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Multi-operator interference issues in 450 MHz band

In case of a multi-operator scenario in the 450 MHz band, the most dominating interference that would affect the coverage, capacity as well as the Quality of Service (QoS) is the adjacent channel interference. In such multi-operator scenario, the following network details should be carefully reviewed:

- Frequency separation (guard band) between the two operators' frequency assignments
- Co-location requirement for two different operator's cell sites due to the site-to-site distance in a non-collocated scenario
- Base Station and Terminal RF specifications of each operator in the given frequency range
- The sources of various external interferences on frequency assignments

Co-location requirements in a Multi-operator scenario

The multi-operator interference is often called "Adjacent Channel Interference", which is very noticeable when the cell towers are not co-located. Figure 1 shown below gives an idea of the effect of Adjacent Channel Interference of Operator # 2's mobile terminal on Operator #1's Base Station when the Operator #2's mobile terminal is situated in close proximity of Operator #1's Base Station. Operator #2's mobile terminal, in Operator #1's Base Station area, is using maximum power on the uplink because its own home Base Station is far away. This creates high amount of interference to Operator #1's Base Station in the uplink due to Operator #2's mobile terminal. Therefore, this affects Operator #1's uplink performance, in terms of capacity degradation due to high interference.

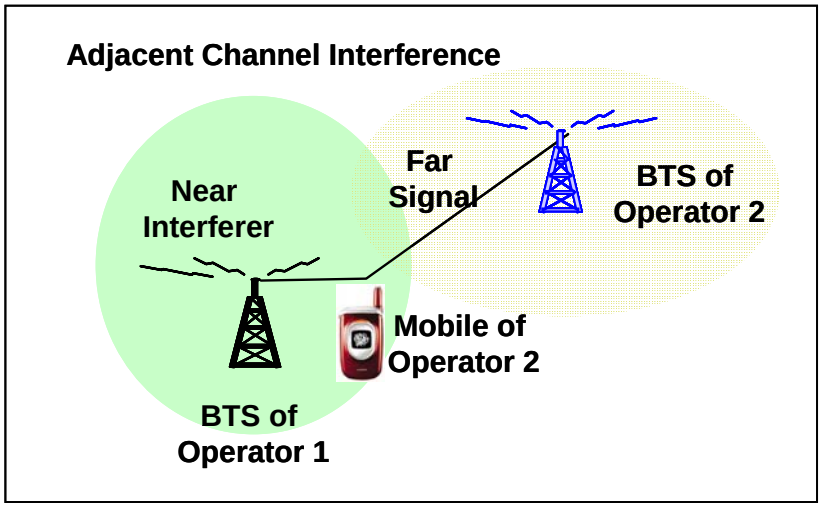

Figure 1: Base Station Interference from Mobile Terminals

In the absence of enough guard band between carriers allocated to different operators not sharing the cell site towers, these transmissions may affect a number of Base Stations in that area based on power, the direction of Base Station's receive antenna and the location of the mobiles in the network. In the worst case, this would mean increased noise on the uplink, resulting in either loss in coverage or a loss in capacity or both. This type of interference is termed as interference due to near-far effect. This type of adjacent channel interference can only be minimized by co-locating the cell sites of both operators.

For non-collocated Base Stations, the difference in path loss ($\Delta PL = PLfar - PLnear$) is one of the main effects that determine the degree of near-far interference. Note that the path loss is really an "effective path loss" which represents theoretical RF propagation loss and fade margin (due to shadowing effects). It is inevitable that there would be some capacity and/or coverage degradation to the CDMA operations in the 450 MHz band due to single carrier allocation to different operators operating non-collocated cell sites.

Effect of Channel Spacing on Adjacent Channel Interference

The amount of adjacent channel interference is a function of guard band between two CDMA channels and the filter responses of Base Stations and mobiles. Guard band is the frequency separation between two CDMA channels in excess of the nominal 1.25MHz center-to-center separation for the 450 MHz band. Adjacent channel interference is also a function of the relative geographical separation between the cell sites in the network carrying the adjacent channels.

