Sea Based Joint Precision Approach and Landing System (JPALS) Data Link Signal-in-Space Interface Specification

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REVISIONS

Revision Number	Date	Description	Pages Affected
-	30 Oct 03	Initial Release	All
A	25 Jun 04	Complete update based on ongoing engineering efforts.	All

Contents

1 Scope

1.1 Identification

This specification establishes the requirements for the Sea Based Joint Precision Approach and Landing System (JPALS) data link (DL) signal in space (SIS) that serves as the interface between the Sea Based JPALS shipboard segment and airborne segment.

Requirements contained within this specification were derived from the *Sea Based JPALS System Requirements Document* (SRD) [14] to support the *Operational Requirements Document (ORD) for the Joint Precision Approach and Landing System (JPALS)* (USAF 002-94-I), Block I Shipboard Operating Environment (SOE) [9].

Note: This specification was developed to support the ORD referenced above. The ORD will be replaced by a Capability Development Document (CDD) and future versions of the Ship Based JPALS specifications will be developed to support the CDD.

1.2 System Overview

JPALS provides the Department of Defense (DoD) with a navigation, air traffic control, and landing capability for Shipboard operations and a terminal navigation, precision approach, and landing capability for Fixed Base, Tactical, and Special Mission operations ashore. JPALS consists of modular avionics and ground components to provide a range of navigation, air traffic control, and landing capabilities that can be tailored to satisfy mission needs. JPALS information will be broadcast from ground or ship systems to aircraft avionics. The JPALS Operational View is shown in Figure 1-1.

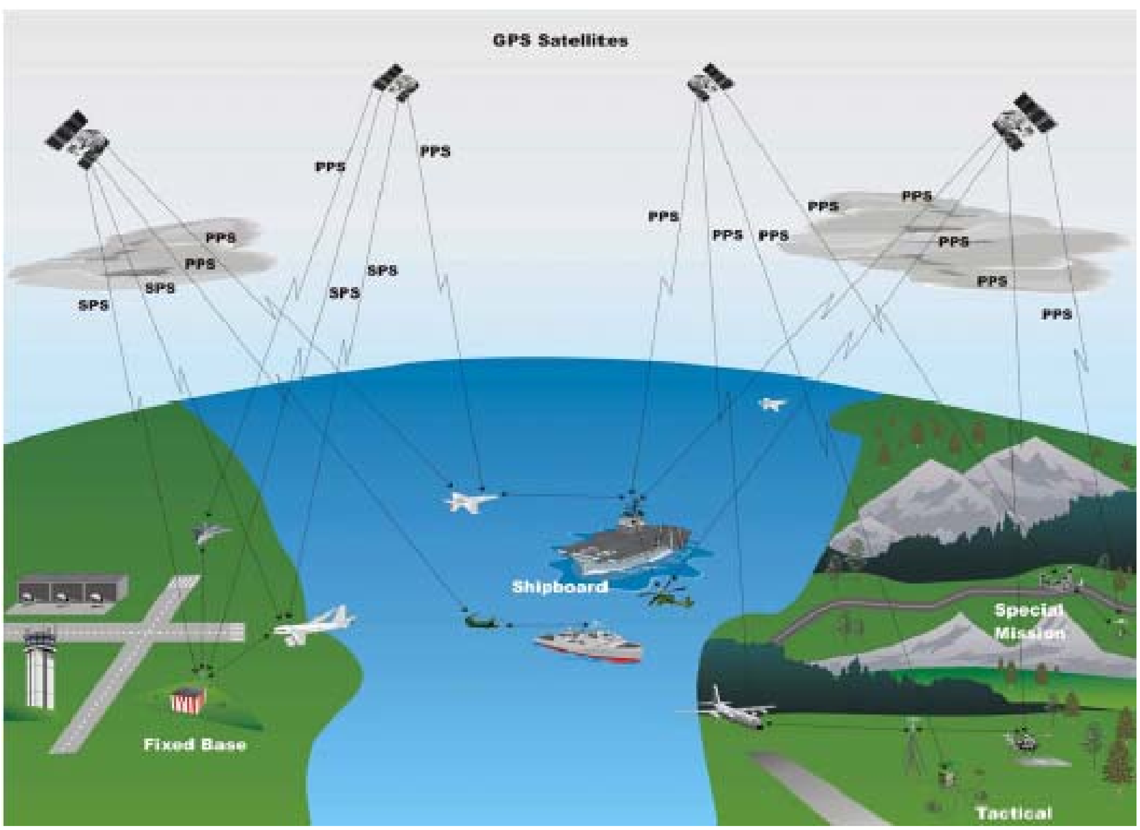

Figure 1-1: JPALS OV-1

Sea Based JPALS supports three-dimensional positioning and guidance, secure two-way communications with the ship, separation of aircraft on approach, and monitoring of approach data by ship operators on military air-capable ships. Sea Based JPALS is a safety-critical system consisting of hardware and software that uses the Navigation Satellite Timing and Ranging (NAVSTAR) Global Positioning System (GPS) Precise Positioning Service (PPS) and a DL network to perform relative navigation to JPALS-equipped US Navy and North Atlantic Treaty Organization (NATO) ships. Relative measurement processing using GPS data is used to meet the accuracy, integrity, continuity, and availability requirements of Sea Based JPALS supported operations. The ship relative augmentations to GPS PPS are based on relative GPS positioning concepts. GPS measurement functions within Sea Based JPALS are protected by GPS anti-jam equipment. The DL network supports the relative navigation functions and is intended to aid in monitoring functions and to supplement ship-to-air and air-to-ship communications.

Sea Based JPALS consists of two main segments:

1. Sea Based JPALS-Ship, which is installed on air-capable ships, and

2. Sea Based JPALS-Air, which is installed on aircraft capable of landing on those ships or that have traditionally used the TACAN service from those ships for area navigation (RNAV).

The communication between the two Sea Based JPALS segments is performed via the Sea Based JPALS DL SIS. The Sea Based JPALS-Ship segment and the Sea Based JPALS-Air segment are specified in separate documents.

1.3 Operating Environment

Sea Based JPALS must be capable of operating while at sea under potentially severe marine weather and ship motion conditions and in a challenging electromagnetic environment. Hostile enemy action will normally be targeted on the aviation ship and will typically include long-range missiles and subsurface threats. Information generated by Sea Based JPALS must be protected against enemy efforts to detect, classify, geo-locate, and/or target friendly forces (e.g., the aircraft carrier). Flight operations are conducted on multiple classes and types of ships that may be deployed individually or within a battle group or task force. The role and use of Sea Based JPALS in support of operations in this environment are described in detail in the *Concept of Operations (CONOPS) for Future Air Traffic Control Operations using the Sea Based Joint Precision Approach and Landing System* [12].

1.4 JPALS Requirements Hierarchy

This Sea Based JPALS Aircraft System Performance Specification is part of a family of documents that establish the system, performance, and interface requirements for Sea Based JPALS. Figure 1-2 illustrates the hierarchy of the various Sea Based JPALS requirements documents.

The JPALS ORD [9] contains the JPALS operational requirements, which are the primary source for the Sea Based JPALS performance requirements. Additional Sea Based JPALS performance requirements were derived to support the capabilities and operations described in the CONOPS [12]. The system level requirements derived from the JPALS ORD [9] and CONOPS [12] are documented in the Sea Based JPALS SRD [14]. From the SRD, performance requirements are then allocated to the Sea Based JPALS-Ship specification and the Sea Based JPALS-Air specification, as applicable. The interface between ship and air is defined in the Sea Based JPALS DL SIS Interface specification.

Both the Sea Based JPALS-Ship and Sea Based JPALS-Air specifications have companion integration guidance documentation. The integration guidance documents will provide detailed information pertaining to the installation and integration of Sea Based JPALS on ships and aircraft.

Design documents will be created during the Technology Development (TD) phase of the JPALS program to reflect the Sea Based JPALS-Ship and Sea Based JPALS-Air design used to validate these requirements and allocation decisions made during that phase.

This specification is to be used with the following specifications:

- Sea Based JPALS-Air System Performance Specification [16]

- Sea Based JPALS-Ship System Performance Specification [15]
- JPALS Aircraft Integration Guide [13]
- JPALS Ship Integration Guide [11]

1.5 Document Overview

This document contains the following sections:

1. **Scope:** Contains the project identification, system and document overviews, and a list of assumptions used in this document
2. **Applicable Documents:** Provides a list of the documents referenced in this standard, references contain the document number, exact title, revision level and issue date
3. **Requirements:** Specifies the relationship between the DL SIS elements for which this specification applies: network, SIS, and application data
4. **Quality Assurance:** Ensures that the requirements of Section 3 and applicable sections are satisfied
5. **Terms and Acronyms:** Provides a listing of term and acronym definition
6. **Classified Content:** Provides a placeholder for classified content. All classified is contained in a separate controlled document
7. **Network Definition:** Provides a definition of the DL network that is implemented for the DL
8. **Signal-in-Space Definition:** Provides description of DL waveform and its modulation scheme
9. **Sea Based JPALS Data Link Application Data:** provides definition of data sent over DL
10. **DLCC Message Definitions:** provides summary of content contained in ATM messages

The word "equipment", as used in this document, includes all components or units necessary (as determined by the equipment manufacturer or installer) to properly perform its intended function.

In this document, the term “shall” is used to indicate requirements. An approved design would comply with every requirement, which can be assured by inspection, test, analysis, or demonstration.

The term “must” is used to identify items which are important but are either duplicated somewhere else in the document as a “shall”, or are covered in another requirements document.

The term “should” is used to denote a recommendation that would improve the Sea Based JPALS equipment, but does not constitute a minimum requirement.

1.6 Assumptions

1.6.1 Interference Environment

It is assumed that the interference environment specified in the SRD for which Sea Based JPALS DL and GPS receivers must operate bounds the actual operational environment. If the interference environment is more severe than that specified in the SRD availability and continuity of Sea Based JPALS may be reduced.

1.6.2 Sea Based JPALS-Ship System

It is assumed that the Sea Based JPALS-Ship is operating in conformance with the requirements stated in the *Sea Based JPALS-Ship System Performance Specification* [15].

1.6.3 Sea Based JPALS-Air System

It is assumed that the Sea Based JPALS-Air is operating in conformance with the requirements stated in the *Sea Based JPALS-Air System Performance Specification* [16].

1.6.4 Sea Based JPALS Applications

Usage of Sea Based JPALS is fundamentally different from current navigation and Air Traffic Control (ATC) systems. Procedures for use of the SPN-41, SPN-46, air surveillance radar, and TACAN are different from one another because the technologies and operating principles are fundamentally different. Sea Based JPALS technology is fundamentally different from all of these current systems; therefore, Sea Based JPALS inherently incorporates some new procedures for operations around Navy ships. However, even though some procedures are different, it is possible to overlay them with current operations in a way that JPALS and legacy aircraft can operate in a compatible manner. In general these differences are reflected in specific operator actions versus the generic functions supporting navigation, communications, and separation. In other words, despite the differences in some procedures, Sea Based JPALS can be used to support the same ATC functions as legacy systems. This allows Sea Based JPALS to be incorporated into the fleet while a large number of aircraft still using legacy systems. As the airwing approaches full Sea Based JPALS equipage, it is anticipated that Sea Based JPALS procedures will be revised or extended to take greater advantage of the Sea Based JPALS performance capabilities. This specification is written to support the ORD [9] and interim *Concept of Operations for JPALS Sea Based JPALS and Joint Unmanned Combat Air System* (CONOPS) [12].

2 Reference Documents

The following documents, in the exact revision and date shown, form a part of this specification to the extent specified herein. If the document's revision or date is not indicated, the most current version of the document as of the date of this specification applies.

[1] CJCSI 6130.01C, *2003 Chairman of the Joint Chiefs of Staff (CJCS) Master Positioning, Navigation, and Timing Plan*, 31 March 2003, Joint Staff, Washington, DC.

[2] Federal Aviation Administration. (2000). Code of Federal Regulations, Part 139-Certification and Operation: Land Airports Serving Certain Air Carriers. Washington, DC: U.S. Government Printing Office.

[3] Department of Defense. (1983). Sealing, Locking, and Retaining Compounds: (Single - Component). (MIL-S-22473E). Washington, DC: U.S. Government Printing Office.

[4] Department of Defense. (1996). Reliability testing for engineering development, qualification, and production. (MIL-HDBK-781A). Washington, DC: U.S. Government Printing Office.

[5] Department of Defense. (2000). NAVSTAR GPS Space Segment/Navigation User Interfaces (ICD-GPS-200C with IRN-200C-005R1, 14 January 2003). Washington, DC: U.S. Government Printing Office.

[6] Department of Defense. (2000). Environmental Engineering Considerations and Laboratory Tests. (MIL-STD-810F). Washington, DC: U.S. Government Printing Office.

[7] Department of Defense. GPS Standard Positioning Service (SPS) Performance Standard; October, 2001.

[8] JPALS Security Classification Guide;(no number); 17 February 1999; ESC, AFMC, Hanscom Air Force Base, Massachusetts

[9] *Operational Requirements Document (ORD) for Joint Precision Approach and Landing System (JPALS)*, USAF-002-94-I, 19 March 2003, Air Force Flight Standards Agency.

[10] Selective Availability and Anti-Spoofing Module (SAASM); SS-GPS-001A; 12 March 1998

[11] *Shipboard Integration Trade Study Report (Shipboard Integration Guide) for the Sea Based Joint Precision Approach and Landing System (JPALS)*, 7 May 2004, Sierra Nevada Corporation.

[12] *Concept of Operations (CONOPS) for Future Air Traffic Control Operations using the Sea Based Joint Precision Approach and Landing System (JPALS) IOC (2012)*, Draft, 15 May 2004, Naval Air Warfare Center.

[13] SRGPS-AIGD-0016, *Joint Precision Approach and Landing System (JPALS) Aircraft Integration Guidance Document,* Version 1.0, 25 March 2004, Naval Air Systems Command.

[14] Sea Based JPALS Systems Requirements Document (025323-001], 25 June 2004

[15] ARINC. Sea Based JPALS-Ship System Performance Specification (025323-003), 25 June 2004

[16] ARINC. Sea Based JPALS-Air System Performance Specification (025323-002) , 25 June 2004

[17] RTCA, Incorporated. (2001). Minimum Operational Performance Standards for Global Positioning System/Local Area Augmentation System Airborne Equipment (RTCA/DO-253A). Washington, DC: RTCA, Incorporated.

[18] Global Navigation Satellite System (GNSS) Based Precision Approach LAAS Signal-in-Space (SIS) ICD; RTCA/DO-246B; 28 September 1998

[19] RTCA, Incorporated. Minimum Aviation System Performance Standards (MASPS) for the LAAS; RTCA/DO-245; 28 September 1998

[20] A Data Interchange Format for NAVSTAR GPS, Format and Usage of Precise Positioning Service (PPS) DGPS Messages for Aviation and other High Performance Applications (North Atlantic Treaty Organization (NATO) Restricted); STANAG 4392 Ed. 2 Annex D; Latest Draft

[21] North Atlantic Treaty Organization (NATO) STANAG 4550, For Use of Differential Global Positioning System (DGPS) for Military Precision Approach and Landing, NATO Unclassified; STANAG 4550 Ed. 1 (Draft 3); 15 October 2001

2.1 Order of Precedence

In case of a conflict between this document and the referenced documents, the order of precedence in descending order is as listed below unless otherwise noted herein:

1. Applicable Federal, State, or Local Laws and Regulations
2. JPALS ORD [9]
3. JPALS Sea Based JPALS SRD [14]
4. Sea Based JPALS DL SIS Interface Specification (this document)
5. Other Referenced Specifications and Documents

In case of a conflict between referenced documents at a lower order of precedence than this document, the more restrictive requirement shall apply, unless otherwise approved by the Government.

Lack of a requirement at a higher level of precedence or a more general requirement at a higher level of precedence shall not be considered a conflict. The more detailed requirement shall apply.

3 Requirements

This document prescribe functional and performance requirements for the Sea Based JPALS DL SIS. Functional requirements and their groupings do not imply allocation of functionality to hardware and software design. When required to establish interoperability, specific design and/or algorithms are specified. Certain other design-specific requirements are given to ensure the accuracy, continuity, availability, and integrity needed to support minimum performance levels required to operate safely in the ship environment.

3.1 System Definition

The Sea Based JPALS SIS DL is intended to serve as the interface between two applications largely defined by their operational environments and functional roles, the Sea Based JPALS-Air and Sea Based JPALS-Ship. These applications use the same SIS, but operational constraints drive different requirements for the airborne and shipboard DL applications as described in *Sea Based JPALS-Air System Performance Specification* [16] and *Sea Based JPALS-Ship System Performance Specification* [15].

3.1.1 Major Functional Capabilities

The Sea Based JPALS DL SIS shall support the following functions:

- Navigation Function: Ship-relative navigation by equipped and participating aircraft,
- Communications Function: Passing of Air Traffic Management (ATM), ship state, launch and recovery, and other data between the ship and aircraft,
- Monitoring Function: Transmission of aircraft state data to support shipboard ATM and final approach monitoring and flight crew situational awareness of nearby air traffic.

The Sea Based JPALS DL SIS shall provide sufficient information bandwidth to support RNAV, precision approach and landing, ATM, and monitoring services over a variety of communications ranges while minimizing detectability of the SIS and protecting against jamming. This specification defines the signal acquisition, throughput, latency/update rate, message error rate, message integrity, and interference/jamming requirements necessary to achieve this.

Note: The Sea Based JPALS DL includes a receive function and a transmit function that pass Sea Based JPALS and other data between the Sea Based JPALS-Air and Sea Based JPALS-Ship using an Ultra High Frequency (UHF) radio channel. This DL SIS Interface Specification reference does not address specific requirements for the receive and transmit functions. Reference the Sea Based JPALS-Air System Performance Specification [16] and Sea Based JPALS-Ship System Performance Specification [15] for that information.

3.1.2 States and Modes of Operation

3.1.2.1 States

There are no states defined for the Sea Based JPALS DL itself. The DL functionality is embodied within shipboard and airborne receiver transmitters (RT). The particular implementation may incorporate a number of specific states, such as operational and non-operational or maintenance and initialization. The design document for the particular RT implementation would describe the states that are defined.

3.1.2.2 Modes

The Sea Based JPALS DL has its own modes which can be used in conjunction with all defined system modes for the Sea Based JPALS-Air and Sea Based JPALS-Ship. There are three DL modes defined based on operational requirements and the resulting waveform characteristics.

The primary mode of operation is referred to as Normal mode. It operates within the normal channel defined for the UHF frequency band which is 1.2 MHz. Specific characteristics for this waveform are defined within Section 8 of this document.

Additional modes of operation are envisioned: Low Probability of Intercept/Low Probability of Detection (LPI/LPD) and Anti-Jam (AJ). Definition of these modes is TBR.

Note: In addition a Reduced Probability of Detection (RPD) mode may be defined. This mode would utilize the 1.2 MHz waveform, but include only a subset of data being sent and support fewer aircraft or both. These parameters need to be analyzed to determine the amount of detection probability offset that might be achieved and the resulting emission control (EMCON) level that could be supported.

3.2 Characteristics

3.2.1 Data Link Operational Requirements

The Sea Based JPALS DL shall carefully tailor signal characteristics to minimize the DL emissions so as to reduce the detectability of the ship. This will allow the DL to be operational during a broader range of EMCON conditions.

Note: Another option is the use of an LPD SIS which would further reduce the detectability of the ship. The LPD SIS may use techniques, such as frequency hopping and spread spectrum, as well as an optional AJ SIS intended to use maximum power to blast through enemy signal jamming.

Communication Security (COMSEC) and Transmission Security (TRANSEC) technologies are used to improve signal security, ensuring that information passed over the DL cannot be intercepted and exploited. A dedicated encryption processor addresses these needs. The aircraft and ship will need to use the same encryption techniques.

Detailed requirements are contained in Section 8 of this document. Information of a sensitive nature is outlined in Section 6 of this document. The actual information will be conveyed in a separate classified document.

3.2.2 Networking Design

The Sea Based JPALS will employ flexible, scalable network architecture. The network functionality is decoupled from the SIS to ensure application flexibility. Sea Based JPALS requires both broadcast and point-to-point communication among up to 50 nodes in each net. The network design is capable of being tailored for a varying number of nodes and node throughput requirements. In addition, a variety of message update rate/latency requirements shall be supported.

Time Division Multiple Access (TDMA) is used to share radio frequency (RF) bandwidth between multiple nodes on the network. The Sea Based JPALS-Ship represents a central network controller for all nodes on the network and allocates time slots within the TDMA structure. The size and content of TDMA slots are dynamic due to different operating scenarios and evolving Sea Based JPALS application requirements.

Detailed requirements for the Sea Based JPALS DL network are contained in Section 7.

3.2.3 DL Transmission Characteristics

The data transmission rate is dependent on the number of aircraft the DL is configured to support. Data content is both broadcast and point-to-point. The majority of data transmissions will be between the ship and aircraft; however transmissions of air state from an individual aircraft can be received by other aircraft.

The SIS waveform (and modulation) are still under development. The requirements for the DL include:

- The carrier frequency range for the DL is in the UHF band between 225 to 400 MHz in 1.2 MHz channels.
- The instantaneous bandwidth is 1.2 MHz for Normal mode and a potential RPD mode.
- The DL may make use of a Dynamic Power Control Algorithm to maintain adequate quality of service with minimum transmitted power.
- Data content being sent over the data link consists of:

- Data packets defining constant data updates (e.g., ship state and air state)
- ATM operational type messages

Data content descriptions for all Sea Based JPALS DL data packets are contained in Section 9. Section 10, DLCC Messages, provides a definition of ATM Uplink and Downlink messages.

3.2.4 Requirements Organization

Detailed requirements are contained in the following sections. The order of the sections mirrors the design hierarchy, starting with the most general requirement and progressively defining more detailed requirements.

A single DL node provides no functionality as there is no other node to communicate with. Once more than a single DL node (including the ship) is operating cooperatively a network has been defined. The detailed requirements for Sea Based JPALS DL networking are contained in Section 7.

The SIS characteristics for the DL waveform are contained in Section 8. This describes the DL waveform sent or received by an RT.

The data content sent over the DL is defined in Section 9. This represents application data being sent between the ship and aircraft.

Several of the data packets defined in Section 9 represent ATM Uplink and Downlink messages. The characteristics of these data packets are contained in Section 10.

4 Quality Assurance & Verification Requirements

This Section will define and describes the activities that ensure the system requirements of Section 3 are satisfied.

The following requirements are also included in this Section:

Responsibility for inspection - The assignment of the responsibility to perform inspections on delivered products, materials, or services to determine compliance with all specified requirements.

Special tests/examinations - Special tests and examinations required for sampling, qualification evaluation, or other tests or examinations, as necessary.

Requirements cross-reference - The correlation of each system requirement stated in Section 3 to the quality assurance provisions specified in this Section.

4.1 Verification Strategy

Note: The verification strategy is TBR and is to be provided in baseline 2.0.

4.1.1 Responsibilities

TBR

4.1.2 Special Tests and Examinations

The tests identified are included in the following sections.

4.1.2.1 Development Test

Developmental Test activities shall be conducted to verify that the implemented hardware and software design meets the functional and performance requirements of the Sea Based JPALS-Ship and Sea Based JPALS-Air specifications, as appropriate. Specific tests for verification are not conveyed, but normally include the verification of software and hardware requirements, stability and dry running, and system level testing.

4.1.2.2 Production Acceptance Test (PAT)

PAT shall be performed on each end-item before it leaves the factory to verify that the end-item conforms to applicable requirements, is free from manufacturing defects, and is substantially identical to the qualified system.

4.1.2.3 Site Acceptance Test (SAT)

SAT is conducted after completion of hardware installation and checkout and the installation has been inspected and approved for workmanship and configuration. SAT is accomplished initially for the developmental system, and is repeated for each production system after PAT. Contractor-conducted testing shall be performed at each field site to verify that the new system is installed and operating properly on site. The government is responsible for testing at each field site.

4.2 Verification Methods

4.2.1 Inspection

Inspection is a method of verification to determine compliance with specification requirements and consists primarily of visual observations, mechanical measurements of the equipment, physical locations, and technical examination of engineering-supported documentation.

4.2.2 Analysis

Analysis is a method of verification that consists of comparing hardware or software design with known scientific and technical principles, technical data, or procedures and practices to validate that the proposed design will meet the specified functional and performance requirements. Analysis also may include the use of modeling and simulation.

4.2.3 Demonstration

Demonstration is a method of verification where qualitative versus quantitative validation of a requirement is made during a dynamic test of the equipment. Demonstration activities are further characterized by the following:

1. If a requirement is validated by test during first article qualification testing and the requirement has enough significance that it is re-tested during acceptance test, then this acceptance testing can be indicated in the matrix as a Demonstration.
2. SW functional requirements are verified during build up testing (module, integration Hardware (HW)/SW integration and system level testing. All requirements need to be validated at the systems level.

4.2.4 Test

Test is a method of verification that will measure equipment performance under specific configuration-load conditions and after the controlled application of known stimuli. Quantitative values are measured, compared against previously predicted success criteria, and evaluated to determine the degree of compliance.

4.2.5 Qualification by Similarity

Qualification by similarity consists of the review of certified/approved test data in conjunction with design evaluation data to substantiate the following:

1. A similar item of equipment has been previously qualified to the requirements of this specification, or a higher level, and;
2. The new item does not incorporate differences that would invalidate the criteria of “1”.

4.3 Requirements Traceability

Note: To be provided in future revision (TBR)

5 Terms and Acronyms

5.1 Terms

The following terms are used throughout this document:

5.1.1 Terms

Term	Definition
Availability	A measure of the degree to which an item is in an operable and committable state at the start of a mission when the mission is called for at an unknown (random) time.
Failure	An event, either software or hardware, inherent or inducted, or combination of events that prevents or degrades an item from performing a specified mission while in an operational environment.

5.2 Acronyms

The following abbreviations, acronyms, and mnemonics are used throughout this document:

Acronym	Description
AJ	Anti-Jam
ATC	Air Traffic Control
ATM	Air Traffic Management
BKN	Broken
BRC	Base Recovery Course
BRI	Burst Rate Identifier
CATCC	Carrier Area Air Traffic Control Center
CCA	Carrier Control Area
CCZ	Carrier Control Zone
CDD	Capability Development Document
CJCS	Chairman of Joint Chiefs of Staff
CLR	Clear
CM	Center of Mass
COMSEC	Communications Security
CONOPS	Concept of Operations
COTS	Commercial-off-the-Shelf
CRC	Cyclic Redundancy Check
dB	Decibel
dBW	Decibel related to a watt
DL	Data Link
DMC	Deck Motion Compensation
DoD	Department of Defense
EAT	Expected Approach Time

EBRC	Expected Base Recovery Course
EIRP	Effective Isotropic Radiated Power
EMCON	Electromagnetic Emission Control
FCS	Frame Check Sequence
FEC	Forward Error Correction
GFI	General Format Identifier
GNSS	Global Navigation Satellite System
GLAR	General Launch and Recovery
GMSK	Gaussian Minimum Shift Keying
GMT	Greenwich Mean Time
GPS	Global Positioning System
HW	Hardware
ICAO	International Civil Aviation Organization
ID	Identification
INFOSEC	Information Security
IODE	Issue of Data Ephemeris
ISO	International Standards Organization
JPALS	Joint Precision Approach and Landing System
J-UCAS	Joint Unmanned Combat Air System
LAT/LON	Latitude/Longitude
LCG	Logical Channel Group
LLC	Link Layer Control
LNA	Low Noise Amplifier
LPD	Low Probability of Detection
LPI	Low Probability of Interception
LSB	Least Significant Bit
LSO	Landing System Officer
MAC	Media Access Control
MASPS	Minimum Aviation System Performance Standards
MER	Message Error Rate
MHz	Megahertz
MSB	Most Significant Bit
MULAL	Maximum Uplinked Lateral Alert Limit
MUVAL	Maximum Uplinked Vertical Alert Limit
NATO	North Atlantic Treaty Organization
NAVSTAR	Navigation Satellite Timing and Ranging
nm	Nautical Mile
NUC	Navigation Uncertainty Category
OVC	Overcast
ORD	Operational Requirements Document

OSI	Open System Interconnection
P(R)	Receive Sequence Number
P(S)	Send Sequence Number
PAT	Production Acceptance Test
PIM	Position and Intended Movement
PN	Pseudorange Noise
PPS	Precise Positioning Service
PRN	Pseudo Range Number
RNR	Receiver Not Ready
RPD	Reduced Probability of Detection
RF	Radio Frequency
RNAV	Area Navigation
RR	Receiver Ready
RT	Radio Transmitter
RX	Receive
SAASM	Selective Availability and Anti-Spoofing Module
SAT	Site Acceptance Test
SCT	Scattered
SOE	Shipboard Operating Environment
SIS	Signal In Space
SKC	Sky Clear (No Clouds)
SN	Slot Number
SNR	Signal to Noise Ratio
SR	Ship Range
SRD	System Requirements Document
SRP	Ship Reference Point
TACAN	Tactical Air Navigation (System)
TBD	To Be Determined
TBR	To Be Reviewed
TD	Technology Development
TDMA	Time Division / Demand Multiple Access
TDP	Touchdown Point
TOA	Time of Arrival
TOD	Time of Day
TRANSEC	Transmission Security
TSN	Time Slot Number
TX	Transmit
UHF	Ultra High Frequency
ULAL	Uplinked Lateral Alert Limit
UTC	Universal Coordinated Time

UVAL	Uplinked Vertical Alert Limit

6 Classified Content

6.1 (U) Scope

6.1.1 (U) Overview

(U) This section establishes the classified requirements for the Data Link Subsystem of the Sea Based JPALS system.

6.2 (U) Data Link Subsystem Requirements

6.2.1 (U) General Requirements

(U) General requirements apply to both Sea Based JPALS-Air and Sea Based JPALS-Ship segments.

6.2.1.1 (U) TRANSEC

(U) Keystream usage shall be restricted to (classified).

6.2.1.2 (U) Signal Detectability

(U) The transmitter subsystem shall be designed and tested to ensure the worst threat intercept receiver must be closer than (classified) nautical miles (with a goal of (classified)) in order to detect the transmitted airborne signal for any function.

(U) All transmit noise, leakage and spurious emissions shall be evaluated as detectable threats.

