Sustaining Air Force Space Systems

New Metrics Show How Investments Affect Operational Performance

As space systems age or operate beyond their planned life spans, the U.S. Air Force Space Command (AFSPC) needs to understand how budgeting for the maintenance and sustainment of the ground segments under its purview affects the performance of their associated space systems. Current metrics for monitoring the performance of the systems' ground segments need to be reexamined so that the links between budgetary investments in maintenance and sustainment and overall space system operational performance can be quantified. The RAND Corporation's Project AIR FORCE (PAF) developed a framework for analysis that predicts how well a space system will perform its operational mission, given various levels of maintenance resources allocated. The framework includes these key features:

- Metrics for the performance of maintenance and sustainment efforts that are defined from the perspective of the user—that is, in terms of operational performance.
- A pilot model developed for one system that illustrates how to link the maintenance and sustainment metrics with operational performance metrics.
- A systemwide view provided by the operational metrics that identifies which components of the system are most important for further data collection. This view also provides an analysis of the frequencies of critical failures and times to restore function.
- Cost data related to minimizing the frequencies of critical failures and improving times to restore function.

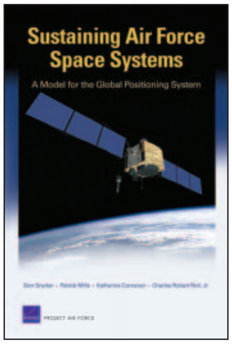
This top-down approach places the components of the systems' ground segments in context and indicates which components are most problematic to the overall system and therefore deserving of the highest level of attention in failure and repair data-collection and analysis. This framework is in contrast to models that analyze the failure rates of each of the many components in the ground segments, along with the time required to restore function. The latter approach alone does not capture the full behavior of the system or predict the full cost of ensuring consistent and accurate service to users.

To illustrate this framework, PAF focused on the Air Force's Global Positioning System (GPS), a satellite-based system that provides accurate location and timing data for military and civilian users. For GPS, the appropriate measure of operational performance is how well the system provides location and timing data. Specifically, the analysis explored the metric of how much variance there is over time in the location and time estimates the system provides to users. PAF examined the effect of the reliability of one subsystem of the GPS ground segment, the ground antennas, on that performance metric. The antennas send updates from the ground monitoring stations and Master Control Station to the system's satellites and are thus critical for maintaining the accuracy of the system. PAF determined predictive curves for how the mean time between critical failures and mean time to restore function of the GPS ground antennas quantitatively determine the accuracy of a user's GPS location estimate.

Next steps would be to expand the work to the remaining subsystems of the GPS ground segment and to link the PAF pilot framework with ongoing component-level work at AFSPC. The result should be a complete, predictive model of GPS that reveals how dollars allocated in the budget affect overall performance of the system. ■

This product is part of the RAND Corporation research brief series. RAND research briefs present policy-oriented summaries of published, peer-reviewed documents.

Corporate Headquarters
1776 Main Street
P.O. Box 2138
Santa Monica, California 90407-2138
TEL 310.393.0411
FAX 310.393.4818



This research brief describes work done for RAND Project AIR FORCE and documented in *Sustaining Air Force Space Systems: A Model for the Global Positioning System*, by Don Snyder, Patrick Mills, Katherine Comanor, and Charles Robert Roll, Jr., MG-525-AF (available at http://www.rand.org/pubs/monographs/MG525/), 2007, 66 pp., ISBN: 978-0-8330-4044-2. The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors. **RAND**® is a registered trademark.

RAND Offices
Santa Monica, CA • Washington, DC • Pittsburgh, PA • Jackson, MS • Cambridge, UK • Doha, QA