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Standard For Distributed Interactive Simulation, Exercise Management And Feedback: Draft

University of Central Florida Institute for Simulation and Training

INSTITUTE FOR SIMULATION AND TRAINING

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STANDARD FOR DISTRIBUTED INTERACTIVE SIMULATION EXERCISE MANAGEMENT AND FEEDBACK

IST DOCUMENTATION

IST-CR-94-20

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Standard for Distributed Interactive Simulation-- Exercise Management and Feedback

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Division of Sponsored Research

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PROPOSED IEEE STANDARD

STANDARD FOR DISTRIBUTED INTERACTIVE SIMULATION - EXERCISE MANAGEMENT AND FEEDBACK

"NOTE: This working draft, dated May 1994, prepared by the Institute for Simulation and Training for STRICOM, has not been approved and is subject to modification. DO NOT USE PRIOR TO APPROVAL. (Project _______)"

Foreword

This standard is part of a set of standards for Distributed Interactive Simulation (DIS). The relationship between this standard and other DIS standards is shown in Figure 1 below.

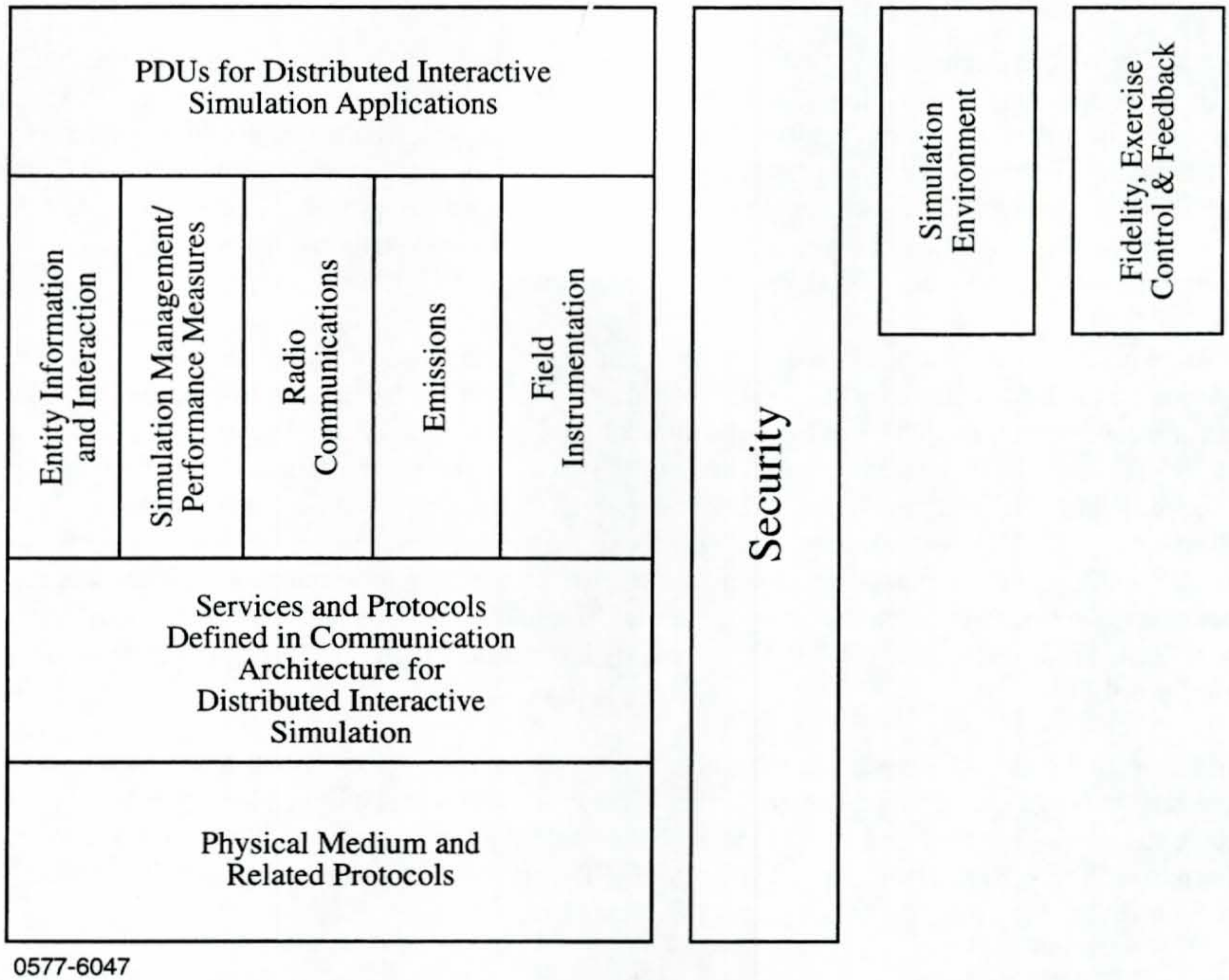

Figure 1. Documentation Relationships

This set of standards deals with requirements for simulations participating in a Distributed Interactive Simulation. There are several elements that make up the DIS environment. Each element is addressed by one or more standard documents. Used together, these standards will define an interoperable simulated battle environment.

The main elements addressed by these standards are:

(1) Communications
(2) Simulation Environment
(3) Fidelity, Exercise Control, and Feedback Requirements

The scope of this document lies within the third element, Fidelity, Exercise Control & Feedback. The purpose of this document is to define the functions that must be implemented at a DIS site in order to control exercises and feedback exercise results and performance measures to exercise participants. Future versions of this standard will contain additional functions required to control exercises and provide feedback functions that are not currently supported. The rationale behind the content of this document is contained in the "Rationale for Distributed Interactive Simulation--Exercise Control and Feedback Requirements," IST-CR-94-10.

