

What Is a Distributed Simulation (i.e., A Federation)?

A distributed simulation is defined as a disparate set of models and/or simulations operating in a common synthetic environment over a network with two or more nodes. In addition to a physical connection, standard architectures, and associated protocols are used to pass information between the component models and/or simulations. A variety of standard protocols exist including the Distributed Interactive Simulation (DIS) protocols, the High-Level Architecture (HLA), and the Test and Training Enabling Architecture (TENA).

The Simulation Interoperability Standards Organization (SISO) is an organization “dedicated to the promotion of modeling and simulation interoperability and reuse for the benefit of diverse modeling and simulation (M&S) communities.” SISO has produced Institute of Electrical and Electronics Engineers (IEEE) standards defining both the DIS distributed environment in the mid-1990s and the High Level Architecture (HLA) with its associated Run-Time Infrastructure (RTI) in the early 2000s. A distributed simulation employing DIS is termed an exercise. One using the HLA is termed a federation.

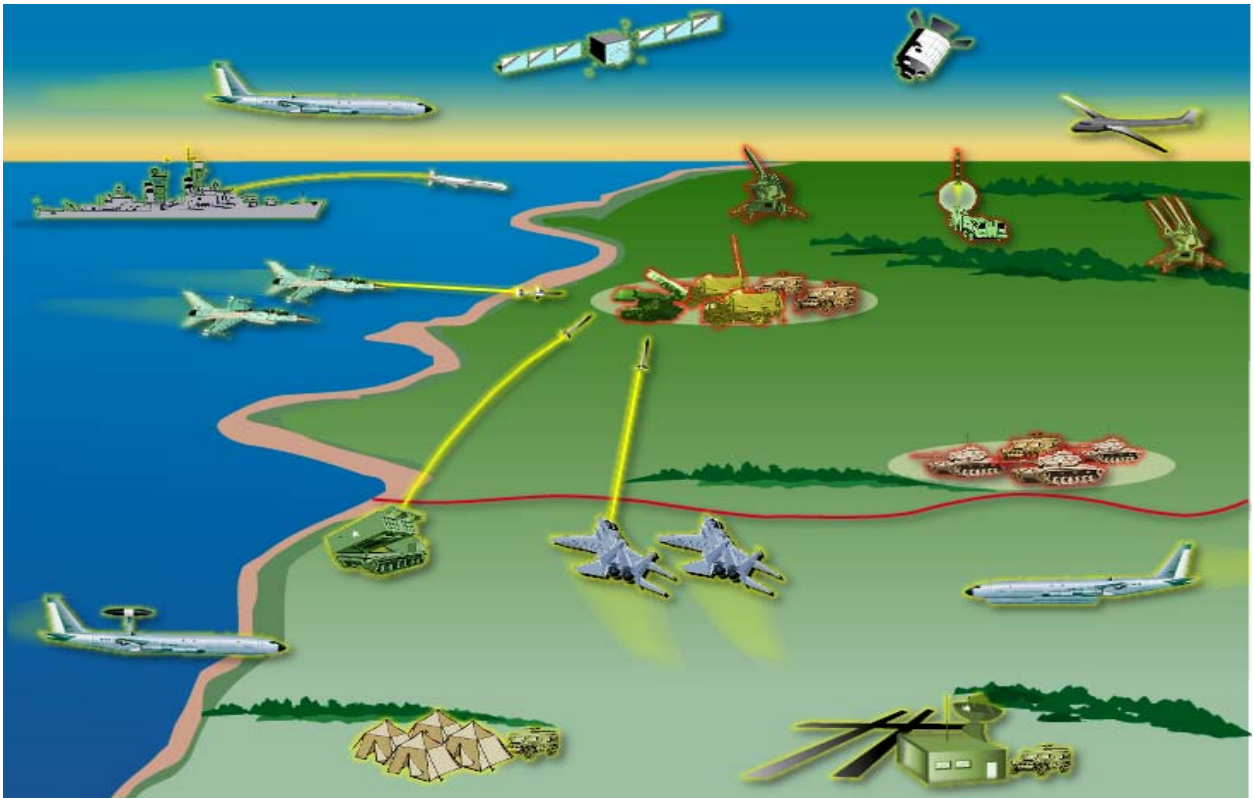
A federation is defined as a system of interacting federates, a common federation object model, and supporting infrastructure relying upon a common understanding of the simulated objects and used as a whole for some specific purpose

