



## DoD MANUAL 5000.102

# MODELING AND SIMULATION VERIFICATION, VALIDATION, AND ACCREDITATION FOR OPERATIONAL TEST AND EVALUATION AND LIVE FIRE TEST AND EVALUATION

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**Purpose:** In accordance with the authority in DoD Directive (DoDD) 5141.02 and the policy in DoD Instructions (DoDIs) 5000.61 and 5000.98, this issuance implements policy, assigns responsibilities, and provides procedures for verification, validation, and accreditation (VV&A) of modeling and simulation (M&S) tools critical to meeting the operational test and evaluation (OT&E) and live fire test and evaluation (LFT&E) objectives of DoD systems and services (referred to in this issuance as "DoD systems") acquired via the Defense Acquisition System or via other non-standard acquisition systems.

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## SECTION 1: GENERAL ISSUANCE INFORMATION

### 1.1. APPLICABILITY.

This issuance applies to:

a. OSD, the Military Departments, the Office of the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Combatant Commands, the Office of Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities within the DoD (referred to collectively in this issuance as the “DoD Components”).

b. DoD systems acquired via the Defense Acquisition System, pursuing any adaptive acquisition framework pathway, in accordance with DoDD 5000.01 and DoDI 5000.02.

c. Non-standard acquisition systems (e.g., missile defense system).

d. DoD systems under special access controls, in accordance with DoDD 5205.07.

e. Any physical, mathematical, or otherwise logical and digital representation of a system, entity, environment, phenomenon, or process used to deliver or support the delivery of results for record in lieu of required live data critical to meeting OT&E and LFT&E objectives. Examples include, but are not limited to:

- (1) Physics-based models.
- (2) Effects-based models.
- (3) Hardware, software, or humans-in-the-loop simulations.
- (4) System integration labs.
- (5) Threat or target systems and environment models.
- (6) Live, virtual, constructive environments.
- (7) Digital engineering models.
- (8) Digital twins.
- (9) Any of their combinations.

### 1.2. POLICY.

In accordance with DoDIs 5000.61 and 5000.98, the DoD will plan, fund, execute, and report on M&S results and their VV&A critical to the evaluation of operational effectiveness, suitability, survivability, and lethality (as applicable) of DoD systems as they mature across the acquisition life cycle.

## **SECTION 2: RESPONSIBILITIES**

### **2.1. DIRECTOR OF OPERATIONAL TEST AND EVALUATION (DOT&E).**

Pursuant to Sections 139, 4171, 4172, and 4231 of Title 10, United States Code; Section 223 of Public Law 117-81; DoDD 5141.02; and DoDI 5000.98, the DOT&E reviews and approves exceptions and procedural deviations from this issuance for acquisition programs on the Test and Evaluation (T&E) Oversight List for OT&E and LFT&E.

### **2.2. UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING (USD(R&E)).**

The USD(R&E), for acquisition category identification programs under T&E oversight for developmental test and evaluation (DT&E), assesses the adequacy and approves DT&E strategies documented in the Test and Evaluation Master Plan (TEMP), T&E strategy, or equivalent document, referred to in this issuance as “TEMP/T&E strategy.” For all other acquisition programs under DT&E oversight, advises the milestone decision authority (MDA) by conducting an independent analysis of test data, reports, M&S results, and the adequacy of the DT&E plan included in the TEMP/T&E strategy.

### **2.3. UNDER SECRETARY OF DEFENSE FOR ACQUISITION AND SUSTAINMENT (USD(A&S)).**

The USD(A&S) enforces this issuance for DoD systems for which the USD(A&S) is the MDA.

### **2.4. DOD COMPONENT HEADS.**

The DoD Component heads follow the procedures outlined in this issuance through:

- a. Component acquisition executives.
- b. Program managers.
- c. LFT&E organizations.
- d. Their designated operational test agency (OTA) or operational test organization (also referred to in this issuance as “OTA”).

