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Standardized Documentation for Verification, Validation, and Accreditation / Paper 08S-SIW-003

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Standardized Documentation for
Verification, Validation, and Accreditation

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ABSTRACT: *This paper updates the Modeling and Simulation (M&S) community on the status of the Department of Defense M&S Steering Committee-sponsored project titled, "Standardized Documentation for Verification, Validation, and Accreditation," since the paper 07F-SIW-068, "Automating Standardized Information for the Verification, Validation, and Accreditation Process: An Acquisition Community Sponsored M&S Project," was presented in September 2007.*

1. Introduction

This paper updates the Modeling and Simulation (M&S) community on the status of the M&S Project "Standardized Documentation for Verification, Validation, and Accreditation (VV&A)" sponsored by the Department of Defense (DoD) M&S Steering Committee (M&S SC). At the 2007 Fall Simulation Interoperability Workshop, paper 07F-SIW-068 titled "Automating Standardized Information for the Verification, Validation, and Accreditation Process: An Acquisition Community Sponsored M&S Project," first introduced the project and provided some background information [1]. The focus of the current paper is on the project's progress and products since September 2007.

2. Project Management

The key to success for this project is oversight by the DoD M&S SC, which comprises Senior Executive Service, flag or general officers of the military, or officials of equivalent rank and precedence. The DoD M&S SC advises and assists the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) in all matters related to M&S. DoD Directive 5000.59 [2], published in August 2007, establishes the committee and prescribes the initial membership representing:

- USD(AT&L)
- Under Secretary of Defense for Policy (USD(P))

- Under Secretary of Defense for Personnel and Readiness (USD(P&R))
- Director, Program Analysis and Evaluation (DPA&E)
- Director, Operational Test and Evaluation (DOT&E)
- Military Secretaries
- Chairman, Joint Chiefs of Staff
- Commander, United States Joint Forces Command

The members of the DoD M&S SC, who produced the new DoD Directive 5000.59 [2], direct and control the future of M&S management across DoD.

The current project management structure and organization are depicted in Figure 1.
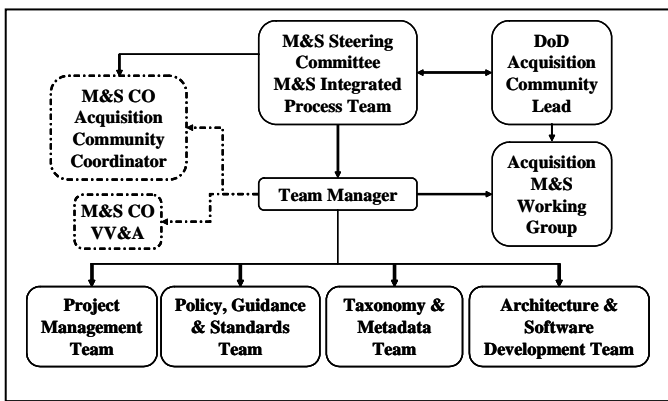

Figure 1. Project Organization

The project management structure comprises four teams:

- Project Management Team (PMT)
- Policy, Guidance & Standards (PG&S) Team
- Taxonomy & Metadata (T&M) Team
- Architecture & Software Development (A&SD) Team

The PG&S Team was added to the structure since the September 2007 report to the M&S community. Each team plays an important role in accomplishing the project's major tasks and producing the associated deliverables:

- Recommending updates to associated policy, guidance, and standards documents
- Developing Extensible Markup Language (XML) schemas for VV&A and a VV&A ontology for M&S
- Producing the DoD VV&A Documentation Tool (DVDT)

Each team will report its progress in subsequent sections of this paper.

The PMT works to keep the project on schedule and focuses on meeting the expectations of the management-level DoD Communities, as well as the working-level M&S and VV&A communities. Project risks have been identified and risk handling strategies put in place. For example, these risks are being monitored:

- Information technology security protocols
- Developer's production schedules

The PMT meets periodically via teleconference to review the status of the other teams' efforts. A standard agenda for each teleconference is followed and minutes are recorded. Action items are assigned and tracked to closure to ensure the focus of the project is understood by all participants and that the project keeps moving forward. Documents associated with the project (e.g., meeting minutes, draft and final products, and reference materials) are stored on a private workspace. At the end of the project, copies of all project products will be provided to the M&S CO for the purpose of archiving and distribution.

