# Interference Analysis for Cellular Satellite Systems Using a Sub-Beam Approach

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In cellular satellite communications systems, a given coverage area is typically filled with a network of contiguous spot beams, which carry concentrated radiation along preferred directions. The coverage regions for such applications are typically large areas, such as continents and many beams need to be generated. Phased arrays are a natural platform for cellular satellite systems as they can direct a large number of beams in multiple directions simultaneously by using a beam former, which applies appropriate phase shifts to each of the radiating elements in the array. The size of the phased array needs to accommodate the peak gain requirements of the spot beams on earth, which are typically defined at the beam contour levels of 3- to 4-dB down from the peak value. This results in a large aperture size and a large number of radiating elements for the phased array antenna as the aperture area is directly related to the peak gain. As a result, complex beam formers with high power and mass requirements need to be employed, and cost can be significant.

Recently, a method has been proposed to address this issue by using a sub-beam approach to reduce the antenna size and complexity while illuminating the same coverage area (US Patent # 7,013,137, 2006). This is done by dividing the basic spot beam into a number of sub-beams that satisfy the edge gain requirements. The sub-beams have broader 3-dB beamwidths, resulting in lower peak gain; therefore require a reduced aperture size. This is at the expense of increased number of beams, which in return changes the configuration of the beam former. In a digital beam former, this leads to a reduction in hardware complexity and more computationally intensive software. One issue that needs to be investigated with this approach is the impact on interference levels for co-channel beams.

Due to bandwidth limitations in cellular communications, the same bandwidth is allocated to beams which are isolated spatially. This is known as frequency reuse. The sub-beam approach replaces each basic beam by a number of broader beams that satisfy the edge gain requirements. The frequency reuse configuration is conserved as each set of sub-beams use the same bandwidth allocated to the basic beam. Since sub-beams are broader than the basic beam they replace, the interference levels at the co-channel beams need to be carefully investigated before this method can be used. This paper studies the overall effects on interference levels in a coverage area, where basic spot beams are replaced by sub-beams.