6.2.1.2.1 (U) Threat Specifications

(U) The transmitter subsystem will use techniques to deny or avoid P_d and P_{fa} performance of both radiometric and non-linear feature detector threats as detailed below. The transmitter subsystem will consider other existing and future threats as identified and deemed appropriate. The threat receiver architectures are described in TBD.

(U) Commercial-off-the-shelf (COTS) spectrum analyzers, manually and automatically tuned receivers: P_d (classified), P_{fa} (classified)

6.2.2 (U) Sea Based JPALS-Air Segment

(U) The following requirements are applicable to the Sea Based JPALS-Air segment.

6.2.2.1 (U) Synchronization

(U) If the receiver subsystem loses power for 7 seconds or less, it shall reacquire within (TBD classified).

(U) With "Wrist Watch Time" loaded, the receiver subsystem shall achieve synchronization within (TBD classified).

(U) With "Coarse Time" loaded, the receiver subsystem shall achieve synchronization within (TBD classified).

(U) With "Fine Time" loaded, the receiver subsystem shall achieve synchronization within (TBD classified).

6.2.3 (U) Sea Based JPALS-Ship Segment

(U) The following requirements are applicable to the Sea Based JPALS-Ship segment.

6.2.3.1 (U) Synchronization

(U) If the receiver subsystem loses power for 7 seconds or less, it shall reacquire within (classified).

(U) The receiver subsystem shall achieve synchronization to a Sea Based JPALS-Air downlink with a probability of (TBD classified).

7 Network Definition

7.1 Scope

Section 7 establishes the network implementation for the Data Link Subsystem of the Sea Based JPALS waveform RF interface. This section is applicable to both airborne and control platform applications.

7.2 System Networking Requirements

7.2.1 Application of the Open Systems Interconnection Model

To accomplish the independent transfer of Sea Based JPALS data, the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) model was selected as a basis of defining the Sea Based JPALS network stack.

While it is not part of this specification, the Layer to Layer interfaces should have well defined interfaces to the protocol layer above and below. These interfaces provide for easy replacement or upgrade of the different protocol layers without impacting the entire protocol stack.

The network services that are provided at each layer must be well defined so that the other protocol layers have clear definition of how to interpret data.

7.2.2 Assumptions

This implementation of Sea Based JPALS assumes the following:

- Application Messages are supplied from an external source to the data link RT.
- There is a stable, fully maintained, external time source, referenced to Universal Coordinated Time (UTC) provided to the data link RT prior to operation.
- Once the data link RT has initial UTC time, the RT does not require resynchronization for up to four hours.

7.2.3 Networking Services Provided

Section 7 describes the protocol to be used for all communications between ships and aircraft on Sea Based JPALS networks. The Sea Based JPALS networks are used by the following functions: Navigation, Monitoring and Communications. Each function can operate at a different maximum radius from the control platform. A TDMA channel allocation scheme is used to provide communication between a ship and one or more aircraft. Each TDMA epoch includes time slots dedicated or assigned to each of the functions and may include time slots for other services, as needed.

Each Sea Based JPALS epoch is 5 seconds long and represents the period of the channel access portion of the waveform. Epoch duration is flexible and is driven by the lowest common multiple of the repetition rates for Application Messages in the Sea Based JPALS application as defined in Section 9 of this specification.

7.2.3.1 Application Layer Services

The services provided at the Application Layer are application specific and are defined to fit the needs of the application programs. The protocol provides two-way communication between a ship and one or more aircraft. Each aircraft **shall** monitor communications from other aircraft in its vicinity to provide situational awareness. This monitoring function is only operative for aircraft that are communicating with the same network.

7.2.3.2 Presentation and Session Layer Services

No services are provided at the Presentation Layer or at the Session Layer. These protocol layers are empty in the current system definition.

While these protocol layers are currently empty and inter-layer interfaces are beyond the scope of this document, it is recommended that designers provide a well defined interface between the Application Layer and the Transport Layer so that services at the Presentation or Session Layer could be easily inserted later.

7.2.3.3 Transport Layer Services

The Transport Layer provides the following services:
- Maintain Layer 4 message ordering
- End-to-End Layer 4 message Acknowledgments (Acks)
- Message retransmissions
- Multipart Layer 4 message segmentation and reassembly
- Message flow control
- Message content information
- Message formatting (including revision) information

The Transport Layer provides message sequencing and message ordering for Acked messages. Only one unAcked message is permitted between any pair of source and destination addresses for each message priority. In this paragraph, an unAcked message refers to a message that requires an Ack, but the Ack for the last message part has not yet been received by the message originator. This ensures that the messages which require Acks will arrive at the destination in the same order the messages are originated.

The Transport Layer is the lowest protocol layer that provides true end-to-end communication. The Transport Layer provides a true end-to-end acknowledgment service. This Ack service is only provided for certain messages and should not be requested for high rate broadcast messages. End-to-end Acks are intended to be used for ATM messages, and no provision for an acknowledgment exists for broadcast messages.

In addition to the end-to-end Acks, the Transport Layer has the ability to retransmit missing message parts. This gives the destination Transport Layer the ability to ensure that only complete messages are passed on to the higher layers. All parts of a message must be received correctly before the message is passed on.

The Transport Layer provides the capability for the message originator to resend a message or part of a message that was not received at the destination. For all messages requiring an End-to-End Ack, the message originator must keep all parts of the message until the last message part is Acked by the destination. This is necessary so that the message can be retransmitted if requested. Once an entire message has been Acked by the destination, the message originating Transport Layer may discard the message.

At the message originator, the Transport Layer will fragment large ATM application messages into multiple message fragments. Each message fragment must fit within a single packet and ATM slot. This fragmentation service only applies to large ATM messages. All of the periodic broadcast messages must fit within the size limitation of the slot assigned to it by the slots.exe program, so either the application messages or the slot size for these messages must be adjusted accordingly.

It is expected that the vast majority of the application messages will fit into a single packet.

This layer provides message flow control for non-broadcast messages. Incoming messages can be slowed by the destination by sending control messages back to the message originator. Broadcast messages cannot be slowed, and they are transmitted at the rate determined by the message originator.

The Transport Layer also has provision to identify the message content. This information is located in the first two bytes of the message, and will be used at the Network Layer to indicate which message had a problem when there is a problem. This information is also used to indicate the revision of a message. This will be discussed in more detail later.

7.2.3.4 Network Layer Services

The Network Layer provides the following services:
- Packet priorities

- Packet routing based on destination addresses
- Destination Address filtering
- Variable length source and destination addresses
- Layer 3 RF Acknowledgments
- Packet retransmissions
- Packet ordering
- Packet flow control
- Aircraft ATM Slot request
- Network Login/Logout procedures
- RF to onboard Network Address translation

The Network Layer controls the communication between adjacent nodes in the network. The communication between an onboard host and the onboard radio or between the ship radio and the aircraft radio is the domain of the Network Layer protocol. There are multiple Network Layer protocols within Sea Based JPALS. The one described herein is the one that is present over the RF link between the ship and an aircraft.

The Network Layer provides the ability to prioritize packets. There are 16 levels of priority available. The Network Layer always processes the highest priority packet that is ready to be processed before processing any packets of a lower priority. Packets of equal priority are processed on a first come first served basis.

The Network Layer provides packet routing based on a packet's destination address. The Network Layer will discard messages that are not intended for the platform. In the case of the aircraft monitoring function, the Network Layer will discard messages that are not addressed to the correct ship. The Network Layer interprets variable length packet addresses.

The Network Layer is designed to provide Network Layer Acks on the RF link between the ship and aircraft. This ability will reduce the number of Transport Layer retransmissions and will improve the response time because of the shorter delays involved at the Network Layer. Only certain packets will have the ability to use the Layer 3 Acks. These are typically the packets from messages that request an end-to-end Ack. These Acked packets also have the provision for Network Layer packet retransmissions in situations where the packets are not received error free.

The Network Layer has the ability to keep packets in the proper order by the use of a numbering scheme. This scheme can be used to keep the packets in the correct order at the receiving node. Broadcast messages are not retransmitted, but this numbering scheme can be used to determine if a broadcast packet was missed by looking at the sequence numbers.

The Network Layer provides packet flow control for non-broadcast packets. The receiving node can temporarily delay the packet transmissions by telling the sender it is busy.

Broadcast packets are not subject to flow control. If broadcast packets arrive at a network node faster than the destination is accepting them and if the packet queue at a network node is full, then the intermediate network node shall discard the oldest message in the same Logical Channel Group (LCG) having the same source/destination address pair as for the newly received packet, if any.

If there are no messages that match, then the node shall discard messages in the following order of preference: oldest message in the same LCG as the received message, oldest message in the next lower priority odd LCG having the same source/destination address pair, oldest message in the next lower priority odd LCG, oldest message in the next lower priority odd LCG having the same source/destination address pair, oldest message in the next lower odd LCG, and so on down to the lowest priority odd LCG. If the node still cannot find space for the newly received message, it should discard it.

The RF Network Layer provides a mechanism for the aircraft to request an ATM time slot to send an ATM message to the ship. A limited number of ATM slots are shared among all of the aircraft, and this mechanism provides a way for each aircraft to request a place to send an ATM message to the ship. The ship does not request slots, but assigns a downlink ATM slot to aircraft that requested one.

The Network Layer also provides a means for aircraft to login to the network. This login is only necessary for the aircraft that need to have 2-way communication with the ship. Each Network Case provides for a maximum number of these aircraft slots. Any number of aircraft can participate in the Network in receive only mode and they are able to receive the broadcast navigation information from the ship.

One function of the Network Layer is to convert the Layer 3 protocol from what is present on the RF Network Layer protocol to the ship or aircraft based Network Layer protocol. This is a network gateway function. This converts the RF Layer 3 address to an onboard based network address. This network address translation is probably a lookup table or routing table that resides in the node closest to the antenna (most likely the RT).

7.2.3.5 Data Link Layer Services

The Data Link Layer provides the following list of Network Services:

- Data Framing
- Variable length frames
- Data Link address filtering
- Variable length Data Link Layer addresses
- Bad frame reject
- Transmit power control information
- COMSEC
- Convolutional coding Forward Error Correction (FEC)
- TRANSEC

The Data Link Layer provides data framing. It has an indication of the start of the frame and an indication of the end of the frame. On the RF link, the start of the frame is indicated by the end of the slot preamble. The first octet of the message begins immediately following the end of the preamble. The end of the frame can be determined using the bit count field from the start of the frame.
The Data Link Layer provides for variable length frames up to the maximum size for a slot. One and only one frame is allowed in a slot.

The Data Link Layer provides some very basic Layer 2 address screening to determine if the message is intended for a ship or an aircraft. The Data Link Layer address can be a variable length.

The Data Link Layer provides a criterion for rejecting bad frames. If a frame is too short, or if it fails the Frame Check Sequence (FCS), the Data Link Layer will discard the entire frame.

The RF Data Link Layer provides the mechanism to control the transmit power for the ship and aircraft. A control bit provides feedback which is used to adjust the transmit power.

While not part of the Data Link Layer protocol directly, this layer also will perform COMSEC to protect the information in the frame, a convolutional code will provide for error correction, and the frame transmission will be protected using TRANSEC.

7.2.4 OSI Reference Model

The protocol is described in terms of a layered architecture patterned after the ISO OSI Basic Reference Model in an attempt to ensure that all protocol functions are adequately described. The descriptions of the suggested protocol imply a specific implementation. The OSI reference model is depicted below.

Note: The physical and data link layers are defined in Section 8.

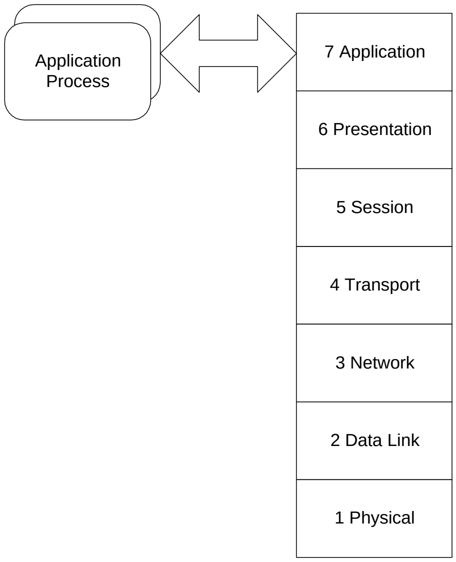

Figure 7-1: OSI Reference Model

7.2.5 Sea Based JPALS Data Link Protocol Stack

The Sea Based JPALS protocol stack is depicted below.

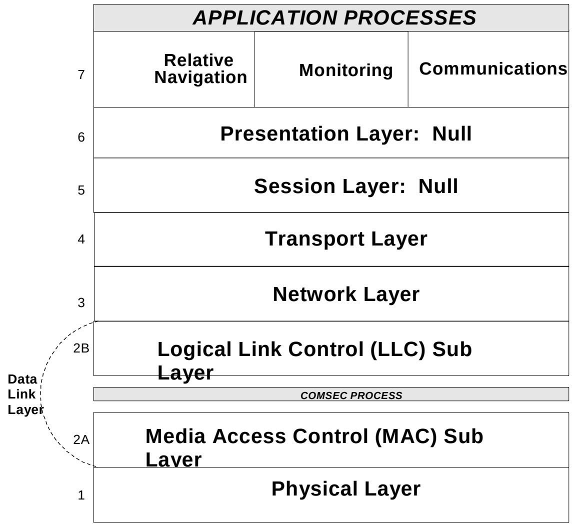

Figure 7-2: Sea Based JPALS Protocol Stack

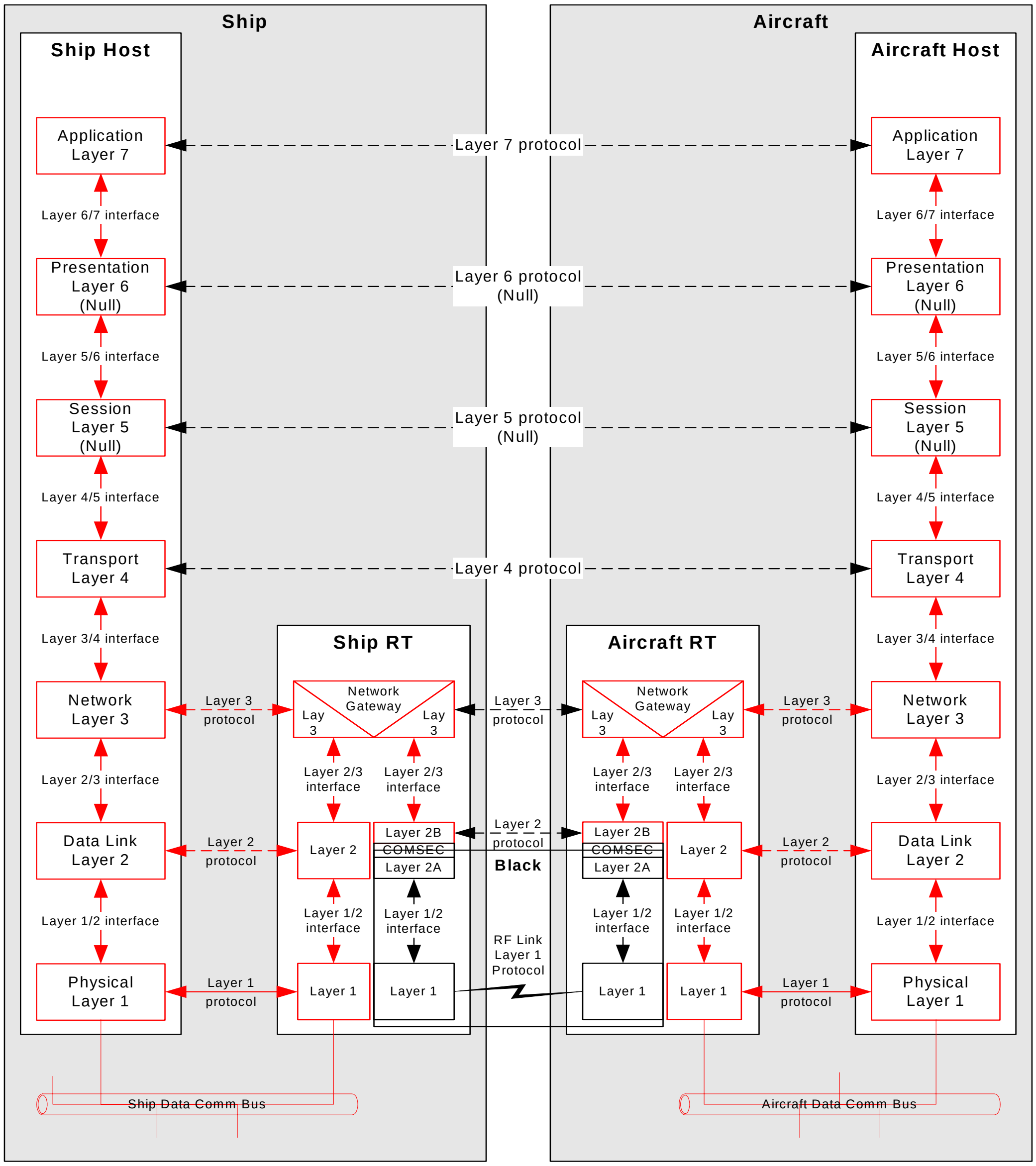

Figure 7-3: OSI Basic Reference Model Overlay

The figure depicts how the OSI Basic Reference Model overlays onto the Sea Based JPALS data communications. The two large gray boxes depict a ship and an aircraft. In each gray box, there is an end user and an intermediate communications node. The peer-to-peer protocols are indicated by the horizontal lines in the figure, while the vertical lines are the interlayer interfaces.

The figure shows the relevant interfaces and protocols necessary to communicate from a host on a ship to a host on an aircraft. Each end user or host will contain an entire 7 layer protocol stack. Some of the layers are empty as Sea Based JPALS does not provide services at all of the protocol layers. Layer 5 and Layer 6 are currently empty in Sea Based JPALS.

7.2.5.1 Application Layer

The Sea Based JPALS network will provide the following types of application functions: non-precision and precision relative navigation, normal and precision monitoring and communications. Each functional type operates at different maximum distances from the control platform.

- Non-precision relative navigation operations extend up to 200 nm (Objective 300 nm)
- Normal mode monitoring operations extend up to 50 nm
- Precision relative navigation operations extend up to 10 nm
- Normal mode monitoring between aircraft within 15 nm of each other and transmitting to the ship
- Precision mode monitoring operations to a minimum of 10 nm
- 2-way communications between a ship and its aircraft extend up to 50 nm

The requirements for the Sea Based JPALS application layer are to perform transport layer address mapping and application data translation.

7.2.5.2 Presentation Layer

The presentation layer typically provides independence to the application process from differences in data representation (syntax). There are no requirements for the presentation layer in Sea Based JPALS. This layer is non-existent in the Sea Based JPALS data link protocol architecture.

7.2.5.3 Session Layer

The session layer typically provides the control structure for communication between applications; it establishes, manages, and terminates connections between applications. There are no requirements for the session layer in Sea Based JPALS. This layer is non-existent in the Sea Based JPALS data link protocol architecture. Application messages that contain data originating in/destined for multiple platform applications are combined into a common Sea Based JPALS application message external to the data link.

7.2.5.4 Transport Layer

The Transport Layer provides reliable transparent transfer of data between end points; it provides end-to-end error recovery and flow control.

The Transport Layer is composed of message structures and elements of procedure which use the message structures to implement the Transport Layer protocol. This section defines the message structures and elements of procedure which make up the Transport Layer protocol.

7.2.5.4.1 Transport Layer Message Structures

The Transport Layer messages and message structures defined in this section are used to control Transport Layer functions.

7.2.5.4.1.1 Transport Layer Header

The following table shows the Layer 4 or Transport Layer Services that are provided and it identifies the artifacts that are used to implement each Transport Layer service.

Table 7-1: Layer 4 Transport Layer Services

Layer 4 Transport Layer Services	
Service	**Layer 4 Header Implementation**
Maintain L4 message delivery order	Message Number
Multi-packet L4 message assembly and disassembly	Message Part Number, Number of Layer 4 Message Parts
End-to-end L4 message Acks	End-to-End Ack bit, Layer 4 Ack messages, Layer 4 Snak messages
Message flow control	Layer 4 Receiver Ready (RR) message, Layer 4 Receiver Not Ready (RNR) msg
Message content information	Packet Number
Format information (including revision info)	Packet Format
Layer 4 message retransmissions	Prioritized Layer 4 Message Queues

The following table shows the structure of the Layer 4 Message Header. The Layer 4 Message Header consists of 5 octets or 40 bits.

Table 7-2: Layer 4 Message Header

8 MSB	7	6	5	4	3	2	1 LS Bit	L4 Octets
Message Number							0	1
Message Part Number							End-to-End ACK	2
Number of Layer 4 Message Parts							0	3
Packet Number								4
Packet Format								5

The Transport Layer or Layer 4 Message Header is used to implement the Transport Layer services previously defined. The functions of each piece of this header will be identified.

The least significant bit of the Layer 4 Message Header is called the Transport Header Format bit. The Transport Header Format bit shall be 0.

The Message Number identifies or serializes messages between address pairs. The Message Number is assigned sequential numbers for sequential messages to the same destination address from a particular message source. The range for the Message Number is 0 through 127 inclusive. The Message Number is modulo 128, so the next Message Number after 127 would be 0. The Message Number is used to identify duplicate messages that were retransmitted by the originator.

The Message Part Number indicates where the message part fits in the sequence of a multipart message. Message parts shall be numbered sequentially beginning with 1 and ending with the last message part up to a maximum of 127. Message part 0 is not used and shall be considered to be an error. Single part messages shall have the message part number set to one. A multi-part message is limited to 127 parts or less.

The End-to-End Ack bit shall be set to 1 for message parts requesting an acknowledgment from the destination address.

The Number of Layer 4 Message Parts field is set to the total number of message parts that comprise the message being sent. The value of this field ranges from 1 to 127 inclusive depending upon the size of the message. A single part message will set this to 1. A value of 0 shall be considered to be an error.

The Packet Number is used to group the information contained in the Application message into broad categories regardless of the message destination address. The assignment of this number is system wide and is not assigned on an address pair by address pair basis. The reason for this is that functions may move from one location to another, and the message Packet Number should not have to change just because the destination address changes. This allows more flexibility in assigning functions to different locations without necessitating changes in the data communications portions of the system. The Packet Number can be assigned any value from 0 to 255 inclusive. Packet Numbers 254 and 255 are reserved for use by data communications network nodes to carry out network functions and are not to be used or assigned by other devices in the system.

The Packet Format is used to further refine the information contained in the Application Message. This can be viewed as an extension of the Packet Number to categorize messages even further. This is also the field that contains information about the version of the message. If a message format is changed, the Packet Format should be changed to inform the message receiver that the message format has changed. This allows the receiver to determine if it has a version of software that can correctly interpret the message contents. The Packet Format can be assigned any value from 0 to 255 inclusive. The Packet Format is unique to each Packet Number, so for example, Packet Format 0 can be used with Packet Number 0, Packet Number 128, or any other Packet Number.

Systems should be designed to process at least three revisions of a message where possible. This eases the burden of the coordination of simultaneous software updates for all boxes that are participating in a network. Specific situations may require the ability to correctly handle more or fewer message versions of a particular message.

The Packet Number and Packet Format fields for the application messages are assigned in Section 9. The data communications network related Packet Number and Packet Format fields are defined in Section 7.

7.2.5.4.1.2 Transport Layer Acknowledgment

The format of the Transport Layer Ack message is shown in the following table:

Table 7-3: Transport Layer Ack Format

8 MSB	7	6	5	4	3	2	1 LS Bit	L4 Octets
Message Number being Acked							0	1
Part Number being Acked							0	2
0	0	0	0	0	0	1	0	3
1	1	1	1	1	1	1	0	4
0	0	0	0	0	0	0	1	5

The Message Number being Acked field shall be the same value as the Message Number of the message that is being Acked. The Transport Header Format bit shall be 0. The Part Number being Acked field shall be the highest Part Number from the message that is being Acked that had its End-to-End Ack bit set. The End-to-End Ack bit shall be 0. The Number of Layer 4 Message Parts shall be set to 1 since the Ack message is a single part message. The Packet Number shall be 254 and the Packet Format shall be 1.

7.2.5.4.1.3 Transport Layer Selective Negative Acknowledgment

The format of the Transport Layer Selective Negative Acknowledgment or Snak message is shown in the following table:

Table 7-4: Transport Layer Snak Format

8 MSB	7	6	5	4	3	2	1 LS Bit	L4 Octets
Message Number being Snaked							0	1
Part Number being Snaked							0	2
0	0	0	0	0	0	1	0	3
1	1	1	1	1	1	1	0	4
0	0	0	0	0	0	1	0	5

The Message Number being Snaked field shall be the same value as the Message Number of the message that is being Snaked. The Transport Header Format bit shall be 0. The Part Number being Snaked field shall be the Part Number from the message that is being requested to be retransmitted. The End-to-End Ack bit shall be 0. The Number of Layer 4 Message Parts shall be set to 1 since the Snak message is a single part message. The Packet Number shall be 254 and the Packet Format shall be 2.

7.2.5.4.1.4 Transport Layer Receiver Abort

The format of the Transport Layer Receiver Abort message is shown in the following table:

Table 7-5: Transport Layer Receiver Abort Format

8 MSB	7	6	5	4	3	2	1 LS Bit	L4 Octets
Message Number							0	1
0	0	0	0	0	0	0	0	2
0	0	0	0	0	0	1	0	3
1	1	1	1	1	1	1	0	4
0	0	0	0	0	0	1	1	5

The Message Number field shall be the same value as the Message Number of the message that is being aborted. The Transport Header Format bit shall be 0. The Part Number field shall be 0, because the entire message is being aborted, not just one part. The End-to-End Ack bit shall be 0. The Number of Layer 4 Message Parts shall be set to 1 since the Receiver Abort message is a single part message. The Packet Number shall be 254 and the Packet Format shall be 3.

7.2.5.4.1.5 Transport Layer Transmitter Abort

The format of the Transport Layer Transmitter Abort message is shown in the following table:

Table 7-6: Transport Layer Transmitter Abort Format

8 MSB	7	6	5	4	3	2	1 LS Bit	L4 Octets
Message Number							0	1
0	0	0	0	0	0	0	0	2
0	0	0	0	0	0	1	0	3
1	1	1	1	1	1	1	0	4
0	0	0	0	0	1	0	0	5

The Message Number field shall be the same value as the Message Number of the message that is being aborted. The Transport Header Format bit shall be 0. The Part Number field shall be 0, because the entire message is being aborted, not just one part. The End-to-End Ack bit shall be 0. The Number of Layer 4 Message Parts shall be set to 1 since the Transmitter Abort message is a single part message. The Packet Number shall be 254 and the Packet Format shall be 4.

7.2.5.4.1.6 Transport Layer Reject

The format of the Transport Layer Reject message is shown in the following table:

Table 7-7: Transport Layer Reject Format

8 MSB	7	6	5	4	3	2	1 LS Bit	L4 Octets
Message Number							0	1
0	0	0	0	0	0	0	0	2
0	0	0	0	0	0	1	0	3
1	1	1	1	1	1	1	0	4
0	0	0	0	0	1	0	1	5

The Message Number field shall be the same value as the Message Number of the message that is being rejected. The Transport Header Format bit shall be 0. The Part Number field shall be 0, because the entire message is being rejected, not just one part. The End-to-End Ack bit shall be 0. The Number of Layer 4 Message Parts shall be set to 1 since the Reject message is a single part message. The Packet Number shall be 254 and the Packet Format shall be 5.

7.2.5.4.1.7 Transport Layer Receiver Ready

The format of the Transport Layer Receiver Ready message is shown in the following table:

Table 7-8: Transport Layer Receiver Ready Format

8 MSB	7	6	5	4	3	2	1 LS Bit	L4 Octets
Message Number							0	1
0	0	0	0	0	0	0	0	2
0	0	0	0	0	0	1	0	3
1	1	1	1	1	1	1	0	4
0	0	0	0	1	0	1	0	5

The Message Number field shall be 0. The Transport Header Format bit shall be 0. The Part Number field shall be 0. The End-to-End Ack bit shall be 0. The Number of Layer 4 Message Parts shall be set to 1 since the Receiver Ready message is a single part message. The Packet Number shall be 254 and the Packet Format shall be 10.

7.2.5.4.1.8 Transport Layer Receiver Not Ready

The format of the Transport Layer Receiver Not Ready message is shown in the following table:

Table 7-9: Transport Layer Receiver Not Ready Format

8 MSB	7	6	5	4	3	2	1 LS Bit	L4 Octets
Message Number							0	1
0	0	0	0	0	0	0	0	2
0	0	0	0	0	0	1	0	3
1	1	1	1	1	1	1	0	4
0	0	0	0	1	0	1	1	5

The Message Number field shall be 0. The Transport Header Format bit shall be 0. The Part Number field shall be 0. The End-to-End Ack bit shall be 0. The Number of Layer 4 Message Parts shall be set to 1 since the Receiver Not Ready message is a single part message. The Packet Number shall be 254 and the Packet Format shall be 11.

7.2.5.4.2 Transport Layer Elements of Procedure

7.2.5.4.2.1 Procedures for Message Transfer

The procedures for message transfer are TBD as they are currently being developed and will be in the next revision of this document.

7.2.5.5 RF Network Layer

This section defines the Network Layer protocol that is used across the RF link in Sea Based JPALS. No assumptions should be made regarding the content nor format of the Network Layer protocol onboard the ship or onboard the aircraft.

The network layer provides upper layers transparent access to nodes. The following is a list of functions performed in the Sea Based JPALS network layer:

- Addressing (ship, aircraft, group of aircraft) and address translation
- End-to-end reliability (network acknowledging/No-acknowledging)
- Service selection (determine RF string and time slot)
- Network login/logout (including network/configuration type)
- Concatenation/Deconcatentation (Note: This function may be performed in the data link layer to minimize throughput latency for fragments of concatenated data packets).

The network layer uses the data link and physical layers to transmit and receive data per the case-specific channel access definition. This is described in section 4.

7.2.5.5.1 RF Network Layer Message Structures

The Network Layer messages and message structures defined in this section are used to control Network Layer functions.

7.2.5.5.1.1 RF Network Layer Header

The following table shows the Layer 3 or Network Layer Services that are provided and it identifies the artifacts that are used to implement each Network Layer service.

