Simulation Interoperability Standards Organization (SISO)

Standard for:

LINK 16 SIMULATIONS

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Link 16 Product Development Group (PDG)

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This protocol is the result of the efforts of the SISO Link 16 Product Development Group. This group is the successor to the SISO Tactical Data Link Study Group, which began as a “grass roots” response to informal community inquiries by the Distributed Mission Operations Center (DMOC), formerly the Theater Aerospace Command and Control Simulation Facility (TACCSF). The Study Group presented a DIS implementation of Tactical Data Link at the Fall 2003 SIW.

This protocol would not have been possible without the contributions and hard work of each of its members.

Drafting Group
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Associate Editor: Joe Sorroche
Associate Editor: Graham Shanks
Associate Editor: Mary Christopher
Associate Editor: Bill Hinkle
Associate Editor: Adin Burroughs
Other Contributors
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Neil Barrett
James Nutaro

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Ralph Weber
Clive Wood

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1. INTRODUCTION

Link 16 is a Communications, Navigation and Identification (CNI) system intended to exchange surveillance and Command and Control (C2) information among various C2 platforms and weapons platforms to enhance varied missions of each of the services. It provides multiple access, high capacity, jam resistant, digital data and secure voice Communication, Navigation, and Identification (CNI) information to a variety of platforms. Link 16 is the primary North Atlantic Treaty Organization (NATO) standard for tactical data link. NATO Standard Agreement (STANAG) 5516 (Reference 10) and MIL-STD-6016B (Reference 7) describe the Link 16 message formats (Link16 messages are also known as TADIL-J messages) and Link 16 network instructions.

Link-16 uses the Joint Tactical Information Distribution System (JTIDS) that is the communications component of Link-16. The terms Link 16 and JTIDS are frequently used interchangeably. The Multi-Function Information Distribution System (MIDS) is the NATO equivalent term for JTIDS.

1.1 PURPOSE

There are immediate operational requirements for existing military simulations to exchange Link 16 data using a single interoperable standard. Several protocols have evolved to satisfy specific needs. The NATO STANAG 5602 Standard Interface for Multiple Platform Link Evaluation (SIMPLE) Link 16 standard (Reference 8) is one such protocol. As military distributed simulation evolves further in mission scale and complexity, tactical datalink implementations need to interoperate.

1.2 SCOPE

This standard applies only to Link 16/JTIDS/MIDS. It does not address Link 16 over SATCOM. In developing a protocol for simulating Link 16 in Distributed Interactive Simulation (DIS) and High Level Architecture (HLA), it is recognized that there are widely varying requirements for achieving fidelity among different users. This protocol attempts to establish procedures that may be used by the vast majority of users, by establishing discrete, scalable, interoperable levels of fidelity for different users. This, in turn, allows for low cost initial implementation with a path toward upgrading to detailed Link 16 emulation as requirements evolve.

The DIS simulation protocol for Link 16 is described in terms of the established DIS Transmitter and Signal Protocol Data Units (PDUs). There has been no change to the Transmitter or Signal PDUs described in Reference 1. Link 16 specific enumerations have been created to populate the standard fields and records. The implementation of Link 16 exploits the fact that both these PDUs are variable length. In the case of the Transmitter PDUs, this protocol sets forth how the variable length “modulation parameter” fields must be populated. In the case of the Signal PDU, Link 16 specific information is relegated to the variable length data fields.

The HLA instructions are formatted in compliance with Reference. 2. The instructions are presented in the form of a Base Object Model (BOM) that may be incorporated into a system

Federation Object Model (FOM). Real-time Platform Reference (RPR)-FOM based simulations should be able to easily integrate the Link 16 BOM into their FOMs. Furthermore, there is a straightforward mapping between the DIS PDU implementations and the corresponding BOM components.

1.3 OBJECTIVE

It is the objective of this protocol to establish a standard for Link 16 message exchange and JTIDS network simulation in the DIS and HLA interoperability frameworks. The intent is to prescribe the content of the standard fields of the Transmitter and Signal PDUs (and the corresponding RPR-FOM Transmitter Object and Signal Interaction) and establish procedures for their use. Compliance with these procedures will facilitate interoperability among Link 16 simulation systems.

2. REFERENCES

1. IEEE 1278.1–1995 IEEE Standard for Distributed Interactive Simulation – Application Protocols
2. IEEE 1516 –2000 IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA)
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4. IST-CF-03-01—5 May 2003: Enumeration and Bit Encoded Values for Use with Protocols for Distributed Interactive Simulation Applications
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6. RPR-FOM 2.0 Draft 17, Real-time Platform Reference Federation Object Model, Version 2.0, Draft 17, 10 September 2003.
7. MIL-STD-6016B, Tactical Digital Information Link (TADIL) J Message Standard (DRAFT) 15 March 2002
8. NATO STANAG 5602, edition 1, Standard Interface for Multiple Platform Link Evaluation (SIMPLE) 20 Feb 2001
9. System Segment Specification for Joint Tactical Information Distribution System Class 2 Terminal, 15 April 1999
10. NATO STANAG 5516, Edition 1, Tactical Data Exchange - Link 16, Ratified 15 January 1997.
11. Link 16 Enhanced Throughput Standard, August 11, 1998 Doc # VSD-618255-97-339-02
12. Joint Interoperability of Tactical Command and Control Systems Variable Message Format (VMF) Technical Interface Design Plan (Test Edition) Reissue 2, August 1996.
13. RFC 1305, Network Time Protocol (v3) Specifications, Implementation & Analysis, March 1992
14. Time Synchronization Server, http://www.ntp.org
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3. TERMS, DEFINITIONS AND CONVENTION

3.1 CONVENTIONS

The following terms and conventions are used for the purpose of this standard:

1. SHALL indicates a procedure or capability is mandatory.
2. SHOULD indicates a recommended procedure or capability.
3. MAY indicates a procedure or capability is optional.
4. WILL/IS/ARE are only used descriptively as statements of fact.

3.2 TERMS AND DEFINITIONS

Automatic Acknowledgement: A machine verification function whereby a terminal that receives a message addressed to it retransmits a copy of that message back to the source during a later time slot, verifying the receipt of the original message.

Emulation Level: Level of fidelity that Link 16 is modeled in a simulation.

Epoch: A 12.8-minute time interval consisting of 98,304 time slot intervals, each of 7.8125 milliseconds duration. The time slots in each epoch are organized into three sets (A, B, or C) of 32,768 time slots each. There are 112.5 epochs in a 24-hour period.

Free Text Message: Bit-oriented messages whose information bits may be used to represent digitized voice, teletype and other forms of free text information. This does not refer to the fixed word format message, J28.2 “AWACS free text message”.

Fidelity Level: In terms of this standard, a fidelity level is a measure of the level of functionality of the implementation of the Link 16 Simulation Standard. This allows for a standard nomenclature to be used within the community to describe the functionality of implementations of this standard. See section 5.1.2 for additional information and table 5.1.2 for definitions of fidelity levels in this standard.

Fixed Word Format (FWF): A 70-bit structure consisting of a formalized arrangement of predefined fields of fixed length and sequence.

Fixed Word Format Message: A Link 16 message utilizing Fixed Word Format (FWF). An FWF message is started by an initial word that may be then followed by one or more extension and/or continuation words.

Geodetic Position Quality: A measure of the quality of a JTIDS/MIDS terminal's geodetic position reported in the terminal's Position and Status Reports. Geodetic Position Quality is reported as an integer from 0-15 where the higher numbers correspond to the higher qualities, i.e., lower errors in position.

Initial Entry: The procedure by which a subscriber terminal becomes a system participant initially and may achieve coarse synchronization with system time.

Initial Entry JTIDS Unit (IEJU): Any JTIDS/MIDS unit that transmits the Initial Entry message in the appropriate time slot.

Joint Tactical Information Distribution System (JTIDS): The communications component of Link-16. It is a joint-service system which provides an Integrated Communications, Navigation, and Identification (ICNI) capability. The JTIDS provides a reliable, secure, jam resistant, high-capacity, ICNI capability through the use of direct-sequence, spread-spectrum, frequency-hopping, and error detection and correction techniques.

JTIDS Header (Message): The leading bits of each message are coded as a Reed-Solomon code word that provides 35 bits of information.

JTIDS/MIDS Net: One of 128 time-division structures comprising a JTIDS/MIDS network. Each net consists of a continuous stream of time intervals (time slots) with 98,304 time slots per 12.8-minute epoch, during which digital data whose signal characteristics are determined by a cryptographic variable in conjunction with a unique net number are distributed.

JTIDS/MIDS Network: The JTIDS/MIDS structure (usable only with Mode 1 communications) having a total usable capacity of 98,304 time slots per epoch per net and 128 nets. All nets are synchronized so that each time slot of each net is time-coincident with the corresponding time slot (same set and number) of every other net.

The signal characteristics of all data distributed within a specified multi-netted structure are determined by a cryptographic variable in conjunction with a set of net numbers that define the structure.

JTIDS/MIDS Unit (JU): A unit communicating directly on Link 16. JU is used within the context of this standard to indicate a simulated TADIL J terminal.

J-Word: JTIDS Word.

Link 16 Message: See TADIL J.

Machine Receipt: See Automatic Acknowledgement.

Mode 1 Communications: Mode 1 JTIDS/MIDS transmissions consist of a sequence of wide-band transmission symbol packets (single pulse, 13-microsecond packets and double-pulse, 26-microsecond packets), the pulses of which are formed by continuous phase shift modulation (CPSM) of the carrier frequency. The signal processing required to transform base-band data to the JTIDS signal waveforms for transmission includes base-band data encryption, forward error correction encoding, error detection encoding, cyclic code shift keying (CCSK) encoding, data symbol interleaving, and the selection of a variable start time.

Mode 2 Communications: Mode 2 JTIDS/MIDS transmissions are identical to Mode 1, except that Mode 2 operates in the narrow-band mode.

Mode 4 Communications: Mode 4 JTIDS/MIDS transmissions have signal waveform characteristics identical to Mode 2, except that Mode 4 does not employ base-band data encryption signal processing.

Multi-Function Information Distribution System (MIDS): The NATO equivalent term for JTIDS.

Navigation Controller: The Navigation Controller establishes the origin and North orientation of the U, V relative grid for the Relative Navigation function.

Network Participation Group (NPG): The **Network Participation Group** is a unique list of applicable messages used to support an agreed upon technical function without regard to subscriber identities. This list is a means of transmitting a common set of messages to all interested users. For the purposes of simulation in this standard, the NPG number creates virtual networks of participants to segregate information within a JTIDS/MIDS network.

Net: See "JTIDS/MIDS Net."

Net Number: A 7-bit code that identifies each net as a decimal number (0 through 127).

Network: See "JTIDS/MIDS Network".

Network Time Reference (NTR): A subscriber terminal that is assigned as the reference for system time for each synchronized netted system. The NTR terminal's clock time is never updated by system information and is the reference to which all other terminals synchronize their own clocks. There is only one NTR.

Position Reference: One or more JUs designated as a network reference. Such a JU has maintained a geodetic position accuracy of 50 feet, one sigma (standard deviation) over a long period of time.

Pulse (JTIDS): A 6.4-microsecond burst of carrier frequency continuous phase shift modulated at a 5-megabit-per-second rate by the transmission symbol.

Precise Participant Location & Identification (PPLI): The PPLI function provides network participation status, identification, and position of JUs on the Link 16 interface.

Radio Silence Mode: A mode of terminal operation where the terminal receives but does not transmit fixed word format or variable message format messages.

Recurrence Rate: The total number of time slots per epoch assigned (or deleted) in a single time block assignment, specified as an integer, R = 0 to 15 where 2^R = the number of time slots.

Recurrence Rate Number (RRN): An integer R, $0 \le R \le 15$, where 2^R is the recurrence rate of the block assignment.

Reed-Solomon (R-S) Code: As applied to JTIDS/MIDS, a forward error correction encoding scheme. In this protocol, indicating Reed-Solomon encoding in the Signal PDU, the data area is still comprised of 75 bit **non** Reed-Solomon encoded Link 16 messages.

Relative Navigation (Relnav): A procedure used by a terminal to determine its position and velocity in a common reference coordinate system by passive observations of Position and Status messages transmitted by other terminals. To make use of Relnav, the simulation system must achieve medium fidelity synchronization.

Relative Position Quality: A measure of the quality of a terminal's relative position with respect to the U, V relative grid. Relative Position Quality is reported in the terminal's Position and Status Reports as an integer from 0-15, where higher numbers correspond to higher quality.

Reporting Responsibility: The requirement for the Interface Unit with the best positional data on a track to transmit track data on the interface.