Two related draft standards make up the communications elements of DIS. The first document, "Standard for Information Technology, Protocols for Distributed Interactive Simulation" defines the messages that are exchanged between simulation applications. These Protocol Data Units (PDUs) provide data concerning simulated entity states and the types of entity interactions that take place in a DIS exercise. "Communication Architecture for Distributed Interactive Simulation" (CADIS) establishes the requirements for the communication architecture to be used in DIS applications. It makes recommendations concerning the communication profiles that can provide the services to meet those requirements. The standard described by this document, along with the CADIS document, provide the necessary information exchange for the communications element of DIS.

In the second element, Simulation Environment, the government's Project 2851 is providing a military standard describing database formats for terrain, culture, and dynamic model representation. The draft military standard "Standard Simulator Data Base (SSDB) Interchange Format (SIF) for High Detail Input/Output (SIF/HDI) and Distributed Processing (SIF/DP)" is recommended for use with the developing DIS standards.

The required fidelity correlation between simulations in a DIS exercise is addressed in the draft standard "Standard for Distributed Interactive Simulation--Fidelity Description Requirements", IST-CR-94-13. DRAFT

The IEEE Working Group that developed this standard had the following membership during the development cycle:

Bruce McDonald, Chair

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1.0 SCOPE

1.1 Scope. This standard establishes the Exercise Management and Feedback requirements for participation in a Distributed Interactive Simulation exercise. It is one in a series of standards addressing the interoperability among interconnected simulations.

1.2 Application. When invoked in a specification or statement of work, these requirements shall apply to simulations intended for participation in a DIS exercise.

2.0 APPLICABLE DOCUMENTS

IST-CF-89-01	-	Summary Report: The First Conference on Standards for the Interoperability of Defense Simulations
IST-CF-90-01	-	Summary Report: The Second Conference on Standards for the Interoperability of Defense Simulations
IST-CR-90-13	-	Summary Report: The Third Workshop on Standards for the Interoperability of Defense Simulations
IST-CR-91-11	-	Summary Report: The Fourth Workshop on Standards for the Interoperability of Defense Simulations
IST-CR-91-13	-	Summary Report: The Fifth Workshop on Standards for the Interoperability of Defense Simulations
IST-CR-92-02	-	Summary Report: The Sixth Workshop on Standards for the Interoperability of Defense Simulations
IST-CR-92-17	-	Summary Report: The Seventh Workshop on Standards for the Interoperability of Defense Simulations
IST-CR-93-10	-	Summary Report: The Eighth Workshop on Standards for the Interoperability of Defense Simulations
IST-CR-93-39	-	Summary Report: The Ninth Workshop of Standards for the Interoperability of Defense Simulations
IST-CF-94-01	-	Summary Report: The Tenth Workshop of Standards for the Interoperability of Defense Simulations
IEEE 1278	-	Standard for Information Technology, Protocol for Distributed Interactive Simulation Applications

IST-CR-94-??	-	Distributed Interactive Simulation Vision Document
IST-TR-94-08	-	Guidance Document: Distributed Interactive Simulation Standards Development Guidance Document Version 2.3
IST-CR-92-21	-	Guidance Document: Communication Architecture for Distributed Interactive Simulation
IST-CR-94-50	-	Standard for Distributed Interactive Simulation--Application Protocols Version; 2.0.4
IST-CR-93-46	-	Enumeration and Bit Encoded Values for use with IEEE 1278.1-1994, Distributed Interactive Simulation--Application Protocols
IST-CR-94-15	-	Standard for Distributed Interactive Simulation--Communication Architecture and Security
IST-CR-94-13	-	Standard for Distributed Interactive Simulation--Fidelity Description Requirements
IST-CR-94-20	-	Standard for Distributed Interactive Simulation--Exercise Management and Feedback
IST-CR-93-03	-	Rationale: Standard for Information Technology-Protocols for Distributed Interactive Simulation Applications
IST-CR-94-10	-	Rationale for Distributed Interactive Simulation--Exercise Control and Feedback Requirements
IST-CR-93-42	-	Rationale Document: Communication Architecture for Distributed Interactive Simulation (CADIS)
IST-CR-93-34	-	Rationale Document: Fidelity Correlation Requirements for Distributed Interactive Simulation

3.0 DEFINITIONS

Accreditation The official certification that a model or simulation is acceptable for use for a specific purpose.

Battlespace Entity - Simulation entity that corresponds to actual equipment, supplies, and personnel that can be seen or sensed on a real battlefield.

Computer Generated Forces- Collection of unmanned battlespace entities generated by computer.

Control Station - Computer connected to a local area network that transmits/receives simulation management protocol data units at the direction of the simulation manager.

Data Logger - Device that accepts PDUs from the network and stores them for later replay on the network in the same time sequence as the PDUs were originally received.

Entity - Any vehicle, craft, weapon system, personnel, or physical object, manned or computer-generated, that is part of a DIS exercise. An entity can assume either a passive or active role in a given exercise.

Exercise - Consists of one or more interacting simulation applications. Simulations participating in the same simulation exercise share a common identifying number called the exercise identifier. These simulations also utilize correlated representations of the synthetic environment in which they operate.

Local Area Network (LAN) - Class of data network that provides high data rate interconnection between network nodes in close physical proximity.

Long Haul Network (LHN) - Also called Wide Area Network (WAN). A communications network of devices that are separated by substantial geographical distance.

Measure of Performance (MOP) - Measure of how the system/individual performs its functions in a given environment (e.g. probability of detection, reaction time, number of targets nominated, susceptibility of deception, task completion time). It is closely related to inherent parameters (physical and structural) but measures attributes of system/individual behavior.

Measure of Effectiveness (MOE) - The method for quantifying effectiveness criteria. MOEs can be directly observed and calculated from Measures of Performance, or derived from evaluator judgment.

Registration - Alignment of coordinate systems and phenomenological agreement between environment models.

Scenario - An initial set of conditions and timeline of significant events imposed on trainees or systems to achieve exercise objectives.

Session Data Base - A standard DIS database that includes network initialization data and simulation entity initialization and control data.

