Test Procedures For Compliance With IEEE 1278 And Interoperability With DIS Compliant Systems

University of Central Florida Institute for Simulation and Training
TEST PROCEDURES FOR COMPLIANCE WITH IEEE1278
AND INTEROPERABILITY WITH DIS COMPLIANT SYSTEMS

DISTRIBUTED INTERACTIVE SIMULATION TESTBED

April 19, 1993
TEST PROCEDURES FOR COMPLIANCE WITH IEEE 1278 AND INTEROPERABILITY WITH DIS COMPLIANT SYSTEMS

PREPARED FOR:

U.S. ARMY SIMULATION TRAINING AND INSTRUMENTATION COMMAND
12350 Research Parkway
Orlando, Florida 32826-3276

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Institute for Simulation and Training
University of Central Florida
12424 Research Parkway
Orlando, Florida 32826
Test Procedures

For Compliance With IEEE 1278-1993 Version 1.2

Standard For Information Technology –
Protocols For Distributed Interactive Simulation Applications

And

Interoperability with DIS Compliant Systems

Version: April 19, 1993
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PART I:  INTRODUCTION

0  INTRODUCTION

The purpose of this document is to define the interoperability requirements for participating in a Distributed Interactive Simulation (DIS) by identifying tests which will determine the level of conformance with the DIS Standards. A system must pass those tests identified in this document for the level of interoperability that the system is trying to achieve in order to be approved for the desired level of interoperability.

0.1  Scope and Criteria

0.1.1  Scope

The tests described in this document are performed under the following set of assumptions:

Network Protocols. Each System Under Test (SUT) is required to be able to connect to and communicate with an Ethernet network. In addition, SUTs are required to select one of the protocol suites (Phase 1, 2 or 3) specified in the Communication Architecture for DIS (CADIS) standard. If the SUT is sending information on the network, it should be able to utilize the communication protocols to send and receive information. If the SUT is only receiving information from the network, it should be able to interpret communication protocols. DIS Protocol Data Units (PDUs) will be sent using broadcast mode. Non-DIS information will be sent using point-to-point services.

Application Messages. Each SUT is required to be able to interpret a subset of the DIS PDUs as defined in the Institute of Electrical and Electronics Engineers (IEEE) "Standard For Information Technology - Protocols For Distributed Interactive Simulation Applications", IEEE 1278-1993 version 1.2. This document will verify that the above noted Protocol Data Units are correct with respect to syntax and consistent with respect to interpretation and utilization by a simulator. SUTs which send information on the network should be able to correctly build the appropriate PDUs according to the rules found in the DIS PDU standard. SUTs which only receive information should be able to correctly interpret the DIS PDUs.

Terrain, Feature, and Model Information. Each SUT is required to use the Project 2851 SIF data base and others for development of terrain, feature, and dynamic entity models for use in testing. Correlation of various terrain databases
developed from SIF and other data must be within specified limits for participation in testing.

**Behavior of SUT.** Each SUT is required to demonstrate the generation and/or interpretation of location, orientation, and velocity information. If a simulation entity generated by the SUT is capable of interacting with other simulation entities, the SUT must demonstrate that it can generate events and respond to externally generated events as specified in the DIS PDU standard.

0.1.2 **Criteria**

Criteria refers to the standards upon which judgements are made. With respect to this document, criteria are the quantity of tests which must be successfully completed for a system to be judged interoperable. Criteria must, therefore, be consistent with the scope in a general sense and the specific tests (enumerated below) in precise terms. A simulator must meet all of the detailed requirements which follow to satisfactorily meet the criteria of interoperability associated with DIS applications. Rationale for deleting/modifying specific tests in this document shall be mutually documented by IST and the SUT.

0.2 **Graduated Testing**

0.2.1 **Rationale**

Validation testing is divided into a sequence of levels in an attempt to isolate problems in the System Under Test (SUT) at the lowest possible level. The tests proceed from basic communications tasks upward through progressively higher-order behavior.

The first test level verifies that the SUT can transmit and receive information on the network using the selected communication protocols. Once communication is established, the SUT will be tested to ensure that the PDUs generated are correct with respect to syntax and consistent with respect to interpretation. The third test level demonstrates that an entity is correctly oriented on the terrain. The next test level demonstrates that an entity is capable of moving around the terrain. The last test level verifies that the entity can interact with other entities on the terrain.
0.2.2 Organization of the Test Levels

NETWORK LEVEL TESTS focus on verifying the ability to transmit and receive data packets using the required communication protocols.

PDU TESTS verify the bi-directional exchange of Application Level Messages (PDUs) generated or interpreted by the SUT.

TERRAIN ELEVATION COMPARISON TESTS verify correlation between the Terrain Database (TDB) used by the SUT and a reference TDB.

APPEARANCE, LOCATION AND ATTITUDE TESTS verify proper generation and interpretation of location, orientation, and velocity information.

INTERACTIVITY TESTS verify that the SUT interacts appropriately with the rest of the simulation by generating events appropriately or by responding properly to externally generated events.

0.2.3 Test Modes

For each of the test levels described above, there are two modes of testing:

Transmission Test - SUT sends data, IST receives data

Reception Test - IST sends data, SUT receives data.

In Transmission mode, IST will verify that the SUT can generate and transmit the required data and will determine if the SUT has successful completed the test. In Reception mode, the SUT will be responsible for verifying that it is capable of receiving the IST generated information. Further analysis of the IST data is encouraged, not required.

SUTs that will be transmitting and receiving data (i.e., CGF and manned simulators) will be required to pass both Transmission and Reception tests. SUTs that will not be transmitting data (e.g., stealth, radar displays) will be required to pass the Reception Tests only.

0.2.4 Test Conditions

Within each level of validation tests, the SUT's behavior is tested under three conditions: Ideal, Adverse, and Erroneous. Ideal tests will verify that the SUT can generate and/or
interpret information as specified in the DIS PDU standard. Ideal tests will be conducted in transmission and reception modes, as defined above.

Adverse tests will be used to evaluate a SUT's performance under adverse conditions. An example would be in the case of network failure where some interaction may be interrupted and data lost. The case where a SUT receives erroneous data will also be tested. Adverse and Erroneous Tests will always be conducted in reception mode only (i.e., IST sends the SUT data). The SUT will not be expected to generate adverse and erroneous data.

0.3 Test Methods

The tests described in this document can be conducted using one of the following methods: by an IST supplied PC-based data logger, by a dial-up facility provided by IST, or via the Defense Simulation Internet (DSI). IST does not exclude the SUT from coming in-house to the testbed laboratory to conduct testing. The three testing methods are described below.

0.3.1 Data Logger Method

For demonstration participants who have assembled a PC-based Data Logger at their site, files will be provided containing data packets for accomplishing the required interoperability tests. These files may be obtained via Internet electronic mail or on floppy disk (5 1/4" or 3 1/2" high density).

Tests that require the SUT to receive information (i.e., Reception Tests) for correct interpretation would utilize the Data Logger to issue pre-recorded packets found in the test files. Tests that require that the SUT send information to the IST test system (i.e., Transmission Tests) would utilize the Data Logger to record the information. This recorded data would be sent to IST for review using either of the above mentioned methods.

0.3.2 Dial-Up Method

Participants who do not have a PC-based Data Logger may conduct the tests described above using an extended Ethernet LAN implemented via a toll-free telephone link provided by IST. IST will record packets produced by the SUT and will play pre-recorded files when transmitting.
The SUT will need to use the Serial Line Internet Protocol (SLIP) or the Point to Point Protocol (PPP) for serial communications via the telephone link. Testing in this fashion will require coordination with IST via a separate voice connection.

0.3.3 Defense Simulation Internet

This test method is not currently available.
PART II: VALIDATION TESTS

1 NETWORK LEVEL TESTS

Specifying the appropriate addressing structures and data length fields is a prerequisite to being able to exchange DIS PDU's. Network Level Tests verify that the player can generate and interpret these addresses and the data lengths for the protocol suite selected by the SUT.

This is not a conformance test of the communication protocols; it is a test of only those fields which are important to the transfer of DIS PDUs, e.g. addressing and data. Data integrity calculations, i.e. checksums, will not be checked other than to determine if the transmitted data has been corrupted. If the data has been corrupted, it will be discarded.

1.1 Phase 1 Protocol Suite

The Phase 1 protocol suite is defined in the proposed IEEE draft standard Communication Architecture for DIS (CADIS). The communication protocols used in this phase are based on the Internet protocol suite. For testing purposes, IST will verify a SUT's use of the required services (as specified in IEEE 1278-1993) through the use of the following protocols:

- Transport Layer: User Datagram Protocol (UDP)
- Transmission Control Protocol (TCP)
- Network Layer: Internet Protocol (IP)

The CADIS standard does not mandate the use of a particular Data Link or Physical Layer protocol. While this document does not exclude and underlying protocols, it uses examples based on IEEE 802.3 (Carrier Sense Multiple Access With Collision Detection - CSMA/CD) and Fiber Distributed Data Interface (FDDI).

1.1.1 Ideal Tests

1.1.1.1 Addressing Validation

The SUT must demonstrate the capability to send and receive DIS PDUs in broadcast, unicast, or multicast mode in order to achieve interoperability in a DIS application. Testing this capability will be done in two steps. The first step is to test the SUT's ability to build and address packets correctly.
The second step is to verify the SUTs ability to receive and interpret such data. The tests are described in the paragraphs that follow.

The fields which are of interest in these tests are destination address, protocol address, data length, and data content.

**Destination Address** - Only destination addresses will be tested because DIS does not care where the data originates. These fields are found in the Ethernet and IP header frames.

**Protocol Address** - There are only three protocols (above the physical interface) to be used, viz. IP, UDP and DIS. Each protocol is identified in the preceding lower layer by a unique number. If these numbers are not used, the PDU will not reach the simulation destination. The tests will be conducted for both valid and invalid protocol numbers.

