ACCREDITATION: WHAT IT IS AND WHAT IT ISN'T

BETH VANN
and DR. KEN KAWANO
AEgis Technologies Group, Inc.
6703 Odyssey Drive, Suite 200
Huntsville, Alabama 35806
bvann@aegisrc.com

JOHN PATE
System Test and Evaluation Directorate,
National Missile Defense Joint Program Office
System Test and Evaluation Directorate (JNT), ISTC Program
PO Box 1500 (Attn: BMDO/JNTS)
Huntsville, Alabama 35807
jpate@hiwaay.net

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ABSTRACT: *The Ballistic Missile Defense Organization (BMDO) Directive 5002 states that accreditation is certification by competent authority that a T&E resource produces realistic, unbiased, credible measurement of specific performance or suitability parameters when operated within a specific domain of scenario and environmental conditions for the examination of a specific test issue.*

It is essential in discussing accreditation, that the object being accredited is uniquely identified. It is also critical that the criteria which must be satisfied for accreditation, be clearly and unambiguously articulated. The formulation of the accreditation criteria must also be traceable to the specific domain of scenario and environmental conditions for the examination of a specific test issue. A clear distinction must also be made between the credible and unbiased reporting of the performance vis a vis an evaluation of the quality (goodness/badness) of the performance of a given representation.

By using the National Missile Defense (NMD) Integrated System Test Capability (ISTC) as an instance, this paper describes 1) the development of the accreditation criteria, 2) the identification of caveats and limitations on the use of data collected, 3) the implications of accreditation; and discusses how and why the accreditation process does not assess the performance of the element representations. Accreditation, does declare that the data collected is unbiased and realistic, and the data collected can subsequently be analyzed to assess the performance of the element representations, subject to identified caveats and limitations on the usage of the data obtained.

1.0 Introduction

Using the National Missile Defense (NMD) Integrated System Test Capability (ISTC) as an instance, this paper describes how the ISTC Accreditation effort is compliant with existing policy guidance, and reflects the strategy for Government Accreditation made by the NMD Joint Program Office (JPO).

1.1 Purpose

To elucidate and provoke discussion on the meaning of "Accreditation" in the context of Models and Simulations.

1.2 Overview

This paper describes the 1) development of the accreditation criteria, 2) the identification of caveats and limitations on the use of data collected, and 3) the implications of accreditation based upon experience in the accreditation of the National Missile Defense (NMD) Joint Project Office (JPO) Integrated System Test Capability (ISTC) for use in Integrated Ground Tests (IGTs).

2.0 Background

2.1 What is the NMD?

2.1.1 NMD Sponsor

The NMD JPO of the Ballistic Missile Defense Office (BMDO) is managing the Program. The Lead System Integrator (LSI) has the responsibility of managing the development and integration of the NMD Elements to deliver the NMD System. In addition, the LSI is responsible for the execution of the Developmental Test and Evaluation (DT&E) and System Verification programs. In support of these programs, the LSI will use simulation for Analysis, Design Verification, Integration, and Test & Evaluation (T&E).

2.1.2 NMD Description

The NMD is the integration of weapon, sensor, battle management, command, control and communications systems designed to provide protection against limited ballistic missile attacks targeted at the United States, including Alaska and Hawaii. The National Ballistic Missile Defense (BMD) mission provides surveillance, warning, cueing, engagement, interception and negation of threat objects prior to impact on US targets. This capability is achieved through integration of the NMD system with the Integrated Tactical Warning and Attack Assessment (ITW/AA) network to execute the BMD mission.

The NMD system is composed of space-based and ground-based sensors, ground-based interceptors, and an associated Battle Management/Command, Control and Communications (BMC3) capability. The NMD mission functions include detection, discrimination, and tracking; logistics and readiness; and collateral and theater support operations.