Table 7-10: Layer 3 Network Layer Services

Layer 3 Network Layer Services	
Service	**Layer 3 Header Implementation**
Layer 3 RF Acks	Q bit, D bit, P(R), P(S), Datagram service signals (L3 message)
Packet priorities	Logical Channel Group
Packet ordering	P(R), P(S)
Packet flow control	P(R), P(S)
Packet retransmissions	Logical Channel Group, Layer 3 RF Acks, Prioritized Packet Queues
Destination address packet routing	Destination Address Octets
Network address translation : RF / onboard	Last 4 bits of Destination Address
Layer 3 address screening	Destination Address Octets
Network Login/Logout procedures	Q-bit datagram service signal L3 message
Aircraft ATM Slot request	Slot Request (SR) bit in Air State Message
Variable length addresses	Source and Destination address lengths

The Network Layer or Layer 3 Packet Header is used to implement the Network Layer services previously defined. The functions of each piece of this header will be identified. This definition applies to the messages that flow across the RF link between the ship and the aircraft.

The Layer 3 Packet Header currently consists of 7 octets or 56 bits given the defined address lengths for the ship and aircraft.

Table 7-11: Layer 3 Packet Header Format

8 MSB	**7**	**6**	**5**	**4**	**3**	**2**	**1 LS Bit**	**L3 Octets**
General Format ID				Logical Ch. Group/Priority				
Q	D	0	1	X	X	X	X	1
Packet Type ID								2
Src Addr Length in semi-octets				Dest Addr Length in semi-octets				3
Destination Address Octet								4
Destination Address Octet								5
Source Address Octet								6
Source Address Octet								7
Packet Data								NA

Octet 1 of the Network Layer header contains the General Format Identifier (GFI) and LCG fields. The GFI contains information about the format of the datagram packet that follows. Bit 8 is the Qualifier bit or Q bit. The Q bit shall be set to 0 for all datagram packets and set to 1 for datagram service signals. Datagram service signals are used solely for network control functions and shall not be used by application programs. All application messages shall be sent with the Q bit set to 0.

The Delivery confirmation bit or D bit, is used to indicate that the source is requesting RF link delivery confirmation. Bit 6 in the GFI shall be 0. Bit 5 in the GFI shall be 1. These bits are used for modulo numbering control of the packets which is not being used at this time. The LCG field is used to designate packet priority with 0 being the highest priority packets and 15 being the lowest priority packets. The least significant bit of the LCG is also used to indicate if the packet can be retransmitted. If the LCG is odd meaning that the least significant bit of the LCG is a 1, then the packet shall not be retransmitted by the RF Network Layer protocol. If the LCG is even meaning that the Least Significant Bit (LSB) of the LCG is a 0, then the packet can be retransmitted at the RF Network Layer.

Octet 2 of the Network Header contains the Packet Type ID. The format of the Packet Type ID is shown in the following table:

Table 7-12: Packet Type ID

8 MSB	7	6	5	4	3	2	1 LS Bit	Packet Type ID
Rcv Seq P(R)			M	Snd Seq P(S)			0	Datagrams
Rcv Seq P(R)			0	0	0	0	1	Receiver Ready
Rcv Seq P(R)			0	0	1	0	1	Receiver Not Ready
Rcv Seq P(R)			0	1	0	0	1	Reject
X	X	X	1	1	0	1	1	Reset Request
X	X	X	1	1	1	1	1	Reset Confirmation
X	X	X	0	1	0	1	1	Restart Request
X	X	X	0	1	1	0	1	Restart Confirmation
X	X	X	1	0	0	0	1	Diagnostic
X	X	X	0	0	0	1	1	Unnumbered Datagrams

The least significant bit of the Packet Type ID is set to 0 to designate datagram packets. The format of the Packet Type ID for datagrams also contains the Receive Sequence Number P(R), the Layer 3 More bit, and the Send Sequence Number P(S). The Receive Sequence Number P(R) is module 8 and can take on any value between 0 and 7 inclusive. The Layer 3 More bit is not used and shall be set to 0. The More bit could be used to implement Layer 3 fragmentation of Layer 4 message parts, but this function is undefined. The Send Sequence Number P(S) is module 8 and can take on any value between 0 and 7 inclusive.

Octet 3 contains the length of the source address in semi-octets and the length of the destination address in semi-octets. Both of these fields can take on any value between 0 and 15 inclusive.

The next Network Layer header field is the destination address. This is a variable length field and contains the address of the intended destination for the packet. It is possible for this address to contain an odd number of semi-octets, in which case, the source address will not necessarily start on an octet boundary, but it may be shifted by one-half an octet. The source address Network Layer header field is also a variable length field. This field begins immediately after the end of the destination address field. If the source address ends in the middle of an octet, the lower 4 bits of that octet are set to zeros to pad out the address to an integer number of octets.

The Transport Layer header follows immediately after the last octet of the source address.

7.2.5.5.1.2 Message Priority

The LCG field in the Layer 3 Packet Header is used to indicate message priority information. There are 16 values for this field, with 0 being the highest priority and 15 being the lowest.

JPALS devices shall give preferential delivery processing to the messages of higher message priority over message of lower priority. All unblocked messages of a higher priority shall be processed before processing a lower priority message. A blocked message is defined as one that is temporarily delayed due to events or conditions outside of the JPALS device, such as waiting for the correct TDMA slot time to arrive or receiving a Receiver Not Ready (RNR) message. If a higher priority message is blocked the JPALS device shall process lower priority traffic and move it closer to its destination while waiting for the higher priority message to become unblocked.

It is expected that there will be the equivalent of an ordered queue in each JPALS device that puts the highest priority messages to the front of the queue, while putting the messages of lower priority behind higher priority messages and the lowest priority message at the back of the queue. Furthermore, the intermediate network devices should maintain packet order by placing the newly arriving packets at the back of the queue of messages of the same priority and ahead of messages of a lower priority.

In some instances it will be possible for a lower priority message of one kind to be delivered before a higher priority message of a different kind due to the message arrival times relative to the timing of the TDMA slots for the two messages.

For any two queued messages that are unblocked and are to be sent in the same kind of slot neither of which has begun transmission, the message with higher priority shall be delivered before the message of lower priority.

If two unblocked messages are of the same priority, the message that was received first shall be sent first.

7.2.5.5.1.3 RF Network Layer Address formats

The RF Network Layer addresses are of the form of a Platform ID followed by a Process ID. The Platform ID is a variable length portion of the address, and the Process ID is defined to be one semi-octet long. The most significant octet in a multi-octet address shall be located closest to the beginning of the packet.

The ship address is composed of 12 bits for the Platform ID and 4 bits for the Process ID. It looks like this: SSSP, where S is one semi-octet of the ship address and P is one semi-octet of the Process ID. The aircraft network address is composed of 8 bits of Platform ID and 4 bits of Process ID. The aircraft address looks like this: AAP, where A is one semi-octet of the aircraft network assigned address, and P is one semi-octet of the Process ID.

A message addressed to an aircraft from the ship would have the following address structure: Source address length is 4, Destination address length is 3, AAPSSSP0 where the letters represent the same as previously described, and the 0 implies 4 bits of 0s are added on the end to fill out the last address octet.

A message addressed to a ship from an aircraft would have the following address structure: Source address length is 3, Destination address length is 4, SSSPAAP0 where the letters represent the same as previously described, and the 0 implies 4 bits of 0s are added on the end to fill out the last address octet.

It is expected that the software use the address length fields to determine the correct address format, and not to make any assumptions about the length of addresses in messages it receives. The least significant 4 bits of an address shall be the Process ID.

The following table is an example of what the address field looks like in messages that are addressed to a ship from an aircraft:

Table 7-13: Sample Message From Aircraft to Ship

8 MSB	7	6	5	4	3	2	1 LS Bit	L3 Octets
Q	D	0	1	X	X	X	X	1
P(R)			0	P(S)			0	2
0	1	0	0	0	0	1	1	3
A	A	A	A	A	A	A	A	4
P	P	P	P	S	S	S	S	5
S	S	S	S	S	S	S	S	6
P	P	P	P	0	0	0	0	7
Remaining portion of the message								

The source address length is 4 and the destination address length is 3. *Note that the source address immediately follows the destination address and that since the two addresses don't end on an octet boundary, the last 4 bits are filled with 0s.*

A network login message will probably contain the aircraft tail number as the source address which is estimated to be a 24 bit number instead of the 8 bit network address.

7.2.5.5.1.4 RF Network Layer Acknowledgment

The format of the delivery confirmation datagram service signal or Network Layer RF Acknowledgment shall be as specified in the table below:

Table 7-14: RF Network Layer Ack Format

8 MSB	**7**	**6**	**5**	**4**	**3**	**2**	**1 LS Bit**	**L3 Octets**
1	0	0	1	X	X	X	X	1
P(R)			0	P(S)			0	2
Src Addr Length				Dest Addr Length				3
Destination Address								4
Destination Address								5
Source Address								6
Source Address								7
Packet Number from L4 header of packet being Acked								8
Packet Format from L4 header of packet being Acked								9
0	0	1	1	0	0	0	1	10

The Q bit is 1 to indicate this is a datagram service signal packet. The D bit is 0 to indicate that the service signal packet is not requesting delivery confirmation. The LCG is the same value that is contained in the packet being Acked. The receive and send sequence numbers are the appropriate values as defined elsewhere. The packet receiver shall use the same addresses in the datagram service signal packet that were in the packet being Acked, except that the source and destination addresses are to be exchanged so the service signal is addressed to the message originator. The source and destination address lengths shall reflect the addresses in the service signal packet. The Packet Number and Packet Format shall be copies of the first two octets of the Layer 4 header from the message that is being Acked. Finally, the Service Signal Cause field shall contain 0x31 as shown above to indicate delivery confirmation.

7.2.5.5.1.5 RF Network Layer Receiver Ready

The format of the RF Network Layer Receiver Ready (RR) packet shall be as specified in the table below:

Table 7-15: RF Network Layer Receiver Ready (RR) Format

8 MSB	**7**	**6**	**5**	**4**	**3**	**2**	**1 LS Bit**	**L3 Octets**
0	0	0	1	X	X	X	X	1
P(R)			Packet Type Identifier					2
			0	0	0	0	1	
Src Addr Length				Dest Addr Length				3
Destination Address								4
Destination Address								5
Source Address								6
Source Address								7

The Q bit is 0 to indicate this is a datagram packet. The D bit is 0 to indicate that the packet is not requesting delivery confirmation. The LCG field contains the value of the LCG for which the RR packet is being sent. The least significant 5 bits of the Packet Type ID are 0x01, and the 3 most significant bits are the receive sequence number (P (R)) or the expected send sequence number of the next packet on this LCG from the remote node.

The destination address is the address for which this RR packet is intended and the source address is the address of the originator of this RR packet. The source and destination address lengths are set accordingly.

7.2.5.5.1.6 RF Network Layer Receiver Not Ready

The format of the RF Network Layer RNR packet shall be as specified in the table below:

Table 7-16: RF Network Layer Receiver Not Ready (RNR) Format

8 MSB	**7**	**6**	**5**	**4**	**3**	**2**	**1 LS Bit**	**L3 Octets**
0	0	0	1	X	X	X	X	1
P(R)			0	0	1	0	1	2
Src Addr Length				Dest Addr Length				3
Destination Address								4
Destination Address								5
Source Address								6
Source Address								7

The Q bit is 0 to indicate this is a datagram packet. The D bit is 0 to indicate that the packet is not requesting delivery confirmation. The LCG field contains the value of the LCG for which the RNR packet is being sent. The least significant 5 bits of the Packet Type ID are 0x05, and the 3 most significant bits are the receive sequence number (P(R)) or the expected send sequence number of the next packet on this LCG from the remote node.

The destination address is the address for which this RNR packet is intended and the source address is the address of the originator of this RNR packet. The source and destination address lengths are set accordingly.

7.2.5.5.1.7 RF Network Layer Reset Request

The format of the RF Network Layer Reset Request packet shall be as specified in the table below:

Table 7-17: RF Network Layer Reset Request Format

8 MSB	**7**	**6**	**5**	**4**	**3**	**2**	**1 LS Bit**	**L3 Octets**
0	0	0	1	X	X	X	X	1
0	0	0	1	1	0	1	1	2
Src Addr Length				Dest Addr Length				3
Destination Address								4
Destination Address								5
Source Address								6
Source Address								7
Resetting cause								8
Diagnostic Code								9

The Q bit is 0 to indicate this is a datagram packet. The D bit is 0 to indicate that the packet is not requesting delivery confirmation. The LCG field contains the value of the LCG for which the Reset packet is being sent.

The Packet Type ID is 0x1B.

The destination address is the address for which this packet is intended and the source address is the address of the originator of this packet. The source and destination address lengths are set accordingly. The resetting cause is coded as shown in the following table:

Table 7-18: Resetting Cause Code Field

8 MSB	7	6	5	4	3	2	1 LS Bit	Cause
0	0	0	0	0	0	0	1	Out of Order
0	0	0	0	0	1	0	1	Local Procedure error
0	0	0	0	0	1	1	1	Network Congestion

The Diagnostic Code octet provides additional information on the reason for the reset. This field is currently empty and should be set to all 0s.

7.2.5.5.1.8 RF Network Layer Reset Confirmation

The format of the RF Network Layer Reset Confirmation packet shall be as specified in the table below:

Table 7-19: RF Network Layer Reset Confirmation Format

8 MSB	**7**	**6**	**5**	**4**	**3**	**2**	**1 LS Bit**	**L3 Octets**
0	0	0	1	X	X	X	X	1
0	0	0	1	1	1	1	1	2
Src Addr Length				Dest Addr Length				3
Destination Address								4
Destination Address								5
Source Address								6
Source Address								7

The Q bit is 0 to indicate this is a datagram packet. The D bit is 0 to indicate that the packet is not requesting delivery confirmation. The LCG field contains the value of the LCG for which the Reset Confirmation packet is being sent. The Packet Type Identifier is 0x1F.

The destination address is the address for which this packet is intended and the source address is the address of the originator of this packet. The source and destination address lengths are set accordingly.

7.2.5.5.1.9 RF Network Layer Restart Request

The format of the RF Network Layer Restart Request packet shall be as specified in the table below:

Table 7-20: RF Network Layer Restart Request Format

8 MSB	7	6	5	4	3	2	1 LS Bit	L3 Octets
0	0	0	1	0	0	0	0	1
1	1	1	1	1	0	1	1	2
Src Addr Length				Dest Addr Length				3
Destination Address								4
Destination Address								5
Source Address								6
Source Address								7
Restarting Cause								8
Diagnostic Code								9

The Q bit is 0 to indicate this is a datagram packet. The D bit is 0 to indicate that the packet is not requesting delivery confirmation. The LCG field contains 0 because it applies to all LCGs. The Packet Type Identifier is 0xFB.

The destination address is the address for which this packet is intended and the source address is the address of the originator of this packet. The source and destination address lengths are set accordingly.

The Restarting Cause is coded as shown in the following table:

Table 7-21: Restarting Cause Code Field

8 MSB	7	6	5	4	3	2	1 LS Bit	Restarting Cause
0	0	0	0	0	0	0	1	Local Procedure error
0	0	0	0	0	0	1	1	Network Congestion
0	0	0	0	0	1	1	1	Network Operational

The Diagnostic Code is used to provide additional information about the Restarting Cause and is coded as shown in the following table:

Table 7-22: Restarting Cause Diagnostic Code

8 MSB	7	6	5	4	3	2	1 LS Bit	Diagnostic Code
0	0	0	0	0	0	0	0	No additional info
0	0	0	0	0	0	0	1	Invalid P(S)
0	0	0	0	0	0	1	0	Invalid P(R)
0	0	0	1	0	0	0	0	Packet Type Invalid
0	0	1	0	0	0	0	0	Packet not allowed
0	0	1	1	0	0	0	0	Timer Expired

7.2.5.5.1.10 RF Network Layer Restart Confirmation

The format of the RF Network Layer Restart Confirmation packet shall be as specified in the table below:

Table 7-23: RF Network Layer Restart Confirmation Format

8 MSB	7	6	5	4	3	2	1 LS Bit	L3 Octets
0	0	0	1	0	0	0	0	1
1	1	1	1	1	1	1	1	2
Src Addr Length				Dest Addr Length				3
Destination Address								4
Destination Address								5
Source Address								6
Source Address								7

The Q bit is 0 to indicate this is a datagram packet. The D bit is 0 to indicate that the packet is not requesting delivery confirmation. The LCG field contains 0 because it applies to all LCGs. The Packet Type Identifier is 0xFF.

The destination address is the address for which this packet is intended and the source address is the address of the originator of this packet. The source and destination address lengths are set accordingly. *Note: there is neither a restarting cause nor a diagnostic code on this packet.*

7.2.5.5.2 RF Network Layer Elements of Procedure

The RF Network Layer Elements of Procedure are TBD as they are currently being developed.

7.2.5.5.2.1 Procedures for Datagram Transfer

7.2.5.5.2.2 Procedures for Flow Control

7.2.5.5.2.3 Procedures for Network Login

7.2.5.5.2.4 Procedures for Network Logout

7.2.5.5.2.5 Procedures for Reset

7.2.5.5.2.6 Procedures for Restart

7.2.5.5.2.7 Effects of Link Failures

7.2.5.6 Data Link Layer

The data link layer provides reliable point-to-point communication across the physical medium. The link layer converts the broadcast RF medium into a stable, reliable path so that the upper layers can transfer data without knowledge of the dynamic nature of the underlying link services. An overview of the data link layer is provided here. Definition of data link layer processes is provided in Section 8.

7.2.5.6.1 Data Link Layer Message Structures

7.2.5.6.1.1 Data Link Layer Header and Trailer

The following table shows the Layer 2 or Data Link Layer Services that are provided and it identifies the artifacts that are used to implement each Data Link Layer service.

Table 7-24: Layer 2 Data Link Layer Services

Layer 2 Data Link Layer Services	
Service	**Layer 2 Header Implementation**
Data Framing	Frame structure, bit count
Data Link address screening	Layer 2 address
Variable length addresses	Address Extension bit
Bad Frame reject	Frame Check Sequence, Min. bit count
Power Control	Layer 2 Control (Power control bit)
Bit order transmission	To be defined in SIS spec
Variable length frames	Bit count
COMSEC	Not in Layer 2 header
Convolutional coding for error correction	Not in Layer 2 header
TRANSEC	Not in Layer 2 header

The Data Link Layer or Layer 2 Frame Header and Trailer are used to implement the Data Link Layer services previously defined. The functions of each piece of this header will be identified. This definition applies to the messages that flow across the RF link between the ship and aircraft.

The Layer 2 Frame Header consists of 4 octets and the Layer 2 Trailer consists of 2 octets for a total of 48 bits.

Table 7-25: Layer 2 Frame Header and Trailer Format

8 MSB	**7**	**6**	**5**	**4**	**3**	**2**	**1 LS Bit**	**L2 Octets**
Layer 2 Address							Addr Extension	1
Signal Quality	SR 50	SR 10	0	Pending Msg LCG				2
Layer 2 bit count								3
Layer 2 bit count								4
Layer 3 User Data								NA
Layer 2 Frame Check Sequence								5
Layer 2 Frame Check Sequence								6

Octet 1 of the Data Link Header is the Layer 2 address. This field is coded as follows:

00000000 = no call (test)
11111110 = all call
00000010 = all aircraft
10000000 = ship
XXXXXXX1 = Address extension (more than 8 address bits)

There are no plans to use the address extension bit. It is reserved, and shall be set to 0.

The most significant bit of Octet 2 is the Signal Quality Indication bit. This bit is used in the power control algorithm and its use is described in the Power Control section in this document. Bit 7 is the ATM 50 Slot Request bit, and is used by only aircraft to request an ATM 50 downlink slot. This bit is set to 1 if the aircraft has an ATM 50 message to send, otherwise it is 0. Similarly Bit 6 is the ATM 10 Slot Request bit, and is used by only aircraft to request an ATM 10 downlink slot. This bit is set to 1 if the aircraft has an ATM 10 message to send, otherwise it is 0. Bit 5 is 0. The last 4 bits of Octet 2 are set to the LCG of the highest priority ATM downlink message that the aircraft has to send. SR refers to the range from ship; either 50 or 10. The Pending Message LCG bits are only valid when either the SR50 or SR10 bit is set to 1. When the aircraft is not requesting a slot, the Pending Message LCG bits shall be set to 1's to indicate the lowest possible priority.

Octet 3 and Octet 4 represent a 16 bit number for the number of bits in the User Data portion of the frame. The count excludes all of the bits in the Layer 2 Header and Trailer. Octet 3 is the least significant byte of the bit count and Octet 4 is the most significant byte.

7.2.5.6.1.2 Frame Check Sequence

The FCS is the 16 bit sequence as defined in ISO 3309.

It shall be the ones complement of the sum (modulo 2) of:
1) the remainder of $x^k(x^{15}+x^{14}+x^{13}+...+x^2+x+1)$ divided (modulo 2) by the generator polynomial $x^{16}+x^{12}+x^5+1$, where k it the number of bits in the frame beginning with the first bit of the address and ending with the bit immediately preceding the first bit of the FCS, and
2) The remainder after multiplication by x^{16} and then division (modulo 2) by the generator polynomial $x^{16}+x^{12}+x^5+1$, of the content of the frame beginning with the first bit of the address and ending with the bit immediately preceding the first bit of the FCS.

7.2.5.6.1.3 Order of Bit Transmission

Addresses and commands shall be transmitted low-order bit first.

The FCS shall be transmitted commencing with the highest order term.

7.2.5.6.2 Logical Link Control

The LLC sub-layer implements the Layer 2 RF protocol. It processes the address and control fields of received frames, and validates the FCS. Frames that do not pass the FCS shall be discarded at the LLC sub-layer. The frames that are received from the MAC sub-layer have been decrypted (COMSEC).
The control octet contains the power control bit and priority information about any pending downlink ATM messages.

Any Data Link Layer address screening is done at this time. The rules for address screening are TBD and will be addressed in Release 2.0 of thisdocument.

Frames are prepared for transmission by adding their Layer 2 frame headers and FCS. Once assembled, the frames are sent through the COMSEC process for encryption and on to the MAC sub-layer for processing.

7.2.5.6.3 INFOSEC Processes

Information Security (INFOSEC) processing consists of the COMSEC and TRANSEC processes. The COMSEC process is a bit manipulation of the bits within a slot. For every bit into the COMSEC process a bit will come out. The TRANSEC process takes inputs from the LLC sub-layer and generates a keystream that is used in the physical layer to generate the SIS and recover data. These processes are denoted in the protocol stack only for the user to understand where they are being done.

7.2.5.6.4 Media Access Control Services

TDMA slots support data communications and management functions among a group of users. A user group will normally consist of a control site user and up to 50 airborne users (depending upon case).

The MAC sub-layer implements a TDMA protocol. Time slots are of fixed length for a given slot in a given network case. Network case denotes a network optimized for a selected operational scenario (e.g., number of users per service type, distribution of data packets across frequencies and data packet monitoring requirements). Time slots for different services may be of different lengths, and time slots for the same service may be different lengths for different network cases. Time slots are able to support a number of circuit (or channel) types.

7.2.5.7 Physical Layer

The physical layer provides transmission and reception of bits over the physical medium (conversion of bits to electrical energy). This layer is defined in Section 8 of this document.

7.2.6 Power Control

7.2.6.1 Transmit Power Control

7.2.6.1.1 Power level rate of change

During active data link operation, power level shall change at a maximum rate of 1 dB/sec.
(Note: This rate allows for an aircraft traveling at the maximum velocity of 550 knots (paragraph 3.2.5.3, SRD reference #) to have the transmit power decrease by the entire 30 dB range in a distance of 33 nm)

7.2.6.1.2 Ship System

Ship system transmitters shall reduce their power when receive Signal Quality Indication bits from 90% or more of aircraft operating in the network are indicating a power reduction.

Ship system transmitters shall increase their power when receive Signal Quality Indication bits from 10% or more aircraft operating in the network are indicating a power increase.

7.2.6.1.3 Air System

Air system transmit power level shall be changed when directed by the receive Signal Quality Indication bits from the ship system.

7.2.6.2 Receive Signal Quality Indication

7.2.6.2.1 Ship System

All ship system transmit messages shall contain for each aircraft in the two-way communication coverage area a single bit indicating the quality of the receive signal from the aircraft system.

7.2.6.2.2 Air System

All air system transmit messages shall contain a single bit indicating the quality of the receive signal from the ship system.

7.2.6.2.3 Signal Quality Bit Coding

The Signal Quality Indication bit shall alternate between logic one and logic zero when the receive signal is at the correct level.

The Signal Quality Indication bit shall be a repeated logic one when the receive signal is too weak.

The Signal Quality Indication bit shall be a repeated logic zero when the receive signal is too strong.

7.2.6.2.4 Correct Receive Level

Correct receive level is TBR and will be addressed in the next document revision.

7.2.6.3 Power Adjustment

A system receiving signal quality indication bits shall adjust its transmit power according to the following subject to the restrictions of Transmit Power Control Range and Maximum Transmit Level Setting Sections in the Air and Ship specifications.

Table 7-26: Transmit Power Control

Signal Quality Indication Bits	Action
All received in last 2 seconds were logic 0	Decrease transmit power 1 dB unless already minimum
All received in last 2 seconds were logic 1	Increase transmit power 1 dB unless already maximum
All other receive patterns	No change
None received	Increase transmit power 1 dB unless already maximum

7.3 Network Management Environment

The Sea Based JPALS data link network layer maps the Sea Based JPALS application data onto a multiple access network structure that satisfies Sea Based JPALS application throughput and latency requirements. The network layer passes information about the network structure to the data link layer so that the SIS microstructure generated in the link and physical layers aligns with the network macrostructure.

The microstructure is the same for all network cases and is defined in Section 8. The following paragraphs define how a macrostructure is generated for a given operating scenario and what information is passed to the link layer to generate the microstructure.

7.3.1 Networking Requirements

7.3.1.1 Networking Protocol and Structure

A TDMA based networking protocol with selectable cases is being defined to satisfy the application messaging requirements.

Network timing shall be referenced to UTC, or a substitute. Refer to Network Time Management in Section 8 for further timing accuracy information.

Once initialized with network time as defined in Section 8, the network shall operate for a minimum of four (TBR) hours without additional time updates.

Overhead transmissions may occur between subsystems with or without application data to update the dynamic power control algorithm and maintain net synchronization.

7.3.1.2 Number of Platforms

A network is defined as coordination of the services required to accommodate the messaging requirements of one control platform and its associated aircraft. Each network will support the functions and number of platforms specified in this document.

Networks for aircraft carrier operations shall support up to 50 aircraft including high-speed tactical aircraft. Cases for carrier operations with less than 50 aircraft that address operational scenarios are allowed.

7.3.1.3 Number of Frequencies per Network

Multiple simultaneous frequencies per net are allowed subject to supporting airborne requirements with a single-channel radio.

7.3.2 TDMA Slot Allocation Algorithm

Each Sea Based JPALS operational scenario may be assigned a unique TDMA network structure. This can be accomplished via a TDMA slot allocation program.

- Capacity allocation for airborne platforms by service type (quantity of ATM 50 and Precision Navigation aircraft)
- Number of channels (bands) simultaneously used for data transmission
- Initial acquisition preamble characteristics, including duration, repetition rate, duty cycle, and
- Application data packet characteristics for each including:
    - Message nomenclature
    - Channel used
    - Monitoring requirements (to preclude simultaneous signaling on multiple bands of data packets the airborne subsystem is required to receive with a single half-duplex transceiver)
    - Communications range (for determining guard band)
    - Number of sources and destinations
    - Data packet length
    - FEC rate
    - Latency/repetition interval
    - Preamble duration
    - Burst data rate multiplier
    - Radio overhead affecting duty cycle (switching times, hopping times, etc.)
    - Whether fragmentation and concatenation should be enabled or disabled
    - Whether two times data packet repetition diversity should be used for selected data packets

The above information constitutes the requirements of the Sea Based JPALS application and the constraints of the data link and physical layers.

The data and information transmission rate are input to the slots.exe program, which generates a TDMA structure and network usage statistics if a solution exists. The data rate input to the program is iterated until the program finds the minimum data rate for which it can find a solution. The reason to seek the minimum data rate is to achieve the minimum energy density possible to meet detectability requirements while satisfying Sea Based JPALS application requirements.

All other things being equal, the following relationships exist between the variables input to the slot allocation program and the data rate at which the slot allocation algorithm finds a solution. This information is provided to assist in high level trading of application requirements versus detectability (or alternately data link margin, if detectability is not a concern). The slot allocation algorithm may be used for sensitivity analysis to determine the effects of changing specific parameters in the input data file.

- Messages to be communicated over a long-range drive the data rate up more than messages to be communicated over a short range. Shorter-range messages are sent at higher data rates than long-range messages, freeing up more channel access time.
- Low latency data packets increase the data rate. Without coupling between the data link and Sea Based JPALS application, bandwidth to send low latency data packets must be allocated frequently to satisfy the latency constraints (bandwidth that will normally be idle may be set aside to meet latency rather than throughput).
- Stricter error rate requirements drive detectability performance. This is not accounted for in the model, but rather in the link analysis to determine the required Effective Isotropic Radiated Power (EIRP) value to achieve the desired error rate. As data packet length increases for a given message

error rate (MER), required EIRP increases. Application messages that are grouped because they have similar MERs should be compared for data packet lengths to determine if the MER requirement is a good representation of the group of messages or if a single data packet is dominating the required EIRP due to significantly (several times) longer length.

- Data packet repetition diversity increases data rate. It should also be noted that repetition diversity means less energy is required for each individual transmission, so the impact from using repetition diversity is not solely a function of added message length.
- The greater the number of aircraft, the higher the data rate. This is true primarily for large numbers of aircraft. Because the Sea Based JPALS application generally requires more data to be uplinked from the control platform than downlinked by the aircraft, and a number of messages are required to be sent regardless of the aircraft quantity, the marginal effect of decreasing aircraft decreases. When the number of aircraft is reduced below 10, the marginal decrease, increases again due to reduction in addressed messages.
- Signaling on multiple bands simultaneously decreases data rate on each band. The decrease in detectability due to data rate deduction outweighs the increase due to use of more frequency spectrum unless the gain in data rate is on the order of 10% or lower. Monitoring requirements drive the degree that the data rate can be reduced below a single band case. Reductions of 50% can not be expected and signaling on multiple bands increases shipboard hardware requirements.
- Concatenation decreases data rate by decreasing SIS overhead for switching times, preambles, and guard times. The effect is generally small in Sea Based JPALS application cases run to date.
- Data rate increases with the number of different message types. This is due to increasing SIS overhead that is reduced through concatenation.