## SECTION 3: M&S VV&A OVERVIEW

### 3.1. SCIENCE- AND TECHNOLOGY-BASED M&S VV&A.

- a. The planning, execution, and reporting of M&S VV&A will be based on the latest advances in science and technology to quantify the uncertainty in the M&S results.
- b. Science- and technology-based M&S VV&A uses mathematically and statistically rigorous design and advanced analysis techniques. It may be further enabled and enhanced by digital engineering, artificial intelligence, and similar advanced tools and technologies. Science- and technology-based M&S VV&A will:
  - (1) Maximize the planning, execution, and reporting of an effective and efficient “predict, live test, refine” feedback loop to reduce the uncertainty in the M&S results for record across the acquisition life cycle.
  - (2) Quantify the statistical confidence in the M&S results with live data collected during applicable contractor T&E (CT&E), DT&E, integrated T&E events, OT&E, LFT&E, or other relevant live experiments, training, or combat events.

### 3.2. M&S VV&A ACROSS THE ACQUISITION LIFE CYCLE.

- a. The DOT&E has identified M&S as critical to meeting OT&E and LFT&E objectives will be integrated with relevant testing across the acquisition life cycle or other applicable live data in a series of predict-test-validate activities to feed applicable live data back into the M&S to support M&S VV&A and M&S improvements.
- b. An integrated decision support key (IDSK) within the TEMP/T&E strategy will detail the M&S strategy including, but not limited to, test events and data in support of VV&A and the needed M&S results. M&S strategy is required to support the evaluation of operational effectiveness, suitability, survivability, and lethality (as applicable) in support of acquisition or other program decisions. The IDSK will also highlight the CT&E, DT&E, integrated T&E, OT&E, LFT&E, and M&S events and data required to support the M&S VV&A.
- c. M&S VV&A will use the available live data at the subcomponent-, component-, subsystem-, system-level and at a system-of-systems (SoS)-level as the DoD system matures across the acquisition life cycle. This building block approach will allow the program to identify and reduce uncertainties in the M&S early, while increasing the opportunity to refine the live tests as the DoD system matures and as the complexity of test conditions increases in OT&E and LFT&E. Several VV&A events may be required to meet OT&E and LFT&E objectives.

### 3.3. M&S IN OT&E.

- a. M&S that has been verified, validated, and accredited in accordance with this issuance may be used to deliver the results needed to enable and augment the evaluation of operational

effectiveness and suitability of the DoD system while taking into equal consideration the survivability and lethality effects. Examples of M&S critical to OT&E include, but are not limited to:

(1) M&S of threats and targets in the absence of actual, operationally relevant threats and targets.

(2) M&S of mission effects or scenarios that cannot be created using live testing due to scale, safety concerns, test limitations, or other defensible constraints.

(3) M&S to extend operational forces and evaluate battlefield effects when physical forces are not otherwise available.

b. M&S V&V will use all relevant data needed to quantify the uncertainty in the M&S results and support a robust accreditation prior to the M&S runs for record.

c. As applicable, M&S results will inform early operational assessments, operational assessments, initial OT&E, follow-on OT&E, and operational demonstrations.

### **3.4. M&S IN LFT&E.**

M&S that has been verified, validated, and accredited in accordance with this issuance may be used in LFT&E to deliver the results needed to enable and augment the evaluation of full spectrum survivability and full spectrum lethality of DoD systems. Examples of M&S critical to LFT&E include, but are not limited to:

a. M&S of threats and targets in the absence of actual, operationally relevant threats and targets.

b. M&S of the DoD system or SoS to explore a range of DoD system or SoS vulnerabilities, crew casualties, or lethal effects not feasible in live tests due to scale, safety, test limitations, or other defensible constraints.

c. M&S of mission-based and lethal effects to support the evaluation of a more comprehensive range of engagement scenarios than possible in live tests alone.

### **3.5. ACCREDITATION.**

a. M&S will be accredited for its intended use.

(1) The OTA is the accreditation authority for M&S intended to support OT&E objectives.

(2) The LFT&E organizations are the accreditation authorities for M&S intended to support LFT&E objectives.

(3) The OTA and LFT&E organizations will develop accreditation plans in coordination with the M&S manager responsible for the development of M&S V&V plans.

