VV&A of Legacy Simulation Overview

VV&A Recommended Practices Guide (RPG)
Core Document

15 September 2006[1]

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[1] This document replaces the 8/4/04 beta version. It contains updated material and formatting changes.

This document corresponds to the web version of the VV&A RPG document of the same name and date. It has been modified to make it suitable for printing.

What Is a Legacy Simulation?

A legacy simulation[2] is any existing model, simulation, or federation of simulations that was developed for a purpose different from the application for which it is being considered.

Examples:

- A missile defense system is being modified to counter a newly identified threat. A simulation of the system is being used to examine alternative approaches. Differences include the data and operational characteristics of the new threat and the alternatives being considered.
- A stand-alone, multi-sided, deterministic, discrete-event simulation developed for use in Joint Task Force analysis is selected for use in a Unit of Employment study. Differences in application include the force structures, weapon systems, and operations and tactics.
- A stand-alone, multi-sided, deterministic, discrete-event simulation used in Joint Task Force and Unit of Employment (UE) studies is being considered for use as the driver in a major UE/Unit of Action (UA) experiment. Differences in application include ability to coordinate and communicate with other simulations in a federation.

There are both advantages and disadvantages associated with using a legacy simulation. Advantages include

- Expediency -- starting with a legacy simulation may be more expedient, requiring less time and fewer resources than a new development
- Established knowledge base -- the experience of previous developers, modifiers, and users may be leveraged to establish a knowledge base that can provide guidance and support training
- Testing and VV&A documentation -- testing and VV&A histories can provide evidence of simulation capabilities and limitations allowing the current effort to focus on high risk areas
- Reputation -- a legacy simulation with a good reputation for providing credible results in similar applications can increase the simulation's credibility (i.e., the User's confidence in the simulation's ability to address the current situation) due to
  - the demonstrated ability to address similar requirements
  - the demonstrated capabilities of the existing simulation

[2] Throughout this document the term *simulation* is used to denote either a model or a simulation and the term *legacy simulation* is used to denote a model or simulation of any type (including hardware-in-the-loop [HWTL], human-in-the-loop [HITL], etc.) that has been used previously or was developed for a different application.

  - the direct experiences of previous users who successfully applied the simulation to related problems

Disadvantages that can impact an intended application include

- M&S requirement differences -- the simulation was developed to address different requirements, which may not correspond to the M&S requirements of the intended application
- Data issues -- the simulation comes with specific data needs; however, the data to fulfill those needs may no longer be authoritative or available
- Hardware and software problems -- the simulation comes with specific hardware and software, which may be obsolete
- Inadequate documentation -- information about the simulation and its previous usage may be incomplete or inconsistent
- Dissimilarities in intended use -- the simulation software may contain unknown or undocumented errors that affect the simulation's behavior when applied to the new purpose
- Inadequate knowledge base -- participants (e.g., Accreditation Agent, V&V Agent) may need time up front to acquire knowledge about the simulation
- Unforeseen consequences -- unexpected and undesirable side effects may occur during execution of the code[3]

Cost, in terms of time and resources, is a major consideration when choosing whether to use a legacy simulation or build a new one. Although using an appropriate legacy simulation is generally considered less costly than developing a new simulation, the User does need to make some investment and allocate some time in the schedule to prepare and accredit a simulation for a new purpose. Factors that can increase costs include

- the need to locate or generate information because the simulation's documentation is incomplete or unavailable
- changing or adding capabilities to an existing simulation to suit the new purpose
- validating the modified legacy simulation
- training users to effectively operate a legacy simulation
- providing local maintenance and support for an unsupported or modified simulation

Factors that can help reduce costs include:

[3] Note that such side effects may have occurred in previous applications but not have been a problem because of differences in the requirements.

- documentation that can directly support the accreditation assessment can reduce the burden of an extensive discovery effort
- documentation that completely and accurately describes simulation capabilities and use history can reduce the discovery and training costs
- a simulation under configuration control with an established user community that can provide necessary information can reduce the support and discovery costs
- participants familiar with the simulation can reduce the need for extensive training

How Does the Nature of a Legacy Simulation Impact VV&A?