**Data Length** - At each layer of the communication stack, the PDU is encapsulated in protocol headers. In each protocol, the data length field represents the total size of the data (i.e., data + header) for that layer. The data length is represented in octets. The test will determine if the appropriate length is calculated for the Fire PDU.

1.1.1.1.1 Transmission Test - Broadcast

To test broadcast transmission, the SUT will generate and transmit a packet whose data will be a Fire PDU. IST will capture the packet and verify correctness of the player's Transport, Network, and Physical Layer header frames.

Successful completion of these tests shall be achieved if the SUT can generate and interpret destination addresses, protocol addresses, and data lengths for the test method in use.

**Fields of Concern**
Except where indicated by a prefix of 0x to indicate base 16 (hexadecimal), decimal values are specified below for all fields of concern. IST will verify that the correct values appear in all fields.

**Destination Address**

Ethernet Dest Address = 255-255-255-255-255-255
(all bits set TRUE)
### Interoperability Validation Test Document

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tr>
<td>IP Destination Address</td>
<td>132.170.255.255</td>
</tr>
<tr>
<td><strong>Protocol Address</strong></td>
<td></td>
</tr>
<tr>
<td>Ethernet Type Field</td>
<td>2048 or 0x0800 // IP</td>
</tr>
<tr>
<td>IP Protocol Field</td>
<td>17 or 0x11 // UDP</td>
</tr>
<tr>
<td>UDP Port Number</td>
<td>3000 or 0x0BB8 // DIS Application</td>
</tr>
<tr>
<td><strong>Data Length</strong></td>
<td></td>
</tr>
<tr>
<td>Ethernet Length Field</td>
<td>4 (LLC length) + 20 (IP length) + 8 (UDP length) + length of UDP data in octets</td>
</tr>
<tr>
<td>IP Length Field</td>
<td>20 (IP length) + 8 (UDP length) + length of UDP data in octets</td>
</tr>
<tr>
<td>UDP Length Field</td>
<td>8 (UDP length) + length of UDP data in octets</td>
</tr>
</tbody>
</table>

#### 1.1.1.2 Reception Test - Broadcast

To test the SUT's ability to receive packets, the IST test system will generate and transmit (in broadcast mode) the packet defined in 1.1.1.1.1 above. It is the responsibility of the SUT to verify that it receives the entire packet and interprets all fields correctly.

#### 1.1.1.3 Transmission Test - Unicast

In the case where the SUT intends to use non-DIS traffic on a network running DIS applications, it is required that the information be sent using a unicast service (also called point-to-point). In this case, the SUT must demonstrate its ability to use this network service in order to be interoperable on the network during a DIS exercise.

Since point-to-point traffic can be generated by other network users, SUTs must expect such data and should be able to receive and subsequently reject such data without adverse effect on the SUT or the network. SUTs not using the point-to-point services are still required to pass the
point-to-point reception tests. SUTs that will be using point-to-point services (those sending non-DIS traffic) are required to pass all tests described in this section.

To test point-to-point transmission, the SUT will generate and transmit a packet whose data will be an example of the non-DIS data the participant will generate. IST will capture the packet and verify correctness of the player's UDP, IP, and Ethernet header frames for the following fields: destination address, protocol address, data length, and data content.

Successful completion of these tests shall be achieved if the SUT can both generate and interpret destination addresses, protocol addresses, and data lengths for the test method in use.

Fields of Concern
Except where indicated by a prefix of Ox to indicate base 16 (hexadecimal), decimal values are specified below for all fields of concern. IST will verify that the correct values appear in all fields.

### Destination Address

- **Ethernet Dest Address** = xxx-xxx-xxx-xxx-xxx-xxx (determined by ARP)
- **IP Destination Address** = xxx.xxx.xxx.xxx (tbd at time of test)
- **Protocol Address**
  - **Ethernet Type Field** = 2048 or Ox0800 // IP
  - **IP Protocol Field** = 17 or Ox11 // UDP
  - **UDP Port Number** = 3000 or Ox0BB8 // DIS Application

### Data Length

- **Ethernet Length Field** = 4 (LLC length) + 20 (IP length) + 8 (UDP length) + length of UDP data in octets
- **IP Length Field** = 20 (IP length) + 8 (UDP length) + length of UDP data in octets
1.1.1.1.4 Reception Test - Unicast

To test the SUT's ability to receive UDP/IP/Ethernet packets, the IST test system will generate and transmit (in point-to-point mode) the packet defined in 1.1.1.1.4. It is the responsibility of the SUT to verify that it receives the entire packet and discards it appropriately.

1.1.1.1.5 Transmission Test - Multicast

Not required at this time.

1.1.1.1.6 Reception Test - Multicast

Not required at this time.

1.1.1.2 Fragmentation Validation

1.1.1.2.1 Transmission Test

Not required at this time.

1.1.1.2.2 Reception Test

Not required at this time.

1.1.1.3 Other Protocols

1.1.1.3.1 Transmission - ARP

In addition to the capability of sending and receiving information, the SUT must be able to implement ARP in order to obtain physical address information. In the point-to-point transmission test, the SUT will be given the IP address for the IST test system. Using the supplied IP address, the SUT must broadcast an ARP Request to the network. The IST system, recognizing the IP address, will respond to the ARP request with an ARP reply containing the Ethernet address of the IST test system. This Ethernet address will be used to establish point-to-point communications with the IST test system.

1.1.1.3.2 Reception - ARP

Similarly, in the point-to-point reception test, the SUT will supply the IST test system with its IP address. The IST test
system will issue an ARP Request to the SUT supplied IP address. The SUT, recognizing its IP address, should respond with an ARP reply containing its Ethernet address. This Ethernet address will be used by the IST test system for point-to-point communications.

1.1.2 Adverse Tests

1.1.2.1 Addressing

1.1.2.1.1 Broadcast

To test the SUT's ability to receive erroneous communication packets, the IST system will generate and transmit (in broadcast mode) the packet defined in section 1.1.1.1.1 with the following changes:

Ethernet Frame  type = 0xFFFF

It is the SUT's responsibility to verify that it receives the packet and discards/processes it appropriately.

1.1.2.1.2 Unicast

To test the SUT's ability to receive erroneous UDP/IP/Ethernet packets, the IST system will generate and transmit (in point-to-point mode) the packet defined in section 1.1.1.2 with the following changes:

Ethernet Frame  type = 0xFFFF

It is the SUT's responsibility to verify that it receives the packet and discards/processes it appropriately.

1.1.2.1.3 Multicast

Not required at this time.

1.1.2.2 Fragmentation

Not required at this time.

1.1.3 Erroneous Tests

1.1.3.1 Addressing
1.1.3.1.1 Broadcast

Not required at this time.

1.1.3.1.2 Unicast

Not required at this time.

1.1.3.1.3 Multicast

Not required at this time.

1.1.3.2 Fragmentation

Not required at this time.

1.2 Phase 2 Protocol Suite

Not available at this time.

1.3 Phase 3 Protocol Suite

Not available at this time.

2 PDU TESTS

PDU Tests will be conducted to determine whether the SUT can build and interpret the Application Level Data structures defined by the DIS Standard IEEE 1278-1993 version 1.2. Both Transmission and Reception tests will be conducted for each of the four required PDU types.

2.1 Description of PDUs

PDUs will be built using the values as specified in this section except where indicated. Values to be placed in fields marked "selected by SUT" will be provided at the time of the test by the operator of the SUT. The intent of the tests is to verify alignment, byte ordering, data types, etc., therefore the values specified below are not intended to realistically depict a specific vehicle at a specific location.

The number of articulation parameters in the Entity State PDU or Detonation PDU is indicated in the # OF ARTICULATION PARAMETERS (numPar) field. If the value of the numPar field is zero, the PDU is 1152 bits in length. If the value of the
numPar field is greater than zero, this indicates how many ARTICULATION PARAMETERS the PDU carries, and the PDU is (1152 + 128 * numPar) bits long.

2.1.1 Entity State PDU

// PDU HEADER

header.version = 0x01
header.exercise = 0x01  // EntityState
header.kind = 0x24 or 2 articulated parts
header.length = 0x2C  // 2 articulated parts

// ENTITY ID

dentityID.simulator.site = selected by SUT
dentityID.simulator.host = selected by SUT
dentityID.entity = selected by SUT

// VARIOUS DESCRIPTIVE FIELDS...

unused_8 = DC
forceID = 0x0  // BLUE FORCE
entityType = selected by SUT

// guise should be 0 when unused

guise.entityKind = selected by SUT
guise.domain = selected by SUT
guise.country = selected by SUT
guise.category = selected by SUT
guise.sub_category = selected by SUT
guise.specific = selected by SUT
guise.extra = selected by SUT

// Standard says this is a 32 bit unsigned integer but least significant bit is a flag to indicate absolute or relative. Therefore, mask out the low-order bit, then divide the high // 31 bits by 2 to get the value. For this test, we'll specify // a value of 0 time units, relative scheme
INTEROPERABILITY VALIDATION TEST DOCUMENT

timestamp = 0x00000000

// Entity Location, Velocity, and Orientation
location.x = selected by SUT
location.y = selected by SUT
location.z = selected by SUT
velocity.x = selected by SUT
velocity.y = selected by SUT
velocity.z = selected by SUT
orientation.psi = selected by SUT
orientation.theta = selected by SUT
orientation.phi = selected by SUT

// Dead Reckoning Parameters
deadReckonParms.algorithm = selected by SUT
deadReckonParms.unused_8 = DC
deadReckonParms.unused_16 = DC
deadReckonParms.unused_32 = DC
deadReckonParms.unused_32_2 = DC
deadReckonParms.unused_32_3 = DC
deadReckonParms.acceleration.x = selected by SUT
deadReckonParms.acceleration.y = selected by SUT
deadReckonParms.acceleration.z = selected by SUT
deadReckonParms.angularVelocity.x = selected by SUT
deadReckonParms.angularVelocity.y = selected by SUT
deadReckonParms.angularVelocity.z = selected by SUT