The Team Manager provides the M&S Coordination Office (M&S CO) Acquisition Community Coordinator (see Figure 1) a monthly update on financial performance, deliverables, schedule, and status. The Team Manager also responds to the Community Coordinator's schedule for In-Process Reviews for the DoD M&S SC and DoD M&S Integrated Process Team (M&S IPT) members. These reviews are held at the initiation and completion of the DoD M&S Project, and as needed during project performance.

The Acquisition M&S Working Group (AMSWG) was briefed at its October 2007 meeting [3]. The Acquisition Community was briefed at the National Defense Industrial Association's 10th Annual Systems Engineering Conference held in San Diego, California, also in October 2007 [4]. At the December 2007 AMSWG meeting, the group reported that as each of the Acquisition Community-sponsored projects were briefed it became obvious how each of the projects touched and leveraged the other projects. An example of the synergy between two projects is found in the DoD M&S Human Capital Strategy (draft) published as part of the M&S Education for the Acquisition Workforce Project [5]. Nine challenges were identified in that study. Challenge 4, "Need for Information Traceability and Associated Documentation" is described as follows:

> Models and simulations are developed based on a requirement for a specific use. Historically

simulations were developed without all the formal documentation required for traceability. Without formal documentation, it is difficult to determine what the original requirement and data pedigree were and if the model or simulation can be utilized for additional applications. Documentation is the core concept behind information traceability for the purpose of achieving successful proliferation of M&S throughout DoD.

The vision for addressing each challenge is to provide a positive impact. To address Challenge 4, the study proposes the following:

Individuals of the DoD M&S workforce will be trained in documenting the details required for model and simulation traceability. Specific emphasis will be placed on documentation for Configuration Management; Verification, Validation, and Accreditation; Technical Control Plan, Simulation Control Plan, etc. By understanding and having the appropriate skill set to develop appropriate documentation, the foundation can be established for DoD to improve consistency and reliability of M&S systems; avoid unnecessary costs; encourage reuse and minimize risk to the M&S user community.

It is easy to see that the DVDT addresses the VV&A documentation challenge and will have a positive impact on the Acquisition M&S Workforce.

There are plans for a Configuration Control Board (CCB); however, the composition and responsibilities for the CCB are yet to be determined. A CCB is needed to manage the baseline versions of the project's products (e.g., the DVDT and the various XML-related products) and to manage technical requirements of the project. The PMT expects that requests for new capabilities will be received during beta testing as well as after the tool is released for the Department's use. Additionally, technology issues will arise for the CCB to address. For the DVDT to be viable, it will have to be advocated, supported, sustained, and technologically relevant.

The DoD Acquisition Community Lead has oversight of this project. However, coordinated and unbiased support from all six DoD Community Leads — Acquisition, Analysis, Planning, Testing, Training, and Experimentation — is necessary to advocate for the changes in policy, guidance, standards, and people's perceptions that are needed to move the transformation in M&S management forward to greater standardization and to realize broader availability of VV&A information.

As Charles Darwin (1809 - 1882) wrote:

"It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change."

DoD M&S management has been undergoing changes for over two years. The DoD Communities that readily adapt to change will become internally stronger and will be better able to allocate scarce resources for M&S in a coordinated and efficient manner. Confidence in the use of M&S results to inform decisions is needed across DoD and is not limited just to one DoD Community. Employing a common tool to produce standard VV&A documentation that can be shared easily will reap rewards for all DoD Communities. VV&A information is important not only for decisions at hand, but also for reuse of M&S by others in the future.
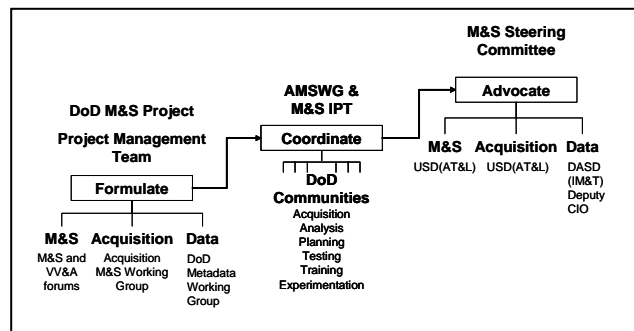
3. Policy, Guidance & Standards

Figure 2. PG&S Process

Figure 2 provides a look at the project's process for:

- formulating recommendations for updates to various policy, guidance, and standards documents,
- coordinating those recommendations with the DoD Communities, and then
- recommending that DoD M&S SC members advocate for the needed changes.