Round-Trip-Timing (RTT): The process used by a JTIDS/MIDS terminal to directly determine the offset between its clock and that of another JTIDS/MIDS terminal. This is used to achieve and maintain fine synchronization and to improve the terminal's time quality. This process involves the exchange of RTT Interrogation and Reply Messages.

RTT Addressed (RTT A): The RTT A message provides the means for a JTIDS Terminal to synchronize with system time using the active synchronization procedure. A specific terminal with a time quality greater than the interrogating terminal is interrogated and responds with the RTT Reply. Typically the interrogating terminal addresses the NTR.

RTT Broadcast (RTT B): The RTT B message provides the means for a JTIDS Terminal to synchronize with the system time using the active synchronization procedure. The RTT B message is not addressed to a specific terminal. The interrogating terminal transmits the RTT B message on the net number of the highest time quality PPLI that it has received. Any terminal with a time quality equal or higher than that net number **shall** reply.

RTT Reply: The RTT reply message provides the means for a JTIDS terminal to support the active synchronization procedure by providing time-of-arrival data in response to either an RTT A or RTT B interrogation.

Stacked Net: The coordinated use of specific blocks of time slots on different nets in a JTIDS/MIDS network by different communities of users.

Subscriber: A participant in the use of the system, either actively (transmission of information) or passively (receiver of information only), or both.

Synchronization:

1. **Active Synchronization:** A procedure used by a JTIDS/MIDS terminal to effect and maintain fine synchronization with system time based on the Round-Trip-Timing (RTT) process.
2. **Passive Synchronization:** A procedure used by a terminal to effect and maintain fine synchronization with system time by passive observations of Position and Status messages transmitted by other terminals. The synchronizing terminal is not required to transmit any information.
3. **Coarse Synchronization:** The state of synchronization with system time that allows a terminal to receive and process messages and to achieve fine synchronization.
4. **Fine Synchronization:** The state of synchronization with system time that allows a terminal to transmit messages. A terminal may utilize a passive or an active synchronization procedure to achieve fine synchronization.
5. **Low Fidelity Synchronization:** Simulated fine synchronization without using RTT messages.
6. **Medium Fidelity Synchronization:** Simulated fine synchronization using RTT messages.

Tactical Digital Information Link (TADIL): A Joint Chiefs of Staff (JCS) approved standardized (TADIL) communications link suitable for transmission of digital information. A datalink is characterized by its standardized message formats and transmission characteristic.

TADIL J: Tactical Digital Information Link J. A secure, jam-resistant, nodeless datalink that utilizes the Joint Tactical Information Distribution System (JTIDS), and the protocols, conventions and Link 16 fixed word message formats defined by the MIL-STD- 6016.

Time (System): The time maintained by the terminal assigned as the Network Time Reference (NTR) to which all other participating terminals are synchronized.

Time (Terminal): The estimate of time derived by a terminal as a result of executing either the active or a passive synchronization procedure. (System Segment Specification for JTIDS/ MIDS Class 2 Terminal).

Time Quality: A measure of the quality of a terminal's state of synchronization with system time reported in the terminal's Position and Status Report. Time Quality is reported as an integer from 0-15 where the higher numbers correspond to the higher levels of quality, i.e., lower errors in timing (System Segment Specification for JTIDS/ MIDS Class 2 Terminal).

Time Slot: A 7.8125-millisecond time interval during which messages may be transmitted.

Time Slot Allocation (TSA) Level: In this simulation standard a TSA level corresponds to one of five selectable levels of fidelity. See table 5.1.2 for a description of each mode.

Time Slot Assignment: The designation to the terminal of the specific time slot block in which it will transmit or receive messages.

Time Slot Block: A collection of time slots spaced uniformly in time over each epoch and belonging to a single time slot set. A block is defined by set (A, B, or C), indexing time slot number (0 to 32,767), and a recurrence rate number (0 to 15). The time slot block is often written as Set-TimeSlotNumber-RecurrenceRate such as A-0-6.

Time Slot Number: A 17-bit code that identifies each full time slot. The code consists of a 2-bit set field (set A, B, or C) and a 15-bit slot field representing the decimal numbers zero to 32,767 (System Segment Specification for JTIDS/MIDS Class 2 Terminal).

Track Quality: A measure of the reliability of the positional information of a reported track.

Users:

1. **Primary User:** A subscriber terminal that utilizes the active synchronization (RTT) procedure and serves as a high-quality source for synchronization by the general Relative Navigation community.
2. **Secondary User:** The general category for the majority of system subscriber terminals. Secondary user terminals generally utilize the Passive synchronization procedures for synchronizing in the Relative Navigation community (System Segment Specification for JTIDS/ MIDS Class 2 Terminal). Secondary users may use RTT messages when improved time quality is needed to maintain position quality.

Variable Message Format (VMF): A message structure using predefined fields of fixed length employing internal syntax and a header extension. The internal syntax specifies the presence, absence, and recurrence of fields as selected by the user.

4. ACRONYMS

BOM	Base Object Model
CNI	Communication, Navigation, and Identification
CPSM	Continuous Phase Shift Modulation
CVSD	Continuous Variable Slope Delta (modulation)
CVLL	Crypto Variable Logic Label
DIS	Distributed Interactive Simulation
DMOC	Distributed Mission Operations Center
EDAC	Error Detection and Correction
FOM	Federation Object Model
HLA	High Level Architecture
IEJU	Initial Entry JTIDS unit
JCS	Joint Chiefs of Staff
JTIDS	Joint Tactical Information Distribution System
JU	JTIDS Unit
LET	Link 16 Enhanced Throughput
LPC	Linear Predictive Coding
MIDS	Multi-Function Information Distribution System
MIL STD	Military Standard
MSEC	Message Security Encryption Code
NATO	North Atlantic Treaty Organization
NDL	Network Data Load
NPG	Network Participation Group
NTR	Network Time Reference
OMT	Object Model Template
PDU	Protocol Data Unit
PPLI	Precise Participant Location & Identification
RPR	Real-time Platform Reference
RelNav	Relative Navigation
R-S Encoding	Reed-Solomon encoding
RTT	Round Trip Timing
SIMPLE	Standard Interface for Multiple Platform Link Evaluation

TACCSF	Theater Aerospace Command & Control Simulation Faculty
TADIL J	Tactical Digital Information Link J
TDMA	Time Division Multiple Access
TDL	Tactical Data Link
TSA	Time Slot Allocation
TSEC	Transmission Security Encryption Code
VMF	Variable Message Format

5. REQUIREMENTS

5.1 JTIDS OPERATING CHARACTERISTICS

JTIDS uses the principle of frequency hopping Time Division Multiple Access (TDMA) to divide network time, and capacity, into divisions called time slots. Each time slot is 7.8125 milliseconds long with 128 time slots per second. Time slots are organized into three interleaved sets (A, B, and C). An epoch is 12.8 minutes long comprised of 98,304 time slots. There are 112.5 epochs in a 24-hour day. Therefore, the current epoch, set and time slot number can be calculated from the current time. Operationally, groups of time slots are assigned to a common function known as a Network Participation Group (NPG). Time slot assignments are published in a network data load (by a central net design agency), with participation groups identified by the time slot set, the “offset” of the time slot, and the time slot recurrence rate. The recurrence rate is expressed as an exponential power of 2, representing how often the time slot assigned to the NPG occurs within the set.

TDMA architecture requires that each JTIDS participant, known as a JTIDS Unit (JU), must know when its transmit time slots occur. JUs must be synchronized with a common network time to receive and transmit on the network. In JTIDS, one JU in a network is designated as the Network Time Reference (NTR).

5.1.1 General Requirements

This section describes general requirements for simulation of Link 16 independent of the simulation protocol used. The specific requirements for implementation under DIS are described in section 5.2. The specific requirements for implementation under HLA are described in section 5.3.

1. Simulators in compliance with this standard **shall** as a minimum have the capability to identify the NPG and net number of transmitted data to allow them to operate at TSA level 0 and 1.
2. All Link 16 messages **shall** be bit encoded in accordance with the MIL-STD-6016 (Reference 7) and STANAG 5516 (Reference 10) TADIL J specification. In the specification, each time slot contains one 35-bit header, padded to 48 bits, and a varying number of 75 bit messages, padded to 80 bits, unless the message type indicator specifies otherwise.
3. Regardless of level of fidelity, all transmission modulation parameter fields **shall** be filled with valid data in accordance with this standard.
4. When the header indicates Reed-Solomon encoding, the data area **shall** still be comprised of non Reed-Solomon encoded Link 16 messages.
5. Any simulator that is not emulating JTIDS network data load throughput **shall** have the ability to configure the maximum number of JTIDS words transmitted per second, but **shall** not exceed the JTIDS maximum of 1536 J-words per second (twelve J-words per Pack-4 Single Pulse time slot multiplied by 128 time slots per second). This upper limit **shall** not apply to JTIDS LET (Link Enhanced Throughput) packets.

6. If the packing mode from the JTIDS header and the number of messages contained in the Signal message do not agree, (i.e. the header states that the packing mode is Pack-2 Double Pulse and there are 12 J-words contained with the message) extra messages **shall** be dropped by the receiving simulator—as would happen in a live JTIDS datalink. If there are fewer messages in the data area than prescribed by the packing mode, the receiver **shall** treat the missing messages as J31.7 "No statement" messages and parse the message stream accordingly.

7. Systems **shall** wait until their time slot occurs to transmit data in order to receive the latest update to data (i.e. time slots **shall** not be "pre-sent"). Receiving systems **shall** buffer messages after the time slot has occurred to account for network delays. The amount of time to buffer messages for a time slot **shall** be a runtime configuration item. The amount of time entered **shall** be the same for all participants in the same network and will cause the simulations to all "retire" a particular time slot at the same time. This effect is not important for lower levels of fidelity (Time Slot Allocation (TSA) levels 0, 1) but is critical for all fidelity levels that tie a message to a particular time slot along with a Network Data Load (NDL). If the effects of messages arriving later than the time slot are not important (multiple JUs transmitting in the same time slot, contention access, or data arriving while the receiving JU is transmitting), or the physical network infrastructure has low delays (less than 3 msec), the buffer time can be set to a low number or to zero. When TSA level 0 or 1 systems interoperate with higher fidelity systems, the buffer has to be the same for all participants. When network is composed exclusive of TSA level 0 and 1 systems, the buffer may be set to a low number or zero.

8. All systems set at TSA level 2 or higher **shall** have their system times synchronized to a common time reference. Any error in the clock synchronization times (e.g. average NTP error) must be added to the network delays (the buffer time) before retiring a time slot. For real-time DIS or HLA simulation applications, NTP (or equivalent) is recommended. For non-real-time simulation applications, HLA time management is recommended.

9. All systems should have some representation of a terminal clock time. If medium fidelity synchronization is to be accomplished, the system **shall** model a terminal clock (and its associated drift).

10. At TSA level 2 or greater, if multiple messages are received with identical Transmission Security Encryption Codes (TSEC), net number and timeslot number, receivers **shall** not process messages except from the closest transmitting entity (in the simulation space).

11. There are three communication modes for a real JTIDS/MIDS network: modes 1, 2 and 4 (See Table 5.1.1). The selected communication mode determines whether or not the network can operate on multiple nets (by employing frequency hopping) and the transmitted data are encrypted. All JUs in a JTIDS/MIDS network must operate in the same communication mode.

    A. The normal JTIDS communication mode is mode 1. Frequency hopping and crypto variables **shall** be simulated appropriately to the specified level of fidelity.

B. When operating with JTIDS communication mode 2, there will be no frequency hopping, but encryption **shall** still be used, depending on the level of fidelity. The explicit frequency of 969 MHz **shall** be set in the transmission message frequency field and the bandwidth will be 3MHz. The net number in the signal message **shall** be zero for all transmissions (no multi-netting).

C. Mode 4 eliminates communications security in addition to the features of communications mode 2. The TSEC and MSEC encryption fields **shall** be set to 255 when in communications mode 4 in addition to specifying the explicit transmit frequency as in communications mode 2.

Table 5.1.1: JTIDS Communication Modes

Communication Mode	Frequency Hopping	Data Encrypted
1	Yes	Yes
2	No	Yes
3	Not Used	Not Used
4	No	No

12. Time slots **shall** be numbered sequentially, such that time slot 0 represents time slot A-1, time slot 98303 represents C-32767. When the epoch is 112, the last valid time slot is 45151 (end of the day).

13. Generated machine receipts **shall** use time slots as assigned in the network description. There is no special consideration given to machine receipts; they are treated as any other Link 16 fixed format message.

14. Relay is accomplished by transmitting relay information in assigned time slots. There is no special mechanism necessary to simulate relay transmissions.