// Appearance; All platforms (but not Life forms or Environmentals) can be depicted as DESTROYED so we'll set only that bit.
appearance = 0x00000001 //Destroyed
marking.characterSet = 0x01 // ASCII
marking.text = 'MARKINGTEXT'

// Does DIS Standard say what these capabilities mean? // Assume it means that the entity can SUPPLY ammo or fuel or miscellaneous supplies or repairs TO OTHER ENTITIES. Make this entity able to supply all those services.
INTEROPERABILITY VALIDATION TEST DOCUMENT

capabilities = 0x0000000F

// Padding
unused_16_2 = DC
unused_8_2 = DC

// Articulated Parts Array Size
numParts = selected by SUT
  // either 0 or 2

  // First record if numParts = 2
  // Not present if numParts = 0
  parts[0].change = selected by SUT
  parts[0].partID = selected by SUT
  parts[0].numberParms = selected by SUT
  parts[0].partsParms = selected by SUT

  // Second record if numParts = 2
  // Not present if numParts = 0
  parts[1].change = selected by SUT
  parts[1].partID = selected by SUT
  parts[1].numberParms = selected by SUT
  parts[1].partsParms = selected by SUT

2.1.2 Fire PDU

  // PDU HEADER
  header.version = 0x01
  header.exercise = 0x01
  header.kind = 0x02 // Fire
  header.length = 0x16

  // ID of firing entity
  attackerID.simulator.site = selected by SUT
  attackerID.simulator.host = selected by SUT
  attackerID.entity = selected by SUT

  // ID of intended target, arbitrary
INTEROPERABILITY VALIDATION TEST DOCUMENT

targetID.simulator.site = selected by SUT
targetID.simulator.host = selected by SUT
targetID.entity = selected by SUT

// If this is a munition that must be flown, it needs a valid
// ID. Otherwise all three munition fields must be set to
// zero for the "INVALID" ID.
munitionID.simulator.site = selected by SUT
munitionID.simulator.host = selected by SUT
munitionID.entity = selected by SUT

eventID.simulator.site = selected by SUT
eventID.simulator.host = selected by SUT
eventID.entity = selected by SUT

// a value of 0 time units, relative scheme
timeStamp = 0x00000000

// Launch Location
location.x = selected by SUT
location.y = selected by SUT
location.z = selected by SUT

burst.munition = selected by SUT
burst.warhead = selected by SUT
burst.fuze = selected by SUT
burst.quantity = selected by SUT
burst.rate = selected by SUT

velocity.x = selected by SUT
velocity.y = selected by SUT
velocity.z = selected by SUT
range = selected by SUT

2.1.3 Detonation PDU

// PDU HEADER

header.version = 0x01
header.exercise = 0x01
header.kind = 0x03  // Detonation
header.length = 0x19 or // length + 0 articulation parameters

INTEROPERABILITY VALIDATION TEST DOCUMENT

= 0x21 // length + 2 articulation parameters

// ID of firing entity
attackerID.simulator.site = selected by SUT
attackerID.simulator.host = selected by SUT
attackerID.entity = selected by SUT

// ID of intended target (arbitrary)
targetID.simulator.site = selected by SUT
targetID.simulator.host = selected by SUT
targetID.entity = selected by SUT

// Make this a munition that must be flown
munitionID.simulator.site = selected by SUT
munitionID.simulator.host = selected by SUT
munitionID.entity = selected by SUT
eventID.simulator.site = selected by SUT
eventID.simulator.host = selected by SUT
eventID.entity = selected by SUT

// a value of 5 time units, relative scheme
timeStamp = selected by SUT
worldLocation.x = selected by SUT
worldLocation.y = selected by SUT
worldLocation.z = selected by SUT
burst.munition = selected by SUT
burst.warhead = selected by SUT
burst.fuze = selected by SUT
burst.quantity = selected by SUT
burst.rate = selected by SUT
velocity.x = selected by SUT
velocity.y = selected by SUT
velocity.z = selected by SUT
entityLocation.x = selected by SUT
entityLocation.y = selected by SUT
entityLocation.z = selected by SUT
result = selected by SUT

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// Articulation Parts Array Size

numParts = selected by SUT
// either 0 or 2

// First record if numParts = 2
// Not present if numParts = 0

parts[0].change = selected by SUT
parts[0].partID = selected by SUT
parts[0].numberParms = selected by SUT
parts[0].partsParms = selected by SUT

// Second record if numParts = 2
// Not present if numParts = 0

parts[1].change = selected by SUT
parts[1].partID = selected by SUT
parts[1].numberParms = selected by SUT
parts[1].partsParms = selected by SUT

2.1.4 Collision PDU

// PDU HEADER

header.version = 0x01
header.exercise = 0x01
header.kind = 0x04 // Collision
header.length = 0x0E

issueID.simulator.site = selected by SUT
issueID.simulator.host = selected by SUT
issueID.entity = selected by SUT

collideID.simulator.site = selected by SUT
collideID.simulator.host = selected by SUT
collideID.entity = selected by SUT
eventID.simulator.site = selected by SUT
eventID.simulator.host = selected by SUT
eventID.entity = selected by SUT

unused_16 = DC

// a value of 16 time units, relative scheme
2.1.5 Service Request

// PDU HEADER
header.version = 0x01
header.exercise = 0x01
header.kind = 0x05 // Service Request
header.length = (160 + 96n)bits, where n = numSupplyType

// RECEIVING ENTITY ID
recEntityID.simulator.site = selected by SUT
recEntityID.simulator.host = selected by SUT
recEntityID.entity = selected by SUT

// SUPPLYING ENTITY ID
supEntityID.simulator.site = selected by SUT
supEntityID.simulator.host = selected by SUT
supEntityID.entity = selected by SUT

// SERVICE TYPE
serviceType = selected by SUT
// 0 - other
// 1 - resupply
// 2 - repair

// NUMBER OF SUPPLY TYPES
numSupplyType = selected by SUT

// Padding
INTEROPERABILITY VALIDATION TEST DOCUMENT

```plaintext
unused_16_2 = DC

// SUPPLY QUANTITY
quantity.entity = selected by SUT
quantity.domain = selected by SUT
quantity.country = selected by SUT
quantity.category = selected by SUT
quantity.subcategory = selected by SUT
quantity.specfic = selected by SUT
quantity.extra = selected by SUT
quantity.quantity = selected by SUT

2.1.6 Resupply Offer

// PDU HEADER
header.version = 0x01
header.exercise = 0x01
header.kind = 0x06 // Resupply Offer
header.length = (160 + 96n)bits, where n = numSupplyType

// RECEIVING ENTITY ID
recEntityID.simulator.site = selected by SUT
recEntityID.simulator.host = selected by SUT
recEntityID.entity = selected by SUT

// SUPPLYING ENTITY ID
supEntityID.simulator.site = selected by SUT
supEntityID.simulator.host = selected by SUT
supEntityID.entity = selected by SUT

// NUMBER OF SUPPLY TYPES
numSupplyType = selected by SUT

// Padding
unused_24_2 = DC

// SUPPLY QUANTITY
quantity.entity = selected by SUT
quantity.domain = selected by SUT
```

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quantity.country = selected by SUT
quantity.category = selected by SUT
quantitysubcategory = selected by SUT
quantity.specifc = selected by SUT
quantity.extra = selected by SUT
quantity.quantity = selected by SUT

2.1.7 Resupply Received

// PDU HEADER
header.version = 0x01
header.exercise = 0x01
header.kind = 0x07 // Resupply Received
header.length = (160 + 96n)bits, where n = numSupplyType

// RECEIVING ENTITY ID
recEntityID.simulator.site = selected by SUT
recEntityID.simulator.host = selected by SUT
recEntityID.entity = selected by SUT

// SUPPLYING ENTITY ID
supEntityID.simulator.site = selected by SUT
supEntityID.simulator.host = selected by SUT
supEntityID.entity = selected by SUT

// NUMBER OF SUPPLY TYPES
numSupplyType = selected by SUT

// Padding
unused_24_2 = DC

// SUPPLY QUANTITY
quantity.entity = selected by SUT
quantity.domain = selected by SUT
quantity.country = selected by SUT
quantity.category = selected by SUT
quantity.subcategory = selected by SUT
quantity.specifc = selected by SUT
quantity.extra = selected by SUT
quantity.quantity = selected by SUT
INTEROPERABILITY VALIDATION TEST DOCUMENT

2.1.8 Resupply Cancel

// PDU HEADER

header.version = 0x01
header.exercise = 0x01
header.kind = 0x08 // Resupply Cancel
header.length = 128 bits

// RECEIVING ENTITY ID

recEntityID.simulator.site = selected by SUT
recEntityID.simulator.host = selected by SUT
recEntityID.entity

// SUPPLYING ENTITY ID

supEntityID.simulator.site = selected by SUT
supEntityID.simulator.host = selected by SUT
supEntityID.entity

2.1.9 Repair Complete

// PDU HEADER

header.version = 0x01
header.exercise = 0x01
header.kind = 0x09 // Repair Complete
header.length = 160 bits

// RECEIVING ENTITY ID

recEntityID.simulator.site = selected by SUT
recEntityID.simulator.host = selected by SUT
recEntityID.entity

// SUPPLYING ENTITY ID

supEntityID.simulator.site = selected by SUT
supEntityID.simulator.host = selected by SUT
supEntityID.entity

// REPAIR

repair = selected by SUT
// Padding
unused_16_2 = DC

2.1.10 Repair Response

// PDU HEADER
header.version = 0x01
header.exercise = 0x01 // Repair Response
header.kind = 0x0A
header.length = 160 bits

// RECEIVING ENTITY ID
recEntityID.simulator.site = selected by SUT
recEntityID.simulator.host = selected by SUT
recEntityID.entity = selected by SUT

// SUPPLYING ENTITY ID
supEntityID.simulator.site = selected by SUT
supEntityID.simulator.host = selected by SUT
supEntityID.entity = selected by SUT

// REPAIR RESULT
repairResult = selected by SUT

// Padding
unused_24_2 = DC

2.2 Ideal Tests

2.2.1 Transmission Tests

During Transmission Tests, IST will verify that the correct values appear in all the fields. If discrepancies arise, IST will attempt to determine the cause (e.g. byte ordering reversed, field not initialized, etc.).