Simulation Fidelity - Refers to the degree of similarity between the simulated situation and the operational situation.

Unit - An aggregation of entities.

Validation - The process of determining the extent to which a Model or Simulation is an accurate representation of the real-world from the perspective of the intended use of the Modeling and Simulation. Validation methods include expert consensus, comparison with historical results, comparison with test data, peer review, and independent review. Validation also refers to the process of determining (a) the manner and degree to which a model is an accurate representation of the real-world from the perspective of the intended uses of the model and (b) the confidence that should be placed on this assessment.

Verification - The process of determining that a Model or Simulation accurately represents the developer's conceptual description and specifications. Verification evaluates the extent to which the Model or Simulation has been developed using sound and established software engineering techniques.

What-If Analysis - An exercise that determines what capabilities an overall system would have if a changed capability were added (e.g., longer range missile).

4.0 GENERAL REQUIREMENTS

4.1 Introduction. This section contains Exercise Management and Feedback requirements for DIS.

4.2 Purpose. This standard provides procedures and guidelines used to plan, set-up, execute, manage, and assess a DIS exercise.

4.3 Use. This standard provides guidance to sponsors, providers and supporters of DIS compliant systems and exercises. This standard does not control who can or cannot participate in a DIS exercise.

4.4 Functions. This standard specifies the functions of the organizations involved in a DIS exercise, the functional requirements of the exercise management and feedback system to be used and the top level process used to accomplish those functions.

5.0 DETAILED REQUIREMENTS

This section provides detailed requirements for the DIS exercise planning, development, conduct and VV&A processes, and also describes the functionality of the involved organizations, and the functionality of the necessary management and feedback system.

5.1 DIS exercise Functions.

5.1.1 User. The person or agency who determines the need for a DIS exercise and establishes the funding for the exercise is the DIS user or sponsor. The user also provides the exercise participants and exercise objectives requirements and specifications. The specific individual within that agency with executive oversight of the DIS exercise is the sponsor's agent. This agent in turn appoints the simulation manager.

5.1.2 Simulation Manager. The Simulation Manager is responsible for creating the exercise, executing the exercise, and conducting the post exercise activities. He continuously coordinates with the VV&A authority during these tasks and then reports the results of the exercise to the sponsor.

5.1.3 Exercise Architect. The Architect shall provide the exercise design integration and test as directed by the simulation manager.

5.1.4 Model/Tool Providers. These agencies develop, stock, store, maintain and issue simulations and models. They maintain historical records of the utilization and VV&A of each simulation and model.

5.1.5 Site Manager. The site managers own, maintain, and operate the physical simulation assets located at their geographic location. They coordinate with the model providers to install, operate and instantiate specific simulation capabilities specified by the simulation manager.

5.1.6 DIS Control. DIS control provides technical assistance to simulation managers attempting to meet specific requirements. They maintain catalogs of sites, models and simulations, and available networks.

5.1.7 Network Manager. The network manager owns, maintains and operates a network capable of providing DIS link between two or more sites. For a given exercise the simulation manager selects a network manager to link together the participating sites.

5.1.8 VV&A Authority. The agency appointed by the exercise sponsor to measure, verify and report on the validity of the exercise and to provide data to the sponsor allowing him to accredit the results.

5.1.9 Exercise Analyst. The agency tasked by the sponsor/user to ??? reduce the new exercise data.

5.2 DIS Exercise Development Process Model The DIS Exercise Development process consists of five phases as shown in Figure 2. These five phases are described below.

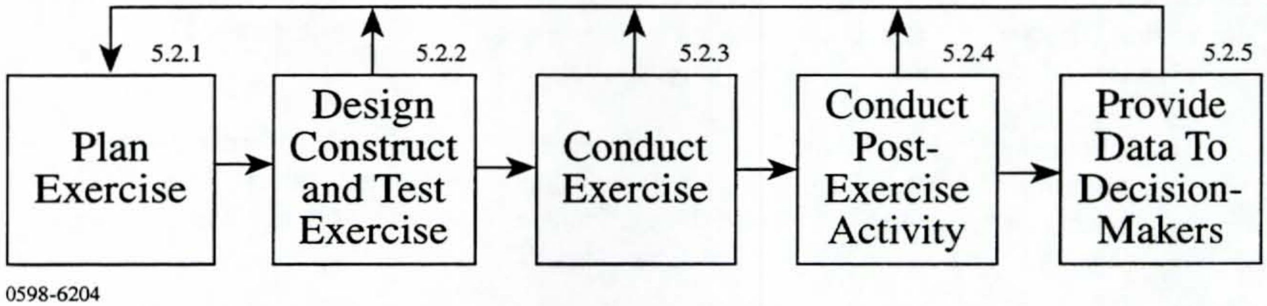

Figure 2. Phases of Developing and Conducting DIS Exercise

Once certain that the planned exercise can achieve the intended objectives, the user will conduct the exercise. After exercise completion, the user will conduct post-exercise activity such as after action review, data analysis, and compilation of aids for decision-makers. As part of each phase, unanticipated results or changes to exercise requirements will be fed back to the appropriate point in the process model for corrective action.

5.2.1 Plan the Exercise. These functions must be accomplished to ensure proper planning. They are accomplished with the advice of DIS technical agencies. The critical planning tasks to be performed for a DIS Exercise are listed below in approximate sequential order:

a. Define exercise purpose, objectives, user's response time, and security requirements.
b. Determine measures of effectiveness and performance applicable to the exercise.
c. Identify feedback products, audience and timeliness required.
d. Determine and define specific data collection requirements and minimum PDU set to support b and c.
e. Develop VV&A Plan.
f. Develop tentative planning schedule.
g. Define rules of engagement and political environment.
h. Identify location to be simulated.
i. Set exercise time frame.
j. Define exercise environment (weather, climate, electromagnetic, oceanographic).
k. Determine exercise forces, friendly, opposing, and neutral.
l. Determine mix of simulation forces among live, virtual and constructive categories.
m. Determine simulation resources available.
n. Determine simulation resources to be developed.
o. Determine support personnel required (e.g., machine operators, observers, data collectors).
p. Define initial conditions, planned events.
q. Select and distribute battlespace data bases.

