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Exercise Control And Performance Measures Feedback Requirements For Distributed Interactive Simulation: Proposed IEEE Draft Standard

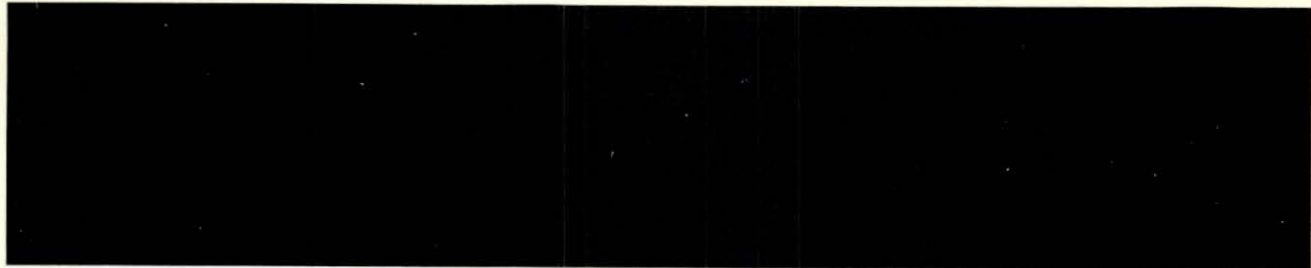
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EXERCISE CONTROL AND
PERFORMANCE MEASURES
FEEDBACK REQUIREMENTS FOR
DISTRIBUTED INTERACTIVE SIMULATION

IST DOCUMENTATION

MARCH 22, 1993

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**Proposed IEEE Draft Standard
Exercise Control and
Performance Measures
Feedback Requirements for
Distributed Interactive
Simulation**



Institute for Simulation and Training
12424 Research Parkway, Suite 300
Orlando FL 32826

University of Central Florida
Division of Sponsored Research

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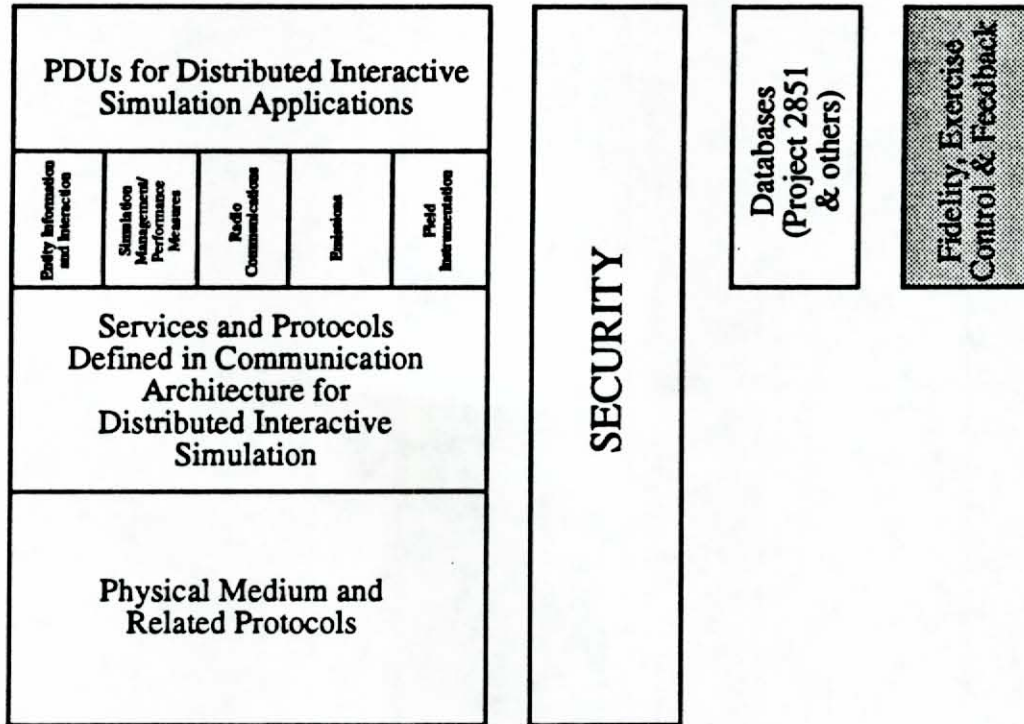
PROPOSED IEEE STANDARD

**PROPOSED EXERCISE CONTROL AND PERFORMANTCE MEASURES FEEDBACK
REQUIREMENTS FOR DISTRIBUTED INTERACTIVE SIMULATION**

"NOTE: This working draft, dated 22 March 1993, 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 the figure below.



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. Its purpose is to define the

(PDUs) provide data concerning simulated entity states and the types of entity interactions that take place in DIS. Future versions of this standard will contain additional functions required to control exercises and provide feedback functions not currently supported. The rationale behind the content of this document is contained in the "Rationale Document - Protocols for Distributed Interactive Simulation Applications", IST-CR-93-3.

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 "Fidelity Correlation Requirements for Distributed Interactive Simulation", IST-CR-92-8.

