



The European Organisation for Civil Aviation Equipment
L'Organisation Européenne pour l'Équipement de l'Aviation Civile

INTEROPERABILITY REQUIREMENTS FOR ATS APPLICATIONS USING ARINC 622 DATA COMMUNICATIONS (FANS 1/A INTEROP STANDARD)

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ED-100A

April 2005

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FOREWORD

1. This document, jointly prepared by EUROCAE Working Group 53 and RTCA Special Committee 189 was accepted by the Council of EUROCAE on 1st April 2005.
2. EUROCAE is an international non-profit making organization. Membership is open to European manufacturers of equipment for aeronautics, trade associations, national civil aviation administrations, users, and non-European organizations. Its work programme is principally directed to the preparation of performance specifications and guidance documents for civil aviation equipment, for adoption and use at European and worldwide levels.

The findings of EUROCAE are resolved after discussion among its members and in cooperation with RTCA Inc., Washington DC, USA and/or the Society of Automotive Engineers (SAE), Warrendale PA, USA through their appropriate committees.
4. This document supersedes EUROCAE ED-100 ‘ Interoperability Requirements Standard for ATS applications using ARINC 622 data communications (Interop FANS 1/A)’ (July 2000).

As compared with ED-100 document, the main changes are:
Correction based upon implementation feedback
Introduction of the message latency functionality
Clarification of Pre-formatted free text
Adding of HFDL and VHF AOA
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CHAPTER 1

INTRODUCTION

This document provides the interoperability requirements (INTEROP) standard for the implementation of the ATS applications using ARINC 622 data communication, henceforth referred to as FANS-1/A (Version 1) systems.

This document was developed in accordance with the criteria for INTEROP standards set forth in EUROCAE ED-78A / RTCA DO-264, "Guidelines for Approval of the Provision and Use of Air Traffic Services Supported by Data Communications." This document represents the minimum set of interoperability requirements and allocations necessary to provide adequate assurance that the elements of the communication, navigation, and surveillance/ air traffic management (CNS/ATM) system are compatible with each other and when operating together will perform their intended function. These elements comprise the aircraft system, the air traffic service provider (ATSP) system, and the operator's provisions to use the air traffic services. The ATSP system and the operator's provisions may include third party or contracted communication services. The communications services include ACARS-compliant subnetworks and the ACARS communications service.

1.1 PURPOSE

The purpose of this document is to define the set of requirements for the interoperability aspects of FANS-1/A (Version 1) systems. It is intended for use in conjunction with a consistent safety and performance requirement standard, other INTEROP standards, and the guidelines described in ED-78A/DO-264 for each approval type associated with the elements of the CNS/ATM system.

NOTE 1: *Based on ED-78A/DO-264, INTEROP and SPR standards provide recommendations intended for government organizations, conference of governments, or agencies having statutory jurisdiction over the use and provision of air traffic services supported by data communications. These recommendations are for use by such government organizations to enunciate official policy, related to such matters, in aeronautical information publications (AIPs), notices to airmen (NOTAMs), airplane flight manuals (AFMs), and operator specifications.*

Interoperability requirements are the minimum technical and functional requirements that provide the basis for ensuring compatibility among the various elements of the CNS/ATM system using a specific technology. These elements comprise the distributed communication services and ATS applications in the aircraft system, the communication service providers' system and the ATS Provider system.

NOTE 2: *This document is not intended to provide requirements to standardize operational procedures in the use of this technology. Refer to appropriate safety and performance (SPR) standards.*

This document will:

- a) Define interoperability requirements for the communication services;
- b) Define interoperability requirements for the ATS applications;
- c) Allocate the interoperability requirements to stakeholders.

1.2 SCOPE

This document covers:

- a) The ATS Facilities Notification (AFN) application;
- b) The Automatic Dependent Surveillance (ADS) application;
- c) The Controller Pilot Data Link Communication (CPDLC) application;

d) The ARINC 622 data communication.

Following elements are out of scope of this document:

- Ground-ground data communications between ATS Providers or between an ATS Provider and an Airline Operational Control (AOC) facility;
- Air-ground data communications between an aircraft and an AOC facility;
- Performance of the communication services and the ATS applications;
- User interfaces of the ATS applications within the aircraft and the ATS Provider facility.

1.3

RELATIONSHIPS TO OTHER DOCUMENTS

Industry has recognized that the development of the FANS-1/A systems required significant standards development. The interoperability requirements of this document supersede those of the RTCA/DO-212 and RTCA/DO-219. This document makes reference to existing standards wherever possible.