5.2.2 Design, Construct and Test Exercise. In this phase, the DIS exercise shall be developed to meet the requirements specified during the planning phase, making maximum reuse of existing DIS components. It consists of a sequence of four steps: Preliminary Design, Detailed Design, Construction and Assembly, and Integration and Test.

a. Preliminary Design. In this step, the requirements outlined during the planning phase are translated into a high level design model of the DIS exercise. An architecture for the exercise is created to show all of the participating components, their interfaces, behavior and control structure.

b. Detailed Design. In this step, the design model and architecture generated in the previous step are elaborated to the extent necessary to support the complete definition of all required functions, dataflow, and behavior.

c. Construction and Assembly. This step consists of assembling existing DIS components and for developing new components.

d. Integration and testing. This step is usually performed as an incremental process starting with a minimum number of components and connectivity, then adding and building until operational status is reached. Testing then occurs to determine whether requirements and performance criteria are being met.

5.2.3 Conduct Exercise. In this phase, the DIS exercise will be conducted using the resources developed during the design, construct, and test phase. The goal of this phase is to satisfy the objectives established during the planning phase. A number of management functions shall be addressed as detailed in paragraph 5.4.2.

a. Monitor the exercise using displays such as plan view, entity and unit status, tabular displays of conditions and capabilities, and three dimensional views of the virtual battlespace from either a free-play non-intrusive viewing platform, or tied to a specific entity.
b. Specific control aids include interdetectability between designated entities. Parameters to include range, bearing, and band sensed.
c. Course, altitude and speed of any entity is to be available.
d. Range, bearing, and closure rate relative to any two entities.
e. Exercise control requires the following functional capabilities:
    1) Initiate exercise- starts a new exercise or continues a previously saved exercise.
    2) Freeze/resume- Temporarily halts and resumes an exercise or entity.
    3) Terminate exercise-
    4) Remove entities- Removes specific entity from battlespace.
    5) Generate entities- Instantiates or reinstantiates an entity.
    6) Save state (n)- Saves the specific conditions of an exercise at the designated time. Allows restarting and exercise for what-if analysis. Multiple save states shall be supported in a single exercise.
    7) Return to saved state (n)- Restarts the exercise from a designated state.
    8) Start segment- Evaluation of operational plans requires the ability to determine the effect of changes in force elements or plans. The start segment will identify the point from which the restart would commence. The new exercise will use the original PDU stream to the save start segment mark and the subsequent PDU stream thereafter. The appending of two or more "PDU tails" to a single stream marks the difference between save state and start segment functions.
    9) Observed event- Observer's note, attached to the record as a PDU to facilitate recall for analysis or review.
    10) Parameter query- request from the Simulation Manager to one or more entities for their specified parameters.

5.2.4 Conduct Post Exercise Activity. Post exercise activity initially centers on rapidly providing after action review material. Events or situations marked with Observed Event markers will be recalled and edited into presentation material to inform all participants of just what their compatriots and adversaries saw and knew at any given time. From this, understanding of the exercise and of each decision can be developed. Those who are charged with preparation of the after action review will be provided tools for selecting, integrating and displaying exercise data. Additionally, exercise data shall be archived so that cross exercise analysis can be accomplished.

The exercise feedback system shall include various data presentation methods. They will present data in accordance with the data indices and filters as described in section 5.4.3.1 and 5.4.3.2. The exercise feedback system shall provide a selection of analytical functions for preliminary analysis and after action review of each exercise as described in section 5.4.3.3.

5.2.5 Provide Results to Decision Makers. Exercise results will be reported to designated levels of decision makers according to the reporting requirements of the exercise.

5.3 Verification, Validation and Accreditation.

The VV&A process is shown on Figure 3 as a series of shadowed boxes numbered 1 through 7 that are superimposed upon the DIS Exercise Development Process Model discussed in detail in Sec. 5.2. The name chosen for each VV&A phase is based on the main activity being performed.