7.3.3 Time of Day Networking Structure

The MAC sub-layer manages the TDMA network macrostructure by assigning each slot and epoch a unique identifier based on Time of Day (TOD). The periodic epoch structure for the case in use is maintained in the MAC sub-layer. The TOD macrostructure data is used by the INFOSEC (COMSEC and TRANSEC) to ensure the correct microstructure is generated to allow recovery of data while keeping the SIS secure and detectability low.

7.3.3.1 Network Slot Number Format, Definition and Example

The network needs a unique identifier for each slot and epoch within a unique time period (day, week, etc.). This fits well with the SIS requirements for changing signal parameters to support security and detectability. Therefore, the network slot identification structure is defined for commonality with the INFOSEC processes in the link layer, which is similar to other military programs.

The link layer performs multiple INFOSEC operations during each network slot. Compatibility with networking slot IDs then dictates that network slots not be assigned contiguous identifiers, so that the multiple link layer operations can be assigned unique identifiers within each network slot.

The hardware and software that perform the INFOSEC processes shall use a unique 32-bit TOD field in the slot identifier, or time slot number (TSN), to identify discrete time increments within a 24-hour period.

The time of day format is subject to restrictions to prevent non-secure INFOSEC operations. The primary restriction is that the TOD field must progress in ascending order for transmitting operations.

Based on the network structure, the following definition is proposed for Sea Based JPALS TSN generation:

- TOD is referenced to Greenwich Mean Time (GMT) with daily rollover at UTC midnight GMT
- Bits 34-39 of the TOD field represent a network number.

- Bits 19-33 of the TOD field represent epoch number of the current 5 second epoch. This is a binary coded epoch past midnight GMT (range 1 to 17,280).
- Bits 5-18 of the TOD field represent the slot within each epoch (16,384 slots/epoch capacity versus less than 10,000 required).
- Bits 1-4 of the TOD field are generated and used in the link layer to designate multiple unique INFOSEC operations within a slot.

As an example of TOD network slot identifier usage, consider identifiers generated for the slots in a sample network structure as shown in table 7-27 below. The table describes identifiers for the 105th through 117th slots of the epoch starting at 21:15:30 GMT (the 15,306th epoch of the day). The least significant nibble is used by the link layer for INFOSEC operations within a slot and is coded as a "don't care" for the network. The results of this example can be generalized to other slots and epochs.

Table 7-27: Sample Network Slot Assignment Example

SEQUENCE OF TOD IDENTIFIERS FOR NETWORK EXAMPLE	
Network Time Slot	Network TOD Identifier
105	02 EF 28 06 9X
106	02 EF 28 06 AX
107	02 EF 28 06 BX
108	02 EF 28 06 CX
109	02 EF 28 06 DX
110	02 EF 28 06 EX
111	02 EF 28 06 FX
112	02 EF 28 07 0X
113	02 EF 28 07 1X
114	02 EF 28 07 2X
115	02 EF 28 07 3X
116	02 EF 28 07 4X
117	02 EF 28 07 5X

8 Signal-in-Space Definition

8.1 Scope

This section establishes the implementation of the SIS for the Data Link Subsystem of the Sea Based JPALS System. This addresses the data link and physical layers. Layers above the data link layer are addressed in Section 7. The waveform is implemented for two applications, airborne and shipboard. These applications use the same SIS. This document is applicable to both applications.

8.1.1 Sea Based JPALS Data Link SIS Overview

The SIS waveform is intended to minimize detectability of the transmitter while providing communications, navigation and monitoring capability at a very low emission level to comply with the appropriate EMCON level. The SIS is responsible for transporting data between the transmitter and one or more receivers with accuracy and integrity.

8.1.2 Section Overview

This section captures the selected functional implementation for the SIS to meet the requirements for signal detectability and information transport. This is not a source of subsystem functional requirements, but a specified implementation that must be adhered to for SIS interoperability.

Key elements of this section are:

1. A concise description of the Sea Based JPALS SIS,
2. Selected implementation definition required for SIS interoperability, and
3. Selected rationale

8.2 SIS Implementation Definition

8.2.1 SIS Structure

Figure 8-1 shows a decomposition of the SIS from the TDMA networking layer to the underlying SIS structure and the elements under it. The transmit and receive processing functions are described below. Figures 8-2 and 8-3 are high-level functional block diagrams of the elements of the data link subsystem (including the SIS elements) for transmit and receive. Note that the figures show one equipment chain. This is sufficient to illustrate a single-thread airborne subsystem. The shipboard subsystem may contain multiple transmit and receive chains and up to two RF elements per chain to support frequency diversity (simultaneous transmission on two frequencies) (TBR).

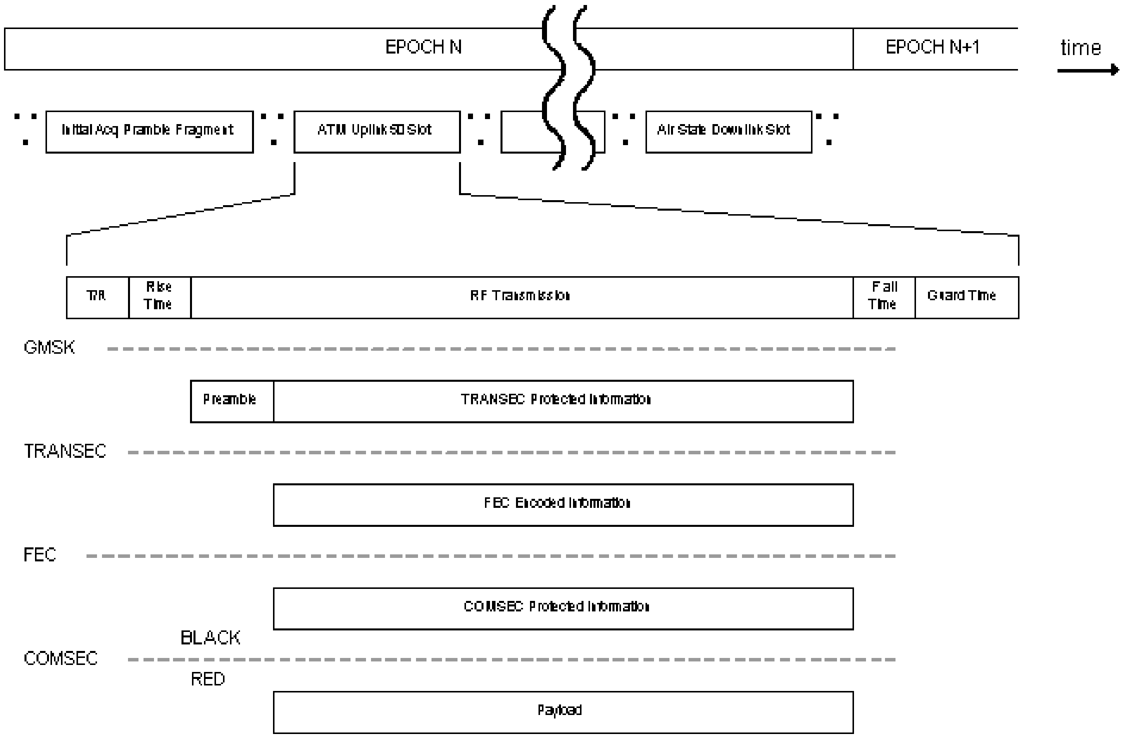

Figure 8-1: SIS Structure

8.2.2 Transmit SIS Processing

The following paragraphs describe application data processing from the data terminal equipment interfacing to the Sea Based JPALS Data Link Subsystem towards the communications channel. Generation of one SIS transmit thread is described. The description can be generalized to generating multiple individual SIS signals simultaneously by the shipboard subsystem.

Figure 8-2 shows the transmit signal processing flow for the JPALS waveform. The input data is convolutionally encoded using a convolutional encoder. The encoded data is masked with a TRANSEC data stream. The TRANSEC processed data stream is then Gaussian Minimum Shift Keying (GMSK) modulated. Transmit processing requires a TRANSEC stream for both Layer 1 data cover and preamble generation. For the Layer 1 preamble, the TRANSEC bit stream is passed directly through to the GMSK modulator. When used as Layer 1 data cover, the TRANSEC modifies the coded data stream through an exclusive-or operation.

In the lower data rate cases (50 nm and 200 nm), the TRANSEC stream used for data cover runs faster than the coded data rate. In these cases, multiple GMSK chips are generated for each coded data bit. In the 200 nm case, each user data bit is coded to four coded data bits. The TRANSEC cover stream generates 80 chips for each coded data bit for a total GMSK chip rate of 800 kcps. The sample rate out of the modulator is 8 samples per GMSK chip for a total baseband I/Q sample rate of 6.4 Msps. In the 50 nm case, the TRANSEC cover stream runs 5 times faster than the coded data rate to produce the same 800 kcps.

For the <10 nm messaging, the data rate is 400 kbps. In this mode, the convolutional encoder is punctured from rate ¼ to rate ½. The rate ½ encoder produces a coded data rate which is equal to the chip rate of 800 kcps. Figure 8-2 shows a simplified block diagram not directly showing the punctured convolutional code and indirectly indicating the chipping.

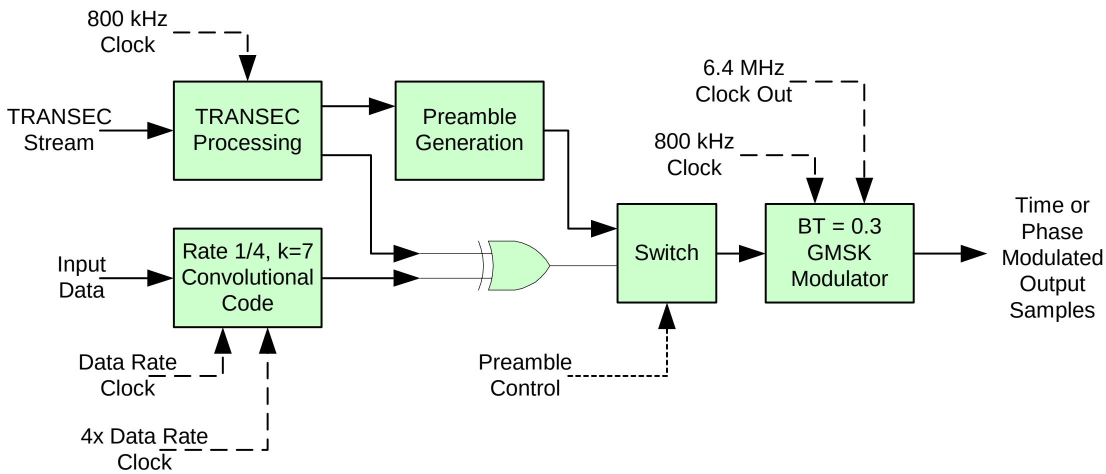

Figure 8-2: Sea Based JPALS Transmit Processing

8.2.2.1 Data Packet Fragmentation

Data packets shall be fragmented into slots for transmission when required.

Fragmentation is required when the over-the-air transmission time of an individual application message exceeds the minimum latency interval for the lowest latency application data message. A fragment may contain an entire data packet or a portion thereof. The size of the fragment is driven by the TDMA structure specific to the network case being used. Thus, the same data packet type may be fragmented into different sizes for different network cases. Subject to definition of the application, fragmentation is determined by the slot allocation algorithm.

8.2.2.2 Concatenation

Data packets shall be concatenated for the purpose of sending more than one application data packet within a single TDMA slot per the slot allocation algorithm.

The advantage this provides is time efficiency since one set of system overhead time (e.g., propagation guard, RT switch time, etc.) is required rather than two or more. The aggregate size of the concatenated fragments is driven by the TDMA structure specific to the network configuration being used and the service type. Only data packets of the same service type and from the same source (i.e., platform) are eligible for concatenation. Different aggregate concatenated data packet lengths and elements are possible with different network cases. Concatenation may be performed at either the network or the data link layer. Subject to definition of the application, fragmentation is determined by the slot allocation algorithm.

8.2.2.3 Encryption

After fragmentation and/or concatenation, application data shall be grouped into lengths for transmission in TDMA slots.

Each application message (TDMA slot) shall be encrypted with a unique TSN that is related to network time.

Time slot number assignment and network time slot identification for INFOSEC operations is defined in Section 7.

8.2.2.4 Forward Error Correction (FEC) Encoding

The convolutional code used in the JPALS waveform is a rate $^1/_4$, k=7 convolutional code with the octal generator polynomial 135-135-147-163. This encoder is shown in Figure 8-3. The input data rate is dependant upon the maximum range of the message. For up to 200 nm messages, the input bits are at a 2500 bps rate. The encoder produces 10 kbps which is then spread using a TRANSEC sequence at the GMSK chip rate of 800 kbps. The spreading rate is 80 chips per coded bit. For up to 50 nm messages, the input bit rate is 16 x 2500 bps = 40 kbps. The encoder produces 4 coded bits per bit for a total rate of 160 kbps. The TRANSEC sequence running at the GMSK chip rate of 800 kbps spreads the coded bits at a rate of 5 chips per coded bit. For the highest data rate, up to 10 nm range messages, the input uncoded bit rate is 400 kbps. These bits are rate ½ coded using coded bits 0 and 2. The resulting 800 kbps data stream is combined with the TRANSEC before GMSK modulation at 800 kcps.

A rate $^1/_2$, k=7 convolutional encoder shall be used to encode the application data to be transmitted to 10 nm.

A rate $^1/_4$, k=7 convolutional encoder shall be used to encode the application data to be transmitted to 50 and 200 nm.

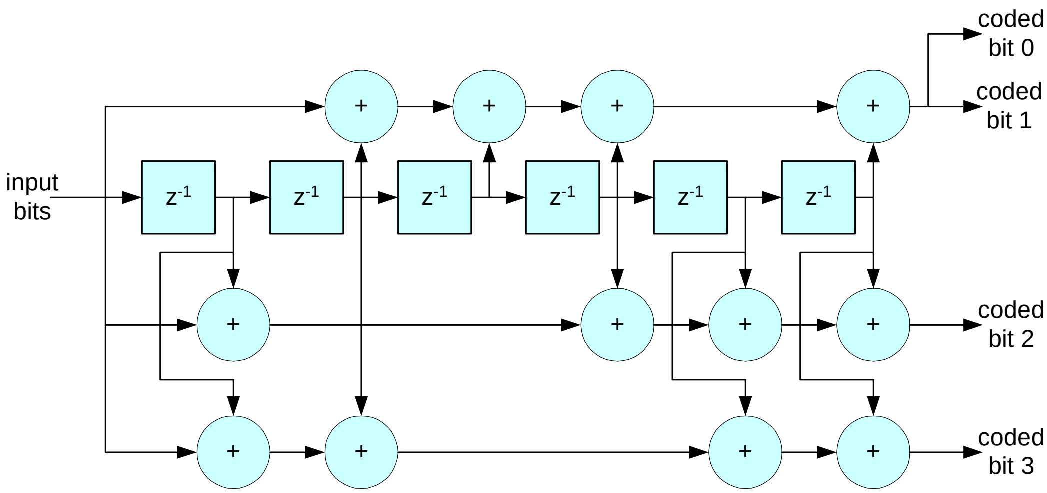

Figure 8-3: Rate $^1/_4$, k=7 Convolutional Encoder

8.2.2.5 Modulation

GMSK modulation shall be used to maximize the allowable bit error rate with respect to the occupied channel bandwidth.

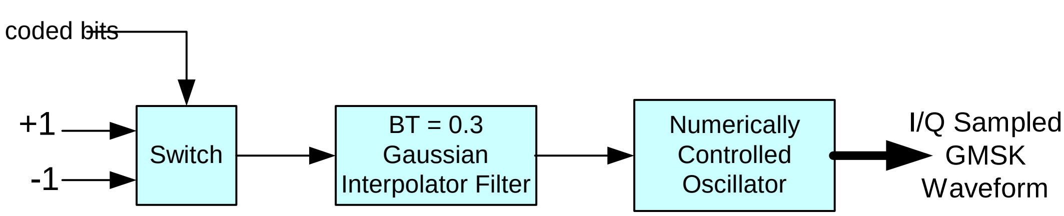

Figure 8-4: GMSK Modulator

A Gaussian filter of an appropriate bandwidth (defined by the BT product) is used before the modulation stage, where B is the pre-modulation filter bandwidth and T is the bit period. A BT of 0.3 has been selected which compromises between bit error rate and out-of-band interference since the narrow filter increases the inter-symbol interference and reduces the signal power.

The chip rate shall be 800,000 chips/sec.

The GMSK modulator maps the encoded data bits into GMSK phase transitions as shown in Figure 8-4. This is a sample implementation of a modulator that produces a baseband I/Q GMSK modulated waveform.

8.2.2.6 Preamble Generation

The TRANSEC generator shall produce a keystream that is used at the start of each TDMA slot to provide a data free preamble to resolve signal time of arrival uncertainty introduced between slots from a given source to a given destination.

Baseline preamble duration (on times plus off times) for TDMA slots is 200 μs (TBR). This is to be reviewed as part of the link budget analysis based on modulation scheme performance, multi-path mitigation approach and maximum allowable transmission power.

The number of chips per bit varies by application data (service) type, and slot type because the data is sent at different rates, but the chipping rate is the same. This provides flexibility in data throughput while using the same SIS for all transmissions. In general, different network configurations will have different base over-the-air information burst rates, which translates to different levels of detectability. The lower the burst rate, the less energy required per unit time for communication and the greater the level of protection. Although different network cases have different base burst rates, the scaled burst rates for different slot types within a network case share a common set of scaling factors based on required communications range and assumed antenna gain on the ship versus the aircraft. Table 8-1 illustrates the coded bit rate scaling factors.

Table 8-1: Coded Bit Rate Scaling Factors by Range

	200 nm	**50 nm**	**10 nm**
Uncoded Bit Rate	2500 bps	40,000 bps	400,000 bps
Coding Rate	0.25	0.25	0.5
Coded Bit Rate	10,000 bps	160,000 bps	800,000 bps
Chips per Bit	80	5	1
Chip Rate	800,000	800,000	800,000

8.2.2.7 RF Signal Generation

The signal is digitally filtered to band limit the signal. The filtered signal shall be up-converted to RF and translated to the appropriate frequency for transmission.

8.2.3 Receive SIS Processing

Figure 8-5 shows the receive processing flow for the JPALS GMSK coded waveform. The receive signal is first converted to baseband, filtered, and down-sampled. The reduced sample rate data runs through the preamble correlator. The correlator detects a burst and determines the timing and phase for the received burst. The timing is based on the peak of the correlator magnitudes with the phase of the correlator output at this peak magnitude used as the block phase.

User data is derived from the received SIS by performing the signal processing and manipulation functions of the transmitted SIS in the reverse order. Elements that are unique to the receive function are described herein.

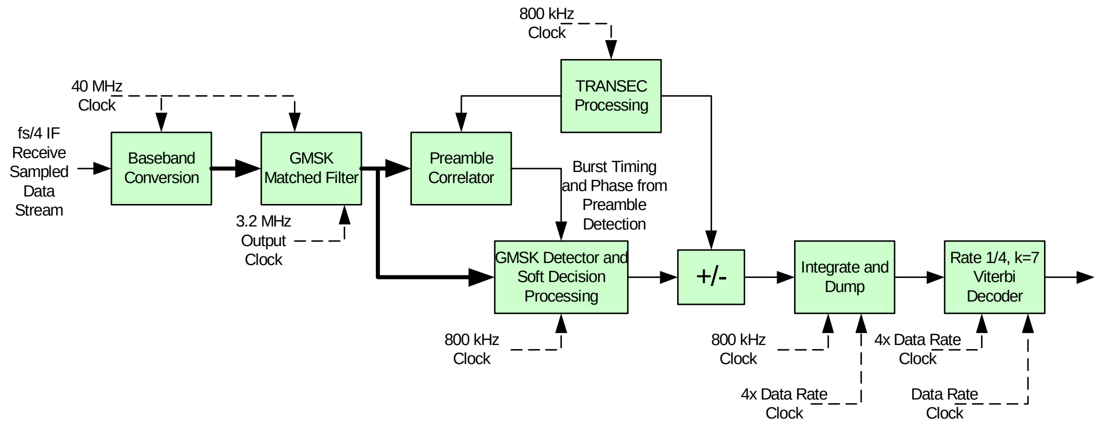

Figure 8-5: Sea Based JPALS Receive Processing

8.2.3.1 Acquisition Processing

To demodulate the SIS successfully, the receiving platform must know the time of arrival of the signal to within less than one chip. Acquisition processing is used to eliminate uncertainty in the time-of-arrival.

The receiver attempts to correlate to the preamble that precedes each slot. This is possible because the receiver knows the time, and therefore knows the preamble sent by the transmitter and can generate a local copy using its TRANSEC generator and key multiplier.

Prior to acquisition of the SIS, the time-of-arrival uncertainty is relatively large (many chips) due to range uncertainty as specified in Section 7. The receiver acquisition strategy has yet to be defined.

After initial acquisition, the receiver uses the preamble at the start of each slot to refine its time-of-arrival estimate from receipt of the last transmission. Each slot preamble is much shorter than the initial acquisition preamble because the time-of-arrival uncertainty is smaller and the received signal power is larger. After receipt of the data free preamble, the receiver prepares to receive and demodulate data.

8.2.3.2 De-spreading

The receiver subsystem shall use the TRANSEC keystream to internally expand and de-spread the Sea Based JPALS SIS data link.

8.2.3.3 Demodulation

The demodulation technique will be based on the GMSK modulation identified previously.

8.2.3.4 FEC Decoding

The receiver subsystem shall perform decoding on 10 nm TDMA slots at rate $^1/_2$, k=7.

The receiver subsystem shall perform decoding on 50 and 200 nm TDMA slots at rate $^1/_4$, k=7.

8.2.3.5 Decryption

After decoding has been performed, the receiver subsystem shall decrypt the received data on a TDMA slot basis.

8.2.3.6 Deconcatenation and Defragmentation

The receiver subsystem shall use deconcatenation and defragmentation to translate TDMA slots into application messages.

8.2.3.7 Data Packet Translation

The receiver subsystem shall perform application data translation and output received messages.

8.2.4 SIS Management Functions

The SIS is managed to achieve the required quality of service for the Sea Based JPALS application. To accomplish this, several techniques are employed to maintain connectivity in dynamic network topologies and propagation environments. Various methods are being investigated to mitigate multi-path or other interference as explained below.

8.2.4.1 Frequency/Antenna "Pipe" Diversity

A combination of frequency and antenna diversity is being analyzed for possible use on the shipboard subsystem to mitigate multi-path interference (TBR). A shipboard antenna subsystem design equipped with an upper and lower antenna is being evaluated.

Shipboard message reception differs from airborne in that two receiver paths are available, but only one signal is present. The shipboard subsystem will attempt to receive the downlink signal on each path and will then select the path on which the signal is present.

8.2.4.2 Network Time Management

8.2.4.2.1 Initial Acquisition Preamble and Burst Rate Identifier

The transmitter subsystem shall transmit an initial acquisition preamble TBD times per five second network epoch.

The acquisition preamble allows a receiver that knows coarse network time (within 1-2 ms) to synchronize to fine network time (within a chip).

Once a fine network time is achieved, the receiving terminal can demodulate the 8-bit burst rate identifier (BRI) field sent at the end of the initial acquisition preamble. The BRI is used to decode network parameters including the TDMA slot structure and base information burst transfer rate over the network. The information burst rate of the BRI in the initial acquisition is the same for all network cases and is set to the minimum base burst rate for all cases. This is done to make the burst rate known a priority for decoding, and to prevent the BRI transmission from driving the network performance since higher burst rates require more received power for demodulation and are thus more detectable.

Because the initial acquisition preamble is intended to reduce time uncertainty below 1-2 ms, the location of the transmission in time must be determinable to within the coarse time window to preclude searching outside this window and lengthening the duration of the preamble accordingly. This must be true across all network cases to minimize the time to acquire (the alternative is to cycle through the possible time deviations until the proper one is selected). Accordingly, the initial acquisition preamble time is independent of network configuration. Location of the initial acquisition preamble time is subject to manipulation for security.

8.2.4.2.2 Network Time Distribution

Sea Based JPALS-Ship shall act as the master time source for network timing and synchronization even if UTC is unavailable.

Time is acquired locally on each platform from GPS or an alternate timing source. The following cases define time nomenclature. See Section 6 for classified requirements identification. Specific information will be conveyed in a separate document.

Case 1, defined as "No Time" covers the rare possibility that no time source is available. Because no time is available the time accuracy relative to GMT is N/A and the synchronization time requirement is not specified.

Case 2, defined as "Wrist Watch Time" covers the case when manually-entered time is used as the time source. The time accuracy relative to GMT is ±1 minute and the synchronization time requirement is classified.

With "Wrist Watch Time" loaded, the receiver subsystem shall acquire coarse time via the SIS and then acquire network time via the initial acquisition preamble.

Case 3, defined as “Coarse Time” covers the case when a Have Quick or equivalent time distribution is used as the time source. The time accuracy relative to GMT is ±1 ms and the synchronization time requirement is classified.

With "Coarse Time" loaded, the receiver subsystem shall acquire network time via the initial acquisition preamble.

Case 4, defined as “Fine Time” covers the case when GPS is used as the time source. The time accuracy relative to GMT is ±100 ns and the synchronization time requirement is classified.

With "Fine Time" loaded, the receiver subsystem shall acquire network time via the initial acquisition preamble.

Case 5, defined as “Network Time” covers the case when the Sea Based JPALS network is used as the time source. The time accuracy relative to GMT is ±1/2 chip (relative to network time rather than GMT) and the synchronization time requirement is N/A.

8.2.4.2.3 Synchronization

8.2.4.2.3.1 Sea Based JPALS-Air

Synchronization is defined as acquiring the initial acquisition preamble and the ability to demodulate the Ship State 200 broadcast message.

In the presence or absence of time, Sea Based JPALS-Air shall achieve synchronization in environments with initial time uncertainty of 1.6 ms due to propagation delay (1.4 ms), GPS error, and local frequency standard error and drift (0.2 ms).

When "Coarse Time" or better is available locally and the uplink has fine synchronization to UTC, Sea Based JPALS-Air shall achieve synchronization within the times indicated in Section 7 with a probability of at 90% (TBR).

8.2.4.2.3.2 Sea Based JPALS-Ship

Synchronization is defined as the ability to demodulate the Air State Report.

In the presence of time, Sea Based JPALS-Ship shall achieve synchronization in environments with initial time uncertainty of 576 μs due to propagation delay (376 μs), GPS error, and local standard error and drift (200 μs).

8.3 Notes

8.3.1 Link Analysis

A link analysis for the data link is provided below. Note the assumptions about different receive antenna gains at the ship and aircraft. Uplinks represent transmissions from the ship to aircraft. Downlinks represent transmissions from aircraft to the ship. Table 8-2 identifies the estimated link system parameters based on projected antenna gain figures.

Table 8-2: Link System Parameters

Transmitter Carrier Frequency	400.0	400.0	400.0	400.0	400.0	MHz
Transmitter Power	4	4	4	4	4	Watts
	6.0	6.0	6.0	6.0	6.0	dBW
Transmitter & Modem Implementation Loss	1.0	1.0	1.0	1.0	1.0	dB
Transmitter Cable Loss	3.0	3.0	3.0	1.0	1.0	dBi
Transmitter Antenna Gain	2.0	2.0	2.0	-3.0	-3.0	dBi
Transmitted Isotropic Power	4.0	4.0	4.0	1.0	1.0	dBW
Path Loss	109.8	123.8	135.9	109.8	123.8	dB
Fading Loss	12.0	12.0	12.0	12.0	12.0	dB
Communication Range (Free Space)	10.0	50.0	200.0	10.0	50.0	nautical miles
	18520	92600	370400	18520	92600	meters
Received Isotropic Power	-117.8	-131.8	-143.8	-120.8	-134.8	dBW
Receiver Antenna Gain	-3.0	-3.0	-3.0	2.0	2.0	dBi
Receiver Cable Loss	1.0	1.0	1.0	3.0	3.0	dBi
Receiver Signal Power	-121.8	-135.8	-147.8	-121.8	-135.8	dBW
Receiver Noise Figure	10.0	10.0	10.0	10.0	10.0	dB
Noise Spectral Density	-204.0	-204.0	-204.0	-204.0	-204.0	dBW-Hz @ T = 290
Received Noise Spectral Density	-194.0	-194.0	-194.0	-194.0	-194.0	dbW-Hz
Receiver SNR	72.2	58.2	46.1	72.2	58.2	dB-Hz
Un-Coded Data Rate	400,000	40,000	2,500	400,000	40,000	bits/s
Normalized Modem Data Rate	56.0	46.0	34.0	56.0	46.0	dB-bits/s
Modem SNR	16.1	12.2	12.2	16.1	12.2	dB-Hz
Receiver & Modem Implementation Loss	1.0	1.0	1.0	1.0	1.0	dB
Required Eb/N0	8.0	7.0	7.0	8.0	7.0	dB-Hz for BER = 1E-6
Link Margin	7.1	4.2	4.2	7.1	4.2	dB

9 Sea Based JPALS Data Link Application Data

9.1 Scope

9.1.1 Section Overview

This section describes the messages that are generated by the Sea Based JPALS system and their organization for transmittal, including data item definitions and transmit rate information. These messages encompass parameters needed for functions described within the Sea Based JPALS SRD [14].

The application data defined in this section is categorized by whether it is initiated by the ship or the aircraft.

The convention for the representation of data is such that the most significant bit (MSB) appears on the left.

9.2 Application Data Overview

9.2.1 Data Summary

Table 9-1 shows a summary of the application layer data. The proposed data packets have been organized into the following general categories:

- Data packets that are sent at a regular interval with a small relative timing variation.
- Data packets that are sent as required and data packets that are sent at a regular interval, which can tolerate a large relative timing variation.
- Data packets not contained in the table, but are sent through one of the ATM data packet pipes on a pseudo-regular schedule when other specific ATM messages are not being transmitted.

Messages in category (B) include all ATM messages (ATM 50, ATM 20). All other data packets fall in category (A).