This INTEROP standard is based upon the guidance of ED-78A/DO-264. Specifically for FANS-1/A (version 1) systems, this INTEROP standard can be used as evidence of the interoperability assessment, which is part of the coordinated requirements determination process. This evidence provides the basis for qualifying the interoperability aspects of elements of the CNS/ATM system. Additional criteria for qualifying the interoperability aspects of an element of the CNS/ATM system to the INTEROP standard can be found in ED-78A/DO-264.

This document does not address safety or performance. These types of requirements are covered in the appropriate safety and performance requirements standard, which are the products of the operational safety assessment (OSA) and the operational performance assessment (OPA), and are based on the operational services and environment definition (OSED). The OSA determines, validates, and allocates requirements to ensure that the CNS/ATM system, as described in the OSED, is acceptably safe. The OPA derives and/or validates required communication performance (RCP) type. Applicants will have to show for approval that this INTEROP standard is viable for the relevant SPR standards per sections 5 and 6 of ED-78A/DO-264.

NOTE: *Recognition of SPR and INTEROP standards and any unique characteristics or adaptation affecting operations, safety, performance and interoperability for a specific ATS provision, aircraft type design, or operator's operation can be found in the respective AIPs, NOTAMs, AFMs, and operator's specifications.*

The terminology is consistent with the Guidelines. Nevertheless, this document contains terms which are specific to the ARINC 622 data communication technology. Those terms are defined in section [1.4.3](#).

Although this document does not address performance, it is recognized that performance may affect interoperability. Examples are:

- a) reaction times by aircraft or ATS Provider systems, to messages which are automatically responded, e.g. ADS requests;
- b) timers for replies to messages;
- c) reaction times to detection of an event which triggers a message, e.g. aircraft altitude change.

These elements are to be covered by the appropriate Safety and Performance Requirements Standards. Those values will either cover specific requirements such as the above, or will be sufficient to ensure that designers of a CNS/ATM system element can discern their own requirements from the above without creating interoperability problems for any specific technology.

1.4 HOW TO USE THIS DOCUMENT

This document assumes previous knowledge of AFN, CPDLC and ADS applications and the airline industry ACARS datalink.

1.4.1 Mandating and Recommendation Phrases

This document contains “shall” and “should” with following meanings:

The use of the word “Shall” indicates that for interoperability concern compliance with the particular procedure or specification is required and no alternative may be applied;

The use of the word “Should” (and phrases such as “It is recommended that...,” etc.) indicates that though the procedure or criterion is regarded as the preferred option, alternative procedures, specifications or criteria may be applied, provided that the manufacturer, installer or tester can provide information or data to adequately support and justify the alternative.

NOTE: *In a regulatory context, the “shalls” are considered a mandated criterion if the:*

- a) *Applicant defines this INTEROP standard, in conjunction with relevant SPR standards, and any adaptation (Refer to EUROCAE ED-78A/RTCA DO-264, paragraph 1.3.3), as the approval basis, and*
- b) *Approval authority accepts this approval basis. The approval basis defines the criteria for compliance. “Shoulds” are typically used to describe guidelines for the processes used to produce elements of the system or for meeting the mandated criterion.*

1.4.2 Document Organization

Section [1](#) defines the purpose and scope of the document and its role in the development and sustaining of FANS-1/A Air Traffic Services supported by data communications. Section [1](#) provides the document organization and lists the reference documents pertaining to the interoperability requirements for the FANS-1/A communication services and ATS applications.

Section [2](#) is a system description, including a list of architectural and functional assumptions.

Section [3](#) defines the interoperability requirements for the FANS-1/A communication services.

Section [4](#) defines the interoperability requirements for the ATS applications of ATS Facilities Notification (AFN), Automatic Dependent Surveillance (ADS), and Controller/Pilot Data Link Communications (CPDLC) which is also known as Air Traffic Control (ATC) Two Way Data Link (TWDL). Protocol convergence functions, ACARS Compatible System (ACS) and Application Interface for bit-oriented applications are also specified in section [4](#). Guidance material is provided and introduces features which are beyond the scope of existing standards, e.g., the relationship between ATS applications and aircraft navigation systems.

Section [5](#) defines the dynamic aspects of the ATS applications and the sequences of operations required for correct FANS-1/A operation.

Section [6](#) allocates requirements specified in sections [3](#), [4](#) and [5](#) to aircraft system, ATS Provider system and communication service providers' system.

Appendix A provides the history of this document and its relationship to the terms of reference of WG-53/SC-189. It includes a summary of unique characteristics of FANS-1/A implementations that existed prior to the original issuance of this standard.

Appendix B contains candidate improvements to the FANS-1/A Version 1 systems. These are grouped into two categories: those which can be implemented without affecting interoperability, and those which cannot.

Appendix C gives an overview of how some uplink CPDLC message elements are loaded into an aircraft flight management function.

Appendix D provides a list of participants who contributed to the development of this standard.

Appendix E is an improvement suggestion form for this document.