How Does the Nature of a Distributed Simulation Impact Verification, Validation, and Accreditation (VV&A)?

The figure below illustrates a complex warfighting environment. In a distributed simulation of such an environment, each subsystem may be represented by an independent simulation. Specifically, each commercial aircraft, military aircraft, radar unit, satellite, tank, troop deployment and weapon might be represented by a separate simulation. When these individual simulations or components are joined under an overarching architecture (e.g., HLA), they form a distributed simulation or federation. As would be expected verification and validation (V&V) of a distributed simulation entails assessments at both the component (e.g., federate) and federation level. Accreditation would be addressed at the federation level.

Both the accreditation process and the V&V effort are heavily influenced by the nature of the simulation environment and the participating simulations. Issues ranging from information latency, differing fidelity levels, inconsistent representations of the natural environment, as well as the maturity and stability of the individual components (e.g., federates), all have an impact on the distributed simulation’s ability to produce representations that support the intended use.

While the basic VV&A methods defined for stand-alone simulation also apply to distributed simulations, the complexity of the resulting distributed simulation provide VV&A implementers with many challenges.



Visualization of a Distributed Simulation Environment

The key, distinguishing feature associated with distributed simulation is interoperability, i.e., the capability of the disparate simulates to effectively interact, both technically and substantively.

Technical Interoperability is characterized by the ability of federates to physically connect and exchange data. Technical interoperability is achieved through the use of common standards, compatible interfaces and coordinated data structures. The elements of technical interoperability are:

- Hardware compatibility
- Standards compatibility
- Time management coordination
- Coordinated use of RTI services
- Security issues

Substantive Interoperability focuses on the capability of federates, when connected, to provide adequate, accurate, and consistent simulated

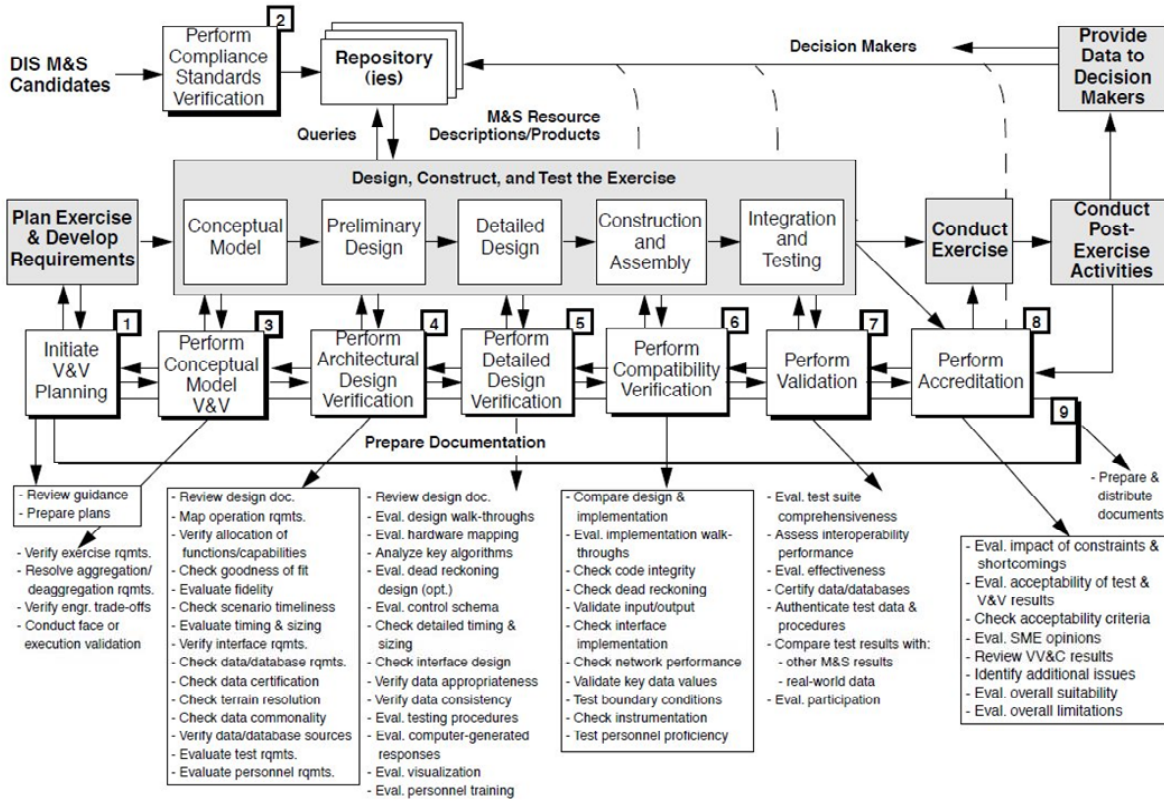
representations that adhere to the principles of “fair fight” and the simulation objectives. The elements of Substantive Interoperability are:

- Logical interaction between entities modeled in different federates
- Temporal resolution
- Spatial resolution
- Coherent relationships between the components of the physical environment: ground, ocean, atmosphere, weather

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

IEEE 1278.4-1997(R2010) “IEEE Recommended Practice for Distributed Interactive Simulation (DIS) VV&A”

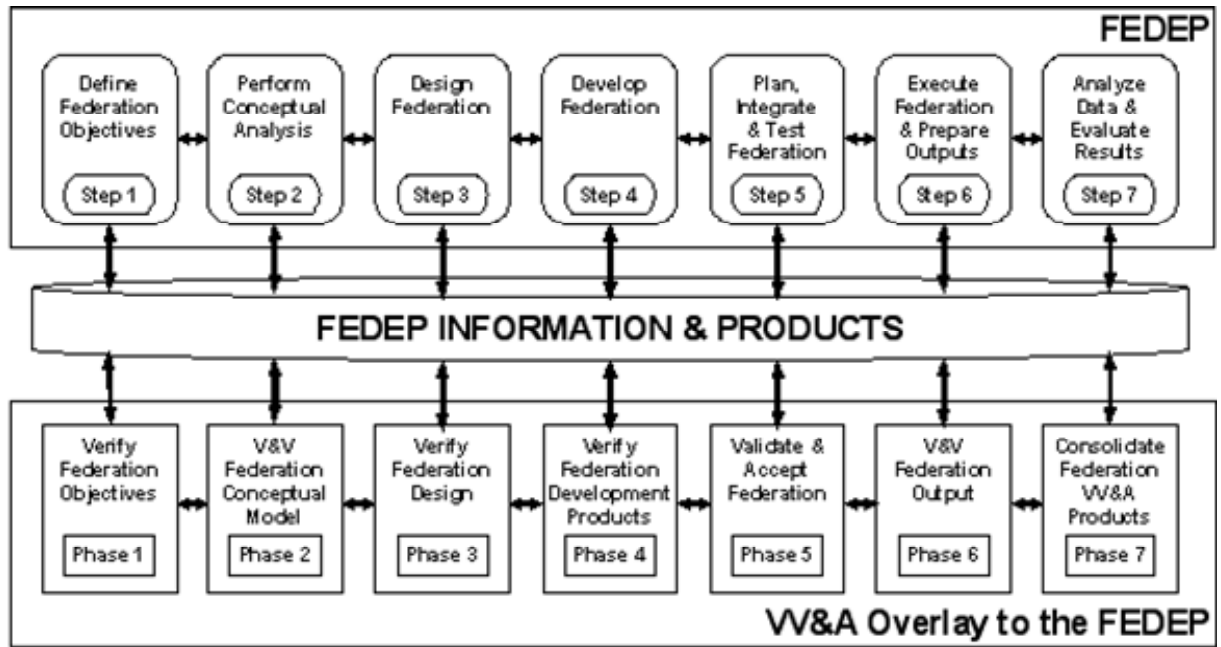
IEEE 1278.4-1997(R2002) was developed as an overlay to the IEEE Recommended Practice for DIS Exercise Management and Feedback (IEEE Std 1278.3-1996). This document defines guidelines for the VV&A of DIS exercises for exercise users, sponsors, and developers. The overlay provides “how-to” procedures for planning and conducting DIS exercise VV&A. The figure below presents data flow and connectivity for all proposed verification and validation activities and provides rationale and justification for each step. Originally approved in the mid-1990s, both IEEE Std 1278.3-1996 and IEEE Std 1278.4-1997 were reaffirmed in June 2010.



