

M&S for Test and Evaluation - Guidance

The Modeling and Simulation (M&S) sections of the TEMP should address how M&S will be employed in the overall test strategy and how the M&S will be verified, validated and accredited (VV&A). Specifically, the TEMP should list any M&S expected to be used, the intended use, an estimate of the data requirements¹, the test objectives to be addressed and/or how test scenarios will be supplemented with M&S, the planned VV&A effort, and who will conduct the VV&A effort ([DoDI 5000.61](#)). The TEMP should list any specific test events required for VV&A of the M&S. The resources for the VV&A test events will be included in Part IV.

M&S capabilities can be used to support developmental, operational and live fire testing, but their credibility must be shown. Addressing the following questions in the TEMP will help in assessing M&S adequacy for a potential T&E application:

- What are the strengths and weaknesses of the M&S capability for T&E; e.g., will the uncertainty and risk reduction in the program be worth the time and cost to develop or acquire and use the M&S capability and complete accreditation?
- What major assumptions will be made in developing the M&S capability, and how would faulty or inaccurate assumptions impact the expected outcome and benefits of M&S use?
- What are the source(s) and the currency of the data and information used for M&S development and validation, and are these adequate?
- What field test data are – or will be – available to support validation and accreditation?
- Under what conditions will the M&S need to be validated for the purpose of accreditation?
- Has an existing capability gone through a verification, validation, and accreditation process?

DOT&E requires all OT&E and LFT&E test agencies to accredit models used to resolve critical operational issues (COIs) for OT&E and critical issues for LFT&E. The accrediting test agency will establish the acceptability criteria for M&S use, and the accreditation must be based on a verification and validation approach that is tailored for the specific intended use of the model or simulation. This means that the OTA will conduct their own assessment to accredit M&S for their use in OT. DOT&E must review and concur with the OTA's accreditation plan before the plan is executed.

¹ Specific details on the type and amount of data needed for validation should be provided in the Operational Test Plan.

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Some important criteria for M&S accreditation for use in conjunction with operational and live fire T&E are:

- Adequate technical information that (quantitatively) evaluates M&S results with respect to actual systems being operated by typical users in realistic operational environments, and the extent to which the technical information covers the performance envelope of the system. In many cases, statistical methods can and should be used to collect and analyze the data from a validation experiment.
- Documentation which summarizes the purpose, development background, assumptions, and application domains and provides a complete and accurate description of M&S capabilities and limitations.
- Sound approaches for M&S capability acquisition, validation, and use.

M&S capabilities used for T&E should be planned and resourced early. The M&S capabilities to be used, the T&E aspects of the system evaluation that these M&S capabilities will address, and the approach for assessing credibility of these models and simulations should all be described in the TEMP.

Establishing M&S Credibility for T&E

Under [DoDI 5000.61](#), each M&S capability must complete a verification, validation, and accreditation (VV&A) process to establish its credibility for a specific intended use. Some M&S capabilities associated with T&E have special validation requirements. If it is necessary, for example, to validate that a non-US forces or threat weapon is appropriately represented in a model, the Director, Defense Intelligence Agency is the final validation authority for oversight systems. DOT&E, through the T&E Threat Resource Activity (TETRA), is the approval authority for threat representation validation reports used for T&E. OTAs accredit threat representation models for use in OT. [The Defense Acquisition Guidebook, Section 9.7.3](#), Validation of Threat Representations (targets, threat simulators, or M&S) provides guidance and references on validating M&S capabilities associated with threats and targets.

Existing M&S capabilities previously accredited for other applications must complete another VV&A process and be accredited for each new intended use. However, previous VV&A may simplify the process because the previous efforts have been documented and the new VV&A effort typically can focus on the changes.

Verification determines whether the M&S accurately represents the developer's specifications. The M&S is expected to add two numbers; does it add two numbers? Validation determines whether the model is an accurate representation of specific aspects of the real world or threat system. The M&S is expected to add two numbers; does it provide the correct sum? Accreditation is the official certification that the M&S and its associated data are acceptable for an intended use.

For accreditation, the intended use is important because an M&S capability useful in one application may not be useful in another due to limitations inherent in the M&S capability, existing validation data, or a prior VV&A process. The accreditation will explicitly state the

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intended use, such as: “The Big Weapon Model will be used to estimate the miss distance between the weapon and the target in support of developmental test DT-II.” It also should acknowledge any significant limitations: “The Big Weapon Model does not include threat countermeasures, and consequently all scenarios are simulated in a clear environment.”

The scope of the accreditation effort and VV&A process are functions of how each M&S capability will be used. For example, high level or conceptual models are often used early in a program (e.g., a spreadsheet model used to estimate system performance) that require limited data for validation and accreditation. Frequently, M&S capabilities used in prior similar programs can be used and pre-existing VV&A artifacts and analysis can simplify or streamline the VV&A process for the new application. At the other extreme are high-fidelity models an evaluator might use to assess a Key Performance Parameter or to help resolve a Critical Operational Issue (e.g., a hardware-in-the-loop missile model used to estimate performance against countermeasures); these must undergo a rigorous VV&A process. In general, the more important the M&S results are to the final evaluation, the more rigorous the VV&A process must be. Where appropriate, Design of Experiments techniques should be leveraged to ensure that test data supporting the VV&A clearly defines the performance envelope of the model or simulation, and corresponding statistical analysis techniques should be employed to analyze the data and identify factors that influence the validity of the M&S.

Some common pitfalls in using M&S for T&E that should be avoided are:

- Faulty assumptions in developing or using M&S such as assuming independence between events that actually have some type of dependency or relationship.
- Using M&S results outside their validation domain which are uncharacterized and include unknown uncertainties.
- Improper use of data for M&S development or validation such as relying solely on heart-of-the-envelope performance data or using specification values instead of actual performance data when the latter is available.
- Averaging validation results across conditions rather than discussing where the M&S is valid and where it isn't.

References

[DoDI 5000.02, 7 January 2015](#)

[DoDI 5000.59](#)

[DoDI 5000.61](#)

[Defense Acquisition Guidebook, Sections 9.7.2 and 9.7.3](#)

Examples

[M&S for OT&E Examples](#)

[M&S for LFT&E Examples](#)