The NMD deployment is an evolutionary process based on an initial capability, known as Capability 1. The NMD system architecture employs the following elements:

- Ground-Based Interceptor (GBI)
- Ground-Based Radar-Prototype (GBR-P) (Prototypical of the objective X-Band Radar (XBR))
- Battle Management/Command, Control and Communications (BMC3) including In-Flight Interceptor Communications System (IFICS)
- Upgraded Early Warning Radar (UEWR)
- Defense Support Program (DSP)
- Space-Based Infrared System (SBIRS)

The Deployment Readiness Program incrementally develops interceptor, sensor and BMC3 technology. As the technology matures, the system capability correspondingly improves.

2.1.3 NMD Approach

The NMD System is a Simulation Based Acquisition (SBA). Simulation is required since it is not feasible to perform real world tests to answer many of the performance questions concerning a possible NMD System. Alternative architectures and Elements will be evaluated using accredited simulations anchored to actual test data. Since the simulations will be extrapolations of the models of the objective system, verification and validation of the simulation and models provides the confidence needed to accept the simulation results.

2.2 What is the ISTC?

2.2.1 ISTC Description

The ISTC is a NMD system-level, Hardware-in-the-Loop (HWIL), Software-in-the-Loop (SWIL) test tool. It is a computer-based system for testing actual NMD element data and signal processors and software in an integrated configuration through the use of simulated environments. The ISTC provides the capability to evaluate the performance of the NMD system, determine the interoperability of the deployed software in the NMD system, and determine the operational suitability of the human interfaces in the NMD system.

To achieve its purpose, the ISTC:

- Provides for the physical incorporation of the actual mission and communications processors of the NMD system,
- Utilizes the actual software that is installed in the mission and communications processors,
- Operates in real-time,
- Drives the NMD system processors with realistic scenarios,
- Subjects the system assets to realistic threat and environment effects in demanding scenarios, and
- Collects data to support post-test system-level performance analysis.

The ISTC has the capability to integrate all of the major components of the NMD system. The test configuration is an accurate representation of individual elements operating in concert, as part of an overall architecture, and its objective is to provide an accurate exercise of the NMD system under realistic stresses that would be encountered in an operational environment. The ISTC is also the only cost-effective means to assess the effects of hostile environments including nuclear effects on the real-time responses of the integrated NMD system's computers.

2.2.2 ISTC Architecture

Individual elements of the NMD system are represented in the ISTC on stand-alone computer stations known as nodes. Each node incorporates actual NMD element mission and communications processors that execute actual element software. The individual element nodes are interconnected by a NMD system communication network driven by real-time system interfaces, and threat and environment input data. The nodes are also connected by separate ISTC networks that control the test equipment. The ISTC supplies the autonomous nodes with simulated threat and environments, natural and man-made, that are consistent for each NMD element in the test scenario.

The ISTC architecture is composed of a Test & Control (T&C) Segment, Global Environment (GE) Segment, System Performance Monitor (SPM) Segment, Element Segments consisting of one or more Element nodes, and an External Interface (I/F) Driver Segment. These segments and nodes are tied together via a Tactical Communications Network and Test Networks.

The following NMD elements are currently represented within ISTC - the NMD BMC3, GBR-P, UEWR, GBI, and SBIRS. These element representations are on the development path to the objective system.

2.3 ISTC Accreditation History

An integrated government – contractor Accreditation team was instrumental in the development of the capstone accreditation strategy and supporting assessment processes and recommendations that led to the formal accreditation of the ISTC for three major NMD test and evaluation (T&E) milestone Integrated Ground Tests (IGT) Three, Four and Five. These processes and the tests they supported are on the critical path of the simulation based acquisition process supporting the acquisition and initial deployment decision for a National Missile Defense System.

3.0 The Accreditation Process

Having asserted that accreditation has been accomplished, it would be beneficial to examine what is accreditation and how accreditation was accomplished in the context of the Integrated System Test Capability (ISTC) for use in Integrated Ground Tests (IGTs).

3.1 What is Accreditation?

The Ballistic Missile Defense Organization (BMDO) Directive 5002 states that "accreditation is certification by competent authority that a T&E

resource produces realistic, unbiased, credible measurement of specific performance or suitability parameters when operated within a specific domain of scenario and environmental conditions for the examination of a specific test issue."

