

IEEE 1278-1993

IEEE Standard for Information Technology—Protocols for Distributed Interactive Simulation Applications

Entity Information and Interaction

Circuits and Devices

Communications Technology

IEEE Computer Society

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IEEE 1278-1993



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IEEE Standard for Information Technology—Protocols for Distributed Interactive Simulation Applications

Entity Information and Interaction

Sponsor

**Standards Coordinating Committee
of the
IEEE Computer Society**

Approved March 18, 1993

IEEE Standards Board

Abstract: Data messages, called protocol data units (PDUs), that are exchanged between simulation applications are defined. These PDUs provide information concerning simulated entity states and the types of entity interactions that take place in a distributed interactive simulation (DIS). The messages defined are for interactions that are primarily within visual range. Future versions of this standard will contain additional PDUs required to exchange information about interactions and functions not currently supported.

Keywords: articulated parts, attached parts, dead reckoning, entity coordinates, Euler angles, field, guise, PDUs, right-hand rule, simulation application, simulation entity

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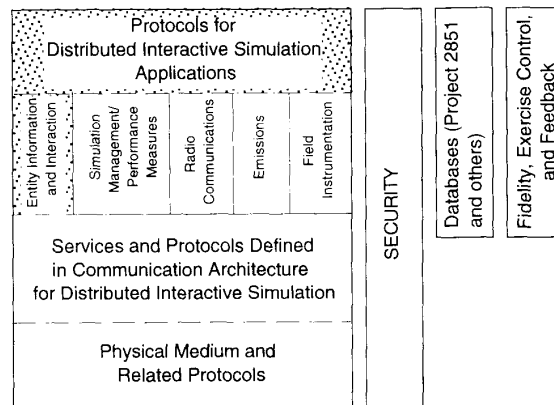
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Introduction

(This introduction is not a part of IEEE Std 1278-1993, IEEE Standard for Information Technology—Protocols for Distributed Interactive Simulation Applications, Entity Information and Interaction.)

This standard is part of a proposed set of standards for distributed interactive simulation (DIS). The relationship between this standard, Entity Information and Interaction, and other proposed DIS standards is shown below.



Documentation relationships

This proposed set of standards discusses requirements for simulations participating in a distributed interactive simulation. There are several elements that make up the DIS environment. Each element is to be addressed by one or more standards. Used together, these standards will define an interoperable simulated battle environment. It should be recognized that these proposed standards will also be applicable to civilian and commercial applications of DIS. Law enforcement, disaster control, environmental control, and gaming are but a few examples.

The main elements to be addressed by these standards are:

- a) Communications
- b) Simulation environment
- c) Fidelity, exercise control, and feedback requirements

The scope of this standard lies within the first element, communications. Its purpose is to define 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. Future versions of this standard will contain additional PDUs required to exchange information about interactions and functions not currently supported. The rationale behind the content of this standard is contained in IST-PD-92-1*.

A related standard draft, IST-CR-92-6, establishes the requirements for the communication architecture to be used in DIS applications (CADIS). It makes recommendations concerning the communication profiles

*Information on references can be found in clause 2.

that can provide the services to meet those requirements. This standard, along with the CADIS document, provide the necessary information exchange for the communications element of DIS.

For the second element, simulation environment, the government of the United States has a draft of a military standard, Project 2851-SIF, describing database formats for terrain, culture, and dynamic model representation. The military standard draft is recommended for use with the developing DIS standards.

For the third element the required fidelity correlation between simulations in a DIS exercise is addressed in the draft of standard 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 of standard IST-CR-92-10.

The first edition of this standard defines messages for interactions that are primarily within visual range. It is anticipated that future editions of this standard will provide additional capabilities to support other DIS application requirements, such as electronic combat.

The area covered by this standard is undergoing evolution. Revisions are anticipated to this standard within the next few years to clarify existing material, to correct possible errors, and to incorporate new related material.