15. Transmission messages **shall** be issued in accordance with clause 4.5.7.2.2 of Ref 1 (Issuance of the Transmitter PDU) and in conjunction with the following events: entering the Link 16 network, exiting the Link 16 network, when a synchronization state changes, and upon issuance of each PPLI or initial net entry message.

5.1.2 Levels of Fidelity

This protocol allows simulations to achieve different levels of fidelity by assigning one of five Time Slot Allocation (TSA) levels. If the simulator allows for a settable level of fidelity, the level of fidelity **shall** be set at runtime. The TSA level **shall** be set in Modulation Parameter #1 of the transmission packet with an enumeration of 0-4 as described in Table 5.1.2.

Table 5.1.2: JTIDS Emulation Levels

TSA Level	Fidelity	Synchronization Fidelity	Issues	Recommended Usage
0	Low	Low	Does not emulate JTIDS network characteristics. Data rates are not constrained. Intended for legacy use.	Experiments and/or training concerned with message format and/or message content only.
1	Low	Low	Does not emulate JTIDS network characteristics.	Experiments and/or training where total network throughput is important. Allows for bandwidth throttling to emulate JTIDS network throughputs without assigning messages to specific time slots. Net Data Loads can be loaded into terminal simulation equipment to simulate data rates in NPGs on the Link 16 network.
2	Medium	Low	Network delay must be sufficiently small if time slot sensitive conversations are required to duplicate live Link 16 networks (e.g. relay emulation, RELNAV, messages requiring responses).	Experiments and/or training concerned with throughput limits of the Link 16 network. Also suitable for experiments/training emulating message traffic and timing of JTIDS networks without emulating effects of RTTs, RELNAV, or stacked/multi-nets.
3	Medium	Low	Same as TSA Level 2.	Experiments and/or training concerned with emulating stacked-, multi-, and crypto-net emulation.
4	High	Medium	Extremely sensitive to network latency.	Experiments and/or training concerned with effects deriving from emulation of network entry and synchronization maintenance.

5.1.2.1 TSA Level 0, Low Fidelity

TSA level 0 is the lowest level of fidelity. The NPG and net fields **shall** be filled in the signal message, but all other data in the JTIDS transmission header **shall** be set to 255. Multiple messages are permitted in a single Signal message. All messages within the signal message **shall** be assumed to be for the same NPG and net number with the same assumed packing. There is no TSA or metering with up to the maximum number of messages (as specified in the DIS standard) packed into the data area of a single signal message. Low fidelity synchronization **shall** be achieved in accordance with paragraph 5.1.4.1 of this protocol.

5.1.2.2 TSA Level 1, Low Fidelity

TSA Level 1 is similar to TSA Level 0 except that there is minimal metered data. When the TSA level is set to 1, one time slot worth of information **shall** be in one Signal message. As in TSA level 0, the NPG and Net Number fields **shall** be filled in, and the rest of the transmission information **shall** be set to 255. Low fidelity synchronization **shall** be achieved in accordance with paragraph 5.1.4.1.

5.1.2.3 TSA Level 2, Medium Fidelity

TSA Level 2 allows for metered data with no encryption. When the TSA level is set to 2, messages **shall** be assigned to individual time slots. The NPG, Net Number, and Time Slot Identification fields **shall** be filled in. The TSEC and MSEC **shall** be set to 255. Low fidelity synchronization **shall** be achieved in accordance with paragraph 5.1.4.1.

5.1.2.4 TSA Level 3, Medium Fidelity

This level enables full TSA to include encryption. When TSA level is set to 3, stacked nets, multi-nets, and crypto-nets can be emulated. All transmission information fields **shall** be filled in. Low fidelity synchronization **shall** be achieved in accordance with paragraph 5.1.4.1.

5.1.2.5 TSA Level 4, High Fidelity

If the TSA level is set to 4, everything from TSA level 3 is emulated, with the addition of the medium fidelity synchronization procedures. All JTIDS header fields in the signal message **shall** be filled with meaningful values. Medium fidelity synchronization **shall** be achieved in accordance with paragraph 5.1.4.2.

5.1.3 Communication between JUs with different fidelity levels

In the event that participants in a simulated JTIDS network cannot set their respective simulations to operate at a common TSA Level, the following procedures **shall** apply:

1. If a low fidelity network participant is in a simulated JTIDS network with a higher fidelity NTR, the network participant **shall** follow the low fidelity synchronization procedures in paragraph 5.1.4.1 by skipping the RTT synchronization process and changing directly to the fine synchronization state once it receives a J0.0 Initial Entry message from the NTR or any IEJU.

2. If a higher fidelity network participant is in a simulated JTIDS network with a lower fidelity NTR, the higher fidelity participant **shall** either follow the low fidelity synchronization procedures in paragraph 5.1.4.1 or achieve fine sync with other high fidelity simulators. This may be accomplished by exchanging RTT B messages or by passively synchronizing with other available high fidelity simulators. If no other high fidelity simulators are available to synchronize with, the high fidelity participant **shall** skip the RTT exchange, and directly enter fine synchronization once the J0.0 is received.
3. If the NTR is a lower fidelity simulation and unable to simulate full NTR duties, the NTR **shall** still have the ability to transmit net entry messages. The signal message **shall** be filled in with a J0.0 with zeroed time slot information. RTT emulation is not required of low fidelity NTRs.
4. A lower fidelity JU entering the net **shall** use the network synchronization ID received from the NTR/IEJU in its Transmitter messages. It **shall** then issue PPLIs at the assigned rate. This is nominally once every 12 seconds (equivalent to the A-0-6 time slot block), though this can occur at times of up to 24 seconds. All simulators, regardless of fidelity, **shall** accept another terminal's statement of synchronization capability if the network synchronization ID matches its own network synchronization ID.
5. In a lower fidelity synchronization simulation, non-reception of a PPLI message pair (two PPLI messages from the same JU) for 60 seconds **shall** indicate that the unit has fallen out of the datalink. Synchronization procedures **shall** be re-accomplished—reception of a PPLI message stating fine synchronization must occur before data from the JU will be accepted.

5.1.4 Time Synchronization

1. For TSA Level 0-2, the Network Synchronization ID **shall** be set to zero. For TSA Level 3-4, the Network Synchronization IDs **shall** be a 32 bit unsigned integer uniquely generated by the NTR. The NTR **shall** use a non-deterministic random number generator, a pseudo-random number generator, or other method using the timestamp of the time they begin to simulate a NTR as the random key seed. However, if using a seed based pseudo-random number generator, use the NTR selection time with precision equivalent to Network Time Protocol (NTP) as the seed. Seedless random number generators are encouraged; the goal is to make sure that all NTRs have unique synchronization IDs in the transmitter PDU.
2. If a system in the real world is capable of acting as NTR, any corresponding simulator **shall** also be capable, at a minimum, of acting as a low fidelity NTR.
3. If no simulators in a simulated JTIDS net are capable of acting as a NTR, participants **shall** be able to set the network synchronization ID to zero and transmit the synchronization state of fine synchronization. A zero in the network synchronization ID field **shall** be accepted as a wildcard matching any network synchronization ID.

4. If a network synchronization ID accompanying received data does not match a JU's own network synchronization ID, the data **shall** be considered as having not been received.

5. Simulated terminals **shall** accept net entry messages (J0.0) from any simulated transmitting terminal within reception range. When medium fidelity synchronization is applicable (TSA level 4), and the net entry message has a network synchronization ID different than the local network synchronization ID, the JU **shall** revert back to coarse synchronization, use the new network synchronization ID, cease sending Link 16 data and attempt re-synchronization with the new network in accordance with the JTIDS terminal specification. If the new network synchronization ID is the same as the locally held key (e.g. during changeover of NTR or multiple IEJUs), the JU **shall** not revert to coarse synchronization status and **shall** not stop transmitting Link 16 data.

6. If an initial net entry message is received from a unit that does not have a Transmitting Terminal Primary Mode of IEJU or NTR, it **shall** still be accepted. Depending upon implementation, the simulation operator may be notified so that the sending simulator can correct this error condition.

7. All simulators **shall** have at least a low fidelity simulation of a terminal clock, potentially independent of the simulator's (or live equipment's) clock. Since whatever time an NTR has set is considered correct, an NTR may transmit a time that significantly varies from the actual simulated wall clock. In high fidelity simulation systems the terminal clock may model the clock drift of an actual JTIDS terminal. It is not expected that terminal clocks will be modeled at a high level of fidelity and the actual level of emulation is left to the implementer.

5.1.4.1 Low Fidelity Synchronization

1. Low fidelity synchronization is applicable to simulation systems interested primarily in providing tactical datalink information as part of an operational scenario. The low fidelity synchronization procedure allows such systems to exchange Link 16 messages without being encumbered by the actual exchange of RTT messages and the associated network latency.

2. The NTR **shall** begin by issuing Net Entry message pairs at a rate in accordance with the JTIDS terminal specification (typically in time slot A-0-6 at a rate of every 12 seconds). For TSA Level 0-2, the network synchronization ID **shall** be set to zero. For TSA Level 3, a unique key **shall** be filled into the network synchronization ID field. The primary JTIDS duty field (Transmitting Terminal Primary Mode) **shall** contain a NTR enumeration.

3. Modulation Parameter 4 (Synchronization State) in the transmission message **shall** be set to fine synchronization after reception of the J0.0 Initial Net Entry message from the IEJU or NTR. The first data message sent by a JU entering the network **shall** be the JU's PPLI.

5.1.4.2 Medium Fidelity Synchronization

1. Medium Fidelity Synchronization corresponds to only the high fidelity TSA level 4. It is applicable to those systems for which simulation of the fine synchronization methodology is paramount, potentially for high fidelity training, network testing and network experimentation. Because the latency of WANs (latencies up to hundreds of milliseconds) is orders of magnitude higher than in a real Link 16 network (latencies up to 3ms), this methodology will not meet the needs of sub-millisecond accuracy. Communities with the need for sub-millisecond accuracy will need to use a centralized server on a real-time operating system to simulate the microsecond intricacies of the JTIDS network. The term “High Fidelity Synchronization” will be reserved for synchronization mechanisms that are able to model the sub-millisecond accuracy of the Link 16 network.

2. The accuracy of the synchronization mechanism **shall** have an error less than the simulated time of propagation. The accuracy of the synchronization mechanism **shall** be taken into account when modeling fine synchronization.

3. The Medium Fidelity Synchronization procedure is as follows:

   A. The NTR **shall** begin by issuing Net Entry message pairs at a rate in accordance with the JTIDS terminal specification (typically in time slot A-0-6 at a rate of every 12 seconds).

   B. A unique randomly generated key **shall** be filled into the network synchronization ID field. The primary JTIDS duty field **shall** contain a NTR enumeration. At this point, the JU is considered to have achieved coarse synchronization.

   C. The JU **shall** then transmit the appropriate RTT message (A or B). The synchronization state **shall** be set to coarse synchronization. The JU **shall** use its own terminal perceived time in the perceived transmit time field.

   D. The appropriate NTR/JU **shall** answer (in accordance with the JTIDS terminal specification), using the JU perceived time and the entity distance to calculate the perceived receive time. The RTT is then transmitted.

   E. The transmitting JU **shall** fill its own terminal perceived time with the received transmit time field. The formula for filling in the receive time in the RTT reply is:

4. $RTT_{reply} = RT_{terminal} - t_{delay} + t_{propagate}$

   The t_{delay} is computed by: $t_{delay} = RT_{time} - TT_{time}$

   Where

   RT_{time} is the actual time held by the receiving/replying participant (Derived from NTP, GPS, etc)

   $RT_{terminal}$ is the value of the simulated Link 16 terminal clock at the receiving/replying participant.

   TT_{time} is the actual time held of transmitting participant (Derived from NTP, GPS, etc).

t_{delay} is the difference between the receiver's real-time clock at the time of receipt and the sender's real-time clock at the time of transmission (i.e. it approximates the emulation network latency), and

$t_{propagate}$ is the propagation time of the radio frequency message in the simulated environment.

This formula computes the perceived time of receipt by the receiving simulator with respect to the simulated terminal clock of the sender.

A. The originating JU **shall** then update its own terminal time in accordance with the simulator model and the Link 16 fine synchronization procedures.

B. After the appropriate number of RTT exchanges have occurred (depending whether the RTT A or RTT B method of synchronization was used and the internal terminal simulation model), the JU **shall** consider itself to be in fine synchronization and **shall** continually issue RTT message pairs to maintain synchronization at rates specified within the JTIDS terminal specification. Once the terminal emulator model has met the requirements for fine synchronization, normal message transmissions **shall** occur in accordance with Reference 7 and Reference. 10.