The AMSWG is chartered to examine the M&S challenges faced by DoD in acquisition, foster cooperative M&S activities, and create plans to improve M&S across the acquisition spectrum [6]. Membership of the AMSWG mirrors the membership of the DoD Systems Engineering Forum sponsored by USD(AT&L) with each member of that forum appointing a government member to the AMSWG.

The AMSWG is both the sounding board for the PMT and the key interface to the DoD M&S SC. As presented in Figure 3, the AMSWG advises the PMT as well as approves the recommendations the PMT will ultimately take to the DoD M&S SC.
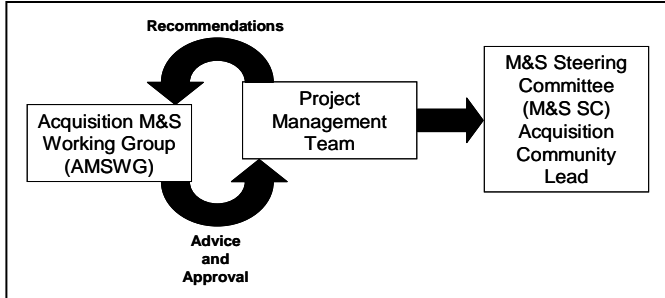

Figure 3. Recommendation Process

The PG&S Team is looking in three areas — M&S, Acquisition, and Data — to identify relevant policy, guidance, or standards, and then to make recommendations for changes. The PG&S Team made recommendations to the PMT, which were provided to the Acquisition Representative of the DoD M&S IPT and to the AMSWG in November 2007. These recommendations were for the following:

- Defense Acquisition Guidebook, Section 4.5.7 Modeling and Simulation (this section was last updated in 2006)
- Defense Acquisition University Continuous Learning Modules
  - CLE011 M&S for Systems Engineering
  - CLE023 M&S for Test and Evaluation

The Acquisition Representative to the DoD M&S IPT and the AMSWG both stated the recommendations were good and will look for opportunities to incorporate them.

Additionally, the PMT contributed content to MIL-STD-3022 [7], which advocates the benefits of automating VV&A document production and archiving VV&A information, as follows:

"Automating the production of VV&A information could enhance the efficiency of preparing VV&A documents for the various individuals involved in either the accreditation or the V&V aspects of a project by eliminating the need to recreate information about the VV&A processes or about the M&S itself (e.g., the problem being solved, the description of the M&S, the intended use, requirements traceability, etc.). VV&A information is important not only for the decision at hand but also for the reuse of an M&S in the future. Archiving the resulting VV&A information will facilitate its search and discovery by future M&S Users."

4. Taxonomy & Metadata

Effective data interchange requires well-defined and readily understood information structures. As the foundation for sharing of VV&A information across the enterprise, the project has defined XML schemas describing metadata at a project level, metadata at a document level, and the content of the four VV&A documents (Accreditation Plan, V&V Plan, V&V Report, and Accreditation Report). MIL-STD-3022 [7] describes standard format and content requirements for these four documents. Some portions of these documents are common (e.g., problem statement) and can be entered into the DVDT once for use in generating any of the individual documents. In addition, some portions of the documents have common structure, even if the actual content across the documents may differ (e.g., document title page). Information structures that are common to two or more of the standard document templates are described in a single XML schema document. The data types defined in this common schema serve as building blocks for defining structure and content in the other schemas. Four XML schema documents describe the structure and content of each of the four standard document templates, using declarations from the common set, and adding XML declarations for structure and content specific to each VV&A document as needed.