Successful completion of these tests shall be achieved if the SUT can transmit each of the PDUs defined in section 2.1.
2.2.2 Reception Tests

During Reception Tests, the SUT operator will verify that all fields of PDUs received are interpreted as defined.

Successful completion of these test shall be achieved if the SUT can receive the PDUs defined in section 2.1.

2.3 Adverse Tests

This test was designed to evaluate the SUT's ability to receive and process/discard PDUs with the extreme range of values that might not normally appear in the PDUs. These tests are meant to help isolate specific fields where the SUT might have problems. The SUT is expected to process/disregard the data without system failure.

For each PDU defined in section 2.1, IST will create a set of PDUs where each PDU progressively replaces a field in the previous PDU with all 1's or all 0's. For example, given the Entity State PDU defined in 2.1.1, the set of PDUs would consist of the data specified in 2.1.1 with the following field value changes:

- PDU 1 - header.version = 0xFF
- PDU 2 - header.version = 0x00
- PDU 3 - header.exercise = 0xFF
- PDU 4 - header.exercise = 0x00
- PDU 5 - header.kind = 0xFF
- PDU 6 - header.kind = 0x00

Articulated parts will be tested slightly different because of the need to have corresponding articulated parameter records. To first test the records, the following PDUs will be used:

- PDU 92 - numParts = 0x00 (no records)
- PDU 93 - numParts = 0x01
  parts.change = 0x0000
- PDU 94 - numParts = 0x01
  parts.change = 0xFFFF
- PDU 95 - numParts = 0x01
  parts.partID = 0x0000
- PDU 96 - numParts = 0x01
INTEROPERABILITY VALIDATION TEST DOCUMENT

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>parts.partID</td>
<td>0xFFFF</td>
</tr>
<tr>
<td>PDU 97 - numParts</td>
<td>0x01</td>
</tr>
<tr>
<td>parts.numberParms</td>
<td>0x00000000</td>
</tr>
<tr>
<td>PDU 98 - numParts</td>
<td>0x01</td>
</tr>
<tr>
<td>parts.numberParms</td>
<td>0xFFFFFFFF</td>
</tr>
<tr>
<td>PDU 99 - numParts</td>
<td>0x01</td>
</tr>
<tr>
<td>parts.partsParms</td>
<td>0x000000000000000000000000</td>
</tr>
<tr>
<td>PDU 100 - numParts</td>
<td>0x01</td>
</tr>
<tr>
<td>parts.partsParms</td>
<td>0xFFFFFFFFFFFFFFFF</td>
</tr>
<tr>
<td>PDU 101 - numParts</td>
<td>0xFF</td>
</tr>
</tbody>
</table>

For this maximum number of Articulated Parts, the number of structures to be created by IST will be 37 and then 40. The number 37 is chosen to test the discrepancy between number of parts and number of structures. The number 40 is chosen to go just beyond the maximum amount of data that will fit into an Ethernet packet before fragmentation (37 is the maximum). The values of the fields in the parts records will be all 0's.

Similar sets of PDUs will be created by IST for the Fire, Detonation, Collision, and Logistics PDUs with the same articulated parts tests repeated for the Detonation PDU.

2.4 Erroneous Tests

Not required at this time.

3 TERRAIN ORIENTATION COMPARISION TESTS

This test is applicable to entities which operate on the terrain or in close proximity to the terrain (within 100 meters of the terrain based on a vertical nadir (lowest point) struck from the entity's center of gravity or axis system origin). Correlation is necessary for successful interoperability since each SUT will have to separately convert the terrain database used in a DIS application.

Note: all coordinates given for the remainder of the test plan are based on the use of the Hunter Ligget database and are computed on the following assumption. The southwest corner of the Fort Hunter Ligget database is:

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>geodetic:</td>
<td>N 35 deg 15' W 122 deg 4' 0</td>
</tr>
<tr>
<td>UTM:</td>
<td>E 584909.6 N 3901166.8 0</td>
</tr>
</tbody>
</table>

¹ The terrain data bases to be used for DIS applications will be supplied by Project 2851 an other organizations, as specified in the Forward of the DIS PDU standard.
INTEROPERABILITY VALIDATION TEST DOCUMENT

3.1 Ideal Tests

3.1.1 Transmission Test

IST will receive Entity State PDUs based upon the following conditions.

An air entity being simulated will follow the stated course. Starting at position:

**UTM (source):**

geocentric (derived):

geodetic (derived):

Proceed North, at a constant speed (to be provided by the SUT) and orientation relative to sea level, along a straight line course toward:

**UTM (source):**

geocentric (derived):

geodetic (derived):

A ground entity being simulated will start at position:

**UTM (source):**

geocentric (derived):

geodetic (derived):

Proceed toward the Lockwood Post Office on a bearing of 125 degrees from North clockwise. Attempt to maintain a constant speed (to be provided by the SUT).

A sea entity being simulated will start at position:

**UTM (source):**

geocentric (derived):

geodetic (derived):
Proceed North, at a constant speed (to be provided by the SUT) along a straight line course toward:

**UTM (source):**
E 594909.6 N 3921166.8 0 alt.

**geocentric (derived):**
X=-2753636.9, Y=-4414546.8, Z=3676789.7

**geodetic (derived):**
N 35 deg. 25' 45.9" W 121 deg. 57' 16" 0 alt.

Ground, sea, and air entities shall follow the specific course as described above. IST will make at least three samplings (at points chosen by IST, but not revealed to the SUT) of Entity State PDUs. IST will examine the position and time stamps to verify internal consistency in the PDUs. Visual observation, if possible, will also be made of this test to note any anomalies not detected in the analytical data. In the case of ground vehicles, IST recognizes that course maneuvering will be required to avoid obstacles. This will be taken into account. Tests up to this point must be completed for minimum interoperability.

IST will also determine the polygon which includes the intersection of the vehicle nadir with the terrain and will compute the absolute location of that intersection with the polygon. The nadir will be determined by examining the Entity State PDU Entity Location fields. The polygon's vertices will be determined by IST based upon IST's semi-automated forces testbed version of the terrain data base (unless another polygonal representation is made available to IST).

IST will compute a normal vector using the three vertices of the terrain polygon described above. If the polygon contains more than three vertices, three consecutive vertices shall be selected at random. The terrain polygon's normal vector shall be decomposed into its component Euler angles based upon its position relative to the geocentric earth and using the assumption that the terrain polygon's normal vector is the same as the polygon's local z-axis.

Successful completion of these tests shall be achieved if at least one Euler angle of the terrain polygon surface normal vector is within .052359877 radians (approximately 3 degrees) of the reference entity's Euler angle. Visual observation will also be made of this test to note any anomalies not detected in the analytical data.
3.1.2 Reception Test

Not required at this time.

3.2 Adverse Tests

Not required at this time.

3.3 Erroneous Tests

Not required at this time.

4 APPEARANCE TESTS

Tests in this section are intended to validate the algorithms used by the SUT to determine and interpret location, attitude, and velocity information, position of articulated parts, and special appearance indications.

4.1 Location and Attitude Tests

Tests in this section shall be made to determine proper interpretation of location and orientation structures used in entity state PDUs. Only the Entity State PDU is used for this section of tests. The Protocol Version, Exercise Identifier, Padding, Entity ID, ForceID, Entity Type, and Alternate Entity Type fields are not evaluated on this set of tests; therefore, their values are not relevant. Unless stated otherwise, all velocities and accelerations shall be equal to zero. These tests will be performed in Transmission mode.

4.1.1 Ideal Tests

4.1.1.1 Location Test

Tests in this section ensure that the Entity Location is interpreted uniformly between simulators. The Entity Location and time stamp fields of the Entity State PDU are the primary fields studied in this section.

Successful completion of these tests shall be achieved if the location of the entity (origin) is within 1 meter (measured along any single axis) and if new PDUs are transmitted at a rate of .2 Hz. The value of 1 meter was determined based upon the approximate value of .00005625 radians*Semi-Major axis of the Earth (meters). The value of .2 Hz is based upon the DIS
default value found in paragraph 4.7.2.1.3.c (minimum issue of once every 5 seconds) of the DIS Standard.

4.1.1.1.1 Transmission Test

**Step 1:**
For ground entities, the SUT shall position a stationary entity on the terrain surface at:

- **UTM (source):** E 670000 N 3980000 298 alt.
- **geocentric (derived):** X=-2671397.8, Y=-4425792, Z=3723839.4
- **geodetic (derived):** N 35 deg. 56' 58.5" W 121 deg. 6' 54.3"

Sea entities shall be positioned at:

- **UTM (source):** E 594909.6 N 3911166.8 0 alt.
- **geocentric (derived):** X=-2756792.7, Y=-4419405.6, Z=3668633.8
- **geodetic (derived):** N 35 deg. 20' 21.3" W 121 deg. 57' 54.3" 0 alt.

A helicopter should hover at:

- **UTM (source):** E 594909.6 N 3911166.8 1000 alt.
- **geocentric (derived):** X=-2757224.4, Y=-4420097.7, Z=3669212.2
- **geodetic (derived):** N 35 deg. 20' 21.3" W 121 deg. 57' 54.3" 1000 alt.

