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IEEE Std 1278.4-1997

IEEE Trial-Use Recommended Practice for Distributed Interactive Simulation—Verification, Validation, and Accreditation

IEEE Computer Society

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IEEE Trial-Use Recommended Practice for Distributed Interactive Simulation—Verification, Validation, and Accreditation

Sponsor

**Distributed Interactive Simulation Committee
of the
IEEE Computer Society**

Approved 9 December 1997

IEEE Standards Board

Abstract: Guidelines are established for the verification, validation, and accreditation (VV&A) of distributed interactive simulation (DIS) exercises. “How-to” procedures for planning and conducting DIS exercise VV&A are provided. Intended for use in conjunction with IEEE Std 1278.3-1996, this recommended practice presents data flow and connectivity for all proposed verification and validation activities and provides rationale and justification for each step. VV&A guidance is provided to exercise users/sponsors and developers.

Keywords: accreditation; certification; Distributed Interactive Simulation; simulation; validation; verification; warfare simulation; wargames

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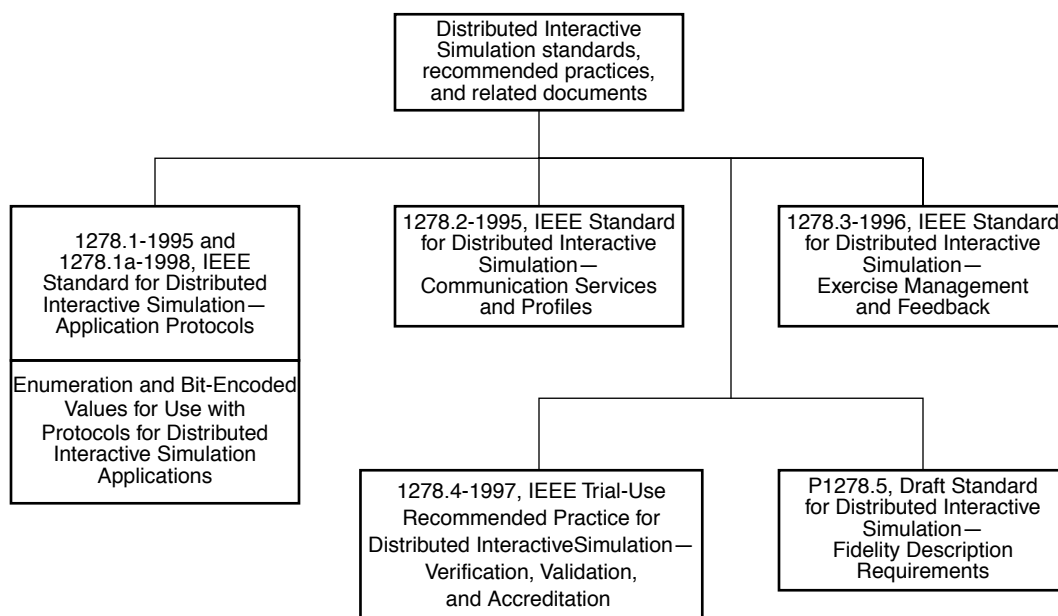
Introduction

(This introduction is not part of IEEE Std 1278.4-1997, IEEE Trial-Use Recommended Practice for Distributed Interactive Simulation—Verification, Validation, and Accreditation.)

Distributed Interactive Simulation (DIS) is a government/industry initiative to define an infrastructure for linking simulations of various types at multiple locations to create realistic, complex, virtual “worlds” for the simulation of highly interactive activities. This infrastructure brings together systems built for separate purposes, technologies from different eras, products from various vendors, and platforms from various services and permits them to interoperate. DIS exercises are intended to support a mixture of virtual entities with computer-controlled behavior (computer-generated forces), virtual entities with live operators (human in-the-loop simulators), live entities (operational platforms and test and evaluation systems), and constructive entities (wargames and other automated simulations). DIS draws heavily on experience derived from the Simulator Networking (SIMNET) program developed by the Advanced Research Projects Agency (ARPA), adopting many of SIMNET’s basic concepts and heeding lessons learned.

In order for DIS to take advantage of currently installed and future simulations developed by different organizations, a means had to be found for assuring interoperability between dissimilar simulations. These means were developed in the form of industry consensus standards. The open forum (including government, industry, and academia) chosen for developing these standards was a series of semi-annual workshops on standards for the interoperability of distributed simulations, which began in 1989. The results of the workshops have been several IEEE standards along with supporting documentation. These standards provide application protocol and communication services and profile standards to support DIS interoperability. In addition, an IEEE recommended practice for exercise management and feedback provides user guidelines for setting up and conducting a DIS exercise.

The relationship between the component documents constituting the set of IEEE DIS documents is shown in the figure below. Used together, these standards and recommended practices will help to ensure an interoperable simulated environment.



Documentation relationships

The interoperability components addressed by these standards and recommended practices are as follows:

- a) Application protocols;
- b) Communication services and profiles;
- c) Exercise management and feedback;
- d) Validation, verification, and accreditation; and
- e) Fidelity description requirements.

IEEE Std 1278.1-1995, *IEEE Standard for Distributed Interactive Simulation—Applications Protocols*, and IEEE Std 1278.1a-1998 (Supplement to IEEE Std 1278.1-1995) define the format and semantics of data messages, also known as protocol data units (PDUs), that are exchanged between simulation applications and simulation management. The PDUs provide information concerning simulated entity states, the type of entity interactions that take place in a DIS exercise, and data for management and control of a DIS exercise, simulated environment states, aggregation of entities, and the transfer of control entities. IEEE Std 1278.1a-1998 also specifies the communication services to be used with each of the PDUs.