At the time this standard was completed, the Distributed Interactive Simulation Working Group had the following membership:

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The Distributed Interactive Simulation Working Group acknowledges and appreciates that many concepts embodied in this standard are based largely upon the SIMulator NETworking (SIMNET) program that was sponsored by the Defense Advanced Research Projects Agency (DARPA) and was described in "The SIMNET Network and Protocols" as written by individuals from Bolt Beranek and Newman Inc. This standard is based on the output of the Interface/Time Mission Critical Subgroup of the workshop on Standards for the Interoperability of Defense Simulations, which is hosted by the University of Central Florida Institute for Simulation and Training and sponsored by the U.S. Army Simulation Training and Instrumentation Command.

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IEEE Standard for Information Technology— Protocols for Distributed Interactive Simulation Applications

Entity Information and Interaction

1. Overview

This standard explains the information technology protocols required for Distributed Interactive Simulation (DIS) applications. This standard is divided into six clauses. Clause 1 provides the scope of the standard. Clause 2 lists references to other standards that are useful in applying this standard. Clause 3 provides definitions of terms and acronyms 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 details key DIS concepts that will help in understanding the context of this standard. Clause 5 contains requirements concerning the content and use of protocol data units (PDUs) in DIS exercises. Clause 6 defines the various PDUs and their fields.

1.1 Scope

This standard is part of a proposed set of standards for DIS applications. Each standard in the proposed set describes one or more of the several elements that constitute the DIS environment. As a whole the set of standards will define an interoperable simulated battle environment. This particular standard addresses the entity information and interaction protocols.

This standard defines the data messages, known as PDUs, that are exchanged on a network between simulation applications. The messages defined are for interactions that are primarily within visual range. This standard does not provide information to support other DIS application requirements, such as electronic combat.

1.2 Terminology

The following six terms, which are defined in clause 3, form the basis for understanding the key concepts stated in clause 4.

- a) Distributed Interactive Simulation (DIS)
- b) Host computer
- c) Simulation application
- d) Simulation entity
- e) Simulation environment
- f) Simulation exercise

2. References

This standard shall be used in conjunction with the following publications:

DMA TR 8350.2, 1987, Department of Defense World Geodetic System, 1984 (WGS 84), Its Definition and Relationships with Local Geodetic Systems.¹

IEEE Std 268-1992, American National Standard for Metric Practice (ANSI).²

IEEE Std 754-1985 (Reaff 1991), IEEE Standard for Binary Floating-Point Arithmetic (ANSI).

ISO 7498 : 1984, Information Processing Systems—Open Systems Interconnection—Basic Reference Model.³

IST-CR-92-6, Draft, Communication Architecture for Distributed Interactive Simulations (CADIS).⁴

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

IST-CR-92-10, Draft, Exercise Control and Feedback Requirement for Distributed Interactive Simulation.

IST-CR-92-16, Enumeration and Bit Encoded Values for Distributed Interactive Simulation for Use with IEEE Std 1278-1993.

IST-PD-92-1, Rationale Document for Entity Interaction Protocol for Distributed Interactive Simulation.

Project 2851-SIF, Draft, Military Standard Simulator Data Base (SSDB) Interchange Format (SIF) for High Detail Input/Output (SIF/HDI) and Distributed Processing (SIF/DP).⁵

SI, Le Système International d'Unités: See for example:

- a) "The Complete Metric System with the International System of Units, (SI)," A.L. LeMaraic and John P. Ciaramella, Abbey Books, 1973.
- b) "Guide for the Use of the International System of Units: The Modernized Metric System," A.O. McCoubrey, Sep. 1991, NIST/SP-811. Also available from Supt. of Docs. as SN003-003-03113-5.
- c) "Interpretation of the SI for the United States and Metric Conversion Policy for Federal Agencies," B.N. Taylor, Oct. 1991, NIST/SP814.