Additional XML schemas describe project-level and document-level metadata for posting to a future M&S Resource Registry Domain residing in the Global Information Grid (GIG). The XML schemas developed for this project conform to the World Wide Web Consortium XML Schema recommendation (see [8] for an introduction to the XML Schema language). The schemas and their relationships are summarized in Figures 4 and 5 and are discussed below.
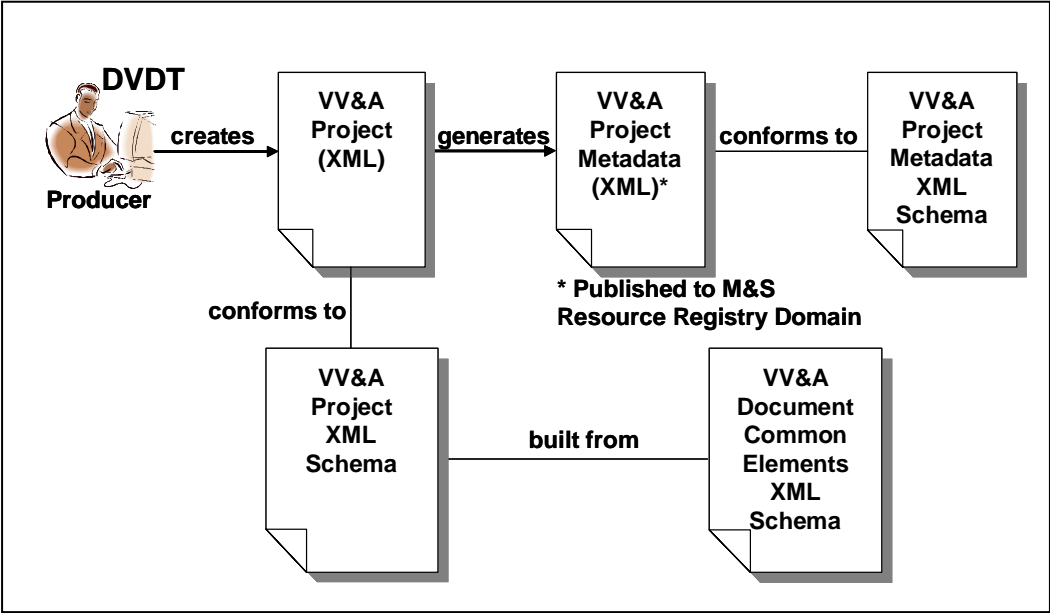
Figure 4. XML Schema documents (Project-level)

Figure 5. XML Schema documents (Document-level)
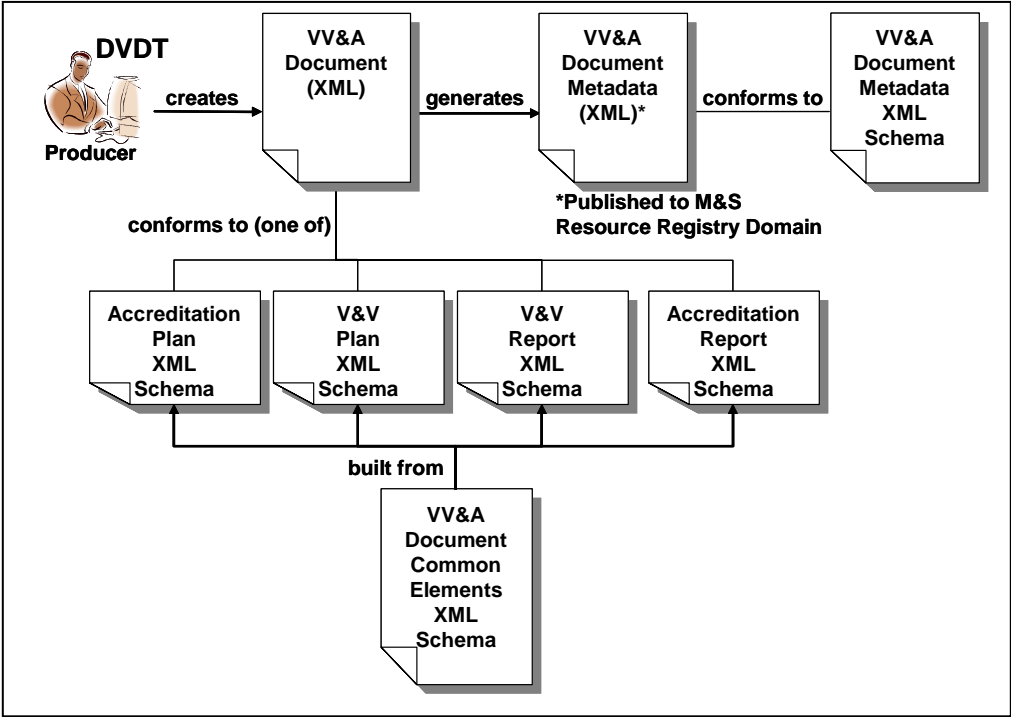
Considering the flow from left to right across the top of Figure 4, upon creation of a VV&A Project, the DVDT Producer can direct the tool to generate metadata describing the VV&A Project.