1.4.3

Acronyms and abbreviations

The following acronyms and abbreviations are used:

Acronym	Description
ACARS	Aircraft Communication And Reporting System
ADS	Automatic Dependent Surveillance
ADSF	Automatic Dependent Surveillance Function
AFN	ATS Facility Notification
AM-MSK	Analog Modulation - Mode Shift Key
AOA	ACARS over AVLK
AOC	Airline Operation Control
ARINC	Aeronautical Radio, Inc
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Services
AVLC	Aviation VHF Link Control
CDA	Current Data Authority
CNS	Communication Navigation Surveillance
CP	Central Processor
CPDLC	Controller Pilot Data Link Communications
CRC	Cyclical Redundancy Check
CSP	Communication Service Provider
FANS	Future Air Navigation System
FCU	Flight Control Unit
FMS	Flight Management System
FOM	Figure Of Merit
GES	Ground Earth Station
GLONASS	Global Orbiting Navigation Satellite System
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
HF	High Frequency
IMI	Imbedded Message Identifier
MAS	Message Assurance
MCP	Mode Control Panel
MFI	Message Format Identifier

Acronym	Description
NDA	Next Data Authority
RCP	Required Communication Performance
SMI	Standard Message Identifier
TCAS	Traffic Collision Avoidance System
TEI	Text Element Identifier
UBI	Unique Block Identifier
UTC	Universal Time Coordinated
VHF	Very High Frequency

1.5 REFERENCES

The references cited in this INTEROP standard are listed below.

1.5.1 General

This section defines the primary reference documents relevant for the interoperability standards for FANS-1/A systems. Wherever possible interoperability standards are defined by direct reference to released industry standard documents.

1.5.2 Communication Service Standards

- a) ARINC Specification 618-2, Dec 96, Air/Ground Character Oriented Protocol Specification;
- b) ARINC Specification 620-2, Dec 94, Data Link Ground System Standard and Interface Specification (DGSS/IS);
- c) ARINC Specification 622-2, Dec 94, ATS Data Link Applications over ACARS Air-Ground Network.

NOTE: *Later versions of these documents may be used when it has been demonstrated that they do not lead to interoperability changes.*

1.5.3 ATS Application Standards

ARINC Specification 622-2, Dec 94, ATS Data Link Applications over ACARS Air-Ground Network.

NOTE: *RTCA/DO-212, RTCA/DO-219 and the unreleased RTCA/DO-219 Change 1 have been used as a source in the generation of this document.*

1.5.4 Aircraft System Standards And Supplementary Specifications

There are several different avionics architectures which will support FANS-1/A functionality on a wide range of aircraft types. There are also many interfacing systems which support the FANS-1/A Communication, Navigation and Surveillance (CNS) functions. These are generally defined by ARINC Characteristics. Specific aircraft system standards which impact interoperability include:

ARINC 424, Navigation Data Base.

1.5.5 ISO Standards

ISO/IEC 8825-2:1996 ASN.1/Packed Encoding Rules (PER) - Basic Unaligned

1.5.6 EUROCAE/RTCA standards

EUROCAE ED-78A/RTCA DO-264, Guidelines for Approval of the Provision and Use of Air Traffic Services Supported by Data Communications.

CHAPTER 2

SYSTEM DESCRIPTION

2.1 OVERVIEW

FANS-1/A Version 1 implements three ATS applications.

- a) The ATS Facilities Notification (AFN) is an ATS application which enables an ATS Provider system to become aware of an aircraft's datalink capabilities and provides an exchange of address information. The AFN messages have no function related to the direct control of the aircraft by an ATS Provider.
- b) The Automatic Dependent Surveillance (ADS) application is an ATS application in which aircraft automatically transmit, via a data link, data derived from on-board navigation systems. As a minimum, the data include three-dimensional position, the corresponding time of the position data, and a Figure of Merit (FOM) that characterizes the accuracy of the position data. Additional data may be provided as appropriate.
- c) The controller pilot data link communication (CPDLC) application is an ATS application in which pilots and controllers exchange messages, via a data link. CPDLC includes a set of clearance/information/request message elements which correspond to existing phraseology employed by current Air Traffic Control procedures. These message elements encompass altitude assignments, crossing constraints, lateral deviations, route changes and clearances, speed assignments, radio frequency assignments, and various requests for information. The pilot is provided with the capability to respond to messages, to request clearances and information, to report information, and to declare/rescind an emergency. A "free text" capability is also provided to exchange information not conforming to defined formats.

2.1.1 AFN

The AFN does not actually establish communications between the airborne and ground peers of ADS and CPDLC applications; this is done by the applications themselves. However to establish communications the ATS Provider systems and the aircraft need the addressing information which the AFN can provide. Two basic procedures exist:

- a) The Initial Notification allows an aircraft to introduce itself to the ATS Provider system and to make that ATS Provider system aware of its aircraft registration and the ATS data link applications that it supports;
- b) The Request for Notification allows an ATS Provider to request an aircraft to notify another ATS Provider.