SIMNET, BBN RPT. 7627 - The SIMNET Network and Protocols.⁶

¹This publication is available from National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, USA.

²This publication is available from The Institute of Electrical and Electronics Engineers, Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

³This publication is available from ISO Central Secretariat, 1 rue de Varembe, Case Postale 56, CH-1211, Genève 20, Switzerland/Suisse and from American National Standards Institute (ANSI), Sales Department, 11 West 42nd Street, New York, NY 10036.

⁴This publication is available from University of Central Florida, Center for Continuing Education, Orlando, FL 32816-0177, USA.

⁵This publication is available from Wright Patterson Air Force Base, ARC/YP-C, Dayton, OH 45433, USA.

⁶This publication is available from National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, USA.

3. Definitions

This clause contains key terms as they are used in this standard.

3.1 application layer (layer 7): The layer of the OSI reference model (ISO 7498 : 1984) that provides the means for simulation applications to access and use the network's communications resources.

3.2 articulated part: A visible part of a simulated entity that is able to move relative to the entity itself.

3.3 attached part: A visible part of a simulated entity that may or may not be present. For example, a bomb on an aircraft wing station.

3.4 ballistic munition: Any munition that follows a predetermined ballistic trajectory.

3.5 best effort service: A communication service in which transmitted data is not acknowledged. Such data typically arrives in order, complete and without errors. However, if an error occurs, nothing is done to correct it (for example, there is no retransmission).

3.6 bit: The smallest unit of information in the binary system of notation.

3.7 dead reckoning: A method for the estimation of the position/orientation of an entity based on a previously known position/orientation and estimates of time and motion.

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

3.9 emitter: A device that is able to discharge detectable electromagnetic or acoustic energy.

3.10 entity: *See: simulation entity.*

3.11 entity coordinate system: A system whereby location with respect to a simulation entity is described by three right-hand Cartesian coordinates (see 4.2).

3.12 Euler angles: A set of three angles used to describe the orientation of an entity as a set of three successive rotations about three different orthogonal axes (x , y , and z). The order of rotation is first about z by angle ψ (Ψ), then about the new y by angle θ (Θ), then about the newest x by angle ϕ (Φ) (see figure 3). Angles ψ and ϕ range between $\pm\pi$, while angle θ ranges only between $\pm\pi/2$ radians. These angles specify the successive rotations needed to transform from the world coordinate system to the entity coordinate system. The positive direction of rotation about an axis is defined by the right-hand rule.

3.13 exercise: *See: simulation exercise.*

3.14 fidelity: A measure of the realism of a simulation.

3.15 field: A series of contiguous bits treated as an instance of a particular data type that may be part of a higher level data structure.

3.16 guise: A function that provides the capability for an entity to be viewed with one appearance by one group of participants, and with another appearance by another group.

3.17 host computer: A computer that supports one or more simulation applications. All host computers participating in a simulation exercise are connected by a common network.

3.18 multicast: A transmission mode in which a single message is sent to multiple network destinations, that is, one-to-many.

3.19 network management: The collection of administrative structures, policies, and procedures that collectively provide for the management of the organization and operation of the network as a whole.

3.20 node: A general term denoting either a switching element in a network or a host computer attached to a network.

3.21 octet: A sequence of eight bits, usually operated upon as a unit.

3.22 protocol: A set of rules and formats (semantic and syntactic) that determine the communication behavior of simulation applications.

3.23 protocol data unit (PDU): A unit of data that is passed on a network between simulation applications.

3.24 real-time: An event or data transfer in which, unless accomplished within an allotted amount of time, the accomplishment of the action has either no value or diminishing value.

3.25 reliable service: A communication service in which the number and type of errors that the user finds in the data are acceptable for the application. Reliable communication may require specific mechanisms in order to achieve the user's requirements—error detection and notification, such as bit errors based on a too high bit error rate as defined by the user; or error detection and correction from PDU errors, such as bit errors, duplicated PDUs, missing PDUs, or out-of-sequence PDUs.