Both the accreditation process and the V&V effort are heavily influenced by the nature of a legacy simulation, (e.g., development for a different purpose, range of previous usage). In new simulation development, the V&V effort is worked hand-in-hand with the development effort to locate and resolve problems before they become major, identify development risk, and collect evidence for the accreditation effort. During the accreditation assessment this evidence is evaluated to determine the risks involved in using the simulation. In legacy simulation usage, both the V&V and accreditation efforts are focused on understanding the capabilities of the existing simulation, identifying the risks associated with using it, and determining what needs to be done to ensure it can satisfy the needs of the intended application.

The VV&A effort for a legacy simulation begins with an assessment of the information available about both the simulation and the intended application to determine if the information is sufficient to provide a clear and complete understanding of both. When information is lacking, decisions are made on how best to obtain it. Once sufficient information is available, the VV&A effort assesses the simulation capabilities to determine if they address the requirements. If deficiencies are found, decisions are made how best to address them. The VV&A effort then evaluates how well each deficiency has been addressed and assesses the fitness of the simulation for the intended use.

Who Participates in the VV&A of a Legacy Simulation?

The basic roles responsible for performing or supporting legacy simulation VV&A include

- **User** – the role responsible for defining the problem (e.g., M&S requirements, measures, acceptability criteria, referent), determining how to solve it, and making the accreditation decision[4]
- **Accreditation Agent** – the role responsible for conducting the accreditation assessment[5]
- **V&V Agent** – the role responsible for providing evidence of the simulation's fitness for the intended use by ensuring that all the necessary V&V tasks are properly carried out[6]

Three other roles are involved primarily when a legacy simulation needs modification:

- **M&S Program Manager (PM)** – the role responsible for managing the modification of the simulation for the intended use, when needed
- **Developer** – the role responsible for providing technical expertise regarding simulation capabilities, for preparing data for use in the simulation, and for making code modifications and developing new code, when needed
- **M&S Proponent (M&S Pro)** – the role responsible for managing the legacy simulation throughout its lifecycle, including configuration management, application, and maintenance, and for approving all modifications to the authorized version of the simulation[7]

What Are the Major Events in the VV&A of a Legacy Simulation?

Flow Diagram for Legacy VV&A

The VV&A of a legacy simulation can be depicted as a series of events and associated decisions. In the diagram below, the boxes and diamonds identify major events and decisions and the connecting arrows indicate typical paths to be followed. The roles normally responsible for each event and decision are identified in brackets, the role with primary responsibility being listed first.

The remainder of this section uses the events, decisions, and relationships depicted in the flow diagram to describe the legacy VV&A process.

