A Comparison of 3-D Antenna Measurement with Hybrid Electromagnetic Simulation for Vehicle Antenna Development

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It is a prime concern for antenna designers to determine the impact of antenna placement on a vehicle. Traditionally, antennas are designed in a free-field environment and then placed on a vehicle. The resulting performance can vary significantly from the theoretical predictions. Time honored practices of place-and-test have been used to determine the impact of antenna placement in a search for the best site on the vehicle. This is time consuming and consequently expensive. Rather, it would be desirable to predict installed performance using a numerical model *a priori* to testing. This raises the question: "How good is the agreement between predictions and actual test data in terms of commercially meaningful metrics?"

A good comparison of measurement to simulation using Method of Moments (MM) based software has been achieved with a vehicle antenna for the FM band of frequencies ranging from 76-108 MHz. As the customer demand for infotainment in a vehicle rises, so also does the need for an increased number of complex antennas on the vehicle. Clearly, many of these services operate at frequencies greater than 108 MHz. As automakers look to meet these needs while lowering design costs and time, simulation becomes a necessity. Unfortunately, using MM based software can be very expensive in terms of RAM requirements and computing time for higher frequencies. This has led to the development of hybrid methods of simulation. Hybrid methods utilize the accuracy of a MM solution at critical locations such as near the feed point while using other methods elsewhere on the vehicle. Recent developments in simulation have allowed the use of hybrid methods of simulation to reduce the required RAM and computation time while maintaining an acceptable tolerance of error from a full MM solution.

This paper compares measurement to simulation using hybrid methods for a vehicle. An antenna is mounted on a simplified simulation model of a vehicle measuring roughly 3.6 x 1.5 x 1.5 meters. The 3-D radiation pattern and input impedance measurements are taken in an outdoor free-field range facility. These measurements are then compared to a hybrid MM simulation for higher frequencies ultimately up to 1 GHz. The many problems faced while using these hybrid methods and the trade off to taking measurements is discussed.