3.26 right-hand rule: This rule states that positive rotation is clockwise when viewed toward the positive direction along the axis of rotation.

3.27 simulation application: The executing software on a host computer that generates one or more simulation entities. The simulation application represents, or simulates, real-world phenomena for the purpose of training or experimentation. Examples of simulation applications include manned vehicle simulators, computer generated forces, and computer interfaces between a DIS network and real equipment. The simulation application receives and processes information concerning entities created by peer simulation applications through the exchange of DIS PDUs. More than one simulation application may execute simultaneously on a host computer. The simulation application is the application layer protocol entity that implements the protocol defined in this standard.

NOTE—This standard will use the term *simulation application* to avoid confusion between protocol entities and simulation entities. The term *simulation* may also be used in place of *simulation application*.

3.28 simulation entity: An element of the synthetic environment that is created and controlled by a simulation application through the exchange of DIS PDUs. Examples of types of simulated entities are: tank, submarine, carrier, fighter aircraft, missiles, bridges, or other elements of the synthetic environment. It is possible that a simulation application may be controlling more than one simulation entity.

NOTE—In this standard simulation entities may be also referred to as *entities*.

3.29 simulation environment: A simulation environment consists of the operational environment surrounding the simulation entities. This environment includes terrain, atmospheric, and bathospheric information. Although environment information is outside the scope of this standard, it is assumed that participants in the same DIS exercise will be using environment information that is adequately correlated for the type of exercise to be performed.

3.30 simulation exercise: An exercise that 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.

3.31 simulation management: A mechanism that provides centralized control of the simulation exercise. Functions of simulation management include start, restart, maintenance, shutdown of the exercise, and collection and distribution of certain types of data.

3.32 tracked munition: A munition for which tracking data is required. A tracked munition's flight path is represented by Entity State PDUs.

3.33 unicast: A transmission mode in which a single message is sent to a single network destination, that is, one-to-one.

3.34 world coordinate system: The origin of the coordinate system is the centroid of the earth. The axes of this system are labeled *X*, *Y*, and *Z*, with the positive *X*-axis passing through the Prime Meridian at the Equator, the positive *Y*-axis passing through 90° east longitude at the Equator, and the positive *Z*-axis passing through the North Pole.

3.1 Acronyms

The following acronyms are used in this standard:

BBN	Bolt Beranek and Newman
CADIS	Communication Architecture for Distributed Interactive Simulation
DARPA	Defense Advanced Research Projects Agency
DIS	Distributed Interactive Simulation
IST	Institute for Simulation and Training
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
SI	The official abbreviation for "Le Système International d'Unités": A universal system of metric weights and measures adopted in 1960 by the international authority on the metric system, the Conference Générale de Poids et Mesures (CGPM)
SIMNET	Simulator Networking
WGS 84	World Geodetic System 1984
UTC	Universal Coordinated Time

4. Key concepts

This clause contains details on key DIS concepts that will help in understanding the context of this standard. This information is of a general or explanatory nature that may be helpful, but is not mandatory.

4.1 Basic architecture concepts

The basic architecture concepts of DIS are an extension of the Simulator Networking (SIMNET) program developed by Defense Advanced Research Project Agency (DARPA). The basic architecture concepts for and their implications to DIS are:

- a) *No central computer controls the entire simulation exercise.* Some war games have a central computer that maintains the world state and calculates the effects of each entity's actions on other entities and the environment. These computer systems shall be sized with resources to handle the worst case load for a maximum number of simulated entities. DIS uses a distributed simulation approach in which the responsibility for simulating the state of each entity rests with separate simulation applications residing in host computers connected via a network. As new host computers are added to the network, each new host computer brings its own resources.
- b) *Autonomous simulation applications are responsible for maintaining the state of one or more simulation entities.* Simulation applications (or simulations) are autonomous and generally responsible for maintaining the state of one entity. In some cases, a simulation will be responsible for maintaining the state of several entities. As the user operates controls in the simulated or actual equipment, the simulation is responsible for modeling the resulting actions of the entity using a high fidelity simulation model. That simulation is responsible for sending messages to others, as necessary, to inform them of any observable actions. All simulations are responsible for interpreting and responding to messages of interest from other simulations and maintaining a model of the state of entities represented in the simulation exercise. Simulations may also maintain a model of the state of the environment and nondynamic entities, such as bridges and buildings, that may be intact or destroyed.
- c) *A standard protocol is used for communicating ground truth data.* Each simulation application communicates the state of the entity it controls (location, orientation, velocity, articulated parts position, etc.) to other simulations on the network. The receiving simulation is responsible for taking this ground truth data and calculating whether the entity represented by the sending simulation is detectable by visual or electronic means. This perceived state of the entity is then displayed to the user as required by the individual simulation.
- d) *Changes in the state of an entity are communicated by simulation applications.*
- e) *Perception of events or other entities is determined by the receiving application.*
- f) *Dead reckoning algorithms are used to reduce communications processing.* A method of position/orientation estimation, called dead reckoning, is used to limit the rate at which simulations shall issue state updates for an entity. Each simulation maintains a high-fidelity model of the entity it represents. In addition, the simulation maintains a simpler model of its entity. The simpler model represents the view of that entity by other simulation applications on the network and is an extrapolation of position and orientation state using a specified dead reckoning algorithm. On a regular basis, the simulation compares the high fidelity model of its entity to the simpler model of the entity. If the difference between the two exceeds a predetermined threshold, the simulation will update the simpler model using the information from the high fidelity model. At the same time, the simulation will send updated information to other simulations on the network so that they can update their model of the entity. By using dead reckoning, simulations are not required to report the status of their entities every frame.

4.2 Coordinate systems

Locations in the simulated world are identified, using a right-handed geocentric Cartesian coordinate system called the world coordinate system. The shape of the world is described by the WGS 84 standard, DMA TR 8350.2, 1987. The origin of the coordinate system is the centroid of the earth. The axes of this system are labeled X , Y , and Z , with the positive X -axis passing through the Prime Meridian at the Equator, the positive Y -axis passing through 90° east longitude at the Equator, and the positive Z -axis passing through the North Pole as shown in figure 1. A distance of one unit measured in world coordinates corresponds to a distance of one meter in the simulated world. A straight line in the world coordinate system is a straight line in the simulated world.

