COMOPTEVFOR INSTRUCTION 5000.1C

From: Commander, Operational Test and Evaluation Force

Subj: USE OF MODELING AND SIMULATION IN OPERATIONAL TEST

Ref: (a) DoDI 5000.61
     (b) 10 U.S.C. §§ 2399
     (c) DoDI 5000.02
     (d) SECNAVINST 5000.2E
     (e) OPNAVINST 3880.6A
     (f) SECNAVINST 5200.40
     (g) MIL-STD-3022 with Change 1
     (h) COMOPTEVFORINST 3980.2H
     (i) OPNAVINST 3960.15B
     (j) Director Operational Test and Evaluation (DOT&E) Handbook on Statistical Design and Analysis Techniques for M&S Validation, DRAFT Version 2, February 2018

Encl: (1) Acronyms and Abbreviations

1. **Purpose.** This instruction provides guidance on using Modeling and Simulation (M&S) in Operational Test and Evaluation (OT&E).

2. **Cancellation.** COMOPTEVFORINST 5000.1B.

3. **Background.** M&S is the discipline that comprises the development and/or use of models, simulations, and associated data. A model is defined as a physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process per reference (a). A model attempts to replicate a system, adding understanding of how a system will work. A simulation is a method for implementing a model on how a system performs over time per reference (a). M&S is used often throughout the acquisition life cycle to inform decision makers and manage risk. This instruction provides guidance on using M&S specific to Operational Test and Evaluation (OT&E).

   a. **M&S and OT&E.** OT&E is an important component of the overall acquisition process. It provides stakeholders with an independent assessment of system effectiveness and suitability. M&S may be used in addition to live-test events to support this assessment. Table 1 provides a summary of general M&S implementation types. In practice, the M&S in question may be a combination or extension of the types listed in Table 1.
<table>
<thead>
<tr>
<th>Simulation Environment</th>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Simulation</td>
<td>DSIM</td>
<td>A full digital representation of the system and intended operational environment</td>
</tr>
<tr>
<td>Hardware in-the-Loop</td>
<td>HITL</td>
<td>A simulation environment that includes actual system hardware</td>
</tr>
<tr>
<td>Software in-the-Loop</td>
<td>SITL</td>
<td>A simulation environment incorporating actual system software and logic</td>
</tr>
<tr>
<td>Operator in-the-Loop</td>
<td>OITL</td>
<td>A simulation environment designed to include inputs and decisions from at least one operator</td>
</tr>
<tr>
<td>Land-Based Test Facility</td>
<td>LBTF</td>
<td>A simulation environment, constructed on an open range, which incorporates various aspects of DSIM, HITL, SITL, OITL, and/or live-test assets</td>
</tr>
<tr>
<td>Laboratory/Chamber</td>
<td>LAB</td>
<td>A facility allowing for the stimulation via DSIM, HITL, SITL, and/or OITL of various aspects of an operational system in a closed secure environment</td>
</tr>
<tr>
<td>Threat Representation</td>
<td>TR</td>
<td>Any engineering representation (physical or digital) of a threat system which will be used</td>
</tr>
<tr>
<td>C4I System Integration Environments and Facilities</td>
<td>C4IEF</td>
<td>A Command, Control, Communications, Computers, and Intelligence (C4I) environment, that operates external to the System Under Test (SUT)/System of Systems (SoS), and provides the capability to test system function and interoperability.</td>
</tr>
<tr>
<td>Reliability Simulation</td>
<td>RSIM</td>
<td>A simulation that provides reliability predictions for the SUT in live/captive carry/chamber or DSIM to represent the SUT</td>
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</table>