2.1.2 ADS

ADS uses the various systems aboard the aircraft to provide aircraft position, velocity, intent and meteorological data. These data can be transmitted to the ATS Provider system for estimating and predicting aircraft position.

ADS reports are generated in response to commands, called contract requests, issued by the ATS Provider system. The contract identifies the types of information and the conditions under which reports are to be transmitted from the aircraft.

Three types of reporting have been defined: periodic contract, event contract and demand contract. The aircraft may also initiate emergency reporting, which is a special case of periodic reporting. In response to a periodic contract the aircraft assembles and transmits a message containing the fields at the interval specified in the contract request. Event contracts define certain events (such as an altitude change) which will cause a report to be sent, independent of any periodic contract in

effect. One demand contract is sent each time it is commanded from the ATS Provider system.

Within the contract request, several different data groups may be specified. These include the basic position report, which contains three-dimensional position and time, and additional on-request groups. These groups include aircraft and wind velocity, vertical speed and limited waypoint information.

An ATS Provider may issue multiple simultaneous contracts to a single aircraft, including one periodic and one event contract, which may be supplemented by any number of demand contracts. Up to four separate ATS Provider systems may initiate ADS contracts simultaneously with a single aircraft.

2.1.3

CPDLC

After valid peer addresses are exchanged via the AFN application, an ATS Provider system will be able to establish a CPDLC connection with the aircraft. If the AFN Contact was successful, the aircraft will accept the connection request. At this point, normal message traffic may be conducted between the pilot and the controller.

When a message is received, the CPDLC application decodes the data units and determines the message urgency requirements, alerting requirements, and response requirements. These requirements then direct CPDLC concerning message handling, alerting, message display, and acceptable responses. The CPDLC application also provides the capability to code a message into data units for transmission. Other features include message recall, control capabilities, and status indications.

NOTE: *The term “ATC Data Authority” is used to refer to an ATS Provider system peer used by the “ATC Control Authority” (controller) responsible to control the airspace/ground environment in which the aircraft is operating.*

Normally, service termination is initiated by the ATC Data Authority to end service or transfer service to the next ATC Data Authority. When an END SERVICE message is received, the aircraft responds by disconnecting with the existing ATC Data Authority. The pilot, the controller, the CPDLC application in the aircraft, or in the ATS Provider system may initiate connection termination. Network conditions may also result in connection termination.

Only the current ATC Data Authority may initiate a connection transfer to the next ATC Data Authority. To accomplish this, the current ATC Data Authority provides the aircraft with the facility designation for the next ATC Data Authority. Once this information is received, the aircraft will only accept a connection request from this “next” ATC Data Authority. However, once established, normal message traffic will not yet be conducted over the next ATC Data Authority connection until this connection is designated as the current ATC Data Authority.

The current ATC Data Authority will initiate the connection transfer by sending an END SERVICE message to the aircraft. When an END SERVICE message is received, the aircraft will respond by terminating the connection. If the aircraft has a connection with the next ATC Data Authority, then the aircraft will transfer to this new connection for normal message traffic. If a new connection has not been established, the aircraft will still terminate the current ATC Data Authority connection.

If, at any time, the connection with the current ATC Data Authority fails, and a connection is established with the next ATC Data Authority, both connections will be terminated. The next ATC Data Authority will only be designated the current ATC Data Authority via proper actions associated with the END SERVICE message.

NOTE: *An aircraft will support a maximum of two connections at any given time but will only support normal message traffic over the connection designated as the current ATC Data Authority.*

2.1.4 ARINC 622 Data Communication

Messages generated by the ATS applications will be exchanged over data links which use the ACARS protocols for air-ground message transfer.

ATS applications may be defined as character-oriented (AFN) or bit-oriented (ADS, CPDLC). Character-oriented data can be carried over the ACARS network without modification. Bit-oriented data must be converted to a format consistent with the ACARS system to transit the air-ground link.

The ACARS compatible system (ACS) will enable the ACARS network to support ATS applications. ACS provides formatting/addressing, cyclic redundancy check (CRC) integrity check and bit-to-hexadecimal conversion process.

In addition, bit-oriented ATS applications require functions specific to each application. An Application Interface will provide the specific functions which allow each bit-oriented application to transparently interact with the ACARS connectionless network service.

“ARINC 622 Data Communication” refers to these processes over ACARS air-ground networks.

