Simulation Tools Prevent Signal Interference on Spacecraft

NASA Technology

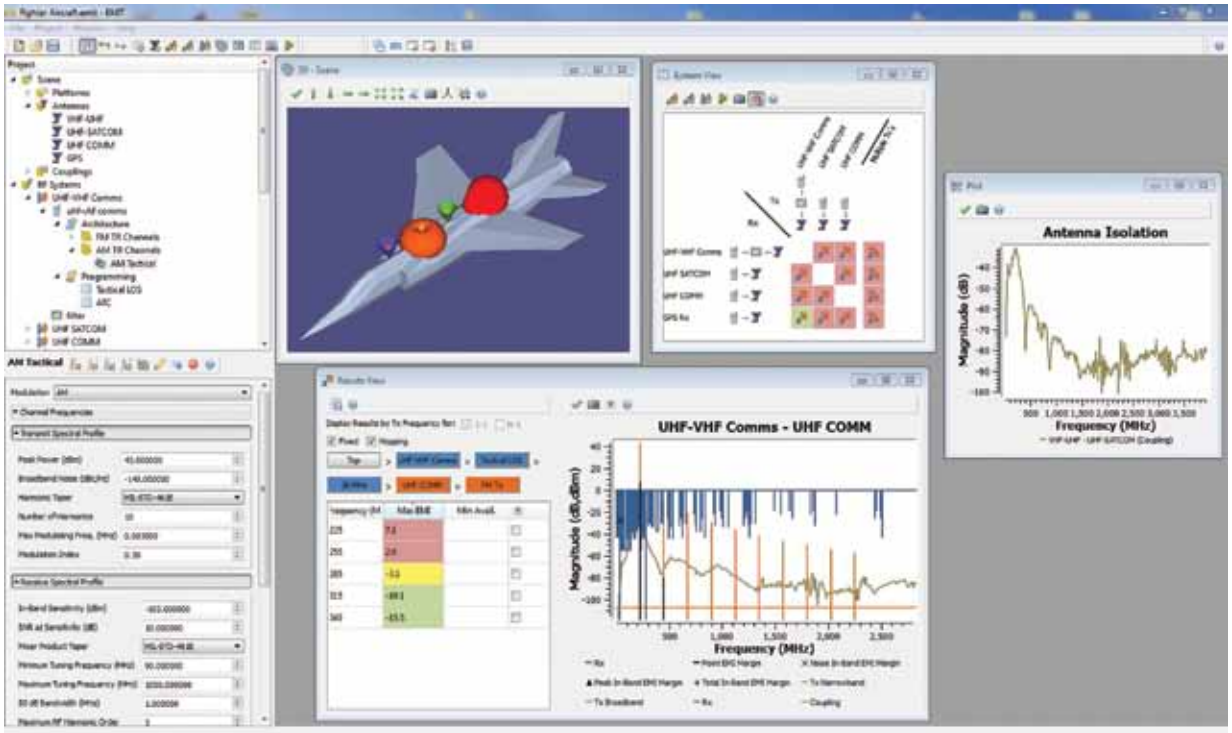
Launching a satellite into space requires painstaking preparation, not only to make sure that a multitude of technologies are functioning, but also to ensure that critical components are working together in unison. A great example: the communication systems onboard satellites and the rockets used to launch them.

A number of receivers and transmitters are installed into both satellites and rockets so that engineers on Earth can use radio signals to track and control their every movement and function and troubleshoot problems that may arise during ascent. Once securely in orbit, satellites also send data back to Earth for telecommunications and scientific research.

But having a smorgasbord of equipment sending and receiving radio signals within close proximity causes cosite interference: transmitters meddle with the signals being sent to receiving systems, preventing critical communications from reaching their desired targets. If the signal interference is severe enough, a launch mission could fail. So before installing radio frequency (RF) systems, NASA engineers use simulation software to analyze and correct for any interference that would occur between a satellite and its launch rocket. They also analyze other RF systems near the launchpad, such as antenna towers and radars, which may also interfere with data transmission.

If the simulator detects the potential for any interference, various measures can be implemented to correct for it. For one, technicians could move antennas to different areas of the spacecraft to reduce the inter-system coupling. Engineers can also engage in frequency planning, which means carefully coordinating when each system operates on specific channels, thereby lessening the chance of interference between devices.

Because there are many systems at play in any launch, and because they all need to be accounted for, staging a computer simulation can be tedious and time-consuming. In the past it was even more painstaking because, in many cases, specifications for each RF system had to be manually inputted before running each individual analysis. That is, until engineers at the Launch Services Program at Kennedy Space Center collaborated with the private sector to customize software that would streamline the work.



Delcross' EMIT interference simulation software analyzes for cosite interference between different radio frequency systems.

Technology Transfer

In March 2012 Kennedy entered into a Small Business Innovation Research (SBIR) contract with Champaign, Illinois-based Delcross Technologies LLC to enhance the company's EMIT interference simulation software by developing a more robust library of RF systems.

The company had already created such a library for EMIT, which allows users to simply drag and drop whichever equipment is being considered for a rocket and satellite. Once all the prospective RF systems are in place, the software assesses whether there is any potential for interference between components. With the new contract, the goal was to increase the number of equipment items to choose from by adding a number of key systems of particular interest to NASA engineers, which would further lessen the amount of time needed to manually input specifications into the program.

Filling out the library, says Dr. Fred German, the company's lead strategist for product development and senior scientist, was accomplished by tapping every publicly available source for all the data parameters needed, such as start and stop frequencies and channel spacing,

to identify specific radios. “We’ve become quite adept at ferreting data out,” he says.

They were so adept that by January 2013, Delcross completed the contract, having added hundreds of RF system specifications to the EMIT library.

Having a more robust library, says Kennedy flight analyst Dr. Gabriel Vazquez, will be an enormous help to the Launch Services Program. “Once you have some experience with the software, it can help tremendously,” he says. “And another thing that gives EMIT a lot of potential is that it takes into account harmonics magnitudes and other factors that aren’t always taken into account during a quick intermodulation analysis.”

Vazquez also stresses that, throughout the project, NASA never divulged any third-party or proprietary information for any of the RF systems it had on hand. “We only provided Delcross with the make and model of the transmitters and receivers, and they worked with what they had,” he says. “And in our opinion they succeeded in getting enough relevant information for the successful completion of the SBIR objectives.”

Benefits

For Delcross Technologies, the collaboration has also been a success. Since the new library was introduced, sales to the US military, telecommunications companies, and other outfits whose success depends on clear radio transmission signals, have increased. German says it is because creating the RF system models is one of the biggest bottlenecks in using a simulation program like EMIT. The database developed under the project goes a long way to removing that bottleneck by providing ready-to-go models, which can shave days off the analysis time.

Sometimes it takes a partnership with an agency like NASA to move a technology forward. “Support for the continued development of EMIT allows Delcross to maintain a strong team of developers to ensure the ongoing improvement to future releases of EMIT,” German says. “Without these collaborations, Delcross would not be able to maintain the development team necessary to ensure regular, high-quality releases of our software tools.” ❖

EMIT™ is a trademark of Delcross Technologies LLC.

NASA uses interference simulation software to prepare for launches. Here, NASA's Mars Science Laboratory spacecraft, sealed inside its payload fairing atop the United Launch Alliance Atlas V rocket, launches from Cape Canaveral Air Force Station in Florida.