The DIS Exercise VV&A Overlay

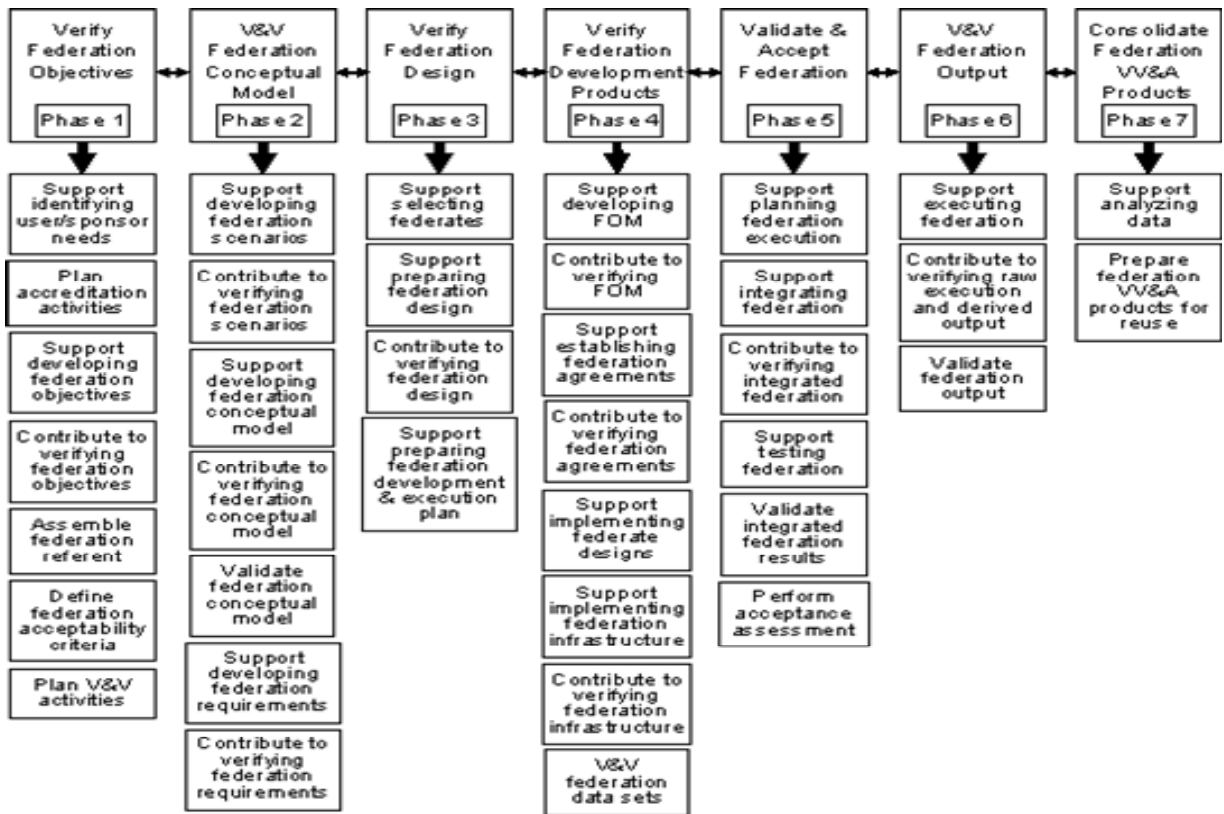
IEEE 1516.4-2007 “IEEE Recommended Practice for VV&A of a HLA Federation”

