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DoD Manual (DoDM) 5000.102

Modeling and Simulation (M&S) Verification, Validation *with Uncertainty* *Quantification*, and Accreditation (VV&A) for OT&E and LFT&E

Director, Operational Test and Evaluation (DOT&E)

UNCLASSIFIED

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DoDM 5000.102 M&S VV&A Overview



DoD Instruction (DoDI) 5000.98, Section 3: M&S



M&S includes any **physical, mathematical or otherwise logical representation of a system, entity, environment, phenomenon or process** critical to meeting OT&E and/or LFT&E objectives.

M & S VV & A



- M&S VV&A is defined as a statistical practice that depends on data-backed analysis to **quantify uncertainty** in the M&S result.
 - ***Uncertainty quantification is the rigor of validation;*** it moves us from a binary "yes" / "no" response on whether the M&S agrees with the physical system to a continuous measure of consistency between the two in light of the limited evidence available.



- **M&S VV&A is expressly a lifecycle process** and will be integrated with Integrated Test, OT&E, and LFT&E across the acquisition lifecycle in **a discrete series of events that engender a model predict-live test-model refine feedback loop** wherein all relevant new live data is used to improve the accuracy and precision of the M&S.

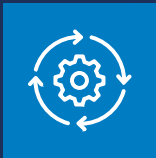


- When used to support OT&E and LFT&E, M&S **will not be accredited until a rigorous V&V has been completed for the intended evaluation in the intended domain or region of the operational envelope** pursuant to DoDM 5000.102 "M&S VV&A in OT&E and LFT&E". More generically, **M&S accreditations apply only to specific intended uses** of the M&S.

DoDM 5000.102 M&S VV&A: Rationale for Policy Update

GOAL

Improve the reliability and confidence of M&S used in OT&E and LFT&E through:



1 The synchronization of M&S to live data



2 Validation centered around uncertainty quantification



3 Adoption of additional new scientifically and statistically rigorous DOT&E-supported methods

Previous Policy and Guidance

Incorporates and cancels:

- Modeling and Simulation
- Guidance on the Validation of M&S used in OT and LF Assessments
- Clarifications on Guidance and the Validation of M&S used in OT and LF Assessments

Continue to leverage old memos on the 'how' until forthcoming M&S VV&A Guidebook is in place.



DoD Manual 5000.102

Modeling and Simulation Verification, Validation, and Accreditation for Operational Test and Evaluation and Live Fire Test and Evaluation

ORIGINATING COMPONENT:

Office of the Director, Operational Test and Evaluation

EFFECTIVE:

December 9, 2024

RELEASABILITY:

Cleared for public release. Available on the [Directives Division Website](http://www.esd.whs.mil/DD/) at: www.esd.whs.mil/DD/

INCORPORATES AND CANCELS:







Director of Operational Test and Evaluation Memorandum, "Modeling and Simulation," June 4, 2002; Director of Operational Test and Evaluation Memorandum, "Guidance on the Validation of Models and Simulation Used in Operational Test and Live Fire Assessments," March 14, 2016; Director of Operational Test and Evaluation Memorandum, "Clarification on Guidance on the Validation of Models and Simulation Used in Operational Test and Live Fire Assessments," January 17, 2017

APPROVED BY:






Douglas C. Schmidt, Director, Operational Test and Evaluation

Overview of Changes



METHODS & PROCESSES

-  Science & Technology-based Approaches
-  Uncertainty Quantification
-  Predict-test-refine approaches
-  Conduct and Tailor VV&A and improve models across acquisition lifecycle
-  Accreditation managers must conduct a VV&A readiness review process before runs-for-record
-  Accreditation criteria will inform the V&V plan

DOCUMENTATION & ROLES

-  Temp/T&E Strategy Requirements
-  M&S included in Integrated Decision Support Key (IDSK)
-  VV&A Plan Requirements
-  M&S Working Group Responsibilities
-  DOT&E Reviews VV&A Plans

DELIVERABLES

-  TEMP/TES, including M&S Strategy and resourcing for VV&A, delivered for DOT&E review and approval no later than 30 calendar days before the decision-point being informed
-  DOT&E must see V&V plans NLT than 30 days before runs-of-record collection



