THE NEXT GENERATION OF TELEMETERING REQUIREMENTS FOR THE AIR FORCE SEEK EAGLE PROGRAM

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ABSTRACT

The Air Force SEEK EAGLE Office (AFSEO) was chartered by the Secretary of the Air Force in December 1987. The mission of the AFSEO is to provide the United States Air Force increased combat capability through central management of the aircraft-stores certification process and provide in-house engineering and operations research capabilities. Additionally, the AFSEO is required to ensure the future viability of the aircraft-stores organic in-house capability with the insertion of evolving technologies.

To accomplish this mission, the AFSEO employs all phases of the test process; from Digital Model and Simulation (DMS) to Open Air Range (OAR) flight tests. The AFSEO desires to prepare for the future DoD environment, and minimize the cost of developing its products that require advanced sensors and telemetry capability. For a number of years, a mainstay in the process has been instrumented aircraft. These aircraft were specially instrumented to support the mission of AFSEO. Similarly, stores were instrumented to obtain environmental data such as loads and vibration.

With the rising cost of instrumentation and the national DoD trend to reduce the cost of development and maintenance of instrumentation, a new method will need to be found.

Several advanced concepts in ground and airborne instrumentation at Eglin AFB are needed to support the mission of the AFSEO. These include a new generation of telemetry devices, sensors, and data acquisition components to provide rapid and cost

effective instrumentation of test aircraft, stores, and suspension equipment. The new generation telemetry will provide integrated circuitry with "peel and stick" subminiature telemetry sensors. These telemetry sensors will provide flutter and structural loads data for aircraft-stores combinations. In conjunction with the telemetry sensors, advanced aircraft platform instrumentation will be needed to match precision flight mechanics to the spatial telemetry measurements for stress, strain, and dynamic activity of stores.

KEY WORDS

Digital Model and Simulation (DMS), Open Air Range (OAR), Spatial Telemetry Measurements, Data Measurement Sensors, Simulation-Based Acquisition, Total System Performance Responsibility (TSPR)

INTRODUCTION

The Air Force SEEK EAGLE Office (AFSEO) provides data, analysis, and engineering judgement which is used to certify stores on USAF aircraft. AFSEO uses a full spectrum of telemetry to support all phases of the test process; from digital modeling and simulation (DMS) to open air ranges (OAR) flight tests as depicted in Figure 1. The work of AFSEO can be categorized as compatibility engineering, ballistics, and safe escape. Within these categories, there are eight disciplines used by AFSEO. These are Fit and Function, Electromagnetic Compatibility/Electromagnetic Interference, Flutter, Loads, Flying Qualities, Store Separation, Ballistics, and Safe Escape: Each of these disciplines needs sensor measurements and telemetry to evaluate their safety-of-flight and functional capability.

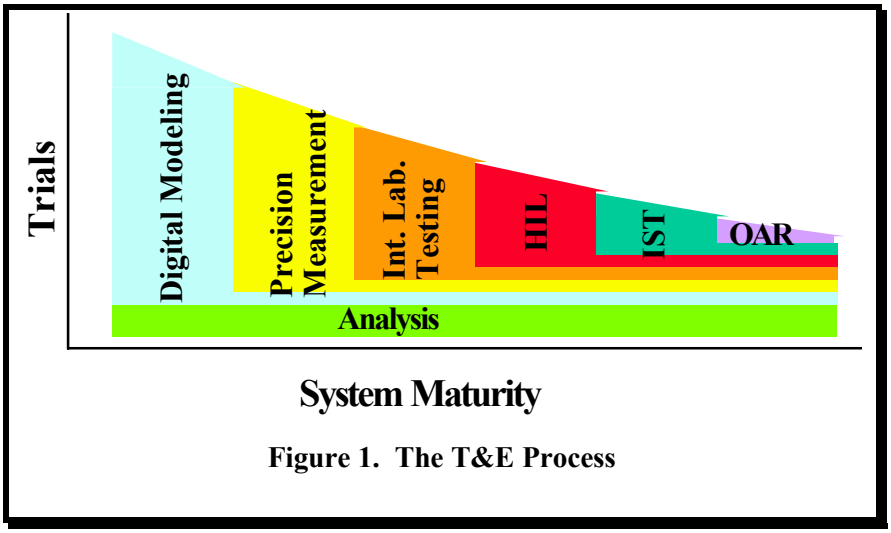

Figure 1. The T&E Process

The AFSEO desires to optimize the process of data measurement sensors and transmitting this data via telemetry streams, for pre-test calibration and real time post-test analysis. Additionally, AFSEO needs to minimize the cost and maximize the confidence for future products. For a number of years, a mainstay in the certification process has been instrumented aircraft. These aircraft were specially instrumented to support the mission of AFSEO. Similarly, stores were instrumented to obtain environmental data such as loads and vibrations. Finally, range instrumentation, such as radar and

cinetheodolites, were used to generate time, space, and position information (TSPI) necessary to evaluate aircraft store trajectories. With the rising cost of instrumentation and the national DOD trend to reduce the cost and maintenance of instrumentation, a new method needs to be found.

