TSG-RAN Working Group 4 (Radio) meeting #5 **TSGW4#5(99)315**
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**Agenda Item:** 7.8

**Source:** Motorola

**Title:** BTS Receiver Intermodulation Characteristics

**Document for:** Discussion and Approval

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## 1. Introduction

Receiver intermodulation (IM) can occur when two large interfering signals with a particular frequency relationship are applied to a BS receiver. Since there are very few carriers when W-CDMA is used, they will generally be spaced at approximately equal frequency intervals, which provides the required relationship to produce IM in many instances.

Of course, two large signals do not occur at the same time very frequently, so it is desirable to quantify the approximate levels of these IM producing signals in terms of their probability of occurrence. This paper shows simulation results of the probability of occurrence of large amplitude signals and proposes an IM specification.

## 2. Description of Simulations

Several simulations have been made to determine how often two very large W-CDMA signals will occur at the input of a BS receiver. These are done in basically the same way as the receiver blocking simulations, except that a search is made to find two large signals. The conditions and methodology are described as follows.

These are static Monte Carlo simulations using a methodology generally consistent with that described in [1]. They are constructed using two uncoordinated networks that are on different frequencies. The frequencies are assumed to be separated by at least 10 MHz so that the BS receiver selectivity will not limit the simulation, and so that the UE spurious and noise performance will dominate over its adjacent channel performance. In a real system, three different frequencies would have to be in use in order for two signals on different frequencies to interfere with a third desired signal. However, this simulation only observes the two interfering signals, and it does not need a third network to do that.

The primary assumptions that are common to all the simulations are: 1) the two networks have maximal geographic offset (a worst case condition), 2) cell radius is 5 km, 3) UE spurious and noise in a channel bandwidth is 46 dB, 4) BS selectivity is 100 dB (to remove its effect), 5) BS antenna gain is 11 dB, 6) UE antenna gain is 0 dB, and 7) minimum path loss is 70 dB including antenna gains. In addition, for the speech simulations, maximum UE power is 21 dBm and the C/I requirement is –21 dB. For the data simulations, maximum UE power is 33 dBm and the C/I requirement is –11.4 dB. Note that this is different from the basic assumption in [1], since its data power level is 21 dBm, just like the speech level.

During each trial of the simulations, uniform drops of the UE are made, power levels are adapted, and data is recorded. At least a thousand such trials are made for the systems under each condition. From these results, CDF's of the second largest signals appearing at the receivers' inputs have been constructed and are shown in the graphs at the end of this paper. Observing the second largest signal at each receiver allows one to construct a CDF that shows the probability that exactly two signals are at or above the given level. When the levels are large, this should give a reasonable approximation to an IM situation.

Simulations have been done for speech only systems and also for mixed speech and data systems. In the mixed systems, it was assumed that 90% of the total were speech users and 10% were data users. This led to about 45% of the total power being utilised by speech and 55% by data. This is also a deviation from [1], in that the 6 dB noise rise criterion was not used. In very large cells, it was found that 6 dB rise produced large outage values (>10%), so instead the number of users was adjusted to provide a 5% outage for either the speech users or the data users.

# 3. Simulation Results

Figure 1 shows the overall CDF's of the second largest input signals to the receivers under three conditions: 1) speech only, 2) mixed speech and data with sufficient numbers of users to obtain a 5% outage for the speech users, and 3) mixed speech and data with sufficient numbers of users to obtain a 5% outage for the data users. The mixed speech and data case using 33 dBm data terminals was found to be significantly worse for blocking, so it was also used for this test. As can be seen in the expanded plot in Figure 2, however, it did not make a significant difference at probabilities in the 99.99% range, but it did change the maximum possible level by a few dB.

The 99.99% occurrence level for IM is seen to be about –59 dBm.

# 4. Conclusions

The in-band IM specification for UTRA should be –59 dBm and at least one of the IM test signals should be an HPSK carrier. Recommended text is in the next section.