DRAFT

The IEEE 1278 Working Group that developed this standard had the following membership during the development cycle:

Bruce McDonald, Chair

*****Insert FECFR mailing list here.*****

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1.0 SCOPE

1.1 Scope. This standard establishes the Exercise Control and Performance Measures Feedback requirements for simulators participating in a Distributed Interactive Simulation. It is the second in a series of standards being developed to address the problem of interoperability among interconnected simulators.

1.2 Application. When invoked in a specification or statement of work, these requirements will apply to simulation devices intended for participation in a Distributed Interactive Simulation (DIS). The contractors are responsible for invoking all the applicable requirements of this Standard on any and all subcontractors they employ.

2.0 APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks.

2.1.2 Documents.

Joint Chiefs of Staff Publication 6 _____

2.2 Non-Government publications

GENERAL INFORMATION

Distributed Interactive Simulation: Operational Concept (Draft 2.0). Orlando, FL: Institute for Simulation and Training.

INTEROPERABILITY MEETINGS

- 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

DRAFT STANDARDS

- IEEE 1278 - Standard for Information Technology, Protocol for Distributed Interactive Simulation Applications
- IST-CR-92-06 - Draft Military Standard: Communication Architecture for Distributed Interactive Simulation (CADIS)
- IST-CR-92-08 - Draft Military Standard: Fidelity Correlation Requirements for Distributed Interactive Simulation
- IST-CR-92-10 - Draft Military Standard: Exercise Control and Feedback Requirements for Distributed Interactive Simulation
- IST-CR-93-01 - (IEEE Standard): Protocol Data Units for Entity Information and Entity Interaction in a Distributed Interactive Simulation Version 2.0 Second Draft
- IST-CR-93-02 - Distributed Interactive Enumeration and Bit Encoded Values for DIS for Use with the Second Draft of Version 2.0

- IST-CR-93-07 - Communication Architecture for Distributed Interactive Simulation (Military Standard Draft)
- IST-CR-93-05 - Exercise Control and Feedback Requirements for Distributed Interactive Simulations (IEEE Standard Draft)

ACCOMPANYING DOCUMENTS

- IST-CR-92-11 - Rationale Document: Exercise Control and Feedback Requirements for Distributed Interactive Simulation (DRAFT)
- IST-CR-92-07 - Rationale Document: Communication Architecture for Distributed Interactive Simulation
- IST-CR-93-03 - Rationale Document: Protocol Data Units for Entity Information and Entity Interaction in a Distributed Interactive Simulation
- IST-CR-93-08 - Rationale Document: Communication Architecture for Distributed Interactive Simulation

3.0 DEFINITIONS

entity

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

- simulation fidelity** - Refers to the degree of similarity between the training situation and the operational situation that is being simulated.
- unit** - An aggregation of entities.
- central station** - A computer connected to a local area network that transmits/receives simulation management protocol data units at the direction of the simulation manager.
- simulation manager** - Test director or training officer who manages the setup, control, and feedback of a simulation exercise after the computer network is setup. This individual is part of the user organization.
- network manager** - Individual who sets up and manages a computer network. This individual is not part of the user organization. (These functions are not covered in this standard.)
- scenario** - A timeline of significant events imposed on trainees or systems to achieve exercise objectives.
- registration** - Alignment of coordinate systems and phenomenological agreement between environment models.
- measure of effectiveness** - Normally the method for quantifying the criteria. MOEs can be directly observed, calculated from Measures of Performance, or derived from evaluator judgement.
- measure of performance** - Closely related to inherent parameters (physical and structural) but measure attributes of system behavior. Measure of how the system performs its functions in a given environment (probability of detection, reaction time, number of targets nominated, susceptibility of deception).
- DIS Control** - Assists users in using DIS.

- Site Manager** - Manages simulations at a site.
- DIS User** - Customer Requiring DIS Resources to Address Training, Testing, Operational, or Analysis Objectives.
- Model Provider** - Organization That Develops and Maintains Entity or Environment Models for Use in DIS Exercises.
- Local Area Network** - A class of data network which provides high data rate interconnection between network nodes in close physical proximity.
- Long Haul Network** - Also called Wide Area Network. A communications network of devices which are separated by substantial geographical distance.
- Session Data Base** - A standard DIS database which includes network initialization data and simulation entity initialization and control data.
- Computer Generated Forces** - A collection of unmanned battlespace entities under control as a unit. They supplant or replace friendly, enemy, or neutral manned simulators during a specific session.
- Battlespace Entity** - A simulation entity which corresponds to actual equipment, supplies, and personnel that can be seen or sensed on a real battlefield.
- Data Logger** - A 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 transmitted.

4.0 GENERAL REQUIREMENTS

4.1 Introduction. This section contains Exercise Control and Performance Measures Feedback Requirements for DIS. Operational scenarios for DIS training and decision support exercises are contained in Section 6.4.

4.2 Purpose. This standard provides procedures and guidelines required to plan, execute, manage, and assess a DIS exercise.

4.3 Use. This standard does not dictate who can or cannot participate in a DIS exercise. This responsibility is in the hands of the activity organizing the DIS exercise, and will be based on the analyses of comparative data required or recommended by this standard.

