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**The Use of EADSIM and TPT for Modeling
System Integration Test 97**

by

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A Review by

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REVIEW

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The Use of EADSIM and TPT for Modeling System Integration Test 97

by

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Live-fire missile tests have become increasingly more expensive. The use of models and simulations (M&S) prior to a test helps to ensure that the information obtained from a live test can be maximized. Additionally, the user of M&S can gain insight into test objectives by predicting results, vary asset location to maximize objectives, and verify planned events against range requirements. This can help lower expenses by reducing the number of tests needed.

This report describes the use of two simulations, Extended Air Defense Simulation (EADSIM) and Theater Planning Tool (TPT), to predict the performance of the System Integration Test (SIT)-97. The System Integration Test (SIT)-97 is to be conducted along with the Willow Dune and Theater Missile Defense (TMD) Critical Measurements Program missile test programs. The Ballistic Missile Defense Organization (BMDO) is sponsoring this TMD Family of Systems "live-fire" missile at the Kwajalein Missile Range. The purpose of the SIT is to conduct a series of interoperability experiments to demonstrate the capability to pass early warning information to TMD Active Defense forces and demonstrate the capability for TMD forces to share data among themselves. In addition, this SIT will establish policy and procedures for conducting future SITs.

The EADSIM and TPT simulations were chosen because they are both capable of simulating Theater Ballistic Missiles (TBMs) and defense systems. The radar and weapon data for both simulations are available along with trained operators for determining pre-test predictions.

EADSIM is a model that is used to analyze TMD scenarios involving air and missile warfare as well as Command and Control decision processes. Communication among the

platforms is modeled on a message-by-message basis at the functional level. EADSIM has the ability to perform Monte Carlo simulations of given scenarios. Post-processing and playback utilities are used to assess and view simulation results. EADSIM does not contain built-in validated radar and weapons parameters. Therefore, TMD-Cost and Operational Effectiveness Analysis data provides values developed by individual Services characterizing their system capabilities.

TPT provides joint forces laydown capability that uses a point-and-click method for placing systems. It quickly demonstrates potential deficiencies in defense placements based on any variety of TBM and cruise missile threats. TPT is a medium-fidelity tool with built-in radar and weapon architectures to model any TMD scenario. It uses Kalman filtering for high fidelity tracking. It is also capable of performing engagement planning and simple discrimination, modeling UV/Visible/IR target signatures, natural, nuclear environments, and evaluating the resolution of closely spaced objects. TPT provides a time-step display of the trajectory with radar volumes, tracking beams, and intercepts.

The EADSIM and TPT model runs were set up with the same input values where possible. The same asset location, launch and impact point was used for each scenario; however, the two simulations used different radar and weapons data. The TPT model data was provided by the Joint National Test Facility and the EADSIM model data was provided by BMDO. Both simulations used a standard 1962 model atmospheric day and both scenarios assumed 100% message transmission success.

The primary data collected from the simulation runs were detection times for the Early Warning System (EWS) and track initiation times for AEGIS, PATRIOT and AN/TPS-59 radars. For each simulation, EWS provided the initial detection followed by AEGIS, AN/TPS-59, and then PATRIOT. When the EWS detection time, PATRIOT track time, and the intercept time were compared between the two models, the differences were less than 5 percent. However, AEGIS and TPS-59 provided an earlier detection in EADSIM than TPT, therefore, it was decided to run the EADSIM parameters in TPT and vice versa. The EWS times were not changed since they were similar for each model.

The AEGIS and the AN/TPS-59 radar demonstrated improved detection times with TPT using EADSIM data values and delayed detection times with EADSIM using TPT data values. However, PATRIOT improved using TPT values with EADSIM and no significant difference with TPT using EADSIM values. This was due to the differences in the input parameters for each of the models. For instance, EADSIM used a constant RCS independent of the aspect angle of the target, whereas, TPT used a look-up table for RCS with respect to the angle of the missile to the radar source. The simulations also differed in the time at which a track was reported. EADSIM is capable of reporting a track based on a first detection "hit", whereas, TPT required a minimum of four "hits" before the radar would report a track. This equated to three more seconds in acquisition time. The differences in acquisition times could be attributed to RCS, antenna losses, and potential differences in modeling algorithms.

After the live-fire test is completed, the data from each sensor will be compared to the predicted data from the simulations. Based on the actual data, modifications to the simulations input data will be studied to increase the accuracy of each simulation.

In conclusion, the use of models and simulations can provide insight into what the results of an actual live-fire missile test will be. The authors concluded that for the best results, input data for any simulation should be obtained from the specific Service that uses the simulation. This would be helpful in predicting the simulation's results. The authors also concluded that for this type of analysis to be more useful, it requires the use of higher fidelity simulations and radar and weapons data that better represents the current and projected capability. EADSIM and TPT provide the basic information about SIT-97 and demonstrated no major problems with the test architecture. Radar positions can detect the targets and missile intercept is possible.

In summary, this paper is recommended to anyone who is considering using M&S to simulate a live test. It is well written and has a good description of what the users had to go through in order to make the simulations work with their tests. This paper is also a good example of how to use EADSIM and/or TPT to model a live-fire test.