5.2 LINK 16 IMPLEMENTATION UNDER DIS

This section contains the requirements for simulation of Link 16 using the DIS Signal and Transmitter PDU. For the DIS Protocol Profiles, transmission and receipt of PDUs, and general service requirements, refer to Reference 1. *In implementing the Signal PDU, perceived data should be able to be sent on a configurable port separate from all other DIS data. This allows datalinks to be selectively routed without additional hardware. This also allows for gateways to forward data between legacy DIS datalink formats and the new standardized format.*

5.2.1 Transmitter PDU Description

Table 5.2.1 shows the format for the Transmitter PDU for JTIDS simulation.

Transmitter PDUs used in Link 16 simulation **shall** comply with requirements established in Reference 1 and Reference 4. Transmitter PDUs associated with Link 16 **shall** conform to the following requirements:

1. Entity ID. IAW clause 4.5.7.1 d) of Reference 1, this field **shall** correspond to an entity active in the exercise. An entity is considered active if the time since last receipt of the entity's Entity State PDU has not exceeded HRT_BEAT_TIMER multiplied by HRT_BEAT_MPLIER.
2. Radio ID. This field **shall** contain the ID of the radio transmitting the signal. Radio ID numbering starts at one.
3. The Radio Entity Type Category field **shall** be set to 21 for Link 16 terminal.
4. The Input Source field **shall** be set to 8 for Digital Data Device.
5. Frequency. This field **shall** specify the JTIDS center frequency of 1131000000 for communications mode 1. For communications mode 2 or 4, a frequency of 969000000 **shall** be used.
6. Transmit Frequency Bandwidth. This field **shall** contain the bandwidth of the JTIDS signal, simulating the use of the entire frequency band as an average over time. The field **shall** be represented by a 32-bit float value of 240000000, unless operating in communications mode 2 or 4, and then a value of 3000000 **shall** be used.
7. Modulation Type. The Modulation Type fields contain enumerations for the major and detail modulation fields:
    A. The Spread Spectrum field is a 16-bit Boolean array, and **shall** be set to 1 for frequency hopping only for JTIDS communications mode 1. For modes 2 or 4, the Spread Spectrum field shall be set to 0.
    B. The Major modulation field is a 16-bit enumeration, and **shall** be set to 7 for Carrier Phase Shift Modulation.
    C. The Detail modulation field is a 16-bit enumeration, and **shall** contain a 0.
    D. The System field is a 16-bit enumeration, and **shall** be set to 8 for JTIDS/MIDS.
8. Crypto System. For Link 16 simulation under this standard this field **shall** be set to 0.

9. Crypto Key ID. For Link 16 simulation under this standard this field **shall** be set to zero.

10. Length of Modulation Parameters. These fields **shall** specify the length in octets of the modulation parameters that follow this field. This length **shall** be set to 8, representing 8 octets for the DIS Transmitter PDU.

11. Modulation Parameters. These fields **shall** specify the modulation type specific characteristics of the Link 16 portion of the Transmitter PDU, and are highlighted in yellow.

    A. Modulation Parameter 1 **shall** contain the TSA level with an enumeration of 0-4 for TSA level 0-4 as described in section 5.1.2.

    B. Modulation Parameter 2 **shall** contain the transmitting terminal's primary mode. Setting the enumeration to 1 **shall** indicate that the entity is the NTR. Setting it to 2 **shall** indicate that the entity is a JU participant.

    C. Modulation Parameter 3 **shall** contain the transmitting terminal's secondary mode, with the following enumerations: 0=None, 1=Net Position Reference, 2=Primary Navigation Controller, 3=Secondary Navigation Controller.

    D. Modulation Parameter 4 **shall** contain the synchronization state. For TSA level 0-3 this **shall** be set to 3 for fine synchronization. For TSA level 4, it **shall** be initially set to 2 for coarse synchronization, and the procedures in section 5.1.4.2 for medium-level synchronization **shall** be followed.

    E. Modulation Parameter 5 **shall** contain the Network Synchronization ID. For TSA levels 0-2, it **shall** be set to zero. For TSA levels 3-4, it **shall** be a 32-bit random integer. Only an NTR can generate a Network Synchronization ID; all other participants **shall** use the ID obtained from the NTR to which they are synchronized.

Table 5.2.1: Transmitter PDU for TADIL J

Field Size (bits)	Transmitter PDU Fields			Description*
96	PDU Header	Protocol Version	8 bit enumeration	
		Exercise ID	8 bit unsigned integer	
		PDU Type	8 bit enumeration	
		Protocol Family	8 bit enumeration	
		Timestamp	32 bit unsigned integer	
		Length	16 bit unsigned integer	
		Padding	16 bits unused	
48	Entity ID	Site	16 bit unsigned integer	
		Application	16 bit unsigned integer	
		Entity	16 bit unsigned integer	
16	Radio ID		16 bit unsigned integer	**Shall** contain the ID of the radio transmitting the signal.
64	Radio Entity Type	Entity Kind	8 bit enumeration	
		Domain	8 bit enumeration	
		Country	16 bit enumeration	
		Category	8 bit enumeration	21 - Link 16 terminal IAW Ref. 4 para 4.2.3.7
		Nomenclature Version	8 bit enumeration	
		Nomenclature	16 bit enumeration	
8	Transmit State		8 bit enumeration	
8	Input Source		8 bit enumeration	8 - Digital Data Device
16	Padding		16 bits unused	
192	Antenna Location	X component	64 bit floating point	
		Y component	64 bit floating point	
		Z component	64 bit floating point	
96	Relative Antenna Location	x component	32 bit floating point	
		y component	32 bit floating point	
		z component	32 bit floating point	
16	Antenna Pattern Type		16 bit enumeration	
16	Antenna Pattern Length		16 bit unsigned integer	
64	Frequency		64 bit unsigned integer	Mode 1 = 1131000000 (center frequency). For Mode 2 or 4, set to 969000000
32	Transmit Frequency Bandwidth		32 bit floating point	240000000 unless in Communications mode 2 or 4, then 3000000
32	Power		32 bit floating point	Power in dBm

Field Size (bits)	Transmitter PDU Fields			Description*
64	Modulation Type	Spread Spectrum	16 bit Boolean array	Bit 1 set to 1: Frequency Hopping for JTIDS communications mode 1. All bits set to 0: For JTIDS communications modes 2 or 4
		Major	16 bit enumeration	7 - Carrier Phase Shift Modulation (CPSM)
		Detail	16 bit enumeration	0 - Other
		System	16 bit enumeration	8 - JTIDS/MIDS
16	Crypto System		16 bit enumeration	0 - Other
16	Crypto Key ID		16 bit unsigned integer	0 - Other
8	Length of Modulation Parameters		8 bit unsigned integer	8= 8 octets
24	Padding		24 bits unused	
8	Modulation Parameter #1	Time Slot Allocation Mode	8 bit enumeration	Integer enumeration 0-4
8	Modulation Parameter #2	Transmitting Terminal Primary Mode	8 bit enumeration	Integer Enumeration: 1 - NTR 2 - JTIDS Unit Participant
8	Modulation Parameter #3	Transmitting Terminal Secondary Mode	8 bit enumeration	Integer Enumeration: 0 - None 1 - Net Position Reference 2 - Primary Navigation Controller 3 - Secondary Navigation Controller
8	Modulation Parameter #4	Synchronization State	8 bit enumeration	Integer Enumeration: 2 - Coarse Synchronization 3 - Fine Synchronization
32	Modulation Parameter #5	Network Synchronization ID	32 bit unsigned integer	TSA Level 0-2, set to 0 TSA Level 3,4, set to 32 bit random number

*If blank, IAW Ref. 1 and Ref. 4

5.2.2 Signal PDU Description

Table 5.2.4 shows the format for the Signal PDU. The Signal PDU includes all standard fields as described in Reference 1. An example of the J2.2 Link 16 message in Hex and binary formats are shown in Annex B.

When used for Link 16 simulation the following specific information **shall** be required:

1. Entity ID. IAW clause 4.5.7.1 d) of Reference 1, this field **shall** correspond to an entity active in the exercise. An entity is considered active if the time since last receipt of the entity's Entity State PDU has not exceeded HRT_BEAT_TIMER multiplied by HRT_BEAT_MPLIER.
2. Radio ID. This field **shall** contain the ID of the radio transmitting the signal. Radio ID numbering starts at one.
3. Encoding scheme. Bits 0-13 **shall** contain the number of J-words not including the JTIDS header. Bits 14-15 **shall** contain the value 1 to indicate an encoding class raw binary data.
4. TDL Type. This field **shall** specify the TDL type as a 16-bit enumeration field, and **shall** be set to 100 for Link 16 JTIDS/MIDS/Link 16.
5. Sample Rate. The sample rate **shall** be set to 0.
6. Data Length. This field **shall** contain the length of data in bits beginning after the samples field.
7. Samples. This field **shall** be set to 0.
8. Link 16 Signal PDU Fields. The Link 16 Network header portion of the Signal PDU Data Fields are highlighted in yellow, and **shall** be set as follows:
   A. Network Participation Group (NPG) Number. This field is a 16-bit unsigned integer (0-511) used to segregate information within a JTIDS/MIDS network. It creates virtual networks of participants.
   B. Net Number. This field is an 8-bit unsigned integer, and is used to create virtual sub-circuits within NPG for stacked nets or between NPGs for multi-net.
   C. TSEC CVLL. This field is an 8-bit unsigned integer, and is used for transmission security, and allows for simulated crypto netting. For TSA level 0-2 this record is not required and the field **shall** be set to 255 indicating a no statement/wildcard.
   D. MSEC CVLL. This field is an 8-bit unsigned integer, and is used for message security, is used in conjunction with the TSEC CVLL, and allows for simulated crypto netting. For TSA level 0-2 this record is not required, and the field **shall** be set to 255 indicating a no statement/wildcard.
   E. Message Type Identifier. This field specifies the format for the type of Link 16 message in the PDU. This field **shall** be set with an enumeration in accordance with Table 5.2.2. The Message types are described in detail in Tables 5.2.5-5.2.12.

Table 5.2.2: Message Type Identifiers

Message Type	Enumeration
JTIDS Header/Messages	0
RTT A/B	1
RTT Reply	2
JTIDS Voice CVSD	3
JTIDS Voice LPC10	4
JTIDS Voice LPC12	5
JTIDS LET	6
VMF	7

F. Time Slot ID. For TSA level 0-1, this field is set to zero. This field is a 32-bit unsigned integer, and **shall** contain time slot information for time slot and epoch number in accordance with Reference. 7. Time Slot number is bits 0 – 16. Time Slot 0 represents time slot A-1, time slot 98303 represents C-32767. When the epoch is 112, the last valid time slot is 45151. Bits 17 – 23 are padding and set to 0. Bits 24 – 31 are the epoch number. An epoch is 12.8 minutes long, and there are 112.5 epochs in a 24-hour day.

G. Perceived Transmit Time. The Perceived Transmit Time (in NTP timestamp format) indicates the time, in seconds relative to 0hours on 1 January 1900 UTC. It has two components. A 32-bit unsigned integer representing the integer (whole seconds) portion of the timestamp and 32-bit unsigned integer representing the fraction (fractions of a second) portion of the time stamp. The precision of this representation is about 200 picoseconds, which should be adequate for even the most exotic requirements. See Reference 13 for detailed format. 4294967295 (all F's in hexadecimal) in each field **shall** indicate a no statement/wildcard.

9. Link 16 message bit orientation **shall** be accomplished in accordance with Table 5.2.3, which shows a Link 16 Header/Message (Message Type 0, Table 5.2.5). The table example does not map to other Link 16 messages illustrated in Tables 5.2.6 through 5.2.12.

The Link-16 message data **shall** be inserted after the Link 16 Signal PDU fields as arrays of 32-bit unsigned integers. The user **shall** ensure that the Link 16 message data is in compliance with big-endian (Reference 1) format, and byte-swap as 32-bit unsigned integers if necessary. An example of a J2.2 message is shown in Appendix B.

