Revisiting NASA's
Recommended Practices Guide for Verification, Validation and Accreditation

Lisa Cain
Bobby Hartway
Danny Thomas
AEgis Technologies Group
631 Discovery Drive
Huntsville, AL 35806
256-922-0802
lcain@aegistg.com
bhartwar@aegistg.com
d.thomas@aegistg.com

Randal Wallace
NASA
Marshal Space Flight Center
Huntsville, AL
256-544-2940
Randal.L.Wallace@msfc.nasa.gov

ABSTRACT: *After three years of broad use, NASA's Recommended Practices Guide (RPG) for Verification, Validation and Accreditation has evolved. Environmental circumstances and increased exposure to established practices have combined with external stimuli, such as the now official NASA Modeling and Simulation Standard 7009, to produce a leaner and more flexible guide. This paper outlines some of the important changes in NASA's RPG.*

INTRODUCTION

The Modeling and Simulation Verification, Validation and Accreditation Recommended Practices Guide (M&S VV&A RPG) provides guidance for conducting VV&A activities for the Constellation Program of the National Aeronautics and Space Administration (NASA). The RPG is a recommended process rather than an encyclopedic body of knowledge for VV&A. It was written to support an M&S VV&A process that would be consistent with the intent of NASA-STD-7009, Standard for Models and Simulations. It offers guidance on how to define, identify, build, and document evidence to verify, validate, and accredit NASA M&S. These guidelines are widely applicable. However, acknowledging that M&S is a diverse discipline and that each VV&A effort will be unique, customization of the recommended process is typically required. The process described in the M&S VV&A RPG was adapted for NASA from several sources, chiefly the Defense Modeling and Simulation Office (formerly, DMSO), with consideration for standards from the Department of Energy.

VV&A OVERVIEW

According to the DMSO VV&A RPG, "M&S credibility is measured by *verification and validation* (V&V) and formally approved as adequate for use in a particular application by *accreditation*.". Stated another way, Verification and Validation comprise activities to answer the question "How good is the M&S?" Accreditation is a mechanism to answer the question "Is it good enough for the intended purpose?" The critical point is that V&V focuses on all aspects and all capabilities of the M&S - while accreditation focuses on only those aspects or capabilities specific to the stated intended use.

SIMPLIFIED VV&A PROCESS OVERVIEW

Recognizing the aforementioned customization is inevitable and perhaps even desirable, this section presents the basic minimal components of the process including a discussion of required resources.

KEY PLAYERS

As shown in Figure 1, Key Players, exercising the VV&A process requires input from two distinct vantage points: the developers of the M&S and the users of the results generated by the M&S. This is important because it is the user who identifies the specific criteria necessary for their particular needs. In this instance, 'user' is the person or party that is using the results of the M&S as input toward a programmatic decision. This may be an analyst or higher-level manager, depending on where the M&S fits into the solution space. 'User' is distinguished from operator, which is the person who runs the M&S to generate results, to illustrate the separate functions; however, it may be that the same person is responsible for both functions.
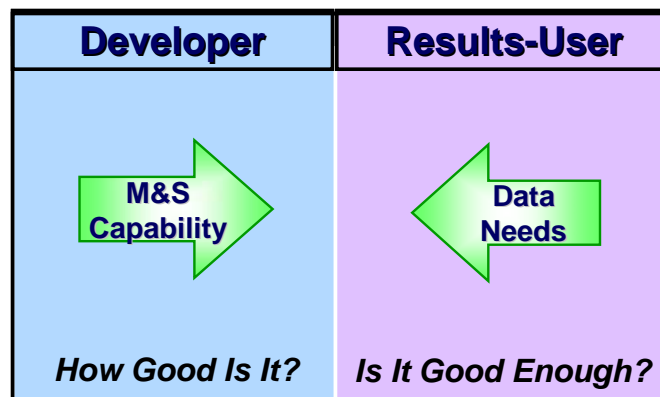

Figure 1: Key Players

The VV&A Process is used to establish evidence of credibility for an M&S for an intended use. Therefore, expanding on the last graphic, the users efforts are focused on articulating the specific capabilities needed, with as much detail as possible. This gives developers direction of where to focus their efforts in building or refining the M&S for that application. In the end, the developers want a product they can endorse and release, based on evidence such as appropriate levels of verification and validation, any certifications that my apply. Conversely, users want confidence that a product meets their needs, typically within a specific timeframe and budget, based on evidence.