Table 9-1: Data Packet Summary

Base Data Rate (coded)
10,000 bps

Category	Name	Range (nm)
	Uplinks	
Ship State	Ship_State_200	200
	Ship_State_50	50
	Ship_State_10	10
ATM Uplink	ATM_Broadcast_50	50
	ATM_Broadcast_10	10
	ATM_Uplink_50	50
	ATM_Uplink_10	10
J-UCAS	JUCAS_Uplink_Pipe_50	50
	JUCAS_Uplink_Pipe_1	1
GPS	GPS_Block_ID	10
	GPS_Pseudorange_Data	10
	GPS_Carrier_Phase_Data	10
Ship Motion	Ship_Motion_20Hz	10
	Ship_Motion_2Hz	10
	Ship_Motion_1Hz	10
	Downlinks	
Air State / Monitor	Air_State_Report	50
	Air_Monitor_Report_Hi	10
ATM Downlink	ATM_Downlink_50	50
	ATM_Downlink_10	10
J-UCAS	JUCAS_Downlink_Pipe_50	50
	JUCAS_Downlink_Pipe_1	1
	Network Control	

9.2.2 Burst Rate Estimate

Table 9-2 identifies the burst rate estimate for the complete set of Sea Based JPALS DL data packets.

Note: The data in these tables is preliminary and is subject to change.

Table 9-2: Burst Rate Estimate

Name	Range (nm)	Message Bits	CRC Bits	Network Overhead	FEC Overhead	Transmit Bits	Rate Multiplier	# slots	Slot Rate	Total slots	Percent
Uplinks											
Ship_State_200	200	98	16	144	300%	1032	1	1	0.2	1	2.48%
Ship_State_50	50	31	16	144	300%	764	16	1	1.0	5	0.68%
Ship_State_10	10	83	16	144	100%	486	80	1	2.0	10	0.38%
ATM_Broadcast_50	50	104	16	144	300%	1056	16	2	1.0	10	1.80%
ATM_Broadcast_10	10	104	32	144	100%	560	80	2	1.0	10	0.40%
ATM_Uplink_50	50	48	16	144	300%	832	16	5	1.0	25	3.66%
ATM_Uplink_10	10	48	16	144	100%	416	80	5	1.0	25	0.90%
UCAV_Uplink_Pipe_50	50	48	16	144	300%	832	16	12	1.0	60	8.79%
UCAV_Uplink_Pipe_1	1	48	16	144	100%	416	80	6	1.0	30	1.08%
GPS_Block_ID	10	50	32	144	100%	352	80	1	1.0	1	0.00%
GPS_Pseudorange_Data	10	927	32	144	100%	2206	80	1	2.0	10	0.89%
GPS_Carrier_Phase_Data	10	1371	32	144	100%	3094	80	1	5.0	25	2.88%
Ship_Motion_20Hz	10	173	16	144	100%	666	80	1	20.0	100	4.35%
Ship_Motion_2Hz	10	67	16	144	100%	454	80	1	2.0	10	0.37%
Ship_Motion_1Hz	10	115	32	144	100%	582	80	1	1.0	5	0.20%
Downlinks											
Air_State_Report	50	64	16	144	300%	896	16	50	1.0	250	40.82%
Air_Monitor_Report_Hi	10	183	32	144	100%	718	80	10	5.0	250	13.07%
ATM_Downlink_50	50	48	16	144	300%	832	16	5	1.0	25	3.85%
ATM_Downlink_10	10	48	16	144	100%	416	80	5	1.0	25	1.08%
UCAV_Downlink_Pipe_50	50	48	16	144	300%	832	16	12	1.0	60	9.23%
UCAV_Downlink_Pipe_1	1	48	16	144	100%	416	80	6	1.0	30	1.30%
Network Control											
Initial_Acquisition_Preamble	200	-	-	-	-	-	-	1	1.0	5	0.23%
Login_Request (Downlink)	50	40	0	144	300%	736	16	1	1.0	5	0.77%
Power_Control (Uplink)	50	80	0	144	300%	896	16	1	1.0	5	0.78%
Totals										**981**	100.00%

9.2.3 Data Descriptions

9.2.3.1 Ship to Air

9.2.3.1.1 Ship State Data

The ship-relative RNAV function is required through 360 deg in azimuth and from a range of zero to 200 nm. The resolution of data required at long range is much less than required at close range, even when considering use of coupled autopilot modes in some aircraft. Further, at closer ranges, additional data is required, that is not required at long range. The Ship State message was therefore broken into three separate data packets transmitted to different ranges, with little overlap in content. Aircraft crossing the 50 nm and 20 nm ranges will begin to use the closer range message in conjunction with the longer range data packets. Once initialized at closer range, loss of the longer range data packets, even for relatively long periods of time, does not affect use of the closer range message.

9.2.3.1.1.1 Ship State 200/DASIS 200

The Ship State 200 message is intended to provide aircraft entering the Sea Based JPALS coverage area sufficient information to perform RNAV functions in terms of determining ship identification (ID), position and intended movement (PIM) and distance and bearing to the ship. It is transmitted from the ship at the rate of every 5 seconds.

Table 9-3: Ship State 200

Ship State 200/DASIS 200							
					Rate	0.2	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
GPS Time of Applicability	sec	8	8		0.5	0	119.5
Latitude	deg	18	18	180	0.0006866	-90.0000	89.9993
Longitude	deg	19	19	360	0.0006866	-180.0000	179.9993
Inertial Horizontal Speed	kts	5	5		2	0	62
Average Inertial Track	deg	8	8	360	1.40625	-180	178.5938
DASIS Data		40	40				
Totals		98	98				

Note 1: Full Ship ID extracted from network layer.

9.2.3.1.1.1.1 GPS Time of Applicability

GPS Time of applicability is an 8 bit message alignment field that is synched with GPS time and repeats (rolls over) every 120 seconds. The resolution is 0.5 seconds.

9.2.3.1.1.1.2 Latitude

The Latitude is a 18 bit data field that contains the Latitude of the ship with a resolution of approximately +/- 76.3 meters. The range for the Latitude is -90 to +90 degrees.

9.2.3.1.1.1.3 Longitude

The Longitude is a 19 bit data field that contains the Longitude of the ship with a resolution of approximately +/- 76.3 meters. The range for the Longitude is -180 to +180 degrees.

9.2.3.1.1.1.4 Inertial Horizontal Speed

The Inertial Horizontal Speed is a 5 bit data field representing the current velocity of the ship in knots. The range for this value is 0 to 63 kts in 2 kt increments.

9.2.3.1.1.1.5 Average Inertial Track

The Average Inertial Track is an 8 bit data field that defines the current inertial heading of the ship. The range for this value is -180 to 180 degrees at a resolution of approximately 1.4 degrees.

9.2.3.1.1.1.6 DASIS Data

There are several categories of DASIS data that are being broadcast out to 200nmi. These data are being broken down into several groups that are defined below. These data groups will be sent out within this 40 bit field on a cyclical basis. The intention is that within a 5 minute time period all of this data will have been received at least once. In the event of a change in the Ship Exclusion Mask or General Launch and Recovery value this group will be immediately sent and will displace the regularly scheduled group.

9.2.3.1.1.1.6.1 Weather

The Weather category within DASIS is split into multiple parts to fit into the 40 bit field allocated for DASIS. Each part will have the same DASIS category number but a different part number to help identify its contents.

Note: A time of applicability will need to be added to qualify the weather data.

9.2.3.1.1.1.6.1.1 Weather Part 1/4

The following table identifies the data content for Part 1 of the Weather data.

Table 9-4: Weather Part 1/4

Weather Part 1/4							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
DASIS Category Number	bits	4	4		1	0	15
Part #	bit	2	2	0-3	1	0	3
Date	bit	5	5	01 to 31	1		
Time	hr	11	11	0000Z to 2359Z	1		
Wind Dir	deg	6	6	010-360	10		
Wind Spd	Kts	6	6	04 to 60	1		
Wind Gust	Kts	3	3	10 to 60	10		
Totals		37	37				

9.2.3.1.1.1.6.1.1.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-5 identifies the value for the category number.

Table 9-5: DASIS Data Groupings (Wx 1/4)

DASIS Data Groupings		
Data Group Category	Binary Value	Decimal Value
SV Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.1.1.2 Part

Indicates which part of the total weather message that is being sent in this message.

9.2.3.1.1.1.6.1.1.3 Date

The Date is a 5 bit field that contais the day of the month that the specified weather is valid.

9.2.3.1.1.1.6.1.1.4 Time

The Time is an 11 bit field that contains the hour and minute that the specified weather is valid. It is specified as Zulu (GMT) time.

9.2.3.1.1.1.6.1.1.5 Wind Direction

The Wind Dir is a 6 bit field that contains the approximate wind direction at the ship.

9.2.3.1.1.1.6.1.1.6 Wind Speed

The Wind Speed is a 6 bit field that contains the average wind intensity at the ship at the given time.

9.2.3.1.1.1.6.1.1.7 Wind Gust

The Wind Gust is a 3 bit field that indicates wind gusts at the ship. Valid values are 10 - 60 knots at 10 degree increments.

9.2.3.1.1.1.6.1.2 Weather Part 2/4

The following table identifies the data content for Part 2 of the Weather data.

Table 9-6: Weather Part 2/4

Weather Part 2/4							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
DASIS Category Number	bits	4	4		1	0	63
Part	bit	2	2	0-3	1	0	3
Cloud Cover		3	3	0-3	1		
Height/ lowest to highest	cft	8	8	0-250	1		
Cloud Cover		3	3	0-3	1		
Height	cft	8	8	0-250	1		
Cloud Cover		3	3	0-3	1		
Height	cft	8	8	0-250	1		
Totals		39	39				

9.2.3.1.1.1.6.1.2.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-7 identifies the value for the category number.

Table 9-7: DASIS Data Groupings (Wx 2/4)

DASIS Data Groupings		
Data Group Category	Binary Value	Decimal Value
SV Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.1.2.2 Part

Indicates which part of the total weather message that is being sent in this message.

9.2.3.1.1.1.6.1.2.3 Cloud Cover

Cloud Cover is a 3 bit data field that enumerates a cloud layer type associated with the following Cloud Height (Ceiling). This parameter is repeated. The enumerated sky conditions are listed as:

Table 9-8: Cloud Cover Data Values

Reportable Value	Meaning	Summation Amount of Layer	Data Value
SKC or CLR[1]	Clear	0	0
FEW[2]	Few	> 0 - 2/8	1
SCT	Scattered	3/8 - 4/8	2
BKN[3]	Broken	5/8 - 7/8	3
OVC	Overcast	8/8	4

[1] The abbreviation **CLR** shall be used at automated stations when no clouds at or below 12,000 feet are detected. The abbreviation **SKC** shall be used at manual stations when no clouds are reported.
[2] Any layer amount less that 1/8 is reported as FEW.
[3] BKN includes sky cover from 5/8 up to, but not including, 8/8.

9.2.3.1.1.1.6.1.2.4 Height

The Height is an 8 bit data field that contains the altitude of the preceding Cloud Type in 100 ft increments. This parameter is repeated. The 0 to 250 value represents a range of 0 to 25,500 feet.

9.2.3.1.1.1.6.1.3 Weather Part 3/4

The following table identifies the data content for Part 3 of the Weather data.

Table 9-9: Weather Part 3/4

Weather Part 3/4							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
DASIS Category Number	bits	4	4		1	0	63
Part #	bit	2	2	0-3	1	0	3
Temperature	deg C	7	7	-50 to 60	1		
Dew point	deg	7	7	-50 to 60	1		
Altimeter	bits	9	9	2800 to 3200	1		
Totals		29	29				

9.2.3.1.1.1.6.1.3.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-10 identifies the value for the category number.

Table 9-10: DASIS Data Groupings (Wx 3/4)

DASIS Data Groupings		
Data Group Category	Binary Value	Decimal Value
SV Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.1.3.2 Part #

Indicates which part of the total weather message that is being sent in this message.

9.2.3.1.1.1.6.1.3.3 Temperature

Temperature is a 7 bit field that contains the surface temperature in degrees C at the ships location at the specified time.

9.2.3.1.1.1.6.1.3.4 Dew Point

Dew Point is a 7 bit field that contains the surface dew point temperature in degrees C at the ships location at the specified time.

9.2.3.1.1.1.6.1.3.5 Altimeter

The Altimeter is a 9 bit data field that contains the current barometric altitude at the ship. The range is 0 to 400 with an implied offset of 2800 making for an overall range of 2800 to 3200 with a resolution of 1/100 inch.

9.2.3.1.1.1.6.1.4 Weather Part 4/4

The following table identifies the data content for Part 4 of the Weather data.

Table 9-11: Weather Part 4/4

Weather Part 4/4							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
DASIS Category Number	bits	4	4		1	0	63
Part #	bit	2	2	0-3	1	0	3
Weather Visibility	smi	5	5	0-7.75	0.25	0	31
Wx Phenomena	bits	10			1		
Intensity			2	0-3	1		
Descriptor			3	0-7	1		
Phenomena			5	0-21	1		
Totals		21	21				

9.2.3.1.1.1.6.1.4.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-12 identifies the value for the category number.

Table 9-12: DASIS Data Groupings (Wx 4/4)

DASIS Data Groupings		
Data Group Category	Binary Value	Decimal Value
SV Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.1.4.2 Part

Indicates which part of the total weather message that is being sent in this message.

9.2.3.1.1.1.6.1.4.3 Weather Visibility

The Visibility is a 5 bit data field that represents the current visibility at the ship. The range is 0 to 7.75 statue miles in 0.25 smi increments.

9.2.3.1.1.1.6.1.4.4 Wx Phenomena

The Wx Phenomena is a 10 bit data field that describes a specific weather activity. The first two bits of the field describe the intensity of the weather, the next three bits are descriptors to apply to the following phenomena and the last 5 bits indicate the type of phenomena being adressed. The table below lists the various parameters indicated by the Wx Phenomena Field.

Table 9-13: Wx Phenomena Codes

Wx Phenomena		
Type	Bit Loc	Binary
Intensity		
Light	0	00
Moderate	1	01
Heavy	2	10
Vacinity	3	11
Descriptor		
Shallow	0	000
Partial	1	001
Patches	2	010
Low Drifting	3	011
Blowing	4	100
Showers	5	101
Thunderstorm	6	110
Freezing	7	111
Phenomena		
Drizzle	0	00000
Rain	1	00001
Snow	2	00010
Snow Grains	3	00011
Ice Crystals	4	00100
Ice Pellets	5	00101
Hail	6	00110
Small Hail and/or Snow Pellets	7	00111
Unknown Precipitation	8	01000

Mist	9	01001
Fog	10	01010
Smoke	11	01011
Volcanic Ash	12	01100
Widespread Dust	13	01101
Sand	14	01110
Haze	15	01111
Spray	16	10000
Dust / Sand Whirls	17	10001
Squalls	18	10010
Funnel Cloud / Tornado / Waterspout	19	10011
Sandstorm	20	10100
Dust Storm	21	10101

The weather group is split into 4 parts so that it may fit within the 40 bit .

9.2.3.1.1.1.6.2 General Launch and Recovery Data

The General Launch and Recovery Data message is approach specific information such as Approach Type and Case Recovery. The data content is defined in Table 9-14.

Table 9-14: General Launch and Recovery Data

General Launch and Recovery Data							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
DASIS Category Number	bits	4	4	0-15	1	0	15
Approach Type (CV-x)		2	2		1	0	3
Case Recovery	bits	2	2			0	3
Outbound Heading	deg	9	9	1-360	1	1	360
Marshal Radial	bits	9	9	1-360	1	1	360
Expected Final Bearing / Expected Base Recovery Course	deg	9	9	1-360	1	1	360
EMCON	bits	3	3		1	0	7
Totals		38	38				

9.2.3.1.1.1.6.2.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-15 defines the values for the data grouping category.

Table 9-15: DASIS Data Grouping (Ship State 200)

DASIS Data Groupings		
Data Group Category	Binary Value	Decimal Value
SV Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.2.2 Approach Type

This parameter refers to the type of approach (1, 2 or 3). It is commonly designated as CV-x where x is 'type' number.

9.2.3.1.1.1.6.2.3 Case Recovery

The Case Recovery is a 2 bit data field that defines the current case recovery (I, II or III) operations under way. The range of values is 1 to 3 matching the current case.

9.2.3.1.1.1.6.2.4 Outbound Heading

Outbound heading refers to the angle of departure over the ship (CV class).

9.2.3.1.1.1.6.2.5 Marshal Radial

This parameter refers to the radial location relative to the ship where the marshal stack is started.

9.2.3.1.1.1.6.2.6 Expected Final Bearing / Expected Base Recovery Course

For Case III recoveries this field contains the Expected Final Bearing which is the magnetic bearing assigned by Carrier Air Traffic Control Center (CATCC) for final approach. It is an extension of the landing area centerline, typically described as the Base Recovery Course (BRC) +/- the Cant Deck Offset. When the Case recovery is Type I or II then this field contains the designated Expected Base Recovery Course (EBRC) assigned by CATCC.

9.2.3.1.1.1.6.2.7 EMCON

The Emissions Control category refers to the state of operation for the ship with regard to RF emissions. The exact assignment of these bits is TBR.

9.2.3.1.1.1.6.3 Bingo Fuel Data

The Bingo Fuel Data is the calculated bingo fuel for each particular aircraft type associated with the current ship position relative to the assigned bingo field. In the case of Blue Water Ops the Aircraft Type will be set to 15 followed by a Send Time instead of Fuel State. If more than 3 aircraft fuel states are required, they will be sent in consecutive Bingo Fuel Messages.

Table 9-16: Bingo Fuel States

Bingo Fuels							
Parameter	Units	Bits Tx	Data Bits		Range	Resolution	Min Value
	Max Value						
DASIS Category Number	bits	4	4	0-15	1	0	15
Aircraft	enum	4	4	0-15	1	0	15
Fuel State	k-lbs	8	8	0-20	1	0	20
Aircraft	enum	4	4	0-15	1	0	15
Fuel State	k-lbs	8	8	0-20	1	0	20
Aircraft	enum	4	4	0-15	1	0	15
Fuel State	k-lbs	8	8	0-20	1	0	20
Totals		40	40				

9.2.3.1.1.1.6.3.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-17 identifies the value of the grouping category.

Table 9-17: DASIS Data Groupons (Ship State 200)

DASIS Data Groupings		
Data Group Category	Binary Value	Decimal Value
Ship Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

For Blue Water Ops use Aircraft Type 15 and Send Time instead of Fuel

9.2.3.1.1.1.6.3.2 Aircraft

The Aircraft field is a 4 bit enumerated field that represents a specific aircraft type for the following bingo Fuel State. The aircraft are indicated as:

- 0 = F/A-18/A/B/C/D
- 1 = F/A-18 E/F
- 2 = F-14
- 3 = EA-6
- 4 = S-3
- 5 = E-2C
- 6 = E-2
- 7 = F-35
- 15 = Blue Water Ops

9.2.3.1.1.1.6.3.3 Fuel State

The Fuel State is a 7 bit data field that contains the current bingo fuel level for the aircraft described in the previous field; corresponds to thousands of pounds of fuel.

9.2.3.1.1.1.6.4 Tank Fuel Data

The Tank Fuel Data is the fuel state for each particular aircraft type such aircraft will be required to conduct aerial refueling. If more than 3 aircraft fuel states are required, they will be sent in consecutive Tank Fuel Messages. Table 9-18 identifies the data content of this message.

Table 9-18: Tank Fuel States

Tank Fuels							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
DASIS Category Number	bits	4	4	0-15	1	0	15
Aircraft	enum	4	4	0-15	1	0	15
Fuel State	k-lbs	8	8	0-20	1	0	20
Aircraft	enum	4	4	0-15	1	0	15
Fuel State	k-lbs	8	8	0-20	1	0	20
Aircraft	enum	4	4	0-15	1	0	15
Fuel State	k-lbs	8	8	0-20	1	0	20
Totals		40	40				

9.2.3.1.1.1.6.4.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-19 identifies the value for the category number.

Table 9-19: DASIS Data Grouping (Tank Fuels)

DASIS Data Groupings		
Data Group Category	Binary Value	Decimal Value
SV Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.4.2 Aircraft

The Aircraft field is a 4 bit enumerated field that represents a specific aircraft type for the following bingo Fuel State. The aircraft are indicated as:

- 0 = F/A-18/A/B/C/D
- 1 = F/A-18 E/F
- 2 = F-14
- 3 = EA-6
- 4 = S-3
- 5 = E-2C
- 6 = E-2
- 7 = F-35
- 15 = Blue Water Ops

For Blue Water Ops use Aircraft Type 15 and Send Time instead of Fuel

9.2.3.1.1.1.6.4.3 Fuel State

The Fuel State is a 7 bit data field that contains the current fuel level for the aircraft described in the previous field.; corresponds to thousands of pounds of fuel.

9.2.3.1.1.1.6.5 Hold Down Fuel Data

The Hold Down Fuel Data applies to carrier qualification training and is the fuel state for each particular aircraft type which requires the aircraft to hold on deck for refuel after a trap on the ship. If more than 3 aircraft fuel states are required, they will be sent in consecutive Hold Down Fuel Messages.

Table 9-20: Hold Down Fuel States

Hold Down Fuels							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
DASIS Category Number	bits	4	4	0-15	1	0	15
Aircraft	enum	4	4	0-15	1	0	15
Fuel State	k-lbs	8	8	0-20	1	0	255
Aircraft	enum	4	4	0-15	1	0	15
Fuel State	k-lbs	8	8	0-20	1	0	255
Aircraft	enum	4	4	0-15	1	0	15
Fuel State	k-lbs	8	8	0-20	1	0	255
Totals		40	40				

9.2.3.1.1.1.6.5.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-21 identifies the value for the category number.

Table 9-21: DASIS Data Groupings (Hold Down Fuel)

DASIS Data Groupings		
Data Group Category	Binary Value	Decimal Value
SV Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.5.2 Aircraft (TBR)

The Aircraft field is a 4 bit enumerated field that represents a specific aircraft type for the following Fuel State. The aircraft are indicated as:

- 0 = F/A-18/A/B/C/D
- 1 = F/A-18 E/F
- 2 = F-14
- 3 = EA-6
- 4 = S-3

- 5 = E-2C
- 6 = E-2
- 7 = F-35
- 15 = Blue Water Ops

For Blue Water Ops use Aircraft Type 15 and Send Time instead of Fuel

9.2.3.1.1.1.6.5.3 Fuel State

The Fuel State is a 7 bit data field that contains the current bingo fuel level for the aircraft described in the previous field; corresponds to thousands of pounds of fuel.

9.2.3.1.1.1.6.6 Primary Divert Field Information

The Primary Divert Field Information category within DASIS is split into multiple parts to fit into the 40 bit field allocated for DASIS. Each part will have the same DASIS category number but a different part number to help identify its contents.

9.2.3.1.1.1.6.6.1 Primary Divert Field Information Part 1/8

Table 9-22: Primary Divert Field Info Part 1/8

Primary Divert Field Info Part 1/8							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Category ID	bits	4	4	0-15	1	0	15
Part#	bit	3	3	0-7	1	0	7
Name: (ICAO) ID (alphanumeric), eg. KNHK		24	24	4 characters			
Totals		31	31				

9.2.3.1.1.1.6.6.1.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-23 identifies the value for the category number.

Table 9-23: DASIS Data Groupings (Primary Divert)

DASIS Data Groupings		
Data Group Category	Binary Value	Decimal Value
SV Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.6.1.2 Part

Indicates the part of the overall DASIS category group that is being sent.

9.2.3.1.1.1.6.6.1.3 Name

This field indicates the 4 character International Civil Aviation Organization (ICAO) identifier.

9.2.3.1.1.1.6.6.2 Primary Divert Field Information Part 2/8

Table 9-24: Primary Divert Field Info (Part 2/8)

Primary Divert Field Info Part 2/8							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
DASIS Category Number	bits	4	4	0-15	1	0	15
Part	bit	3	3	0-7	1	0	7
Bearing	deg	9	9	001-360	1		
Distance	Nm	11	11	20-2000	1		
Totals		27	27				

9.2.3.1.1.1.6.6.2.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-25 identifies the value for the category number.

Table 9-25: DASIS Data Groupings (Primary Divert Field Part 2/8)

DASIS Data Groupings		
Data Group Category	Binary Value	Decimal Value
SV Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.6.2.2 Part

Indicates the part of the overall DASIS category group that is being sent.

9.2.3.1.1.1.6.6.2.3 Bearing

Bearing is angular direction to the divert field.

9.2.3.1.1.1.6.6.2.4 Distance

Distance is the distance to the divert field.

9.2.3.1.1.1.6.6.3 Primary Divert Field Information Part 3/8

Table 9-26: Primary Divert Field Info Part 3/8

Primary Divert Field Info Part 3/8							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
DASIS Category Number	bits	4	4	0-15	1	0	15
Part	bit	3	3	0-7	1	0	7
Weather Part 1		31	31				
Totals		38	38				

9.2.3.1.1.1.6.6.3.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-27 identifies the value for the category number.

Table 9-27: DASIS Data Groupings (Primary Divert File Info Part 3/8)

DASIS Data Groupings		
Data Group Category	Binary Value	Decimal Value
SV Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.6.3.2 Part #

Indicates the part of the overall DASIS category group that is being sent.

9.2.3.1.1.1.6.6.3.3 Weather Part 1

Weather Part 1 refers to the format specified in the DASIS Weather group above.

9.2.3.1.1.1.6.6.4 Primary Divert Field Information Part 4/8

Table 9-28: Primary Divert Field Info Part 4/8

Primary Divert Field Info Part 4/8							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
DASIS Category Number	bits	4	4	0-15	1	0	15
Part	bit	3	3	0-7	1	0	7
Weather Part 2		30	30				
Totals		37	37				

9.2.3.1.1.1.6.6.4.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-29 identifies the value for the category number.

Table 9-29: DASIS Data Groupings (Primary Divert Field Info Part 4/8)

DASIS Data Groupings

Data Group Category	Binary Value	Decimal Value
Ship Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.6.4.2 Part

Indicates the part of the overall DASIS category group that is being sent.

9.2.3.1.1.1.6.6.4.3 Weather Part 2

Weather Part 2 refers to the format specified in the DASIS Weather group above.

9.2.3.1.1.1.6.6.5 Primary Divert Field Information Part 5/8

Table 9-30: Primary Divert Field Info Part 5/8

Primary Divert Field Info Part 5/8							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
DASIS Category Number	bits	4	4	0-15	1	0	15
Part	bit	3	3	0-7	1	0	7
Weather Part 3		23	23				
Totals		30	30				

9.2.3.1.1.1.6.6.5.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-31 identifies the value for the category number.

Table 9-31: DASIS Data Grouping (Primary Divert Field Info 5/8)

DASIS Data Groupings Data Group Category	Binary Value	Decimal Value
Ship Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.6.5.2 Part #

Indicates the part of the overall DASIS category group that is being sent.

9.2.3.1.1.1.6.6.5.3 Weather Part 3

Weather Part 3 refers to the format specified in the DASIS Weather group above.

9.2.3.1.1.1.6.6.6 Primary Divert Field Information Part 6/8

Table 9-32: Primary Divert Field Info Part 6/8

Primary Divert Field Info Part 6/8							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Category ID	bits	4	4	0-15	1	0	15
Part	bit	3	3	0-7	1	0	7
Weather Part 4		23	23				
Totals		30	30				

9.2.3.1.1.1.6.6.6.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-33 identifies the value for the category number.

Table 9-33: DASIS Data Groupings (Primary Divert Field Part 6/8)

DASIS Data Groupings Data Group Category	Binary Value	Decimal Value
Ship Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.6.6.2 Part

Indicates the part of the overall DASIS category group that is being sent.

9.2.3.1.1.1.6.6.6.3 Weather Part 4

Weather Part 4 refers to the format specified in the DASIS Weather group above.

9.2.3.1.1.1.6.6.7 Primary Divert Field Information Part 7/8

This section is reserved for future definition.

9.2.3.1.1.1.6.6.8 Primary Divert Field Information Part 8/8

This section is reserved for future definition.

9.2.3.1.1.1.6.7 PIM Data

The position and intended movement (PIM) Data provides the Latitude (11 bits), Longitude (12 Bits) and Time-Of-Arrival (TOA) (5 bits plus 7 spare) for the location of the ship at a future point in time.

Table 9-34: PIM Data

PIM Data							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
DASIS Category Number	bits	4	4	16	1	0	15
PIM Latitude	deg	11	11	360	0.1757813	-180	179.8242
PIM Longitude	deg	12	12	360	0.0878906	-180	179.9121
PIM TOA	hrs	5	5		0.2	0	6.2
Totals		32	32				

9.2.3.1.1.1.6.7.1 DASIS Category Number

The DASIS Category Number is a 4 bit data field that defines the type of data category contained in the DASIS 200 data field of the Ship State 200 / DASIS 200 message. Table 9-35 identifies the value for the category number.

Table 9-35: DASIS Data Groupings (PIM Data)

DASIS Data Groupings		
Data Group Category	Binary Value	Decimal Value
SV Exclusion Mask	0001	1
Weather	0010	2
General Launch and Recovery	0011	3
Bingo Fuels	0100	4
Tank Fuels	0101	5
Hold Down Fuels	0110	6
Divert Fields	0111	7
PIM Data	1000	8

9.2.3.1.1.1.6.7.2 PIM Latitude

PIM Latitude is sent to represent the intended latitude of the ship. The range of the latitude is -90 to +90 degrees with a resolution of 0.088 degrees or 9.8 kilometers

9.2.3.1.1.1.6.7.3 PIM Longitude

PIM Latitude is sent to represent the intended latitude of the ship. The range of the longitude is -180 to +180 degrees with a resolution of 0.088 degrees or 9.8 kilometers

9.2.3.1.1.1.6.7.4 PIM TOA

PIM TOA represents the amount of time in which the other PIM data (latitude and longitude) is valid. The range of the TOA is 0 to 6.3 hours with a resolution of 0.2 hours

9.2.3.1.1.2 Ship State 50

The Ship State 50 message is an increase in resolution of the ship track and position information broadcast in the Ship State 200 message. It is transmitted from the ship to the aircraft at a rate of once per second. It is intended as a refinement of location information for aircraft entering the Carrier Control Area (CCA). It also contains a figure representing the navigation uncertainty category (NUC) for the computed ship position. The transmitted message size is 29 bits. No message cycling takes place in this message so the entire message is received each second. Table 9-36 identifies the data content for the Ship State 50 message.