Table 5.2.3: Link 16 Message Bit Orientation

31 … 19	18 … 4	3	2 … 0
Secure Data Unit Serial Number (SDUSN) Start	Source Track Number of Sender (5 octal value of 3 bits each)	RTI	Time Slot Type

31 … 29	28 … 26	25 … 23	22 … 18	17 16	15 … 3	2 … 0
	Msg Length Indicator	J Msg Sub-label	J Message Label	J Word Format	Padding	SDUSN End

31 … 0
First J-Word Continued (bits 47--16)

31 … 27	26 … 0
Padding	First J-Word Continued (bits 74--48)

31 … 2	1 0
Second J-Word (bits 31--2)	J Word Format

31 … 0
Second J-Word Continued(bits 63--32)

31 … 18	17 16	15 … 11	10 … 0
Third J-Word (bits 15--2)	J Word Format	Padding	Second J-Word Continued (bits 74--64)

31 … 0
Third J-Word Continued (bits 47--16)

31 … 27	26 … 0
Padding	Third J-Word Continued (bits 74--48)

Table 5.2.4: SIGNAL PDU for Link 16

Field Size (bits)	Signal PDU Fields			Valid Range	Description
96	PDU Header	Protocol Version	8 bit enumeration		
		Exercise ID	8 bit unsigned integer		
		PDU Type	8 bit enumeration		
		Protocol Family	8 bit enumeration		
		Timestamp	32 bit unsigned integer		
		Length	16 bit unsigned integer		
		Padding	16 bits unused		
48	Entity ID	Site	16 bit unsigned integer		
		Application	16 bit unsigned integer		
		Entity	16 bit unsigned integer		
16	Radio ID		16 bit unsigned integer		**Shall** contain the ID of the radio transmitting the signal.
16	Encoding Scheme		16 bit enumeration		Bits 0-13 **shall** contain the number of J-words not including the JTIDS header. Bits 14-15 **shall** contain the value 1 to indicate an encoding class raw binary data
16	TDL Type		16 bit enumeration		This field **shall** be set to 100 for SISO-STD-002 Link 16
32	Sample Rate		32 bit integer		This field **shall** be set to 0
16	Data Length		16 bit integer		This field **shall** contain the length of data in bits beginning after the samples field.
16	Samples		16 bit integer		This field **shall** be set to 0
		NPG Number	16 bit unsigned integer	0-511	Network Participation Group (NPG) Number. Used to segregate information within a JTIDS/MIDS network. Creates virtual networks of participants.

Field Size (bits)	Signal PDU Fields				Valid Range	Description
160	**Link 16 Signal PDU Fields**	Net Number		8 bit unsigned integer	0-127	Network Number. Used to create virtual sub-circuits within NPG for stacked nets or between NPGs for multi-net.
		TSEC CVLL		8 bit unsigned integer	0-127, 255	Transmission Security, an integer identification of the crypto variable used for JTIDS transmission encryption. This variable allows for simulated crypto netting. 255 in this field **shall** indicate a no statement/wildcard.
		MSEC CVLL		8 bit unsigned integer	0-127, 255	Message Security, an integer identification of the crypto variable used to encode the JTIDS message. This variable allows for simulated crypto netting. 255 in this field **shall** indicate a no statement/wildcard.
		Message Type Identifier		8 bit enumeration		Determines whether normal JTIDS header and message, RTT A/B, RTT Reply, JTIDS Voice, LET JTIDS, or VMF follows. See table 5.2.2 for message type identifier enumerations
		Padding		16 bits	0	Set to 0
		Time Slot ID	Time Slot Number	Bits 0-16	0-98303	Time Slot number; Time Slot 0 represents time slot A-1, time slot 98303 represents C-32767. When the epoch is 112, the last valid time slot is 45151 (end of the day)
			Padding	Bits 17-23	0	Set to 0
			Epoch Number	Bits 24-31	0-112	An epoch is 12.8 minutes long, 112.5 Epochs in a 24 hour day. Part of time slot identification
		Perceived Transmit Time	Integer Part	32 bit unsigned integer	0-4294967295, 4294967295	NTP timestamp format-- NTP timestamps are represented as a 64-bit unsigned fixed-point number, in seconds relative to 0h on 1 January 1900 UTC. The integer part is in the first 32 bits and the fraction part in the last 32 bits. The precision of this representation is about 200 picoseconds, which should be adequate for even the most exotic requirements. See Reference 13 for detailed format. . All Fs (4294967295) in both fields **shall** indicate a no statement/wildcard.
			Fraction Part	32 bit unsigned integer	0-4294967295, 4294967295	
Message Data				Array of 32 bit unsigned integers		The message data, corresponding to the appropriate message type and described in tables 5.2.5 through 5.2.12 below

The following tables describe in detail the Signal PDU data fields for each message format indicated in the Message Type Identifier field.

Table 5.2.5: Message Type = 0, JTIDS Header/Message

Field Size (bits)	Link 16 Message Fields		Bits	Description
48	**Link 16 Message Header Word Format**	Time Slot Type	Bits 0-2	Table 3.3-7 of Reference 7
		Relay Transmission Indicator	Bit 3	Table 3.3-6 of Reference 7
		Source Track Number of Sender	Bits 4-18	Table 3.3-6 of Reference 7
		Secure Data Unit Serial Number	Bits 19-34	Table 3.3-6 of Reference 7
		Padding	Bits 35-47	
80	Link 16 Word #1	Link 16 Word	75 Bits	Reference 7
		Padding	5 Bits	
80	Link 16 Word #N (to maximum number of messages)	Link 16 Word	75 Bits	Reference 7
		Padding	5 Bits	
Signal PDU C2 Padding to doubleword boundary IAW Ref. 1				Padding (if needed) to increase total PDU size to a multiple of 32 bits.

Table 5.2.6: Message Type = 1, RTT A/B

Field Size (bits)	Link 16 Message Fields		Bits	Description
48	RTT A/B	RTT A/B	Bits 0-34	Table 3.3-8 of Reference 7
	(Used in place of JTIDS header during RTT transmission)	Padding	Bits 35-47	
16	Signal PDU C2 Padding to doubleword boundary IAW Ref. 1			16bits to increase total PDU size to a multiple of 32 bits.

Table 5.2.7: Message Type = 2, RTT Reply

Field Size (bits)	Link 16 Message Fields		Bits	Description
48	RTT Reply	RTT Reply	Bits 0-34	Table 3.3-8 of Reference 7
	(Used in place of JTIDS header during RTT transmission)	Padding	Bits 35-47	
16	Signal PDU C2 Padding to doubleword boundary IAW Ref. 1			16bits to increase total PDU size to a multiple of 32 bits.

Table 5.2.8: Message Type = 3, JTIDS Voice CVSD

Field Size (bits)	Link 16 Message Fields		Bits	Description
48	**Link 16 Message Header Word Format**	Time Slot Type	Bits 0-2	Table 3.3-7 of Reference 7
		Relay Transmission Indicator	Bit 3	Table 3.3-6 of Reference 7
		Source Track Number of Sender	Bits 4-18	Table 3.3-6 of Reference 7
		Secure Data Unit Serial Number	Bits 19-34	Table 3.3-6 of Reference 7
		Padding	Bits 35-47	
225-1860	JTIDS Free Text Voice Data	CVSD Encoded Voice Data	225-1860 Bits	Reference 7. Size of data area is dependent upon time slot type.
Signal PDU C2 Padding to doubleword boundary IAW Ref. 1				Padding (if needed) to increase total PDU size to a multiple of 32 bits.

Table 5.2.9: Message Type = 4, JTIDS Voice LPC10

Field Size (bits)	Link 16 Message Fields		Bits	Description
48	**Link 16 Message Header Word Format**	Time Slot Type	Bits 0-2	Table 3.3-7 of Reference 7
		Relay Transmission Indicator	Bit 3	Table 3.3-6 of Reference 7
		Source Track Number of Sender	Bits 4-18	Table 3.3-6 of Reference 7
		Secure Data Unit Serial Number	Bits 19-34	Table 3.3-6 of Reference 7
		Padding	Bits 35-47	
225-1860	JTIDS Free Text Voice Data	LPC10 Encoded Voice Data	225-1860 Bits	Reference 7, Size of data area is dependent upon time slot type.
Signal PDU C2 Padding to doubleword boundary IAW Ref. 1				Padding (if needed) to increase total PDU size to a multiple of 32 bits.

Table 5.2.10: Message Type = 5, JTIDS Voice LPC12

Field Size (bits)	Link 16 Message Fields		Bits	Description
48	**Link 16 Message Header Word Format**	Time Slot Type	Bits 0-2	Table 3.3-7 of Reference 7
		Relay Transmission Indicator	Bit 3	Table 3.3-6 of Reference 7
		Source Track Number of Sender	Bits 4-18	Table 3.3-6 of Reference 7
		Secure Data Unit Serial Number	Bits 19-34	Table 3.3-6 of Reference 7
		Padding	Bits 35-47	
225-1860	JTIDS Free Text Voice Data	LPC12 Encoded Voice Data	225-1860 Bits	Reference 7, Size of data area is dependent upon time slot type.
Signal PDU C2 Padding to doubleword boundary IAW Ref. 1				Padding (if needed) to increase total PDU size to a multiple of 32 bits.

Table 5.2.11: Message Type = 6, JTIDS LET Header/Message

Field Size (bits)	Link 16 Message Fields		Bits	Description
48	Message Header	LET ID Symbol	Bits 0-3	Reference 11
		Relay Transmission Indicator	Bit 4	Reference 11
		LET Message Packing Type	Bits 5-8	Reference 11
		Source Track Number of Sender	Bits 9-23	Reference 11
		Secure Data Unit Serial Number	Bits 24-39	Reference 11
		Padding	Bits 40-47	
80	Link 16 Word #1	Link 16 Word	75 Bits	Reference 7
		Padding	5 Bits	
80	Link 16 Word #N (to maximum number of messages)	Link 16 Word	75 Bits	Reference 7
		Padding	5 Bits	
Signal PDU C2 Padding to doubleword boundary IAW Reference 1				16bits (if needed) to increase total PDU size to a multiple of 32 bits.

Table 5.2.12: Message type = 7, VMF Header/Messages

Field Size (bits)	Link 16 Message Fields		Bits	Description
48	Link 16 Message Header Word Format	Time Slot Type	Bits 0-2	Table 3.3-7 of Reference 7
		Relay Transmission Indicator	Bit 3	Table 3.3-6 of Reference 7
		Source Track Number of Sender	Bits 4-18	Table 3.3-6 of Reference 7
		Secure Data Unit Serial Number	Bits 19-34	Table 3.3-6 of Reference 7
		Padding	Bits 35-47	

Field Size (bits)	Link 16 Message Fields		Bits	Description
	Link 16 Word #1	Link 16 Word	75 Bits	Reference 7
		Padding	5 Bits	
	Link 16 Word #N (to number messages)	Link 16 Word	75 Bits	Reference 7
		Padding	5 bits	
Signal PDU C2 Padding to doubleword boundary IAW Reference 1				16bits (if needed) to increase total PDU size to a multiple of 32 bits.

5.3 LINK 16 IMPLEMENTATION UNDER HLA

Link 16 TDL simulations are almost always part of a wider simulation - such simulations are used for many purposes including system development, test & evaluation and training. It is therefore almost certain that the HLA implementation of the Link 16 protocol will form part of a larger Federation Object Model (FOM). The HLA implementation of Link 16 is therefore defined as a Base Object Model (BOM), as described in BOM Study Group Final Report: (SISO-REF-005-2001). A BOM is defined as "a single aspect of simulation interplay that can be used as a building block" within a FOM.

The Link 16 BOM is described in the Object Model Template (OMT). In the HLA standard (Reference 2) the OMT is formatted in extensible Markup Language (XML). However, at the time of writing, many federations still use the older HLA 1.3 (Reference 3) pre-XML OMT format. In order to facilitate implementation, two versions of the BOM have been created. The file Link16-BOM.omd contains the HLA 1.3 OMT tables. These tables are reproduced in Annex A of this standard. A second file, link16bom.xml, complies with the OMT XML format found in Reference 2. Both files, as well as the complete OMT tables may be found at the SISO web site (http://www.sisostds.org).

5.3.1 The Link 16 BOM

The Link 16 BOM is intended to describe how to implement a simulation of the Link 16 Tactical Data Link (TDL) and its associated message set, Link 16, within a High Level Architecture (HLA) simulation. The Link 16 BOM is designed for integration within the Federation Object Model (FOM) of the HLA federation.

5.3.1.1 Assumptions

The Link 16 BOM assumes that:

1. The parent FOM contains all current DIS Transmitter PDU PDU records (not those associated with the PDU header) in accordance with Ref 1as part of its object class hierarchy.
2. The parent FOM contains all current DIS Signal PDU PDU records (not those associated with the PDU header) in accordance with Ref 1as part of its interaction class hierarchy.

5.3.1.2 Naming Convention

Conventions within the Link 16 BOM in OMT 1.3 format follow those adopted by the RPR FOM version 1.0 (reference 5) and version 2.0 (reference 6). These conventions are intended to address some of the OMT 1.3 format shortcomings, which have been addressed in the IEEE 1516.2 specification. These include:

1. All names have the initial letter of each word capitalized.
2. All enumeration names end in the text "Enum" followed by a number. The number indicates the number of bits in the enumerated value.

