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Introduction

Radio base stations for point-to-multipoint communications usually employ arrays of antennas at a certain height from the ground for omnidirectional coverage, with element excitations being exercised in order to achieve a suitable elevation pattern synthesis. More recently, attention has been focused on point-to-multipoint (not necessarily mobile ones, but fixed as well) services such as broadband wireless (high-density fixed) systems for which compact shaped reflector antennas comprise an interesting alternative to usual base station arrays due to their ability in providing customized coverage patterns, with bandwidth requirements now being met via adequate feed designs. Prospective reflector designs, while producing cosecant squared-like power patterns in the vertical plane to account for free space attenuation, should also concentrate radiated energy bellow the horizon line for reduced interference. One such configuration, explored in [1], involved a nodal station comprising up to four shaped offset reflector antennas for quadrant sectors coverage, with substantial design effort aimed at properly modeling the reflector surfaces [2]. Alternatively, a compact configuration employing a single circularly symmetrical shaped reflector surface fed by an axial horn, has been investigated in [3]. A specific design of the latter configuration is further explored herein with a view towards evidencing the benefit of a strictly numerical analysis tool such as the Method of Moments (MoM) for both reflector and feed structures, as compared to the more conventional optical (geometrical and physical) route.

Antenna design and analysis

One of the antenna configurations considered in [3] comprised a design where the feed points towards the zenith, as illustrated in Fig.1, and both feed design and reflector synthesis efforts were aimed at reducing spillover energy above the horizon line and back-scattered feed interference with antenna radiation pattern bellow (towards main coverage area) that line. A coaxial conical horn was employed due to its ability of radiating an omnidirectional azimuthal pattern and geometrical parameters were chosen so as to yield a good compromise between spillover and feed sidelobe levels; the influence of feed back-scattered energy was reduced by introducing a corrugated flange in the horn aperture. An initial Geometrical-Optics (GO) synthesis procedure for the reflector surface was implemented via simultaneous solution of Snell's law of reflection and the principle of energy conservation for the prescribed (cosecant-

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squared) far field antenna radiation pattern in the vertical plane, while also checking for avoidance of reflected ray blockage by the reflector surface itself. A Physical-Optics (PO) synthesis procedure, involving the minimization of an objective function descriptive of the difference between PO-obtained and specified power patterns in the main coverage, then followed.

The above design has been further explored by examining its outcome via MoM, a more rigorous analysis tool than that provided by conventional integration of PO induced currents and, therefore, widely accepted as a reference solution for scattering problems. Moreover, feed radiation, which, in order to account for near-field characteristics as well as aperture flange effects, had previously been obtained through implementation of a spherical harmonics expansion of measured data pertaining to a constructed feed prototype, has also been attained by making use of MoM. Fig. 2 illustrates the comparison of measured and MoM-obtained feed patterns, thus evidencing the adequacy of the latter as no meaningful difference between curves is perceived for the angular sector within which the reflector surface is illuminated; flange field suppressing effects as well as those pertaining to return (incoming reflection from sinthesized surface) losses is also properly accommodated by MoM analysis as expected.

In fact, one is now bearer of a powerful analysis tool capable of also rendering available the influence of several mechanisms of physical interaction between feed and reflector structures, as governed by primary and subsequent antenna field propagation. Antenna radiation patterns for the central (specified cosecant-squared) synthesis frequency shown in Fig.3 reveal a good agreement between MoM and PO results up to a certain observation (from horizon line) angle within the main coverage area. Beyond that, or above the horizon, backscattering and/or spillover effects, as well as second-order interaction-oriented interferences are handled more precisely by the MoM, yielding, as expected, the displayed differences. Work in progress, motivated by the present findings, will exercise the insertion of MoM in the synthesis step itself as a means of automating a precision oriented design procedure where localized (optimized) surface shaping efforts may be enforced via an adequate treatment of subsets of corresponding (MoM) impedance matrices.

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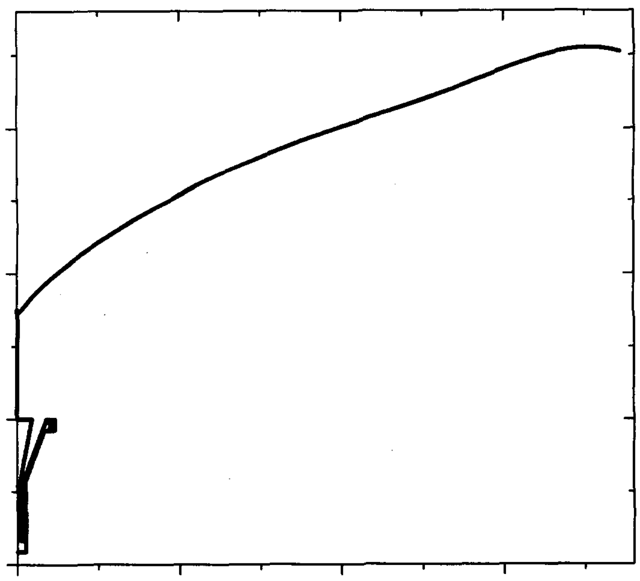

Figure 1 - Antenna Configuration

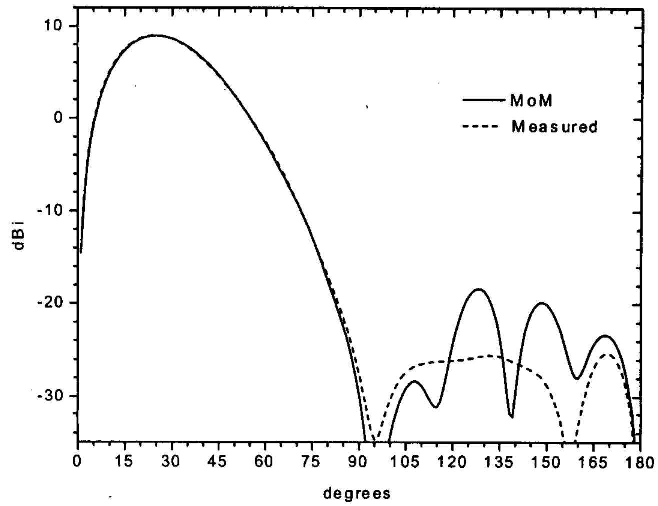

Figure 2 – Feed Radiation Pattern

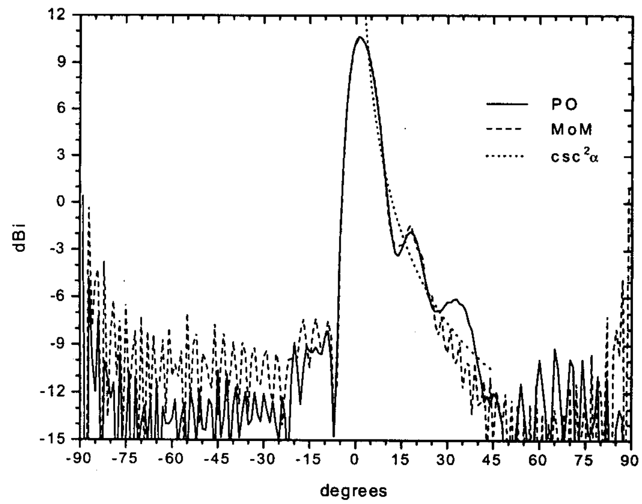

Figure 3 – Antenna Radiation Pattern