b. Laws and Guidance. The use of M&S as the only basis for making evaluations (Initial Operational Test and Evaluation (IOT&E) or Follow-on Operational Test and Evaluation (FOT&E)) is strictly prohibited under reference (b). Thus, every Operational Test (OT) must have some form of live testing to evaluate effectiveness and suitability. In this context, “live” testing refers to testing that employs the actual SUT in the intended operational environment. In addition to U.S. Code, Department of Defense and service component guidance has been provided to the acquisition community in references (c) and (d). Reference (c) states the conduct of T&E, integrated with M&S, shall facilitate learning, assess technology maturity and interoperability, facilitate integration into fielded forces, and confirm performance against documented capability needs and adversary capabilities. Per reference (e), the Navy Science and Technology Intelligence Liaison Officer (STILO) provides consistent liaison and coordination among the acquisition, Research, Development, Test and Evaluation (RDT&E) communities and intelligence community. The coordinated efforts of the Office of Naval Intelligence (ONI) and the STILO will ensure accurate updated threat intelligence data for M&S. Analysts from the ONI, or another appropriate intelligence agency, will participate as an Integrated Product Team (IPT) member in developing and review of validation reports. This will ensure the validity and accuracy of threat descriptions, threat data, and associated capabilities emulated by the threat representation. Similarly, reference (d) states M&S may be used during T&E of an Acquisition
Category program to represent conceptual systems that do not exist, and existing systems, which cannot be subjected to actual environments due to safety requirements or the limitations of resources.

c. **Accreditation.** The use of M&S to supplement OT&E is not automatic and requires accreditation by the Operational Test Agency (OTA). Accreditation is defined as the official certification of a model or simulation, and its associated data, is acceptable for use for a specific purpose per reference (a). Reference (c) states that every distinct use of a model or simulation, in support of an operational evaluation, must be accredited for each intended use by the OTA for a specific phase of test. The intended use describes the problem the M&S will address, including the system or process being represented, and the role it plays in the overall program. Reference (f) states COMOPTEVFOR is the OTA and accreditation authority for all M&S used to support Navy OT&E. For programs under Director, OT&E (DOT&E) Oversight, the use of M&S in support of OT&E must be approved by DOT&E per reference (c). Accreditation Plans must be approved as early as possible, but not later than the OT Readiness Review. During this M&S approval process DOT&E will:

1. Agree/concur with M&S during the COMOPTEVFOR Integrated Evaluation Framework (IEF) development process.
2. Review and concur with the COMOPTEVFOR Accreditation Plan.
3. Approve the Test and Evaluation Master Plan.
4. Approve the COMOPTEVFOR test plan prior to each phase of OT&E.

d. **Verification and Validation (V&V).** The accreditation decision is based on results of V&V efforts. V&V provides the rigorous testing and analysis necessary to support a subsequent OT accreditation. Verification is defined as the process of determining that a model or simulation implementation and its associated data accurately represent the developer's conceptual description and specifications in reference (a). Validation is defined as the process of determining the degree to which a model or simulation and its associated data are an accurate representation of the real world from the perspective of the intended uses of the model in reference (a). The Program Manager (PM) is required to complete a V&V Plan and the V&V Report, prior to an accreditation decision by the OTA reference (d). The V&V plan will define the PM’s strategy to fulfill the OTA’s accreditation requirements as defined in the OTA approved Accreditation Plan. Paragraph 5 (j) below is a detailed discussion of the Verification, Validation, and Accreditation (VV&A) process.

e. **VV&A Stakeholders.** VV&A requires a collaborative effort amongst all stakeholders. The stakeholders involved in the overall VV&A process, and therefore affected by this instruction are as follows:
(1) **Accreditation Authority (AA).** The organization or individual who approves using M&S for a particular intended use. The AA represents the M&S user's interests. The AA is a government entity. COMOPTEVFOR is the AA for OT.

(2) **Accreditation Agent.** The individual, group, or organization, designated by the accreditation authority, to conduct an accreditation assessment of any model or simulation. In OT, the accreditation agent is the cognizant COMOPTEVFOR division director (A-code).

(3) **M&S Developer.** The individual, group, or organization, responsible for developing or modifying a simulation, per a set of design requirements and specifications.