In addition to the requirements discussed above, there are several "external" pressures that will affect the way AFSEO does business.

Acquisition Reform. This process has already shown major "savings" by simply reducing the number of stores available for testing. This was done largely through the assumption of improved use of digital simulation. For example, a typical air- launched missile program would expend approximately 100 test missiles in the 80s to reach milestone 3. To reach the same milestone today, less than 20 launches are planned by program offices. This major reduction in the number of available stores for open air testing will greatly affect AFSEO's ability in the future.

Increased Complexity of Aircraft and Stores. There is simply no reasonable way, with today's complex aircraft and stores, to test every permutation. There will have to be increased reliance on digital modeling and simulation and ground tests, in order to focus the few open-air flight tests that will be possible.

Validation of Digital Modeling and Simulation Tools. With increased reliance on digital modeling and simulation, will come increased requirements to generate data in order to validate these codes. This will significantly increase the number of parameters which will have to be measured on any given flight test.

Real Time Evaluation of Data. Because of reduced number of flight tests available, more will have to be accomplished during each test to evaluate the same environment. This means that increased reliance on real time evaluation of test results. This will further increase the number of parameters being measured, as well as the requirements for high speed computing.

Frequency Spectrum Selloff. The auctioning off of the frequency spectrum will continue to decrease the available spectrum for test and evaluation (T&E).

CORE COMPETENCIES FOR THE AIR FORCE SEEK EAGLE OFFICE

Compatibility engineering encompasses a variety of areas required during the aircraft–stores certification process, which includes engineering analyses, computer simulations, wind tunnel tests, computerized physical fits, and flight tests. Ballistics and safe escape analysis involves weapon delivery, accuracy verification, and computing safe fuze

arming times and distances required to avoid weapon fragments. These are critical/necessary abilities that are directly related to successful mission accomplishment.

CURRENT ENVIRONMENT

Currently, the digital modeling and simulation (DMS) capability of AFSEO is used to assess the ability of a store to interface with an aircraft, without adverse effect on either. Thus, it is focused on stores and aircraft at or beyond milestone 3. This focus means that the hardware is available and this hardware is usually used as the final validation of the DMS and demonstration of the capability. Using these DMS capabilities at an earlier phase of the acquisition process is desirable under simulation-based acquisition (SBA), but will require significant effort.

Because of the use of flight testing for final validation of the DMS and demonstration of the capability as shown in Figure 2, it is necessary to instrument these flight tests to obtain data necessary for validation and/or evaluation. Such data as absolute TSPI, relative TSPI, dynamic environment, flight environment, stress/strain environment, and handling qualities are some of the data required for the various DMSs. These requirements have been met by using instrumented (internal, and therefore, intrusive) aircraft and stores, and heavily instrumented test ranges.

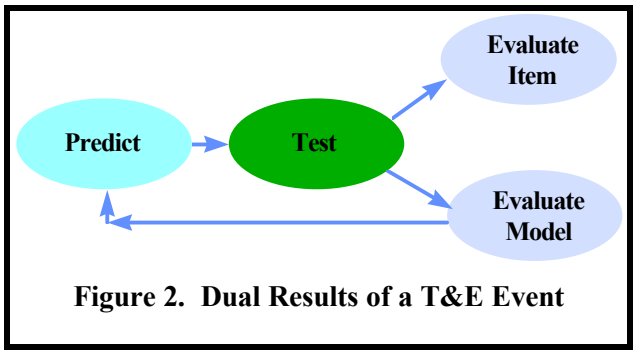

Figure 2. Dual Results of a T&E Event

Thus, the current environment involves merging of DMS, wind tunnel tests, and flight tests in a mixture which supports air-to-air and air-to-ground weapon delivery analysis for conventional and nuclear weapons. The AFSEO aircraft stores certification capability is recognized as the most accurate, “hands-on”, certification process used in the joint services. However, most of the DMSs that support this process are legacy codes that are over 20 years old. The process and its supporting infrastructure have been optimized to deal with aircraft and stores at or beyond milestone 3. The DMSs are thus engineering tools that require significant engineering judgement in their application.