In the case of a jet, the scenario will be mutually determined by IST and the SUT.

The SUT shall then send Entity State PDUs for a period of one minute. IST will check the resulting PDUs to verify that the location of the entity (origin) is within 1 meter (tolerance) of the designated position and that PDUs are transmitted at a rate of approximately .2 Hz. IST will also check the resulting PDUs to verify that all fields in the Entity State PDU remain the same except for the time stamp. IST will also verify that the PDUs are sent at the correct frequency by analyzing the timestamp field.

**Step 2:**
Relocate (instantaneously BEAM) the entity listed above from its initial position to each of the following positions and generate one PDU at each new location.
INTEROPERABILITY VALIDATION TEST DOCUMENT

- X = -2709413.024104
  Y = -4421360.215115
  Z = 3701210.935812

- X = -2652154.227640
  Y = -4425581.830435
  Z = 3744003.785569

Successful completion of this test shall be achieved if the location of the entity (origin) is within 1 meter (tolerance) of the designated position.

4.1.1.1.2 Reception Test

Not required at this time.

4.1.1.2 Attitude Test (Full Compliance)

Tests in this section shall be made to validate consistent interpretation of axis system orientation in the DIS Standard. Tests in this section primarily use the Entity Orientation field of the Entity State PDU.

Successful completion of these tests shall be achieved if the actual orientation, as measured by each Euler angle, is within .00005625 radians of the commanded orientation. The tolerance is to ensure an accuracy of approximately 1 meter if the angular deviation is multiplied by the Semi-Major axis of the earth (per WGS 84). Positional accuracy shall be within 1 meter along any axis.

4.1.1.2.1 Transmission Test

STEP 1:
At the coordinates of X=6378137.0, Y=0.0, Z=0.0 create an axis system with the x-axis oriented to the local east (i.e., aligned to be parallel with line of latitude), the y-axis oriented to the local north (i.e., aligned to be parallel with the line of longitude), and the z-axis perpendicular to the x and y axes and oriented to create a right hand cartesian coordinate system. Record the Euler angles (in the Entity Orientation field of an Entity State PDU) between this local axis system and the reference axis system (i.e., WGS 84).

STEP 2:
With the axis system established as above, perform the following rotations in sequence. After each rotation, record
the Euler angles (using the Entity Orientation field of a new Entity State PDU) between the local axis system and the reference axis system. The rotations below shall be understood as angular displacements from the initial position.

<table>
<thead>
<tr>
<th>Pitch</th>
<th>Roll</th>
<th>Yaw</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.52359877 rad</td>
<td>1.04719754 rad</td>
<td>57.3 rad</td>
</tr>
<tr>
<td>-0.52359877 rad</td>
<td>-1.04719754 rad</td>
<td>-57.3 rad</td>
</tr>
<tr>
<td>0.52359877 rad</td>
<td>1.04719754 rad</td>
<td>57.3 rad</td>
</tr>
</tbody>
</table>

STEP 3:
Orient the local axis system from step 1 as follows; the origin shall be located at X=-2650618.45033, Y=-4423019.118142, Z=3741.8211509920. The x-axis shall be oriented positive south and parallel to the origin's longitude. The y-axis shall be oriented positive west and parallel to the origin's latitude. The z-axis shall be perpendicular to the x and y axes and oriented to yield a right hand cartesian coordinate system. Record the Euler angle (using the Entity Orientation field of an Entity State PDU) between this local axis system and the reference axis system.

STEP 4:
Same as Step 2 above.

4.1.1.2.2 Reception Test
Not required at this time.

4.1.1.3 Attitude Test (Reduced Scope)
For minimum interoperability, the SUT must pass the following attitude test.

4.1.1.3.1 Transmission Test
For ground entities, the SUT shall position an entity on the terrain surface at:

FQ 70 80
UTM (source): E 6700000 N 39800000 298 alt.
INTEROPERABILITY VALIDATION TEST DOCUMENT

geocentric (derived): $X = -2671397.8$, $Y = -4425792$, $Z = 3723839.4$
geodetic (derived): $N = 35$ deg. 56' 58.5" W 121 deg. 6' 54.3"

Proceed North for approximately 10 seconds, make a 720 degree right turn, proceed North for approximately 10 seconds. Then make a 90 degree left turn.

Sea entities shall be positioned at:

UTM (source):

geocentric (derived): $X = -2756792.7$, $Y = -4419405.6$, $Z = 3668633.8$
geodetic (derived): $N = 35$ deg. 20' 21.3" W 121 deg. 57' 20.2" 0 alt.

Proceed North for approximately 10 seconds, make a 720 degree right turn, proceed North for approximately 10 seconds. Then make a 90 degree left turn.

Air vehicles shall fly through:

UTM (source):

geocentric (derived): $X = -2761110.1$, $Y = -4426326.8$, $Z = 3674417.9$
geodetic (derived): $N = 35$ deg. 20' 21.3" W 121 deg. 57' 20.2" 10000 alt.

Proceed North for approximately 10 seconds, make a 720 degree right hand turn, fly North for approximately 10 seconds, make a 90 degree left hand turn. Then, if possible, make a barrel roll and an inside loop, steady up and head West straight and level.

Acceptability will be mutually determined by IST and the SUT.

4.1.1.3.2 Reception Test

Not required at this time

4.1.2 Adverse Tests

4.1.2.1 Location Test

Not required at this time.

4.1.2.2 Attitude Test (Full Compliance)

Not required at this time.
4.1.2.3 Attitude Test (Reduced Scope)

Not required at this time.

4.1.3 Erroneous Tests

4.1.3.1 Location Test

Not required at this time.

4.1.3.2 Attitude Test (Full Compliance)

Not required at this time.

4.1.3.3 Attitude Test (Reduced Scope)

Not required at this time.

4.2 Dead Reckoning Validation

This section will build upon tests conducted in Section 4.1 to test the consistency between a simulator's representation of linear velocity, orientation, and other dead reckoning parameters. These tests will be performed in both Transmission and Reception mode.

4.2.1 Ideal Tests

4.2.1.1 Algorithm Validation

The Algorithm Validation test will be used to determine whether a SUT properly dead reckons another entity.

4.2.1.1.1 Transmission Test

IST will create entities as described in section 3.1. The SUT will create "echo" PDUs for the dead reckoned entity and issue these PDUs every half second. IST will log and examine the PDUs generated by the SUT and compare them with the dead reckoning done by the IST test software.

Successful completion of the test will be determined by the accuracy of the SUT dead reckoned information.
4.2.1.1.2 Reception Test

Not required at this time.

4.2.1.2 Linear Velocity Validation

The Linear Velocity Validation test will be used to determine if a SUT can maintain constant velocity for an entity it is generating.

4.2.1.2.1 Transmission Test

Begin moving the entity in a straight line to the east (parallel to the Equator). When the entity crosses the beginning coordinates defined in section 3.1, it should be at a constant velocity of:

- tank: 5 m/s
- ship: 20 m/s
- helo: 100 m/s
- aircraft: 300 m/s

Continue in a straight line with a constant velocity until the entity crosses the end coordinates defined in section 3.1. IST will record the PDUs generated and will examine the position, velocity, and time stamps to verify internal consistency in the PDUs.

Successful completion of these tests shall be achieved if the entity crosses the designated end point (within 1 cm) within 200ms of the idealized time necessary to traverse the linear distance at a constant velocity.

4.2.1.2.2 Reception Test

Not required at this time.

4.2.1.3 Angular Velocity Validation

Tests in this section shall be made to validate the correct dead reckoning of angular velocity of a SUT. This test is to be used only for those systems implementing second order algorithms.

4.2.1.3.1 Transmission Test

The SUT shall repeat the reduced scope test in section 4.2.1.1.1. The location will be hand calculated by IST based
on velocity, time stamp, and Euler angles.

Acceptability will be determined by frequency of update.

4.2.1.3.2 Reception Test

Not required at this time.

4.2.1.4 Linear Acceleration Validation

Tests in this section shall be made to validate the correct dead reckoning of linear acceleration of a SUT.

4.2.1.4.1 Transmission Test - Acceleration

The SUT shall repeat the test in section 4.2.1.2 except that when the entity crosses the beginning coordinates defined in section 3.1, it will be at the starting velocity of:

- tank 5 m/s
- ship 20 m/s
- helo 100 m/s
- aircraft 300 m/s

and with the acceleration of +1 m/s/s. The entity shall continue in a straight line toward the end coordinates defined in section 3.1 for a period of 5 seconds. IST will record the PDUs generated and will examine the position, velocity, and time stamps to verify internal consistency in the PDUs.

4.2.1.4.2 Reception Test - Acceleration

Not required at this time.

4.2.1.4.3 Transmission Test - Deceleration

To test deceleration, repeat the test in 4.2.1.4.1 with an acceleration of -1 m/s/s.

4.2.1.4.4 Reception Test - Deceleration

Not required at this time.

4.2.2 Adverse Tests
4.2.2.1 Algorithm Test

To test the SUT’s ability to handle adverse data, IST will create another set of the entities described in section 3.1. As the PDUs are being issued, IST will change the dead reckoning algorithm to another algorithm and then back three times. The SUT must demonstrate the ability to accept/reject the adverse data without affecting the network.

4.2.2.2 Linear Velocity

Not required at this time.

4.2.2.3 Angular Velocity

Not required at this time.

4.2.2.4 Linear Acceleration

Not required at this time.

4.2.3 Erroneous Tests

4.2.3.1 Algorithm Test

Not required at this time.

4.2.3.2 Linear Velocity

Not required at this time.

4.2.3.3 Angular Velocity

Not required at this time.

4.2.3.4 Linear Acceleration

Not required at this time.