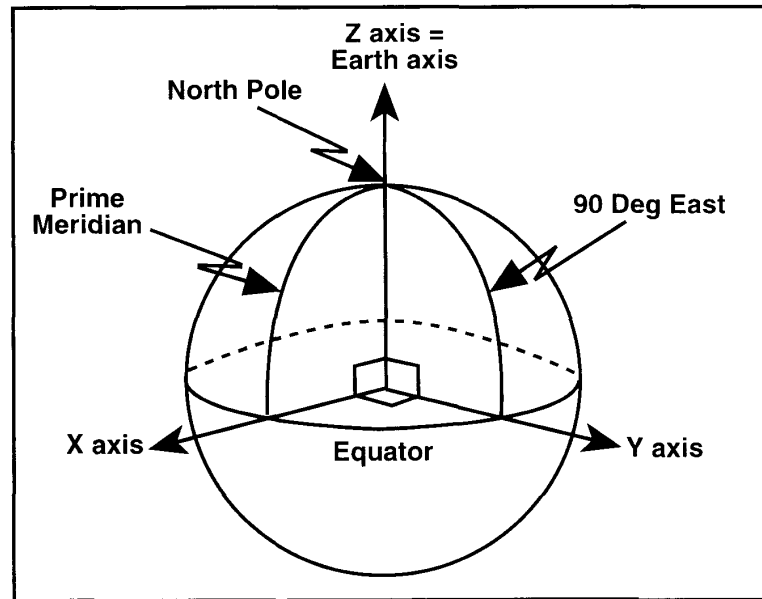


Figure 1—Geocentric Cartesian coordinates

To describe the location and orientation of any particular entity, an entity coordinate system is associated with the entity. This is also a right-handed Cartesian coordinate system with the distance of one unit corresponding to one meter as in the world coordinate system. The origin of the entity coordinate system is the center of the entity's bounding volume. The axes are labeled x , y , and z with the positive x -axis pointing to the front of the entity, the positive y -axis pointing to the right side of the entity, and positive z -axis pointing down as shown in figure 2.

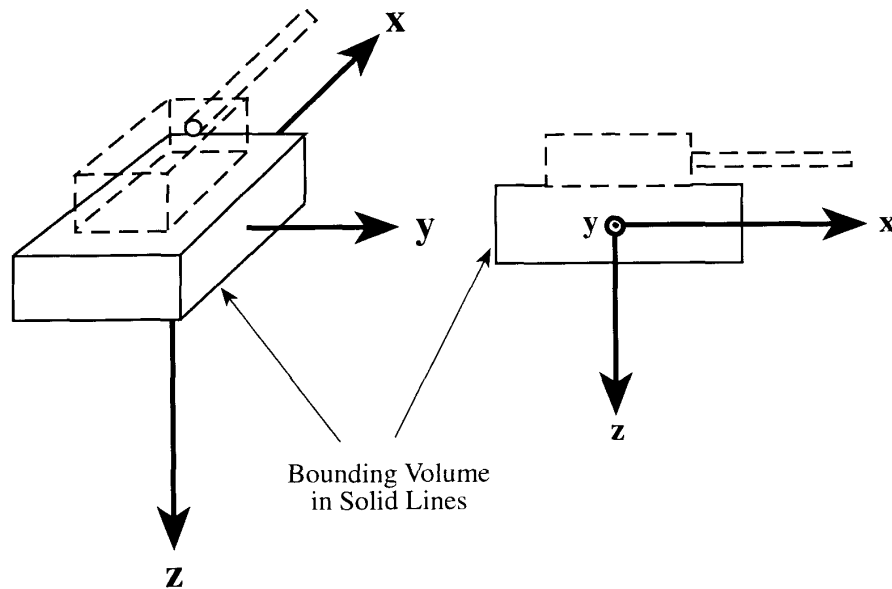
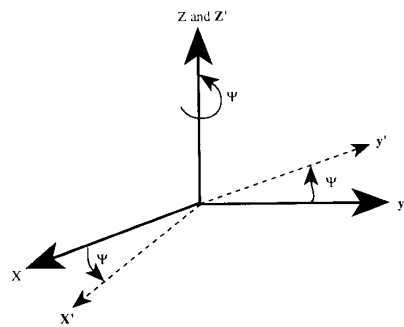
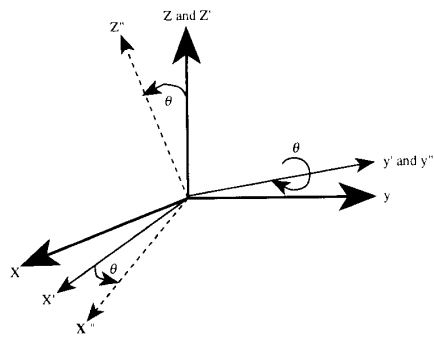