Similarly, in Figure 5, the Producer can create individual VV&A documents in a project and can direct the tool to generate metadata describing each VV&A document as it is developed.

The project-level metadata (labeled VV&A Project Metadata in the Figure 4) initially informs the consumer that VV&A is being performed for a particular M&S. At a minimum, this metadata identifies the VV&A Project and provides point of contact information. Subsequent generation of the VV&A Project metadata (generated at the discretion of the DVDT Producer) will provide current summary information about the project, including identification of current documents and their versions. The VV&A Project metadata conforms to a separate XML schema, identified in Figure 4 as the VV&A Project Metadata XML Schema.

As introduced above, much of the information in the VV&A document templates is similar in structure and content. For example, all four documents have a title page consisting of a particular collection of information, all four documents have a Problem Statement, and the V&V Plan and V&V Report share a V&V Scope. Such common information structures are described in a single XML schema, identified in Figures 4 and 5 as the VV&A Document Common Elements XML Schema. Data structures defined in this schema are used by reference in the VV&A document-specific schemas (identified across the middle area of the diagram). The document-specific schemas (Figure 5) add other data structures specific to the document structure being described. The document-specific schemas, together with the document common elements schema, describe data structures for the full information content of the respective standard VV&A templates. On the other hand, the schemas do not capture template information that is considered to be indicative of presentation style, as opposed to the actual information content. For example, the schemas describe the information that would be used to populate the Accreditation Scope section of the VV&A documents, but the schemas do not provide a data structure for indicating that this section is numbered 1.4 in the standard templates. In this example, the section numbering relates to one approach to presenting the information; it is not part of the VV&A information itself. Separation of presentation from content is a fundamental precept in the effective use of XML for information storage and processing [9].

As the Producer proceeds with creation of individual VV&A documents, the Producer can direct the DVDT to produce a set of metadata describing the document (labeled VV&A Document Metadata in Figure 5). This metadata conforms to a separate XML schema, identified in Figure 5 as the VV&A Document Metadata Set XML Schema. This schema describes the metadata that will be posted to the enterprise to facilitate discovery of information about the VV&A documents, in the same way the project-level metadata is used to facilitate discovery of information about the VV&A project as a whole.

Recognizing the current DoD evolution toward the GIG, the schema design for the VV&A project-level and document-level metadata addresses requirements from the DoD Discovery Metadata Specification (DDMS) [10] and the M&S Community of Interest (COI) Discovery Metadata Specification (MSC DMS) [11].

The major challenge in the design of the schemas was the need to begin an evolution from the free-text narrative content of traditional documentation to more precise data content in XML files. In addition, information that has traditionally been documented in lists or tables needs to be expressed very explicitly in XML structures, from which the content in the lists or tables can be constructed for a particular presentation of the data (such as in a written report). The decision to move toward more precise description of the document content leads to specification of information elements from which the narrative content can be constructed.

Consider, for example, the section on M&S assumptions, capabilities, limitations, and risks/impacts contained in each of the VV&A document templates. Each of these may be broken out into separate subsections in the actual documents, and may provide the information in various formats: free text narrative, tables, bulleted lists, etc. Looking specifically at the identification of risks and associated impacts, the XML structure tries to make the content as precise as possible, as indicated in Figure 6, which presents an example structural excerpt (notional content shown) from an XML representation of a VV&A document.

The current draft XML schemas only provide an initial breakout of the information content (one can easily think of additional information detail that would be helpful in describing risks and associated impacts; the above is only a start). The schemas will continue to be refined as the project proceeds.

The VV&A Document Metadata XML Schema (see Figure 5) defines the structure of an XML document that will be posted to the enterprise for discovery of VV&A documents supporting M&S resources. As stated previously, this schema references data structures from the DDMS to describe information elements in the VV&A documents, such as:

- project identifier (ddms:TitleType),

- submitter (ddms:creatorType),
- sponsor (ddms:pointOfContactType),
- title (ddms:titleType),
- version (ddms:subtitleType),
- date (ddms:DatesType),
- points of contact (ddms:pointOfContactType), and
- security (ddms:security).