4.4 Functions. The functions discussed in this document may be used to manage exercises at the same site as the control station over the local area network (LAN), or at other sites over the wide area network (WAN). Each DIS exercise site should have a control station with the capability of (1) transmitting the protocol data units (PDUs) described herein when requested by the simulation manager; and (2) receiving these same PDUs from other control stations and executing the required functions.

5.0 DETAILED REQUIREMENTS

5.1 Planning and Pre-Exercise Setup. A proper DIS setup requires the DIS user to obtain information for planning and setup tasks. This information must be obtained from either the exercise specification or the subsequent operation orders generated by exercise organizations. DIS planners should be aware that staff planning is detailed, concurrent and continuous. As details are worked out in supporting plans, a ripple will invariably be produced in all associated plans. Thus, exercise support measures must be reviewed for applicability throughout the planning process. Critical planning and pre-exercise setup tasks must be performed in order to conduct a successful DIS exercise. These tasks are listed below:

- a. Define exercise objective(s) and security (test/training objectives): who or what is being trained/evaluated
- b. Determine measures of effectiveness (performance measurement data requirements)
- c. Determine and define specific data collection requirements for evaluating your measures of effectiveness
- d. Develop tentative schedule
- e. Define rules of engagement and political environment
- f. Identify simulated location
- g. Set timeframe

- h. Define simulated environment (day-night, weather, electromagnetic, ocean, terrain features)
- i. Determine forces, assets (friendly and opposing organic and non-organic)
- j. Determine simulations required (manned, simulated, CGF, constructive, live)
- k. Determine personnel required (e.g., participants, operators, support, etc.)
- l. Determine physical simulation resources available
- m. Develop scenario(s)
- n. Define initial conditions including intelligence
- o. Select and distribute battlefield databases, develop or locate maps
- p. Assess interoperability
 - entity performance models (e.g., weapons, countermeasures)
 - registration of environment models (terrain, ocean, atmosphere)
 - line-of-sight intervisibility
 - target/background color contrast
 - communications
 - 1. network
 - 2. tactical voice/data
 - 3. exercise control, voice/data/video
 - depending on test results, go back to i, or a, and continue the process until acceptable test results are achieved
- q. Finalize exercise schedule (includes resources, network, etc.)
- r. Provide schedule to participants
- s. Develop/distribute session databases (e.g., DIS parameters, locations, stores, fuel)

5.1.1 User Tailoring. The tasks listed above are required to plan and set up a full joint exercise. An example of the steps for planning a joint exercise per Joint Chiefs of Staff Publication 6 is contained in Section 6.5 of this document. The user will tailor these tasks to agree with the scope of their exercise.

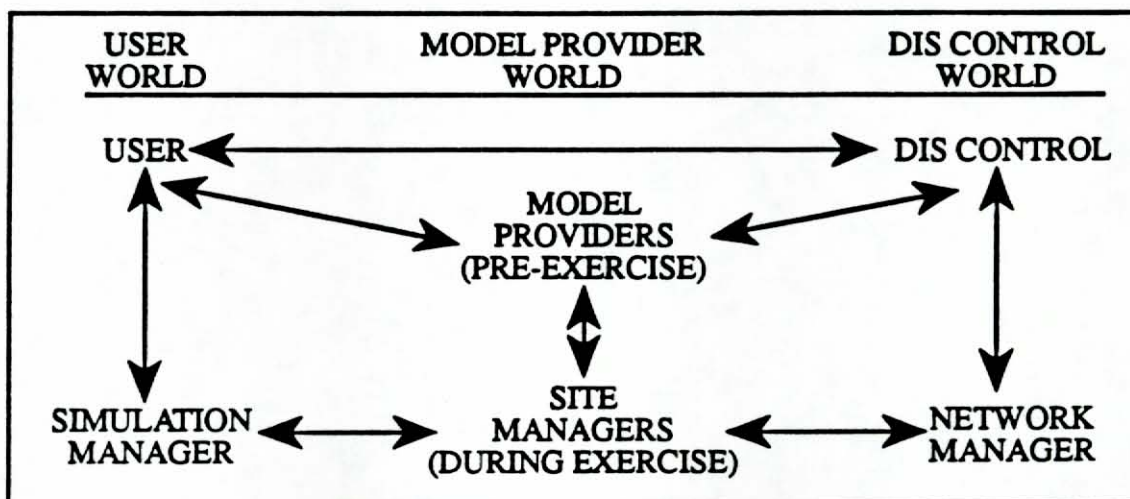
5.1.2 Exercise Objectives. As part of defining exercise objectives, training objectives, test objectives or mission rehearsal objectives should be identified. These objectives enable participants to achieve overall exercise objectives. Each training objective, for example, needs to describe the skills, knowledge and abilities that will be taught. For each skill, those participants who are expected to learn the skill need to be described (individuals, teams, etc.) Additionally, measurable behavior needs to be identified that will be used to indicate the skill has been

learned. These measures will be part of the performance measurement system. A summary of these behaviors would be part of the debrief. Thus, if the desired behaviors occur, it can be determined that those training objectives have been achieved. During exercise setup, specific parameters reports need to be tied to performance measures. During exercise management, some of these measures need to be monitored. During exercise feedback, some of these measures will be debriefed.