An additional, non-IEEE document is required for use with IEEE Std 1278.1-1995 and IEEE Std 1278.1a-1998. This document is entitled *Enumeration and Bit-Encoded Values for Use with Protocols for Distributed Interactive Simulation Applications* and is available from the Defense Modeling, Simulation and Tactical Technology Information Analysis Center.¹

IEEE Std 1278.2-1995, *IEEE Standard for Distributed Interactive Simulation—Communication Services and Profiles*, defines the communication services required to support the message exchange described in IEEE Std 1278.1-1995 and IEEE Std 1278.1a-1998. In addition, IEEE Std 1278.2-1995 provides several communication profiles that meet the specified communications requirements.

Taken together, IEEE Std 1278.1-1995, IEEE Std 1278.1a-1998, and IEEE Std 1278.2-1995 provide the necessary information exchange for the communications element of DIS.

IEEE Std 1278.3-1996, *IEEE Recommended Practice for Distributed Interactive Simulation—Exercise Management and Feedback*, provides guidelines for establishing a DIS exercise, managing the exercise, and providing proper feedback. This recommended practice is used in conjunction with IEEE Std 1278.1-1995, IEEE Std 1278.1a-1998, and IEEE Std 1278.2-1995.

IEEE Std 1278.4-1997, *IEEE Trial-Use Recommended Practice for Distributed Interactive Simulation—Verification, Validation, and Accreditation*, provides guidelines for verifying, validating, and accrediting a DIS exercise. This recommended practice, used in conjunction with IEEE Std 1278.3-1996, presents data flow and connectivity for all proposed verification and validation activities and provides rationale and justification for each step.

IEEE P1278.5, *Draft Standard for Distributed Interactive Simulation—Fidelity Description Requirements*, provides a taxonomy of fidelity characteristics with a consistent and uniform language to describe fidelity at six levels: resource, fidelity domain, capability, implementation, characteristic, and descriptor.

Publication of this trial-use recommended practice for comment and criticism has been approved by the Institute of Electrical and Electronics Engineers. Trial-use standards are effective for 24 months from the date of publication. Comments for revision will be accepted for 18 months after publication. Suggestions for revision should be directed to the Secretary, IEEE Standards Board, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331 USA, and should be received no later than 20 January 2000. It is expected that following the 24-month period, this trial-use recommended practice, revised as necessary, shall be submitted to the IEEE Standards Board for approval as a full-use recommended practice.

¹For information about the Defense Modeling, Simulation and Tactical Technology Information Analysis Center, see their Web site at <http://dmsttiac.hq.ittri.com/>.

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IEEE Trial-Use Recommended Practice for Distributed Interactive Simulation—Verification, Validation, and Accreditation

1. Overview

1.1 Scope

This recommended practice establishes guidelines for the verification, validation, and accreditation (VV&A) of Distributed Interactive Simulation (DIS) exercises. It provides “how-to” procedures for planning and conducting DIS exercise VV&A.

1.2 Application

This recommended practice is intended for use by persons responsible for or participating in DIS exercise VV&A activities (e.g., VV&A agents, VV&A teams, exercise managers, exercise architects). It provides VV&A guidance to exercise users/sponsors and developers. It does not specify who can or cannot participate in a DIS exercise or in the VV&A process.

DIS exercises are conducted for a variety of reasons (e.g., technical demonstration, training, requirements definition, concept definition, acquisition, analysis, test, and evaluation). Because each objective has different requirements, this recommended practice offers latitude in defining and applying the principles of DIS exercise VV&A to suit the needs of the exercise user/sponsor and the accreditation agent. Depending upon the exercise objectives and the allocated time and assets, the procedures involved and the degree to which they should be followed can vary significantly.

2. References

This recommended practice shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision should apply.

IEEE Std 1278.1-1995, IEEE Standard for Distributed Interactive Simulation—Application Protocols.¹

¹IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

IEEE Std 1278.2-1995, IEEE Standard for Distributed Interactive Simulation—Communication Services and Profiles.

IEEE Std 1278.3-1996, IEEE Recommended Practice for Distributed Interactive Simulation—Exercise Management and Feedback.

IEEE P1278.5, Draft Standard for Distributed Interactive Simulation: Fidelity Description Requirements.²

IST-CF-97-23, Enumeration and Bit-Encoded Values for Use with Protocols for Distributed Interactive Simulation Applications.³

3. Definitions and list of acronyms and abbreviations

3.1 Definitions

For purposes of this recommended practice, the following terms and definitions apply:

3.1.1 acceptability criteria: A set of standards, established by the modeling and simulation (M&S) application sponsor or accreditation authority, that a particular model or simulation must meet to be accredited for a given use. The criteria will be unique to each problem and will give key insights to potential solutions.

3.1.2 accreditation: (1) Distributed simulation accreditation is the official certification that a distributed simulation is acceptable for use for a specific purpose. (2) Model/simulation accreditation is the official certification that a model or simulation is acceptable for use for a specific purpose.

3.1.3 compatible/DIS compatible: Two or more simulations/simulators that are Distributed Interactive Simulation (DIS) compliant and whose models and data that send and interpret protocol data units (PDUs) support the realization of a common operational environment among the systems (i.e., they are coherent in time and space).

3.1.4 compliant/DIS compliant: A simulation/simulator that can send or receive protocol data units (PDUs) in accordance with IEEE Std 1278.1-1995⁴ and IEEE Std 1278.2-1995. A specific statement must be made regarding the qualifications of each PDU.

3.1.5 component: A model, simulation, or database used or considered for use in a Distributed Interactive Simulation (DIS) exercise.