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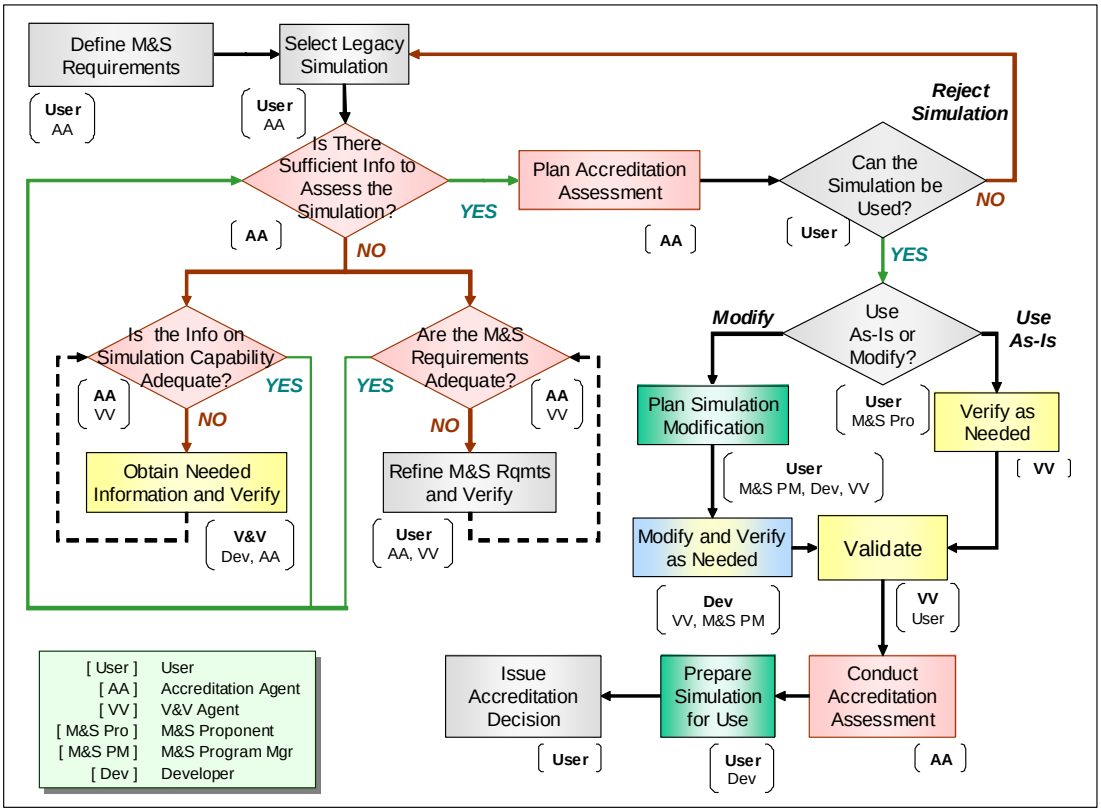
[4] See the core document on the User Role in the VV&A of Legacy Simulations for additional information.
[5] See the core document on the Accreditation Agent Role in the VV&A of Legacy Simulations for additional information.
[6] See the core document on the V&V Agent Role in the VV&A of Legacy Simulations for additional information.
[7] Note that the M&S Proponent role is responsible to the simulation program.



Flow Diagram for the VV&A of a Legacy Simulation

Preliminary Events

The first events involve the identification of requirements for the intended application, the decision to use a legacy simulation and the selection of that simulation.

Define M&S Requirements. The preparation or development of any simulation begins with the User's definition of requirements that articulate what is needed (e.g., data, scenarios, simulation capabilities) to address the problem.[8] These requirements drive the selection of a legacy simulation based on its capability. In situations where a specific simulation is stipulated for use, these requirements are used to determine if modifications are needed to provide a good fit.

Select Legacy Simulation. When no simulation has been preselected, the User may need to conduct a search for potential candidates.[9] Each simulation under consideration should undergo a high-level assessment to determine if it is a viable candidate for use in the intended application.[10]

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[8] See the special topic on Requirements for additional information.
[9] Note that potential candidates may be different versions of the same simulation.
[10] Information on legacy simulation selection is available in the User Role in Legacy Simulation core document.

Events to Assess Information

The next set of events and decisions focuses on determining that there is sufficient information available about both the simulation and the intended application to continue.

Is there Sufficient Information Available to Assess the Legacy Simulation? Once the legacy simulation has been selected, the Accreditation Agent assesses its fitness for the intended use.[11] To perform this assessment, detailed information is needed about both the simulation and about the requirements of the intended application. To determine if sufficient information is available about both, the following two questions need to be answered:

Is the Information Available about the Simulation's Capabilities Adequate? To determine if sufficient information about the legacy simulation exists, all available simulation documentation and artifacts should be collected and reviewed. The purpose of this assessment is not to determine if the existing simulation has complete documentation but rather to establish whether the documentation can provide enough accurate information about the simulation to determine if it is fit to use in the intended application.

If the information is not sufficient, then the missing information needs to be generated.

Obtain Needed Information and Verify. Missing simulation information can be obtained a number of different ways. In the simplest case, it can be pieced together from available artifacts and documentation. In the worst case, it needs to be created from scratch.