5.1.3 User Interaction With DIS Resources. In order to conduct a DIS exercise, the user will require access to the DIS Network, Sites, Simulations and Models. The DIS network belongs to the DIS Control Organization. The sites and simulations belong to the site managers. Models belong to the organization that develops and maintains them. Figure 1 indicates the organizations the user will interact with during the planning and execution of a DIS exercise. After defining the exercise objectives, the user will first contact the DIS Control who:

- Accepts Requests for DIS Use
- Does Scheduling Conflict Resolution
- Recommends Simulation and Data Base Resources to Satisfy User Requirements
 - Entity Simulations
 - Terrain, Atmosphere, Ocean Models
 - Field Instrumentation Systems
 - Performance Measurement Systems
 - VV&A Results
 - Fidelity & Granularity of Models
- Maintains and Distributes Schedules
- Recommends Communication Resources To Support User Requirements
- Recommends Network Manager To Manage the Network For This Specific Exercise

The user will then select DIS sites with the simulations required to achieve the exercise objectives. The Site Manager manages simulations at a site, provides on-site support for simulations and communications and provides availability data for DIS Control. In some cases, these simulation sites will not have all of the models required to meet exercise objective. In these cases, the user will contact the model providers recommended by the DIS Control and arrange for use of these models at the desired simulation sites. DIS Control and the site managers will work with the model providers to facilitate this transaction. DIS Control and the Site Managers will also work with the Network Manager to arrange for the necessary network bandwidth to run the planned exercise. Once the resources for the DIS exercise have been put into place, the Simulation Manager (member of the User organization) will work with the site managers to conduct the exercises as discussed below.



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FIGURE 1
Interactions Between DIS
Users, Model Providers And Control

5.2 Exercise Setup. The functions listed below enable proper initialization and subsequent control of each entity in the exercise. Table 1 provides a matrix of exercise setup functions along with the exercise setup PDUs which support it. These PDUs are defined in the IEEE 1278 Standard listed in Section 2.2. Each DIS site should have a control station with the following exercise setup capabilities:

- a. Instantiate session - provide mechanism to allow master exercise controller to instantiate session
 1. Synchronize clocks - provides a mechanism to allow each entity to synchronize their internal clock with a master clock
 2. Issue command to instantiate session data bases
 1. Set Initial Conditions - provide a mechanism to set initial exercise conditions to include:
 - entities (types and amounts)
 - environment (states and conditions for environment models)
 - database (set 2851 database which will be used for a given exercise. Information will include terrain and features, ocean models, and atmosphere models, as appropriate.)

2. Set Expendables - provide a mechanism to set expendable items such as fuel, ammunition, etc.
 3. Instantiate Entities - provide mechanism to allow appearance of entities on the network
 4. Select Exercise Area - provide mechanism to set an exercise area within a given database.
 5. Initialize Computer-Generated Forces (CGFs) - provide a mechanism to initialize computer-generated forces to include rules of engagement and proficiency or intelligence level.
- b. Parameters Report Request - provide a mechanism to allow entities to transmit exercise parameters (not contained in session data base) to a master exercise controller.
 - c. Network Health Monitor - provide a mechanism for a master exercise controller to assess the technical status and health of the network (e.g., number players initialized, current number of players, average network delay, etc.).
 - d. Entity Status Report - provide a mechanism for each entity to report its status (i.e., damage, fuel, etc.) to a master exercise controller.

Exercise Setup Functions	Simulation Management PDUs
Synchronize Clocks	done by Network Time Protocol
Position Forces	Set Data PDU
Set Expendables	Set Data PDU
Set Initial Conditions	Set Data PDU
Instantiate Entities	Create Entity PDU Set Data PDU Start/Resume PDU
Select Exercise Area	Set Data PDU
Initialize SAPOR	Set Data PDU
Parameter Report Request	Data Query PDU
Network Health Monitoring	done by Network Manager
Entity Status Report	Data Query PDU or Event PDU

Table 1. Exercise Setup Functions and PDUs to Support Them.

5.3 Exercise Management. The functions listed below will allow the master exercise controller to manage the DIS exercise. Table 2 provides a matrix of exercise management functions along with the simulation management PDUs which supports it. These PDUs are defined in the IEEE 1278 Standard listed in Section 2.2. Each DIS site should have a control station with the following exercise management capabilities.

- a. Exercise Initiation - provides a mechanism to initiate a previously saved exercise (see item f below)
- b. Freeze/Resume - provides a mechanism to temporarily freeze and then resume a given exercise

- c. Exercise Termination - provides a mechanism to terminate an exercise. It is envisioned that an exercise would be "frozen" before it is terminate in order to inform participants
- d. Remove Entities - provides a mechanism for selectively removing entities (by entity ID number) from an exercise
- e. Regenerate Entities - provides a mechanism for regenerating a given entity after it has been killed or, for some other reason, removed from the exercise
- f. Save States - provides a mechanism to save a given exercise state (i.e., entity locations and states, and environment conditions) for later use
- g. Exercise Monitoring - provides a mechanism for monitoring exercise progress via graphical and tabular display(s). Displays include:
 - Plan View
 - Entity Status - (this provides a list of all exercise participants along with their current status)
 - 3D display with free-play eye point
- h. Observed Event Input - provide a mechanism for the exercise controllers at both the LANs and the WAN to input an observed event into a given exercise
- i. Parameter Query - provides a mechanism for the exercise controllers to request a parameters report from one or more entities (see item h, Section 5.2 Exercise Setup)
- j. Instructor/Test Director Aids - provides the master exercise controller with specific exercise information. These aids are envisioned to work with the exercise monitoring displays in item g above. These aids include:
 - intervisibility - (i.e., can two entities see each other?)
 - range between two entities
 - closure rate between two entities
 - speed of a given entity
 - bearing of a given entity

