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Communication Architecture For Distributed Interactive Simulation (CADIS): Proposed IEEE Final Draft Standard

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INSTITUTE FOR SIMULATION AND TRAINING

PROPOSED IEEE FINAL DRAFT STANDARD
COMMUNICATION ARCHITECTURE
FOR DISTRIBUTED INTERACTIVE
SIMULATION (CADIS)

JUNE 1993

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Proposed IEEE Final Draft Standard

Communication Architecture for Distributed Interactive Simulation (CADIS)



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CHANGE 1
TO
COMMUNICATION ARCHITECTURE FOR DIS DRAFT STANDARD

JUNE 1993

IST-CR-93-13

References: (a) Proposed IEEE Draft Standard - Communication
Architecture for Distributed Interactive
Simulation (CADIS), IST-CR-93-07, March 1993

This package contains the pages to be changed in the document
specified in reference (a). Please follow the directions below
for changing pages:

1. Insert this page into the document after the title page.

2. Replace the following pages in the document with the
corresponding pages in this package:

the title page,
i through v,
2,
11 through 16.

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document:

17.

DRAFT STANDARD
JUNE 1993

COMMUNICATION ARCHITECTURE
FOR
DISTRIBUTED INTERACTIVE SIMULATION
[CADIS]

| "NOTE: This draft, dated June 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."

FOREWARD

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.

This set of standards deals with requirements for simulations participating in a Distributed Interactive Simulation. There are several elements that make up the DIS environments. 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 first element, Communications. Its purpose is to define the requirements for the communication architecture to be used to support distributive interactive simulation applications. This document makes recommendations concerning the communication profiles that can provide the services to meet those requirements.

A related draft standard, the "Standard For Information Technology Protocols For Distributed Interactive Simulation Applications (IEEE P1278)", defines the data 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.

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) and 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. The proposed method for setup and control of a DIS exercise and providing feedback at the end is addressed in the draft standard "Exercise Control and Feedback Requirement," IST-CR-92-10.

The Communication Architecture/Security Subgroup that developed this standard had the following membership during the development cycle:

This draft standard has been prepared by the Institute for Simulation and Training for the Simulation, Training and Instrumentation Command (STRICOM), the Defense Advanced Research Projects Agency (DARPA), and the Defense Modeling and Simulation Office (DMSO). This draft is based on currently available technical information but it has not been approved for promulgation. It is subject to modification. However, pending its promulgation as a coordinated standard, it may be used.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document

| should be addressed to: Danette Haworth, Institute for Simulation and Training, 12424 Research Parkway, Suite 300, Orlando, FL 32826. Use the self-addressed Standardization Document Improvement Proposal Form that appears at the end of this document or send comments by letter.

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1.3.3 Non-PDU Traffic. The communication architecture is specified to support several types of data transmission as stated earlier. This data may be directly related to DIS applications or not.

1.3.4 Communication Management Requirements. This standard does not recommend or preclude the use of network management protocols.

1.3.5 Security. This Standard provides intersite and intrasite interoperability between DIS participants. This Standard neither provides, nor precludes, specific security requirements. In this way, security is as an attribute of those exercises which process unclassified sensitive or classified information, and that use this Standard for interoperability. From a DIS perspective the owners of specific systems and exercises must independently assess their security vulnerabilities and threats. Thereafter, they are responsible for implementing appropriate countermeasures in accordance with the system- or exercise-specific security policy in effect.

2. GENERAL REFERENCES

The following documents are referenced in this Standard:

FIPS PUB 146-1
April 1991

U.S. Government Open Systems
Interconnection Profile
(GOSIP) Version 2.0.

This is available from:

U.S. Department of Commerce
National Technical Information
Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161

IEEE P1278

Standard for Information Technology,
Application Protocol for Distributed
Interactive Simulation

This is available from:

IEEE Inc.
445 Hoes Lane
P.O. Box 1331
Piscataway, N.J. 08855-1331
USA
Telephone: 1-800-678-IEEE

CLASS 1 Best Effort Multicast

A mode of operation where the multicast service provider uses no added mechanisms for reliability except those inherent in the underlying service. It is more important to satisfy the latency requirements than to exceed the latency while providing reliability and ordering. Mechanisms for specifying quality of service are for further study.

CLASS 2 Reliable Unicast

A mode of operation where the unicast service provider uses whatever mechanisms are available to ensure the data is delivered in sequence with no duplicates and no errors.

4.2.1.2 Multicasting. The network layer shall support multicast addressing. The capability of a single simulation to send PDUs to a group of other simulation hosts is a fundamental requirement of a network supporting DIS exercises.