NEW

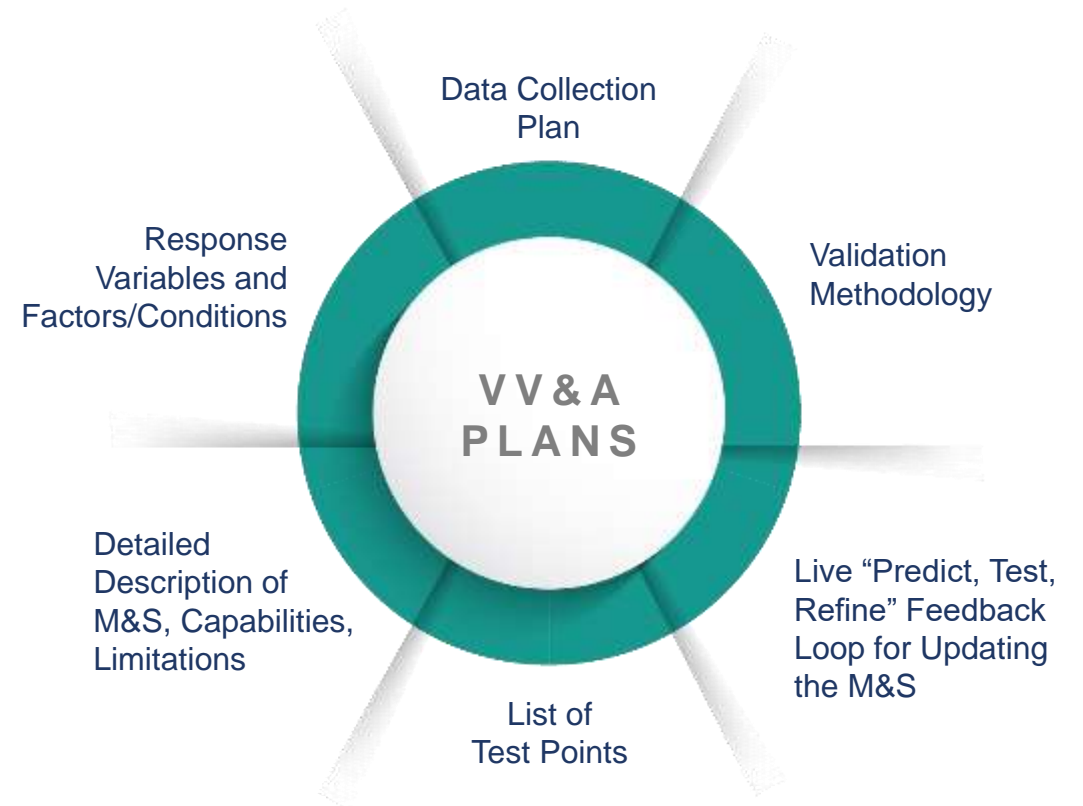
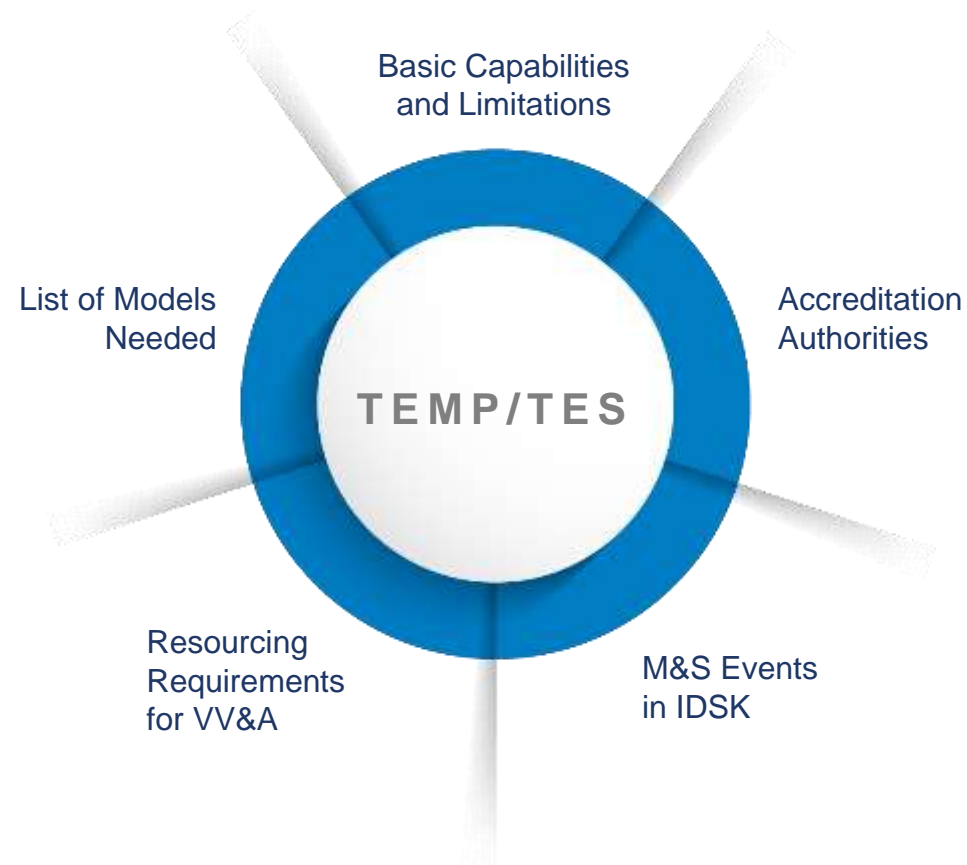


UPDATED



RE-EMPHASIZED

What the T&E Community Needs to Do



Not much is fundamentally different in the way VV&A should be executed.
The way you document VV&A has changed.