The effective path loss difference between the geographical locations of the base stations carrying adjacent channels range from a minimum of 65 dB in a best-case nearby situation to 150 dB at the maximum border cell distance of about 3.5 Km (under LOS conditions). For best results, it has been observed that an inter operator carrier-to-carrier spacing of about 72 NMT channels (1.8 MHz) in the case of non-collocated base stations may be required to significantly reduce the near-far problem in urban environment where the site-to-site distance of the different operators base stations would normally be about 500 meters. Reduced carrier-to-carrier spacing, less than 1.8 MHz but still greater than 1.25 MHz, is possible with some impact on capacity and coverage. The worst-case scenario that should be avoided is when the adjacent operator's base stations are located on the edge of the coverage area of the competing operator.

At center-to-center spacing of 1.5 MHz (60 NMT channels with 10 NMT channels of guard band between operators), the isolation between interferer and source is about 44 dB. When reduced to 1.4 MHz (i.e., 56 NMT channels with 6 channels of guard band between operators), the available isolation is reduced to 38 dB. The typical effect of adjacent channel to in-band power ratio under 0 dB SINR conditions for different values of channel spacing is typically shown in figure 2 below.

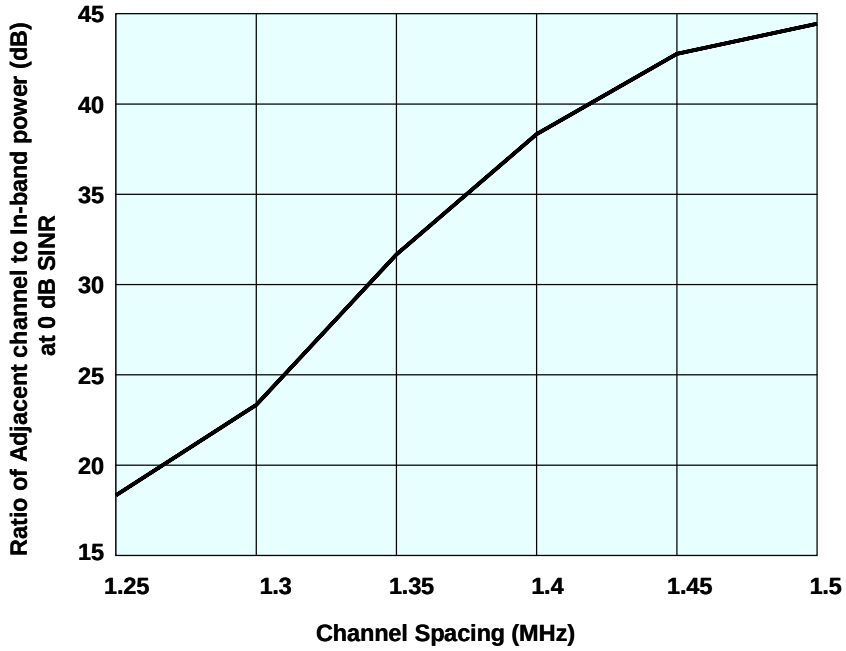

Figure 2: Adjacent channel to in-band power ratio for varying channel spacing

Recommendations

Providing 300 kHz or more of guard band between two different operators' CDMA carriers would largely take care of the effect of adjacent channel interference. Higher amounts of channel spacing would give better adjacent channel to in-band power ratio (available isolation). Co-location of cell sites amongst two CDMA operators provides the following benefits:

1. By co-locating cell sites, the adjacent channel interference due to near-far effect is significantly reduced
2. Non-collocation of cell sites under insufficient guard band between two different CDMA channels of competing CDMA operators would degrade performance of the CDMA system
3. Co-location would lessen the number of possible CDMA cell sites thus reducing overall interference

4. The co-location of cell sites reduces the initial cost of installations (reduction in CapEx)