(4) The accreditation plan will establish performance parameters and acceptability criteria, including acceptable uncertainty in the M&S results for their intended use. The accreditation plan will be developed at the beginning of the VV&A process based on applied mathematics, statistics, and other science-based test design and analysis methods.

(5) The accreditation criteria will inform the V&V plan, including the live data collection strategy, to support the VV&A objectives and uncertainty quantification.

b. The accreditation will be based on the outcome of the V&V plan that is tailored for the specific intended use of the M&S and conducted in accordance with the procedures outlined in Section 4 of this issuance.

c. M&S will not be accredited until V&V has been completed for the intended evaluation in the intended domain or region of the operational envelope, in accordance with the procedures outlined in Section 4 of this issuance. Any M&S that has been previously verified and validated will be reviewed for compliance with the procedures outlined in Section 4 of this issuance and applicability to the intended use.

### **3.6. M&S OF SOS.**

a. For programs in SoS (or family of systems) configurations, the program manager, in coordination with the M&S working group (MSWG), will coordinate the VV&A efforts across relevant programs in the SoS and the relevant M&S environment. Compatibility and interoperability will be critical for SoS M&S VV&A to confirm that different input and output assumptions among multiple combined accredited models do not lead to SoS-level outputs that are inconsistent or incorrect for the specific intended uses. The MSWG will verify and validate the SoS approach that connects and feeds data and messages between the models.

b. M&S VV&A of SoS programs for OT&E and LFT&E will be founded on the relevant and technically verified mission threads to describe how the SoS reacts to various operational stimuli. These operational stimuli may include external events, operator activities, and automated activities that take place at different times. M&S VV&A will consider this series of events and how the M&S of any single system integrates into the larger SoS M&S to evaluate the end-to-end sequence.

### **3.7. M&S VV&A MANAGEMENT.**

#### **a. Program Manager.**

The program manager will:

(1) Establish the MSWG to support the T&E Working-level Integrated Product Team (WIPT), also known as the integrated test team (ITT), (referred to in this issuance as “T&E WIPT/ITT”) in executing M&S VV&A.

(2) Confirm that all interfacing M&S not within the program manager’s system boundary are available for the SoS M&S and its VV&A, as applicable.

(a) Determine a method (e.g., federation) of joining the models and the ability of the external models to interface within the SoS model.

(b) Develop working agreements with the owners of external models for their intended use.

(c) Develop a plan to manage configuration of the models throughout the life cycle of the SoS model.

(3) Assign resources and schedule the live test data collection for M&S and its VV&A, including subject matter experts, to adequately employ planned live testing, and confirm the T&E schedule supports M&S updates and fixes throughout the acquisition life cycle.

(4) Ensure contracts are in place to adequately support government-led M&S VV&A planning activities and government M&S VV&A.

(5) Track all M&S limitations and deficiencies.

(6) Confirm M&S and required VV&A are captured in the TEMP/T&E strategy including in its IDSK.

(7) Maintain live test data and related metadata for the life cycle of the program.

(8) Ensure M&S tools, technical capabilities, analytics, analysis, and data are based on standards that support interoperable and sharable data analysis, including reuse, across all necessary stakeholders for broad mission-based assessments.

(9) Ensure the means of access, methods of management and storage, data, metadata, and all supporting results management capabilities are secure and maintain the necessary level of verified and validated protection.

#### **b. MSWG.**

The MSWG, a sub-group within the T&E WIPT/ITT, led by a subject matter expert appointed by the program manager, will:

(1) Enable coordination between the OTA, LFT&E organizations, M&S managers, system engineers, accreditation authorities, and the program office to effectively support the predict-test-fix approach across the acquisition life cycle.



(2) Coordinate the planning, management, execution, and reporting of all M&S VV&A efforts with necessary programmatic activities, the T&E WIPT/ITT, and other programmatic integrated product teams (as appropriate) to employ tool capabilities, resources, data, and analysis program wide.

(3) Include specialized expertise to support planning, execution, and analysis of M&S and its VV&A.

(4) Define M&S and VV&A requirements for inclusion in requests for proposals and contracts (e.g., physical, mathematical, or otherwise logical and digital representation of the system, entity, environment, phenomenon, or process supporting M&S).