Table 9-36: Ship State 50

Ship State 50							
					Rate	1.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
GPS Time of Applicability	sec	5	5	30	1	0	29.0
Latitude LSB	deg	2	2	0.000687	0.0001717	-0.000343	0.000172
Longitude LSB	deg	2	2	0.000687	0.0001717	-0.000343	0.000172
Height	m	10	10	200	0.1953125	-100	99.80469
Inertial Horizontal Speed	kts	4	4		0.125	0	1.875
Average Inertial Track	deg	4	4	1.40625	0.0878906	-0.703	0.615
NUC Position	bits	4	4		1	0	15
Totals		31	31				

9.2.3.1.1.2.1 GPS Time of Applicability

GPS Time of Applicability is a 6 bit message alignment field that is synched with GPS time and repeats (rolls over) every 30 seconds.

9.2.3.1.1.2.2 Latitude LSB

The Latitude LSB is a 3 bit data field that further refines the Ship State 200 latitude position into a resolution of approximately 19 meters.

9.2.3.1.1.2.3 Longitude LSB

The Longitude LSB is a 3 bit data field that further refines the Ship State 200 longitude position into a resolution of approximately 19 meters.

9.2.3.1.1.2.4 Height

Height is a 10 bit data field that represents the WGS-84 height of the ship reference point.

9.2.3.1.1.2.5 Inertial Horizontal Speed

The Inertial Horizontal Speed is a 9 bit measure of the current speed of the ship in knots. It is a separate field from the Ship State 200 and provides 4 more bits of resolution.

9.2.3.1.1.2.6 Average Inertial Track

The Average Inertial Track is a 4 bit increase on the Ship State 200 Average Inertial Track message and when combined together yields a resolution of approximately 0.089 degrees.

9.2.3.1.1.2.7 NUC Position

The NUC is a 4 bit data field that reflects the overall accuracy of the current Ship State 50 message. The implementation of the field is TBR since it is still being defined.

9.2.3.1.1.3 Ship State 10

The Ship State 10 data packets are transmitted from the ship to the aircraft at a rate of twice per second. It primarily contains increased bits of resolution of the Ship State 50 message as well as a heading, wind and ship attitude information. This last information contains ship ID, heading quadrant and cant deck offset and is cycled to reduce bit count. Final message data size is 118 bits while the transmitted message size is 102 bits. Table 9-37 provides a definition of the data content for the Ship State 10 message.

Table 9-37: Ship State 10

Ship State 10							
					Rate	2.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
GPS Time of Applicability	sec	6	6	30	0.5	0	29.500
Latitude	deg	8	8	0.000172	6.706E-07	-8.58E-05	8.52E-05
Longitude	deg	8	8	0.000172	6.706E-07	-8.58E-05	8.52E-05
Inertial Horizontal Speed	kts	4	4		0.0078125	0	0.1172
Average Inertial Track	deg	2	2	0.088	0.022	-0.0439	0.022
Inertial Track Rate	deg/s	12	12	8	0.002	-4	3.998
Heading	deg	10	10	360.000	0.352	-180.00	179.648
Heading Rate	deg/s	12	12	8	0.002	-4	3.998
Wind Over Deck Speed		6	6		1	0	63
Wind Over Deck Dir		9	9	360	0.7031	-180	179.30
Ship Water Speed		6	6	63	1	0	63.00
Totals		83	83				

9.2.3.1.1.3.1 GPS Time of Applicability

GPS Time of Applicability is an 8 bit message alignment field that is synched with GPS time and repeats (rolls over) every 30 seconds. The resolution is 0.125 seconds.

9.2.3.1.1.3.2 Latitude

The Latitude is an 8 bit data field that further refines the Ship State 50 latitude position into a resolution of approximately 7.5 centimeters. The unit of measure is degrees.

9.2.3.1.1.3.3 Longitude

The Longitude is an 8 bit data field that further refines the Ship State 50 longitude position into a resolution of approximately 7.5 centimeters. The unit of measure is degrees.

9.2.3.1.1.3.4 Inertial Horizontal Speed

The Inertial Horizontal Speed is a 4 bit data field that further refines the Ship State 50 measure of the current speed of the ship in knots. Combined with the Ship State 50 measurement the final resolution is approximately 0.0078 knots.

9.2.3.1.1.3.5 Average Inertial Track

The Average Inertial Track is a 2 bit increase on the Ship State 50 Average Inertial Track message and when combined together yields a resolution of approximately 0.022 degrees.

9.2.3.1.1.3.6 Inertial Track Rate

The Inertial Horizontal Speed is a 12 bit measure of the current speed of the ship in knots. It is a separate field from the Ship State 50 and has 12 bits of resolution.

9.2.3.1.1.3.7 Heading

The heading field describes the ships heading within the heading sector provided in the cyclic data below.

9.2.3.1.1.3.8 Heading Rate

The Heading Rate field describes the rate of heading change in degrees per second. It has 12 bits of resolution and the range is +/- 4 degrees/sec. The resolution is 0.001953 degrees/sec.

9.2.3.1.1.3.9 Wind Over Deck Speed

The Wind Over Deck Speed is a 6 field containing the current wind speed at the ship in knots. The range is 0 to 63.0 with a resolution of 1 knot.

9.2.3.1.1.3.10 Wind Over Deck Dir

The Wind Over Deck Dir is a 12 bit data field that describes the direction of the wind over the deck with respect to the landing area in degrees. The range is 0 - 360 with a resolution of 0.0879 degrees.

9.2.3.1.1.3.11 Ship Water Speed

The Ship Water Speed is a 6 bit data field that describes the speed of the ship through the water in knots. The range is 0 to 63 knots with a resolution of 1 knot.

9.2.3.1.2 Ship Motion Data

Ship motion data was separated into three data packets. Acceleration data is sent at 20 Hz, rate data at 1 Hz, and delta position data at 0.2 Hz. This approach relies on using sample-synchronized reconstruction filters within the ship and aircraft processing to adjust out small residual errors the aircraft integration of ship acceleration and ship velocity. The delta position measurements are relative to the ship reference point (SRP); from the survey data, stabilization and deck motion compensation (DMC) data for any number of other touchdown or reference points on the ship can be derived in the aircraft. Additional data to enhance the robustness of the DMC process with respect to missed data packets may be desired, however, this would not significantly affect the base/burst rate. It should be noted here that this architecture relies on a calibration of ship inertial sensor errors using a combination of slow high-pass filtering as well as low-gain GPS aiding. Small residual calibration errors that would be present in the airborne solution would be removed if necessary through the use of a complementary error filter in the aircraft processing (as used in the testbed design).

9.2.3.1.2.1 Ship Motion High

The Ship Motion High data packet refers to the High Update Rate of the ship motion information. This data packet contains three-dimensional acceleration information and is updated at a 20 Hz rate. Table 9-38 provides the data content definition for Ship Motion High.

Table 9-38: Ship Motion High

Ship Motion High									
						Rate	20.0	Hz	
Parameter	Units	Sign	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value	Description
S1tov	sec		10	10		0.002	0	2.046	Time of Validity
SMS_Lax	ft/s^2	north	13	13	10	0.001221	-5.000	4.999	Ship Motion Sensor acceleration - X
SMS_Lay	ft/s^2	east	13	13	10	0.001221	-5.000	4.999	Ship Motion Sensor acceleration - Y
SMS_Laz	ft/s^2	down	14	14	20	0.001221	-10.000	9.999	Ship Motion Sensor acceleration - Z
SMSpdot	deg/s^2	rwd	28	28	4	1.49E-08	-2.000	2.000	Ship roll acceleration
SMSqdot	deg/s^2	nu	28	28	4	1.49E-08	-2.000	2.000	Ship pitch acceleration
SMSrdot	deg/s^2	nr	28	28	4	1.49E-08	-2.000	2.000	Ship yaw acceleration
CMrSCM_Lax	ft/s^2	north	13	13	10	0.001221	-5.000	4.999	Ship Center of Motion rel. to stab. acceleration - X
CMrSCM_Lay	ft/s^2	east	13	13	10	0.001221	-5.000	4.999	Ship Center of Motion rel. to stab. acceleration - Y
CMrSCM_Laz	ft/s^2	down	13	13	10	0.001221	-5.000	4.999	Ship Center of Motion rel. to stab. acceleration - Z
Totals			173	173					

Note 1: GPS Time of Applicability rolls over every 2.048 seconds.

Note 2: Flags indicate validity in LSB to MSB order.

Note 3: Parameters initially out-of-range to be resolved with mid-rate data.

9.2.3.1.2.1.1 S1tov

The S1tov is a 10 bit data field that represents that GPS Time Of Validity for the accompanying data. It has a resolution of 0.002 seconds and rolls over every 2.048 seconds.

9.2.3.1.2.1.2 SMS_Lax

The SMS_Lax is a 13 bit data field that contains the X value of acceleration from the Ship Motion Sensor. The units are ft/sec^2 with North indicating a positive X direction. The range of values is +/- 5 ft/sec^2 with a resolution of approximately 0.0012.

9.2.3.1.2.1.3 SMS_Lay

The SMS_Lay is a 13 bit data field that contains the Y value of acceleration from the Ship Motion Sensor. The units are ft/sec^2 with East indicating a positive Y direction. The range of values is +/- 5 ft/sec^2 with a resolution of approximately 0.0012.

9.2.3.1.2.1.4 SMS_Laz

The SMS_Laz is a 14 bit data field that contains the Z value of acceleration from the Ship Motion Sensor. The units are ft/sec^2 with Down indicating a positive Z direction. The range of values is +/- 10 ft/sec^2 with a resolution of approximately 0.0012.

9.2.3.1.2.1.5 SMSpdot

The SMSpdot is a 28 bit data field that contains the p (roll) value of angular acceleration from the Ship Motion Sensor. The units are deg/sec^2 with starboard side down indicating a positive p direction. The range of values is +/- 2 deg/sec^2 with a resolution of approximately 1.49e-8.

9.2.3.1.2.1.6 SMSqdot

The SMSqdot is a 28 bit data field that contains the q (pitch) value of angular acceleration from the Ship Motion Sensor. The units are deg/sec^2 with bow up indicating a positive q direction. The range of values is +/- 2 deg/sec^2 with a resolution of approximately 1.49e-8.

9.2.3.1.2.1.7 SMSrdot

The SMSrdot is a 28 bit data field that contains the p (yaw) value of angular acceleration from the Ship Motion Sensor. The units are deg/sec^2 with bow toward right of course indicating a positive r direction. The range of values is +/- 2 deg/sec^2 with a resolution of approximately 1.49e-8.

9.2.3.1.2.1.8 CMrSCM_Lax

The CMrSCM_Lax is a 13 bit data field representing the X acceleration value for the ship's Center of Motion relative to a stabilized X acceleration value. The units are ft/sec^2 with North indicating a positive X direction. The range of values is +/- 5 ft/sec^2 with a resolution of approximately 0.0012.

9.2.3.1.2.1.9 CMrSCM_Lay

The CMrSCM_Lay is a 13 bit data field representing the Y acceleration value for the ship's Center of Motion relative to a stabilized Y acceleration value. The units are ft/sec^2 with East indicating a positive Y direction. The range of values is +/- 5 ft/sec^2 with a resolution of approximately 0.0012.

9.2.3.1.2.1.10 CMrSCM_Laz

The CMrSCM_Laz is a 13 bit field representing the Z acceleration value for the ship's Center of Motion relative to a stabilized Z acceleration value. The units are ft/sec^2 with Down indicating a positive Z direction. The range of values is +/- 5 ft/sec^2 with a resolution of approximately 0.0012.

9.2.3.1.2.2 Ship Motion Med

The Ship Motion Med data packet refers to the Medium Update Rate of the information. This message contains velocity information related to changing ship attitude and is updated at a 2 Hz rate. Table 9-39 provides the data content definition for Ship Motion Med.

Table 9-39: Ship Motion Med

Ship Motion Med									
						Rate	2.0	Hz	
Parameter	Units	Sign	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value	Description
S2tov	sec		10	10		0.002	0	2.046	Time of Validity
SMSpb	deg/s	rwd	19	19	6	1.14441E-05	-3.000	3.000	Ship roll rate
SMSqb	deg/s	nu	19	19	6	1.14441E-05	-3.000	3.000	Ship pitch rate
SMSrb	deg/s	nr	19	19	4	7.62939E-06	-2.000	2.000	Ship yaw rate
Totals			67	67					

Note: Time of Validity rolls over every 2.048 seconds.

9.2.3.1.2.2.1 S2tov

The S2tov is a 10 bit data field that represents GPS Time Of Validity for the accompanying data. It has a resolution of 0.002 seconds and rolls over every 2.048 seconds.

9.2.3.1.2.2.2 SMSpb

The SMSpb is a 19 bit data field that contains the p (roll) rate from the Ship Motion Sensor. The units are deg/sec with starboard side down indicating a positive p direction. The range of values is +/- 3 deg/sec with a resolution of approximately 1.14e-5.

9.2.3.1.2.2.3 SMSqb

The SMSqb is a 19 bit data field that contains the p (pitch) rate from the Ship Motion Sensor. The units are deg/sec with bow up indicating a positive q direction. The range of values is +/- 3 deg/sec with a resolution of approximately 1.14e-5.

9.2.3.1.2.2.4 SMSrb

The SMSrb is a 19 bit data field that contains the p (yaw) rate from the Ship Motion Sensor. The units are deg/sec toward right of course indicating a positive r direction. The range of values is +/- 2 deg/sec with a resolution of approximately 7.63e-6.

9.2.3.1.2.3 Ship Motion Low

The Ship Motion Low data packet refers to the Low Update Rate of the ship motion information. This message contains information related to ship position and attitude and is updated at a 1 Hz rate. Table 9-40 provides the data content definition for Ship Motion Low.

Table 9-40: Ship Motion Low

Ship Motion Low									
						Rate	1.0	Hz	
Parameter	Units	Sign	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value	Description
S3tov	sec		10	10		0.002	0	2.046	Time of Validity
SMSphi	deg	rwd	10	10	30	0.029297	-15.00	14.97	Ship roll
SMStheta	deg	nu	10	10	20	0.019531	-10.00	9.98	Ship pitch
SMSpsi	deg	cwn	16	16	360	0.005493	-180.0	179.99	Ship true heading
CMrSCM_Lpx	ft	north	19	19	50	9.54E-05	-25.00	25.00	Ship Center of Motion rel. to stab. position - X
CMrSCM_Lpy	ft	east	19	19	50	9.54E-05	-25.00	25.00	Ship Center of Motion rel. to stab. position - Y
CMrSCM_Lpz	ft	down	19	19	30	5.72E-05	-15.00	15.00	Ship Center of Motion rel. to stab. position - Z
Shipspeed	ft/sec	12	12	12	64	0.015625	0	63.98	Ship Horizontal speed
Totals			115	115					

Note: Time of Validity rolls over every 2.048 seconds.

9.2.3.1.2.3.1 S3tov

The S3tov is a 10 bit data field that represents GPS Time Of Validity for the accompanying data. It has a resolution of 0.002 seconds and rolls over every 2.048 seconds.

9.2.3.1.2.3.2 SMSphi

The SMSphi is a 10 bit data field that contains the roll attitude from the Ship Motion Sensor. The units are degrees with starboard side down indicating a positive direction. The range of values is +/- 15 deg with a resolution of approximately 0.0293.

9.2.3.1.2.3.3 SMStheta

The SMStheta is a 10 bit data field that contains the pitch attitude from the Ship Motion Sensor. The units are degrees with bow up indicating a positive direction. The range of values is +/- 10 deg with a resolution of approximately 0.0195.

9.2.3.1.2.3.4 SMSpsi

The SMSpsi is a 16 bit data field that contains the true heading from the Ship Motion Sensor. The units are degrees with positive values indicated clockwise from North. The range is -180 to + 179.99 degrees with a resolution of approximately 0.0055 degrees.

9.2.3.1.2.3.5 CMrSCM_Lpx

The CMrSCM_Lpx is a 19 bit data field containing the X coordinate position relative to a stabilized position. The units are feet with North indicating a positive X direction. The range is +/- 25 feet with a resolution of approximately 9.45e-5 ft.

9.2.3.1.2.3.6 CMrSCM_Lpy

The CMrSCM_Lpy is a 19 bit data field containing the Y coordinate position relative to a stabilized position. The units are feet with East indicating a positive Y direction. The range is +/- 25 feet with a resolution of approximately 9.45e-5 ft.

9.2.3.1.2.3.7 CMrSCM_Lpz

The CMrSCM_Lpz is a 19 bit data field containing the Z coordinate position relative to a stabilized position. The units are feet with Down indicating a positive Z direction. The range is +/- 15 feet with a resolution of approximately 7.63e-6 ft.

9.2.3.1.2.3.8 Shipspeed

The Shipspeed is a 12 bit data field containing the ships horizontal speed. The units are ft/sec. The range is 0 to 64 ft/sec with a resolution of approximately 0.016.

9.2.3.1.3 ATM Data packets

ATM data packets sent from the ship to the aircraft are either:

1. Intended for all aircraft within the CCA coverage area and sent on a regularly scheduled basis or
2. Sent to specific aircraft on an as required basis

The data packets designated for all aircraft are identified as broadcast data packets while the data packets intended for specific aircraft are Uplink data packets. The content of these data packets are referred to as messages since in many cases they replace the function of voice messages.

Additionally, all of the ATM data packets were separated based on range to take advantage of the range-squared rate factor. There are data packets (both Broadcast and Uplink) corresponding to system modes for both 50 and 10 nm.

9.2.3.1.3.1 ATM Broadcast 50

The ATM Broadcast 50 message is transmitted from the ship to aircraft within a 50 nm radius at a 1 Hz rate. Table 9-41 provides the data content definition for ATM Broadcast 50. These data packets are automatically generated messages that contain a variety of information relevant to an aircraft entering the CCA. This information consists of General Launch and Recovery data, Weather and Bingo Fuels relevant for the current operations. The transmitted message size is 104 bits with 8 bits of Sequence Number and 96 bits of Message Data. Message Data longer than 96 bits will be transmitted in successive uplink ATM slots. The ship ID is appended in the network layer. Additional ATM Broadcast 50 data packets may be defined in the future.

Table 9-41: ATM Broadcast 50

ATM Broadcast 50							
					Rate	1.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Sequence Number	bits	8	8		1	0	255
Message Data	bits	96	96				
Totals		104	104				

9.2.3.1.3.1.1 Sequence Number

The Sequence Number is an 8 bit data field that rolls over every 256 messages to allow receiving aircraft to make sure all messages are received and in order.

9.2.3.1.3.1.2 Message Data

The Message Data consists of various automatically generated messages containing information relevant to aircraft entering and within the CCA (50 nm)

9.2.3.1.3.1.3 Launch and Recovery Data

The General Launch and Recovery Data message is Approach and Ship specific information such as Case Recovery, Glideslope Angle and Cant Deck Offset. This message content is interleaved with other ATM Broadcast 50 messages and is cycled through at least every TBR seconds. Table 9-42 provides the data content definition for Launch and Recovery Info.

Table 9-42: General Launch and Recovery Data

Launch and Recovery Info							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Message ID	bits	3	3		1	0	7
Case Launch / Recovery	bits	2	2	1		0	1
Launch Status	bits	6	6	50	1	0	50
Deck Status	bits	1	1	1		0	1
Ships Turn	enum	2	2	Steady, Port, Starboard	1	0	2
Departure Reference Radial	bits	9	9	1-360	1	1	360
Final Bearing / Base Recovery Course	deg	9	9	1-360	1	1	360
Totals		32	32				

9.2.3.1.3.1.3.1 Message ID

The Message ID is used to identify the specific type of ATM50 broadcast message being sent.

01 = 1 Launch and Recovery Info
10 = 2 TDP Info

9.2.3.1.3.1.3.2 Case Launch/Recovery

The Case Launch/Recovery is a 2 bit data field that defines the current case launch/recovery (I, II or III) operations under way. The range of values is 1 to 3 matching the current case.

9.2.3.1.3.1.3.3 Launch Status

Launch Status is a 6 bit code to indicate the ship's capality to launch aircraft. The definition of this field are being redefined and are TBR.

9.2.3.1.3.1.3.4 Ships Turn

Ships Turn is s 2 bit field used to determine whether the ship is steady, turning port or starboard. The definition of this field are being redefined and are TBR.

9.2.3.1.3.1.3.5 Deck Status

The Deck Status is a one bit data field that describes the current recovery status of the deck. The range is 0 (Not Closed) to 1 (Closed).

9.2.3.1.3.1.3.6 Departure Reference Radial

The Reference Radial is a 9 bit data field that contains the designated reference radial for the current operations. The unit is in degrees with a range of 1 - 360 degrees and a resolution of 1 degree.

9.2.3.1.3.1.3.7 Final Bearing/Base Recovery Course

For Case III recoveries this field contains the Final Bearing which is the magnetic bearing assigned by CATCC for final approach. It is an extension of the landing area centerline, typically described as the BRC +/- the Cant Deck Offset. When the Case recovery is Type I or II then this field contains the designated BRC assigned by CATCC.

9.2.3.1.3.1.4 TDP Info

Touchdown Point (TDP) Info is referring to Touchdown Point of the ship. It is the location of guidance to the ship. For LHA ships there can be multiple TDPs. Table 9-43 provides the data content definition for TDP Info.

Table 9-43: Touchdown Point Info.

TDP Info							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Message ID	bits	3	3		1	0	7
Approach Number (x)	bits	4	4	15	1	0	15
Approach x Glideslope Angle	deg	5	5	16	0.5	0	15.5
App x TDP Select/Origin X Distance	m	16	16	656	0.01	-328	328
App x TDP Select/Origin Y Distance	m	16	16	656	0.01	-328	328
App x TDP Select/Origin Z Distance	m	16	16	656	0.01	-328	328
App x ULAL	m	8	8	40	0.2	0	40
App x UVAL	m	8	8	40	0.2	0	40
App x MULAL	m	8	8	40	0.2	0	40
App x MUVAL	m	8	8	40	0.2	0	40
Totals		92	92				

9.2.3.1.3.1.4.1 Message ID

The Message ID is used to identify the specific type of ATM50 broadcast message being sent.

01 = 1 Launch and Recovery Info
10 = 2 TDP Info

9.2.3.1.3.1.4.2 Approach Number

Approach Number is identifier of the TDP information listed below. The identifier value is just the sequence number of the TDP identified.

9.2.3.1.3.1.4.3 Glideslope Angle

The Glideslope Angle is an 8 bit data field that defines the selected glideslope for current recovery operations. The unit is degrees. The range is 0 to 15.9375 degrees with a resolution of 0.0625 degrees.

9.2.3.1.3.1.4.4 TDP Select/Origin X Distance

The TDP Select/Origin X Distance is a 16 bit data field that contains the X coordinate distance from the ships origin to the selected TDP in meters.

9.2.3.1.3.1.4.5 TDP Select/Origin Y Distance

The TDP Select/Origin Y Distance is a 16 bit data field that contains the Y coordinate distance from the ships origin to the selected TDP in meters.

9.2.3.1.3.1.4.6 TDP Select/Origin Z Distance

The TDP Select/Origin Z Distance is a 16 bit data field that contains the Z coordinate distance from the ships origin to the selected TDP in meters.

9.2.3.1.3.1.4.7 Uplinked Lateral Alert Limit (ULAL)

The ULAL is an 8 bit data field that contains the lateral alert limit for the chosen approach in meters. The range is 0 to 12 meters and the resolution is .05 meters.

9.2.3.1.3.1.4.8 Uplinked Vertical Alert Limit (UVAL)

The UVAL is an 8 bit data field that contains the vertical alert limit for the chosen approach in meters. The range is 0 to 12 meters and the resolution is .05 meters.

9.2.3.1.3.1.4.9 Maximum Uplinked Lateral Alert Limit (MULAL)

The MULAL is an 8 bit data field that contains the maximum splay value of the lateral alert limit for the chosen approach in meters. The range is 0 to 40 meters and the resolution is 0.2 meters.

9.2.3.1.3.1.4.10 Maximum Uplinked Vertical Alert Limit (MUVAL)

The MUVAL is an 8 bit data field that contains the maximum splay value of the vertical alert limit for the chosen approach in meters. The range is 0 to 40 meters and the resolution is 0.2 meters.

9.2.3.1.3.2 ATM Broadcast 10

The ATM Broadcast 10 message is transmitted from the ship to aircraft within a 10 nm radius at a 1 Hz rate. These messages are automatically generated messages that contain a variety of information relevant to an aircraft within the Precision mode coverage area and required prior to entering the Carrier Control Zone (CCZ). This information consists of a Ship Survey Data message which contains TDPs and ship Center of Motion (CM) location for Guidance and Control calculations.

The transmitted message size is 104 bits with 8 bits of Sequence Number and 96 bits of Message Data. Message Data longer than 96 bits will be transmitted in successive uplink ATM slots. The ship ID is appended in the network layer. Table 9-44 provides the data content definition for ATM Broadcast 10.

Table 9-44: ATM Broadcast 10

ATM Broadcast 10							
					Rate	1.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Sequence Number	bits	8	8		1	0	255
Message Data	bits	96	96				
Totals		104	104				

Note 1: Ship ID and Aircraft ID appended in network layer.

Note 2: Aircraft Network ID includes coding TBR to address a message to all aircraft.

Note 3: Sequence Number rolls over at 255.

Note 4: Message Data longer than 96 bits transmitted in successive messages.

9.2.3.1.3.2.1 Sequence Number

The Sequence Number is an 8 bit data field that rolls over every 256 messages to allow receiving aircraft to make sure all messages are received and in order.

9.2.3.1.3.2.2 Message Data

The Message Data consists of various automatically generated messages containing information relevant to aircraft within the CCA (50 nm) and particularly those intending approach and landing operations.

9.2.3.1.3.2.3 Center of Motion Data

The Center of Motion data contains the physical mapping of the ships CM relative to the ships origin. Table 9-45 provides the data content definition for Center of Motion Data.

Table 9-45: Center of Motion Data

Center of Motion Data							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Message ID	bits	3	3		1	0	7
CM/Origin X Distance	m	16	16	655.36	0.01	-328	327.67
CM/Origin Y Distance	m	16	16	655.36	0.01	-328	327.67
CM/Origin Z Distance	m	16	16	655.36	0.01	-328	327.67
Totals		51	51				

9.2.3.1.3.2.3.1 Message ID

The Message ID is used to identify the specific type of ATM10 broadcast message being sent.

01 = 1 Center of Motion Data
10 = 2 Broadcast Command/Info

9.2.3.1.3.2.3.2 CM/Origin X Distance

The CM/Origin X Distance is a 16 bit data field that contains the X coordinate distance from the origin to the ship CM in meters. The range is +/- 328 meters and the resolution is 0.01 meter.

9.2.3.1.3.2.3.3 CM/Origin Y Distance

The CM/Origin Y Distance is a 16 bit data field that contains the Y coordinate distance from the origin to the ship CM in meters. The range is +/- 328 meters and the resolution is 0.01 meter.

9.2.3.1.3.2.3.4 CM/Origin Z Distance

The CM/Origin Z Distance is a 16 bit data field that contains the Z coordinate distance from the origin to the ship CM in meters. The range is +/- 328 meters and the resolution is 0.01 meter.

9.2.3.1.3.2.4 Broadcast Command/Info

The Broadcast Command provides a summary of important ship deck actions to relate to aircraft within the 10 mi radius. Table 9-46 provides the data content definition for Broadcast Command/Info.

Table 9-46: Broadcast Command/Info

Broadcast Command/Info							
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Message ID	bits	3	3		1	0	7
Command/Info	bits	5	5		1	0	31
Totals		8	8				
Command/Info:	1 = Waveoff Occurred						
	2 = Bolter						
	3 = All Deck movement halt						
	4 = Suspend Cat						
	5 = SAR in progress						

9.2.3.1.3.2.4-3.1 Message ID

The Message ID is used to identify the specific type of ATM10 broadcast message being sent.

01 = 1 Center of Motion Data
10 = 2 Broadcast Command/Info

9.2.3.1.3.2.4-3.2 Command/Info

The Command/Info is a 5 bit field used to indicate events of interest to all aircraft within a 10 nmi. radius of the ship.

9.2.3.1.3.3 ATM Uplink 50

The ATM Uplink 50 message is transmitted from the ship to aircraft within a 50 nm radius at a 1 Hz rate. These messages are automatically generated messages that contain a variety of information relevant to an aircraft entering the CCA. The message content is defined in Section 10 of this document.

The transmitted message size is 104 bits with 8 bits of Sequence Number and 96 bits of Message Data. Message Data longer than 96 bits will be transmitted in successive uplink ATM slots. The ship ID is appended in the network layer. Table 9-47 provides the data content definition for ATM Uplink 50.

Table 9-47: ATM Uplink 50

ATM Uplink 50							
					Rate	1.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Sequence Number	bits	8	8		1	0	255
Message Data	bits	96	96				
Totals		104	104				

9.2.3.1.3.3.1 Sequence Number

The Sequence Number is an 8 bit field that rolls over every 256 messages to allow receiving aircraft to make sure all messages are received and in order.

9.2.3.1.3.3.2 Message Data

The Message Data consists of various automatically generated messages containing information relevant to aircraft entering and within the Precision mode coverage area (10 nm).

9.2.3.1.3.4 ATM Uplink 10

The ATM Uplink 10 message is transmitted from the ship to aircraft within a 50 nm radius at a 1 Hz rate. These messages are automatically generated messages that contain a variety of information relevant to an aircraft entering the Precision mode coverage area.

The transmitted message size is 104 bits with 8 bits of Sequence Number and 96 bits of Message Data. Message Data longer than 96 bits will be transmitted in successive uplink ATM slots. The ship ID is appended in the network layer. Table 9-48 provides the data content definition for ATM Uplink 10.

Table 9-48: ATM Uplink 10

ATM Uplink 10							
					Rate	1.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Sequence Number	bits	8	8		1	0	255
Message Data	bits	96	96				
Totals		104	104				

9.2.3.1.3.4.1 Sequence Number

The Sequence Number is an 8 bit field that rolls over every 256 messages to allow receiving aircraft to make sure all messages are received and in order.

9.2.3.1.3.4.2 Message Data

The Message Data consists of various automatically generated messages containing information relevant to aircraft entering and within the CCA (50 nm).