3.1.6 conceptual model: A simulation implementation-independent representation of the exercise architect's understanding of the exercise objectives, requirements, and environment. The model includes logic and algorithms and explicitly recognizes assumptions and limitations.

3.1.7 data: A representation of facts, concepts, or instructions in a formalized manner suitable for communication, interpretation, or processing by humans or by automatic means.

3.1.8 database (DB): A collection of interrelated data, often with controlled redundancy, organized according to a schema to serve one or more applications; the data are stored so that they can be used by different

²IEEE P1278.5 was an authorized standards project at the time this standard was balloted; however, as this standard goes to press plans are under way to withdraw the draft. The IEEE Standards Department will maintain a copy of the last edition of this draft for reference.

³For information on this and other projects under way at the Defense Modeling, Simulation and Tactical Technology Information Analysis Center, check their web site at <http://dmsttiac.hq.itri.com/>.

⁴Information on references can be found in Clause 2.

programs without concern for the data structure or organization. A common approach is used to add new data and to modify and retrieve existing data.

3.1.9 data verification, validation, and certification (VV&C): The process of verifying the internal consistency and correctness of data, validating that it represents real-world entities appropriate for its intended purpose or expected range of purposes, and certifying it as having a specified level of quality or as being appropriate for a specified use, type of use, or range of uses. The process is conducted from two perspectives: (1) the data producer ensures the data produced satisfy the appropriate standards and (2) each data user ensures the data selected are appropriate for the specific application.

3.1.10 Distributed Interactive Simulation (DIS): A time-and-space-coherent synthetic representation of world environments designed for linking the interactive, free play activities of people in operational exercises. The synthetic environment is created through real-time exchange of data units between distributed, computationally autonomous simulation applications in the form of simulations, simulators, and instrumented equipment interconnected through standard computer communicative services. The computational simulation entities may be present in one location or may be distributed geographically.

3.1.11 exercise/DIS exercise: (1) One or more sessions involving two or more interacting simulation applications with a common objective and accreditation. Participating simulations share a common identifying number called the exercise identifier and use correlated representations of the synthetic environment in which they operate. (2) The total process of designing, assembling, testing, conducting, evaluating, and reporting on an activity.

3.1.12 interoperable/DIS interoperable: Two or more simulations/simulators that, for a given exercise, are Distributed Interactive Simulation (DIS) compliant and DIS compatible and whose performance characteristics support the fidelity required for the exercise.

3.1.13 measure of effectiveness (MOE): Measure of how the system/individual performs its functions in a given environment. Used to evaluate whether alternative approaches meet functional objectives and mission needs.

3.1.14 measure of performance (MOP): Measure of how the system/individual performs its functions in a given environment. It is closely related to inherent parameters (physical and structural), but measures system/individual behavior.

3.1.15 protocol data unit (PDU): A Distributed Interactive Simulation (DIS) data message that is passed on a network between simulation applications according to a defined protocol.

3.1.16 session: A portion of an exercise that is contiguous in wall clock (sidereal) time and is initialized by a session database that includes network, entity, and environment initialization and control data.

3.1.17 validation: The process of determining the degree to which a distributed simulation is an accurate representation of the real world from the perspective of the intended use(s) as defined by the requirements. Validation also refers to the process of determining the confidence that should be placed on this assessment.

3.1.18 verification: The process of determining that an implementation of a distributed simulation accurately represents the developer's conceptual description and specifications.

3.2 List of acronyms and abbreviations

ARPA Advanced Research Projects Agency
ATM asynchronous transfer mode
CASE computer-aided software engineering

DB	database
DIS	Distributed Interactive Simulation
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
DSI	Defense Simulation Internet
EMF	exercise management and feedback
IDEF0	Integrated Computer-Aided Manufacturing Definition process modeling technique
IST	Institute for Simulation and Training
M&S	modeling and simulation; model and/or simulation, models and/or simulations
MOE	measure of effectiveness
MOP	measure of performance
MSRR	Model and Simulation Resource Repository
PDU	protocol data unit
SAF	semiautomated forces
SME	subject matter expert
V&V	verification and validation
VV&A	verification, validation, and accreditation
VV&C	verification, validation, and certification (of data)

4. Factors relating to the implementation of exercise VV&A

This clause describes some of the considerations of exercise development and VV&A activities that impact the relationship between the exercise life cycle and the VV&A process.

4.1 Factors relating to the exercise

4.1.1 Credibility/risk

Credibility is essential for the acceptance of results of any model or simulation. DIS exercises are no exception. Users must have assurance that models and simulations will perform as expected, are capable of being integrated into the planned DIS exercise, and can adequately support the intended purpose of the exercise. VV&A activities can assist in lowering development and integration risk while greatly enhancing the credibility of distributed simulations. Such considerations drive the need for a formal, systematic, disciplined approach to the VV&A of distributed simulation exercises.

4.1.2 Reuse

Reuse of existing components is a cost-effective method for building a DIS exercise. Reuse is encouraged and supported by thorough and consistent record keeping and configuration management. The extent of the VV&A effort necessary for an exercise is determined in part by the availability and completeness of the VV&A histories of the components. When an exercise configuration uses a well-documented preexisting architecture or when the configuration comprises individual components with detailed VV&A histories, fewer and less intense verification and validation (V&V) activities are needed than when the configuration is new or when records and VV&A histories are nonexistent or incomplete. The maintenance of detailed records of model versions, deficiencies, remedial actions performed, and resources assigned and consumed on each task also contributes to the continuous improvement and refinement of VV&A procedures and assists in the calibration of VV&A cost models.