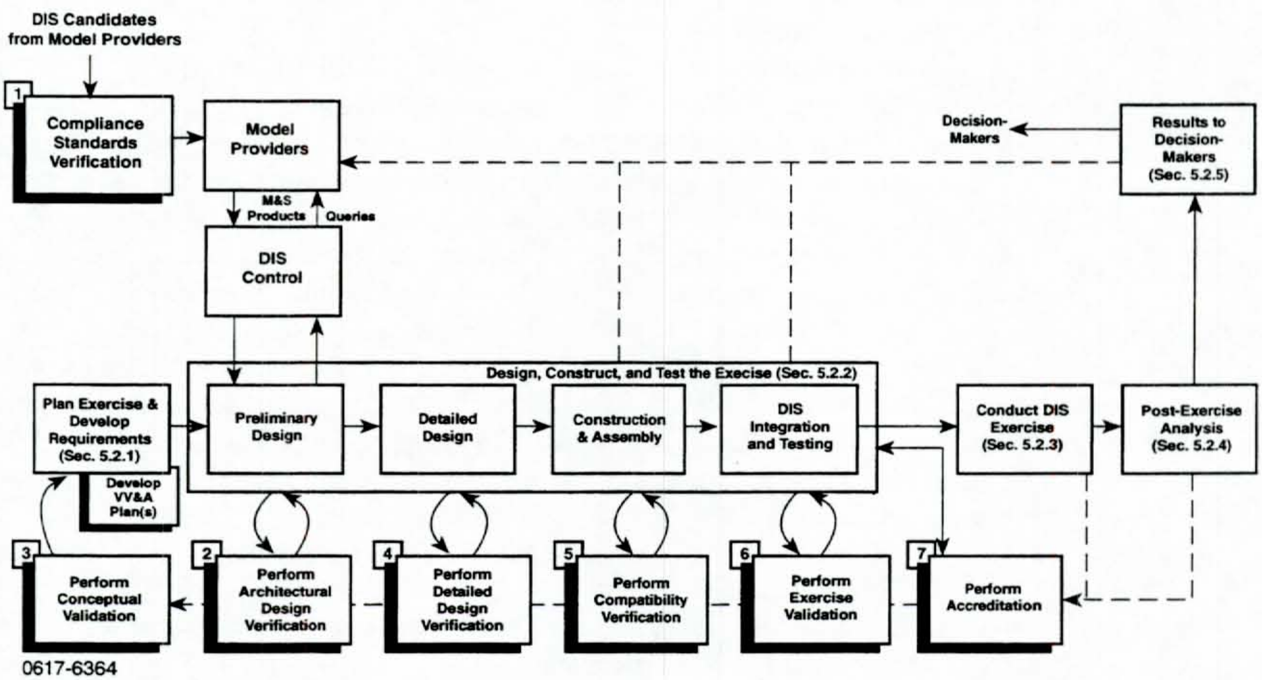

Figure 3. Applying the VV&A Process to a DIS Exercise

5.3.1 Phase 1 - Compliance Standards Verification. This process element serves as the gatekeeper to prevent non-conforming M&S components from entering the DIS repository. The main verification mechanism is the approved DIS compliance (also called conformance) test suite set up and coordinated by the Institute for Simulation and Training (IST) in Orlando, FL, for STRICOM, who in turn has responsibility for DIS interface standards and protocols. Regardless of where or who is planning and administering the DIS exercise, this set of tests is appropriate for ensuring DIS interface compliance. Products that pass these tests are then further in-processed by the repository. Thus, this verification step can in-process models and simulations products at any time independent of pending DIS exercises, or can be used to screen products just prior to an exercise.

5.3.2 Phase 2 - Architectural Design Verification. This phase is coupled to the preliminary (architectural) design of the DIS. It should be remembered that most or all of the components will a) already exist, and b) already have had some amount of VV&A at the component level. This reduces the time and engineering effort required to perform DIS VV&A. This verification phase evaluates the completeness and correctness of the DIS exercise architecture; verifies the allocation of functions to appropriate DIS model and simulation components; traces the requirements established by the user; and examines the input data, interface requirements and designs to ensure compatibility and interoperability using appropriate protocol data units (PDUs). It is here that the theoretical assumptions, degree of fidelity, interaction with the environment, modeling of phenomena, precision, and level of aggregation all have to be understood in the context of the proposed DIS configuration. Consistency in using common DIS resources and databases--earth model, terrain, weather, phenomena, man-made and natural objects, etc.--is verified. Overall behavior and performance of the DIS exercise is approximated, hardware platforms are evaluated and benchmarked, timing and sizing estimates are made and compared to those developed by the DIS designer, and the scenario timelines are analyzed.

5.3.3 Phase 3 - Concept Validation. This phase is a counter-flow activity used to validate the conceptual model developed in the preliminary design phase against the DIS exercise requirements. It is during this process that the measures and performance (MOPs) and effectiveness (MOEs) are analyzed, aggregation/deaggregation requirements are settled and rationalized, and any essential trade-offs are made before it becomes more costly to change the exercise architecture. Philosophically speaking, validation invariably involves testing. In this case, the testing is most commonly performed by prototyping and executing a model of the DIS, in essence a low-fidelity model of the high-fidelity DIS model. If the DIS designer has already assembled such a model, VV&A should share, verify, and use it. If the designer has not assembled one, VV&A can do so if resources allow. There are a number of comprehensive CASE tools that enable rapid generation of such a model. If resources simply do not allow this independent modeling to occur, face validation of whatever model is available is performed. The goal of all of these options is to confirm that all of the operational requirements are satisfied by the DIS architecture. If this is not the case, positive actions should be taken not to continue into detailed design of the DIS until all the requirements issues are resolved.

5.3.4 Phase 4 - Detailed Design Verification. It is here that the detailed design of the DIS is carefully examined. Despite the extensive reuse of components, the detailed design of a DIS is very similar in scope to the detailed design of any system. Final hardware decisions have to be made, detailed interfaces have to be chosen and/or designed, software logic and key algorithms have to be reviewed to ensure that they satisfy the requirements, and the input data/database sources have to be verified. Preliminary design defines what messages and PDUs have to flow between two or more points; detailed design defines how each of these is processed and what is done with the information. It is very important to the designer that the DIS design be as complete as possible to ensure smooth and efficient DIS process assembly and later integration and test. VV&A ensures that the operational and function requirements are in a usable form for tracing and verification. At this phase, VV&A either participates in the DIS designer's design walk-throughs or holds independent ones for the purpose of fully understanding the detailed design. Through analysis, necessary dead reckoning designs are generated and verified, and their initial thresholds are selected. As the overall timing, sizing, and behavior estimates of the DIS are refined, VV&A verifies the roles of semi-automated forces, calculates the expected behavior of the live players, and evaluates the test criteria for each component and the overall DIS.

5.3.5 Phase 5 - Compatibility Verification. This phase verifies the compatibility of components during their coding, construction and assembly into the DIS. Compatibility not only examines the internal attributes of the component that will make it interact correctly with other interfacing DIS components, but also ensures that the component is compatible with the common "shared" DIS models and databases--earth, terrain, sea, weather, atmosphere, phenomena, etc. All DIS components do not have to have the same fidelity or performance characteristics as long as the DIS designer knows what is expected of each part, and there is compatibility among the parts that exchange data and all components must share a common visualization of reality. Code verification uses the most appropriate tools and techniques available for the software language in question. It is in this step that the implementation of dead reckoning algorithms and thresholds are verified, input and output data values are carefully analyzed, databases are verified, and the interfaces are continuously tested to ensure that loading and latency do not adversely affect the behavior of the component(s). At least two classes of experts are needed--those very knowledgeable in the domain and those expert in DIS. Here also is where the instrumentation for the component as well as the DIS stealth must be operational so that all message traffic can be recorded and performance data can be collected and displayed.