(4) **M&S Proponent.** The organization (typically the program office) who has primary responsibility for M&S planning and management to include funding, development, V&V, configuration management, maintenance, and use of models and/or simulations.

(5) **M&S Use.** The individual, group, or organization, who uses the results or products from a specific application of M&S. The M&S user is a government entity. In OT, COMOPTEVFOR, DOT&E, and the Fleet are M&S users. Similarly, for DT the PM is an M&S user.

(6) **Subject Matter Expert (SME).** An individual who, by virtue of education, training, or experience, has expertise in a particular technical or operational discipline, system, or process.

(7) **V&V Agent.** The individual, group, or organization, designated by the M&S proponent, to verify and validate M&S.

(8) **Intelligence Production Center (IPC).** The agency designated to provide a threat model containing IPC validated representation of the advisory threat.

4. **Scope and Applicability.** This instruction is applicable to all Navy acquisition programs intending to use M&S in support of OT&E.

5. **Policy.** Policies on using M&S, V&V evidence, and documentation are as follows:

   In addition to the formal M&S document processes described below, COMOPTEVFOR warfare divisions will proactively socialize M&S requirements and processes as early as possible with the appropriate Program Office M&S leadership. They will maintain frequent and open communications throughout the system development and test processes, to anticipate and resolve issues as they arise.

   a. **COMOPTEVFOR will attend M&S WIPTs with all stakeholders to include the program office, technical support, and oversight during development of the overall VV&A plan.** The PM will establish an M&S WIPT that includes all M&S stakeholders as soon as feasible in the acquisition process. The COMOPTEVFOR Operational Test Director (OTD), or designated representative, will participate on all M&S WIPTs, and will clearly and proactively articulate COMOPTEVFOR positions on V&V plans, results, and emergent issues. Unresolved issues will be reported immediately back to headquarters, and an appropriate plan of action will be
identified. A strong M&S WIPT is essential to successful application of M&S in OT. Any delays or gaps in the WIPT process should be communicated quickly by the OTD to warfare division leadership and the PM.

b. COMOPTEVFOR may withhold an accreditation decision until all referent data has been collected and OT M&S results have been analyzed. Referent data is defined as the data that provides the information which M&S results are compared to validate M&S. No M&S results will support OT&E evaluation in an OT report (Operational Assessment (OA), Quick Reaction Assessment (QRA), IOT&E, and FOT&E) without an accreditation.

c. COMOPTEVFOR will require notification of any and all changes to the M&S during V&V and formal OT, and must provide approval to continue the V&V and formal OT.

d. COMOPTEVFOR reserves the right to invalidate M&S results if modifications to the M&S are judged to alter the operational representation prior to completing all M&S Runs-For-the-Record (RFR). In such cases, additional V&V may be required to accredit the M&S for use during OT.

e. COMOPTEVFOR will designate a STILO to ensure accurate and up-to-date representation of advisory threats throughout the M&S process.

f. For multi-service OT, M&S will be conducted per the lead OTA’s guidelines and policies. Analysis and accreditation of M&S will be a collaborative effort of all OTAs involved.

g. The use of M&S must be identified in the OPTEVFOR IEF, TEMPs, and Test Plans.

h. COMOPTEVFOR will require the following information from the M&S Proponent to support accreditation plan development:

(1) Updates or recommended changes to OT intended uses.

(2) Schematic diagrams of the conceptual simulation architecture and individual simulations.

(3) Listing of all assumptions and limitations associated with all model federates (if any) and the overall federation of models.

(4) Descriptions of the factors that describe the operational envelope.

(5) OT measures of interest.

(6) Identification of all referent data to be used for validation.

(7) Details on the program’s M&S configuration management plan.

(8) Listing of all significant input parameters and a quantification of input parameter uncertainty.
(9) Development of Acceptability Criteria (AC). AC development for all federated models, and some complex stand-alone models, may require inputs from the M&S WIPT, comprised of SMEs from DT, OT, the M&S Proponent, and the M&S developer.

i. COMOPTEVFOR will require the M&S Proponent to provide the following information as part of V&V Reports.