4.1.3 Communication requirements

Communication linkage between models and simulations is the backbone of any distributed exercise. Systems currently used to support DIS exercises include the Defense Simulation Internet (DSI) and dedicated

telephone lines. Future transmission schemes, such as the asynchronous transfer mode (ATM) and the Defense and Engineering Network (the next phase of DSI), may offer expanded bandwidth and better balance among data, video, and voice requirements and will undoubtedly affect the communications architectures and interfaces used in a DIS exercise. A major part of the VV&A effort should involve evaluation of the linkage to ensure that it allows appropriate and timely interactions and accurate transmissions between the proper components.

4.1.4 Aggregation/deaggregation requirements

Objects or entities are often aggregated or deaggregated in constructive modeling to reduce network traffic or to provide the views of entities that are appropriate for the various situations. An exercise may employ varying levels of resolution. If a simulation is used to examine the behavior of single entities inside an aggregated unit, special interface adapters may be required to deaggregate the unit, allowing interactions between entities on a one-on-one basis. In addition, aggregation and deaggregation can affect the fidelity of the objects being represented. Deaggregated assets are often viewed and modeled at a higher level of fidelity than aggregated assets. The exercise VV&A effort will involve testing the effectiveness of the interface adapters as well as evaluating the appropriateness of the levels of fidelity represented.

4.2 Factors relating to VV&A

4.2.1 Component-level VV&A

A DIS exercise is formed by electronically linking individual components (e.g., constructive models, virtual reality simulations, simulators, instrumented field exercises). Component V&V done previously for a similar application can serve as a foundation for the exercise VV&A effort. However, if a component's VV&A history is inadequate or inappropriate, the exercise sponsor decides if additional component-level VV&A is needed to ensure that the component can meet the compliance, compatibility, and interoperability criteria appropriate for the particular DIS exercise being planned.

4.2.2 Effectiveness and efficiency

Factors affecting the efficiency and effectiveness of a DIS exercise VV&A effort include

- a) Early V&V involvement in the exercise planning and development process;
- b) Thorough knowledge of external interfaces, environment, phenomenology, and opposing forces;
- c) Access to previously accredited models and simulations, certified data sources, and interfaces to live play;
- d) Thorough knowledge of the specific domains, such as weapons, communications, sensors, information systems, forces, and materiel;
- e) Access to historical VV&A information to evaluate candidate models, simulations, and test objects;
- f) Effective use of independent test and evaluation assets at the developmental and operational levels;
- g) Close ties with testing and data communities; and
- h) Careful tailoring of the process.

4.2.3 VV&A tailoring

An exercise VV&A effort must be cost-effective, responsive, and sufficient if it is to succeed. To maintain a balance between exercise needs and real-world constraints, the VV&A process should be tailored to address the particular concerns of the exercise domain and simulation types involved within the constraints of available resources. Tailoring, the selection of specific V&V tasks based on exercise requirements and resource availability, is done as a part of the VV&A planning process to determine the most appropriate and cost-effective ways to address the exercise requirements and acceptability criteria. Tailoring and costing are more fully discussed in Annex D.

5. Exercise development and VV&A

This clause describes the relationship between the exercise life cycle and the VV&A process, including the exercise organization and management systems involved, the exercise life cycle, and fundamental concepts inherent in exercise VV&A.

5.1 Functional roles and responsibilities

IEEE Std 1278.3-1996 describes the roles and responsibilities of the personnel, agencies, and systems involved throughout the exercise management and feedback (EMF) process. The entities most closely associated with the VV&A process are identified in the following subclauses.

5.1.1 Exercise user/sponsor

The person, agency, or organization that determines the need for and scope of a DIS exercise and/or establishes the funding and other resources for the exercise. The user/sponsor also determines the exercise participants, objectives, requirements, and specifications and appoints the exercise manager and VV&A agent.

5.1.2 Exercise manager

The person responsible for creating the exercise, executing the exercise, and conducting the post-exercise activities. The exercise manager coordinates with the VV&A agent during these tasks and reports the results of the exercise to the user/sponsor. The exercise manager serves as the primary coordinator between the exercise user/sponsor and the VV&A team.

5.1.3 Exercise architect

The person or organization responsible for designing, integrating, and testing the exercise as directed by the exercise manager.

5.1.4 Network manager

The person or agency responsible for maintaining and operating a network capable of providing the DIS link between two or more sites. For a given exercise, the exercise manager selects the network manager.

5.1.5 Model/tool provider

A person or agency responsible for developing, stocking, storing, maintaining, and issuing simulation assets. The model/tool provider also maintains historical records of utilization and VV&A.

5.1.6 Database provider

A person or agency responsible for developing and/or providing data for the exercise. Responsibilities include producer verification, validation, and certification (VV&C) of the data and configuration management of the data and its associated metadata.

5.1.7 VV&A agent

The person, agency, or organization appointed by the exercise user/sponsor to measure, verify, and report on the validity of the exercise and to provide data allowing the user/sponsor to accredit the results. The VV&A agent may be part of the exercise development team or may be an independent evaluator.

5.1.8 VV&A team

The persons designated by the VV&A agent to plan and conduct the VV&A activities for an exercise. Team size and composition should be tailored to address the needs of the particular exercise and should be formed according to organization and/or service involvement. The team should include one or more members with current knowledge and understanding of the following:

- Specific behaviors required of the exercise;
- Individual modeling and simulation (M&S) components of the exercise;
- Types of data to be used in the exercise;
- Appropriate V&V policies and procedures;
- Appropriate VV&C policies and procedures; and
- Appropriate accreditation policies and procedures.