4.3 Appearance Validation

This set of tests shall verify the proper use of Entity Type, Entity Appearance, Entity Marking, Capabilities, # Articulation Parameters, and Articulation Parameters fields in the Entity State PDU.
4.3.1 Ideal Tests

4.3.1.1 Entity Type Validation

The Entity Type Validation test will be performed to ensure that a SUT can correctly generate Entity State PDUs for each type of entity it is capable of representing. The SUT should also be capable of accepting Entity State PDUs from any type of entity allowed by the DIS standard.

4.3.1.1.1 Transmission Test

The SUT will be required to send Entity State PDUs for each of the entities it can generate. IST will log the PDUs and verify the fields are set as specified.

4.3.1.1.2 Reception Test

IST will send Entity State PDUs for a variety of entity types that are allowed by the DIS standard. The SUT will be required to receive Entity State PDUs without adversely effecting the IST test system. The SUT is not required to visually represent each type of entity.

4.3.1.2 Entity Appearance Validation

The appearance of an entity is totally determined by the SUT's model of the entity. In military exercises, the basic assumption of an entity's state is either active or destroyed. If active, the entity has certain attributes such as color, smoke, dust clouds, etc. that can be simulated. If destroyed, the entity should change appearance and become inactive. The following sections discuss validation tests for these various entity appearances.

4.3.1.2.1 Transmission Test - Destroyed Appearance

The basic assumption of an entity's state is either active or destroyed. Therefore, a validation test for destroyed entities will be required. Many entities go through a destruction sequence of flaming, smoking, and finally destroyed which is usually indicated by the color black. For all destroyed entities, the bit 0 (zero) of the Entity Appearance field of the Entity State PDU should be set to indicate its destruction. The SUT can go through any destruction sequence as long as this bit is set within 15 seconds of destruction.
In the ground case, the SUT will create a stationary vehicle on the ground at Lockwood Post Office (approximate location of X=-2669926.874155, Y=-4428900.674144, Z=3720707.134921). In the surface case, the SUT will create a ship at anchor (approximate location X=-2716162.393570, Y=-4432374.185066, Z=3683167.978451). In the air case, the SUT will create a helicopter at Alder Peak location hovering at 500' Above Ground Level (AGL) (approximate location of X=-2692454.020881, Y=-4416723.773855, Z=3726193.449712).

IST will create one entity of its choice at least 1000 meters from the SUT entity. The IST will maneuver toward the SUT's vehicle until it is close enough to use its weapon of choice. Once in a position to open fire, IST will do so in an attempt to achieve a kill.

IST will record the exercise using its data logger and will verify that Entity Appearance bit was set within 15 seconds. Acceptability will be mutually determined by IST and the SUT. Visualization may also be used if available at either site (i.e., IST or SUT sites).

4.3.1.2.2 Reception Test - Destroyed Appearance

Not required at this time.

4.3.1.2.3 Transmission Test - Other Entity Appearances

Every SUT models its entity(s) uniquely. Certain appearance characteristics are not required and may not be needed. To accurately test the possible entity appearances, the SUT will provide IST with the capabilities of the entity. IST will then design a test to make sure the bits for the appropriate appearances are set at the appropriate times. These tests will include the modeling of fired munitions in detonation and sky shot conditions. Acceptance will be mutually determined by IST and the SUT.

4.3.1.2.4 Reception Test - Other Entity Appearances

Not required at this time.

4.3.1.3 Entity Marking Validation

This test will verify that a SUT which has entity marking capabilities can consistently generate the PDUs with the marking and interpret the markings.
4.3.1.3.1 Transmission Test

The SUT will repeat the test in section 3.1 and create the marking to be provided by IST at the time of this test. IST will log the PDUs and review them to verify the marking. If the SUT has visual representation of the entity, IST will view the representation to verify the marking.

4.3.1.3.2 Reception Test

This test is used to validate the capability of a SUT to model and interpret markings on entities. IST will create an entity with a specific marking of:

marking.characterSet  = 0x01 "Ascii"
marking.text   = "IST1"

After a period of time, IST will alter the marking text to be:

marking.text   = "IST2"

If the SUT has visual representation of the entity, IST will view the representation to verify the marking.

4.3.1.4 Entity Capability Validation

Not required at this time.

4.3.1.5 Articulated Parts Validation

This test is only applicable for SUTs that have entities with articulates parts or SUTs that can visually display entities with articulated parts. The validation tests are divided into transmission and reception to test these two types of systems.

4.3.1.5.1 Transmission Test

The SUT will position and entity anywhere on the terrain, including in the air or at sea, within the specified terrain database. The entity will then proceed to move each articulated part from one end of its range of motion to the other end of its range of motion. Any rate of movement is acceptable.

For rotating parts without a finite range of motion, perform the following test. Turn the part clockwise three revolutions and then turn the part counter-clockwise 3 revolutions.
For parts with a finite range of motion, put the part in a neutral position and move from the neutral position to one end and back to neutral three times. Then move from neutral to the other end of range of motion and back to neutral three times.

IST will record the PDUs generated by these movements and examine a time history of the articulated fields.

For munitions, the SUT will generate an entity anywhere on the terrain. The entity will then fire the munition. IST will record the PDUs generated during this sequence and then examine a time history of the articulated fields.

4.3.1.5.2 Reception Test

For those SUTs that can display entities with articulated parts, IST will generate the PDUs for those entities and put the articulated parts through the range of motions described in section 4.3.1.5.1. IST will visually observe the representation of the entity and make a timing analysis.

4.3.2 Adverse Tests

4.3.2.1 Entity Type Validation

Not required at this time.

4.3.2.2 Entity Appearance Validation

Not required at this time.

4.3.2.3 Entity Marking Validation

Next, to test adverse conditions, IST will send one PDU that has a non-Ascii value in the marking.text field:

\[
\text{marking.text} = 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
\]

IST will observe the SUT to make sure it can accept/discard the adverse marking without affecting the network.

4.3.2.4 Entity Capability Validation

Not required at this time.
4.3.2.5 Articulated Parts Validation

Not required at this time.

4.3.3 Erroneous Tests

4.3.3.1 Entity Type Validation

Not required at this time.

4.3.3.2 Entity Appearance Validation

Not required at this time.

4.3.3.3 Entity Marking Validation

Not required at this time.

4.3.3.4 Entity Capability Validation

Not required at this time.

4.3.2.5 Articulated Parts Validation

Not required at this time.

5 INTERACTIVITY TESTS

These tests verify that the SUT interacts appropriately with the rest of the simulation by generating events appropriately or by responding properly to externally generated events. These tests will be performed in both Transmission and Reception modes.

5.1 Maneuver, Shoot, Kill

In order to accommodate the diversity of simulators to be tested, the operator of the SUT may choose to interact with a ground, surface, or air entity in the tests described below. These tests apply to those entities which have the capability of maneuvering and firing munitions.

Acceptability of test will be mutually determined by IST and the SUT. Visualization may also be used if available at either site (i.e., IST or SUT sites). These tests will be performed in Transmission and Reception modes.
5.1.1 Ideal Tests

5.1.1.1 Stationary

5.1.1.1.1 Transmission Test

In the ground case, IST will create a stationary and harmless vehicle on the terrain surface at Lockwood Post Office:

UTM (source): E 670000 N 3980000 298 alt.
geocentric (derived): X=-2671397.8, Y=-4425792, Z=3723839.4
geodetic (derived): N 35 deg. 56' 58.5" W 121 deg. 6' 54.3"

In the surface case, IST will create a ship at anchor:

UTM (source): E 594909.6 N 3911166.8 0 alt.
geocentric (derived): X=-2756792.7, Y=-4419405.6, Z=3668633.8
geodetic (derived): N 35 deg. 20' 21.3" W 121 deg. 57' 20.2" 0 alt.

In the air case, IST will create a helicopter at:

UTM (source): E 594909.6 N 3911166.8 1000 alt.
geocentric (derived): X=-2757224.4, Y=-4420097.7, Z=3669212.2
geodetic (derived): N 35 deg. 20' 21.3" W 121 deg. 57' 20.2" 1000 alt.

The SUT will create one entity of its choice at least 1000 meters from the IST entity. The SUT will maneuver toward IST's vehicle until it is close enough to use its weapon of choice. Once in position to open fire, the SUT will do so in an attempt to achieve a kill. Next, the SUT will fire a sky shot away from the target entity up into the air. Last, the SUT will fire a munition away from the target entity but at the terrain.

IST will record the exercise using its data logger and will verify that Entity State, Fire, and Detonation PDUs were produced at appropriate times.

IST will verify that the SUT entity's velocity vector and position updates are in the general direction of the IST entity and that relevant articulated parts (e.g., turrets and guns) move in a direction toward the IST entity.
INTEROPERABILITY VALIDATION TEST DOCUMENT

For munitions fired, IST will verify that the SUT is creating separate Entity State PDU for the each tracking munition modeled by verifying the unique entity identifier, or by verifying an entity identifier of zero for non-tracking munitions. For single rounds, IST will verify that the quantity field contains a value of one and the rate field contains a value of zero. For multiple rounds, IST will verify that the quantity field and rate fields contain the values given by the SUT. IST will also verify the remaining information in the Fire PDU.

For detonation, IST will verify the information in the Detonation PDU as specified by IEEE P1278. IST will verify the time the PDU was issued, the target entity ID, type of munition, etc. For impact with the entity, IST will verify the detonation result of "entity impact" or "entity proximate detonation". For sky shots, IST will verify that a Detonation PDU was issued with a detonation result of "none" at the time the munition ceased to be modeled. For the terrain shot, IST will verify the impact of "ground impact" or "ground proximate detonation".

5.1.1.1.2 Reception Test

Not required at this time.