Figure 2—Entity Coordinate system

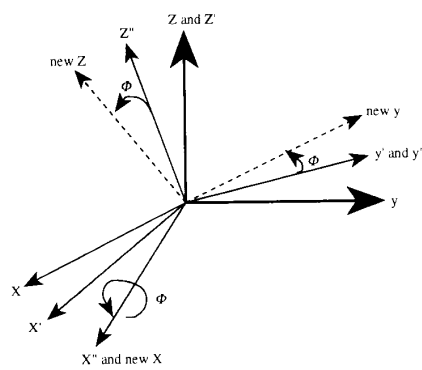
The location of an entity is specified as the position of the origin of its entity coordinate system, expressed in world coordinates. The entity's orientation is specified using three angles that describe the successive rotations needed to transform from the world coordinate system to the entity coordinate system. These angles are called Euler angles and specify a set of three successive rotations about three different orthogonal axes as shown in figure 3. The order of rotation is first, rotate about z by the angle ψ (ψ), then rotate about the new y (y') by angle θ (θ), then about the newest x (x'') by the angle ϕ (ϕ). The positive direction of rotation about an axis is defined as clockwise when viewed toward the positive direction along the axis of rotation.



(a)
First rotate about z by angle psi



(b)
Second, rotate about new y (y') by theta



(c)
Third, rotate about newest x (x'') by phi

Figure 3—Definition of Euler angles

4.3 Communication services

The communication services required by each DIS PDU are described in detail in IST-CR-92-6. A brief summary of the basic communication services necessary for DIS is as follows:

- a) *Data transfer.* Each simulation application must be able to transfer data to another simulation application on the network in a single operation, with or without first establishing a logical connection with the destination computer. The unit of data passed in a single operation is called a packet.
- b) *Delivery.* The communication architecture must support either, multicast, broadcast, or unicast packets. Multicast packets are delivered to a subset of all computers on a network. Broadcast packets are delivered to all computers on a network. (Broadcasting is actually a special kind of multicast.) Unicast packets are delivered to a single computer on a network.
- c) *Best effort service.* The communication architecture should support best effort delivery. Although DIS simulation applications will tolerate occasional failures of the network to deliver packets, these should be allowed to occur only rarely.
- d) *Packet integrity.* The communication protocols should be capable of detecting transmission errors associated with the network. Corrupted packets should not be delivered to the simulation application.
- e) *Performance requirements.* The communication architecture should provide a certain level of performance characterized in terms of throughput and delay. Both network delay and network delay variance are to be minimized.

4.4 Functional requirements for DIS

DIS is intended to support the following functional requirements:

- a) Entity information
- b) Entity interaction
- c) Management
- d) Environment information

Currently only the first two requirements are discussed in this standard. Enhancement of the first two requirements and the addition of capabilities for the second two requirements are the subject of future standards. A brief description of each follows.

4.4.1 Entity information

The entity information exchanged between simulation applications includes the type of entity, its location and orientation, and how the entity might appear to others.

- a) *Types.* The simulation entity could be a vehicle, a building, a munition (such as a missile), or a cloud of smoke. DIS requires that entities be classified based on their entity type, allowing a variety of different entities to be represented.
- b) *Location and orientation.* Sending the location and orientation of an entity is critical for correct representation of the entity by other simulations on the network. Inclusion of the velocity and the acceleration parameters allows receiving simulations to employ higher-level, higher-accuracy extrapolation routines. See 4.1, f) on dead reckoning.
- c) *Appearances.* The appearance of an entity can be expressed in a number of ways. Entities may be on fire or smoking. An entity may emit engine smoke or have a wake trailing behind in the water.

4.4.2 Entity interaction

Throughout a simulation exercise, the state information associated with the interactions that take place between entities needs to be exchanged. Interactions that are currently supported include weapons fire, logistics support, and collisions.

- a) *Weapons fire.* When an entity fires a weapon, the simulation application controlling the entity needs to communicate the location of the firing weapon and the type of munition fired. The detonation of the munition also is communicated by the simulation application controlling the firing entity. Using the information in the detonation message, all simulation applications controlling affected entities assess damage to their entities.
- b) *Logistics support.* Certain services may be modeled in a simulation exercise such as resupply or repair of vehicles. These services are provided under logistics support.
- c) *Collisions.* In the event that two entities collide, the simulations controlling the entities must be informed of the collision. A message about the collision is sent by each simulation when it detects that its entity has collided with another entity. Each simulation determines the damage to its own entity based on information in the collision message.