5.2 Exercise life cycle

IEEE Std 1278.3-1996 describes the EMF process shown in Figure 1. A summary of the five phases of this process is provided in Figure 1.

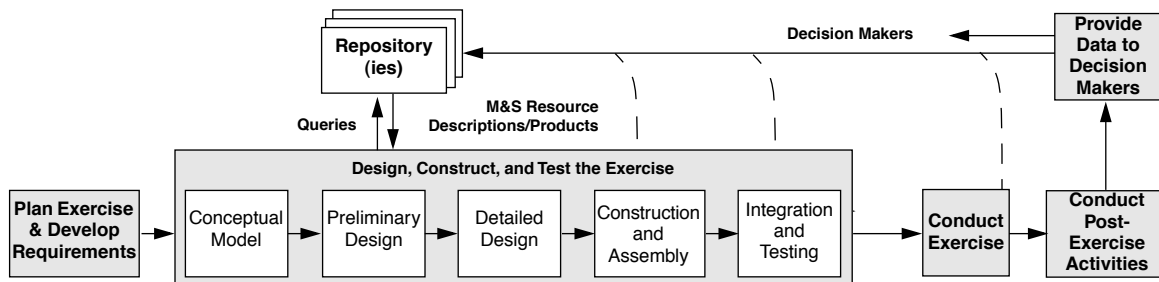


Figure 1—Exercise life cycle

5.2.1 Plan exercise and develop requirements

This phase includes a number of functions that support proper planning, such as

- Select measures of effectiveness (MOEs) and measures of performance (MOPs) applicable to the exercise;
- Develop support plans (e.g., VV&A, data development, VV&C, testing);
- Define exercise simulated natural environment (e.g., weather, climate, electromagnetic, oceanographic);
- Determine mix of simulation forces among live, virtual, and constructive categories;
- Identify available simulation resources;
- Determine technical and exercise support personnel requirements; and
- Develop functional requirements and interface specifications.

These functions also support the development of VV&A plans.

5.2.2 Design, construct, and test the exercise

During this phase, the exercise is developed to meet the requirements specified during the planning phase. This phase consists of five steps: *Conceptual Model*, *Preliminary Design*, *Detailed Design*, *Construction and Assembly*, and *Integration and Testing*.

V&V activities are conducted during and following each step. Accreditation activities are conducted following *Integration and Testing*. Results of these VV&A activities must be accepted by the exercise manager before proceeding.

5.2.2.1 Conceptual model

The exercise architect develops the conceptual model and high-level architecture for the exercise that show the participating components, interfaces, behaviors, and control structure.

5.2.2.2 Preliminary design

The exercise architect translates the requirements into a preliminary exercise design by developing scenarios, mission plans, and databases; by designing communication networks and tests; and by planning for training and rehearsals.

5.2.2.3 Detailed design

The exercise architect and exercise manager expand the design model and architecture to support and complete the definition of all required functions, behaviors, and data flow, specifically including communication data rate requirements and data latency limitation requirements.

5.2.2.4 Construction and assembly

The exercise manager and model/tool providers assemble existing components and develop new components to meet all exercise and security requirements.

5.2.2.5 Integration and testing

The exercise manager and exercise architect work this step as an incremental process, starting with a minimum number of components and connectivity and adding and building until operational status is achieved. Testing is done concurrently to determine whether requirements and performance criteria are met and support personnel are trained and rehearsed.

5.2.3 Conduct exercise

The exercise manager conducts the exercise using resources developed during the design, construct, and test phase to satisfy objectives established during the planning phase.

5.2.4 Conduct post-exercise activity

The exercise manager oversees the collection and processing of output data, analysis of results, after-action review, and preparation of exercise documentation.

5.2.5 Provide results to decision makers

The exercise manager reports exercise results to designated user/sponsors and other audiences according to the reporting requirements of the exercise. These results may include such factors as exercise credibility, cause-and-effect relationships, detail and aggregation, analysis, and exercise improvement.

5.3 Exercise VV&A fundamentals

Figure 2 maps the VV&A process to the exercise life cycle. The exercise life cycle from Figure 1 is shown in the shaded area. The nine basic VV&A activities are depicted as numbered, shadowed boxes. Small arrows

represent the normal information flow between VV&A activities and the exercise life cycle. Wide arrows represent the collection of evidence that occurs throughout the VV&A process and culminates in a set of VV&A documents.