5.3.6 Phase 6 - Exercise Validation. Validation addresses how well each component as well as the total DIS meets the real-world behavior, appearance, performance, fidelity, and interoperability expectations for this application. It is in this phase that interoperability is stressed. By the end of this phase, the integration of all of the DIS components will be complete, visualization of the entities will be accomplished in the context of their appearance in the exercise, and the DIS will have predictable behavior with normal loading. If one simulator engages another, both must see the same terrain, encounter the same obstacles, agree on position and movement, etc. Thus, a significant part of this phase concentrates on testing and evaluating the measures of performance and effectiveness (MOPs and MOEs) discussed in Phase 3 - Concept Validation that are tied directly to the exercise requirements. As the testing continues, performance boundaries and sensitivities are determined that evolve into a performance baseline keyed to one or more scenarios. It is expected that this testing will produce a comprehensive test suite that enables the evaluators and validators to profile and evaluate the effectiveness of the entire DIS, more or less entity-by-entity. Non-intrusive monitoring and data collection software is required to observe the network continuously to measure traffic and each participant's activity, and to pinpoint problems and possible stressing conditions. During this part of the testing process (that typically takes several weeks), automatons are often used as surrogates for live forces to reduce resource burdens. This validation step makes comparisons to the real world and to any other validated and/or accredited sources available and critically examines the input data sources to ensure that they are valid and certified where possible. In summary, validation focuses on the completeness and structural soundness of the DIS and the realism of the outputs in terms of the needs of the specific application. It also determines the acceptability of each component in the context of the complete DIS.

5.3.7 Phase 7 - Accreditation. This phase involves the formal acceptance of a DIS exercise by the user (sponsor) based on results of the Verification and Validation phases that precede it. Interservice DIS exercises should be accredited according to the responsible Service/DOD Component's accreditation policies or guidelines. Joint (intraservice) DIS exercise accreditation decisions should be based upon mutually accepted guidance.

5.4 Required Functions For Exercise Setup, Management and Feedback.

5.4.1 Exercise Setup. The functions listed below enable proper initialization and subsequent control of each entity in the exercise. The exercise setup PDUs are defined in IEEE 1278. Each DIS exercise shall have at least one control station, known as the Simulation Manager station, with the following capabilities during exercise setup:

5.4.1.1 Instantiate session - The following functions are required to instantiate a session:

5.4.1.1.1 Synchronize clocks - Allow each entity to synchronize their internal clock with a master clock.

5.4.1.1.2 Issue commands to instantiate session data bases.

a. Set Initial Conditions - set initial exercise conditions to include:
   - entities (states, conditions, types and amounts)
   - environment (states and conditions)
   - database (identify database which will be used for a given exercise. Information will include terrain and features, ocean models, and atmosphere models, as appropriate.)

b. Select Exercise Area - set an exercise area within a given database.

c. Set Expendables - set expendable items such as fuel, ammunition, etc.

d. Initialize Computer-Generated Forces (CGFs) - initialize computer-generated forces to include rules of engagement and proficiency or intelligence level.

e. Instantiate Entities - bring entity on line to start issuing entity state PDUs.

5.4.1.2 Request Parameters Report - direct a simulation host to transmit entity parameters not routinely available on the network.

5.4.1.3 Display Entity Status - show status of each entity (e.g., damage, fuel, other entity parameters).

5.4.1.4 Display Network Health - show the technical status and health of the network.

5.4.2 Exercise Management. An exercise consists of one or more sessions each consisting of a set of entities interacting within the virtual environment to accomplish the goals of the exercise. Exercise management involves setup, initialization, control, and the monitoring tools necessary to administer each session within an exercise.

5.4.2.1 Set Up the Exercise. Much of the information needed to initialize the network for a session can be generated and stored for later use during the initialization of a session.

As part of a session, each simulation application must be given a role to play. Each role consists of initial conditions, or other pertinent data necessary to initialize a simulation. Like network initialization data, these roles can be generated and stored in advance.

A session database, therefore, shall be generated for each session consisting of the aforementioned network initialization data along with the data necessary to give a role to each simulation included in each session.

5.4.2.2 Initialize A Session. The functions listed below enable proper initialization and subsequent control of each simulation in the session. Session initialization PDUs are defined in IEEE 1278. Each DIS exercise shall have at least one control station known as the Simulation Management Station, possessing, but not limited to, the following capabilities capable of performing at least the following functions.

5.4.2.2.1 Synchronize clocks - Direct participant to synchronize their clocks with common time reference.

5.4.2.2.2 Issue commands to instantiate session data bases.

a. Select Session Area - set a session area within a given database.

b. Initialize Computer-Generated Forces (CGFs) - initialize computer-generated forces to include rules of engagement and proficiency or intelligence level.

c. Create Entities - bring entity on line.

d. Set Initial Conditions - set initial session conditions to include:
- entities (states, conditions, types and amounts)
- environment (states and conditions)
- database (identify the database representing the virtual environment which will be used for a given session. The database will include terrain and features, ocean models, and atmosphere models, as appropriate.
- expendable items such as fuel, ammunition, etc.

5.4.2.2.3 <u>Query Parameters</u> - Direct a simulation application to transmit entity parameters that are not routinely available on the network for one or more entities.