3. All complex data type names end in the text "Struct".

5.3.2 Levels of Fidelity

The HLA levels of fidelity are directly equivalent to the corresponding DIS levels of fidelity as defined in section 5.1.2.

5.3.3 Time Synchronization

The HLA time synchronization mechanism is directly equivalent to the corresponding mechanism for DIS as defined in section 5.1.

5.3.4 Protocol Implementation Details

This section defines how Link 16 BOM compliant federates **shall** implement the Link 16 protocol. The HLA protocol implementation details are directly equivalent to the corresponding details for DIS as defined in section 5.2.

5.3.4.1 Object Class Data

The Link 16 BOM defines no new object classes. Instead the BOM defines a single complex data type (`JTIDSTransmitterStruct`) that corresponds to the modulation parameters in the DIS Transmitter PDU defined in section 5.2.1. An attribute of this complex data type should be added to the object class in the parent FOM corresponding to the DIS Transmitter PDU (see assumption 1 in section 5.3.1).

Modulation parameters of the Transmitter PDU shown in section 5.2, table 5.2.1, map to the fields of the `JTIDSTransmitterStruct` complex data type attribute, shown in Annex A.5.

Parent object class fields are also modified such that they refer to the corresponding Transmitter PDU fields (see Assumption 1 in section 5.3.1).

NOTE: For a RPR FOM implementation, an attribute of the `JTIDSTransmitterStruct` complex data type should be added to the `RadioTransmitter` object class.

5.3.4.2 Interaction Class Data

The Link 16 BOM adds a family of interactions that will support future TDL implementation of other datalinks. The family of interactions is a hierarchy in which the BOM's base class for this interaction is a generic class - the `TDLBinaryRadioSignal` interaction. This class is an empty class, contains no parameters, and is neither publishable nor subscribable. The specific parameters are properties of the various subclasses of this generic base class, and it is these subclasses that are published and subscribed to.

The `Link16RadioSignal` interaction, shown in Annex A.3, which is a subclass of the `TDLBinaryRadioSignal` interaction, contains the JTIDS Network Header Parameters as shown in table 5.2.4. The `JTIDSMessageRadioSignal` interaction contains the Link 16 message data. Additional interactions shown in Annex A.3 define the other types of Link 16 messages.

The Link 16 BOM design is such that the TDLBinaryRadioSignal interaction becomes a subclass of the parent FOM's equivalent of the DIS Signal PDU (see Assumption 2 in section 5.3.1).

5.3.5 BOM Implementation

The BOM implementation, in OMT 1.3 format, is described in annex A.

5.3.6 Adding the Link 16 BOM to the RPR FOM

Adding the Link 16 BOM to the RPR FOM consists of three steps: adding the Link 16 Radio Signal interaction, adding the JTIDSTransmitterData structure, and adding the contents of table A.5, A.6, A.7, and A.8 in Annex A. Adding the interaction is the same for both RPR FOM version 1.0 (Reference 5) and version 2.0 (Reference 6). The manner of adding the JTIDSTransmitterData structure differs between the two RPR FOM versions and is described in sections 5.3.6.1 and 5.3.6.2 .

The TDLBinaryRadioSignal class **shall** be added as a subclass of the RawBinaryRadioSignal interaction class; this is done in order to allow access to the HostRadioIndex parameter in the RawBinaryRadioSignal interaction class. The HostRadioIndex parameter ties the Link 16 message to a specific Host and Radio Transmitter.

The Link16RadioSignal interaction class is added as a subclass of a new interaction class, the TDLBinaryRadioSignal interaction, which itself is a subclass of the RPR FOM's RawBinaryRadioSignal interaction class as shown in Table 5.3.1 below.

Table 5.3.1: Link 16 BOM Interactions in the RPR-FOM

Interaction1	Interaction2	Interaction3	Interaction4	Interaction5
RadioSignal	ApplicationSpecifcRadioSignal			
	DatabaseIndexRadioSignal			
	EncodedAudioRadioSignal			
	RawBinaryRadioSignal	TDLBinaryRadioSignal	Link16RadioSignal	JTIDSMessageRadioSignal
				RTTABRadioSignal
				RTTReplyRadioSignal
				JTIDSVoiceCVSDRadioSignal
				JTIDSVoiceLPC10RadioSignal
				JTIDSVoiceLPC12RadioSignal
				JTIDSLETRadioSignal
				VMFRadioSignal

NOTES:

1. The addition of the TDLBinaryRadioSignal interaction class and its associated subclasses was necessary because of the RPR FOM implementation limitations of the DIS Signal PDU. Section 5.2.2 defines the DIS Signal PDU used for all Link 16 messages in a Raw Binary Signal PDU. The RPR FOM equivalent of this PDU type (the RawBinaryRadioSignal interaction class) contains a parameter, called SignalData, containing one or more octets containing the signal data. If the

SignalData octet based storage scheme to store Link 16 messages was used, then the Link 16 message would be lost during byte swapping. The implementation is defined such that the Link 16 interaction becomes a subclass of the RawBinaryRadioSignal interaction to ensure the SignalData storage is not used. Data integrity is achieved by moving the Link 16 message storage into the lowest level classes (i.e the JTIDSMessageRadioSignal).

2. DIS to HLA gateways will require modification, but the modifications are described in detail in SISO Reference Product SISO-REF-XXX-2006. DIS Raw Binary Signal PDUs need to be split into a RawBinaryRadioSignal interaction or the appropriate Link 16 interaction class, depending on the TDL type. Conversely, a HLA to DIS gateway must merge both interaction types into a single DIS Signal PDU. DIS to HLA translations are

5.3.6.1 Adding the Link 16 BOM to the RPR FOM version 1

For RPR FOM version 1 (reference 5) the JTIDSTransmitterData **shall** be added to the ModulationStruct complex data type as shown in Table 5.3.2.

Table 5.3.2: Link 16 BOM Complex Datatypes in RPR-FOM 1.0

Complex Datatype	Field Name	Datatype	Cardinality
ModulationStruct	SINCGARModulation[52]	SINCGARSModulationStruct	0-1
	JTIDSTransmitterData[56]	JTIDSTransmitterStruct	0-1

The RFModulationSystemTypeEnum16 enumerated value **shall** be extended to add JTIDS_MIDS with a representation of 8, as shown in Table 5.3.3.

Table 5.3.3: Link 16 BOM Enumerated Values in RPR-FOM 1.0

Identifier	Enumerator	Representation
RFModulationSystemTypeEnum16	Other	0
	Generic	1
	HQ	2
	HQII	3
	HQIIA	4
	SINCGARS	5
	CCTT_SINCGARS	6
	JTIDS_MIDS	8

Note 56 **shall** be added to the Notes Table as shown in Table 5.3.4.

Table 5.3.4: Link 16 BOM Notes in RPR-FOM 1.0

ID	Text
56	This optional field **shall** be included (cardinality 1) when the RFModulationSystemType is equal to JTIDS_MIDS. It **shall** be excluded (cardinality 0) when the RFModulationSystemType is equal to any other value.

5.3.6.2 Adding the Link 16 BOM to the RPR FOM version 2

For RPR FOM version 2 (reference 6) the `JTIDSTransmitterData` **shall** be added to the `SpreadSpectrumStruct` complex data type as shown in Table 5.3.5.

Table 5.3.5: Link 16 BOM Complex Datatypes in RPR-FOM 2.0

Complex Datatype	Field Name	Datatype	Cardinality
SpreadSpectrumStruct	SpreadSpectrumType	SpreadSpectrumEnum16	1
	Padding	Octet	2
	SINCGARModulation[52]	SINCGARSModulationStruct	0-1 (SpreadSpectrumType = SINCGARSFrequencyHop)
	JTIDSTransmitterData[56]	JTIDSTransmitterStruct	0-1 (SpreadSpectrumType = JTIDS_MIDS_SpectrumType)

The `RFModulationSystemTypeEnum16` enumerated value **shall** be extended to add JTIDS_MIDS with a representation of 8, and the `SpreadSpectrumEnum16` enumerated value **shall** be extended to add `JTIDS_MIDS_SpectrumType` with a representation of 2 as shown in Table 5.3.6.

Table 5.3.6: Link 16 BOM Enumerated Values in RPR-FOM 2.0

Identifier	Enumerator	Representation
RFModulationSystemTypeEnum16	Other	0
	Generic	1
	HQ	2
	HQII	3
	HQIIA	4
	SINCGARS	5
	CCTT_SINCGARS	6
	JTIDS_MIDS	8
SpreadSpectrumEnum16	None	0
	SINCGARSFrequencyHop	1
	JTIDS_MIDS_SpectrumType	2

ANNEX A: LINK 16 BASE OBJECT MODEL (BOM) OMT 1.3 TABLES

A.1 OBJECT MODEL IDENTIFICATION TABLE

Category	Information		
Name	Link 16 BOM		
Version	v1.0		
Date	11/08/2005		
Purpose	Link 16 Base Object Model (BOM)		
Application Domain	C4ISR & C2 platform simulations		
Sponsor	SISO		
POC (Title, First, Last)	Mr	Graham C	Shanks
POC Organization	BAE Systems Integrated System Technologies		
POC Telephone	+44 1383 828062		
POC Email	graham.shanks@baesystems.com		

A.2 OBJECT CLASS TABLE

There are no Link 16 unique object classes in the Link 16 BOM

A.3 OBJECT INTERACTION TABLE

Interaction1	Interaction2	Interaction3	Interaction4
Parent (N)	TDLBinaryRadioSignal (N)	Link16RadioSignal (R)	JTIDSMessageRadioSignal (IR)
			RTTABRadioSignal (IR)
			RTTReplyRadioSignal (IR)
			JTIDSVoiceCVSDRadioSignal (IR)
			JTIDSVoiceLPC10RadioSignal (IR)
			JTIDSVoiceLPC12RadioSignal (IR)
			JTIDSLETradioSignal (IR)
			VMFRadioSignal (IR)

A.4 ATTRIBUTE TABLE

Object	Attribute	Datatype	Cardinality	Units	Resolution	Accuracy	Accuracy Condition
Parent	JTIDSTransmitterData	JTIDSTransmitterStruct	1	N/A	N/A	N/A	N/A

A.5 PARAMETER TABLE

Interaction	Parameter	Datatype	Cardinality	Units	Resolution	Accuracy	Accuracy Condition	Routing Space
JTIDSLETradioSignal	LETHeader	LETHeaderStruct	1	N/A	N/A	N/A	N/A	N/A
	TADILJMessage	TADILJWordStruct	1+	N/A	N/A	N/A	N/A	
JTIDSMessageRadioSignal	JTIDSHeader	JTIDSHeaderStruct	1	N/A	N/A	N/A	N/A	N/A
	TADILJMessage	TADILJWordStruct	1+	N/A	N/A	N/A	N/A	
JTIDSVoiceCVSDRadioSignal	JTIDSHeader	JTIDSHeaderStruct	1	N/A	N/A	N/A	N/A	N/A
	Data	octet	29+	N/A	N/A	perfect	always	
JTIDSVoiceLPC10RadioSignal	JTIDSHeader	JTIDSHeaderStruct	1	N/A	N/A	N/A	N/A	N/A
	Data	octet	29+	N/A	N/A	perfect	always	
JTIDSVoiceLPC12RadioSignal	JTIDSHeader	JTIDSHeaderStruct	1	N/A	N/A	N/A	N/A	N/A
	Data	octet	29+	N/A	N/A	perfect	always	
Link16RadioSignal	NPGNumber	unsigned short	1	N/A	N/A	perfect	always	N/A
	NetNumber	octet	1	N/A	N/A	perfect	always	
	TSEC_CVLL	octet	1	N/A	N/A	perfect	always	
	MSEC_CVLL	octet	1	N/A	N/A	perfect	always	
	TimeSlotID [3]	unsigned long	1	N/A	N/A	perfect	always	
	PerceivedTransmitTime [2]	long long	1	N/A	N/A	perfect	always	
RTTABRadioSignal	RTTAB	RTTABStruct	1	N/A	N/A	N/A	N/A	N/A
RTTReplySignal	RTTReply	RTTReplyStruct	1	N/A	N/A	N/A	N/A	N/A
VMFRadioSignal	JTIDSHeader	JTIDSHeaderStruct	1	N/A	N/A	N/A	N/A	N/A
	TADILJMessage	TADILJWordStruct	1+	N/A	N/A	N/A	N/A	