2.2 ASSUMPTIONS

2.2.1 Architectural Assumptions

- a) At the time of writing, all FANS-1/A Communication Service Providers (CSPs) share a common architecture (Figure 2.2-1) which comprises:
 1. a Central Processor (CP), through which all communication passes;
 2. a number of air-ground communication facilities, which may be Very High Frequency (VHF) ground stations and/or satellite Ground Earth Stations (GESs) and/or High Frequency (HF) ground stations (if supported by CSP);
 3. a data communication network linking the VHF ground stations, GESs and HF ground stations (if supported by CSPs) to the CP and also linking the ground users (ATS Provider systems) to the CSP.

NOTE 1: VHF ground stations may be capable of “Plain old ACARS” (based upon Analog Modulation - Mode Shift Key (AM-MSK) ACARS VHF) or of ACARS over Aviation VHF Link Control (AVLC) (AOA).

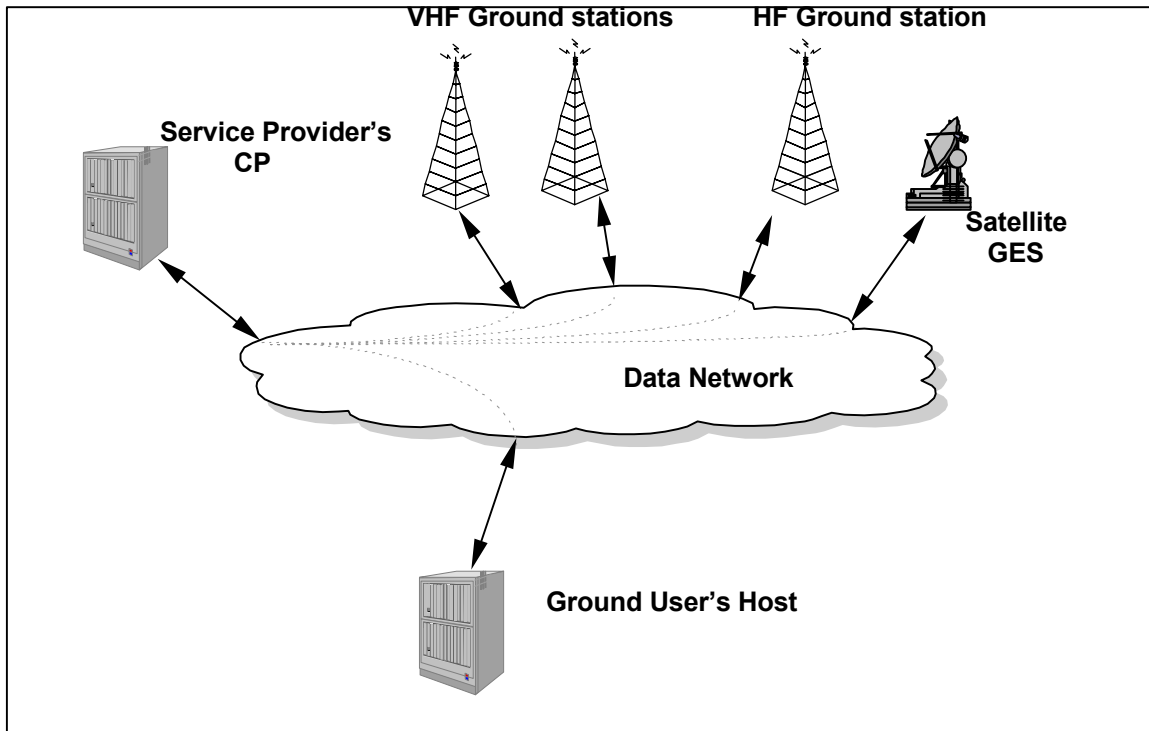


FIGURE 2.2-1 : GENERIC DATALINK ARCHITECTURE (COMMUNICATION SERVICE PROVIDER)

- b) In general, each CSP operates only one CP, however this may change in the future. Nevertheless, if a CSP adopts a distributed architecture (with multiple CPs) in the future, the provisions described in this document will still apply;
- c) Aircraft operators may make use of different CSPs and/or media depending on the availability of services and their individual contractual arrangements. Aircraft operators will ensure that all CSPs with whom they have contracts have the appropriate labels configured to support the FANS-1/A messages;

NOTE 2: *As satellite datalink service is usually global, an aircraft operator generally needs to contract with only one CSP for satellite datalink service. VHF datalink facilities, on the other hand, are supported in different regions by different CSPs. This means that aircraft operators may contract with more than one CSP for VHF datalink service. In a given region an aircraft operator may receive VHF datalink service from one CSP and Satellite datalink service from another CSP. There are cases where a number of CSPs support VHF datalink service in the same region. Where this occurs, the aircraft operator's contractual arrangements will determine the choice of VHF CSP by the aircraft.*