Exercise Management Functions	Simulation Management PDU(s)
Exercise Initiation	Set Data PDU
Freeze/Resume	Start/Resume PDU Stop/Freeze PDU
Exercise Termination	Stop/Freeze PDU
Remove Entities	Remove Entity PDU
Regenerate Entities	Stop/Freeze PDU Set Data PDU Start/Resume PDU
Save States	Action Request PDU
Exercise Monitoring	Internal to Simulation Node
Observed Event Input	Event PDU
Parameter Query	Data Query PDU
Instructor/Test Director Aids	Data Query PDU

Table 2. Exercise Management Functions and PDUs to Support Them.

5.4 Exercise Feedback. The 24 items below are functional specifications for a unit performance feedback system for use with networked simulators in a DIS exercise. These specifications are intended to provide a flexible set of tools that will apply to a wide variety of collective training objectives, at varying echelons, within and across branches of the military. These tools make use of various types of figures to integrate data collected from a network (entity status, location, firing event and tactical communications data) with environment data and unit plans to provide a more complete picture of unit performance. Each DIS site shall have a control station with the following exercise feedback capabilities.

- a. The feedback system shall provide the user with a means of specifying the IDs of the entities for which PDUs are to be collected. (Entity IDs are described in IEEE 1278-Standard for Information Technology, Protocol for Distributed Interactive Simulation Applications.)
- b. The network data collection portion of the feedback system shall either be capable of addressing peak data loads, or temporarily stop collecting one or more types of the less critical, high frequency PDUs (such as Entity Status PDUs) when it cannot keep up with the network load.
- c. The data collection system shall be capable of organizing data to allow the user to assess quickly whether (1) the sequence of numbered firing events is complete for each entity and (2) each Fire PDU is associated with a Detonation PDU.
- d. The network data collection system shall number PDUs as they are collected and generate a time index file upon the termination of data collection. The file shall show the first PDU number at the beginning of each interval of the exercise. The interval for this index (e.g., one minute, one second) shall be user selectable.
- e. The network data collection system shall load network data into a relational or hierarchical database that can be accessed using System Query Language (SQL).
- f. The data collection system shall provide the user with the capability to designate the time interval at which entity appearance data will be loaded into the computational database.
- g. The feedback system shall provide menus of data summary graph and table options for the user. It shall also provide the capability for users (with a knowledge of SQL) to modify graph and table definitions, create new

graphs and tables, and insert new graphs and tables into menus of options.

- h. The feedback system shall provide the capability to prepare an Exercise Timeline displaying critical exercise events, as defined by the user.
- i. The feedback system shall provide the user with the capability to load and access the following information about unit plans for the mission: name and location of control measures; precise statement of the unit's mission; threat situation as described to the unit; time-cued and situation-cued events from the operations order; a description of the role to be played by each subordinate unit in executing the mission.
- j. The feedback system shall be capable of using the environment model to provide a context for interpreting network data.
- k. The feedback 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 graphic 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 PDUs (e.g., assessed as casualty, dismount)
 - (3) movement
 - (4) evasive actions other than movement described by PDUs (e.g., smoke, flares)
 - (5) movement of gun tubes and other articulated parts
 - (6) C3 Connectivity (active, passive, and broken), and
 - (7) significant events in the electromagnetic spectrum.

The feedback system shall provide the capability to display unit control measures from the unit's operations order and terrain features, at the option of the user.

- l. The feedback system shall be capable of freezing the action (at a time designated by the user) and calling up additional information (designated by the user) to provide a detailed snapshot of the exercise.
- m. The feedback system shall provide the capability to display a trace of the movement of selected units or entities, and include the capability for the user to (1) specify the interval at which trace positions are to be marked on the display and (2) limit trace to a specific period within the exercise (beginning and end point of the trace). The system shall allow marker intervals as small as one second to be selected by the user.
- n. The feedback system shall include a map display that shows the location of firing events over a period of time that can be selected by the user.
- o. The feedback system shall provide the user with the capability to include environment features and unit control measures into map displays, at the user's discretion.
- p. All displays (animated replay, trace, firefight, and snapshot) shall provide the user with the capability to change the origin and scale of the display so that the user can either focus on a particular part of the exercise area (zoom) or obtain a broader view of the action (pan). Changes in the origin shall be accomplished by having the user point to the desired location of the new origin.
- q. The feedback system shall provide the user with the capability to specify the units or entities in an animated replay, trace, snapshot, exercise timeline, graph, or table. The feedback system shall provide displays having the capability to aggregate and deaggregate entities according to the command hierarchy.
- r. Displays shall be capable of indicating detectability between two or more entities selected by the user.
- s. The feedback system shall be capable of storing the following information about non DIS PDU radio communications: the time of the message; the sending unit; the receiving unit; the duration of the message; the type of message; and message content. The methods to be used in collecting information on message type and content are not addressed by this standard.
- t. The feedback system shall provide a 3-D view of playback with free-play viewpoints.