4.4.3 Future capabilities

A number of capabilities that are not presently a part of this standard are expected to be included in future versions of this standard or in related standards. These capabilities are described in the following paragraphs.

4.4.3.1 Entity information—Other types of appearances

In addition to visual appearance, the entities may also have a certain infrared signature. Also, an entity makes a variety of sounds, some of which may identify the entity under some circumstances. Consequently, each entity has several appearances, which include emission of sound, light, and heat as well as the reflection of light, radar, and sound (sonar).

4.4.3.2 Entity interaction—Electromagnetic interactions

The development of technology in the area of sensory data has produced a variety of sensors and emitters, such as sonar, radar, and communications. Representations of these devices are essential in a simulation exercise.

4.4.3.3 Management

Centralized management of a simulation exercise is desirable to facilitate the operation of the network and certain aspects of the simulation exercise. DIS management functions can be divided into network management and simulation management.

- a) *Network management.* Network management functions handle the basic network functions, such as load management, monitoring of nodes and gateways, and error recovery. The network manager would also have knowledge of host computers on the network, such as their physical locations and network addresses. Analysis of network performance would be performed here.
- b) *Simulation management.* Functions of simulation management include start, restart, maintenance, and shutdown of the exercise. Other functions required include the introduction of entities after exercise start, and collection and distribution of certain types of data.

4.4.3.4 Environment information

For simulation entities to participate in the same exercise, they must have access to the same environment information. Different types of information about the environment are necessary to make the exercise as realistic as possible. This information may include changes in the terrain, weather conditions, and degrees of ambient illumination, as well as other environmental effects.

- a) *Changes in the terrain.* Changes in the terrain can be caused by a number of factors. These include engineering effects such as the construction of a bridge or a building; weapons effects that could destroy objects created via engineering effects, as well as change the shape of the terrain due to the impact of shells or explosion of mines; or natural effects such as flooding.
- b) *Weather conditions.* Conditions, such as wind, rain, snow, fog, or clouds, need to be represented in DIS to add to its realism. For instance the wind and its effect on a cloud of smoke can affect vehicle visibility. Chemical clouds and their dispersal can affect dismounted infantry.
- c) *Degrees of ambient illumination.* Night battles, as well as day battles, should be simulated. DIS will support battles that can take place in any degree of ambient illumination.
- d) *Other environmental effects.* The subsurface environment plays a significant role in subsurface simulations. The effects of water temperature, pressure, and salinity on the propagation of sound will be considered.

4.4.3.5 Field instrumentation

Requirements for real entities on instrumented ranges operating within the DIS environment and interacting with simulated and real entities will be addressed. Among the issues to be addressed are limited communication bandwidth, volume of data, methods of data transmission, and type of data transmitted.

4.4.3.6 Data collection and analysis

DIS may be used to train individuals to work as a team or to evaluate the performance of developmental hardware and software, proposed weapon system platforms, tactics, or operational procedures in a realistic operational scenario. In any case, some data on the performance of exercise participants will be required beyond that data that can be observed from the responses that are transmitted over the communication medium. This data will be used by the exercise manager to determine the extent to which exercise participants (humans and platforms) achieved the goals of the exercise. Example data includes engine temperature, target detection, target classification, expendables state, and instructor comments.

4.4.3.7 Mechanisms for efficient use of network resources

It may not be necessary that all participants receive all PDUs of an exercise. Mechanisms to allow for efficient use of network resources may include filtering PDUs at various locations in the network, data compression schemes, and sending only changes in the PDU information rather than the entire PDU. Multicast addressing schemes and protocols will be used to create and control groups where PDUs are sent only to members of that group. The multicast mechanisms are currently being developed and will be specified in the areas of communication architecture, network management, and simulation management.