DoDM 5000.102 Contents



Section 1: General Issuance Information

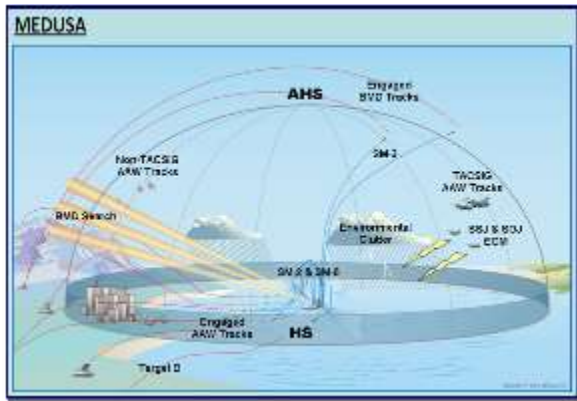
- 1** Applies to all DoD **systems and services acquired via the DAS** pursuing any adaptive acquisition framework pathway **intending to use M&S** to support OT&E or LFT&E.
- 2** Any physical, mathematical, or otherwise **logical and digital representation** of a system, entity, environment, phenomenon, or process **critical to meeting OT&E and LFT&E objectives**.
- 3** According to DoDIs 5000.98 and 5000.61, DoD Components **will plan, fund, execute, and report** on M&S VV&A critical to meeting OT&E and LFT&E objectives of DoD systems and services acquired via the DAS.



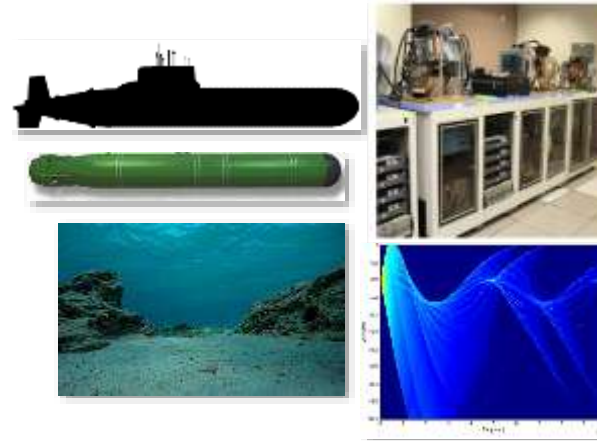
Types of M&S

M&S examples and models include physics-based; effects-based; hardware-, software-, or operator-in-the-loop simulations; system integration labs; threat and target systems and environment; live, virtual, constructive environments; digital engineering, digital twins; or any combination of these

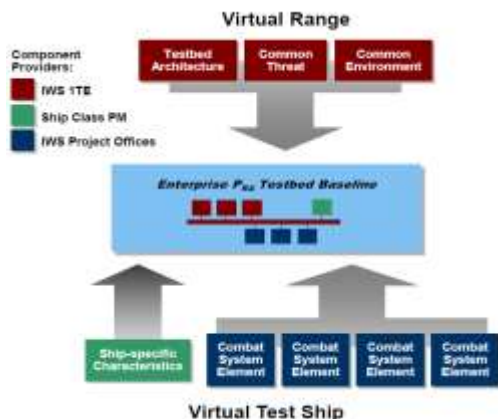
DOT&E Commonly Encounters Four (Not Exclusive) Types of Simulations



Digital Simulations:
Multi-Target Effectiveness
Determined under
Simulation by Aegis



Hardware in the Loop:
e.g., Environment Centric
Weapons Analysis Facility



**Tactical Computer/Software
in the Loop:**
Probability of Raid
Annihilation Test Bed



Operator in the Loop:
F-35 Joint Simulation
Environment

Section 2: Responsibilities

DOT&E:

Reviews and approves exceptions and procedural deviations from this issuance for acquisition programs on the T&E Oversight List for OT&E and LFT&E.

The USD(A&S) supports the delivery of M&S tools critical to the evaluation of technical and operational requirements, and operational performance of acquisition programs in the context of joint warfighting concepts.

In accordance with DoDI 5000.98, the DoD Component heads will follow the procedures outlined in this issuance.

*Pursuant to Sections [139](#), [4171](#), [4172](#), and [4231](#) of Title 10 U.S.C., Section 223 of Public Law 117-81, DoDD 5141.02, and DoDI 5000.98,



Section 3: M&S VV&A Overview

SCIENCE- and TECHNOLOGY- BASED M&S VV&A

SCIENCE –

math, statistics, physical law, various other scientific and computational methods, etc. to quantify the uncertainty in the M&S in light of the limited evidence available

+

TECHNOLOGY –

digital engineering, artificial intelligence, machine learning, Monte Carlo simulation, high performance computing, etc.