SIMPLIFIED ROLES AND RESPONSIBILITIES

In general, those developing the M&S do the V&V activities, while those wishing to employ the M&S for a specific application do accreditation. Figure 2, Simplified VV&A Responsibilities, depicts the some of the common synonyms for the responsibilities of the two major kinds of organizational entities.
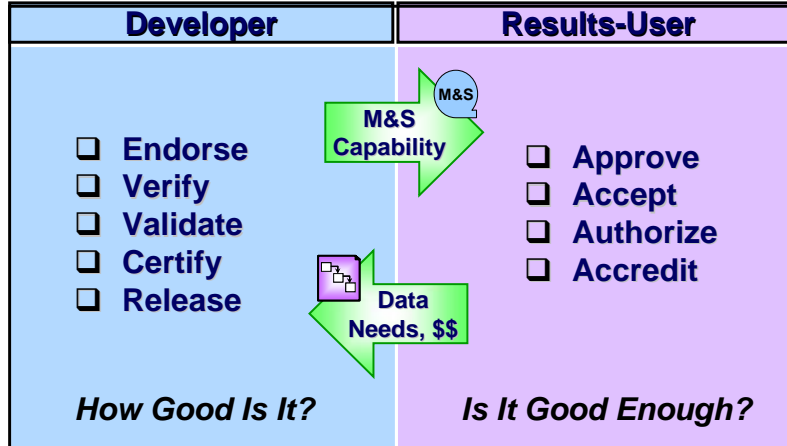
Figure 2: Simplified VV&A Responsibilities

It is useful to view the various functions and activities needed to accomplish these responsibilities as "roles" as shown in Figure 3, MS& VV&A Roles.
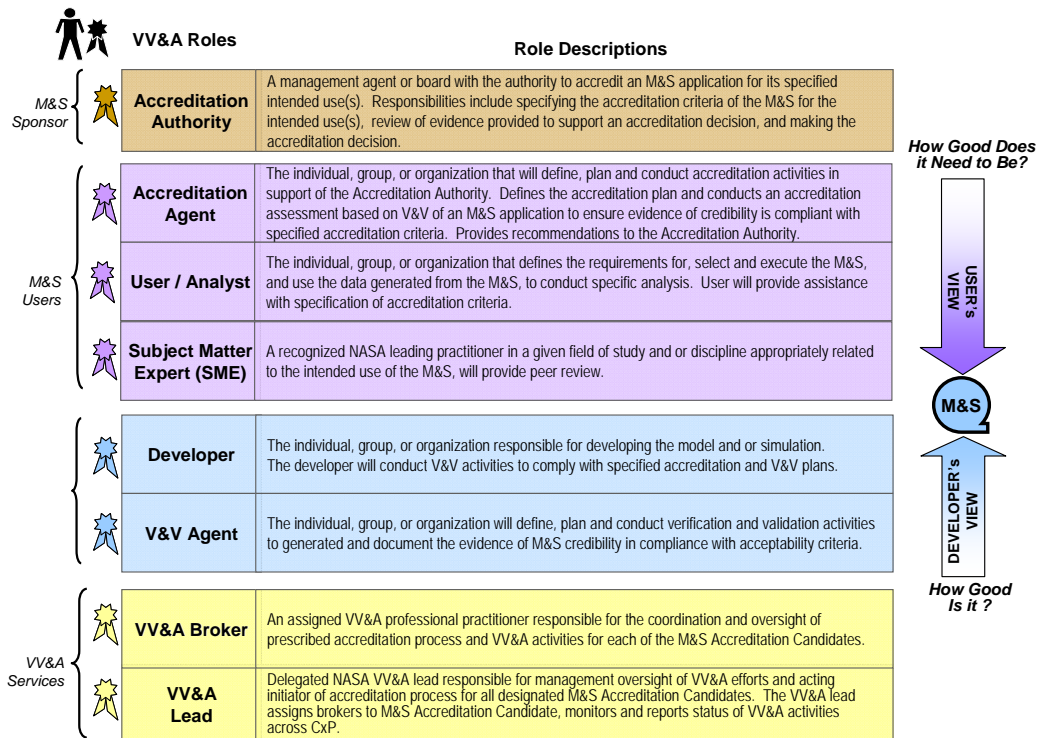
Figure 3: M&S VV&A Roles

The term "roles" does not imply positions. Indeed, in several successful projects a single individual filled all these roles. Even in those cases, it was useful to consider the roles with their associated viewpoints. Figure 3, M&S VV&A Roles, shows the various roles. For easier recognition of the key functions and activities of VV&A, this document employs a color-coding scheme throughout. As shown in the Figure 3, Yellow denotes M&S Management activities, Green is VV&A activities, Blue is developer activities, Purple is Analysis activities, and Brown is decision-makers. Note that the same person may perform many of these functions.