# 5. Recommended Text

### *7.8 Intermodulation characteristics*

Third and higher order mixing of the two interfering RF signals can produce an interfering signal in the band of the desired channel. Intermodulation response rejection is a measure of the capability of the receiver to receiver a wanted signal on its assigned channel frequency in the presence of two or more interfering signals which have a specific frequency relationship to the wanted signal.

The static reference performance as specified in clause 7.3.1 ashould be met when the following signals are applied to the receiver;:

- A wanted signal at the assigned channel frequency, 3 dB above the static reference level.
- An HPSK interfering signal at a frequency offset of Δf, where Δf is at least 10 MHz, and an amplitude of –59 dBm.
- A CW or an HPSK interfering signal at a frequency offset of 2Δf and an amplitude of –59 dBm.

~~? A CW interfering signal at frequency [ 10 MHz] and a [CW] signal at frequency [ 20.1 MHz] with a level of [ ] dBm.~~

# 6. References

[1] AH 02 on ACIR simulation, Version: 0.3, 26/3/1999, editor: Omnitel

**Figure 1: CDF of Two Signals with 5km Cells and Worst Case Geographic Offset**

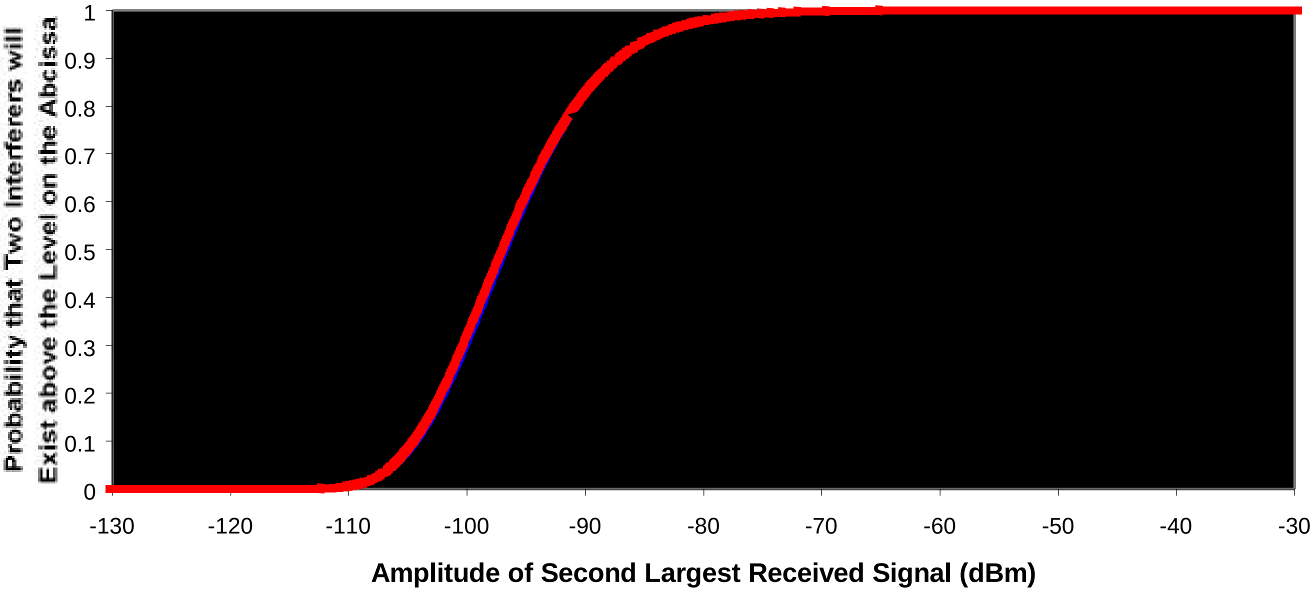


**Figure 2: CDF of Two Signals with 5km Cells and Worst Case Geographic Offset**