(1) Analysis of M&S results using Design of Experiments to characterize performance across the operational envelope for the intended use(s). COMOPTEVFOR warfare divisions or COMOPTEVFOR 01B will support characterization analysis if requested. Reference (j) is identified as an additional resource to M&S proponents.

(2) Comparisons of the outcomes of live-test events with simulation results, where applicable, replicating each live test event.

(3) A PM recommendation for accreditation of models for use in OT.

(4) When the model is a federation of models: In addition to individual federate V&V reports, one should provide a summary V&V report encompassing the entire kill chain across all federates addressing any additional assumptions and limitations.

j. The VV&A process shall be properly documented, to include specific intended usage and proposed M&S articles. The Simulation Coordination Office developed reference (g) to establish templates to support the M&S VV&A process. Reference (g) should be consulted by all stakeholders during the documentation process. The core documentation associated with the COMOPTEVFOR VV&A process is as follows:

(1) Integrated Evaluation Framework (IEF). This document formalizes the overall data requirements, test design, and M&S resources necessary to resolve the Critical Operational Issues (COI). This is the first formal acknowledgement M&S will be used in OT to supplement live-test events. COMOPTEVFOR M&S intended uses are presented in this document. Definitions of RFR are included in the IEF. COMOPTEVFOR is responsible for developing and disseminating this document. The IEF will describe all M&S anticipated to support OT, including all simulated environments listed in table 1. This document is required for all M&S (e.g. DSIM, HITL, SITL, OITL, LBTF, LAB, Target (TGT), C4IEF, and RSIM). The IEF is discussed in reference (h).

(2) M&S Requirements Letter: This document summarizes the capabilities the M&S must possess to satisfy the OT intended use(s) identified in the IEF. COMOPTEVFOR is responsible for developing and disseminating this document. It is a formal letter from the COMOPTEVFOR warfare division director, to the M&S proponent, communicating the intent to use M&S for OT. If M&S is required for a program, it can be provided to the program office prior to IEF commencement. Draft COMOPTEVFOR M&S intended uses are presented in this document. This document must be provided to the program office no later than 60 days after completing In Progress Review-2 (IPR-2), the last meeting of the COMOPTEVFOR Mission Based Test Design (MBTD) Process. The IPR-2 meeting finalizes the description of the M&S
used to supplement live test events. The MBTD process is discussed in reference (h). The development of the M&S requirements must be a collaborative effort with all stakeholders. This document is required for all M&S (e.g. DSIM, HITL, SITL, OITL, LBTF, LAB, TGT, C4IEF, and RSIM).

(3) **M&S Accreditation Plan.** This document focuses on:

(a) Defining the scope of the accreditation associated with V&V efforts,

(b) The criteria to be used during the accreditation assessment,

(c) Defining the methodology to conduct the accreditation assessment,

(d) Establishing a configuration management plan, and

(e) Identifying issues associated with performing the accreditation assessment.

The overall resource requirements needed to perform the accreditation assessment and conduct OT are determined as part of the (MBTD) Process. The resource requirements are documented in the IEF and the associated accreditation plan. COMOPTEVFOR is responsible for developing and disseminating this document. The accreditation plan must be provided to the M&S proponent to support development of the V&V plan prior to completing formal OT M&S runs. These formal OT M&S runs, often referred to as RFR, are defined in the IEF and considered to be the minimum but adequate number of runs required to resolve the associated COIs. The scope of the accreditation plan will be tailored to match each unique simulation environment. DOT&E, for oversight programs, reviews and concurs with the accreditation plan prior to COMOPTEVFOR accreditation plan approval. This document is required for the following types of M&S (e.g. DSIM, HITL, SITL, OITL, LBTF, LAB, and RSIM).