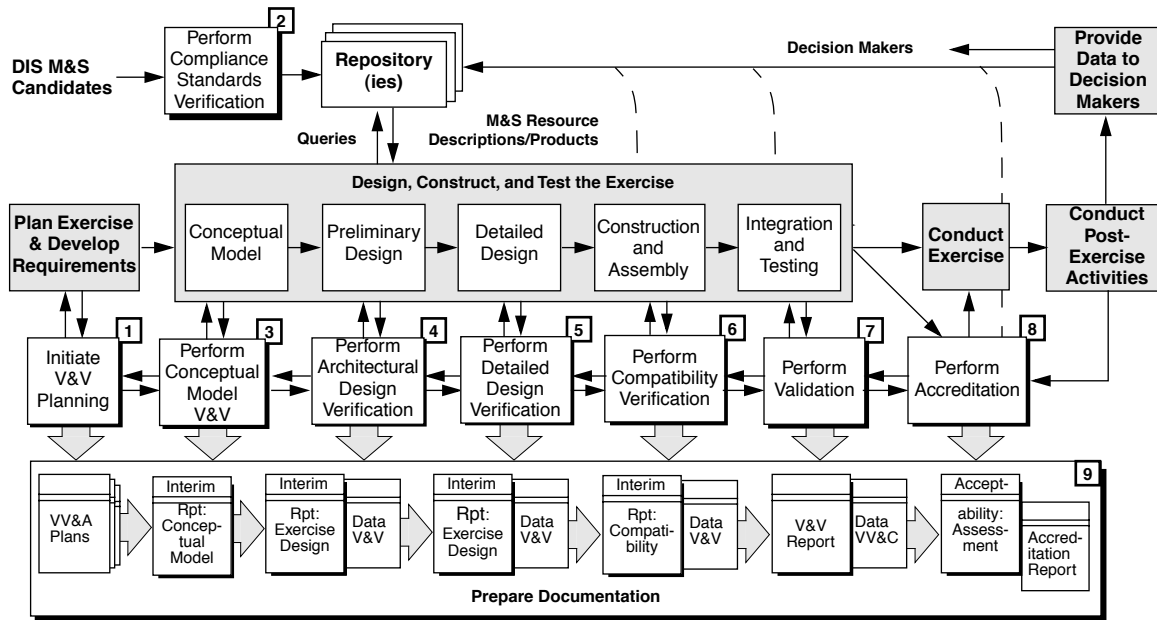


Figure 2—Exercise life cycle and VV&A

5.3.1 Evolution of exercise VV&A

The VV&A process diagram in Figure 2 illustrates the synergetic relationship between the exercise life cycle and the VV&A process. Although the process appears to be linear, a considerable amount of iteration occurs between steps. Individual VV&A activities are performed interactively with and in response to specific exercise life cycle activities. Results of each VV&A activity, risk assessments, and recommendations are reported to the exercise manager and, as necessary, to the exercise architect, network manager, and appropriate model and data providers. Critical issues are reported immediately to avoid costly delays and to facilitate a timely recovery. The exercise manager reviews VV&A results and coordinates with the exercise sponsor to determine the course of action.

5.3.2 Basic VV&A tools and techniques

The VV&A team needs a computing environment appropriate for the various analytic applications involved and word processing capability to support briefing and document production. In addition, the VV&A team may need access to the data and tools used during the design, development, and testing of the exercise. Tools and techniques typically used during specific VV&A activities are identified throughout Clause 6. These tools and techniques are examples only and should not be construed as all-inclusive or as requirements.

5.3.3 VV&A products

Information resulting from VV&A activities is vital for reuse and long-term maintenance of the DIS exercise and participating components. Information collected throughout the process is used for decision making and to prepare the final reports for storing in appropriate M&S repositories and component archives. Additional information about VV&A products is provided in 6.9 and Annex B.

6. Exercise VV&A process

This clause provides procedures and guidelines for planning and conducting exercise VV&A by discussing individually the nine basic activities constituting the VV&A process. Each activity addresses specific objectives and fulfills a unique function in the overall VV&A process. The VV&A process diagram in Figure 3 has been modified to show a number of the techniques normally associated with individual activities. Although an individual exercise VV&A effort should include all nine activities, the individual tasks involved and techniques selected to perform those tasks should depend on the requirements of the exercise and the availability of resources.

