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IEEE Standard for Distributed Interactive Simulation—Application Protocols

IEEE Computer Society

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(Revision of
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Abstract: Data messages, known as Protocol Data Units (PDUs), that are exchanged on a network among simulation applications are defined. These PDUs are for interactions that take place within specified domains called protocol families, which include Entity Information/ Interaction, Warfare, Logistics, Simulation Management, Distributed Emission Regeneration, Radio Communications, Entity Management, Minefield, Synthetic Environment, Simulation Management with Reliability, Information Operations, Live Entity Information/Interaction, and Non-Real-Time protocol.

Keywords: data messages, Distributed Interactive Simulation, IEEE 1278.1™, protocol data units (PDUs), simulation network

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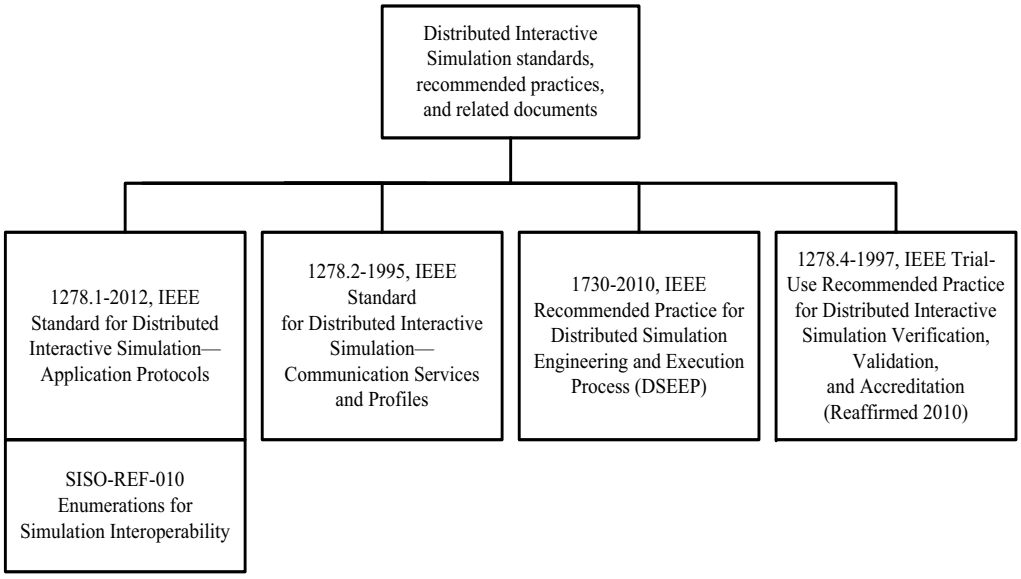
Introduction

This introduction is not part of IEEE Std 1278.1-2012, IEEE Standard for Distributed Interactive Simulation—Application Protocols.

This edition of IEEE Std 1278.1 supersedes both IEEE Std 1278.1-1995 and the material included in the IEEE Std 1278.1a-1998 amendment. Distributed Interactive Simulation (DIS) is a government/industry initiative to define an infrastructure for linking simulations of various types at multiple locations to create realistic, complex, virtual worlds for the simulation of highly interactive activities. This infrastructure brings together systems built for separate purposes, technologies from different eras, products from various vendors, and platforms from various services and permits them to interoperate. DIS exercises are intended to support a mixture of virtual entities with computer-controlled behavior (computer-generated forces), virtual entities with live operators (human-in-the-loop simulators), live entities (operational platforms and test and evaluation systems), and constructive entities (wargames and other automated simulations). DIS draws heavily on experience derived from the Simulation Networking (SIMNET) program developed by the Advanced Research Projects Agency (ARPA), adopting many of SIMNET's basic concepts and heeding lessons learned.

For DIS to take advantage of currently installed and future simulations developed by different organizations, a means had to be found for assuring interoperability between dissimilar simulations. These means were developed in the form of industry consensus standards. The open forum (including government, industry, and academia) chosen for developing these standards was a series of semiannual Workshops on Standards for the Interoperability of Distributed Simulations that began in 1989. The workshops resulted in several IEEE standards and recommended practices.

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



Documentation relationships

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

- Application protocols
- Communication services and profiles
- Distributed simulation engineering and execution
- Verification, validation, and accreditation

IEEE Std 1278.1-2012 defines the format and semantics of data messages, also known as Protocol Data Units (PDUs), that are exchanged among simulation applications and simulation management. The PDUs provide information concerning simulated entity states, types of entity interactions that take place in a DIS exercise, data for management and control of a DIS exercise, simulated environment states, aggregation of entities, and the transfer of ownership of entities. This standard also specifies the communication services to be used with each of the PDUs.

An additional, non-IEEE document is required for use with IEEE Std 1278.1-2012. This document is titled Enumerations for Simulation Interoperability and is available from the Simulation Interoperability Standards Organization, Orlando, Florida.

IEEE Std 1278.2™-1995[a] defines the communication services required to support the message exchange described in IEEE Std 1278.1-2012. In addition, IEEE Std 1278.2-1995 provides several communication profiles that meet the specified communications requirements.

Together IEEE Std 1278.1-2012 and IEEE Std 1278.2-1995 provide the necessary information exchange for the communications element of DIS.