(5) Identify the live test data required to support adequate VV&A.

(6) Provide M&S and VV&A input to the development of the TEMP/T&E strategy.

### **c. OTA.**

The OTA will:

(1) Develop the accreditation plan and accredit M&S intended to support OT&E objectives in accordance with this issuance and DoDI 5000.61.

(2) Coordinate with the M&S manager on the development of M&S V&V plans. The M&S manager may provide the V&V plan in a separate document or as part of any related accreditation plan or OT&E plan.

(3) Plan and track test execution plans critical to the M&S V&V and accreditation plans.

(4) Develop plans for the M&S runs for record and confirm that the M&S results for record support the OT&E objectives required to inform acquisition decisions.

(5) Confirm that the OT&E events capture the live data required for M&S VV&A pursuant to the procedures outlined in this issuance.

### **d. LFT&E Organizations.**

The LFT&E organizations will:

(1) Develop the accreditation plan and accredit M&S intended to support LFT&E objectives in accordance with this issuance and DoDI 5000.61.

(2) Coordinate with the M&S manager on the development of M&S V&V plans. The M&S manager may provide the V&V plan in a separate document or as part of any related accreditation plan or LFT&E plan.

(3) Plan and track test execution plans critical to the M&S V&V and accreditation plans.

(4) Develop plans for the M&S runs for record and confirm that the M&S results for record support the LFT&E objectives required to inform acquisition decisions.

(5) Confirm the LFT&E events capture the live data required for M&S VV&A pursuant to the procedures outlined in this issuance.

### **3.8. DATA MANAGEMENT.**

The program manager, in coordination with the MSWG, will enable access to all M&S results and related M&S VV&A artifacts in accordance with the data management procedures outlined in Paragraph 3.8. of DoDI 5000.98.

a. Information on M&S tools and associated artifacts, including live data in support of M&S VV&A, reports, and other VV&A artifacts, will be stored in a common T&E database owned by the program for dissemination to internal and external VV&A stakeholders.

b. Live data collected prior to the applicable phase of testing needed to accredit M&S will be inventoried, structured, catalogued, and maintained for future use in accordance with the data management and configuration management plans for data required for VV&A and developed by the MSWG in coordination with the program manager.

### **3.9. DOT&E OVERSIGHT.**

a. For programs on the T&E Oversight List for OT&E and LFT&E, the DOT&E is the approval authority for the M&S strategy outlined in the TEMP/T&E strategy. The DOT&E will review the M&S V&V plans supporting the M&S VV&A for OT&E and LFT&E.

b. M&S managers in coordination with the OTA and LFT&E organizations, as appropriate, will coordinate draft M&S V&V plans with DOT&E staff early and often, and will submit the final product for DOT&E review no later than 30 calendar days prior to the start of the test, the required accreditation, or M&S runs for record.

c. The DOT&E will review the official M&S VV&A reports and independently analyze the M&S V&V and M&S results for record to determine their use in supporting the DOT&E's evaluation of operational effectiveness, suitability, survivability, and lethality (as applicable).

## SECTION 4: M&S VV&A PROCESS

### 4.1. M&S VV&A PLANNING.

The M&S VV&A planning will:

- a. Support initiation of the acquisition program, including, but not limited to, mission engineering analysis, analysis of alternatives, development of the acquisition strategy, and the TEMP/T&E strategy.
- b. Use the latest advances in human-centered design methods and specific, measurable, achievable, relevant, time-bound (SMART) goals to support structured development of a science-based, executable M&S VV&A strategy and supporting M&S V&V plans critical to the evaluation of the DoD system's operational effectiveness, suitability, survivability, and lethality (as applicable), with scientific rigor.
- c. Continue across the acquisition life cycle to update M&S VV&A artifacts in support of acquisition decisions and maximize the use of all relevant live data to reduce the uncertainty of M&S results.
- d. Establish a predict-test-validate process by which M&S managers will update the M&S using any new, relevant data.

