PLANEWAVE

PADT | Ansys ELITE CHANNEL PARTNER

Pushing the Boundaries of what Antenna Sub-systems can do with PlaneWave

Introduction

Simulating antenna placement in various platforms is crucial for both commercial and defense applications, ranging from consumer devices to aerospace systems. However, designing antennas that can withstand the complexities of real-life scenarios—such as those encountered in space communication—requires sophisticated simulation tools to account for the geometry of the environment and electromagnetic interactions. **This is usually a challenging task due to the geometry size relative to wavelength trade-offs and the complexity of the model geometry.**

Electromagnetic simulation of antenna design and its interaction with the entire system allows designers to evaluate "what-if" real-life scenarios. No matter the sector, simulation is the solution to execute high-performance antenna and platform designs with minimal wasted effort and cost while maximizing performance.

This case study highlights how PlaneWave, a company specializing in RF and antenna systems for space applications, used Ansys HFSS SBR+ to solve a complex challenge involving the multipath effect in lunar communication.

Complexity of RF in Space

PlaneWave, a company founded by ex-Spacex engineers with a lengthy history of designing and manufacturing antennas and RF front ends, needed to estimate the impact of multipath interference on a Direct-to-Earth (DTE) communication link from the South Pole of the Moon. The company produces products that cover a wide breadth and depth of spacecraft applications, such as Telemetry, Tracking & Command (TT&C), Navigation, and Communication.

Given the near-horizontal position of the Earth from that vantage point, multipath effects posed a significant risk to communication efficiency. Existing tools overestimated the multipath effects, leading to over-design and excessive cost. This pushed PlaneWave to seek a more accurate and optimized solution.

With all of this in mind, PlaneWave reached out to local Ansys Elite Channel Partner, PADT, in order to get a better understanding of how these proposed capabilities could be directly applied to their current challenges.

Simulation as a Solution

PlaneWave's CEO, Keyvan Bahadori, a highly experienced Ansys user with more than twenty years of experience under his belt, turned to Ansys HFSS SBR+; a high-frequency electromagnetic simulator designed for complex, large-scale environments.

The software uses shooting and bouncing ray (SBR) techniques, integrated with advanced diffraction physics like the uniform theory of diffraction (UTD) and physical theory of diffraction (PTD), to deliver highly accurate simulation results with minimal computational resources. By importing a ~2km long and ~0.6km wide high-resolution lunar topography map provided by NASA [Fig.1] , PlaneWave was able to perform realistic and precise simulations of the lunar surface. Multicore CPU, message passing interface (MPI) for multi-system clusters, and graphic processing unit (GPU) acceleration features enable significant analysis time reduction. The HFSS material definition module was used to assign appropriate electric parameters for the surface model as well.

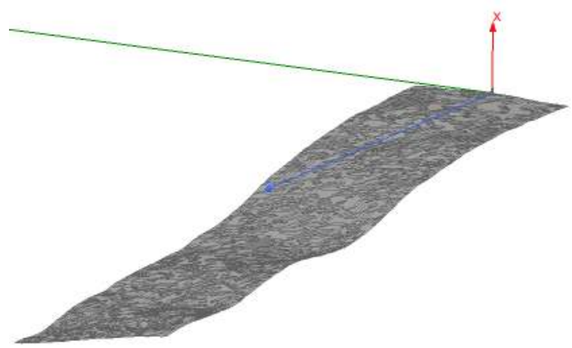

Fig. 1. Imported High Resolution Surface Model of the Moon (Provided by PlaneWave)

Accurate Results, faster than ever

The SBR simulation results in Figure 2, for the X-band frequency, provided much more accurate predictions of multipath effects compared to earlier models. This allowed PlaneWave to explore various antenna configurations and minimize the impact of multipath interference by tweaking parameters such as attitude and beamwidth. With the support of PADT, PlaneWave also leveraged other advanced features in HFSS, such as vacuum multipaction analysis, to predict and mitigate potential risks in the space environment. This allowed them to identify potential problems early on in the design process.

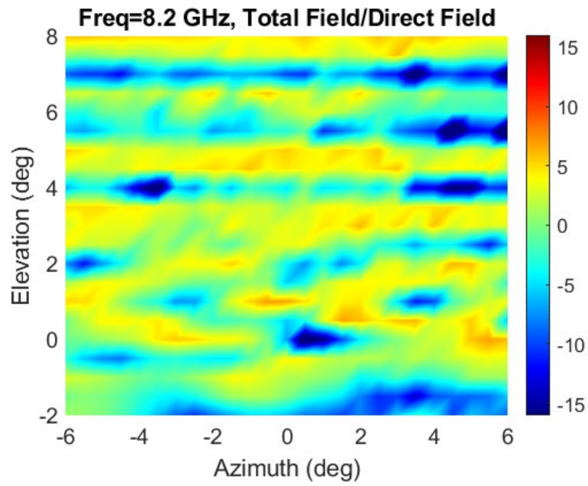

Fig. 2. Multipath effect on lunar communication from Moon South pole at X-band (Provided by PlaneWave)

PADT also helped PlaneWave get familiar with HFSS' impressive finite antenna array simulation capabilities, including the Finite Array Beam toolkit that automatically sets up array beam scanning for phased array antennas.

The Ansys Electronics Desktop software suite includes many tools that can co-simulate with HFSS. PlaneWave worked with PADT to learn how to use the Ansys Circuit solver in conjunction with HFSS to quickly design impedance-matching networks for their microwave components.

Conclusion

Thanks to Ansys HFSS SBR+ and PADT support team, PlaneWave now has a powerful tool for simulating antenna performance in the challenging environments of space. The accurate and time-sensitive results have not only improved the design process for lunar communication systems but also opened up new opportunities to refine their other aerospace projects.

Ansys simulation capabilities have become the benchmark for validating antenna performance in future developments.

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