3GPP TSG-RAN WG4 Meeting #78 **R4-160294**
St. Julian's, Malta, 15 – 19 Feb, 2016

Source: **SoftBank Corp.**

Title: **Antenna related issues on Band 8 and Band 28 CA**

Agenda item: **6.16.2.2 (REL-13)**

Document for: **Approval**

1. Introduction

The standardisation of Band 8 + Band 28 CA was conducted as a part of 3CA of B1+B8+B28 [1] and B3+B8+B28 [2] WIs. The main technical argument so far has been on the performance of quadplexers but quite recently, a new issue was raised around antenna implementation. This paper is to explain the new issue and to consider possible solutions.

2. Issues on antenna implementation/performance

During Anaheim meeting last year, there were a couple of offline comments on B8+B28 CA: a current low-band antenna could not offer sufficient performance. In response to those comments, we discussed this issue with UE manufacturers.

Although an antenna implementation/performance is not a subject of RAN4 at present and is largely up to individual implementation, observations in general are:

1) It is quite challenging to design/implement an antenna which could support the full range of low band (700 – 960MHz in this paper). This is especially true for equipment with smartphone or mobile phone form factor.

2) It looks like a current low-band antenna design is optimised for 800-900MHz for various reasons (including form factor limitation) and the lower edge of 700MHz becomes very hard to cover.

3) For single band operation, an antenna tuner is then needed to obtain appropriate performance in 700MHz range.

4) This situation makes CA of two largely separated low-bands difficult or impractical as one band could be out of the range of rational resonance of the antenna.

So, all in all, it sounds hard to implement B8+B28 CA in a straight-forward manner. While we can standardize these combinations as if there is no such issue (since there is no question asked on antenna in RAN4/5), we think that it is worth to bring this issue to RAN4.

[Observation -1] Current low-band antenna is impossible to cover the whole range of low-band (700MHz – 960 MHz) without an antenna tuner and this could be problematic for low-low CA with large separation.

3. Possible solutions

3.1 Antenna performance deterioration

According to the UE vendors, performance degradation in B8+B28 CA due to antenna would roughly be estimated below. Sensitivity loss in the table comes from antenna gain variation alone and is relative to single band performance.

Antenna tuning (Pcell)	B8 Rx sensitivity loss	B28 Rx sensitivity loss
No tuning (Band 8)	--	Several dB
Tuned to lower freq. (Band 28)	10 – 20dB	--

Band 28 Pcell might give 2-digit dB loss of antenna gain/sensitivity in Band 8 region and it is almost hopeless to justify "CA" in the most of the cases. Band 8 Pcell would still introduce some loss but be better than B28 Pcell case. This comes from a trend that a low-band antenna could still offer certain level of gain in B28 Rx portion but not in the lower edge of B28 (i.e. Tx): To support the whole B28, antenna tuning is needed and upper part of the low-band would be suffered as a consequence. (Therefore it won't be practical to imagine 2UL CA of B8+B28.)

In addition, there might be an option to limit the range of B28 to improve the situation. As both B8 and B28 are global bands, a rational border could be in B28A/B28B and UE vendors' feedbacks are that improvement is limited to 1-2dB.

Thus, if B8+B28 CA is realized with a conventional antenna, only the possible approach seems to limit Pcell to Band 8 and accept some dB loss in Band 28 Rx. On the other hand, since the issue is largely up to implementation, the exclusion of Band 28 Pcell in 3GPP standard might not be likely.

[Observation -2] Only the realistic approach of B8+B28 CA seems to limit Pcell to Band 8 and accept some loss in Band 28 Rx.

3.2 Potential issues relevant to antenna tuning

The proposal above imposes some dB variation in Scell Rx depending on antenna states (tuned or not). There might be potential issues relevant to that.

One possible problem is on measurements to trigger the CA. It is expected that measurement of Scell should be done in a measurement gap with antennas tuned to the target frequency. So accepting some dB discrepancy in Scell as above, CA triggering condition and realized Scell CSI might be misaligned due to the difference in antenna gain. What is worse in this case, since we do not have measures to define/test the performance including antennas, this could depend on UE implementation and it might be impossible to control the degree of discrepancy. This would make eNB implementation difficult, probably adjusting such difference with "outer-loop link adaptation".

4. Moving Forward

This combination is subject to REL-13 but it seems hard to conclude in this meeting. Then we'd like to postpone these to REL-14 to conduct study. Firstly, to clean up REL-13 things, we'd like to propose to delete all the TPs in the relevant technical reports. Companion documents [3] – [4] are prepared for make the relevant sections "void".

Secondly, we need to define the new set of CA WID of these. The necessary info. for these combinations have been informed to relevant editors to capture these in basket WIDs.

[Proposal -1] The CAs relevant to Band 8 + Band 28 is to postpone to REL-14.

In addition, we'd like to get feedbacks on subjects in section 3, whether B8 Pcell operation is still rational or current antenna performance assumption as above sounds rational and if there is a good way to define B8+B28 in the next meeting.

To wrap up, essential findings and proposals are:

[Observation -1] Current low-band antenna is impossible to cover the whole range of low-band (700MHz – 960 MHz) without an antenna tuner and this could be problematic for low-low CA with large separation.

[Observation -2] Only the realistic approach of B8+B28 CA seems to limit Pcell to Band 8 and accept some loss in Band 28 Rx.

[Proposal -1] The CAs relevant to Band 8 + Band 28 is to postpone to REL-14.

5. Reference

[1] RP-150447 Revised Work Item Proposal: LTE Advanced 3 Band Carrier Aggregation (3DL/1UL) of Band 1, Band 8 and Band 28, SoftBank Mobile

[2] RP-142193 New Work Item Proposal: LTE Advanced 3 Band Carrier Aggregation (3DL/1UL) of Band 3, Band 8 and Band 28, SoftBank Mobile.

[3] R4-160339 TP for Rel-13 2DL TR36.852-13: Deletion of LTE-A Inter-band Carrier Aggregation (2DL/1UL) of Band 8 and Band 28, SoftBank Corp.

[4] R4-160340 TP to REL-13 3DL TR36.853-13: Deletion of LTE-A Inter-band Carrier Aggregation (3DL/1UL) of Band 1, Band 8 and Band 28 and Band 3, Band 8 and Band 28, SoftBank Corp.