#### (1) M&S VV&A Input to the TEMP/T&E Strategy.

(a) The MSWG will perform the following efforts to support the development of the TEMP/T&E strategy:

1. Provide the list of M&S critical to meeting OT&E and LFT&E objectives. For each one, summarize the basic information including, but not limited to, the intended use; proper and improper employment usage; appropriate conditions for use; and basic descriptions of capabilities, limitations, and uncertainty. Identify the M&S manager and the accreditation authority.
2. Outline the M&S events, scenarios, conditions, and results required to meet OT&E and LFT&E objectives in the IDSK, along with live data requirements for V&V and the accreditation decision. The IDSK will reflect a series of predict-test-validate activities to feed applicable live data back into the M&S to support M&S V&V and improvements.
3. Summarize input to the M&S VV&A requirements that the contractor should meet and the approach that will support the acceptance of CT&E data and results in support of M&S VV&A for OT&E and LFT&E.
4. Capture funding requirements to accomplish M&S and its VV&A, including resources and schedule of laboratories, M&S managers and analysts, test ranges, specialized hardware, specialized software, and other supporting infrastructure that must be procured to conduct M&S and its VV&A.

(b) The early TEMP/T&E strategy will inform the development of requests for proposals and acquisition contracts to maximize access to contractor M&S, expertise, and resources.

## (2) M&S V&V Plans.

The M&S V&V plans must follow Military Standard MIL-STD-3022 for the outline of information required in V&V plans and must follow the procedures described in this issuance. The M&S V&V plan may be submitted as part of accreditation plans, related OT&E and LFT&E plans, or in separate M&S V&V plans, as appropriate, and must include:

(a) A detailed description of the type of M&S (e.g., hardware-in-the-loop, software-in-the-loop, humans-in-the-loop), its intended use, version control plan, capabilities, assumptions, limitations, and an assessment of uncertainty and its root cause. It must also identify the M&S manager and accreditation authority.

(b) A list of response variables for each M&S that will be used for evaluation and validation (i.e., the metric(s), rationale, and logical reasoning that will be used to match live data with simulation to determine the validity of the M&S). The response variables may be temporal in nature and measured at a particular time of execution.

(c) The range of conditions over which the M&S will undergo V&V (i.e., the factors that will be varied for M&S and live test trials in support of V&V and determination of their significance or sensitivity to the M&S output). Any conditions that will not be varied or parameters that are missing (e.g., due to assumptions and limitations) but that may significantly influence M&S results must also be described, because M&S may be considered valid under some conditions and not others.

(d) The plan for collecting live data and generating the M&S results needed for V&V (i.e., a method for strategically varying the factors that affect DoD system performance and the associated variables of interest). The plan must also describe the extent to which live data will cover the operational envelope to be explored with M&S, detail the M&S assumptions, and describe additional artifacts that will be required to validate the remaining operational envelope, when possible.

(e) A description of the live predict-test-refine feedback loop for updating the M&S based on the collected live data across the acquisition life cycle. M&S may not be validated using data which was used to create, fit, or train it.

(f) Summarize the planned V&V methodology and an analysis of the associated risk and quantification of uncertainty, including a description of mathematical methods that will be used to V&V each M&S (e.g., power analysis, justifying the amount of live test and M&S trials that are adequate to V&V each M&S suite and quantify the associated uncertainty).

(g) A schedule that shows when results from the accredited M&S will be generated.

(h) A list of the specific test points that will be executed in the M&S as justified by the mathematical test design methods and how those test points tie factors that are being varied

to the results being measured in support of VV&A and evaluation of operational effectiveness, suitability, survivability, and lethality (as applicable).

### (3) Input to Acquisition Contracts.

The OTA and LFT&E organizations must work with the program manager to inform acquisition contracts intended to ensure:

- (a) Government access to any M&S tools, M&S results, and associated VV&A reports critical to meeting OT&E and LFT&E objectives.
- (b) Delivery of data from CT&E, including relevant plans, reports, and artifacts needed for the VV&A of M&S tools.
- (c) Access to contractor subject matter expertise on M&S tools critical to meeting OT&E and LFT&E objectives.
- (d) Contractor support for government-led M&S VV&A planning activities (e.g., use of contractor systems integration laboratories and simulators, delivery of contractor-developed M&S and its VV&A artifacts) and government M&S VV&A.
- (e) Contractor support to refine and improve M&S using new data collected during testing.