Once sufficient information has been collected and verified, it is submitted to the Accreditation Agent for use in the accreditation assessment.

Are the M&S Requirements Adequately Defined? The M&S requirements[12] of the intended application are the basis for evaluating capability. If they do not provide sufficient detail to identify what simulation capabilities are needed, then they need to be refined. In addition, how the success of each requirement is to be measured (e.g., the type of measure to be used, such as measures of effectiveness (MOE), measures of performance (MOP) and the acceptability criteria that need to be met) needs to be established.[13]

If the requirements are not adequate, then additional refinement and verification is necessary.

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[11] See the core document on the Accreditation Agent Role in the VV&A of Legacy Simulations for additional information.
[12] See the special topic on Requirements for additional information.
[13] See the special topic on Measures for additional information.

Refine M&S Requirements and Verify. This event occurs when the initial set of requirements defined by the User is incomplete, inconsistent, or lacks the detail necessary to identify all the simulation capabilities needed for the intended application. Individual requirements may be decomposed or expanded and additional requirements may be added. The requirements and their associated acceptability criteria are verified to ensure they are adequate and complete.

Once the M&S requirements have been refined and verified, they are submitted to the Accreditation Agent for use in the accreditation assessment.

Events to Assess the Simulation

Plan Accreditation Assessment. The capabilities of the legacy simulation, as described in the collected information, are compared to the simulation capabilities needed to address the M&S requirements in order to identify any deficiencies or limitations (e.g., capabilities the simulation needs but lacks) that would adversely affect the intended application. The information is used in the following decisions, which, in turn, determine the scope of overall effort.

Can the simulation be used in the intended application? The limitations of the simulation are examined to determine if the risks associated with using it outweigh the costs of preparing it for use. When the risks are so serious that modification is deemed infeasible (e.g., the costs involved are beyond the scope of the budget), then the simulation is rejected and the User either selects a different simulation or chooses a different approach to solve the problem.

Can the simulation be used as-is or are modifications needed? Once the decision has been made to use the simulation, the simulation deficiencies are assessed to determine how critical they are to the current application and decisions are made about how best to address them. The alternatives are to modify the simulation or use the simulation as-is.

Modify Simulation. When the deficiencies are serious, a modification effort should be planned and implemented.

Plan Simulation Modification. Because changes to one area of the code can have unintended consequences elsewhere, the modification effort should be planned carefully to minimize both the risks and costs involved.

Modify and Verify. The modification effort should emulate the new M&S development process, proceeding in phases and including updates of the associated development artifacts (e.g., conceptual model, design documentation). Verification activities should be

conducted on all modifications and on other areas of the simulation that may be impacted by the modifications.[14]

Use Simulation As-Is. A simulation can be used as-is when only very minor deficiencies exist and a simulation modification effort is considered unnecessary (i.e., no code or hardware changes are needed).

Verify As Needed. Even when a simulation can be used as-is, there may be aspects of it or its associated artifacts (e.g., input data[15]) that may require additional verification.

Validate. Validation activities should be conducted as needed throughout the process to provide missing information about the simulation's validity.

> Example:
>
> Review of the legacy simulation capabilities reveals that the simulation contains a logistics module that may address the needs of the intended use; however, previous applications had no logistics requirement and so the module was never validated.

When verification activities are complete, the overall simulation and its data[16] should be tested and validated to ensure its fitness for the intended application. When the simulation is being used as-is, the validation event should focus on the key capabilities for the intended application. When the simulation has been modified, the validation event addresses changes in the simulation and the simulation artifacts resulting from the modifications (e.g., modified conceptual model, modified design, modified code) in addition to validating the modified simulation for the intended use (results validation).[17]

Conduct Accreditation Assessment. Once validation activities have been completed, the information is reassessed to determine if it is sufficient to perform the accreditation assessment and the assessment is performed.[18]

Prepare Simulation for Use. Once the necessary verification and validation efforts have been completed, the accreditation assessment has been performed, and an accreditation recommendation has been made, the simulation is prepared for use by initializing the input databases, establishing methods for collecting output data, and training the participants.