=

Enable the understanding and trust of M&S results comparable with data collected during applicable DT&E and Integrated T&E events, as well as operational OT&E, LFT&E or other relevant live data. Supports efficient “predict, live test, refine” feedback loop.

Section 3: M&S in OT&E and LFT&E

OT&E and LFT&E

M&S may be used to deliver results for record needed to enable and augment the evaluation of operational effectiveness, suitability, survivability, and lethality (as applicable).

Examples of M&S Critical to OT&E or LFT&E:

- M&S of threats and targets in the absence of actual, operationally relevant threat and targets.
- M&S of mission effects that cannot be created using live testing

M&S of System of Systems (“Federated Models”)

- M&S development and VV&A efforts will be coordinated across all programs in the SoS and the relevant M&S environment.
- M&S VV&A of SoS programs for OT&E and LFT&E will be founded on the relevant mission thread to describe how the SoS reacts to various operational stimuli.



Section 3: M&S VV&A Management

PROGRAM MANAGER

Charters the M&S Working Group (MSWG)

Confirms all interfacing with M&S of SoS is available

Ensures live data are integrated into the M&S across the acquisition life cycle

Confirms M&S is included in the IDSK and resources the M&S events and the required VV&A

Tracks all M&S deficiencies and limitations

M&S Working Group

Forum for coordination across testers, M&S managers, system engineers, accreditation authorities.

Includes specialized expertise to support M&S uncertainty quantification

Defines M&S and VV&A requirements to inform acquisition contracts and informs requirements

Identifies the live data needed for M&S VV&A and enables access to those data in accordance with the T&E data management plan

Provides M&S and VV&A input to the IDSK and the TEMP/T&E Strategy

Lead OTA & LFT&E Organizations

- The accreditation authority for M&S used to support OT&E and LFT&E
- Develop the detailed M&S V&V plans, in conjunction with the M&S manager, in a separate document or as part of any related test plan

Section 3: DOT&E Oversight for M&S



DOT&E approves the M&S strategy outlined in the TEMP/T&E Strategy ... as part of our TEMP/T&E Strategy approval



DOT&E reviews relevant M&V V&V plans

- Drafts should be coordinated early and often
- Final product submitted no later than 30 calendar days prior to the start of the test, the required accreditation, or M&S runs for record



DOT&E reviews official M&S VV&A reports and independently analyzes the results

- Can determine their use for supporting DOT&E operational and live fire evaluations



Section 4: M&S VV&A Process



M & S PLANNING

Begins at
program initiation!

TEMP/T&E Strategy
and M&S V&V Plans

Resource Needs

Apply latest advances in
science and technology



PREPARATION AND EXECUTION

Determine and certify
M&S readiness for use
in runs for record
required to meet OT&E
and LFT&E objectives



ANALYSIS AND EVALUATION

Statistical Analysis
right data and
enough data

Extrapolation when live
data are not available

Uncertainty
Quantification required
to fully understand the
M&S results



REPORTING

M&S Managers report
on V&V

Accreditation Authority
reports on VV&A

Test agencies report
on M&S results

The VV&A report will include
uncertainty quantification

Section 4: M&S Planning

TEMP/T&E Strategy

- List of and basic information on the M&S critical to meeting OT&E and LFT&E objectives including their intended use.
- M&S events and results required to meet OT&E and LFT&E objectives in the IDSK.
- M&S VV&A requirements that the contractor must meet.
- Funding requirements to accomplish M&S VV&A.

M&S V&V Plan

- A detailed description of the type of M&S.
- A list of response variables (results) for each M&S that will be used for evaluation and validation.
- The range of conditions over which the M&S will undergo VV&A.
- The plan for collecting live data and generating the M&S results needed for VV&A.
- A description of the live test-refine-predict feedback loop for updating the M&S.
- The VV&A methodology used and an analysis of the associated risk and uncertainty.
- A schedule that shows when results from the accredited M&S must be generated.
- A list of the specific test points that will be executed in the M&S.



DoDM 5000.102 Guidebook Plan



Next Steps: M&S VV&A Guidebook & Engagement

- Joint written guidance between DOT&E and DTE&A *coming soon*
- Four video modules in production
 - Overview of Policy
 - Documentation and Planning
 - Test Design for M&S
 - Analysis and Reporting for M&S
- Additional modules, explanations and examples to follow



PLANNED ACTIONS STEPS

- Develop and facilitate workshops on lessons learned and best practices
- Work with stakeholders to address identified gaps and implementation challenges
- Provide joint guidance from DOT&E and DTE&A



CLOSING STATEMENTS Q/A



THANK YOU