4.2.2 Performance Requirements

4.2.2.1 Network Bandwidth. Network bandwidth requirements are subject to estimation procedures based on the latest available data on networked simulations. See the Guidance Document for a detailed explanation of bandwidth estimation procedures.

4.2.2.2 Latency. Proper operation of DIS systems requires strictly bounded network latency.

4.2.3 Error Detection. The DIS communications architecture shall include mechanism(s) to detect corrupted PDUs.

4.3 Approach to Communication Architecture. The communications architecture for DIS employs a layered model which is based on the seven layer OSI Reference Model (ISORM) (see ISO 7498). The ISO 7498 standard defines the communication functions of the network by dividing them into a hierarchical set of layers. Each layer performs an integral subset of special functions required to communicate with another layer of similar type. There are seven layers in the ISORM: Application, Presentation, Session, Transport, Network, Link, and Physical (Layers 7-1, respectively).

The DIS functions provided by each layer are summarized below:

Number	Name	Example Content
7	Application	Kind of data exchanged (position, orientation,...) Dead reckoning rules. Rules on determining hit or miss and damage.
6	Presentation	Representation of position (local vs geocentric coordinates), orientation (Euler angles, Quaternions, SPV), units (English, metric, degrees, BAMs..), and encoding (integer vs float, big vs little endian).
5	Session	Procedure for starting and ending an exercise. Rules for joining and leaving an exercise, and freezing an exercise.
4	Transport	Addressing from end user to end user. Assuring communications reliability, if required.
3	Network	Addressing information from host to host.
2	Link	Framing of information on a physical link. Flags, zero bit insertion. Conflict resolution.
1	Physical	Wire, optical fiber, radio transmission. Voltage levels, impedance values, clock rates.

4.3.1 Communication Architecture Protocol Suites for DIS.

The DIS communication architecture shall evolve in three phases. Each phase of evolution uses a different suite of communication protocols.

Phase 1 is based upon products and services currently available and widely used. Phase 2 is based upon OSI protocols, and Phase 3 is based upon full GOSIP compliance. Phase 2 and Phase 3 are not included in this standard because they contain protocols that have not yet been standardized. When needed protocols are defined and accepted by a recognized standards body, these protocol suites shall be included in this Standard. The proposed protocol suites for Phase 2 and Phase 3 are currently included in the Rationale Document.

5. DETAILED REQUIREMENTS

This section contains specific requirements for DIS. These requirements are *Mandatory* for DIS compliance. In addition, several requirements which are identified as *Recommended* which include those requirements that should be met in order to support large-scale DIS applications.

5.1 Communication Architecture Overview. The communication architecture requirements consist of a set of specific service requirements, and a protocol suite that supports those requirements.

5.2 Service Requirements.

5.2.1 Communication Service Requirements.

5.2.1.1 Service Requirements of PDUs. Two classes of communications service are required: CLASS 1, Best Effort Multicast, and CLASS 2, Reliable Unicast.

5.2.1.2 Multicasting. The multicast addressing capability of a DIS-compliant network has the characteristics defined in the following sections.

5.2.1.2.1 Mandatory Multicast Services. These services shall be required after January 1, 1994.

- a. A multicast group shall be able to include members anywhere on the network.
- b. The maximum number of members in a single multicast group shall be large enough to encompass all hosts in a DIS exercise.
- c. The simulation application need know nothing about a group except the address of the multicast group to which it is sending PDUs.

5.2.1.2.2 Recommended Multicast Services. These services are not required but are recommended for compatibility with future phases.

- a. A simulation application shall be able to belong to more than one multicast group at the same time. The maximum number of groups to which a simulation application may belong at any one time is not defined.
- b. A simulation application shall be able to drop its membership from a group and/or join another at will. The time required to drop or join membership should be the minimum possible.

- c. Change in membership of a multicast group shall be entirely initiated by the simulation application.
- d. The number of multicast groups shall be exercise dependents and is envisioned to be on the order of 500 to 1000.