The crux of the process called "accreditation" is to insure that the given simulation "produces realistic, unbiased, credible measurements of specific performance or suitability parameters" and in those instances where such is not the case, to specifically identify the limitations on the use of data and analysis produced by the given simulation. Activities and analysis must be undertaken to define the degree to which the data produced by the specified simulation represents a true measure of the individual and combined performance of the various components of the simulation as a whole. Accreditation is not an assessment of the quality of the performance of the simulation nor is it a measure of the goodness/badness of the individual integrated components. Accreditation, properly executed, provides a basis whereby one can establish the level of confidence (believability) in the results of a simulation --- both in terms of the data collected (measurements) and conclusions reached as a result of the analysis (performance) of the data. Accreditation by its very nature, defines the bounds on the appropriate use of the data and conclusions from a given simulation.

It must be recognized that M&S are abstractions and may not duplicate actual observed phenomena but rather provide an approximation of observed behavior. Therefore, accreditation procedures are the formal process by which the M&S application sponsor gains confidence in the model and simulation for its intended purpose. Any use of the results of an M&S is often considered de facto accreditation and the M&S application sponsor will be held responsible for the results of an M&S that has not been formally accredited. However, the preferred method of accreditation involves a determination that the M&S is appropriate before use.

3.2 Development of the Accreditation Process

It is essential in discussing accreditation, that the object being accredited is uniquely identified. It is also critical that the criteria which must be satisfied for accreditation, be clearly and unambiguously articulated. The formulation of the accreditation criteria must also be traceable to the specific domain of scenario and environmental conditions for the examination of a specific test issue. A clear distinction must also be made between the credible and unbiased reporting of the performance vis a vis an evaluation of the quality (goodness/badness) of the performance of a given representation.

To accomplish the ISTC accreditation, the team broke new ground in establishing a detailed accreditation planning and execution process to develop meaningful criteria consistent with applicable directives and sound engineering judgement. The team formalized the process in the publication of an overarching Capstone Accreditation Plan upon which subsequent Detailed Accreditation Plans for each specific integrated ground test were derived. These accreditation documents, and the incorporated processes, set a high standard and will serve as a basis for future NMD ISTC and test resource accreditation planning.

Efforts included:

- Identification of the Accreditation Authority. (Normally the sponsor of the simulation)
- Clarifying the specific domain of scenario and environmental conditions. (This was specified in the Detailed Test Plan associated with the simulation under consideration.)
- Clarifying the specific test issue(s). (These were derived from the stated Test Objectives and Test Requirements cited in the Detailed Test Plan and Technical Interface Control Document.)
- Identifying and tracking the given test resources (Basic resources --- element representation, framework, common test environments, etc --- were specified in the Detailed Test Plan.)

It is critical to note that a given NMD JPO ISTC IGT is continually a work in progress. Thus it is essential that changes in scenario and environmental condition, specific test issues and test resources (changes in Builds, Versions, Revisions, etc.) be constantly monitored. Tracking these changes is mandatory to insure that appropriate verification and validation (V&V) activities, accreditation criteria, data collection efforts and acceptability assessments

are addressing the most current configuration of the test resource to be used in a given test.

3.3 Acceptability Criteria

The accreditation process must answer the question; "Will this M&S meet my objectives?" The M&S application sponsor appoints an accreditation agent to establish a set of acceptability criteria by which to determine the suitability of the M&S for the intended use. These acceptability criteria are unique to each problem and give key insights to potential solutions. Acceptability criteria become a set of standards that a particular M&S must meet to be accredited for a given use. In all cases, the accreditation agent must identify and articulate the acceptability criteria. Failure of an M&S to achieve a particular acceptability criterion does not automatically result in disqualification. Such an occurrence may result in an evaluation of the criticality of the criterion to overall success and may merely serve to restrict the range of applicability of the M&S at hand.

How are appropriate accreditation criteria developed?