Attributes from the Intelligence Community Information Security Markings are used to describe document classification, dissemination controls, and other security information.

```
<MSRisks>
  <MSRisk>
     <MSRiskCategory>Cost</MSRiskCategory>
     <MSRiskStatement>some statement of cost risk
…</MSRiskStatement>
     <MSRiskMitigationAction>some statement of
necessary action to mitigate the risk…
</MSRiskMitigationAction>
     <MSRiskProbability>.50</MSRiskProbability>
     <MSImpacts>
        <MSImpact>
           <MSImpactCategory>Schedule
</MSImpactCategory>
           <MSImpactStatement>some statement of
impact on schedule resulting from the risk
</MSImpactStatement>
        </MSImpact>
           <MSImpactCategory>Functionality
</MSImpactCategory>
           <MSImpactStatement> some statement of
impact on required functionality resulting from the
risk</MSImpactStatement>
        </MSImpact>
     </MSImpacts>
  </MSRisk>
  <MSRisk>
     …etc. as above…
  </MSRisk>
```

Figure 6. Notional XML representation

It is important that all metadata required by the DDMS are included in the VV&A Document Metadata XML Schema so that the metadata extracted from the VV&A documents will fully support discovery of M&S resources on the GIG. Identification of the M&S (in the context of the VV&A Project) uses M&S Resource data structures defined by the MSC DMS [11].

The VV&A Document Metadata XML Schema has been provided to the GIG M&S COI for inclusion in the MSC DMS [11] as specification of the VV&A Coverage Metadata Set described in that document. Finally, it is important to recognize that each VV&A document may be considered an M&S Resource according to the MSC DMS[1]. The document-level metadata needs to provide sufficient information to generate M&S Resource descriptions in accordance with that specification. In essence, then, descriptions of certain M&S resources (such as software, federations, etc.) using the MSC DMS will have accompanying references to VV&A information, and the VV&A documents themselves will be described as M&S resources according to the MSC DMS.

At the time of this writing, the VV&A documentation XML schemas are under review by the GIG M&S COI. They can be made available to interested members of the SISO community for discussion and possible refinement. The breakdown of the documentation content into more precise information elements is also informing the ongoing taxonomy and ontology development work in the project.

5. Architecture & Software Development

"Most people make the mistake of thinking design is what it looks like," says Steve Jobs, Apple's C.E.O. "People think it's this veneer -- that the designers are handed this box and told, 'Make it look good!' That's not what we think design is. It's not just what it looks like and feels like. Design is how it works." [12]

5.1 Design

Since September 2007, the A&SD Team has focused on the web usability aspects of the engineering life cycle, including iterative design, heuristics, designing for change, and conducting usability tradeoffs. The key goal for functionality is that the DVDT should reduce the producer's workload.

When possible, code or functions that were successfully used in other projects and met defined requirements were incorporated. One example of this is the editor, which is a fully functional open-source tool that provides word processor like capabilities. The opportunity to incorporate

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[1] M&S resources include: M&S software and software components; adjunct tools; federations of simulations; M&S services; M&S data and data models; M&S specifications; M&S software design documents. [10]

existing technologies that meet requirements was always examined.

The DVDT will be served from the M&S CO domain. The portal will include a search capability and user-defined collaboration workspaces. In addition, the DVDT will have a help system. The DVDT functions are basic since a benefit of using the tool is easier management of VV&A information. One of those basic functions is requirements traceability, which is displayed as a matrix (RTM). Figure 7 shows a notional example of the display. Navigation is in the left pane; data entry is upper-right, and context-sensitive help is lower-right.

Figure 7. Example Requirements Traceability (Notional)

The open architecture of the DVDT allows for the integration of data into other tools. For example, if the producer requires more robust analysis of requirements, the XML can be exported and then imported into the producer's tool of choice.

5.2 Versions

Two versions will be tested-fixed-tested prior to deployment of DVDT Version 1.0.

Alpha	Tested by A&SD Team
Beta	Tested by end-users
DVDT 1.0	Deployed version

6. Testing

A test plan addressing each requirement was produced by the A&SD Team. The test plan traces each requirement to a use case and then to a specific test as shown in Figure 8. The results of each test are analyzed to determine if the results are satisfactory or not.
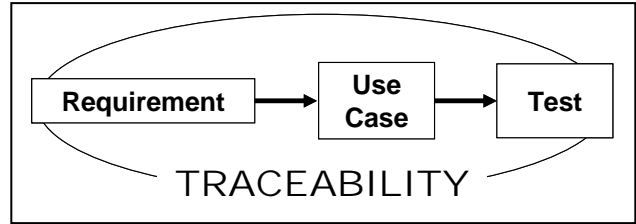

Figure 8. Test Plan Traceability

As an example, one of the general functional requirements is that the DVDT shall provide the capability to a producer to post VV&A project data to the M&S Resource Registry Domain. This requirement is expressed in two use cases Enter/Modify Project-Level Information and Generate Document Metadata[2].