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[14] See the core document on the V&V Agent Role in the VV&A of Legacy Simulations for additional information.
[15] See the reference document on M&S Data Concepts and Terms for additional information.
[16] See the special topic on Data V&V for Legacy Simulations for additional information.
[17] See the core document on the V&V Agent Role in the VV&A of Legacy Simulations for additional information.
[18] See the core document on the Accreditation Agent Role in the VV&A of Legacy Simulations for additional information.

Issue Accreditation Decision. All events shown in the flow diagram are focused on gathering evidence and providing information for the accreditation assessment and the resulting decision. During this assessment, all the evidence gathered from information about the intended use and the legacy simulation, from testing, and from the V&V effort is evaluated. The User then makes the accreditation decision based on these results.

Summary

The purpose of VV&A is to establish a simulation's fitness for each application it is asked to address. Thus, VV&A helps establish the relationship between the intended application and the simulation being used to solve it. The legacy VV&A flow diagram illustrates this relationship as a series of inter-related events and decisions. The following table lists these basic events and decisions and identifies the primary and secondary roles typically associated with each.

Primary and Secondary Role Responsibilities						
Events and Decisions	**User**	**VV**	**AA**	**M&S PM**	**Dev**	**M&S Pro**
Define M&S Requirements	**P**		**S**			
Select Legacy Simulation	**P**		**S**			
Is there sufficient information to assess the simulation?			**P**			
• Is the information on simulation capability adequate?		**S**	**P**			
Obtain Needed Simulation Information and Verify		**P**	**S**		**S**	
• Are the M&S requirements adequately defined?		**S**	**P**			
Refine M&S Requirements and Verify	**P**	**S**	**S**			
Plan Accreditation Assessment			**P**			
Can the simulation be used?	**P**					
• Does the simulation need to be modified?	**P**					**S**
Plan Simulation Modification	**P**	**S**		**S**	**S**	
Modify and Verify Simulation		**S**		**S**	**P**	
• Can the simulation be used as-is?						
Verify as Needed		**P**				
Validate	**S**	**P**				
Conduct Accreditation Assessment			**P**			
Prepare Simulation for Use	**P**				**S**	
Issue Accreditation Decision	**P**					
P: Role with primary responsibility	**S: Role with supporting responsibility**					

Note that the roles responsible for individual events and decisions may change depending on the situation.

Examples:

- The Accreditation Agent may call upon the Developer for assistance in evaluating simulation information
- Simulation information may be collected and assessed by the V&V Agent in the absence of a Developer.
- When the intended application is extremely similar to previous uses and there is sufficient information to demonstrate that no modification will be needed, then the roles of M&S Proponent and Developer may be subsumed by the User and the V&V Agent role subsumed by the Accreditation Agent.

In a given legacy VV&A effort, the specific VV&A tasks to be performed during these events, as well as the specific roles responsible for performing them, will depend on the circumstances of legacy simulation and the intended application. The challenge is to determine what tasks are needed and how best they should be performed. The legacy core documents offer guidance on these, and other, VV&A issues from the point of view of each of the different roles involved:

- Role of Accreditation Agent in the VV&A of Legacy Simulations
- Role of User in the VV&A of Legacy Simulations
- Role of V&V Agent in the VV&A of Legacy Simulations

References

RPG References in This Document

select menu*: RPG Core Documents*, select item: "Accreditation Agent Role in the VV&A of Legacy Simulations"

select menu*: RPG Core Documents*, select item: "User Role in the VV&A of Legacy Simulations"

select menu*: RPG Core Documents*, select item: "V&V Agent Role in the VV&A of New Simulations"

select menu*: RPG Special Topics*, select item: "Data V&V for Legacy Simulations"

select menu*: RPG Special Topics*, select item: "Measures"

select menu*: RPG Special Topics*, select item: "Requirements"

select menu*: RPG Reference Documents*, select item: "M&S Data Concepts and Terms"

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