## 4.2. M&S VV&A PREPARATION.

The accreditation authorities must establish an M&S VV&A readiness review process for determining and certifying M&S readiness for use in runs for record required to meet OT&E and LFT&E objectives.

## 4.3. M&S VV&A EXECUTION.

M&S VV&A must be planned and executed in accordance with the procedures outlined in this issuance and Paragraph 4.3. of DoDI 5000.98. For programs on the T&E Oversight List for OT&E and LFT&E, the M&S must be accredited for the intended use prior to the M&S runs for record event, unless a waiver is approved by the DOT&E.

## 4.4. M&S VV&A ANALYSIS AND EVALUATION.

### a. Statistical Analysis.

(1) Successful and rigorous M&S V&V requires the right data and enough data to ensure accuracy of M&S results.

(a) The right data is determined by matching conditions in the operational space in the live test and in the M&S event spanning as much of the operational space as possible. Live

data collected on range to support M&S VV&A must be directly comparable to runs for record that are generated with the simulation. The requirements of the evaluation of operational effectiveness, suitability, survivability, and lethality (as applicable) will generally dictate the test points that should be generated in M&S.

(b) Enough data is determined by conducting a prospective statistical analysis, such as a power analysis.

(2) Programs will use experimental design techniques, including, but not limited to, space-filling designs, to determine the right type and amount of test data for adequate V&V. For stochastic models with limited data or other models where experimental design is not possible, non-statistical methods along with quantitative same size justification may be appropriate.

### **b. Extrapolation.**

(1) In planning to collect live data for M&S V&V, live data should be collected in a manner that minimizes the extent of extrapolation. If live data for quantitative comparisons are unavailable, an alternative approach will be taken to determine what, if any, information may be gleaned from M&S. Some examples include characterization across the operational space, sensitivity analysis, high-fidelity model comparisons, and subject matter expert review.

(2) Empirical models (e.g., emulators or metamodels) may be used to understand M&S results across the operational space and assist in the uncertainty quantification. In the operational space where no live data are available, the results of the M&S will be discussed in the context of limitations. In some instances, the absence of live data may prevent the accreditation of the M&S for use in the operational space.

(3) In data-constrained environments, live tests may be designed to collect partial data. Structural validation that includes breaking a model into parts and validating each part and all interconnections may also be necessary in these environments. Some parts might be validated with laboratory tests and DT&E that may not be appropriate for the model as a whole. Structured data collection and analysis may be able to support the V&V of the whole M&S.

(4) In some instances, physical law or other well-established sources of knowledge may be used to extrapolate live data-based performance in one area of the operational space to another where no live data are available. In those cases, it is critical that the limitations of the M&S are understood and the uncertainty in the results quantified.

### **c. Uncertainty Quantification.**

(1) Uncertainty quantification is the process of estimating the accuracy and precision to which the M&S results are confirmed consistent with the physical phenomena they represent. Uncertainty quantification is required to assess the uncertainty present in M&S results for record and is necessary for decision makers to fully understand the risk accepted when relying upon M&S for meeting OT&E and LFT&E objectives. Statistical methods and uncertainty quantification must be included in M&S V&V to quantify the degree to which the M&S reflects accurate representations of the real world.

(2) Uncertainties may be categorized as either statistical or non-statistical. Statistical uncertainty arises from stochastic effects in a measurement process. Statistical uncertainty is caused by random effects, and it may be reduced by accumulating more samples. Non-statistical or systematic uncertainty is due to unknown but constant errors in a measurement or M&S and is independent of the number of samples. V&V reports will provide quantitative estimates of both statistical and non-statistical uncertainties using a variety of methods such as Monte Carlo simulations, even in situations where it might not be possible to quantify M&S results against real-world live data. Rough value estimation or Fermi estimates also allow for comparison to the rough estimate to quantify the uncertainty.

