Evaluation of the polarization performance of a cone-shaped antenna array

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Conformal antenna arrays are used in various applications when it is either imposed by the shape of the surface, or required by the radiation pattern specifications. One particularly interesting shape of a conformal array is the truncated cone. It might be used in satellite applications where an iso-flux EIRP profile is required (like for example: E. Vourch et al., "Conformal array antenna for LEO observation platforms," *IEEE AP-S International Symposium, 1998*). In that solution the top of a cone-shaped antenna is directed to Earth's nadir direction. The radiating elements are distributed on the cone side surface and are organized into linear subarrays. In order to provide an iso-flux steered beam each subarray is required to have a special spatial directivity profile. A Beam Forming Network composed of phase shifters and Butler-like matrices provides the signals required to steer the beam. Since this is an antenna intended for Low Earth Orbit space applications, circularly polarized radiation is required.

The linear subarrays consist of planar antennas and therefore their axial ratio degrades when moving from their broadside direction towards higher theta angles. However, due to the natural rotational symmetry of the truncated cone, for the nadir direction of radiation the antenna array is behaving like a sequentially rotated array. Therefore, for this direction the circularly polarized radiation is obtained no matter what the polarization of the subarrays radiation in that direction is. When scanning the beam from the nadir direction the influence of the rotational symmetry of the array wanes.

This paper presents an investigation of the polarization properties of a truncated cone antenna array of linear subarrays of planar antenna elements. The analysis is focused on the beam scanning. Since the complete truncated-cone antenna array system is too big to be simulated directly, a simplified hybrid approach is proposed. A complete single subarray model, placed on a PEC cone, is simulated and the far-field radiation patterns are extracted. In this way all the diffraction phenomena are taken into account. Obviously, this approach is neglecting the mutual coupling between the subarrays. However, it is proved through numerical simulations and measurements of a prototype that the effect of this simplification is negligible. The obtained subarray patterns are later used to estimate the far-field patterns of the complete truncated cone array. A set of design rules on the maximum axial ratio that can be corrected by the truncated cone geometry is established.