5.4.2.3 <u>Control A Session</u> - Session Control PDUs are defined in IEEE 1278. For session control, the Simulation Management Station shall possess at least the following functions during session execution:

a. Session Initiation - initiates a new or continues a previously saved session (see item f below).

b. Freeze/Resume - temporarily freezes and then resumes a given session and/or entity.

c. Session Termination - terminates an session. It is envisioned that a session would be "frozen" before it is terminated in order to inform participants.

d. Remove Entities - selectively removes entities (by entity ID number) from a session.

e. Generate Entities - generates a given entity or regenerates an entity in its old or reconstituted state after it has been killed or, for some other reason, removed from the simulation.

f. Save State - Allows the simulation manager to direct a save to a given simulation state (i.e., entity locations and states, and approximate environment conditions). Multiple save states in a single session shall be accommodated.

g. Return to Save State - Allows the Simulation Manager to direct all entities to return to a selected save state.

h. Start Segment - allows the Simulation Manager to identify and initiate session segments from any save state. (Note: Evaluation of operational plans requires a what-if capability. Therefore, the system shall be able to stop a session, return to an earlier point, and restart a new sequence. This new sequence will consist of the save state point and the subsequent PDU stream. The new sequence will be collected without destroying the original sequence.)

i. Observed Event Input - allows the Simulation Manager through both the LANs and the WAN to input an observed event into the PDU stream for recording and later analysis.

j. Parameter Query Application - allows the Simulation Manager to direct a simulation to transmit entity parameters that are not routinely available on the network from one or more entities.

k. Modify Entity Parameters - allows the simulation manager to modify simulation application internal data.

5.4.2.4 Monitor A Session. In order to monitor each session, the Simulation Management Station shall provide a mechanism for monitoring session progress via graphical and tabular displays. These displays shall include but will not be limited to:

a. Plan View or Map display - shows a graphical representation of the virtual environment and the entities involved in a session from on overhead perspective.

b. 3D display with free-play eye point - shows a 3D representation of the virtual environment and the entities involved in a session from a free-moving, user-controlled perspective.

c. Entity and/or Unit Status display - shows status (e.g. damage, fuel, or other entity/unit parameters) of each entity and/or unit (group of entities).

d. Network Health display - shows the technical status and health of the network.

Additional Instructor/Test Director Aids provide the Simulation Manager with specific session information. These aids are envisioned to work with the session monitoring displays. These aids may include:

- interdetectability (i.e. Can two entities see or sense each other?)
- safety parameters
- range between two entities
- closure rate between two entities
- course and speed of a given entity
- range and bearing of a given entity

5.4.3 Exercise Feedback. An exercise feedback system is required to monitor the exercise as described in section 5.2.3 and perform the post-exercise functions outlined in sections 5.2.4 and 5.2.5. The system shall include analytical tools for selecting, integrating, and displaying exercise data in a way which is appropriate to the audience. The feedback system shall replay exercises against an appropriate environmental model. The feedback system may consist of one or more components at one or more locations. For example, a device for archiving the PDU stream for replay may be at one node while other devices for analysis, display, and debrief are at other locations. The feedback devices and capabilities required at each node for a particular exercise are determined in the planning and design phases outlined in sections 5.2.1 and 5.2.2. Due to the variable nature of debrief requirements (depending on desired media, display capabilities, exercise scope and objectives, etc.), there is no standard for the transmission of the post-exercise feedback.

5.4.3.1 Data. The exercise feedback system shall collect, process and store data as described below:

a. The system shall collect and archive PDU's such that the PDU stream can be reproduced exactly as received to include any what-if exercise data.

b. The system shall accept and archive non-PDU data such as operation and fragmentary orders and voice radio traffic. These data shall be indexed to the PDU data.

c. The system shall archive the collected PDU's and non-PDU material such that data can be retrieved for analysis of single exercises or across exercise boundaries.

d. The system shall provide user selectable checks to validate events determined by two or more PDU's, e.g., a fire PDU must be matched by a detonation PDU.

e. The system shall provide user selectable filters to reduce data flow by eliminating undesired PDU's.

5.4.3.2 Presentation Functions. The exercise feedback system shall provide data presentations. Displays shall be presented in accordance with the data indices and filters established above. The following displays and functions shall be provided:

a. A bird's eye/plan/overhead view that depicts all of the entities, topographic and cultural features, and user-defined annotations. These depictions shall be user selectable.

b. A three dimensional view with free-play view point. It shall be possible to link the view point with an entity.

c. Playback functions, such as fast forward/reverse, jump forward/reverse, single frame, pause/freeze, selectable play speed forward/reverse.

d. Zoom in or out on any view as well as pan the view across the display and adjust map display scale.

e. Select specific entities or classes of entities for replay.

f. Environmental effects (e.g. smoke, illumination, rain).

g. Movement of articulated parts as required by the user.

h. Hard copy (snapshot) output of any display.

i. Video output compatible with video transmission and storage media.

j. Audio playback.

5.4.3.3 <u>Analytical Functions</u>. The exercise feedback system shall provide a selection of analytical functions for preliminary analysis and after action review.

a. The system shall allow users to overlay displays with appropriate non-DIS data such as unit missions, or other pertinent portions of orders.

b. The system shall replay exercises at a level appropriate to the exercise participants being debriefed against an appropriate environment model. It shall use changes in entity icons and other graphical aids to indicate all relevant variables and status changes. Examples include:

(1) firing events
(2) major changes in entity status where information is contained by PDU's (e.g., assessed as casualty, dismount)
(3) real-time movement and track history with user-specified start, stop and interval time
(4) evasive actions other than movement described by PDU's (e.g., smoke, flares)
(5) movement of gun tubes and other articulated parts
(6) C3 Connectivity (active, passive, and broken)
(7) significant events in the electromagnetic spectrum
(8) reported contact movement and track, track start and stop time

c. The system shall display interdetectability of two or more entities at user command.

d. The system shall provide alphanumeric and graphical displays including graphs, tables, summaries and time lines showing critical exercise events, as defined by the user, and tools to customize the output.

e. The system shall provide editing features for the preparation of structured debriefs.

6.0 NOTES

6.1 Introduction. DIS will take advantage of currently installed and future simulations manufactured by different organizations. Consequently, a means must be found for assuring interoperability between dissimilar simulations. The first step in achieving this interoperability is to develop a set of standards to address:

- Protocol Data Units
- Communication Architecture
- Fidelity Correlation
- Exercise Control and Feedback

The current work on standards began in August 1989 with the first workshop on Standards for the Interoperability of Defense Simulations. Seven subsequent workshops were held at six month intervals. As a result of these workshops and subsequent subgroup meetings, over 150 position papers containing recommendations for the standards were submitted to the Institute for Simulation and Training (IST). Using the work of SIMNET as a baseline and considering recommendations made in meetings and position papers, IST is developing draft standards which address the topic areas listed above.

