Issues of carrier aggregation intermodulation distortions in LTE-Advanced System

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1 Background
Increasing transmission speed has always been the target for any telecommunication system. For that purpose, LTE-Advanced adopted components carrier aggregation. Up to 5 components carrier can be aggregated (in 3GPP Release 10), and with 20 Mhz bandwith for each component, a total bandwith of 100 Mhz can be reached. 3GPP Release 13 will allow up to 32 components carrier aggregation. On the other hand, power amplifier’s high efficiency is only possible in the nonlinear operation mode. But carrier aggregated signal amplification in that mode leads to intermodulation products. This paper focuses on intermodulation of carrier aggregated components.

2 Introduction
As stated above, nonlinear amplification results in intermodulation of carrier aggregated signals. Based on 3GPP Release 12, we will list all the possible carrier aggregations and analyze all their intermodulations. We will answer to the following questions:

- What are the frequencies of intermodulation products?
- Can transmission intermodulation products fall in the reception frequencies of considered band? If they can, they will cause interference with the received signal. This can happen for the uplink transmission as well as for the downlink transmission.
- For a given eNodeB(Base Station for LTE-Advanced), can the downlink transmission intermodulation products fall in the reception frequency bands of other LTE/LTE-A bands?

3 Methodology
Intermodulation products are calculated from band aggregations listed by 3GPP Release 12 and for a given transmission direction and the direction in which influence of intermodulation products is analyzed. The number of aggregated bands is limited to three, and the order of intermodulation products is also limited to three. The following figure illustrates the interference of uplink transmission intermodulation products with the reception frequencies. The example is given for carrier aggregation of band 4 and band 17 in uplink transmission.

![Figure 1: Bands 4 and 17 and their IMD products, transmission up](image)

4 Results and Discussion
We were able to calculate the intermodulation products of aggregated bands in LTE-Advanced system. The calculation showed that the answer for both question in the introduction section is positive. There are intermodulation products which fall in reception frequencies of a given band. This will put more requirements on linearity of power amplifiers both in uplink and downlink transmission.

5 Conclusion
Carrier aggregation is an attractive technique but its practical implementation remains difficult due to, among other things, intermodulation distortions. The above example illustrated that phenomena with only 2 bands aggregation. 3GPP Release 13 will allow up to 32 carriers, and there will be more intermodulation products.

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