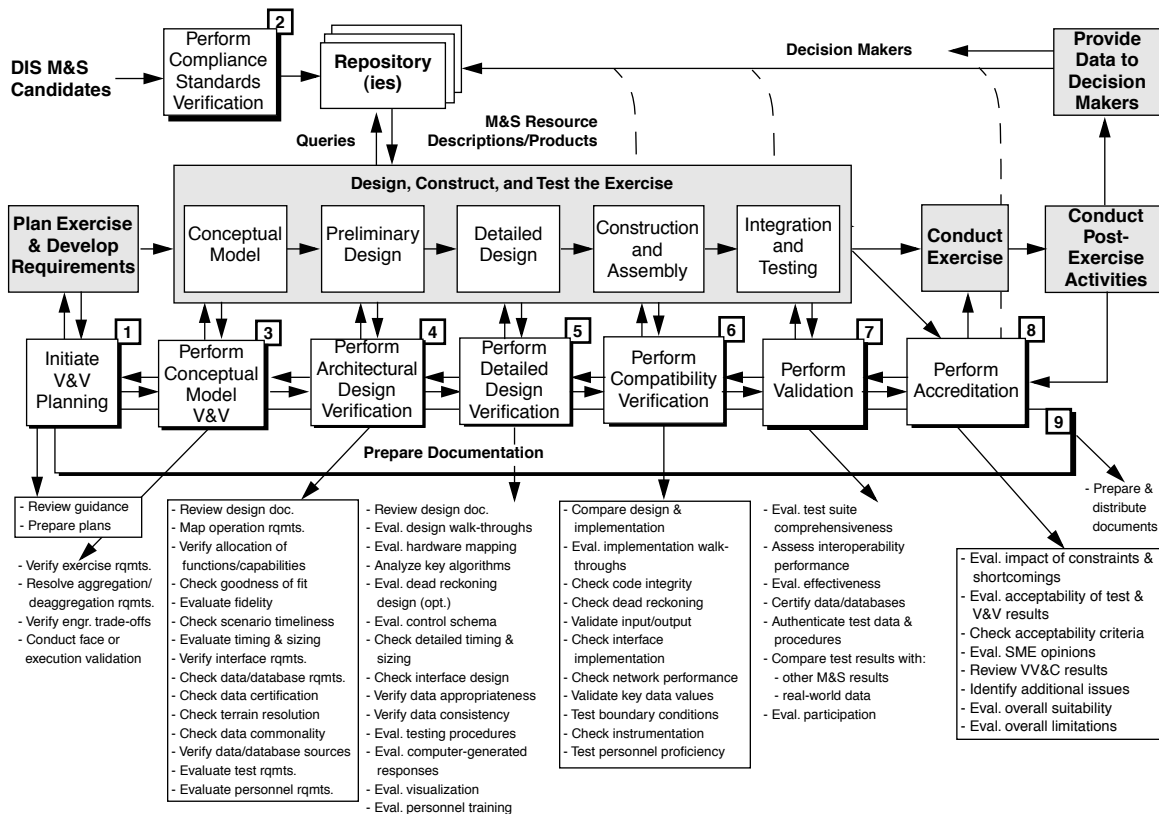


Figure 3—Exercise VV&A process

6.1 Activity: Initiate VV&A planning

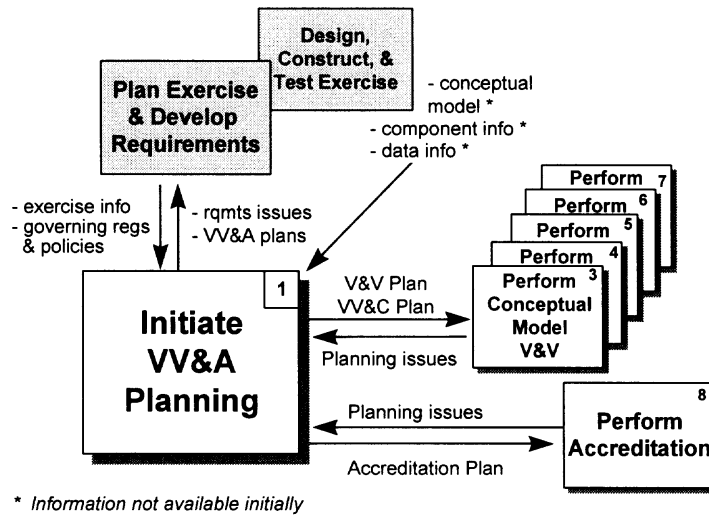
Figure 4 depicts the basic interactions between exercise and VV&A activities and *Initiate VV&A Planning*. Arrow annotation provides examples of the types of information exchanged and products produced.

6.1.1 Objective

The objective of this activity is to develop plans for executing exercise V&V, data VV&C, and exercise accreditation in support of exercise requirements and development.

6.1.2 Overview

Although it is possible to develop one comprehensive plan to address V&V, VV&C, and accreditation, it is generally more convenient to create individual plans for each area. The VV&A team should develop the

**Figure 4—Planning in the VV&A process**

plan(s) by identifying the tasks required in a manner that matches and complements the exercise development plan, exercise requirements, test plans, component requirements, available resources, and timelines. The VV&A team should ensure that the plan(s) address the requirements and associated acceptability criteria and map to the available resources. The plan(s) should be flexible allowing for adjustment and refinement as required throughout the exercise development process.

Initially, all plans should be working documents that are expected to evolve as the exercise takes shape. When new information is available or changes occur, the VV&A team should update the plans and submit them to the exercise manager for approval.

6.1.3 Recommended resources

6.1.3.1 Information

The accreditation process is governed by a number of constraints (e.g., accreditation policies, regulations, and directives of the participating organizations, services, agencies) that should be taken into consideration when developing the plan(s). Table 1 lists examples of references used during the VV&A planning process and their normal sources. Additional information is provided in Annex B.

Table 1—VV&A planning information

Information	Source
Regulations, directives, instructions, policies Standards, recommended practices	Exercise user/sponsor M&S respiratory, Modeling and Simulation Resource Repository (MSRR)
Exercise requirements Exercise environment Acceptability criteria Exercise plan, schedule VV&A resources	<i>Plan Exercise and Develop Requirements</i> (5.2.1) Exercise manager
Validated conceptual model ^a M&S and data component information ^a	<i>Design, Construct, and Test Exercise</i> (5.2.2) Exercise architect

^aNot available during initial planning phase.

6.1.3.2 Functional responsibilities

Individual V&V, VV&C, and accreditation plans should be developed by qualified members of the VV&A team:

- V&V planners should include experts in the specific behaviors required in the exercise and analysts with V&V experience;
- VV&C planners should include data experts and data analysts; and
- Accreditation planners should include developmental and operational test and evaluation personnel, independent evaluators, and/or appropriate subject matter experts (SMEs).

6.1.4 Procedure

V&V, VV&C, and accreditation planning can each be accomplished using the following approach: *Obtain Planning Guidance, Review Requirements, Select Approach, and Prepare Plan.*

The V&V, VV&C, and accreditation plans should serve as primary controls throughout the entire exercise VV&A process. In particular,

- The V&V plan should establish a process for collecting evidence to evaluate the acceptability and to support decisions on the sufficiency of the exercise configuration;
- The VV&C plan should identify the data V&V issues and measures to be used to evaluate the appropriateness of the data; and
- The accreditation plan should elaborate the accreditation issues and acceptability criteria.

Working drafts of each plan should be submitted to the exercise manager for review and comment. When all necessary information has been obtained and no additional changes are expected, the (final) plans should be submitted to the exercise user/sponsor for approval.

6.1.4.1 Obtain planning guidance

Policies, regulations, guidelines, standards, and directives pertinent to the administration and execution of VV&A activities are collected and reviewed to determine the constraints under which the V&V, VV&C, and accreditation efforts should operate.

6.1.4.2 Review requirements

Exercise requirements and acceptability criteria are reviewed; the exercise environment is examined; and appropriate V&V, VV&C, and accreditation issues and metrics are identified. Once candidate M&S and database components have been identified by the exercise manager, VV&A and VV&C histories should be reviewed to ascertain what additional V&V tasks are required to achieve a suitable level of acceptability or risk.