6.2 Description of Distributed Interactive Simulation. The basic concepts of Distributed Interactive Simulation (DIS) are an extension of the Simulation Networking (SIMNET) program developed by the Advanced Research Projects Agency (ARPA). The purpose of DIS is to allow dissimilar simulators distributed over a large geographical area to interact in a team environment. These simulators communicate over local area networks and wide area networks. The basic DIS concepts are:

- No central computer for event scheduling or conflict resolution

- Autonomous simulation nodes responsible for maintaining the state of one or more simulation entities

- There is a standard protocol for communicating "ground truth" data

- Receiving nodes are responsible for determining what is perceived

- Simulation nodes communicate only changes in their state

- Dead reckoning is used to reduce communications processing

6.3 DIS Mission. The primary mission of DIS is 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 (human-in-the-loop simulators), live entities (operational platforms and test and evaluation systems), and constructive entities (wargames and other automated simulations).

The DIS infrastructure provides interface standards, communications architectures, management structures, fidelity indices, technical forums, and other elements necessary to transform heterogeneous simulations into unified seamless synthetic environments. These synthetic environments support design and prototyping, education and training, test and evaluation, emergency preparedness and contingency response, and readiness and warfighting.

6.4 DIS Activity Planning Guidelines

6.4.1. Define:

a. Purpose of the DIS Activity (i.e., Exercise, Test, Demonstration)
b. Critical Operational Issues*
c. Objectives*
d. Measures of Effectiveness/Performance/Outcome*
e. Data Collection Requirements*
f. Operational Scenarios

    1. Political Situation
    2. Time Frame of Operations
    3. Friendly and Adversary air, ground, sea, and electronic orders of battle.
    4. Area of Operation
    5. Mission Objectives
    6. Targets
    7. Battle Management, Command, Control, Communications, Computers, and intelligence (BMC4I) architecture.

g. Concepts of Operation (CONOPS)

    1. Control Authority
    2. Rules of Engagement
    3. Airspace Control Procedures
    4. Areas of Responsibility
    5. Defended Assets
    6. Communications Frequency Management Plan

7. Support Operations (e.g., airlift, refueling, special operations, electronic countermeasures, emissions control)
8. Coordination Procedures

h. Preliminary Scope of Tactical Employment Options.

6.4.2. Develop Conceptual Model of Simulation

a. BMC4I Architecture
b. Functions
c. Data Requirements (Inputs/Outputs)
d. Behaviors

6.4.3. Determine Simulation Requirements

a. Fidelity (constructive, virtual, live)
b. Level of detail (engineering, engagement, mission, campaign)
c. Granularity (e.g., terrain, level of aggregation)
d. Communications Protocols (DIS, LRP, ALSP, other)
e. Emissions
f. Environmental Effects
g. Data Collection Capability*
h. Run Rates and Lengths of Scenarios
j. Tactical Data Links
k. Voice Communications

6.4.4. Determine Availability of Required Modeling and Simulation (M&S)

6.4.5. Select M&S for Planned DIS Activity

6.4.6. Coordinate with Selected Sites as Required

a. Memorandums of Agreement (MOAs)
b. Security
c. Schedule
d. Required Simulation Upgrades
e. Resource Commitments
f. Funding Requirements

6.4.7. Prepare Draft DIS Activity Plan and Circulate Through Appropriate Organizational Channels

6.4.8. Develop and Coordinate a Detailed Schedule

a. M&S Development
b. Hardware/Software Module and Integration Testing

c. DIS Activity Milestones.

6.4.9. Design, Code, and Verification Test Upgrades to Site-Specific M&S

6.4.10. Develop Detailed Scenarios

a. Test Scenarios for Verification and Validation
b. Operational Scenarios for Accreditation and Planned DIS Activity
c. Perform Data Base Reviews (Performance Parameters, Terrain, etc.)

6.4.11. Coordinate Scenario Validation with Approval Authority

6.4.12. Compile Live Test Data to Validate Simulation as Required

6.4.13. Perform DIS Verification Testing

a. Exercise Synchronization
b. Data Base Correlation
c. Line-of-Sight Intervisibility
d. Target/Background Color Contrasts
e. Voice Communications (Tactical and Test Control)
f. Data Links (Actual and Simulated)
g. Registration and Correlation of Environment Models (Terrain, Ocean, Atmosphere)
h. Entity/Unit Performance (e.g., Update Rates, Spatial Relationships, etc.)
i. PDU Timing and Completeness

6.4.14. Validate Integrated Simulation Through an Initial Operational Test and Evaluation (IOT&E)

a. Use Qualified M&S Operators as Applicable
b. Exercise the Data Management Analysis Plan (DMAP) as Required*
c. Checkout Operational Scenarios
d. Train White Force on Procedures
e. Conduct Stress Testing/Check System Reliability

6.4.15. Finalize and Coordinate Plan and Resource Requirements

6.4.16. Coordinate Resource Requirements (TDY Funding, Tasking to Participating Units)

6.4.17. Develop and Present an Overview Briefing for the Crews and Observers

a. Mission Objectives
b. Scenarios
c. CONOPS

d. Communications Plan
e. Data Collection* and Participant Feedback

6.4.18. <u>Provide Familiarization Training on Simulations Prior to Conducting Trials for Score</u> (If applicable)

6.4.19. <u>Provide Applicable Materials</u> (e.g., Operations Plans, Air Tasking Orders, Airspace Control Orders, and Maps) to Participating Crews for Mission Planning.

NOTE: Many of tasks listed above may be done in a parallel and require an iterative process.

*Items normally associated with formal analysis or test and evaluation activities.