- u. The feedback system shall include tools for selecting, integrating and displaying exercise debriefing aids (replays, graphs, tables) in an efficient manner.
 - v. All collected PDUs shall be stored such that the data logger can reproduce PDUs in the same order and format as the original PDU stream. A means shall be provided for storage of this PDU stream on permanent storage media for use by the analysis community or exercise participants.
 - w. The feedback system shall provide capability to print a hard copy of graphs, tables, replays (at specific times), traces, snapshots, and time lines.
 - x. The feedback system shall provide a quick search feature for the replay, trace, and snapshot that will allow the user to jump directly (forward or backward) from one point (time or event) in an exercise to another.
- 5.4 Exercise Feedback. The fifteen items below are functional specifications for a unit performance feedback system for use with networked simulators in a DIS exercise. These specifications are intended to provide a flexible set of tools that will apply to a wide variety of collective training objectives, at varying echelons, within and across branches of the military. These tools make use of various types of figures to integrate data collected from a network (entity status, location, firing event and tactical communications data) with terrain data and unit plans to provide a more complete picture of unit performance. Each DIS site shall have a control station with the following exercise feedback capabilities.

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 Defense Advanced Research Projects Agency (DARPA). 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 Intended Use. The primary mission of DIS is to create synthetic, virtual representations of warfare environments by systematically connecting separate elements or subcomponents of simulation which reside at distributed, multiple locations. DIS can be used as a substitute for some field training and testing, and can allow for practice of warfighting skills when cost, safety, environmental and political constraints will not permit the field training and testing required to maintain readiness.

The property of connecting separate sub-components or elements affords the capability to configure a wide range of simulated warfare representations patterned after the task force organization of actual units, both friendly and opposing. These representations include joint and combined force operations to represent a wide range of warfighting missions facing U.S. forces today and in the future. Equally important is the property of interoperability which allows different simulation environments to efficiently and consistently interchange data elements essential to representing warfighting interactions and outcomes.

In effect, interoperable simulations will exchange data in a manner such that the differences in the representation of the simulated battlefield will be transparent or "seamless" as experienced by participants interacting with their particular representation of the warfighting environment. This property affords the opportunity for linking heterogeneous representations, each providing a locally consistent simulated environment, through use of buffers or translators to create a seamless interconnection. With these properties, it is possible to have simulation components which meet special purpose local uses and when required can link together to form larger scale warfighting environment representations.

In addition to DIS's primary mission of supporting training and testing needs, DIS can serve as a tool for mission planning and mission rehearsal.

6.4 Operational Scenarios.

6.4.1 DIS Training Exercise Scenarios. The primary customers for DIS training exercises are commanders, from unit commanders to Commanders In Chief (CINCs). Unit commanders who wish to conduct a training exercise involving only their unit will coordinate with other unit commanders at that base, schedule time for their personnel on the simulators and conduct the exercise using the simulation resources attached to the Local Area Network (LAN) at the base. If the unit commander requires outside support in the form of an opposing force (OPFOR) or additional friendly forces, the commander will follow the procedure discussed below for CINCs.

CINC Procedure

CINCs will use the wide area network WAN services of DIS. The CINC will specify the mission objective (liberate country green) and the CINC's staff will plan the exercise in the same manner as an actual mission. Once the staff has determined which forces will be required to conduct the exercise, they will contact the commanders of these forces through normal channels. In addition, they will contact the DIS Administrative Unit to determine the availability of (1) simulators at those forces' bases; and (2) bandwidth on DIS. DIS is being designed such that a number of separate exercises can be conducted simultaneously on the WAN in a way that is transparent to the participants. The DIS administrative unit will assign a unique exercise number to differentiate it from other simultaneous exercises. It will also calculate the required bandwidth for the required simulators as well as that required for the exercises already scheduled during the desired time period. If the available bandwidth is exceeded, the administrative unit will resolve the conflicts with rescheduling acceptable to all participants. Once this

scheduling is complete, all participants will complete their planning for the exercises.

As the planning continues, the CINC will hold video conferences (over the DIS WAN) with the unit commanders to simulate actual planning meetings. As the mission start day approaches, the Operations Officer will issue orders to the unit commanders for initial deployment of forces. These unit commanders will determine the deployment of their forces and give the initial locations to the local DIS exercise controllers to feed into the simulators.

As the day of exercise start arrives, the local commanders and their staffs will assemble in the DIS LAN controller's room to participate in a video conference final briefing with the CINC. At the mission start time, the DIS WAN will issue a start command to each location and the LAN controllers will issue start commands to the simulators. The other threats and friendlies will then begin to appear on each simulator's displays. Radio communications will be digitized and sent in packets over the DIS network to the appropriate simulators and replayed if the receiving simulator is in range and on the same frequency. As the battle proceeds and each side takes losses, the LAN controllers may be allowed to reconstitute forces to simulate replacements and to allow participants to continue training. During the battle, the debrief station at each location will store all forces location and status messages (protocol data units) for later replay.