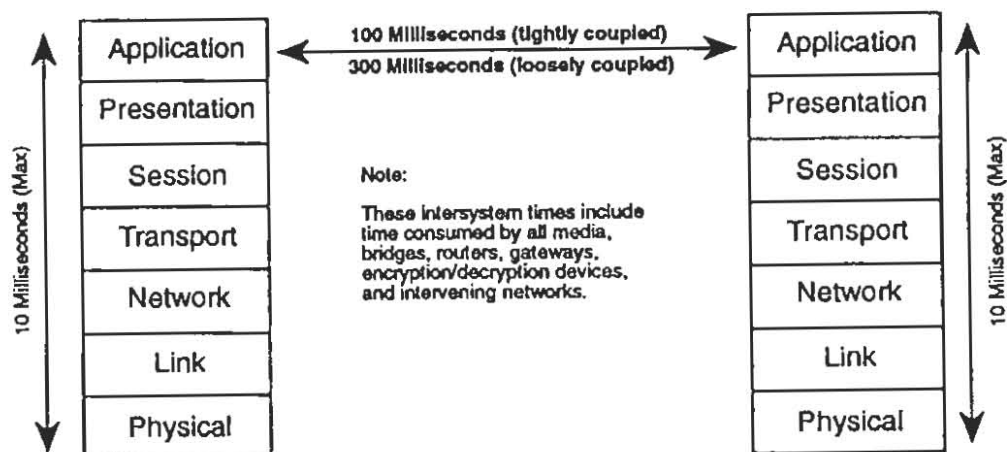
5.2.2 Performance Requirements.

5.2.2.1 Network Bandwidth Requirements. Network bandwidth requirements are exercise specific and should be determined on a per exercise basis. See the Guidance Document for recommended estimation procedures.

5.2.2.2 Latency Requirements. The following latency shall not be exceeded:

100 milliseconds	Total latency permitted between the output of a PDU at the application level of a simulator and input of that PDU at the application level of any other simulator in that exercise when that exercise contains simulated units whose interactions may be tightly coupled.
300 milliseconds	Total latency permitted between the output of a PDU at the application level of a simulator and input of that PDU at the application level of any other simulator in that exercise when that exercise contains only simulated units whose interactions are not tightly coupled.
50 milliseconds	Maximum dispersion of arrival times of the voice PDU at the application level of the device converting digital voice to analog.
10 milliseconds	Maximum latency between the application and physical layers of any DIS simulator.

Figure 1 summarizes the latency standards.



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Figure 1. Standard Latency Values

5.2.3 Error Detection. In Phase 1, error detection shall be handled by the UDP and TCP checksum.

5.3 The Communication Architecture Protocol Suites for DIS. This section lists the specific requirements for the protocol suites.

5.3.1 Phase 1 - Initial Internet Protocol Suite. The Phase 1 protocol suite is based on current Internet network products and communications service. Under Phase 1, CLASS 1, Best Effort Multicast, shall be implemented using UDP over IP Multicast, and CLASS 2, Reliable Unicast, shall be implemented using TCP over IP. This service can be used to support current exercises and early implementations of DIS applications. At each site there shall be a Local Area Network (LAN) with a local broadcast capability. For testing, demonstrations, and exercises involving multiple sites, the LANs shall be interconnected using a Wide Area Network (WAN) that can provide the required communications services at those locations. The Phase 1 protocol suite is as shown below.

Layer	Name	Content
7	Application	- DIS (IEEE P1278) - NTP (RFC 1119) provides global clock synchronization
6	Presentation	- DIS (IEEE P1278)
5	Session	- DIS (IEEE P1278)
4	Transport	- UDP (RFC 768) provides best-effort transport - TCP (RFC 793) provides reliable unicast transport
3	Network	- IP (RFC 791)
2	Link	- any permitted LAN protocol(s)
1	Physical	- any permitted LAN protocol(s)

Each simulator shall support IP, with both UDP and TCP. TCP provides reliable point-to-point service while UDP provides the best effort multicast service.

This Standard does not specify the physical layer media and data link layer protocols to be used since these choices are to be implementation defined.

5.3.1.1 Host Requirements. Each host shall comply with the Hosts Requirements RFC (currently RFC 1122 and RFC 1123). In addition, each host shall support:

- a. IP reassembly of datagrams of maximum FDDI size = 4352 octets (RFC 1122, section 3.3.2).
- b. IP limited broadcast address (RFC 1122, section 3.3.6).
- c. IP multicast address (RFC 1122, section 3.3.7).
- d. Checksum (RFC 1122, section 4.1.3.4).

5.3.1.2 Receipt of PDUs.

5.3.1.2.1 PDU Encapsulation. Every host shall be able to receive multiple DIS PDUs concatenated inside a single UDP datagram.

5.3.1.2.2 PDU Size. Each host shall be capable of receiving DIS PDUs of maximum UDP size = 6400 octets.

5.3.1.3 Transmission of PDUs. The simulation application shall support a configuration parameter for maximum DIS PDU size.

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