A.6 ENUMERATED DATATYPES TABLE

Identifier	Enumerator	Representation
JTIDSPrimaryModeEnum8 [1]	NTR	1
	JTIDSUnitParticipant	2
JTIDSSecondaryModeEnum8 [1]	None	0
	NetPositionReference	1
	PrimaryNavigationController	2
	SecondaryNavigationController	3
JTIDSSynchronizationStateEnum8 [1]	CourseSynchronization	2
	FineSynchronization	3
TSALevelEnum8 [1]	LowFidelityLevel0	0
	LowFidelityLevel1	1
	MediumFidelityLevel2	2
	MediumFidelityLevel3	3
	HighFidelityLevel4	4

A.7 COMPLEX DATATYPES TABLE

Complex Datatype	Field Name	Datatype	Cardinality	Units	Resolution	Accuracy	Accuracy Condition
JTIDSHeaderStruct	Data	octet	6	N/A	N/A	perfect	always
JTIDSTransmitterStruct	TimeSlotAlocationMode	TSALevelEnum8	1	N/A	N/A	N/A	N/A
	TransmittingTerminalPrimaryMode	JTIDSPrimaryModeEnum8	1	N/A	N/A	N/A	N/A
	TransmittingTerminalSecondaryMode	JTIDSSecondaryModeEnum8	1	N/A	N/A	N/A	N/A
	SynchronizationState	JTIDSSynchronizationStateEnum8	1	N/A	N/A	N/A	N/A
	NetworkSynchronizationID	unsigned long	1	N/A	N/A	perfect	always
LETHeaderStruct [4]	Data	octet	6	N/A	N/A	perfect	always
RTTABStruct [5]	Data	octet	6	N/A	N/A	perfect	always
RTTReplyStruct [6]	Data	octet	6	N/A	N/A	perfect	always
TADILJWordStruct [7]	Data	octet	10	N/A	N/A	perfect	always
SpreadSpectrumStruct							

A.8 NOTES TABLE

ID	Text
1	This is an 8-bit enumeration
2	Perceived Transmit Time. The Perceived Transmit Time (in NTP timestamp format) indicates the time, in seconds relative to 0h on 1 January 1900 UTC. It has two components. A 32-bit unsigned integer representing the integer (whole seconds) portion of the timestamp and 32-bit unsigned integer representing the fraction (fractions of a second) portion of the time stamp. The precision of this representation is about 200 picoseconds, which should be adequate for even the most exotic requirements. See Reference 13 for detailed format. 4294967295 (all F's in hexadecimal) in each field **shall** indicate a no statement/wildcard.
3	See TimeSlot ID structure in Table 5.2.4 in this document
4	See LET Message Header structure in Table 5.2.11 in this document
5	See RTT A/B Message structure in Table 5.2.6 in this document
6	See RTT Reply Message structure in Table 5.2.7 in this document
7	See Link 16 Message Bit Orientation in Table 5.2.3 in this document

ANNEX B: EXAMPLE OF J2.2 PPLI LINK 16 MESSAGE

To ensure consistency between simulations, the following example shows a bit stream for a Link 16 J2.2 Air PPLI Header/Message (Message Type 0) in Hex format, packed into 32-bit integers arranged in big-endian format. Users can verify their algorithm against these sets of data.

Signal PDU Fields			Data (Little Endian)	HEX Dump (Big Endian)
Entity ID	Site		48	0030
	Application		1	0001
	Entity		1	0001
Radio ID			1	0001
Encoding Scheme	Number of J Words		3	000B
	Encoding Class		1	
TDL Type			100	0064
Sample Rate			0	00000000
Data Length			448	01C0
Samples			0	00
Link 16 Signal PDU fields	NPG Number		6	0006
	Net Number		0	00
	TSEC CVLL		255	FF
	MSEC CVLL		255	FF
	Message Type ID		JTIDS	00
	Padding		0	0000
	Time Slot ID	Time Slot Num	0	00000000
		Padding	0	
		Epoch Number	0	
	Perceived Transmit Time		4294967295	FFFFFFFF
			4294967295	FFFFFFFF

Message Data		
Variable Label	**Variable Value**	**Hex Dump, 32 bit fields**
TIME SLOT TYPE:	0	0000 0090
RTI:	1	
Source Trace Number:	0011	
SDUSN	00	
JWORD Format	2	0908 0000
J Msg Sub Label	2	
Msg Length Indicator	2	
EX IND	0	
MC IND	0	

FT IND	0	
EMG IND	0	
C2 IND	1	D80B F0BA
SIM IND	0	
ABN IND	1	
FLT LD	1	
ARI WAN	1	
RRS	0	
Network Particiation Status	1	
Time Quality	7	
Geodetic Position Quality	15	
Strength	1	
BLT IND	0	
Altitude	8992	0000 FFE4
Non C2 to Non C2 JU NPG A	127 (No Statement)	
Non STSA	1	
Altitude Quality	To 800 Feet	
Parity	0	0000 0000
Padding	0	
JWORD Format	2 (Extension)	2C6B 4B2A
Latitude	36.04707081	
Longitude	139.901897	CD74 B734
Course	349	
Speed	185 MPH	
Parity	0	
JWORD Format	1	3505 0005
Continuation Word Label	1	
Mode 1 Code	25	
Mode 2 Code	71	9200 7207
Mode 3 Code	162	
Air Platform	0 (No Statement)	0000 0001
Air Platform Activity	16	
Parity	0	
Padding	0	

ANNEX C: DIS TO HLA TRANSLATIONS

C.1.0 HLA RPR FOM 1.0 RADIO TRANSMITTER OBJECT VERSUS DIS RADIO TRANSMITTER PDU

The translation between the HLA RPR FOM 1.0 Radio Transmitter Object and the equivalent DIS Radio Transmitter PDU are well established and therefore not addressed in this section. What is addressed is the following:

> ***SISO-STD-002-2005 Section 5.3.4.1 Object Class Data:***
>
> *"The Link 16 BOM defines no new object classes. Instead the BOM defines a single complex data type (JTIDSTransmitterStruct) that corresponds to the modulation parameters in the DIS Transmitter PDU defined in Section 5.2.1. An attribute of this complex data type should be added to the object class in the parent FOM corresponding to the DIS Transmitter PDU (see assumption 1 in section 5.3.1)"*

This paragraph describes the changes to the HLA RPR FOM 1.0 Radio Transmitter Object contained in the Link 16 BOM. At issue is the statement: *"An attribute of this complex data type should be added to the object class in the parent FOM corresponding to the DIS Transmitter PDU".* This statement seems to require clarification from an HLA perspective:

1. SISO-STD-002-2005 Section 5.3.6.1 describes the implementation of the `JTIDSTransmitterStruct` as a variant record of the `ModulationParameters` field. The `ModulationParameters` field is a complex data type `ModulationStruct`, which contains either the `SINCGARModulation` field or the `JTIDSTransmitterData` field, ***but not both***.

2. Table 5.3.2 indicates this variant record implementation by specifying cardinality of 0-1 for both the `SINCGARModulation` and the `JTIDSTransmitterData` fields. **NOTE:** *The cardinality 0-1 of the SINCGARModulation field of the Link 16 BOM differs from the original RPR FOM implementation, which specified cardinality 1.*

3. The `ModulationParameters` field should be encoded and decode, based on the `RFModulationSystemType` enumerated field of the HLA RPR FOM Radio Transmitter Object class to determine which record variant is to be encoded or decoded.

NOTE: *Earlier DRAFTS of the SISO-STD-002-2005 specified a different implementation of the JTIDSTransmitterStruct, which defined a separate JTIDSTransmitterData attribute of the parent class RadioTransmitter. The user should be careful to note this change.*

C.1.1 HLA RPR FOM 1.0 RADIO SIGNAL INTERACTION VERSUS DIS RADIO SIGNAL PDU

The HLA RPR FOM 1.0 JTIDS Interactions used to publish the Link 16 JTIDS Message are made up of several HLA subclasses of the HLA RPR FOM 1.0 Radio Signal class. The following sections describe the translations of the fields contained in these classes with their DIS Radio Signal PDU counterparts and translation criteria.

C.2.1 HLA RPR FOM RadioSignal Class

The HLA RPR FOM 1.0 `RadioSignal` class is an empty class and contains no attributes.

C.2.2 HLA RPR FOM RawBinaryRadioSignal Class

The HLA RPR FOM 1.0 `RawBinaryRadioSignal` class contains several attributes, which come into play for the Link 16 JTIDS messages and require translations from DIS to HLA and visa versa.

Table C.2.2.1: HLA Raw Binary Radio Signal Translation

HLA Radio Signal Class Attribute	DIS Radio Signal PDU Attribute	Description
HostRadioIndex	Entity ID Radio ID	The HLA Host Radio Index is the unique HLA object name of the associated Radio Transmitter object. There is no implied direct relationship between the DIS Entity ID/Radio ID and the HLA HostRadioIndex.
DateRate	Sample Rate	These fields are defaulted to a value of zero (0).
SignalDataLength	Data Length	These fields are defaulted to a value of zero (0).
SignalData		**NOTE:** *For the HLA implementation, because the Signal Data Length is set to a value of zero (0), the Signal Data attribute is simply not published.*
TacticalDataLinkType	TDL Type	These fields are set to 100 for the SISO-STD-002 Link 16.
TDLMessageCount	Encoding Scheme Bits 0-13	These fields contain the number of J-Words, not including the JTIDS Header.

C.2.3 HLA Link 16 BOM TDLBinaryRadioSignal Class

The Link 16 BOM `TDLBinaryRadioSignal` class is an empty class and contains no attributes.

C.2.4 HLA Link 16 BOM Link16RadioSignal Class

The Link 16 BOM Link16RadioSignal class contains several attributes, which come into play for the Link 16 JTIDS messages and require translations from DIS to HLA and visa versa.

Table C.2.4.1. HLA Link 16 Radio Signal Translation

HLA Link16 Radio Signal Class Attribute	DIS Radio Signal PDU Attribute	Description
MessageSubType	Message Sub Type	Network Participation Group (NPG) Number. Used to segregate information within the JTIDS/MIDS network. Specifies the virtual network currently being participated in.
NetNumber	Net Number	Network Number. Used to create virtual sub-circuits within the NPG for stacked nets or between NPGs for multi-net implementations.
TSEC_CVLL	TSEC CVLL	Transmission Security, an integer identification of the crypto variable used for JTIDS transmission encryption. This variable allows for simulated crypto netting. A value of 255 in this field **shall** indicate a no statement/wildcard.
MSEC_CVLL	MSEC CVLL	Message Security, an integer identification of the crypto variable used to encrypt the JTIDS message. This variable allows for simulated crypto netting. A value of 255 in this field **shall** indicate a no statement/wildcard.
	Message Type Identifier	Determines whether normal JTIDS header and message, RTT A/B, RTT Reply, JTIDS Voice, LET JTIDS, or VMF follows. **NOTE:** *In HLA the message type is inherent to the HLA classes used and therefore is not explicitly specified by attribute in HLA.*
	Padding	
TimeSlotID	Time Slot ID	In both HLA and DIS this field specifies the Time Slot Number and Epoch Number. The bit assignment as specified in Table 5.2.4 of the SISO-STD-002-2005 applies to both the DIS and HLA fields.

HLA Link16 Radio Signal Class Attribute	DIS Radio Signal PDU Attribute	Description
PerceivedTransmitTime	Perceived Transmit Time	In both HLA and DIS this field specifies the Integer and Fractional portions of the Perceived Transmit Time. The byte field assignment is as specified in Table 5.2.4 of the SISO-STD-002-2005 applies to both the DIS and HLA fields. This should be a direct translation.
	Message Data	**NOTE:** *In HLA the Message Data is contained in subclasses of the Link 16 Radio Signal class. The descriptions for mappings for DIS and HLA follow.*

C.2.5.1 HLA Link 16 BOM JTIDSMessageRadioSignal Class

The SISO-STD-02-2005 standard specifies that the JTIDS Message Data be split across two HLA attributes. This decision most certainly was driven by a desire to embrace the object oriented design paradigm, which HLA encourages. Unfortunately the decision to split the JTIDS Message Data between two attributes introduced a significant complication into the implementation of a translation or mapping of the JTIDS Message Data into the HLA equivalent fields. The following description attempts to clarify this complexity.