When the CINC has achieved his goal, he will issue a Cease Fire command and the DIS LAN controllers will issue a freeze command to all simulators. After participants have gathered in each DIS LAN controller's room, the CINC will conduct a video conference debrief of the exercise. During this debrief, the WAN manager will issue commands to each LAN exercise feedback device to replay the exercise. The CINC will have the controller start, stop and reverse the playback as required to illustrate the lessons learned during the exercise. If desired, the debrief will be broken into segments such as maneuver, logistics, etc. and the LAN controller will enter a command for the debrief station to display only the desired forces.

Once the CINC's debrief is completed, the unit commanders will call in lower ranking personnel for a debriefing. During this debriefing, the LAN controllers will play back the exercise but will concentrate the debrief view on the area of responsibility for that unit. After completion of the exercise debriefs, the stored forces location and status messages will be permanently stored for use in future classroom demonstrations or analysis efforts.

6.4.2 DIS Decision Support Scenarios. The primary customers for DIS decision support exercises are the Combat Development, System Acquisition, Test and Evaluation and Training communities. If the test organization has sufficient simulations of threat and friendly forces at the test facility, they will schedule time for their personnel on the simulators and conduct the exercise using the simulation resources attached to the LAN at the test facility. If the test organization requires outside support in the form of an OPFOR or additional friendly forces, the commander will follow the procedure discussed below.

Procedure

Tests that require outside simulation resources will use the wide area network (WAN) services of DIS. The test organization will specify the test objectives (determine system improvement's effect on outcome of realistic battle engagement) and the test director's staff will plan the exercise. Once the staff has determined which forces will be required to conduct the exercise, they will contact the DIS administrative unit to determine (1) the availability of the simulated/actual equipment/personnel at other locations; and (2) bandwidth on DIS. DIS is being designed such that a number of separate exercises can be conducted simultaneously on the WAN in a way that is transparent to the participants. The administrative unit will assign a unique exercise number to differentiate it from other simultaneous exercises. It will also calculate the required bandwidth for the required simulators as well as that required for the exercises already scheduled during the desired time period. If the available bandwidth is exceeded, the administrative unit will resolve the conflicts with rescheduling acceptable to all participants.

Once this scheduling is complete, all participants will complete their planning for the exercises. As the planning continues, the test director may hold video conferences (over the DIS WAN) with the participants to iron out procedures.

As the day of exercise start arrives, the distributed participants will assemble in the DIS LAN controller's room to participate in a video conference final briefing with the Test Director. At the exercise start time, the DIS WAN will issue a start command to each location and the LAN controllers will issue start commands to the simulators/actual equipment. The other threats and friendlies will then begin to appear on each simulator's/actual equipment's displays. Radio communications will be digitized and sent in packets over the DIS network to the appropriate simulators/actual equipment and replayed if the receiving entity is in range and on the same frequency. As the exercise proceeds and each side takes losses, the LAN controllers may be allowed to reconstitute forces to simulate

replacements and to allow participants to continue provide additional threats and friendlies. During the exercise, the debrief station at each location will store all forces location and status messages (protocol data units) for later replay.

When the exercise is complete, the Test Director will issue a stop command and the DIS LAN controllers will issue a freeze command to all simulators/actual equipment. After participants have gathered in each DIS LAN controller's room, the Test Director will conduct a video conference debrief of the exercise. During this debrief, the WAN manager will issue commands to each LAN exercise feedback device to replay the exercise. The Test Director will have the controller start, stop and reverse the playback as required to illustrate the lessons learned during the test exercise. If desired, the debrief will be broken into segments such as maneuvers, electronic warfare, etc. and the LAN controller will enter a command for the debrief station to display only the desired forces. After completion of the exercise debriefs, the stored forces location and status messages will be permanently stored for use in future demonstrations or analysis efforts.

6.5 Detailed Example of DIS Exercise Planning Process Per Joint Chiefs of Staff Publication 6. The exercise specification and operation orders will normally be in the JCS prescribed operation order format listed below. (This material is extracted from AFSC Pub 1, Appendix H.)

TRANSMISSION INFORMATION

1. FROM. Command originating or updating the information.
2. TO. Appropriate planning participants identified by the originator.
3. INFO. Other interested agencies identified by the originator.
4. DISTRIBUTION. This establishes distribution within the issuing headquarters.

BEGINNING TEXT.

1. The first line of the text contains the highest security classification of the message information followed by the exercise term (e.g., CONFIDENTIAL PRIME RATE).

2. The second line of text contains the following items separated by virgules (/):

- a. OPREP-1. Message title entry "OPREP-1: identifies the message as an Operations Planning Report.
- b. UIC. Unit Identification Code of command submitting report; e.g., DJJ010 (six characters).
- c. SERIAL NUMBER. Reports by each reporting command will be numbered serially, starting with 001 (three digits) for the duration of a particular planning sequence or operation. Data in the most recent report, as determined by the serial number, will have precedence over the same data item reported in previous messages.
- d. PID OF CODE WORD OR NICKNAME. Plan Identification Number (PID) of the OPLAN/COPLAN supported or code word or nickname assigned to the operation, if available, e.g., 4000, or REPLAY (15 characters maximum). Include security classification of the code word, if used.