5.1.1.2 Moving

5.1.1.2.1 Transmission Test

A test of interaction with a moving target will be conducted in a manner similar to that of 5.1.1 above except that the targets will maneuver in a closed loop on the ground, on the surface, or in the air. The vehicles shall all move in circular patterns. The center of rotation shall be at the locations noted in 5.1.1, above for each entity type. The radius of rotation, and velocity, in a parallel plane consistent with each vehicle shall be as follows:

- Helicopter. Radius=500 meters velocity=30m/s
- Ground Veh. Radius=100 meters velocity=2m/s
- Ship Radius=2000 meters velocity=6m/s

5.1.1.2.2 Reception Test

Not required at this time.
5.1.2 Adverse Tests

5.1.2.1 Stationary

During interaction, the SUT should be able to survive the introduction of a corrupted PDU. To introduce these adverse conditions into the test, IST will repeat the test in 5.1.1.1 and the following problems:

(1) During the test, IST will issues one PDU that transports the entity being attacked to the SW corner of the terrain and back the next PDU.

(2) During the test, IST will change the entityID.entity field to 0xFFFF for one PDU.

(3) During the test, IST will change the deadReckonParms.algorithm to 0xFF for one PDU.

(4) During the test, IST will change the elevation of the entity for two seconds to an elevation where the entity would not normally reside:
   - helicopter to underground
   - tank to underground
   - ship to in the air 100m.

5.1.2.2 Moving

During interaction, the SUT should be able to survive the introduction of a corrupted PDU. To introduce these adverse conditions into the test, IST will repeat the test in 5.1.1.2 and the following problems:

(1) During the test, IST will issues one PDU that transports the entity being attacked to the SW corner of the terrain and back the next PDU.

(2) During the test, IST will change the entityID.entity field to 0xFFFF for one PDU.

(3) During the test, IST will change the deadReckonParms.algorithm to 0xFF for one PDU.

(4) During the test, IST will at some time increase the velocity of the entity by velocity x 3 for a period of 2 seconds and then resume the original velocity.
5.1.3 Erroneous Tests

5.1.3.1 Stationary

Not required at this time.

5.1.3.2 Moving

Not required at this time.

5.2 Collisions

For Transmission mode, IST will provide an entity to be used as the target for a collision to be generated intentionally. For Reception mode, the SUT will create an entity to be use as the target for a collision.

5.2.1 Ideal Tests

5.2.1.1 With a Stationary Vehicle

5.2.1.1.1 Transmission Test

IST will create the target entity as in section 5.1.1.1 above. The SUT will create its entity as before and will then maneuver it to cause a collision with IST's entity.

IST will record the exercise and will verify that a valid Collision PDU is produced by the SUT. IST will attempt to determine that a consistent collision has occurred between entities (i.e., elastic or inelastic based upon conservation of momentum). Visual verification of the collision will also be conducted, if feasible.

5.2.1.1.2 Reception Test

The SUT will create the target entity in the same location as as specified in 5.1.1.1. IST will create an entity at least 1000 ft away and will maneuver it to cause a collision with the SUT target entity.

IST will record the exercise and will verify if a valid Collision PDU is produced by the SUT. IST will attempt to determine that a consistent collision has occurred between entities (i.e., elastic or inelastic based upon conservation of momentum).
5.2.1.2 With a Moving Vehicle

5.2.1.2.1 Transmission Test

A test of collision with a moving target will be conducted in a manner similar to that of 5.2.1.1 above except that the target created by IST will travel in a circular path at a constant linear and angular velocity. If on the ground, it will conform to the surface. If on the surface, the entity will follow the terrain. If in the air, the entity will maintain constant elevation of 100 meters AGL.

IST will record the exercise and will verify that a valid Collision PDU is produced by the SUT. IST will attempt to determine that a consistent collision has occurred between entities (i.e., elastic or inelastic based upon conservation of momentum). Visual verification of the collision will also be conducted, if feasible.

5.2.1.2.2 Reception Test

The SUT will create a target similar to the one in Section 5.2.1.1 except it will travel in a circular path at a constant linear and angular velocity. If on the ground, it will conform to the surface. If on the surface, the entity will follow the terrain. If in the air, the entity will maintain constant elevation of 100 meters AGL.

IST will record the exercise and will verify if a valid Collision PDU is produced by the SUT. IST will attempt to determine that a consistent collision has occurred between entities (i.e., elastic or inelastic based upon conservation of momentum). Visual verification of the collision will also be conducted, if feasible.

5.2.1.3 Collision with Articulated Parts

5.2.1.3.1 Transmission Test

A test of collision with an entity's articulated part will be conducted in a manner similar to that of 5.2.1.2.1 above. The collision test will be performed for three positions of the articulated part: maximum position, minimum position, and neutral position. IST will observe the position of the entity at the collision point, as well as if the collision is elastic or inelastic.
5.3.1.3.2 Reception Test

A test of collision with an entity's articulated part will be conducted in a manner similar to that of 5.2.1.2.2 above. The collision test will be performed for three positions of the articulated part: maximum position, minimum position, and neutral position. IST will observe the position of the entity at the collision point, as well as if the collision is elastic or inelastic.

5.2.2 Adverse Tests

5.2.2.1 With Stationary Vehicle

To introduce adverse conditions into the test, IST will repeat the test in 5.2.1.1 and add the problems specified in section 5.1.2.1.

5.2.2.2 With Moving Vehicle

To introduce adverse conditions into the test, IST will repeat the test in 5.2.1.2 and add the problems specified in section 5.1.2.2.

5.2.3 Erroneous Tests

5.2.3.1 With Stationary Vehicle

Not required at this time.

5.2.3.2 With Moving Vehicle

Not required at this time.

5.3 Logistics Support - Resupply

In order to accommodate the diversity of simulators to be tested, the operator of the SUT may choose to interact with a ground, surface, or air entity. This test applies only to those entities that can actually perform resupply. This is expressed in the capabilities field of the entity's Entity State PDU.

Prior to starting the logistics tests, the following initial conditions must be established before one entity can resupply another entity. These conditions include:
5.3.1 Ideal Tests

The Resupply test consists of 2 separate scenarios. The first test will evaluate the SUT's performance in a normal resupply activity, i.e. a request is made, supplies are offered, and supplies are accepted. The second test will evaluate the SUT's performance when the resupply activity is canceled by both sides.

5.3.1.1 Request, Receive, Accept

Prior to the resupply test, the SUT and IST will mutually determine the rate at which the transfer of supplies will take place. The SUT's transfer rate will be recorded as part of its capabilities.

5.3.1.1.1 Transmission Test

The resupply interaction test will begin when the SUT determines that it is in a state such that it should be resupplied. The SUT should send a Service Request PDU indicating the resupply needed to start the interaction.

In the ground case, the SUT should be located on the terrain surface at Lockwood Post Office:

- FQ 70 80
- E 670000 N 3980000 298 alt.
- X=-2671397.8, Y=-4425792, Z=3723839.4
- N 35 deg. 56' 58.5" W 121 deg. 6' 54.3"

In the surface case, the SUT should be a ship at anchor:

- EQ 94 11
- E 594909.6 N 3911166.8 0 alt.
- X=-2756792.7, Y=-4419405.6, Z=3668633.8
- N 35 deg. 20' 21.3" W 121 deg. 57' 20.2" 0 alt.

In the air case, the SUT's starting location should be:

- EQ 94 11
IST will create one supply entity of its choice at least 1000 meters from the SUT entity. IST will maneuver toward the SUT's vehicle until it is within the established distance required to perform the resupply activity. Once in position, IST will offer a subset of those supplies requested by the SUT. The SUT will accept a subset of the supplies offered by IST.

IST will record the interaction using its data logger and will verify that the SUT generates Service Request PDUs at a rate of every 5 seconds. The SUT should continue to generate Service Request PDUs until such time that the IST entity transmits a Resupply Offer PDU. After this PDU is issued, IST will verify that the SUT does not continue to transmit Service Request PDUs. IST will then verify that the SUT transmits a Resupply Received PDU within 1 minute of the issue of the Resupply Offer PDU. A verification of the supply types and supply quantity will be made. IST will verify that the SUT's supply quantity is less than the quantity indicated in the Resupply Offer PDU.

Based on the time required to return the Resupply received PDU and the quantity of supplies reported by that PDU as taken, the supply transfer rate will be recorded as a capability.

5.3.1.1.2 Reception Test

The resupply interaction test will begin when IST determines that it is in a state such that it should be resupplied. IST shall position its entity at the coordinates stated in section 5.3.1.1.1 and issue a Service Request PDU to initiate the activity.

The SUT will create one supply entity of its choice at least 1000 meters from IST's entity. The SUT will maneuver toward IST's vehicle until it is within the established distance required to perform the resupply activity. Once in position, the SUT will offer those supplies requested by IST. IST will accept a subset of the supplies offered by the SUT.

IST will record the interaction using its data logger and will verify that the SUT generates a Resupply Offer PDU. IST will transmit a Resupply Received PDU within 1 minute of the issue of the Resupply Offer PDU.
5.3.1.2 Request, Cancel

5.3.1.2.1 Transmission Test

The resupply interaction test will begin when the SUT determines that it is in a state such that it should be resupplied. The SUT shall position its entity at the coordinates stated in section 5.3.1.1.1.

IST will create one supply entity of its choice at least 1000 meters from the SUT entity. IST will maneuver toward the SUT's vehicle until it is within the established distance required to perform the resupply activity. Once in position, IST will offer the supplies requested by the SUT. The SUT will cancel the interaction prior to receiving supplies from IST.

IST will record the interactions using its data logger. This test will be performed in two parts:

First, the SUT should generate a Service Request PDU followed by a Resupply Cancel PDU. IST will verify that the SUT's supply quantity is less than the supply quantity indicated in the Resupply Offer PDU.

Second, the SUT should generate a Service Request PDU at a rate of every 5 seconds. The SUT should continue to generate Service Request PDUs until such time that the SUT receives a Resupply Offer PDU from the IST entity. The SUT should then transmit a Resupply Cancel PDU. IST will verify that the SUT's supply quantity is less than the supply quantity indicated in the Resupply Offer PDU.