FUTURE ENVIRONMENT

Looking forward 5 to 10 years we can define a number of attributes/drivers for that future environment. Each of these attributes and how they will affect the world of telemetry will now be discussed. For purposes of this discussion, telemetry will include not only the receiver, transmitter, or transceiver, but also the sensors.

Increased reliance on DMS. This attribute is a common thread through all the others. It is the cornerstone of the future AFSEO environment. It assumes that our ability to predict an engineering event will continue to improve exponentially. However, in order to achieve this improvement, significant quantities of data are going to have to be obtained, mostly from flight tests. This data will be required by AFSEO to validate physics-based models or to generate empirically based models. In other cases, as predictions become more detailed, data necessary to accomplish the validation will have to be of higher fidelity.

Dedicated Flight Tests by Exception Only. This attribute implies that flight testing will only be done if there is no other way to acquire the necessary confidence. Therefore, the flight test will only be accomplished after all ground testing and DMSs have been investigated. There will be tremendous pressure on the test agency to acquire all necessary data that would preclude this flight test from being repeated.

Combined Testing will be Common. Most tests will have multiple purposes and stakeholders. A "super data set", composed of the data sets needed by each of the stake holders, will then have to be acquired for these type tests.

Total System Performance Responsibility (TSPR). With all our weapon systems, both aircraft and munitions, going to the TSPR format, the likelihood of multiple primes being involved in any given test increases. This will add additional stakeholders to each test. As a result, the number of parameters to be measured will probably increase.

Test Aircraft Availability. The number of aircraft dedicated to T&E, will decrease. This will result in an increased use of operational aircraft to conduct T&E.

All-up Testing. The trend will be toward end-to-end testing of a weapon system. This means putting aircraft in an operational environment and launching the weapon against an actual target. This requires the instrumentation on the aircraft and the store to be unobtrusive.

T&E Infrastructure. The T&E infrastructure will be relying more heavily on such things as GPS to generate TSPI data. Use of radars will be limited as well as cinetheodolites. The trend will be toward a more mobile test capability.

Considering all the above attributes, we see that the most probable future will call for small, nonintrusive sensors, coupled to a communications method that is also nonintrusive. This telemetry suite will have to be deployed on operational aircraft as well as T&E aircraft. The sensors will have to be capable of generating data for absolute TSPI, relative TSPI, dynamic environment of the aircraft and store, flight environment, stress/strain environment, and handling qualities among many others.

POTENTIAL SOLUTIONS.

There is a significant amount of ongoing work using subminiature TM, coupled with miniaturized sensors. This work is currently being done through Small Business Innovative Research (SBIR) and Central Test and Evaluation Investment Programs (CTEIP). It is believed that the culmination of these efforts will generate a solution to the problems of the future. A future test (Figure 3) may combine the use of low-power wireless sensors with low to medium- power transceivers to provide accurate environmental measurements of the actual test conditions. Measurements of pressure, attitude, temperature, acceleration and strain could then be correlated with the DMSs and used for validation purposes. It may well be that a chase aircraft will have to be used in order to capture data from small transmitters. This data could then be encrypted and retransmitted to a control site. However, even with these potential problems, the solution appears to be a valid one given the advances in both miniaturization and telemetry technologies.

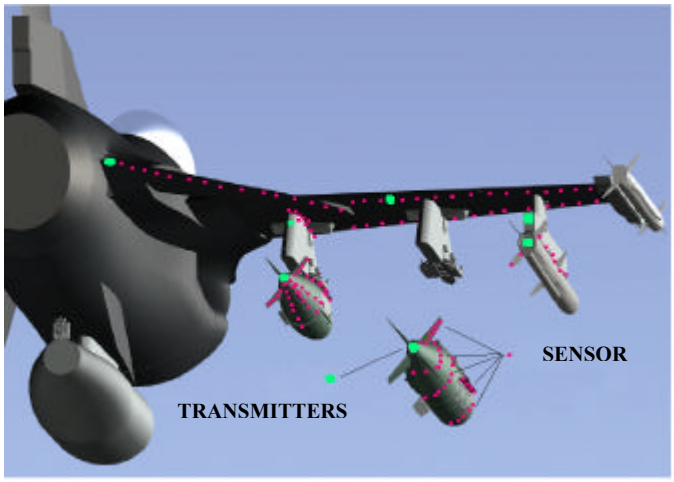

Figure 3. Future Aircraft-Store Test Scenario