- d) The aircraft operator will ensure that it has the appropriate contract(s) with one or more CSP for the intended operational environment;
- e) The requirement for a particular medium on a particular route will be specified by the appropriate authorities based on factors such as performance and coverage;

NOTE 3: *An authority's performance or coverage requirement can lead to a need for carriage of different communications equipment. For example, FANS-1/A operations in an oceanic environment require satellite and/or HF data communications for coverage and/or performance reasons; a VHF datalink capability may not be available in this environment. Conversely, FANS-1/A operations in some continental environments may require VHF data communications for performance reasons; satellite and/or HF data communications may not be required in these environments*

- f) ATS Providers will usually be connected to the network of only one CSP. In order for ATS Providers to have communication with all aircraft in their airspace, “internetworking” between the CSPs is necessary where aircraft operate in the same airspace using different CSPs so that communication is possible regardless of the aircraft’s choice of CSP and/or media;
- g) Whether handled by a single CSP or a number of CSPs operating in an internetworked arrangement, all datalink traffic will be subject to the same performance requirements. The routing procedures have been developed to ensure that message delivery will meet the performance requirements for FANS-1/A datalink;
- h) Architecture of ATS Provider systems is a local implementation issue. It will be transparent to the aircraft;
- i) Within the aircraft, several architectures are possible. ATS Provider systems and CSPs will support any avionics architecture through the appropriate air-ground protocols.

NOTE 4: *Aircraft addressing for uplink messages differs between aircraft types, due to differences in the avionics architecture. Two levels of addressing are needed to correctly route a FANS-1/A message to the aircraft:*

1. *an addressing mechanism to route the message via the CSP network; and*
2. *an addressing mechanism to support routing and handling within the avionics.*

The aircraft registration number, also known as the aircraft ID or tail number, is the only unique address used by the CSPs to deliver uplink messages to the aircraft.

2.2.2

Functional Assumptions

- a) The function implemented within FANS-1/A aircraft to access the ACARS air-ground networks will be referred to as the ACARS management function;
- b) The interoperability requirements for error detection and correction functions are specified herein to provide technical mechanism to ensure system performance, e.g., integrity, as may be required by relevant SPR standards.

NOTE: *Procedural or other means, which may be equivalent to the functionality of these technical mechanism, are negotiated with appropriate approval authorities and, if acceptable, are defined in appropriate approval documents, i.e., AIP/NOTAM, AFM or operational specifications;*

- c) Because of ATC operational differences between facilities, varying functional capabilities of ATC automation systems, and the need to effectively manage transitions between voice only and mixed voice and data link operations, it may not be possible to realize a uniform level of ATC data link service initially. For example, oceanic, en route, terminal, and tower ATC facilities may exhibit differing ATC data link functional capabilities. These differences may be functional subsets of the message elements defined in section [4.6.3.3](#). It has been determined that greater operational flexibility may be realized by using administrative mechanisms to denote these operational differences. An example would be the use of Advisory Circulars or Notices to Airmen (NOTAMs) to inform potential users of the level of service available from a specific facility or facility type;
- d) After the AFN is completed, the address of ADS and CPDLC within the aircraft and appropriate aircraft information will be made available to the ATS Provider system;
- e) The filed flight plan will indicate the aircraft data link related equipage;

NOTE 1: *Currently aircraft data link related equipage cannot be indicated in the filed flight plan. Activities are underway to update ICAO flight plan equipage codes.*

- f) Position data is supplied to the airborne ADS function from an external source;
- g) There is a stable fully-maintained external time source, referenced to Universal Coordinated Time (UTC), independent of the ADS to relate position data to time. If the aircraft's position data is provided by Global Navigation Satellite Systems (GNSS) such as the Global Positioning System (GPS) or the Global Orbiting Navigation Satellite System (GLONASS), accurate time should be provided with the position data and the Automatic Dependent Surveillance Function (ADSF) should transmit it directly. If the aircraft's position data is provided by any other airborne system (such as an inertial navigation system (INS)), a message time stamp should be provided to the ADS function that will vary no more than two seconds from UTC time;
- h) Data link use of standard pilot/controller nomenclature will be consistent with published definitions;
- i) If a data link message which requires a closure response is subsequently negotiated via voice, an appropriate data link closure response for that message will still be initiated;

NOTE 2: *Even though a voice response may have been provided, a data link response is necessary to ensure proper synchronization of ATS Provider and aircraft systems.*

- j) Pilots alerts will be suppressed during takeoff and landing as required for a given aircraft;

NOTE 3: *Some aircraft will reject messages with an ERROR (unexpected data) in critical phases of takeoff and landing*

- k) The ATS Provider system will ensure technical compatibility with ADS and CPDLC within the aircraft through the utilization of the ADS and CPDLC version number;

NOTE: *Operational or procedural means are used to ensure aircraft are properly equipped for the intended airspace;*

- l) Changes in ATC Control Authority (controller) may be initiated via data link or voice. Changes in ATC Data Authority (respective ATS Provider system peer) must be initiated via data link;
- m) Only the current ATC Data Authority can assign the next valid ATC Data Authority and initiate the transfer to that authority.