5.3.1.2.2 Reception Test

The resupply interaction test will begin when IST determines that it is in a state such that it should be resupplied. IST shall position its entity at the coordinates stated in section 5.3.1.1.1.

The SUT will create one supply entity of its choice at least 1000 meters from IST's entity. The SUT will maneuver toward IST's vehicle until it is within the established distance required to perform the resupply activity. Once in position, the SUT will offer a subset of those supplies requested by IST. IST will cancel the interaction prior to receiving supplies from the SUT.
**INTEROPERABILITY VALIDATION TEST DOCUMENT**

IST will record the interaction using its data logger. This test will be performed in two parts:

First, IST will transmit a Service Request PDU followed by a Resupply Cancel PDU. IST will verify that the SUT does not decrement its supply counter.

Second, IST will generate a Service Request PDU. The SUT will issue a Resupply Offer PDU. IST will then immediately transmit a Resupply Cancel PDU.

### 5.3.2 Adverse Tests

This test will determine if the SUT responds appropriately to abandoning the supply activity.

#### 5.3.2.1 Request, Receive, Abandoned

The resupply interaction test will begin when IST determines that it is in a state such that it should be resupplied. IST shall position its entity at the coordinates stated in section 5.3.1.1.1.

The SUT will create one supply entity of its choice at least 1000 meters from IST's entity. The SUT will maneuver toward IST's vehicle until it is within the established distance required to perform the resupply activity. Once in position, the SUT will offer a subset of those supplies requested by IST. IST will neither cancel nor accept the supplies from the SUT.

IST will record the interaction using its data logger. IST will generate a Service Request PDU. The SUT will issue a Resupply Offer PDU. IST shall never transmit a Resupply Received PDU. After a period of 1 minute, IST will verify that the SUT does not exhibit any adverse behavior.

### 5.3.3 Erroneous Tests

Not required at this time.

### 5.4 Logistics Support - Repair

In order to accommodate the diversity of simulators to be tested, the operator of the SUT may choose to interact with a ground, surface, or air entity. This test applies only to those entities that can actually perform repair. This is
expressed in the capabilities field of the entity's Entity State PDU.

Prior to starting the logistics tests, the following initial conditions must be established before one entity can repair another entity. These conditions include:

- both entities must be alive,
- the entities involved in the repair activity is within a specified distance, and
- both entities are stationary (relative to each other).

5.4.1 Ideal Tests

The Repair test consists of 2 separate scenarios. The first test will evaluate the SUT's performance in a normal repair activity, i.e. a request is made, repairs are offered, and repairs are accepted. The second test will evaluate the SUT's performance when repair is offered but the entity requiring repair does not respond.

5.4.1.1 Request, Complete

5.4.1.1.1 Transmission Test

The repair interaction test will begin when the SUT determines that it is in a state such that it should be repaired. The SUT shall position its entity at the coordinates stated in section 5.3.1.1.1.

IST will create one repair entity of its choice at least 1000 meters from the SUT's entity. IST will maneuver toward the SUT's vehicle until it is within the established distance required to perform the repair activity. Once in position, IST will offer to perform the repairs requested by the SUT. The SUT will accept the repairs offered by IST.

IST will record the interaction using its data logger and will verify that the SUT generates Service Request PDUs at a rate of every 5 seconds. The SUT should continue to generate Service Request PDUs until such time that the IST entity transmits a Repair Complete PDU. The SUT should then issue a Repair Response PDU within 12 seconds. A verification of the repair result will also be made.

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5.4.1.1.2 Reception Test

The repair interaction test will begin when IST determines that it is in a state such that it should be repaired. IST shall position its entity at the coordinates stated in section 5.3.1.1.1.

The SUT will create one repair entity of its choice at least 1000 meters from IST's entity. The SUT will maneuver toward IST's vehicle until it is within the established distance required to perform the repair activity. Once in position, the SUT will offer to perform the repairs requested by IST. IST will accept the repairs offered by the SUT.

IST will record the interaction using its data logger and will generate Service Request PDUs at a rate of every 5 seconds. IST will verify that the SUT issues a Repair Complete PDU. IST will issue a Repair Response PDU within 12 seconds.

5.4.1.2 Request, Cancel

5.4.1.2.1 Transmission Test

The repair interaction test will begin when the SUT determines that it is in a state such that it should be repaired. The SUT shall position its entity at the coordinates stated in section 5.3.1.1.1.

IST will create one repair entity of its choice at least 1000 meters from the SUT's entity. IST will maneuver toward the SUT's vehicle until it is within the established distance required to perform the repair activity. Once in position, IST will offer to perform the repairs requested by the SUT. The SUT will cancel the repair activity.

IST will record the interaction using its data logger and will verify that the SUT generates at least one Service Request PDU. The SUT should then cease to generate Service Request PDUs thereby canceling the repair activity.

5.4.1.2.2 Reception Test

The repair interaction test will begin when IST determines that it is in a state such that it should be repaired. IST shall position its entity at the coordinates stated in section 5.3.1.1.1.

The SUT will create one repair entity of its choice at least 1000 meters from IST's entity. The SUT will maneuver toward
IST's vehicle until it is within the established distance required to perform the repair activity. Once in position, the SUT will offer to perform the repairs requested by IST. IST will cancel the repair activity.

IST will record the interaction using its data logger and will generate at least one Service Request PDU. IST will then cease to issue Service request PDUs thereby canceling the repair activity. No Repair Complete PDU should be issued by the SUT.

5.4.2 Adverse Tests

These tests will determine if the SUT responds appropriately to canceling the repair activity.

5.4.2.1 Request, No Response

The repair interaction test will begin when IST determines that it is in a state such that it should be repaired. IST shall position its entity at the coordinates stated in section 5.3.1.1.1.

The SUT will create one repair entity of its choice at least 1000 meters from IST's entity. The SUT will maneuver toward IST's vehicle until it is within the established distance required to perform the repair activity. Once in position, the SUT will offer to perform the repairs requested by IST. IST will not respond to the repairs offered by the SUT.

IST will record the interaction using its data logger and will generate Service Request PDUs at a rate of every 5 seconds. IST will verify that the SUT issues a Repair Complete PDU within 12 seconds of the last Service request PDU. IST will not issue a Repair Response PDU thereby ending the repair activity.

5.4.3 Erroneous Tests

Not required at this time.
PART III: INTEROPERABILITY TESTS

IST may perform other tests if deemed technically feasible, beneficial to determining interoperability, and mutually agreeable to all parties concerned. In addition to the tests specified below, additional tests envisioned could include testing Sections 3, 4, and 5 on a simplified version of a terrain data base.

6 MANNED SIMULATOR INTERACTION (Qualitative Testing)

IST shall conduct interactive tests using its M-1 simulators with operators in the loop. The purpose shall be to make qualitative assessments regarding interoperability and to identify any problems which quantitative testing may have missed. The identification and resolution of problems shall be determined mutually by IST and the SUT.

7 PROTOCOL TRANSLATOR TESTS

The abundance of existing systems which do not currently use the DIS PDUs to communicate indicate the potential abundance of protocol translator mechanisms to be used as front ends to these systems. Protocol translation applications convert from DIS to whatever information format the system will be using. Protocol translation applications also translate between coordinate systems and dead reckoning algorithms. To test a protocol translation device, the protocol that is being translated to/from IEEE P1278 must be completely known so that discrepancies can be identified. The following sections give guidance for additional tests which must be performed on protocol translation applications. These tests will be expanded as more experience is gained with the integration of these devices/applications into DIS.

7.1 System Setup

To accurately test a protocol translation application, IST must have access to the information on both sides of the translation. If the protocol translation is accomplished with an independent device, IST will monitor all network connections into and out of the device.

7.2 Network Protocols

For an independent protocol translation device, IST will monitor the network traffic on all network connections of the
device. IST will verify consistency of the network protocols for information traveling on these connections. IST will verify that the device does or does not meet throughput as stated by the SUT.

7.3 Translation

For the translation performed by the device/application, the SUT must provide a very complete capabilities statement of what is being translated. IST will verify that the stated translation is taking place based on the information provided by the SUT. In coordination with the tests stated in the earlier sections of this document, IST will verify that coordinate transformations are accurate, that entity IDs remain consistent, that entity types are consistent, and that movement (velocity and acceleration) is consistent. IST will also verify that translation of dead reckoning information is consistent.

8 CAPABILITY TESTS (Quantitative Testing)

This section is reserved for those tests that determine the level of interoperability a SUT may possess. These tests are intended to identify the limits of system performance, network performance, and correlation of simulations. These tests are quantitative and the measurements may be compared against those of other systems to determine level of compatibility for interacting in DIS applications. Specific tests, below, will be mutually selected by IST and the SUT.

8.1 System Loading

IST will present the SUT with a continual increase in PDU's (both broadcast and point to point) up to a load representing 200 entities, if possible. The SUT shall proceed along a course as outlined in Section 3.1, above (repeating the route until conclusion of this test). The purpose will be to observe the PDU type and quantity from the SUT and to discern, visually and analytically (through frequency analysis of PDU type) the ability of the SUT to handle (or ignore) heavy network traffic.

8.2 Line of Sight Correlation Test

This test is intended for those systems with image generators. It will produce a measure of the intervisibility of a SUT's generated image by creating entities on the terrain and recording if a human can see them. This test is used to
determine terrain correlation for systems which generate their own terrain databases. IST will provide the test software to be used on a PC. This software will drive the image generator to create the entities on the terrain. A person at the PC indicates whether or not he can see the entity. The correlation index is used as an indicator of how different the terrain database is represented between different image generators and because of this difference, whether those generators can compete in a fair fight.

8.3 Target Background Contrast Ratio

This test is used for any system with an image generator. IST will use a chronometer to measure the contrast ratio between a target and the background for specified colors. This measure will be used to determine the level of fair fight that the simulator can compete in.