#### **4.5. M&S REPORTING.**

a. M&S managers must deliver the M&S V&V report(s) to the program manager, the T&E WIPT/ITT, and for programs on the T&E Oversight List for OT&E and LFT&E, the DOT&E. The reports must be generated in accordance with the M&S reporting schedule agreed upon in the TEMP/T&E strategy. The report must discuss the feedback step that tracks the agreement of M&S results with subsequent live test data to maximize the use of data in refining and improving M&S.

b. Accreditation authorities must deliver the accreditation report to the program manager, the T&E WIPT/ITT and, for programs on the T&E Oversight List for OT&E and LFT&E, the DOT&E. Accreditation authorities must deliver the accreditation report in time to support the M&S runs for record.

c. M&S managers, in coordination with either the OTA or LFT&E organizations, must report on the M&S results and their uncertainty in time to support accreditation timelines and the relevant acquisition or program decision.

d. All M&S reports must at a minimum include the uncertainty quantification of the M&S; any assumptions, capabilities, and limitations; and the live data used as a source of V&V.

e. The V&V and accreditation reports must characterize the significance of the M&S uncertainty with respect to its specific intended uses and the criteria that were used to accredit the M&S for those intended uses.

f. M&S VV&A reports indicating an operational advantage, vulnerability, or system shortfall that an adversary could exploit to gain an advantage must be protected from unauthorized disclosure to maintain operations security throughout the lifecycle of the program.

## **SECTION 5: M&S VV&A FOR ADAPTIVE ACQUISITION FRAMEWORK PATHWAYS**

M&S events must support the OT&E and LFT&E events, as appropriate, outlined for each of the adaptive acquisition framework pathways in Section 5 of DoDI 5000.98. The scope of M&S events, within the planned OT&E and LFT&E, in support of acquisition and program decisions, must be included in the IDSK within the TEMP/T&E strategy.



## GLOSSARY

### G.1. ACRONYMS.

<b>ACRONYM</b>	<b>MEANING</b>
CT&E	contractor test and evaluation
DoDD	DoD directive
DoDI	DoD instruction
DOT&E	Director of Operational Test and Evaluation
DT&E	developmental test and evaluation
IDSK	integrated decision support key
ITT	integrated test team
LFT&E	live fire test and evaluation
M&S	modeling and simulation
MBT	main battle tank
MDA	milestone decision authority
MSWG	modeling and simulation working group
OT&E	operational test and evaluation
OTA	operational test agency
SMART	specific, measurable, achievable, relevant, time-bound
SoS	system-of-systems
T&E	test and evaluation
TEMP	test and evaluation master plan
USD(A&S)	Under Secretary of Defense for Acquisition and Sustainment
USD(I&S)	Under Secretary of Defense for Intelligence and Security
USD(R&E)	Under Secretary of Defense for Research and Engineering
V&V	verification and validation
VV&A	verification, validation, and accreditation
WIPT	working-level integrated product team

**G.2. DEFINITIONS.**

Unless otherwise noted, these terms and their definitions are for the purpose of this issuance.

<b>TERM</b>	<b>DEFINITION</b>
<b>accreditation</b>	Defined in DoDI 5000.98.
<b>acquisition decision</b>	Defined in DoDI 5000.98.
<b>digital engineering</b>	Defined in DoDI 5000.98.
<b>digital twin</b>	Defined in DoDI 5000.98.
<b>emulator</b>	A computer or program that emulates or imitates another computer or program.
<b>family of systems</b>	A family of systems is a series of systems that share the same basic core system characteristics, e.g., a main battle tank (MBT). If the family is developed nearly simultaneously, then two or more variants are developed which share the characteristics of the core system and additionally have unique characteristics based on its specific mission, e.g., Army MBT, USMC MBT. If the family is improved upon over time, as in a series of upgrades, blocks, or increments, then the family consists of a first increment system and then additional increments that are similar but improved upon from the first increment system, e.g., MBT Inc1, MBT Inc2.
<b>Fermi estimate</b>	A problem-solving approach that uses rough but educated guesses to simplify complex problems. This technique is particularly useful when data are unavailable, yet a general understanding or rough approximation is needed. The approach also focuses on getting a useful answer without the large amounts of thought and research needed to attain greater accuracy.
<b>human-centered design</b>	Defined in DoDI 5000.98.
<b>IDSK</b>	Defined in DoDI 5000.98.
<b>integrated T&amp;E</b>	Defined in DoDI 5000.98.
<b>LFT&amp;E</b>	Defined in DoDI 5000.98.
<b>live data</b>	Defined in DoDI 5000.98.