IEEE Std 1730™-2010 [B5][b] is a recommended practice defining the processes and procedures that should be followed by users of distributed simulations to develop and execute their simulations; it is intended as a higher level framework into which low-level management and systems engineering practices native to user organizations can be integrated and tailored for specific uses. This recommended practice is intended to replace IEEE Std 1278.3™-1996 [B4]. This recommended practice is used in conjunction with IEEE Std 1278.1-2012 and IEEE Std 1278.2-1995.

IEEE Std 1278.4™-1997 provides guidelines for verifying, validating, and accrediting a DIS exercise. This recommended practice, used in conjunction with IEEE Std 1730-2010 [B5], presents data flow and connectivity for all proposed verification and validation activities and provides rationale and justification for each step.

The principal changes between IEEE Std 1278.1™-1995 and IEEE Std 1278.1a™-1998 and the present standard are as follows:

a) Extensive clarification of requirements throughout the standard.

b) The general requirements have been expanded to cover detailed requirements related to simulations, enumerations, objects, heartbeats, timeouts, thresholds, gateways, and communication services.

c) All identifiers used in the standard have been clarified, and consistent, simplified terminology has been adopted.

d) To provide flexibility and reduce the number of heartbeats, entity heartbeats are now defined by entity kind, domain, and whether the entity is moving or stationary.

e) A new Information Operations (IO) family has been added along with two new PDUs, the IO Action PDU and IO Report PDU, to support information warfare.

f) The Electromagnetic Emission PDU has been clarified, and a new jammer field has been added using an existing padding field to better support a wider range of multiresolution simulations.

g) A new Directed Energy Fire PDU has been added to support high-fidelity directed energy engagements.

h) A new Entity Damage Status PDU has been added to reflect high-fidelity damage to an entity.

[a]Information on references can be found in Clause 2.

[b]The numbers in brackets correspond to those of the bibliography in Annex J.

i) The Transfer Control function has been renamed the Transfer Ownership function, and the Transfer Control Request PDU has been retitled the Transfer Ownership PDU. The entire Transfer Ownership function has been revised to improve its functionality.

j) Transponder and Interrogator requirements have been updated to support high-fidelity Mode 5 Identification Friend or Foe (IFF) and Mode S systems.

k) Time requirements have been extensively clarified and revised.

l) Dead reckoning requirements have been updated including the addition of a new quaternion equation. Annex E Dead Reckoning has been completely revised to clarify requirements, although all the existing formulas have been retained.

m) The Articulation Parameter record found in the Entity State and other PDUs has been renamed the Variable Parameter record to denote that its original design supports more than just its use for articulated and attached parts records. This now provides a way for additional attribute data to be added to entities and detonation characteristics to be added to the Detonation PDU.

n) A new Attribute PDU has been added to support DIS extensibility.

o) The Warfare—General requirements subclause (5.4.2) has been rewritten to incorporate the use of the Fire and Detonation PDUs for expendables and the use of the Detonation PDU for non-munition explosions.

p) The Transmitter PDU was revised to add the capability to have variable Transmitter Parameters records in addition to having a single Modulation Parameters record and multiple Antenna pattern records.

q) Entity separations have been addressed by clarifying how it is to be done for various situations including for multistage missiles and submunition portrayal.

r) Seven new annexes have been added as follows:

   1) Annex A. Warfare (normative). Provides additional requirements related to PDUs used to support the warfare functional area.

   2) Annex B. Specific transponder and interrogator systems (normative). Contains detailed requirements applicable to specific transponder and interrogator systems.

   3) Annex C. Radio systems (normative). Contains detailed requirements applicable to specific radio systems.

   4) Annex D. Objects (normative). Contains detailed requirements related to object types and primary and secondary identifiers.

   5) Annex F. Heartbeats, timeouts, and thresholds (informative). Provides guidance on how to maintain interoperability when some simulations have implemented the new entity timeout requirements and some have not.

   6) Annex G. Time calculations and uses (informative). Provides additional information on time and its uses in a distributed simulation environment.

   7) Annex H. Transfer ownership function (normative). Contains detailed requirements for transfer ownership.

Contents

IEEE Standard for Distributed Interactive Simulation—Application Protocols

1 Overview

1.1 General

This standard explains the information technology protocols required for Distributed Interactive Simulation (DIS) applications. This standard is divided into nine clauses. Clause 1 provides the scope of the standard and details key DIS concepts that will help in understanding the context of this standard. Clause 2 lists references to other standards that are useful in applying this standard. Clause 3 provides definitions of terms, acronyms, and abbreviations that are used in the standard. It is imperative for the user of this standard to thoroughly review these definitions before proceeding on to the other clauses. Clause 4 contains requirements concerning the content and use of Protocol Data Units (PDUs) in DIS exercises. Clause 5 defines the various PDUs and their fields. Clause 6 contains requirements concerning the representation of data within the PDUs. Clause 7 defines the layout and contents of the PDUs. Clause 8 contains the definition of a protocol specifically for applications operating in non-real time. Clause 9 is a stand-alone, self-contained clause that contains both the requirements and the PDU definitions for use by live entities participating in a DIS exercise.

1.2 Scope

This standard is part of a set of standards and recommended practices for DIS applications. Each standard and recommended practice in the set describes one or more of the elements that constitute the DIS environment. As a whole, the set of standards and recommended practices defines an interoperable simulation environment. This particular standard addresses the application protocols.