CHAPTER 3

REQUIREMENTS FOR COMMUNICATION SERVICES

3.1 INTRODUCTION

This section of the document provides:

- a) the basic constraints;
- b) a description of the routing procedures used;
- c) the requirements levied on the CSPs;
- d) the requirements levied on the ATS Providers;
- e) the requirements levied on the aircraft.

Where the term “ATS contracted CSP” is used in this section, it refers to the particular CSP contracted by an ATS Provider to provide all FANS-1/A datalink services (e.g. VHF and SATCOM).

The term “alternate ATS CSP” applies to another CSP whose network is needed by the ATS Provider to communicate with some aircraft.

The sections describing the routing procedures also provide a set of requirements to be met under the possible operational scenarios.

3.2 BASIC CONSTRAINTS

FANS-1/A communication services comply with ARINC Specifications 618, 620 and 622.

Support for FANS-1/A datalink will be further bound by the following specific requirements:

3.2.1 Label Support

- a) All FANS-1/A uplink traffic shall be identified by the use of “A” labels or Message Function Identifiers (MFIs). (Refer to ARINC Specification 620);
- b) All FANS-1/A downlink traffic shall be identified by the use of “B” labels or Message Function Identifiers. (Refer to ARINC Specification 620).

3.2.2 Message Assurance

Delivery of FANS-1/A uplink messages to an aircraft can be confirmed to an ATS Provider by a downlink Message Assurance message. Delivery of Message Assurance messages to an ATS Provider is driven by the contractual arrangements between that ATS Provider and the CSP.

- a) CSPs shall support the Message Assurance function. (Refer to ARINC Specification 620);
- b) If the ATS Provider requests Message Assurance, the contracted CSP shall provide one of the following notifications to the ATS Provider for each uplink message:

1. “success” (MAS/S), indicating that the uplink message has been received and positively acknowledged by the aircraft;

NOTE 1: Success indicates that the message has been received by the ACARS management function.

2. “failure” (MAS/F), indicating that all parts of the uplink message have not been received and positively acknowledged by the aircraft, or have been delayed;

NOTE 2: *It is possible that an uplink message can be successfully delivered and still be notified as an MAS/F, e.g., if the aircraft Acknowledgement messages are not received by the CSP.*

3. “not known” (MAS/X), indicating that the CSP is unable to provide an indication of delivery for this uplink message.

NOTE 3: *This could be due to internetworking limitations.*

3.2.3

ACARS Uplink Block Identifiers

- a) The CSPs shall use unique block identifiers (UBIs) for uplink messages to a given aircraft;
- b) Aircraft avionics shall use the UBIs to differentiate between uplink messages and copies of these uplink messages;
- c) Aircraft avionics shall reject uplink messages with duplicate UBIs.

3.3

FANS-1/A MESSAGE DELIVERY

The message media for uplink and downlink messages may differ. Uplink and downlink message delivery will be covered in separate sections below.

NOTE: *Description and requirements for media selection in this section may need to be adjusted. It is not within the scope of this document to determine the suitability of any particular media for the intended use in a given airspace.*

3.3.1

Downlink Message Delivery

The downlink message delivery logic is determined by the aircraft. Logic within the aircraft ACARS management function will select the appropriate media. Typically, depending on the availability of the different media, an aircraft will use VHF then satellite, then HF.

Messages of greater than 220 characters in length will be broken down into blocks of 220 characters or part thereof, by the avionics. Part of the CSP processing includes the re-assembly of multiblock messages.

NOTE: *When using VHF with ACARS over AVL (AOA), some CSPs break messages into larger blocks.*

All downlink messages received by the air-ground facilities of a CSP will be processed by the CP of that CSP. Message delivery will only be possible if the aircraft operator has a contractual arrangement in place with that CSP.

FANS-1/A messages shall have priority over AOC messages. Specific algorithms for prioritization are defined in ARINC Specification 618.

3.3.1.1

Downlink Message Delivery - Sequence of Events

The aircraft will deliver the message in accordance with the operational scenarios given below.

- a) From the downlink message, the CSP shall extract the address of the ATS Provider to which the message will be delivered;
- b) The CSP shall translate the message from air-ground format to ground-ground format.

3.3.1.2 Downlink Message Delivery - Operational Scenarios

The various airline contractual situations described above give rise to the following scenarios.