<b>TERM</b>	<b>DEFINITION</b>
<b>live testing</b>	Defined in DoDI 5000.98.
<b>live, virtual, constructive environment</b>	Defined in DoDI 5000.98.
<b>metamodel</b>	A simplified model of an actual model. It can be a mathematical relation or algorithm representing input and output relations.
<b>Monte Carlo simulation</b>	A mathematical technique that predicts possible outcomes of an uncertain event. Computer programs use this method to analyze past data and predict a range of future outcomes based on a choice or action.
<b>mission thread</b>	Defined in DoDI 5000.98.
<b>model</b>	Defined in DoDI 5000.98.
<b>M&amp;S manager</b>	Responsible for the development, V&V, sustainment, and configuration management of the M&S tool(s).
<b>M&amp;S VV&amp;A</b>	Defined in DoDI 5000.98.
<b>operational effectiveness</b>	Defined in DoDI 5000.98.
<b>operational suitability</b>	Defined in DoDI 5000.98.
<b>operationally relevant</b>	Defined in DoDI 5000.98.
<b>OT&amp;E</b>	Defined in DoDI 5000.98.
<b>power analysis</b>	The calculation used to estimate the smallest sample size needed for an experiment, given a required significance level, statistical power, and effect size. It helps to determine if a result from an experiment, test, or survey is due to chance or if it is significant.
<b>program decisions</b>	Defined in DoDI 5000.98.
<b>realistic full spectrum lethality</b>	Defined in DoDI 5000.98.

<b>TERM</b>	<b>DEFINITION</b>
<b>realistic full spectrum survivability</b>	Defined in DoDI 5000.98.
<b>stochastic</b>	Having a random probability distribution or pattern that may be analyzed statistically but may not be predicted precisely.
<b>runs and results for record</b>	Defined in DoDI 5000.98.
<b>scientific rigor</b>	Defined in DoDI 5000.98.
<b>simulation</b>	Defined in DoDI 5000.98.
<b>SMART</b>	Refers to specific, measurable, achievable, relevant, and time-bound goals. SMART helps ensure that T&E objectives are attainable within a certain timeframe. This approach eliminates generalities and guesswork, sets a clear timeline, and makes it easier to track progress and identify missed milestones.
<b>SoS</b>	Defined as “system-of-systems” in DoDI 5000.98.
<b>T&amp;E Oversight List</b>	Defined in DoDI 5000.98.
<b>T&amp;E resources</b>	Defined in DoDI 5000.98.
<b>uncertainty quantification</b>	Defined in DoDI 5000.98.
<b>validation</b>	Defined in DoDI 5000.98.
<b>verification</b>	Defined in DoDI 5000.98.

## **REFERENCES**

- DoD Directive 5000.01, “The Defense Acquisition System,” September 9, 2020, as amended
- DoD Directive 5141.02, “Director of Operational Test and Evaluation (DOT&E),”  
February 2, 2009
- DoD Directive 5205.07 “Special Access Program (SAP) Policy,” July 1, 2010, as amended
- DoD Instruction 5000.02, “Operation of the Adaptive Acquisition Framework,”  
January 23, 2020, as amended
- DoD Instruction 5000.61, “DoD Modeling and Simulation (M&S) Verification, Validation, and  
Accreditation (VV&A),” December 9, 2009, as amended
- DoD Instruction 5000.98, “Operational and Live Fire Test and Evaluation,” December 9, 2024
- Military Standard MIL-STD-3022, “Documentation of Verification, Validation, and  
Accreditation (VV&A) for Models and Simulations,” January 28, 2008, as amended
- Public Law 117-81, Section 223, “National Defense Authorization Act for Fiscal Year 2022,”  
December 27, 2021
- United States Code, Title 10