hence, direct-hit conditions may not always be met for harmonic orders.

Rationale for 2):

This proposal ensures that up to harmonic 5, the UL harmonic power spectral density is always entirely overlapped by the DL carrier CBW, even for the worst-case of 5MHz DL CBW. This proposal removes the uncertainty of UL harmonic BW exceeding the DL CBW.

**<Way forward on “RBstart=0”>**

To ensure the harmonic centre frequency meets the direct hit collision with the DL carrier centre frequency, companies are invited to share their views on the following options at the next meeting. In all cases, the “Lcrb” requirements are kept, only “RBstart” may be changed.

* Option 1: RAN4 corrects all RBstart=0 values to ensure that the non-fully allocated RBs are centered in the middle of the UL channel. This means correcting several NR-CA, and EN-DC test points,
* Option 2: RAN4
  + Removes RBstart=0 from all UL Harmonic and Rx Harmonic mixing MSD tables, and
  + Adds an equation in the core requirement text that guarantees the UL RBs are centered in the middle of the UL channel,
* Option 3: RAN4
  + Removes RBstart=0 from all UL harmonic and Rx harmonic mixing MSD tables, and
  + Adds a sentence in the core requirement text that RAN4 MSD levels assume the UL RBs are centered in the middle of the UL channel,
  + Informs RAN5 that RBstart are no longer specified and that RAN5 needs to specify RBstart in the test requirement technical specifications.
* Other options are not precluded.

**<Way forward on UL “Lcrb”>**

* For UL Harmonic and Rx harmonic mixing MSD test points, RAN4 recommends that UL Lcrb are corrected as follows for SCS 15kHz / SCS 30kHz respectively:
  + For UL2/DLx test point, Lcrb=12RB / 6RB
  + For UL3/DLx test point, Lcrb=8RB / 4RB
  + For UL4/DLx test point, Lcrb=6RB / 3RB
  + For UL5/DLx test point, Lcrb=5RB / 2RB
* Additionally, for UL Rx harmonic mixing UL1/DLx, Lcrb=25RB / 12RB.

References

1. R4-2405453, Harmonic Mixing clean-up, 3GPP TSG-RAN WG4#110bis, Changsha, China, Qualcomm Inc.
2. R4-2405961, Corrections to UL harmonic MSD, 3GPP TSG-RAN WG4#110bis, Changsha, China, Skyworks Solutions, Inc.
3. R4-2406574, WF on PC2 FDD MSD Guidelines, 3GPP TSG-RAN WG4#110bis, Changsha, China, Skyworks Solutions, Inc., Qualcomm, Nokia.
4. R4-2408860, Draft CR for EN-DC Harmonic Mixing clean-up PC3, 3GPP TSG-RAN WG4#111, Fukuoka, Japan, Qualcomm Inc.
5. R4-2409422, Draft CR for EN-DC Uplink Harmonic clean-up PC3, 3GPP TSG-RAN WG4#111, Fukuoka, Japan, Skyworks Solutions, Inc.
6. R4-2408862, Draft CR for NR CA Harmonic Mixing clean-up PC3 PC5, 3GPP TSG-RAN WG4#111, Fukuoka, Japan, Qualcomm Inc.
7. R4-2409420, Draft CR for NR CA Uplink Harmonic clean-up PC3, 3GPP TSG-RAN WG4#111, Fukuoka, Japan, Skyworks Solutions, Inc.
8. R4-2407164, Further improvements to Harmonic MSD tables, 3GPP TSG-RAN WG4#111, Fukuoka, Japan, Skyworks Solutions, Inc.