Figure C.2.5.1.1 JTIDS Message Data

DIS J Message Octet 0 | DIS J Message Octet 1 | DIS J Message Octet 2 | DIS J Message Octet 3

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Secure Data Unit Serial Number (SDUSN) Start													Source Track Number of Sender (5 octal value of 3 bits each)															RTI	Time Slot Type		

First 32 bit word

DIS J Message Octet 4 | DIS J Message Octet 5 | DIS J Message Octet 6 | DIS J Message Octet 7

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
			J Message Length Indicator			J Message Sub-label			J Message Label					J Word Format		Padding													SDUSN End		

Second 32 bit word

DIS J Message Octet 8 | DIS J Message Octet 9 | DIS J Message Octet 10 | DIS J Message Octet 11

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
First J-Word Continued (bits 47--16)																															

Third 32 bit word

DIS J Message Octet 12 | DIS J Message Octet 13 | DIS J Message Octet 14 | DIS J Message Octet 15

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Padding					First J-Word Continued (bits 74--48)																										

Fourth 32 bit word

DIS J Message Octet 16 | DIS J Message Octet 17 | DIS J Message Octet 18 | DIS J Message Octet 19

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Second J-Word Continued (bits 31--2)																														J Word	

Fifth 32 bit word

DIS J Message Octet 20 | DIS J Message Octet 21 | DIS J Message Octet 22 | DIS J Message Octet 23

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Second J-Word Continued (bits 63--32)																															

Sixth 32 bit word

DIS J Message Octet 24 | DIS J Message Octet 25 | DIS J Message Octet 26 | DIS J Message Octet 27

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Third J-Word (bits 15--2)													J Word Format		Padding						Second J-Word Continued (bits 74-64)										

Seventh 32 bit word

Figure C.2.5.1.1 JTIDS Message Data (Cont)

DIS J Message Octet 28 | DIS J Message Octet 29 | DIS J Message Octet 30 | DIS J Message Octet 31

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Third J-Word Continued (bits 47--16)																															

Eighth 32 bit word

DIS J Message Octet 32 | DIS J Message Octet 33 | DIS J Message Octet 34 | DIS J Message Octet 35

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Padding					Third J-Word Continued (bits 74-48)																										

Ninth 32 bit word

Since the HLA `JTIDSHeaderStruct` is defined as a Data field of octets with cardinality of 6, we must pack the appropriate DIS JTIDS Message fields into the equivalent HLA `JTIDSHeaderStruct` octets. The following table summarizes this mapping.

Table C.2.5.1.2. HLA JTIDS Header Translation

HLA JTIDSMessageRadioSignal class Attribute		DIS Radio Signal PDU Attribute	Description
JTIDSHeaderStruct	Data[0] octet	JMessageData[6] octet	This is the byte mapping between the DIS JTIDS Header and the equivalent HLA JTIDS Header field. The mapping ensures that the statements pertaining to message bit orientation in Section 5.2.2 is adhered to within the HLA context as well.
	Data[1] octet	JMessageData[7] octet	
	Data[2]octet	JMessageData[0] octet	
	Data[3] octet	JMessageData[1] octet	
	Data[4] octet	JMessageData[2] octet	
	Data[5] octet	JMessageData[3] octet	

The HLA `TADILJMessage` attribute is defined as a Data field of octets with cardinality 1+. The HLA `TADILJMessage` contains Link 16 J-Words padded to a 10-byte size, just as described in Section 5.2.2. The `TDLMessageCount` field of the HLA `RawBinaryRadioSignal` class specifies the number of J-Words contained in the `TADILJMessage` field and therefore is used in computing the size of this variable record. The number of J-Words varies based on the J-Message type specified, as well as the Time Slot Type specified in the HLA `JTIDSHeaderStruct`. The Table 2.5.3 shows the translation for a J Message containing three 10 Byte J-Words, although there can be up to twelve 10 Byte J-Words in a Link 16 J-Message.

Table C.2.5.1.3. HLA TADILJMessage Translation

HLA JTIDSMessageRadioSignal class Attribute		DIS Radio Signal PDU Attribute	Description
TADILJMessage	Data[0] octet	JMessageData[12] octet	This is the byte mapping between the DIS JTIDS Message Data and the equivalent HLA TADILJMessage field. The mapping ensures that the statements pertaining to message bit orientation in Section 5.2.2 is adhered to. **NOTE:** *This shows the octet translation pattern for three J-Words contained in the J-Message, the reader is encouraged to derive the translation of additional J-Words based on these examples.*
	Data[1] octet	JMessageData[13] octet	
	Data[2] octet	JMessageData[14] octet	
	Data[3] octet	JMessageData[15] octet	
	Data[4] octet	JMessageData[8] octet	
	Data[5] octet	JMessageData[9] octet	
	Data[6] octet	JMessageData[10] octet	
	Data[7] octet	JMessageData[11] octet	
	Data[8] octet	JMessageData[4] octet	
	Data[9] octet	JMessageData[5] octet	
	Data[10] octet	JMessageData[26] octet	
	Data[11] octet	JMessageData[27] octet	
	Data[12] octet	JMessageData[20] octet	
	Data[13] octet	JMessageData[21] octet	
	Data[14] octet	JMessageData[22] octet	
	Data[15] octet	JMessageData[23] octet	
	Data[16] octet	JMessageData[16] octet	
	Data[17] octet	JMessageData[17] octet	
	Data[18] octet	JMessageData[18] octet	
	Data[19] octet	JMessageData[19] octet	
	Data[20] octet	JMessageData[32] octet	
	Data[21] octet	JMessageData[33] octet	
	Data[22] octet	JMessageData[34] octet	
	Data[23] octet	JMessageData[35] octet	
	Data[24] octet	JMessageData[28] octet	
	Data[25] octet	JMessageData[29] octet	
	Data[26] octet	JMessageData[30] octet	
	Data[27] octet	JMessageData[31] octet	

	Data[28] octet	JMessageData[24] octet	
	Data[29] octet	JMessageData[25] octet	

C.2.5.2 HLA Link 16 BOM RTTABRadioSignal Class

Since the HLA `RTTABStruct` is defined as a Data field of octets with cardinality of 6, we must pack the appropriate DIS JTIDS Message fields into the equivalent HLA `RTTABStruct` octets. The following table summarizes this mapping.

Table C.2.5.2.1. HLA RTT A/B Translation

HLA JTIDSMessageRadioSignal class Attribute		DIS Radio Signal PDU Attribute	Description
RTTABStruct	Data[0] octet	JMessageData[6] octet	This is the byte mapping between the DIS RTT A/B and the equivalent HLA RTTAB field. The mapping ensures that the statements pertaining to message bit orientation in Section 5.2.2 is adhered to within the HLA context as well.
	Data[1] octet	JMessageData[7] octet	
	Data[2]octet	JMessageData[0] octet	
	Data[3] octet	JMessageData[1] octet	
	Data[4] octet	JMessageData[2] octet	
	Data[5] octet	JMessageData[3] octet	

C.2.5.3 HLA Link 16 BOM RTTReplyRadioSignal Class

Since the HLA `RTTReplyStruct` is defined as a Data field of octets with cardinality of 6, we must pack the appropriate DIS JTIDS Message fields into the equivalent HLA `RTTReplyStruct` octets. The following table summarizes this mapping.

Table C.2.5.3.1. HLA RTT A/B Translation

HLA JTIDSMessageRadioSignal class Attribute		DIS Radio Signal PDU Attribute	Description
RTTReplyStruct	Data[0] octet	JMessageData[6] octet	This is the byte mapping between the DIS RTT Reply and the equivalent HLA RTT Reply field. The mapping ensures that the statements pertaining to message bit orientation in Section 5.2.2 is adhered to within the HLA context as well.
	Data[1] octet	JMessageData[7] octet	
	Data[2]octet	JMessageData[0] octet	
	Data[3] octet	JMessageData[1] octet	
	Data[4] octet	JMessageData[2] octet	
	Data[5] octet	JMessageData[3] octet	

C.2.5.4 HLA Link 16 BOM JTIDSVoiceCVSDRadioSignal Class

Since the HLA `JTIDSHeaderStruct` is defined as a Data field of octets with cardinality of 6, we must pack the appropriate DIS JTIDS Message fields into the equivalent HLA `JTIDSHeaderStruct` octets. The following table summarizes this mapping.

Table C.2.5.4.1. HLA JTIDS Header Translation

HLA JTIDSMessageRadioSignal class Attribute		DIS Radio Signal PDU Attribute	Description
JTIDSHeaderStruct	Data[0] octet	JMessageData[6] octet	This is the byte mapping between the DIS JTIDS Header and the equivalent HLA JTIDS Header field. The mapping ensures that the statements pertaining to message bit orientation in Section 5.2.2 is adhered to within the HLA context as well.
	Data[1] octet	JMessageData[7] octet	
	Data[2]octet	JMessageData[0] octet	
	Data[3] octet	JMessageData[1] octet	
	Data[4] octet	JMessageData[2] octet	
	Data[5] octet	JMessageData[3] octet	

The HLA `JTIDSVoiceCVSDRadioSignal` class Data field is defined as octets with cardinality 29+. The HLA `JTIDSVoiceCVSDRadioSignal` class Data contains Link 16 Free Text Voice Data padded to a 10-byte size, just as described in Section 5.2.2. The `TDLMessageCount` field of the HLA `RawBinaryRadioSignal` class specifies the number of J-Words contained in the `TADILJMessage` field and therefore is used in computing the size of this variable record. The number of J-Words varies based on the J-Message type specified, as well as the Time Slot Type specified in the HLA `JTIDSHeaderStruct`. The Table 2.5.3 shows the translation for a J Message containing three 10 Byte J-Words, although there can be up to twelve 10 Byte J-Words in a Link 16 J-Message.

Table C.2.5.4.2. HLA JTIDSVoiceCVSDRadioSignal Class Data Field Translation

HLA JTIDSVoiceCVSDRadioSignal class Attribute		DIS Radio Signal PDU Attribute	Description
Data	Data[0] octet	JMessageData[12] octet	This is the byte mapping between the DIS JTIDS CVSD Voice Data and the equivalent HLA JTIDSVoiceCVSDRadioSignal class Data field. The mapping ensures that the statements pertaining to message bit orientation in Section 5.2.2 is adhered to. **NOTE:** *This shows the octet translation pattern for a 29 byte Free Text message, the reader is encouraged to derive the translation of additional bytes based on these examples as there is a potential for up to 233 bytes of Free Text allowed.*
	Data[1] octet	JMessageData[13] octet	
	Data[2] octet	JMessageData[14] octet	
	Data[3] octet	JMessageData[15] octet	
	Data[4] octet	JMessageData[8] octet	
	Data[5] octet	JMessageData[9] octet	
	Data[6] octet	JMessageData[10] octet	
	Data[7] octet	JMessageData[11] octet	
	Data[8] octet	JMessageData[4] octet	
	Data[9] octet	JMessageData[5] octet	
	Data[10] octet	JMessageData[26] octet	
	Data[11] octet	JMessageData[27] octet	
	Data[12] octet	JMessageData[20] octet	
	Data[13] octet	JMessageData[21] octet	
	Data[14] octet	JMessageData[22] octet	
	Data[15] octet	JMessageData[23] octet	
	Data[16] octet	JMessageData[16] octet	
	Data[17] octet	JMessageData[17] octet	
	Data[18] octet	JMessageData[18] octet	
	Data[19] octet	JMessageData[19] octet	
	Data[20] octet	JMessageData[32] octet	
	Data[21] octet	JMessageData[33] octet	
	Data[22] octet	JMessageData[34] octet	
	Data[23] octet	JMessageData[35] octet	
	Data[24] octet	JMessageData[28] octet	
	Data[25] octet	JMessageData[29] octet	
	Data[26] octet	JMessageData[30] octet	
	Data[27] octet	JMessageData[31] octet	
	Data[28] octet	JMessageData[24] octet	

C.2.5.6 HLA Link 16 BOM JTIDSVoiceLPC10RadioSignal Class

The fields contained in the HLA `JTIDSVoiceLPC10RadioSignal` class are equivalent to the HLA `JTIDSVoiceCVSDRadioSignal` class. See Section 2.5.6 of this Appendix for a description of the HLA `JTIDSVoiceCVSDRadioSignal` class translation.

C.2.5.7 HLA Link 16 BOM JTIDSVoiceLPC12RadioSignal Class

The fields contained in the HLA `JTIDSVoiceLPC12RadioSignal` class are equivalent to the HLA `JTIDSVoiceCVSDRadioSignal` class. See Section 2.5.6 of this Appendix for a description of the HLA `JTIDSVoiceCVSDRadioSignal` class translation.

C.2.5.8 HLA Link 16 BOM VMFRadioSignal Class

The fields contained in the HLA `VMFRadioSignal` class are equivalent to the HLA `JTIDSMessageRadioSignal` class. See Section 2.5.1 of this Appendix for a description of the HLA `JTIDSMessageRadioSignal` class translation.

C.2.5.9 HLA Link 16 BOM JTIDSLETRadioSignal Class

The fields contained in the HLA `JTIDSLETRadioSignal` class are equivalent to the HLA `JTIDSMessageRadioSignal` class. See Section 2.5.1 of this Appendix for a description of the HLA `JTIDSMessageRadioSig`