This is, itself a stand-alone topic for discussion. At the top level, however, development of accreditation is an analytical process of identifying and articulating questions (criteria) which must be answered to insure that the data collected is not biased. An integral part of this criteria development process is to insure that any special considerations of the Accreditation Authority are incorporated into the formulation of the accreditation criteria. Formulation of the accreditation must also take into account data collection requirements and limitations on the collectability of the requisite data.

The resultant criteria is formalized and documented in a Detailed Accreditation Plan specific to a given Test Resource for use in a Specific Test. This Detailed Accreditation Plan was formally approved by the Accreditation Authority and represented a de facto declaration of the requirements which had to be met for the given test resource to be accredited.

Once we accept that accreditation is the assessment of a test resource to provide data which when analyzed, allows us to assess the performance of the components, we can begin the accreditation process.

3.4 Needs-Driven V&V

ISTC is being developed as a test resource to meet NMD system developmental and operational test and evaluation requirements. The specific V&V activities identified for execution and formal documentation in the ISTC V&V Plan have been selected with the goal of satisfying the fundamental data needed for accreditation decisions.

The ISTC V&V activities definition is driven by data requirements that support BMDO and other government agency accreditation decisions. The accreditation data requirements influence the identification and selection of V&V data products during the ISTC V&V activity definition/design process. The ISTC V&V accreditation data products are subsequently flowed down to entities to be evaluated (units-under-test), then to pertinent V&V activities (with associated procedures and evaluation criteria), and finally to the agents or staff resources necessary to execute the activities. Identification of the accreditation data requirements, V&V data products, associated units-under-test, applicable V&V activities and V&V agents comprise the ISTC V&V Plan. The ISTC V&V Plan optimizes the potential for accreditation by ensuring the ISTC V&V activities planned for execution are responsive to the information needs of the accreditation authority.

3.5 Identification of Caveats and Limitations

Inherent is the assumption that a given element representation is on the development path to the objective system. If the element representation was the objective system, the observed performance of the representation would be identical to that of the objective system. If the element representation possesses only a subset of the capabilities of the objective system, then by definition, the observed performance would only be a subset of the performance of the objective system.

The key feature of the ISTC Accreditation Team's efforts was the development and implementation of a process, which identified the caveats and limitations associated with the disparate participating simulations and NMD Element representations used in each IGT. This was accomplished prior to the execution of runs for record for each integrated test that provided data used to assess the degree of successful integration and the relative status of the participating NMD Elements.

Caveats provided warnings on the analysis and use of the test data produced and limitations identified capabilities or performance shortfalls for the incorporated NMD Element representations. These caveats and limitations were keyed to the objectives and requirements of a given test and were incorporated into the final acceptability assessment and accreditation recommendation provided to the accreditation authority for the ISTC-based developmental test and evaluation.

4.0 Implementation Of The Accreditation Process

To implement the accreditation process, the Accreditation Team designed, developed and executed a stepwise process which provided for the documentation of the many and varied steps in the integration of previously disparate systems into a coherent whole. A concerted effort maximized the successful incorporation of previous verification and validation efforts and defined new requirements and procedures that were subsequently implemented.

A key feature of the process was to develop a method of assessing and documenting that the integrated test resource did not bias the performance of the integrated representations. A significant aspect of this process was to maintain a clear distinction between processes and procedures which provided assurances that the test resource was not biasing or assessing the performance of the incorporated components vis a vis a defacto assessment of the incorporated components.

The ISTC Accreditation Team tried to insure that when a Representation is integrated into the ISTC and tested, the information reported by ISTC accurately represents the performance of the Representation. Inherent in this is the need to insure that the performance of the Representation accurately represents what is intended.

At the fundamental level, the objective of the ISTC Accreditation Process is to establish that the performance of each of the integrated element representations, singularly as well as in concert with other integrated element representations is accurately reported. This is the key to accreditation. It is imperative that we distinguish between reporting vis a vis evaluating performance.