6.1.4.3 Select approach

The basic approach and the methods and techniques to be used should be selected based on exercise requirements and priorities, policy constraints, and availability of resources.

6.1.4.4 Prepare plan

Each plan should document the issues, priorities, techniques used, resources assigned, problem areas, and potential risks (when identified). Individual tasks should be scheduled to coincide with appropriate exercise activities and each other. Draft plans should be revisited throughout the VV&A process to ensure their integ-

ity. Whenever changes are made, plans should be updated and submitted to the exercise manager for approval.

6.1.5 Expected results

This activity should result in the products listed in Table 2.

Table 2—Major planning products

Plans
Exercise V&V plan
Exercise VV&C plan
Exercise accreditation plan

6.2 Activity: Perform compliance standards verification

Figure 5 illustrates the two phases involved in compliance standards verification. The shaded portion of the figure shows the initial process that is performed independently by the M&S provider. The remainder of the figure depicts the basic interactions between exercise and VV&A activities and *Perform Compliance Standards Verification*. Arrow annotation provides examples of the types of information exchanged and products produced.

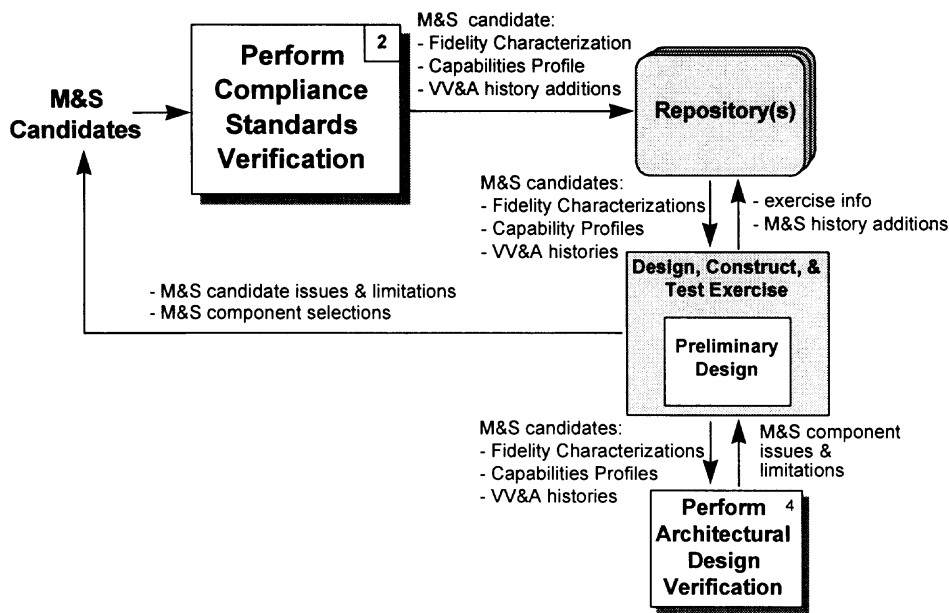


Figure 5—Compliance standards verification

6.2.1 Objective

The objective of this activity is to verify that a model, simulation, or simulator complies with the appropriate protocol standards as specified in IEEE Std 1278.1-1995 and IEEE Std 1278.1a-1998.

6.2.2 Overview

DIS protocol data units (PDUs) and their associated enumerations were developed as a method of communication to support the interactions that take place between entities during a DIS exercise (e.g., passive detection, weapons fire, logistics support, collisions, radio/tactical communications, active emissions). To evaluate heterogeneous systems that simulate or represent diverse sets of operational systems, the capabilities of each system should be described sufficiently to allow evaluation criteria to be developed.

Compliance implies that a model or simulation can communicate using a specified compliance profile (e.g., a PDU configuration and its corresponding enumerations) and will interact with the connecting environment without corrupting the network. Initial compliance testing may be independent of a specific exercise. An M&S provider with the need or desire to be DIS compliant should

- a) Complete a capabilities statement describing the operational capabilities (e.g., move, shoot, repair) of each system, sensor, entity and/or object to be supported by DIS PDUs and enumerations;
- b) Download the appropriate DIS test system from the DIS Service Center; and
- c) Conduct the tests.

The resulting compliance profile, including the capabilities statement and test results, should be archived in a M&S repository (e.g., MSRR) and made available to exercise managers and exercise architects to use when selecting participants for their exercise configuration.

6.2.3 Recommended resources

Tools are being developed in the government and commercial sectors to support the compliance testing process. Typical resources used to perform compliance verification are shown in Table 3.

Table 3—Compliance testing resources

Information
Specified versions of IEEE Std 1278.1-1995 and IEEE Std 1278.1a-1998 and associated enumeration documents IEEE P1278.5 DIS test system Test simulated natural environment data and visual models Compliance test procedures for DIS application protocols Capabilities statement form

6.2.4 Procedure

Two primary tasks are involved: *Conduct Compliance Tests* and *Develop Fidelity Characterization*.

6.2.4.1 Conduct compliance tests

Compliance tests are conducted to evaluate the consistency and correctness of PDU interpretation and utilization by an M&S. Compliance test procedures are based on the “shall” statements in IEEE Std 1278.1-1995 and IEEE Std 1278.1a-1998 and are organized into reception and transmission tests for each PDU type.

- a) Reception tests are conducted to ensure the M&S under test can respond to the PDUs identified as meaningful in the capabilities statement.
- b) Transmission tests are conducted to ensure the M&S can transmit the PDUs required to support the interactions described in its capabilities statement. Transmission test procedures that verify appro-