The first allows the producer to post metadata about the project as a whole – and in fact will not allow the producer to proceed to document creation until a minimal set of project-level metadata is posted. The second allows the producer to post metadata about the document currently being worked by the producer.

Testing of the posting requirement, therefore, will occur in those two use cases. Data will be entered into the respective project-level and document-level forms, the posting operation will be triggered, and then metadata output intended for the M&S Resource Registry Domain will be examined for correctness and completeness (compared to the entered data).

In all, there are 17 use cases currently proposed to capture the functional requirements of the DVDT. Figure 9 shows these use cases and their relationships.

The following subsections describe the full range of testing to be conducted in support of the DVDT.

6.1 Alpha Testing

Testing of the alpha version is scheduled for Q3 FY08. Members of the PMT will individually test the alpha version against the test plan, recording the result of each test. Since some members of the PMT have extensive experience with VV&A documentation, testing will not be limited to a mechanical checklist. Impressions and suggestions for improvements also will be captured, as well as reports of problems. If a required feature does not function properly, it will be reported to the A&SD Team to fix. If an opportunity for improvement is observed, it will be recorded and submitted to the CCB.

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[2] The actual use cases are under development; these specific examples are provisional.

6.2 Beta Testing

Beta testing of the DVDT is also scheduled to begin in Q3 FY08. Both the PMT and a small group of volunteers representing organizations and projects interested in using the DVDT in the future will carry out the testing. Volunteers will be requested from the DoD Communities at the invitation of the AMSWG.

Beta testing will require teamwork between the PMT, A&SD Team, and the volunteer beta testers, who are in other projects and organizations. A partial list of organizations that have volunteered includes:

- National Security Agency
- Joint Test and Evaluation Methodology Joint Test
- Military Satellite Communications Joint Program Office (MILSATCOM JPO) Transformational Satellite

Communications System (TSAT) Program Systems Engineering and Integration
- Modeling Architecture for Technology, Research, and Experimentation (MATREX) Program, United States Army Research, Development, and Engineering Command
- MOVES Institute, Naval Postgraduate School
- Naval Air Warfare Center Aircraft Division (AIR 5.1.6.11)
- Naval Air Systems Command (PMS-263 P-8A Poseidon Multi-Mission Aircraft and AIR 4.10 Strategic Director of M&S)
- NAVSEA Dahlgren Accreditation Team

As with alpha testing, defects discovered that affect the existing requirements will be provided to the A&SD Team to fix; while suggestions for improvements will be submitted to the CCB for future consideration.
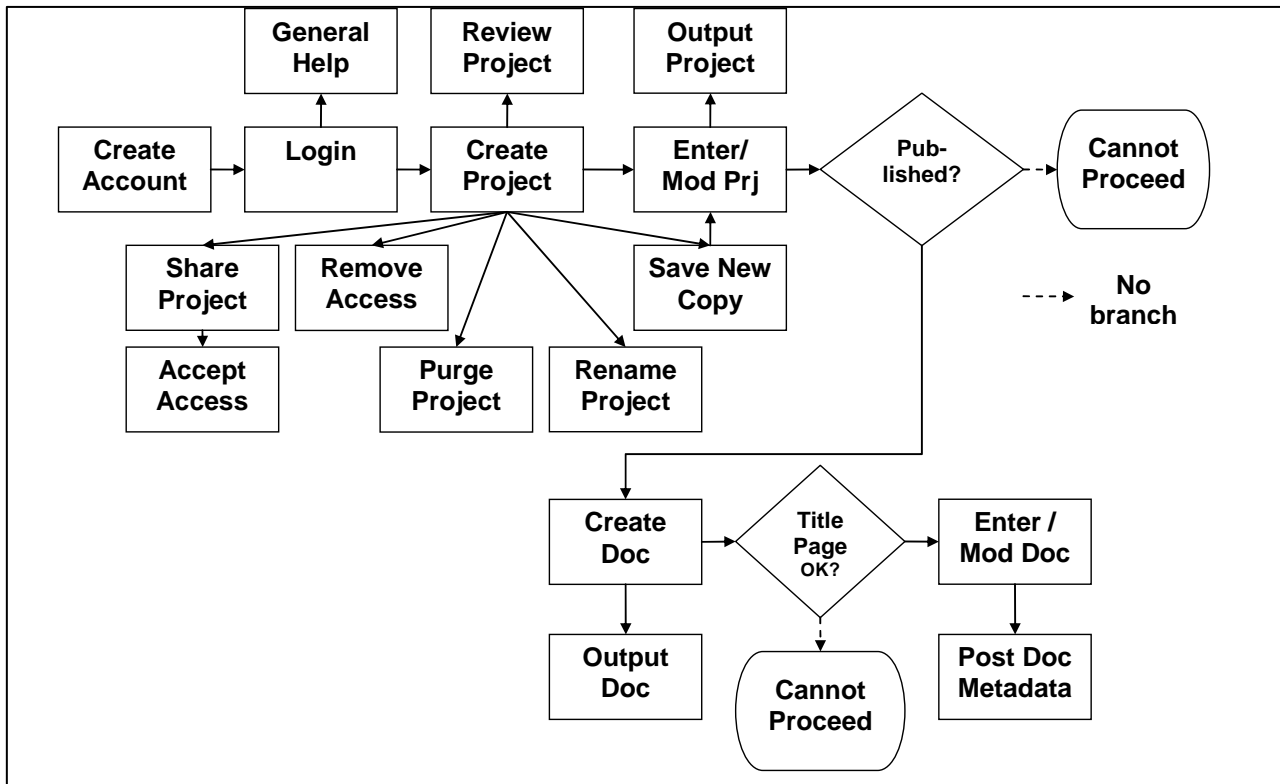