Conceptually what this entails is sequentially 1) establishing the stand-alone performance of a given representation; 2) establishing the performance of the representation as the only participant incorporated into the test frame work; 3) establishing the performance of the representation when incorporated as one of several participants in the test framework; 4) establishing the performance of the representation when operated in the context of an integrated system operating in the defined scenario (s) environment.

4.1 Establishing the Performance of a Given Representation

For each integrated ground test, the LSI Element Integrated Product Team (IPT)/Element PM is responsible for the V&V and certification of their Element Representation in ISTC prior to its use. The ISTC PM is responsible for certifying the Framework, the Common Test Environment and the Global Environments. The test community will not accredit the ISTC for use without formal PM/LSI certification that their Representation is a faithful representation and is ready for use given the specified caveats and limitations.

The developer/sponsor of the given representation establishes the performance envelope of the representation. The representation sponsor must conduct and document the requisite verification, validation and testing of their respective representation. Inherent in this process is the identification and documentation of what the given representation can and cannot do. A critical feature of this process is configuration management of the representations through out the process. This is especially critical in that an inherent feature of the ISTC is the continual development of new Builds; Versions; Revisions, and upgrades, etc., which were incorporated when technically feasible, to insure that the best available representations were being used in a given test. Accurate configuration management insured an accurate tracking of "upgrades" necessary to insure that accreditation activities accomplished to date are still valid and/or are re-executed as required.

Execution of the forgoing places an upper limit on the expected performance of the given representation and establishes a performance baseline for the given representations.

4.2 Establishing the Element to Framework Performance of the Representation

This is effected by incorporating the given representation into the test framework and using various test drivers to represent the remainder of the representations to be used in the test (simulation suite). Testing at this point must be designed to examine the performance of the representation as well as the framework when they are coupled with each other. Two fundamental questions need to be answered: When coupled, 1) does the framework affect the performance of the incorporated representation; 2) does the incorporated representation affect the performance of the framework? If yes, one must then identify and assess the degree and direction of the impact. In both instances, it is essential to identify the nature (degree and direction) of the impact. Is it enhancing or degrading? Is it constant or intermittent? Is it an across-the-board effect or limited to certain sections of the test spectrum? Can the problem be fixed (negated), will it be? The results of these findings and actions must all be documented and all changes maintained under strict configuration management.

4.3 Establishing the Element to Element Performance of the Representation

In an ideal world, the next series of events would entail the stepwise incorporation of various element representations into the framework, and determining how each of the combinations operate in concert. As a practical matter, however, resource constraints will generally necessitate the incorporation of all representations, the test environments and the framework into an integrated entity. This integrated entity is then used to examine the effects of interactions between the various representations, test environments and framework. Testing at this point is focused on identifying and documenting the effects of the interactions among the incorporated representations insofar as they do or do not affect the performance of each individual representation. This also represents a "find and fix" period. In any case however, configuration management must be maintained so that the test configuration can be unambiguously identified.

4.4 Establishing the Integrated System Performance of the Representation

To assist in the analysis, the foregoing processes were performed incrementally, using several "standard" scenarios. This facilitated the identification, isolation and resolution of problem areas. To establish that the integrated system will function in the defined scenario environments, a series of runs are conducted using the various scenarios identified in the detailed test plan. Ideally, several runs are made for each test scenario identified in the Detailed Test Plan. The purpose of these tests is to insure that the integrated test resource will operate in the regime of scenarios specified. At the completion of these integrated tests, the integrated configuration is "locked down" and brought under formal configuration management.

To this point, all efforts have been focused on identifying the various components of the test resource, the degree of accuracy with which data is transferred between components, the identification of shortfalls (both intrinsic and extrinsic) of a representation, and the degree to which data is accurately reported (recorded). This coupled with the Caveats and Limitations delineate the degree to which the test resource can be used to produce data to meet the Test Requirements. This analysis identifies the degree to which the representations can accurately generate, transmit, receive and process data in an integrated environment and is documented in the "Acceptability Assessment and Accreditation Recommendation Report" which is provided to the Accreditation Authority for decision.

Upon approval, a campaign of "Runs for Record" is executed to generate and collect data which can subsequently be analyzed to assess the performance of the integrated test resource.

