On the Modelling of Antenna Pattern Performance Using Equivalent Source Distributions for Vehicle Antenna Placement Engineering

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It is well-known that when an antenna is mounted on a complex platform (eg. ship; aircraft; land-vehicle) its radiation patterns are altered by the presence of the platform. Much effort may be needed to model the effect of the platform in order to determine a suitable location for the antenna so that its pattern performance will not be so distorted as to render it inadequate for its intended system function. The use of computational electromagnetics (CEM) or asymptotic methods such as the uniform geometrical theory of diffraction (UTD), has over the past 30 years made theoretical trade-off studies of platform-based antennas possible and (almost) routine. In most instances, the modelling of the platform itself is computationally taxing. Fortunately, detailed modelling of the actual antenna is not needed if only pattern effects are of interest (as opposed to input/output port return loss, and coupling to other antennas). Thus equivalent source distributions have been successfully used to emulate actual antennas in such placement modelling applications for many years (eg. Y.T.Lo & S.W.Lee, Edits., *Antenna Handbook*, Chap.20, Van Nostrand Reinhold, 1988).

As with many things in engineering, once a new tool becomes established the demands on the technique are steadily tightened in attempts to answer increasingly difficult technical questions. In the case of on-platform antenna placement studies (assuming platform details are being properly modelled) this has resulted in queries as to how precise the equivalent-source modelling of the target antenna radiation patterns can be, and needs to be. Any response to the latter questions must consider not only the theoretical advances that have occurred, but also the significant improvement in the information forthcoming from antenna measurement systems. Numerically-based pattern synthesis methods of great flexibility are now available that can be used for equivalent-source synthesis of a wide variety of antenna patterns. On the measurement side, many antennas are now being tested in spherical near-field (SNF) measurement facilities. The resulting spherical wave coefficients could be used directly with the CEM model of the platform (a capability available in some commercial electromagnetic simulation codes). However, in many cases such detailed measurement information is withheld by suppliers for proprietary reasons, or direct use of such spherical wave coefficients might for some other reason not be suitable. If a given antenna has specially shaped radiation pattern, the pattern synthesis methods referred to earlier remain suitable. But these require some form of “warm start”, that could be provided by back-projection of SNF data onto the plane over which the equivalent-source is assumed to exist, even if spherical wave coefficients cannot be used directly.

This paper discusses, and compares, approaches such as those mentioned above (and others) for setting up equivalent-source models for cosecant pattern antennas (such as surveillance and collision avoidance radars) in antenna placement modelling. Such comparisons, and in some cases the use of a particular method, exist in the open literature for pencil beam patterns in the context of antenna placement, but not (to the best of our knowledge) for cosecant patterns.