IEEE 1516.4-2007 defines processes and procedures to implement VV&A for federations being developed using the HLA Federation Development and Execution Process (FEDEP) (IEEE Std 1516.3™-2003). It focuses on the unique aspects of federation development and application, leveraging the FEDEP as a higher-level framework into which VV&A practices can be integrated and tailored for specific uses. The figure below shows the relationship between VV&A activities and the FEDEP.



The HLA Federation VV&A Overlay

The figure below shows the more detailed decomposition of VV&A activities at each phase of the federation development and execution process, providing implementation-level guidance to VV&A practitioners.



Detailed Activity Decomposition of the HLA Federation VV&A Overlay

Both IEEE Std 1516.4™-2007, IEEE Recommended Practice for Verification, Validation, and Accreditation of a Federation—An Overlay to the High Level Architecture Federation Development and Execution Process, 20 December 2007 and IEEE Std 1278.4-1997, IEEE Trial-Use Recommended Practice for Distributed Interactive Simulation - Verification, Validation, and Accreditation, 20 July 1998 (reaffirmed June 2010) are available at <https://sbwsweb.ieee.org/>

Summary

The purpose of VV&A is to establish a simulation's fitness for each potential application. Thus, VV&A helps establish the relationship between the intended use and the simulation. The data flow diagram for DIS and the VV&A overlay to the FEDEP illustrate the relationship as a series of interrelated activities and decisions. The following table lists these basic activities and decisions. The table also 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	Prop
Define requirements	P		S			
Refine requirements and verify	P	S	S			
Select simulation	P		S			
<ul style="list-style-type: none"> Is there sufficient information to assess the simulation? 			P			
<ul style="list-style-type: none"> Is the information on simulation capability adequate? 		S	P			
<ul style="list-style-type: none"> Are the requirements adequately defined? 		S	P			
Obtain needed simulation information and verify		P	S		S	
Plan simulation modification	P	S		S	S	
Modify and verify simulation		S		S	P	
Validate Simulation Results	S	P				
Plan and conduct accreditation assessment			P			
<ul style="list-style-type: none"> Can the simulation be used? 	P					
<ul style="list-style-type: none"> Can the simulation be used as-is or does it need to be modified? 	P					S
Issue accreditation decision	P					
P: Role with primary responsibility	S: Role with supporting responsibility					

In a given VV&A effort, the specific VV&A tasks to be performed during these activities, as well as the specific roles responsible for performing them, will depend on the circumstances of federation development, the maturity of the federates and the intended use. The challenge is to determine what tasks are needed and how best they should be performed.

Acronyms

AA	Accreditation Agent
DIS	Distributed Interactive Simulation
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
FEDEP	Federation Development and Execution Process
HLA	High-Level Architecture
IEEE	Institute of Electrical and Electronics Engineers
M&S	Modeling and Simulation
PM	Program Manager
RPG	Recommended Practices Guide
RTI	Run-Time Infrastructure
SISO	Simulation Interoperability Standards Organization
SME	Subject Matter Expert
TENA	Training Enabling
V&V	Verification and Validation
VV	Verification and Validation Agent
VV&A	Verification, Validation, and Accreditation

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