9.2.3.1.4 GPS Data

The GPS Data packets contain the GPS corrections information as well as data quality information. It consists of four basic data packets:

- GPS Pseudorange Block Header
- GPS Pseudorange Data Block
- GPS Carrier Phase Block Header
- GPS Carrier Phase Data Block

9.2.3.1.4.1 GPS Pseudorange Block Header

The GPS Pseudorange Block Header contains data time of applicability information as well as how many and what type of measurements are going to be following. Table 9-49 provides the data content definition for GPS Pseudorange Block Header.

Table 9-49: GPS Pseudorange Block Header

GPS Pseudorange Block Header							
					Rate	2.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
GPS Time of Applicability	sec	8	8		0.1	0	19.9
Number of Measurements	bits	4	4		1	0	12
Ranging Source Block ID	bits	4	4		1	0	12
Measurement Type	bits	3	3		1	0	7
Issue of Data	bits	8	8		1	0	255
Ephemeris CRC	bits	16	16		1	0	65535
Source Availability Duration	sec	8	8		10	0	2550
Totals		51	51				

Note 1: GPS Time of Applicability rolls over every 20.0 seconds.

Note 2: Ephemeris Cyclic Redundancy Check (CRC) and Source Availability Duration cycle through available ranging sources.

9.2.3.1.4.1.1 GPS Time of Applicability

GPS Time of Applicability is an 8 bit data field that describes the time that the correction data will be applicable. This is needed for the receiving aircraft to apply the corrections to the proper GPS epoch measurements. It repeats (rolls over) every 20.0 seconds. The range is 0 to 19.9 seconds and the resolution is 0.1 seconds.

9.2.3.1.4.1.2 Number of Measurements

The number of measurements is a 4 bit data field that describes the number of correction blocks that will be broadcast following this message. The range is 0 to 12 with growth capability to 15. The resolution is 1.

9.2.3.1.4.1.3 Ranging Source Block ID

The Ranging Source Block ID is a 4 bit data field. The range is 0 to 15 with a resolution of 1.

9.2.3.1.4.1.4 Measurement Type

The Measurement Type field is a 4 bit value that describes the type of GPS data corrections (C/A, L1Y, L2Y, etc) that are being broadcast. The range of value is 0 to 15 with a resolution of 1.

9.2.3.1.4.1.5 Issue of Data

The Issue of Data is an 8 bit data field that contains Issue of Data Ephemeris (IODE) for the particular satellite Ephemeris CRC that is being broadcast in this epoch. The range is 0 to 255 with a resolution of 1.

9.2.3.1.4.1.6 Ephemeris CRC

The Ephemeris CRC is a 16 bit integrity check on the ephemeris that is performed on each GPS source for which corrections are broadcast. This allows the aircraft to verify the integrity of the ephemeris message being used. This field rotates each second through all the satellites that are being corrected. The range is 0 to 655335 with a resolution of 1.

9.2.3.1.4.1.7 Source Availability Duration

The Source Availability Duration is an 8 bit field which identifies the time duration that the correction will be available for use.

9.2.3.1.4.2 GPS Pseudorange Data Block

The GPS Pseudorange Data Block contains the pseudorange correction information for each GPS satellite being tracked and corrected. A separate Data Block is sent for each satellite being corrected. Currently a maximum of 10 blocks are possible. Table 9-50 provides the data content definition for GPS Pseudorange Data Block.

Table 9-50: GPS Pseudorange Data Block

GPS Pseudorange Data Block							
					Rate	2.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
SV	bits	5	5		1	0	31
L1 Pseudorange Corr	m	8	8	16	0.0625	-8	7.9375
L1 Pseudorange Est Err	m	6	6	4	0.0625	-2	1.9375
B1	m	5	5	4	0.1250	-2	1.8750
B2	m	5	5	4	0.1250	-2	1.8750
B3	m	5	5	4	0.1250	-2	1.8750
B4	m	5	5	4	0.1250	-2	1.8750
L2 Pseudorange Corr	m	8	8	16	0.0625	-8	7.9375
L2 Pseudorange Est Err	m	6	6	4	0.0625	-2	1.9375
B1	m	5	5	4	0.1250	-2	1.8750
B2	m	5	5	4	0.1250	-2	1.8750
B3	m	5	5	4	0.1250	-2	1.8750
B4	m	5	5	4	0.1250	-2	1.8750
Totals		73	73				

9.2.3.1.4.2.1 SV

The SV is a 5 bit data field that defines which satellite Pseudo Range Number (PRN) number is associated with the following data. The range is 0 to 31 with a resolution of 1.

9.2.3.1.4.2.2 L1 Pseudorange Corr

The L1 Pseudorange Corr is an 8 bit correction value to be used to reconstruct the full ship L1 pseudorange value for the ranging source specified in the ranging source block ID, on the aircraft side. The units are meters with a range of +/- 8 meters and a resolution of 0.0625 meters.

9.2.3.1.4.2.3 L1 Pseudorange Estimate Err

The L1 Pseudorange Estimate Err is a 6 bit value that estimates the 1 sigma uncertainty in the L1 pseudorange correction for the ship. The units are meters with a range of +/- 2 meters and a resolution of 0.0625 meters.

9.2.3.1.4.2.4 B1

The B1 value is a 5 bit value that represents the error in the pseudorange correction for a specific ranging source attributable to receiver one. The units are meters with a range of +/-2 meters and a resolution of 0.125 meters.

9.2.3.1.4.2.5 B2

The B2 value is a 5 bit value that represents the error in the pseudorange correction for a specific ranging source attributable to receiver two. The units are meters with a range of +/-2 meters and a resolution of 0.125 meters.

9.2.3.1.4.2.6 B3

The B3 value is a 5 bit value that represents the error in the pseudorange correction for a specific ranging source attributable to receiver three. The units are meters with a range of +/-2 meters and a resolution of 0.125 meters.

9.2.3.1.4.2.7 B4

The B4 value is a 5 bit value that represents the error in the pseudorange correction for a specific ranging source attributable to receiver four. The units are meters with a range of +/-2 meters and a resolution of 0.125 meters.

9.2.3.1.4.2.8 L2 Pseudorange Correction

The L2 Pseudorange Correction is an 8 bit correction value used to reconstruct the full ship L2 pseudorange value for the ranging source specified in the ranging source block ID, on the aircraft side. The units are meters with a range of +/- 8 meters and a resolution of 0.0625 meters.

9.2.3.1.4.2.9 L2 Pseudorange Estimate Error

The L2 Pseudorange Estimate Error is a 6 bit value that estimates the 1 sigma uncertainty in the L2 pseudorange correction for the ship. The units are meters with a range of +/- 2 meters and a resolution of 0.0625 meters.

9.2.3.1.4.2.10 B1

The B1 value is a 5 bit value that represents the error in the pseudorange correction for a specific ranging source attributable to receiver one. The units are meters with a range of +/-2 meters and a resolution of 0.125 meters.

9.2.3.1.4.2.11 B2

The B2 value is a 5 bit value that represents the error in the pseudorange correction for a specific ranging source attributable to receiver two. The units are meters with a range of +/-2 meters and a resolution of 0.125 meters.

9.2.3.1.4.2.12 B3

The B3value is a 5 bit value that represents the error in the pseudorange correction for a specific ranging source attributable to receiver three. The units are meters with a range of +/-2 meters and a resolution of 0.125 meters.

9.2.3.1.4.2.13 B4

The B4 value is a 5 bit value that represents the error in the pseudorange correction for a specific ranging source attributable to receiver four. The units are meters with a range of +/-2 meters and a resolution of 0.125 meters.

9.2.3.1.4.3 GPS Carrier Phase Block Header

The GPS Carrier Phase Block Header contains data time of applicability information as well as how many and what type of measurements are going to be following.

Table 9-51: GPS Carrier Phase Block Header

GPS Carrier Phase Block Header							
					Rate	5.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
GPS Time of Applicability	sec	8	8		0.1	0	19.9
Number of Measurements	bits	4	4		1	0	12
Measurement Type	bits	3	3		1	0	7
Totals		15	15				

9.2.3.1.4.3.1 GPS Time of Applicability

GPS Time of Applicability is an 8 bit data field that describes the time that the correction data will be applicable. This is needed for the receiving aircraft to apply the corrections to the proper GPS epoch measurements. It repeats (rolls over) every 20.0 seconds.

9.2.3.1.4.3.2 Number of Measurements

The number of measurements is a 4 bit data field that describes the number of correction blocks that will be broadcast following this message.

9.2.3.1.4.3.3 Measurement Type

The Measurement Type field is a 3 bit value that describes the type of GPS data corrections (C/A, L1Y, L2Y etc) that are being broadcast.

9.2.3.1.4.4 GPS Carrier Phase Data Block

Table 9-52: GPS Carrier Phase Data Block

GPS Carrier Phase Data Block							
					Rate	5.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
SV	bits	5	5		1	1	32
Ant 1 L1 Carrier Phase Corr	m	12	12	4	0.0010	-2	1.9990
Ant 1 L1 Carrier Ph Est Error	cm	6	6	16	0.2500	-8	7.7500
Ant 1 L2 Carrier Phase Corr	m	12	12	4	0.0010	-2	1.9990
Ant 1 L2 Carrier Ph Est Error	cm	6	6	16	0.2500	-8	7.7500
Ant 2 L1 Carrier Phase Corr	m	12	12	4	0.0010	-2	1.9990
Ant 2 L1 Carrier Ph Est Error	cm	6	6	16	0.2500	-8	7.7500
Ant 2 L2 Carrier Phase Corr	m	12	12	4	0.0010	-2	1.9990
Ant 2 L2 Carrier Ph Est Error	cm	6	6	16	0.2500	-8	7.7500
Ant 3 L1 Carrier Phase Corr	m	12	12	4	0.0010	-2	1.9990
Ant 3 L1 Carrier Ph Est Error	cm	6	6	16	0.2500	-8	7.7500
Ant 3 L2 Carrier Phase Corr	m	12	12	4	0.0010	-2	1.9990
Ant 3 L2 Carrier Ph Est Error	cm	6	6	16	0.2500	-8	7.7500
Totals		113	113				

9.2.3.1.4.4.1 SV

SV is a 5 bit data field that defines which data block this is, so the receiving end can be certain to have a complete set of data. The range is 0 to 10 with a resolution of 1.

9.2.3.1.4.4.2 Ant x L1 Carrier Phase Correction

The L1 Carrier Phase Correction is a 12 bit correction value to be used to reconstruct the full ship L1 carrier phase value for the ranging source specified in the ranging source block ID on the aircraft side. The units are meters with a range of +/- 2 meters and a resolution of 0.0010 meters. This information is repeated for each antenna used (Ant x where x=0, 1, 2).

9.2.3.1.4.4.3 Ant x L1 Carrier Phase Estimate Error

The L1 Carrier Phase Estimate Error is a 6 bit value that estimates the 1 sigma uncertainty in the L1 carrier phase correction for the ship. The units are centimeters with a range of +/- 8 centimeters and a resolution of 0.25 centimeters. This information is repeated for each antenna used (Ant x where x=0, 1, 2).

9.2.3.1.4.4.4 Ant x L2 Carrier Phase Correction

The L2 Carrier Phase Correction is a 12 bit correction value to be used to reconstruct the full ship L2 carrier phase value for the ranging source specified in the ranging source block ID, on the aircraft side. The units are meters with a range of +/- 2 meters and a resolution of 0.0010 meters. This information is repeated for each antenna used (Ant x where x=0, 1, 2).

9.2.3.1.4.4.5 Ant x L2 Carrier Phase Estimate of Error

The L2 Carrier Phase Estimate Error is a 6 bit value that estimates the 1 sigma uncertainty in the L2 carrier phase correction for the ship. The units are centimeters with a range of +/- 8 centimeters and a resolution of 0.25 centimeters. This information is repeated for each antenna used (Ant x where x=0, 1, 2).

9.2.3.1.5 J-UCAS Uplink Data Packet

The Joint Unmanned Combat Air System (J-UCAS Data Packets) are a generic wrapper around a 40 bit data field. Data packets are defined for uplink and downlink at two different ranges (50 nm for CCA ops and 1 nm for deck operations). Data content is defined by the individual J-UCAS manufacturers. The data packets consist of two parts: a sequence number to assure proper reception order and the data itself which is limited to 40 bits per message. This structure is identical for data packets sent from the ship as well as from the J-UCAS. The budgeted capacity for this message is twelve messages per second for 50 nm message and 6 messages per second for the 1 nm message.

Table 9-53: J-UCAS Uplink / Downlink

J-UCAS Uplink / Downlink							
					Rate	1.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Sequence Number	bits	8	8		1	0	255
Message Data	bits	40	40				
Totals		48	48				

Note: J-UCAS Specific ID will be applied in network layer

9.2.3.1.5.1 Sequence Number

The Sequence Number is an 8 bit data field that rolls over every 256 data packets to allow receiving aircraft to make sure all data packets are received and in proper order.

9.2.3.1.5.2 Message Data

The Message Data is J-UCAS manufacturer specific and limited to 40 bits per message.

9.2.3.2 Air to Ship

9.2.3.2.1 ATM Data Packets

There are two types of ATM Data Packets defined for air to ship data link operations, ATM Downlink 50 and ATM Downlink 10. They correspond to the Sea Based JPALS system modes and are sent only within the coverage volume defined by the mode.

The data content defined with the data packet is referred to as a message and is defined in Section 10 of this document.

9.2.3.2.1.1 ATM Downlink 50

The ATM Downlink 50 message is transmitted from the ship to aircraft within a 50 nm radius at a 1 Hz rate. The transmitted message size is 104 bits with 8 bits of Sequence Number and 96 bits of Message Data. Message Data longer than 96 bits will be transmitted in successive uplink ATM slots. The ship ID is appended in the network layer. Table 9-54 provides the data content definition for ATM Downlink 50.

Table 9-54: ATM Downlink 50

ATM Downlink 50							
					Rate	1.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Sequence Number	bits	8	8		1	0	255
Message Data	bits	96	96				
Totals		104	104				

9.2.3.2.1.1.1 Sequence Number

The Sequence Number is an 8 bit data field that rolls over every 256 messages to allow receiving aircraft to make sure all messages are received and in order.

9.2.3.2.1.1.2 Message Data

The Message Data consists of various automatically generated messages containing information relevant to aircraft entering and within the CCA (50 nm).

9.2.3.2.1.2 ATM Downlink 10

The ATM Downlink 10 message is transmitted from the ship to aircraft within a 10 nm radius at a 1 Hz rate. These messages are automatically generated messages that contain a variety of information relevant to an aircraft entering the Precision Mode coverage area. The transmitted message size is 104 bits with 8 bits of Sequence Number and 96 bits of Message Data. Message Data longer than 96 bits will be transmitted in successive uplink ATM slots. The ship ID is appended in the network layer. Table 9-55 provides the data content definition for ATM Downlink 10.

Table 9-55: ATM Downlink 10

ATM Downlink 10							
					Rate	1.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Sequence Number	bits	8	8		1	0	255
Message Data	bits	96	96				
Totals		104	104				

9.2.3.2.1.2.1 Sequence Number

The Sequence Number is an 8 bit data field that rolls over every 256 messages to allow receiving aircraft to make sure all messages are received and in order.

9.2.3.2.1.2.2 Message Data

The Message Data consists of various automatically generated messages containing information relevant to aircraft entering and within the CCA (10 nm).

9.2.3.2.2 Air State Report

The Air State Message is transmitted from each aircraft. Its primary function is to send position information for the controllers but the information may be used by other aircraft in the vicinity to perform area surveillance functions. It is sent at a rate of once per second per aircraft. There is only 64 bits to be transmitted so portions of the Air State Report was sent cyclically as defined in this section. Table 9-56 provides the data content definition for Air State Report.

Note: Aircraft identification appears in network header information.

Table 9-56: Air State Report

Air State Report							
					Rate	1.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
GPS Time of Applicability	sec	8	8		0.1	0	19.9
Position Grid			4		1	0	15
Latitude Fine	deg		12	0.18	4.29E-05	-0.0879	0.0878
Longitude Fine	deg		12	0.70	1.72E-04	-0.3516	0.3514
Height Coarse	feet		5		2550	-2550	76500
Height Fine	feet		8		10	-1280	1270
Baro Alt Coarse Delta			3		1	-3	3
Baro Alt Fine	feet		8		10	-1280	1270
West Velocity	ft/s		11	2000	1	-1000	1000
North Velocity	ft/s		11	2000	1	-1000	1000
Vertical Velocity	ft/s		10	40.96	0.04	-20.48	20.48
Airspeed	kts		8		5	0	1275
Heading	deg		11	360	0.1758	0.00	360.000
Heading Rate	deg/s		8	12	0.0469	-6.00	5.953
NUC Position			4		1	0	15
NUC Rate			4		1	0	15
Malfunction and Priority Status	bits		8				
Maintenance Codes			8		1	0.0	255
Ordnance Loadout			8		1	0.0	255
Expected Approach Time	min		6		1	0	60
Fuel State	klbs		8		0.1	0.0	25.5
Totals			165				

Note 1: GPS Time of Applicability rolls over every 20 seconds.

Note 2: Transmit timing shown below.

9.2.3.2.2.1 GPS Time of Applicability

GPS Time of Applicability is an 8 bit message alignment field that is synched with GPS time and repeats (rolls over) every 20 seconds. The resolution is 0.1 seconds.

9.2.3.2.2.2 Position Grid

The Position Grid is a 4 bit data field that describes the coarse location of the aircraft within a 4 x 4 grid surrounding the ship. The range of values is 0 to 15 and the mapping of these values into the grid is xxyy, where xx is 00 and yy is 00 at the upper left corner of the grid.

9.2.3.2.2.3 Latitude Fine

Latitude Fine is a 12 bit data field that describes latitude offset of the aircraft within the grid defined in the field above in degrees. The range of values for the Latitude Fine is -0.0879 to +0.0878 degrees with a resolution of 4.29e-5 degrees which translates to an accuracy of approximately 4.77 meters.

9.2.3.2.2.4 Longitude Fine

Longitude Fine is a 12 bit data field that describes longitude offset of the aircraft within the grid divined in the field above in degrees. The range of values for the Longitude Fine is -0.352 to +0.351 degrees with a resolution of 1.72e-4 degrees which translates to an accuracy of approximately 19.07 meters.

9.2.3.2.2.5 Height Coarse

The Height Coarse is a 5 bit data field that describes the height of the aircraft in feet referenced to the SRP. The range of values is -2550 to 76500 feet with a resolution of 2550 ft.

9.2.3.2.2.6 Height Fine

The Height Fine is an 8 bit data field that increases the resolution of the Height Coarse datum. It has range of -1280 to +1270 feet in 10 foot increments.

9.2.3.2.2.7 Baro Alt Coarse Delta

The Baro Alt Coarse Delta is a 3 bit data field that combines with the Baro Alt Fine value to give an offset from the Height fields above. The range is +/- 3 with a resolution of 1. Each bit represents a multiplier amount to be applied to the Baro Alt Fine value.

9.2.3.2.2.8 Baro Alt Fine

The Baro Alt Fine value is an 8 bit data field that describes the offset from the Height Field shown above. Its' value is multiplied by the value in the Baro Alt Coarse Delta field to produce the total Baro vs Height delta. This value may then be added to the Height value for representation of Baro Altitude. The range of this field is -1280 to 1270 feet with a resolution of 10 feet.

9.2.3.2.2.9 Velocity

Velocity consists of three components.

Note: It is planned that Sea Based JPALS will eventually also transmit east-west and north-south velocity vector components relative to the WGS-84 reference frame. These will be likely transmitted simultaneously with and in the same message as the ship-relative vector components.

9.2.3.2.2.9.1 East Velocity

The East Velocity is an 11 bit data field that describes the velocity of the aircraft in an Eastward direction. The units are feet/sec and it has a range of +/- 1000 feet/sec with positive value indicating a velocity to the East with respect to the ship reference frame. The resolution is 1 foot/sec.

9.2.3.2.2.9.2 North Velocity

The North Velocity is an 11 bit data field that describes the velocity of the aircraft in a Northward direction. The units are feet/sec and it has a range of +/- 1000 feet/sec with positive value indicating a velocity to the North with respect to the ship reference frame. The resolution is 1 foot/sec.

9.2.3.2.2.9.3 Vertical Velocity

The Vertical Velocity is a 10 bit data field that describes the velocity of the aircraft in the vertical direction. The units are feet/sec and it has a range of +/- 20.48 feet/sec with positive value indicating a velocity in the upward direction with respect to the ship reference frame. The resolution is 0.04 feet/sec.

9.2.3.2.2.10 Airspeed

The Airspeed is an 8 bit data field. The units are in knots. The range of values is 0 to 1275 in 5 knot increments.

9.2.3.2.2.11 Heading

The Heading is an 11 bit data field that describes the aircraft Heading in degrees.

9.2.3.2.2.12 Heading Rate

The heading rate is an 8 bit data field that describes the rate of change of the heading field. The units are degrees per second. The range is +/- 6 deg/s with 0.0469 deg/s resolution.

9.2.3.2.2.13 NUC Position

The NUC Position is a 4 bit data field that describes the navigation uncertainty of the reported position information. The range is 0 to 15 with a resolution of 1. NUC is defined in the *Sea Based JPALS-Air System Performance Specification* [16].

9.2.3.2.2.14 NUC Rate

The NUC Rate is a 4 bit data field that describes the navigation uncertainty of the reported rate information. The range is 0 to 15 with a resolution of 1. The NUC is defined in the *Sea Based JPALS-Air System Performance Specification* [16].

9.2.3.2.2.15 Malfunction and Priority Status

The Malfunction and Priority Status field is used to report urgent information about the aircraft. Current assigments for this field are 1=No Malfunction / Not Reported, 2=Hydraulic, 3=Electric, 4=Fuel, 5=Oxygen, 6=Engine, 7 =Communications, 8=NavAids, 9=Other

9.2.3.2.2.16 Maintenance Codes

The Maintenance Codes field is an 8 bit data field that contains the code for any maintenance issue existing on the aircraft.

9.2.3.2.2.17 Ordnance Loadout Code

The Ordnance Loadout Code is an 8 bit data field that describes the current status of the ordnance on the aircraft. Codes could indicate Unexpended, expended or hung ordnance.

9.2.3.2.2.18 Expected Approach Time

The Expected Approach Time (EAT) field is a 6 bit data field that contains the current EAT issued to the particular aircraft. This can be used as a cross check to assure the aircraft has received its current recovery instructions.

9.2.3.2.2.19 Fuel State

The Fuel State field is a 7 bit data field that describes the current aircraft fuel in k-lbs. The range is 0 to 12.7 k-lbs in 0.1 k-lbs increments.

9.2.3.2.2.20 Air State Timing

Due to the large number of aircraft and the fact that each one broadcasts an Air State Report, this message contributes heavily to the system capacity. In effort to reduce the amount of data broadcast from each aircraft, the data packets are decimated into 64 bit pieces. The data is cycled through in consecutive transmissions. Some data that is more time critical than others is sent in each message. The structure of the data decimation and transmission is shown below. Table 9-57 provides the data content definition for Transmit Timing for the Air State Report.

Table 9-57: Transmit Timing

Transmit Timing					
Time	T	T	T	T	8
Latitude, Longitude	Lat/Lon			Flags	8
Height, Baro Altimeter	H	Baro	H	Baro	8
Track, Emergency Stat	Trk	Emer	Trk	Emer	8
Horizontal Accel Param	Hacc	Hacc	Hacc	Hacc	8
VSI, NUC, Fuel	VSI	NUC	VSI	Fuel	8
Velocity, Delta Velocity	Vel	Delv	Vel	Delv	8
Maint, Ord, EAT	Maint	Ord	Eat	spare	8
					64

9.2.3.2.3 Air Monitor Report

The Air Monitor Report message is sent from the aircraft to the ship to support ATC and Landing Signal Officer (LSO) monitoring during final approach and recovery operations. This information includes high rate positioning information in relationship to approach path, aircraft status and attitude. This data is valid for selected aircraft within 10 nm of the ship and is sent at a 5 Hz rate. Less critical or slow rate data is cycled in subsequent data packets. Table 9-58 provides the data content definition for Air Monitor Report.

Note: The range of a number of these parameters is limited to the values expected during a normal approach and are intended to be used by the LSO.

Table 9-58: Air Monitor Report

Air Monitor Report							
					Rate	5.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
GPS Time of Applicability	sec	8	8		0.05	0	12
Cycle Position		3	3				
Position Cycle Data		16					
Delta Latitude (Feet North)	ft		16	65536	1	-32768	32767
Delta Longitude (Feet East)	ft		16	65536	1	-32768	32767
Delta Height (Feet Up)	ft		16	8192	0.125	0.0000	8192
Velocity Cycle Data		10					
East Velocity	fps		10	1024	1	-512.0	511.00
North Velocity	fps		10	1024	1	-512.0	511.00
Vertical Velocity	fps		10	40.96	0.04	-20.48	20.44
East Accel	g	10	10	4.096	0.004	-2.048	2.044
North Accel	g	10	10	4.096	0.004	-2.048	2.044
Vertical Accel	g	10	10	4.096	0.004	-2.048	2.044
El Dev	pct	8	8	2.8	0.011	-1.40	1.389
Az Dev	pct	8	8	6.0	0.023	-3.00	2.977
Protection Level Cycle		8					
Horiz Protection Level	m		8	20	0.078	-10.00	9.922
Vert Protection Level	m		8	8	0.031	-4.00	3.969
Air Speed	kts		8		4	0	1020
Attitude Cycle Data		14					
Heading	deg		14	360.000	0.0219727	-180.000	179.978
Pitch	deg		14	40	0.002	-20.00	19.998
Roll	deg		14	90	0.005	-45.00	44.995
Heading Rate	deg/s	11	11	2.048	0.001	-1.024	1.023
Pitch Rate	deg/s	11	11	2.048	0.001	-1.024	1.023
Roll Rate	deg/s	11	11	20.48	0.01	-10.240	10.230
Angle of Attack	deg	14	14	40.96	0.003	-20.48	20.478
Engine Status (2 Hz) (see table)		20	50				
Aircraft Configuration (0.5 Hz)		2.4	24				
Data Cycle		8					
Est Gross Weight	k-lbs		8		0.25	0	63
TDP Select			4				
Totals		182.4	334				

9.2.3.2.3.1 GPS Time of Applicability

GPS Time of applicability is an 8 bit message alignment field that is synched with GPS time and repeats (rolls over) every 12 seconds.

9.2.3.2.3.2 Cycle Position

Cycle Index is an 3 bit data field that indicates the current index into the following data items that are sequenced through in consecutive data packets.

9.2.3.2.3.3 Position Cycle Data

Position Cycle data is 3D position information as a delta from the TDP. This information is rotated through Delta Latitude, Longitude and Height in consecutive data packets. Indication of current transmitted parameter is denoted with the Cycle Index field described above.

9.2.3.2.3.3.1 Delta Latitude

The Delta Latitude is a 16 bit data field that describes the deviation in Latitude from the TDP. The units are feet and it has a range of +/- 32767 feet (approximately 5 NM) with positive value indicating a displacement east of the TDP.

9.2.3.2.3.3.2 Delta Longitude

The Delta Longitude is a 16 bit data field that describes the deviation in Longitude from the TDP. The units are feet and it has a range of +/- 32767 feet (approximately 5 nm) with a positive value indicating a displacement north of the TDP.

9.2.3.2.3.3.3 Delta Height

The Delta Height is a 16 bit data field that describes the deviation in height from the TDP. There is a 100 foot correction that must be applied to the interpreted value of this data parameter.

9.2.3.2.3.4 Velocity Cycle Data

Velocity Cycle data is information describing the current velocity of the aircraft in terms of x, y , and z values representing Eastward, Northward and Upward velocities. This information is rotated through East Velocity, North Velocity and Vertical Velocity in consecutive data packets. Indication of current transmitted parameter is denoted with the Cycle Index field described above.

9.2.3.2.3.4.1 East Velocity

The East Velocity is a 10 bit data field that describes the velocity of the aircraft in an Eastward direction. The units are feet/sec and it has a range of +/- 512 feet/sec with positive value indicating a velocity to the East.

9.2.3.2.3.4.2 North Velocity

The North Velocity is a 10 bit data field that describes the velocity of the aircraft in a Northward direction. The units are feet/sec and it has a range of +/- 512 feet/sec with positive value indicating a velocity to the North.

9.2.3.2.3.4.3 Vertical Velocity

The Vertical Velocity is a 10 bit data field that describes the velocity of the aircraft in the vertical direction. The units are feet/sec and it has a range of +/- 20.48 feet/sec with positive value indicating a velocity in the upward direction.

9.2.3.2.3.5 East Accel

East Accel is a 10 bit data field that describes the acceleration of the aircraft in an Eastward direction. The units are feet/sec^2 and it has a range of +/- 2.048 feet/sec^2 with positive value indicating acceleration to the East.

9.2.3.2.3.6 North Accel

North Accel is a 10 bit data field that describes the acceleration of the aircraft in a Northward direction. The units are feet/sec^2 and it has a range of +/- 2.048 feet/sec^2 with positive value indicating acceleration to the North.

9.2.3.2.3.7 Vertical Accel

The Vertical Accel is a 10 bit data field that describes the acceleration of the aircraft in a vertical direction. The units are feet/sec^2 and it has a range of +/- 2.048 feet/sec^2 with positive value indicating acceleration in an upward direction.

9.2.3.2.3.8 El Dev

El Dev is an 8 bit data field that describes the angular deviation in elevation from the selected glidepath.

9.2.3.2.3.9 Az Dev

Az Dev is an 8 bit data field that describes the angular deviation in azimuth from the selected course.

9.2.3.2.3.10 Horiz Protection Level

The Horiz Protection Level is an 8 bit data field that describes the calculated horizontal limit for the current recovery operation and approach type. The units are meters with a range of 0 - 20 meters and resolution of 0.078 meters.

9.2.3.2.3.11 Vert Protection Level

The Vert Protection Level is an 8 bit data field that describes the calculated vertical limit for the current recovery operation and approach type. The units are meters with a range of 0 - 8 meters and resolution of 0.031 meters.

9.2.3.2.3.12 Air Speed

The Air Speed parameter is an 8 bit data field that contains the true air speed of the aircraft. The units are knots and the range is 0 to 255 knots with a resolution of 1 knot.

9.2.3.2.3.13 Attitude Cycle Data

Attitude Cycle data contains data pertaining to the orientation of the aircraft. These parameters consist of Heading, Pitch and Roll. The data is cycled in consecutive Air Monitor data packets and the relevant data is indicated by the Cycle Index field described above.