Figure 9. Use Cases
(Proposed; subject to change)

6.3 Regression Testing

Regression testing will ensure that correcting errors in the DVDT or making changes do not create other errors or have unintended consequences that can affect previous functionality. For example, each time the software,

hardware, networking, security, collaboration, or portal capabilities change, regression testing is needed to ensure those changes do not affect the overall functionality.

The A&SD Team will re-test modifications against the existing test plan with needed amendments. Good records

of previous tests (both the features being tested and the test results) will be needed to minimize the amount of effort required to create each new version's test plan. The test plan will be placed under configuration management to facilitate future regression testing. Automated testing will be used by the A&SD Team to help reduce the effort involved.

7. Summary

This paper updated the status of the DoD M&S Project, "Standardized Documentation for VV&A" by focusing on the progress made since September 2007. Initial policy, guidance, and standards recommendations were made to the DoD Acquisition Community Lead through the AMSWG, while various XML description documents began coordination through the GIG M&S COI.

The DoD M&S Project remains on schedule and plans to release the DVDT beta production version in Spring 2008. If the reader is interested in becoming a beta tester or using the DVDT to support a VV&A project, please contact any of the authors to obtain more information.

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Acronyms

A&SD	Architecture and Software Development
AMSWG	Acquisition Modeling and Simulation Working Group
CCB	Configuration Control Board
COI	Community of Interest
DDMS	DoD Discovery Metadata Specification
DoD	Department of Defense
DOT&E	Director of Operational Test and Evaluation
DPA&E	Director of Program Analysis and Evaluation
DVDT	DoD VV&A Documentation Tool
GIG	Global Information Grid
JPO	Joint Program Office
M&S	Modeling and Simulation, model(s) and simulation(s)
M&S CO	Modeling and Simulation Coordination Office
M&S IPT	Modeling and Simulation Integrated Process Team
M&S SC	Modeling and Simulation Steering Committee
MATREX	Modeling Architecture for Technology, Research, and Experimentation

MILSATCOM Military Satellite Communications
MOVES   Modeling, Virtual Environments, and Simulation
MSC DMS   Modeling and Simulation Community of Interest Discovery Metadata Specification
NMSO   Navy Modeling and Simulation Office
PG&S   Policy, Guidance, and Standards
PMT   Project Management Team
T&M   Taxonomy and Metadata
TSAT   Transformational Satellite Communications System
USD(AT&L)   Under Secretary of Defense for Acquisition, Technology, and Logistics
USD(P&R)   Under Secretary of Defense for Personnel and Readiness
USD(P)   Under Secretary of Defense for Policy
VV&A   Verification, Validation, and Accreditation
XML   Extensible Markup Language

Author Biographies

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