In short, the user is responsible for defining accreditation criteria at the beginning of the process, and measuring the evidence against those criteria in the end to determine accreditation status (Accreditation activities). The developer(s) of the M&S compiles and documents evidence to support credibility of the M&S against those defined accreditation criteria (V&V activities). The VV&A Broker is the liaison between the two perspectives. Ultimately, the Accreditation Authority gauges which V&V efforts are critical to a useful accreditation for program and mission success, documents the basis for that decision, and communicates to management the necessary resources to enact such a recommendation. The Accreditation Authority also has the authority to prescribe the use of the model.

THREE-PHASE VV&A PROCESS

Experience has shown that within NASA's dynamic and diverse environment, the VV&A process can take many forms. Consequently, the major driving force for developing a phased process was the realization that estimating the time and resources required to complete the VV&A process may entail more than cursory analysis. NASA's Three-Phase VV&A Process shown in Figure 4 is designed specifically for NASA to accommodate each unique situation. It allows the practitioner to evaluate and determine which activities are relevant to their needs. It also allows for necessary information gathering and subsequent planning before committing to V&V activities that can be cost and resource-intensive.
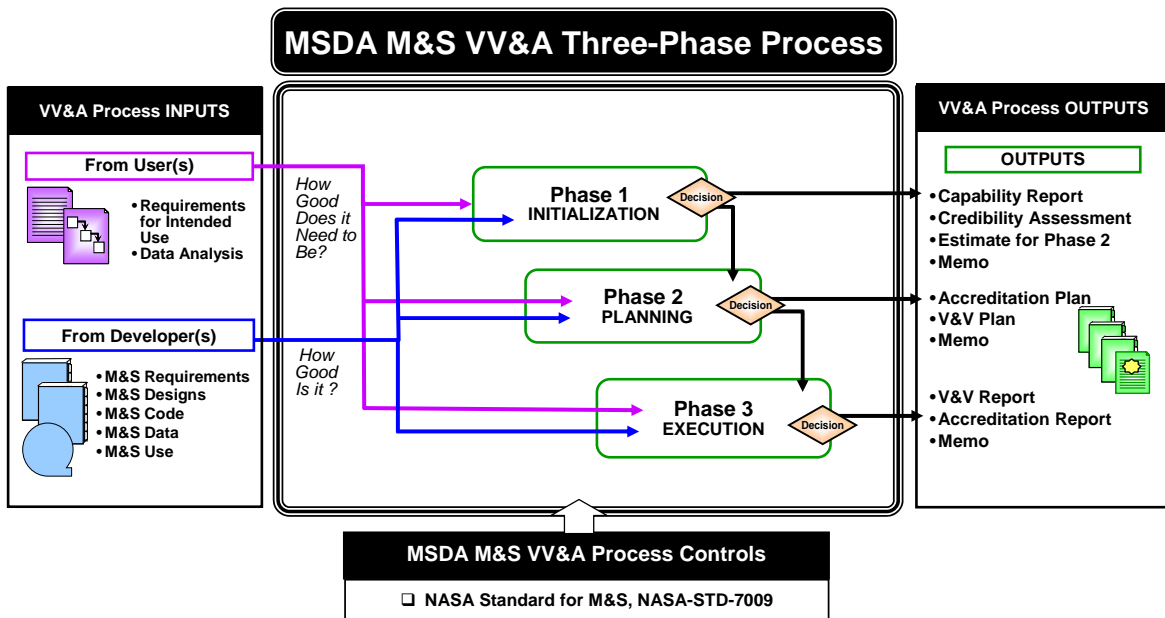

Figure 4: NASA's Three-Phase VV&A Process

Benefits of this approach include:

- Developing a customized, efficient, effective, and relevant VV&A process.
- Gaining valuable insight into the analysis process that will drive mission success.
- Evaluation and allocation of appropriate resources for V&V activities to support accreditation efforts.

The distinguishing characteristic of the Three-Phase VV&A Process is the decision point at the end of each Phase, allowing for an informed decision when contemplating the need for additional evidence of credibility against the available resources and achievability of obtaining that desired outcome. More specifically, breaking the VV&A activities up into discernable phases allows the practitioner or manager to determine whether to accredit the M&S based on evidence in existence at that time, or proceed to the next phase as illustrated in the center portion of Figure 4. An example of where this is useful is the situation where further development of a tool is not economically feasible or relevant, but the M&S is still appropriate and credible for its intended use at that time.