OPERATION DESCRIPTION This free text paragraph briefly describes the specific operation for which the present plan was developed. This paragraph will reference previous messages, applicable maps, charts, and time zones. The initial message will include the target areas, role to be played by U.S. forces, and other significant characteristics.

NARRATIVE. This free text paragraph is used to amplify the Operation Description and to give informative or directive guidance.

TASK ORGANIZATION. If relatively simple, the unique and specific organization of the exercise unit is listed here. If more complex, Annex A will be published, and referenced herein.

1. **SITUATION.** Briefly states the situation, for the understanding of subordinate commanders, under the following headings:

- a. General situation. Describes the general politico-military environment.
- b. Enemy forces. Composition, disposition, location, movements, estimated strengths, identification, and capabilities in the intended area of operations. This information may be prepared as Annex B and referenced here.
- c. Friendly forces. Provides information on friendly forces not otherwise listed in the operation order that may directly affect the action of subordinate commanders. These forces include those not attached or organic to the exercise organization, but whose capabilities or presence on a flank or other adjacent area is of interest. Information on such forces is limited to what subordinate commanders need to know to accomplish their tasks.
- d. Attachments and detachments. If as normally done, these actions are already indicated in the task organization

description preceding paragraph 1, or indicated in the task organization annex, appropriate reference here will suffice.

2. MISSION. The mission of the command for this operation is stated in full.

3. EXECUTION.

- a. Concept of Operations. Describes briefly, how the commander visualizes the execution of the operation.
- b. A subparagraph then assigns specific tasks for each tactical grouping of the command.
- c. The second to the last subparagraph contains instructions for the element of the command initially designated as the reserve.
- d. Coordinating Instructions.

1. Paragraph 3's last sub-paragraph contains coordinating instructions pertinent to two or more tactical groupings of the command. Typically, such instructions might include boundaries, objectives, beaches, lines of departure, time and direction of attack, and other specifics needed to coordinate the activities of two or more tactical groupings.

2. D-day and H-hour are specified in this subparagraph.

4. ADMINISTRATION AND LOGISTICS. Includes a statement of the administrative and logistical arrangements applicable to the operations.

5. COMMAND AND SIGNAL.

a. Command.

1. Command relations, and planned changes thereto must be specified in some detail for Joint Operations. Often this text is expanded by a diagram in Annex J.
2. Command posts, alternate command posts, flagships, and alternate flagships along with their times of activation and deactivation are provided in this paragraph.

b. Communications. Communication specifics such as call signs, nets, channelization, frequencies, operating procedures, recognition and identification procedures, electronic emission constraints. Usually published as Annex K.

ANNEXES. (Although all annex titles may not be used for any specific operation, annex designations will remain constant. Thus the Distribution Annex is always Annex Z.)

- A--Task organization
- B--Intelligence
- C--Operations
- D--Logistics
- E--Personnel
- F--Public affairs
- G--Civil affairs
- H--Environmental services
- J--Command relationships
- K--Command, control, and communications systems
- L--Operations security
- M--Mapping, Charting, and Geodesy
- N--Space operations
- P--Wartime host nation support
- X--Execution checklist
- Z--Distribution

The DISimulation Manager requires the following information from the exercise sponsor or the exercise commander. Lead time required for each element will depend on the computer and communications assets assigned the operation. The DIS supervisor must identify such times to the exercise sponsor early enough to allow incorporation in the exercise specification. The paragraph or annex where each information element can be found is indicated:

- a. Exercise objectives-Operation Description
- b. Exercise location-Operation Description
- c. Exercise environment-Operation Description
- d. H-Hour and D-Day for exercise-Last sub-paragraph, paragraph
- e. Exercise forces
 - 1. Friendly forces and their organization for combat-Task Organization and Paragraph 1b
 - 2. Opposing forces-Paragraph 1a
 - 3. National collection assets available to exercise forces-Paragraph 1b
 - 4. Out of area forces liable to assignment - Paragraph 1b
- f. Simulations required-Operation Description
- g. Support personnel required-Derived from Operation Description
 - 1. participants
 - 2. computer operators
 - 3. exercise control evaluators
- h. Specific simulation resources needed-Derived from Operation Description
- i. Simulation resources available

- j. Scenario(s) required and agency to develop-Operation Description
- k. Time parameters
 - 1. Zone time to be used-Operation Description
 - 2. Problem time relation to sidereal time-Operation Description
- l. Target lists-Annex C (Each tactical organization will generate target lists.)
- m. Geographic control measures-Coordination sub-paragraph of Paragraph 3
- n. Applicable SOP's
- o. Applicable OPLAN-The Operation Plan supported by this exercise will be listed in the second line of the text. The Operation Description will list additional plans to be used as references.
- p. Communications plans-Annex K
 - 1. Satellite channelization
 - 2. Radio frequency plan
 - 3. Switching networks
- q. Exercise planning schedule-Operation Description or coordination sub-paragraph of the Exercise Specification.
 - 1. Milestones
 - 2. Planning conferences
- p. Rules of Engagement-Annex C
- q. Reconstitution of exercise casualties-Operation Description

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