(4) **V&V Plan.** This document defines the methodology for scoping the V&V effort to the application and the acceptability criteria. It defines the V&V tasks that will produce information to support the accreditation assessment. It also defines the resources needed to perform the V&V, the V&V schedule, and identifies issues associated with performing V&V. The M&S proponent is responsible for the development, approval, and dissemination of this document. The V&V plan will normally commence when the PM has a signed accreditation plan from COMOPTEVFOR, and considers the model mature enough to conduct RFRs. This document is required for all M&S (e.g. DSIM, HITL, SITL, OITL, LBTF, LAB, TGT, C4IEF, and RSIM). V&V Plans, executed prior to approval of the Accreditation Plan, may require the collection of additional data in the approved Accreditation Plan.

(5) **V&V Report(s).** This document focuses on:

(a) Results of the V&V tasks,

(b) Documents M&S assumptions, capabilities, limitations, risks, and impacts,

(c) Identifies unresolved issues associated with V&V implementation, and
(d) Documents lessons learned during V&V.

The M&S proponent is responsible for developing and disseminating this document. For a federation of models, V&V reports shall include the task analysis and the M&S assumptions, capabilities, limitations, and risks for each federate and the overall federation of models. The V&V report must be provided to COMOPTEVFOR prior to the OT M&S accreditation decision by COMOPTEVFOR. The V&V report often requires OT data for validation, and in these cases, will not be submitted until after the start of OT. The V&V report must include an accreditation recommendation from the PM. This document is required for all M&S (DSIM, HITL, SITL, OITL, LBTF, LAB, TGT, C4IEF, and RSIM). V&V reports for TR should include all configurations or profiles presented to the SUT during OT&E, taking into account target modifiers or payloads like Electronic Attack emitters, infrared emissions generators, or underwater acoustic noise generators. For test targets where a completed V&V report exists from prior use in OT&E, a V&V report supplement may be required to document the necessary data (as described above) for any novel profiles or configurations planned by the current program. If a program will be using a test target in the same manner as described in a previously used V&V report, then that previously used V&V report can be submitted for accreditation without a supplement. If RFR analysis identifies significant flaws in the model, a V&V addendum will be issued, quantifying the new M&S limitations; or additional resources will be negotiated with the PM to allow for correction of the M&S and follow-up live event(s) to confirm the corrections, including regression confirmations.

(6) Accreditation Memo. This document is optional, and focuses on COMOPTEVFOR’s approval to conduct the OT RFR based on a review of the V&V report. The accreditation memo content is the same as the final accreditation letter minus the RFR analysis. Based on the level of resources required to conduct RFR, the model proponent can request an accreditation memo from COMOPTEVFOR approving the conduct of RFR.

(7) Accreditation Report or V&V Addendum. This document is optional and focuses on documenting any additional analysis or interpretations not already included in the V&V Report. Specifically, the Accreditation Report should be used to document situations where only limited or no accreditation will be achieved. The V&V Report(s), plus any additional analysis in this addendum, form(s) the basis for the accreditation decision. COMOPTEVFOR is responsible for developing and disseminating this document.

(8) Accreditation Letter. This document summarizes the findings and final decision to:

(a) Fully accredit,

(b) Accredit with limitations, or

(c) Not accredit the M&S in question to support the OT intended use(s).

COMOPTEVFOR is responsible for developing and disseminating this document. This document is required for all M&S (DSIM, HITL, SITL, OITL, LBTF, LAB, TGT, C4IEF, and
RSIM). The accreditation letter must be approved prior to including M&S results in any OT report (QRA, OA, IOT&E, and FOT&E).

Figure 1 illustrates the Verification, Validation, and Accreditation process discussed in paragraph 5(j) 1-8 above.