ASSIGNING RESPONSIBILITIES FOR THE THREE PHASE PROCESS

Figure 6, VV&A Activities, Roles, Phases, and Products shows the work flow of VV&A activities. The arrows imply general task dependency and information flow although there is usually cross communication, feedback and at least some concurrent engineering. The phases appear in chronological order down the left side of the figure. The color-coded columns show which "role" is responsible for each activity. Activities spanning columns are shared responsibilities. Five of the actrivities correspond directly with the five major VV&A products – Capability Report, Accreditation Plan, V&V Plan, V&V Report, and Accreditation Report. The excution of V&V activities may generate many products like Test Reports, but the information generated may simply appear in the V&V repport.
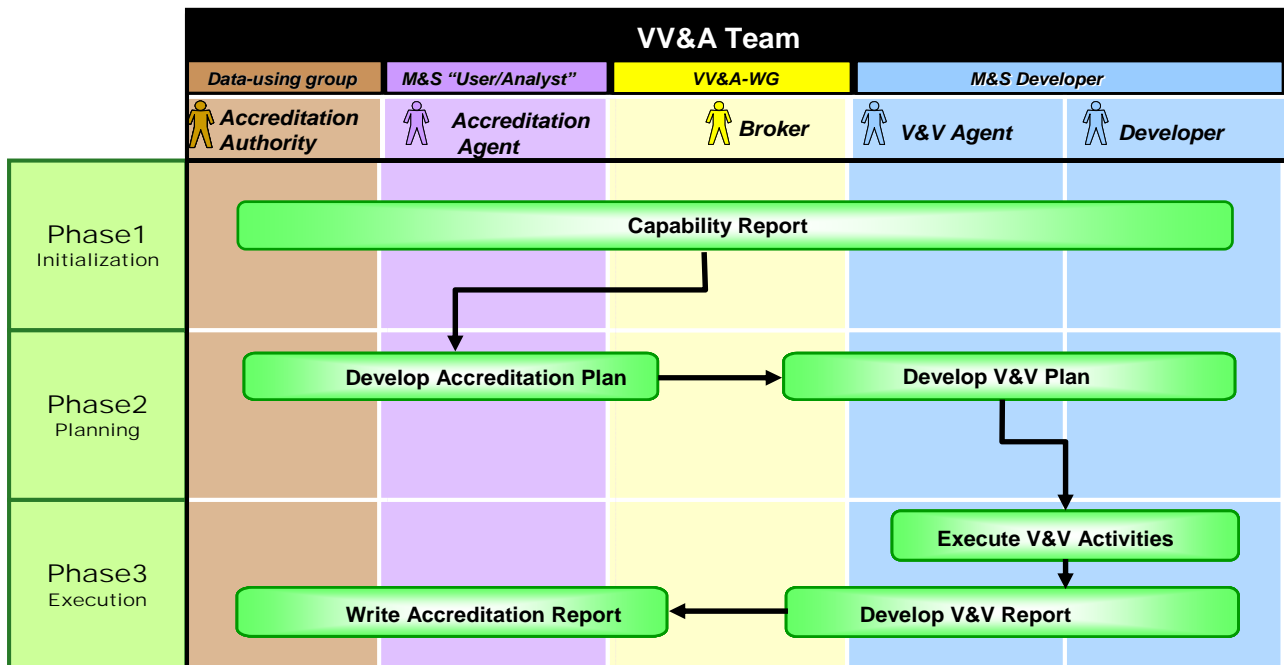

Figure 6: VV&A Activities, Roles, Phases, and Products

AUTHOR BIOGRAPHIES

LISA CAINE is a Systems Engineer with AEgis Technologies Group in Huntsville, Alabama. She supports the Exploration Mission Space Directorate (ESMD) VV&A Program. Ms. Caine earned a BS degree in Engineering and Information Systems from Michigan State University and a Masters in Project Management from Keller Graduate School of Management in Chicago. She was also recently awarded the Project Management Professional certification through the Project Management Institute (PMI).

BOBBY HARTWAY is a Senior Research Scientist with AEgis Technologies Group in Huntsville, Alabama. He has developed a new paradigm for simulation characterization and requirements development for space and defense systems. He is using this paradigm to support NASA's activities for integrated management of modeling and simulation. Mr. Hartway is a Certified Modeling and Simulation Professional (CMSP).

DANNY THOMAS is a Senior Research Scientist with AEgis Technologies Group in Huntsville, Alabama. He is supporting NASA's effort to institute consistent management practices for simulation development and use. He has developed simulations for space and defense. Mr. Thomas is a Certified Modeling and Simulation Professional (CMSP).

RANDY WALACE is a senior engineer on loan to NASA through cooperative agreements between the Marshall Space Flight Center, the University of Alabama in Huntsville, and the US Army Space and Missile Defense Command. He has extensive experience in the use and development of large, complex M&S in support of tactical and strategic missile defense programs.