9.2.3.2.3.13.1 Heading

The Heading is a 14 bit data field that contains the current heading of the aircraft relative to true North. The units are degrees with a range of +/- 180 degrees and a resolution of 0.022 degrees.

9.2.3.2.3.13.2 Pitch

The Pitch is a 14 bit data field that contains the current pitch of the aircraft relative to level flight. The units are degrees with a range of +/- 20 degrees and a resolution of 0.002 degrees. A positive value indicates a nose up pitch indication.

9.2.3.2.3.13.3 Roll

The roll is a 14 bit data field that contains the current wing attitude relative to wings level flight. The units are degrees with a range of +/- 45 degrees and a resolution of 0.005 degrees. A positive value indicates a right wing up attitude.

9.2.3.2.3.14 Heading Rate

The Heading Rate is an 11 bit data field that represents the rate of change for the Heading parameter. The units are degrees per second with a range of +/- 1 deg/sec and a resolution of 0.001.

9.2.3.2.3.15 Pitch Rate

The Pitch Rate is an 11 bit data field that represents the rate of change for the Pitch parameter. The units are degrees per second with a range of +/- 1 deg/sec and a resolution of 0.001.

9.2.3.2.3.16 Roll Rate

The Roll Rate is an 11 bit data field that represents the rate of change for the Roll parameter. The units are degrees per second with a range of +/- 10 deg/sec and a resolution of 0.01.

9.2.3.2.3.17 Angle of Attack

The angle of attack is a 14 bit data field that contains the aircraft angle of attack in degrees. The range is ±20 degrees with a resolution of 0.003 degrees.

9.2.3.2.3.18 Engine Configuration Status

The Engine Configuration Status is a data field that contains information the current state of the engine. Table 9-59 provides the data content definition for Engine Configuration.

Table 9-59: Engine Configuration Status

Engine Configuration							
Parameter	Units	Bits Tx	Data bits	Range	Res	Min	Max
Nr. 1 Engine Speed	pct	11	11	0-120	0.1		
Nr. 2 Engine Speed	pct	11	11	0-120	0.1		
Nr. 1 Engine Throttle pos	pct	7	7	0-100	1		
Nr. 2 Engine Throttle pos	pct	7	7	0-100	1		
Nr. 1 JPT	deg	7	7	0-1000	10		
Nr. 2 JPT	deg	7	7	0-1000	10		
Totals		50	50				

9.2.3.2.3.19 Aircraft Configuration Status

The Aircraft Configuration Status field is a combination field containing the state of various aircraft systems. These systems typically exist in a fixed or limited range of states (e.g., Gear Up or Down). The systems and their allowable states are described below. Table 9-60 provides the data content definition for Aircraft Configuration.

Table 9-60: Aircraft Configuration Status

Aircraft Configuration							
Parameter	Units	Bits Tx	Data bits	Range	Res	Min	Max
Weight on Wheels	bits	1	1	0-1	1		
Landing Gear	bits	2	2	0-2	1		
Flaps/slats	deg	4	4	0-75	5		
Autopilot engaged	bits	1	1	0-1	1		
Hook position	bits	1	1	0-1	1		
Launch bar command	bits	1	1	0-1	1		
Launch bar status	bits	1	1	0-1	1		
Wing-fold	bits	2	2	0-2	1		
Parking brake	bit	1	1	0-1	1		
Direct Lift Control status	bit	1	1	0-1	1		
APC/Autothrottle engaged	bit	1	1	0-1	1		
Nozzle Position	pct	8	8	0 - 100	0.5		
Totals		24					

9.2.3.2.3.20 Data Cycle

Data Cycle field refers to various aircraft parameters and their current state or measurement. These parameters are cycled through in consecutive data packets. Indication of current transmitted parameter is denoted with the Cycle Index field described above.

9.2.3.2.3.20.1 Est Gross Weight

Est Gross Weight is an 8 bit data field that describes the estimated weight of the aircraft in thousand pound units. The range is 0 to 63 k-lbs with a resolution of 0.25 k-lbs.

9.2.3.2.3.20.2 TDP Select

The TDP Select is a 4 bit data field that contains the TDP profile number for the assigned approach.

9.2.3.2.4 J-UCAS Downlink Data Packet

The J-UCAS Data Packets are a generic wrapper around a 40 bit data field. Data packets are defined for uplink and downlink at two different ranges (50 nm for CCA ops and 1 nm for deck operations). Data content is defined by the individual J-UCAS manufacturers. The data packets consist of two parts: a sequence number to assure proper reception order and the data itself which is limited to 40 bits per message. This structure is identical for data packets sent from the ship as well as from the J-UCAS. The budgeted capacity for this message is twelve messages per second for 50 nm message and 6 messages per second for the 1 nm message. Table 9-61 provides the data content definition for J-UCAS Uplink / Downlink.

Table 9-61: J-UCAS Uplink / Down Link

J-UCAS Uplink / Downlink							
					Rate	1.0	Hz
Parameter	Units	Bits Tx	Data Bits	Range	Resolution	Min Value	Max Value
Sequence Number	bits	8	8		1	0	255
Message Data	bits	40	40				
Totals		48	48				

Note: J-UCAS Specific ID will be applied in network layer.

9.2.3.2.4.1 Sequence Number

The Sequence Number is an 8 bit data field that rolls over every 256 data packets to allow receiving aircraft to make sure all data packets are received and in order.

9.2.3.2.4.2 Message Data

The Message Data is J-UCAS manufacturer specific and limited to 40 bits per message.

10 DLCC Message Definitions

10.1 Scope

10.1.1 Section Overview

This section is intended to provide an example of the current set of DLCC messages as defined by the CONOPS group. This information represents the content to be delivered in ATM10, ATM50 Uplink and Downlink.

10.2 Application Data

10.2.1 Data Definition

The Data Definition is still being evaluated and is TBR.

10.2.2 Data Description

10.2.2.1 ATM 50 Uplink Messages

The ATM 50 Uplink Messages are defined in Tables 10-1 through 10-4.

Table 10-1: Uplink-Responses and Acknowledgements

Uplink - Responses and Acknowledgements								
FLT Phase	Message #	Message Element	Message Intent	Expected Response	Data Elements	Rng (NMI)	Priority	Case
CCA	**UL0 (ACK2)**	UNABLE	Controller is unable to comply with the request. Amplifying information maybe required to be sent in a free text message. The exchange is not closed and the request will be responded to when conditions allow.	N/A	N/A	50	Priority	All
CCA	**UL1**	STANDBY	Message received and understood.	N/A	N/A	50	Priority	All
CCA	**UL3 (ACK1)**	ROGER	ROGER is the only correct response to an uplink free text message. Under no circumstances will ROGER be used instead of AFFIRM.	N/A	N/A	50	Priority	All
CCA	**UL4 (ACK5)**	AFFIRM	Yes. AFFIRM is an appropriate response to an uplinked negotiation request.	N/A	N/A	50	Priority	All
CCA	**UL5 (ACK4)**	NEGATIVE	NO. NEGATIVE is an appropriate response to an uplinked negotiation request.	N/A	N/A	50	Priority	All
	UL6 - UL10 RESERVED							

Table 10-2: Uplink CCA Command and Control Instructions (Part 1)

Uplink - CCA Command and Control Instructions (part 1)								
FLT Phase	**Message #**	**Message Element**	**Message Intent**	**Expected Response**	**Data Elements**	**Rng (NMI)**	**Priority**	**Case**
CCA	**UL11 (NS15)**	Radar contact [lost] [(X) miles]	Aircraft under or lost positive control by CATCC. (Until positive control established aircraft under advisory or monitor control.)	Roger (DL3)	X=1-50	50	Priority	All
CCA	**UL12 (NS17/NS18)**	[left l right] (X)	Instruction to turn left or right to specified magnetic heading	Roger (DL3)	X=001-360	50	Priority	All
CCA	**UL13 (NS19)**	Fly heading (X)	Instruction to fly a specific heading	Roger (DL3)	X=001-360	50	Priority	All
CCA	**UL14 (NS20)**	Fly present heading	Instruction to fly current heading	Roger (DL3)	N/A	50	Priority	All
CCA	**UL15 (NS21)**	Expect vectors to (X)	Advisory information to inform pilot to expect vectors	Roger (DL3)	X=final brg, brc, overhead	50	Routine	II/III
CCA	**UL16 (NS22)**	Expect vectors [across l through] [the] final bearing [for spacing]	Advisory Information to inform pilot to expect vectors	Roger (DL3)	Across, through	50	Routine	II/III
CCA	**UL17 (NS25)**	Take angels (X) [point (#)]	Instruction to climb or descend and maintain specified altitude measured in ft	Roger (DL3)	X=1-30, #=1-9	50	Priority	All
CCA	**UL18 (NS27)**	Level off [angels (X) point (#)]	Instruction to stop climb or descent	Roger (DL3)	X=1-30, #=1-9	50	Priority	All
CCA	**UL19 (NS28)**	Maintain angels (X) point (#)	Instruction to maintain altitude	Roger (DL3)	X=1-30, #=1-9	50	Priority	All
CCA	**UL20 (NS30)**	Take speed (X)	Instruction to increase or decrease speed to specified value	Roger (DL3)	X=80-300 (increments of 5)	50	Priority	All
CCA	**UL21 (NS42, NS43, NS44)**	Check in button (X)	Control transfer	Roger (DL3)	X=1-20	50	Routine	All
CCA	**UL22 (NS46)**	Hold (X) at (#) [angel ($) [point (*)]]	Instruction to hold at described position	Wilco (DL0)	X=001-360, #=1-50, $=1-30, *=1-9	50	Priority	All
CCA	**UL23 (NS47)**	Return to holding	Instruction for aircraft to return to holding	Roger (DL3)	N/A	50	Priority	II/III
CCA	**UL24 (NS64)**	Signal (divert l Bingo) (divert field) pigeons [X] for [#]	Instruction to proceed to divert or Bingo field	Roger (DL3)	Divert Field=12 alpha characters, X=001-360, #=1-999	50	Priority	All
CCA	**UL25 (NS11)**	Recycle parrot	Instruction for Pilot to reset transponder	Roger (DL3)	N/A	50	Routine	All

Table 10-3: Uplink - CCA Command and Control Instructions (Part 2)

Uplink - CCA Command and Control Instructions (Part 2)								
FLT Phase	**Message #**	**Message Element**	**Message Intent**	**Expected Response**	**Data Elements**	**Rng (NMI)**	**Priority**	**Case**
CCA	**UL26 (NS12)**	Parrot (sweet I sour)	Transponder status	Roger (DL3)	N/A	50	Routine	All
CCA	**UL27 (NS13)**	Ident	Instruction to activate transponder ident	Roger (DL3)	N/A	50	Priority	All
CCA	**UL28 (NS31)**	Increase speed (X) knots	Instruction to increase or decrease speed by specified value	Roger (DL3)	X=5-50 (increments of 5)	50	Priority	All
CCA	**UL29 (NS32)**	Maintain speed (X) [until (#) miles]	Instruction to maintain specific speed	Roger (DL3)	X=80-300 (increments of 5)	50	Priority	All
CCA	**UL30 (NS33)**	Reduce speed (X) knots	Instruction to reduce speed	Roger (DL3)	X=5-50 (increments of 5)	50	Priority	All
CCA	**UL31 (NS-35)**	Mark your father	Request for position report	Roger (DL3)	N/A	50	Priority	All
CCA	**UL32 (NS37)**	Traffic (X) o'clock (#) miles angels (*) [point ($)] [(&) bound]	Report of aircraft traffic in vicinity	Roger (DL3)	X=1-12, #=1-20, *=1-30, $=1-9, &=east, south west north	50	Priority	All
CCA	**UL33 (NS40)**	Join up with (call sign) [overhead] [(X) o'clock] [angels (#)] [report joined]	Instruction to join SA a flight and position of aircraft to join with	Roger (DL3)	X=1-12, #=1-30	50	Routine	All
CCA	**UL34 (NS63)**	Signal tank	Instruction for in-flight refueling	Roger (DL3)	N/A	50	Priority	All
CCA	**UL35 (NS85)**	Report (on top I VMC)	Instruction to report above the clouds	Roger (DL3)	N/A	50	Routine	All
CCA/PRI	**UL36 (NS95)**	Enter starboard delta (report established)	Instruction to enter starboard holding	Roger (DL3)	N/A	50	Routine	All
CCA/PRI	**UL37 (NS96)**	Say red light [souls on board]	Fuel remaining in minutes until red light for helo	DL81 Red Light (X) [(x) souls on board]	N/A	50	Routine	All
CCA	**UL38 (NS110)**	Roger pogo [button] (X)	Acknowledgement of a button change request with and instruction to return back to previous button when complete	Roger (DL3)	X=1-20	50	Routine	All
CCA	**UL39 (NS104)**	Signal Buster	Instruction to take best speed	Roger (DL3)	N/A	50	Priority	All
	UL40 - UL65 RESERVED							

Table 10-4: Uplink - Approach Command and Control Instructions

Uplink - Approach Command and Control Instructions								
FLT Phase	Message #	Message Element	Message Intent	Expected Response	Data Elements	Rng (NMI)	Priority	Case
APP	**UL141 (NS52)**	[(X) miles] Dirty up	Instruction to transition to landing configuration (gear, hook, etc.)	Roger (DL3)	X=1-20	50	Priority	III
APP	**UL142 (NS53)**	Stay clean through 10	Instruction to maintain 250 knots past ten miles from ship	Wilco (DL0)	N/A	50	Priority	III
APP	**UL143 (NS54)**	Clean up	Instruction to raise landing gear	Roger (DL3)	N/A	50	Priority	All
APP	**UL144 (NS58)**	Cleared downwind [heading (X)]	Authorized turn downwind	Roger (DL3)	X=001-360	10	Priority	All
APP	**UL145 (NS60)**	Intercept final bearing (X)	Authorized turn to intercept final bearing	Roger (DL3)	X=001-360	50	Priority	III
APP	**UL146 (NS61)**	Intercept bullseye	Authorized to turn to intercept SPN-41 azimuth	Roger (DL3)	N/A	10	Priority	III
APP/ PRI	**UL147 (NS62)**	Continue [upwind I straight ahead I downwind]	Instruction to continue to fly upwind, straight ahead, or downwind	Roger (DL3)	N/A	10	Priority	All
	UL148 - 170 RESERVED							

10.2.2.2 ATM 10 Uplink Messages

The ATM 10 Uplink Messages are defined in Tables 10-5 through 10-8.

Table 10-5: Uplink - Final Command and Control Instructions

Uplink - Final Command and Control Instructions								
FLT Phase	**Message #**	**Message Element**	**Message Intent**	**Expected Response**	**Data Elements**	**Rng (NMI)**	**Priority**	**Case**
FIN	**UL171 (NS105)**	Take minimum approach speed	Instruction to decrease speed on final	Roger (DL3)	N/A	10	Priority	III
FIN	**UL172 (NS65)**	[(X) Mile] Call the Ball	Instruction to report if OLSI is visible	DL-NA24	X=1 1/4, 1, 3/4, 1/2	10	Priority	All
FIN/AP P	**UL173 (NS86)**	Fly bullseye	Instruction to fly SPN-41	Roger (DL3)	N/A	10	Priority	III
FIN	**UL174 (NS87)**	Approaching glidepath	Aircraft approaching glidepath	Roger (DL3)	N/A	10	Priority	III
FIN	**UL175 (NS88)**	At tipover	Aircraft is at tipover	Roger (DL3)	N/A	10	Priority	III
FIN	**UL176 (NS89)**	(at I inside I approaching) surveillance minimums I (one I one half I three quarter mile) call the ball	Aircraft at surveillance minimums, control transferred to the LSO	Roger (DL3)	N/A	10	Priority	III
FIN	**UL177 (NS90)**	Begin descent	Instruction to commence descent	Roger (DL3)	N/A	10	Priority	III
FIN	**UL178 (NS91)**	(continue I fly) mode (three I two [delta] I one) approach	Instruction to continue approach	Roger (DL3)	N/A	10	Priority	III
FIN	**UL179 (NS92)**	Disregard needles	Instruction to disregard needles	Roger (DL3)	N/A	10	Priority	III
FIN	**UL180 (NS93)**	Downgrade mode (two I three)	Instruction to downgrade approach mode	Roger (DL3)	N/A	10	Priority	III
FIN	**UL181**	[Check] hook (up I down) [this pass]	Instruction for the position of the tailhook	Roger (DL3)	N/A	10	Routine	All
	UL182-200 RESERVED							

Table 10-6: Uplink - PriFly Flight Deck Instructions

Uplink - PriFly Flight Deck Instructions								
FLT Phase	**Message #**	**Message Element**	**Message Intent**	**Expected Response**	**Data Elements**	**Rng (NMI)**	**Priority**	**Case**
PRI	**UL201**	You're stuck on the wire standby	Advise the pilot he is stuck on the arresting gear cable	Roger (DL3)	N/A	0	Routine	All
PRI	**UL202**	Cleared to come up on the power	Advise the pilot it is safe to add power	Roger (DL3)	N/A	0	Routine	All
PRI	**UL203**	Easy on the power	Advise the pilot to not add addition power	Roger (DL3)	N/A	0	Priority	All
PRI	**UL204 (NS113)**	Suspend	Instruction to suspend a catapult	N/A	N/A	0	Priority	All
PRI	**UL205 (NS113)**	Cat (X) you're suspended	Inform pilot cat is suspended	N/A	X=1-4	0	Priority	All
PRI	**UL206**	Wipe it out again	Instruction for the pilot to wipe out the controls	N/A	N/A	0	Priority	All
PRI	**UL207**	Follow your director	Instruction to follow instruction of yellow shirt	N/A	N/A	0	Routine	All
PRI	**UL208**	Keep it moving	Instruction to expedite taxi	N/A	N/A	0	Routine	All
PRI	**UL209**	You're a hot pump crew switch	Advise the pilot the aircraft is to receive fuel and of a switch in pilots	Roger (DL3)	N/A	10	Routine	All
PRI	**UL210**	They want to spin you off the cat to have a look at your airplane	Advise the pilot of the intention to taxi the aircraft off the catapult for the trouble shooters to check the aircraft	Roger (DL3)	N/A	0	Routine	All
PRI	**UL211**	Hands up	Instruction for the pilot to raise his hands	N/A	N/A	0	Routine	All
	UL235 - 245 Reserved							

Table 10-7: Uplink - PriFly Command and Control Instructions

Uplink - PriFly Command and Control Instructions								
FLT Phase	**Message #**	**Message Element**	**Message Intent**	**Expected Response**	**Data Elements**	**Rng (NMI)**	**Priority**	**Case**
PRI	**UL212**	Off the cat your interval (X) miles upwind	Advise the pilot of interval to follow in the Case I/II pattern	Roger (DL3)	X=1-6	10	Priority	I/II
PRI	**UL213**	Turn downwind	Instruction for the pilot to commence turn to the downwind	Roger (DL3)	N/A	10	Priority	I/II
PRI	**UL214**	Keep it climbing	Instruction for the pilot to continue climbing	Roger (DL3)	N/A	10	Immediate	All
PRI	**UL215**	Clearing turn	Instruction for the pilot to execute a clearing turn following launch	N/A	N/A	10	Priority	I/II
PRI	**UL216**	Don't cross the bow	Instruction to not fly across the extended line from the bow	N/A	N/A	10	Priority	All
PRI	**UL217**	At the (X) take it around	Instruction for the pilot to go around	Roger (DL3)	X= 90, 135, 180	10	Priority	All
PRI	**UL218**	At the 180 extend	Instruction for the pilot to extend downwind	Roger (DL3)	N/A	10	Priority	I/II
PRI	**UL219**	(X) to go	Remaining number of aircraft to launch or recover	N/A	X=1-20	10	Routine	All
PRI	**UL220**	In the break spin it	Instruction to enter the spin pattern	Roger (DL3)	N/A	10	Priority	I/II
PRI	**UL221 (NS97)**	Spin	Instruction to enter the spin pattern	Roger (DL3)	N/A	10	Priority	I/II
PRI	**UL222 (NS98)**	Break [at (X) miles]	Instruction for aircraft to break	Roger (DL3)	X=1-6	10	Priority	I
PRI	**UL223 (NS99)**	Take it (X) miles upwind	Instruction to continue upwind	Roger (DL3)	X=1-6	10	Priority	I
PRI	**UL224 (NS101)**	Depart the pattern	Instruction to depart and re-enter the pattern	Roger (DL3)	N/A	10	Priority	I/II
PRI	**UL225 NS112**	[99 I (X)] Charlie	Instruction to enter the pattern	Roger (DL3) or N/A	X = 001-999	10	Priority	I
PRI	**UL226**	Delta [easy]	Instruction to continue or enter holding overhead	N/A	N/A	10	Priority	I/II
PRI/APP/ FIN	**UL227**	Hook (X)	Instruction for tailhook up or down	Roger (DL3)	X= up, down	10	Priority	All
PRI	**UL228**	Cleared for a flyby no lower than 200 feet [subsonic]	Clearance for a flyby with altitude and speed restriction	Roger (DL3)	N/A	10	Routine	I
PRI	**UL229**	Close it up	Instruction for helo in starboard delta to move in close in prep for recovery	Roger (DL3)	N/A	10	Routine	I/II
PRI	**UL230**	Cleared to land spot (X)	Clearance for the helo to land the landing spot	Roger (DL3)	X=1-6	10	Routine	All
PRI	**UL231**	Cleared to cross the [bow I stern]	Clearance for the helo to cross in from or behind the ship	Roger (DL3)	N/A	10	Routine	All
PRI	**UL232**	Cleared to (X)	Clearance for the helo to start or stop engines	Roger (DL3)	X = start, engage, disengage, shutdown	10	Routine	All
PRI	**UL233**	Deleted (combined with 232)						
PRI	**UL234 (NS112)**	Deleted (duplicate to 225)						
	UL 246 - UL260 Reserved							

Table 10-8: LSO Command and Control Instructions

Uplink - LSO Command and Control Instructions								
FLT Phase	Message #	Message Element	Message Intent	Expected Response	Data Elements	Rng (NMI)	Priority	Case
LSO	**UL261 (NS66)**	Roger Ball	LSO Acknowledge handoff	N/A	N/A	10	Immediate	All
LSO/PRI	**UL262 (NS67)**	Wave off	Instruction to execute missed approach	N/A	N/A	10	Immediate	All
	UL263 - UL300 Reserved							

10.2.2.3 ATM 50 Downlink Messages

The ATM 50 Downlink Messages are defined in Tables 10-9 through 10-12.

Table 10-9: Downlink - Responsese and Acknowledgements

Downlink - Responses and Acknowledgements								
FLT Phase	Message #	Message Element	Message Intent	Expected Response	Data Elements	Rng (NMI)	Priority	Case
CCA	**DL0 (ACK1)**	WILCO	The instruction is understood and will be complied with.	N/A	N/A	50	Priority	All
CCA	**DL1 (ACK2)**	UNABLE	Aircraft is unable to comply with the command or request. Amplifying information maybe required to be sent in a free text message. The exchange is not closed and the request will be responded to when conditions allow.	N/A	N/A	50	Priority	All
CCA	**DL2**	STANDBY	Message received response suspended	N/A	N/A	50	Priority	All
CCA	**DL3 (ACK1)**	ROGER	ROGER is the only correct response to an uplink free text message. Under no circumstances will ROGER be used instead of AFFIRM.	N/A	N/A	50	Priority	All
CCA	**DL4 (ACK5)**	AFFIRM	Yes. AFFIRM is an appropriate response to an uplinked negotiation request.	N/A	N/A	50	Priority	All
CCA	**DL5 (ACK4)**	NEGATIVE	NO. NEGATIVE is an appropriate response to an uplinked negotiation request.	N/A	N/A	50	Priority	All
	DL6 - DL10 RESERVED							

Table 10-10: Downlink - Command and Control Responses

Downlink - Command and Control Responses								
FLT Phase	**Message #**	**Message Element**	**Message Intent**	**Expected Response**	**Data Elements**	**Rng (NMI)**	**Priority**	**Case**
CCA/PRI	**DL11 (NA16)**	On top angels (X) [point (#)]	Aircraft reports above the clouds	Roger (UL3)	X=1-30 #=1-9	50	Routine	All
CCA	**DL12**	Popeye	Aircraft is in the clouds	Roger (UL3)	N/A	50	Routine	ALL
CCA	**DL13 (NA26)**	Tally-ho	Pilot reports traffic or tanker in sight	N/A	N/A	50	Routine	All
CCA	**DL14 (NA25)**	Joined with (X)	Aircraft reports joined as a flight	Roger (UL3)	X=000-999	50	Routine	All
CCA/PRI	**DL15 (NA47)**	(X) at (#)	Reply to request for position (mark your father)	Roger (UL3)	X=001-360, #=1-50	50	Routine	All
CCA	**DL16 (NA23, NA40)**	Switching button (X)	Intention to switch to another communication channel	Roger (UL3)	X=1-20	50	Routine	All
	DL17 - DL30 RESERVED							

Table 10-11: Downlink - Recovery information and Reports

Downlink - Recovery Information and Reports								
FLT Phase	**Message #**	**Message Element**	**Message Intent**	**Expected Response**	**Data Elements**	**Rng (NMI)**	**Priority**	**Case**
CCA	**DL31 (NA13)**	(Controller $) checking in (X) at (#) angels (*)	Pilot position report when changing controllers	Roger (UL3)	$=Marshall, Approach, Final, Departure, PriFly X=1-360, #=1-50, *=1-30	50	Priority	All
MAR	**DL32 (AA2, NA2)**	Expected approach time (X)	Acknowledgement of approach time	Roger (UL3)	X=00-59	50	Priority	II/III
MAR	**DL33 (NA9)**	Commencing	Pilot reports commencing approach	Roger (UL3)	N/A	50	Priority	II/III
CCA	**DL34 (NA15)**	[(X) miles] see you	Pilot reports ship in sight with distance. Message notifies Marshal to transfer control to Prifly (Case I).	Roger (UL3)	X= 1-20	50	Priority	I/II
FIN/PRI	**DL35 (NA55)**	Going Dirty [(X) miles]	Aircraft initiated dirty call, transition to landing configuration	Roger (UL3)	X=1-15	50	Priority	All
	DL42 - DL70 RESERVED							

Table 10-12: Downlink - Departure Information and Reports

Downlink - Departure Information and Reports								
FLT Phase	**Message #**	**Message Element**	**Message Intent**	**Expected Response**	**Data Elements**	**Rng (NMI)**	**Priority**	**Case**
DEP	**DL74 (NA49)**	Kilo	Aircraft ready for mission	Roger (UL3)	N/A	50	Routine	All
DEP	**DL75 (NA27)**	Established overhead angels (X) [point (#)] ($) point (*) to give	Pilot reports holding overhead with tanker fuel to give	Roger (UL3)	X=1-30, #=1-9, $=1-20, *=1-9	50	Routine	All
DEP	**DL76 (NA28)**	[Package check complete ([sweet I dry]) [(X) point (#) to give]	Tanking package status and available fuel	Roger (UL3)	X=1-20, #=1-9	50	Routine	All
DEP	**DL77 (NA29)**	Sour	Tanking package out of service	Roger (UL3)	N/A	50	Routine	All
DEP	**DL78 (NA30)**	Consolidation complete sweet (X) [point (#) to give]	Tanking fuel transferred to the on-coming tanker	Roger (UL3)	X=1-20, #=1-9	50	Routine	All
DEP	**DL79 (NA31)**	Plugged and receiving	Aircraft is receiving fuel from the tanker	Roger (UL3)	N/A	50	Routine	All
DEP	**DL80 (NA32)**	Tanking complete	Aircraft reports tanking complete	Roger (UL3)	N/A	50	Routine	All
DEP/PRI	**DL81 (NA36)**	[(X) souls-on-board] red light (#)	Helo reports airborne with personnel on board and fuel in time	Roger (UL3)	X=1-20, #=0001-2359	50	Routine	All
	DL84 - DL110 RESERVED							

10.2.2.4 ATM 10 Downlink Messages

The ATM 10 Downlink Messages are defined in Tables 10-13 through 10-14.

Table 10-13: Downlink - Recovery Information and Reports

Downlink - Recovery Information and Reports								
FLT Phase	**Message #**	**Message Element**	**Message Intent**	**Expected Response**	**Data Elements**	**Rng (NMI)**	**Priority**	**Case**
Pri	**DL36 (NA34)**	Spinning	Aircraft acknowledgement of spin instruction or pilot initiated spin	N/A or Roger (UL3)	N/A	10	Priority	I/II
PRI	**DL37 (NA35)**	Departing	Aircraft notify Prifly of departing the pattern	Roger (UL3)	N/A	10	Priority	I
PRI	**DL38 (NA56)**	Breaking	Aircraft initiated break	Roger (UL3)	N/A	10	Priority	I/II
FIN/LSO	**DL39 (NA24)**	[J-UCAS, JPALS, auto] Ball	Pilot reports OLS in sight, J-UCAS transitions to LSO phase	Roger Ball (UL-NS66)	N/A	10	Immediate	All
LSO	**DL40 (NA46)**	Clara [coupled]	Pilot reports OLS is NOT in sight	Revert to voice	N/A	10	Immediate	All
LSO	**DL41 (AA19)**	Wave off	Aircraft initiated wave off	Roger (UL3)	N/A	10	Immediate	All
	DL42 - DL70 RESERVED							

Table 10-14: Downlink - Departure Information and Reports

Downlink - Departure Information and Reports								
FLT Phase	**Message #**	**Message Element**	**Message Intent**	**Expected Response**	**Data Elements**	**Rng (NMI)**	**Priority**	**Case**
DEP/PRI	**DL71 (NA51)**	Up on deck	Aircraft ready to taxi to the cat	Roger (UL3)	N/A	10	Routine	All
DEP/PRI	**DL72**	Down	Aircraft is down for maintenance	Roger (UL3)	N/A	10	Routine	All
DEP	**DL73 (AA15, NA52)**	Suspend cat (X)	Request from aircraft to suspend catapult	Roger (UL3)	X=1-4	10	Immediate	All
DEP/PRI	**DL82 (NA37)**	Established papa golf	Plane guard helo reports established in plane guard position	Roger (UL3)	N/A	10	Routine	All
PRI	**DL83**	Needs a (X) K weight board	Pilot advises Prifly of the aircraft weight for the catapult	Roger (UL3)	X=30-60	10	Priority	All
	DL84 - DL110 RESERVED							

10.2.3 Operational Scenarios

The Operational Scenarios for this data is still being define and is TBR.