**Figure 1. Verification, Validation, and Accreditation Process**

- Integrated Evaluation Framework (COMOPTEVFOR)
  - Requirements Letters (COMOPTEVFOR)
  - Accreditation Plan (COMOPTEVFOR)
  - Verification and Validation Plan (Program)
    - V&V Report (Program)
    - Runs-for-Record
    - Optional Accreditation Memo (COMOPTEVFOR)
  - Accreditation Letter (COMOPTEVFOR)

k. Threat Simulations: For Navy threat targets and digital threat representations, the Office of the Chief of Naval Operations, Deputy Director of Naval Intelligence (OPNAV N2N6I) and the COMOPTEVFOR designated STILO will participate in developing and review of V&V reports. This will ensure the validity and accuracy of threat descriptions, and the threat data and associated capabilities emulated by the threat representation. Per reference (i) for threat representations, an entity, independent of the developing agency, who possesses a thorough understanding of references (a) through (i), will manage the validation effort, and will serve as the validation IPT lead. This same entity will be responsible for developing the validation report, and coordinating data measurement efforts. A validation IPT should be established and comprised of an IPT lead and SMEs from the developing entity, appropriate warfare centers, the intelligence and T&E communities, the resource sponsor, and the Test and Evaluation Threat Resource Activity.

6. Records Management

   a. Records created as a result of this instruction, regardless of format or media, must be maintained and dispositioned for the standard subject identification codes (SSIC) 1000, 2000, and 4000 through 13000 series per the records disposition schedules located on the Department of the Navy/Assistant for Administration (DON/AA), Directives and Records Management Division (DRMD) portal page at
For SSIC 3000 series dispositions, please refer to part III, chapter 3, of Secretary of the Navy Manual 5210.1 of January 2012.

b. For questions concerning the management of records related to this instruction or the records disposition schedules, please contact your local records manager or the DON/AA DRMD program office.

7. Review and Effective Date. Per OPNAVINST 5215.17A the Administrative Officer will review this instruction annually on the anniversary of its issuance date to ensure applicability, currency, and consistency with Federal, Department of Defense (DoD), SECNAV, and Navy policy and statutory authority using OPNAV 5215/40. This instruction will automatically expire five years after its issuance date unless reissued or canceled prior to the five year anniversary date, or an extension has been granted.

P. A. SOHL

Releaseability and distribution:
Electronically only, via COTF KMS website https://kms.cotf.navy.mil
ACRONYMS AND ABBREVIATIONS

AA  Accreditation Authority
AC  Acceptability Criteria
C4I  Command, Control, Communications, Computer, and Intelligence
C4IEF  C4I System Integration Environments and Facilities
COI  Critical Operational Issue
COMOPTEVFOR  Commander, Operational Test and Evaluation Force
DoDI  DoD Instruction
DOT&E  Director, Operational Test and Evaluation
DSIM  Digital Simulation
FOT&E  Follow-on Operational Test and Evaluation
HITL  Hardware in-the-loop
IEF  Integrated Evaluation Framework
IOT&E  Initial Operational Test and Evaluation
IPC  Intelligence Production Center
IPR  In Progress Review
IPT  Integrated Product Team
LAB  Laboratory/Chamber
LBTF  Land-Based Test Facility
M&S  Modeling and Simulation
MBTD  Mission Based Test Design
OA  Operational Assessment
OITL  Operator in-the-loop
ONI  Office of Naval Intelligence
OPTEVFOR  Operational Test and Evaluation Force
OT  Operational Test(ing)
OT&E  Operational Test and Evaluation
OTA  Operational Test Agency
OTD  Operational Test Director
PM  Program Manager
QRA  Quick Reaction Assessment
RFR  Runs-For-the-Record
RSIM  Reliability Simulation
SITL  Software in-the-Loop
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<tr>
<th>Acronym</th>
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<tr>
<td>SME</td>
<td>Subject Matter Expert</td>
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<tr>
<td>SoS</td>
<td>System of Systems</td>
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<td>STILO</td>
<td>Science and Technology Intelligence Liaison Officer</td>
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<td>System Under Test</td>
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