5.0 Observations and Conclusions

Several observations are supported by The AEgis Technologies Group, Inc. experience in Accreditation Planning for ISTC and other similarly complex tools.

5.1 Conclusions

As evidenced by our experiences in the accreditation of the ISTC for use in IGTs, a common, reoccurring misperception is that Accreditation is synonymous with an evaluation of the goodness of a given representation participating in the Ground Test. We have tried to demonstrate here, as well as when we were working on the accreditation of the ISTC, such is not the case.

As a process, accreditation provides a means for identifying the degree to which data exchanged among participants is consistent with what a given

representation produces and what a receiving representation expects. It attempts to identify (and quantify, if possible) the instances in which data is enhanced or degraded (in terms of quality, quantity and timeliness) when transmitted between participants. It uses the caveats and limitations process as an open forum to identify shortfalls in the simulation and delimits the expectations on the information that can be gleaned from the execution of the simulation. An unexpected benefit of the process was the examination of the historical listing of caveats and limitations to assess the maturing of the various representations. The accreditation process also identifies the outer limits of the degree to which the test requirements and objectives can be expected to be met. The process also identifies the limits to which data obtained from the simulation can be used.

As a statement, accreditation is formal declaration by the Accreditation Authority (Sponsor) that the test resource is suitable for the specified purpose. It formally recognizes the limitations of the representations being used in the test and the impact such limitations will have on meeting the stated requirements and objectives of the test. It also identifies the limitation on the value and use of data obtained during the test.

The ISTC Accreditation process is not measuring or assessing the goodness/badness of the objective system, the incorporated representations or the objective system components. That measurement can only be obtained by an analysis of the data resulting from the execution of the integrated test configuration. Accreditation is a process whereby the sponsor of a given simulation can assess the degree to which a simulation is responding to the purpose and requirements that form the basis of the simulation. Alternatively stated, the function of the accreditation process is to establish that in the integrated configuration of the test resource, the individual element representations and the framework do not adversely (or beneficially) affect the results in an unintended fashion and where unavoidable, to quantify the nature of such effects.

5.2 Observations

A key feature of the accreditation process is the early identification of the caveats and limitations associated with the various representations to be used in the simulation. An initial request for written input with follow-on face-to-face forums were found to be very advantageous in identifying and establishing the impacts of various caveats and limitations on participating elements. This forum was also a very valuable means of identifying the impacts that various caveats and limitations would have on the degree to which the test objectives and requirements could be met.

Maintaining timely cognizance of the configurations of the various representations being used in the integrated configuration is also essential. As noted, the ISTC is a HWIL/SWIL simulation. New Builds; Versions; Revisions, etc., were constantly being developed and incorporated when technically feasible. It was essential that these "upgrades" were accurately tracked to insure that accreditation activities accomplished to date were still valid and/or re-executed as required.

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AUTHOR'S BIOGRAPHIES

BETH VANN is a Systems Engineer with AEgis Technologies Group in Huntsville, Alabama. She supports the Accreditation of the ISTC and previously served as the VV&A Lead Engineer for the Common Test Environment areas of the ISTC. Miss Vann was awarded a BS degree in Computer Science from the University of Alabama-Huntsville (UAH).

DR. KEN KAWANO is a Senior Systems Engineer with AEgis Technologies Group in Huntsville, Alabama. He received a BS in Chemistry from the Massachusetts Institute of Technology, Cambridge, Massachusetts and a PhD in Organic Chemistry from the University of Wisconsin, Madison, Wisconsin.

JOHN PATE is an Aerospace Engineer with the US Army Aviation and Missile Command (USA AMCOM) assigned to the System Test and Evaluation Division, US Army National Missile Defense Joint Program Office (NMD JPO) in Huntsville, Alabama. He serves as the government's Verification, Validation and Accreditation Lead for NMD test resources, including the real-time, NMD element simulations within the NMD Integrated System Test Capability. Mr. Pate has a BS in Aerospace Engineering from the Auburn University.