- a) If VHF is available the aircraft shall deliver the message via VHF (contracted or alternate CSP);
- b) If VHF is available and failure to deliver a message on the current VHF frequency occurs, or VHF is unavailable, then the aircraft shall deliver the message via satellite (contracted or alternate CSP). If both VHF and satellite are unavailable or failed to deliver a message, HF may provide an appropriate alternative.

NOTE: *An attempt to deliver a message generally consists of several tries on the current VHF frequency, SATCOM, or HF frequency.*

3.3.1.3 Downlink Internetworking Function

Figure 3.3-1 provides an overview of the internetworking architecture for downlink delivery paths.

- a) When a downlink message is received by the CP of a CSP, it shall be routed to the unique address of the ATS Provider;
- b) The CSP shall use both of the following mechanisms in the CP to provide this routing:
 1. Mapping of 4 character supplemental address to the corresponding 7 character IATA Type B address; and
 2. Use of actual 7-character supplemental address in the downlink message;
- c) Each ATS Provider is connected to only one CSP's ground network. The 7 character address assignment of each ATS Provider is unique and shall be configured in the networks of all CSPs; and
- d) If the addressed ATS Provider is not connected to the ground network of the CSP which received the downlink message, the message shall be forwarded to the correct CSP's network via a connection between the networks of the CSPs.

NOTE: *An aircraft operator can request the CSP to have FANS-1/A messages copied to a pre-configured address in addition to the ATS Provider.*

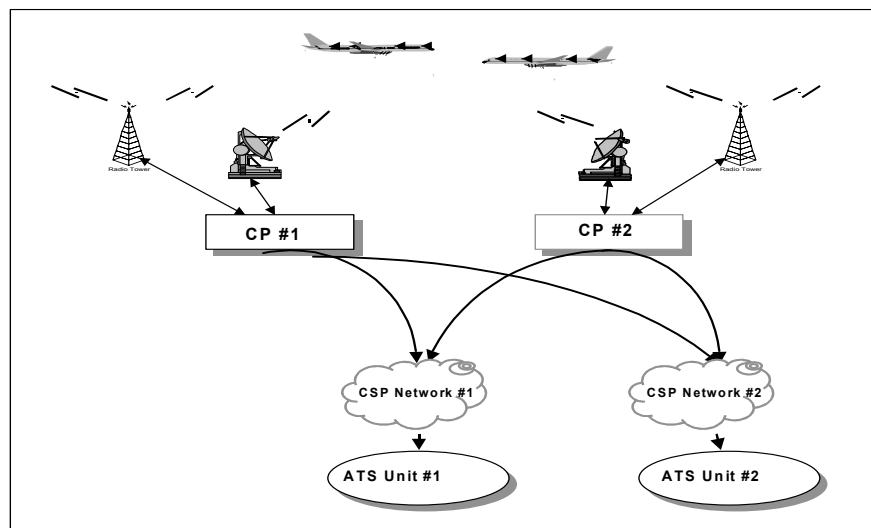


FIGURE 3.3-1 : INTERNETWORKING ARCHITECTURE – DOWNLINK DELIVERY PATHS

3.3.2 Uplink Message Delivery

Uplink FANS-1/A messages are delivered to a CSP's CP for delivery to an aircraft. In order to reach the correct CP, the message may have traversed the networks of a number of CSPs.

- a) Each CSP offering FANS-1/A communication service to an ATS Provider shall support an internetworking function. The internetworking function provides the logic that determines the CP and/or media to be used for delivery of uplinks to the aircraft;
- b) When received by a CSP, uplink messages of greater than 220 characters in length will be broken down into blocks of 220 characters or part thereof. Part of the on-board processing carried out by the ACARS Management function includes the re-assembly of multiblock messages;

NOTE: *When using VHF with ACARS over AVLC (AOA), some CSPs break messages into larger blocks.*

- c) FANS-1/A messages shall have priority over AOC messages. Specific algorithms for prioritization are defined in ARINC Specification 618.

3.3.2.1 Uplink Message Delivery - Sequence of Events

- a) An uplink message generated by an ATS Provider shall be addressed and delivered (by the ATS contracted CSP's network) to the platform hosting the internetworking function;
- b) The internetworking function shall address and deliver the message to the appropriate CSP for delivery (based on current media advisory information or default delivery preferences), with the request for Message Assurance delivery confirmation. If the CSP's own CP is chosen, the message may have Text Elements Identifiers (TEIs) added indicating the correct message path for delivery. If an alternate CSP is chosen for uplink message delivery, the alternate CSP will use own uplink algorithm for delivery of message;
- c) If successful delivery (indicated by receipt of an aircraft ACK as described in ARINC Specification 618) is achieved, a Message Delivery Confirmation message shall be returned to the internetworking function;
- d) Upon receipt of the Message Delivery Confirmation message the internetworking function shall forward this to the ATS Provider, if requested as the message assurance;
- e) If delivery is unsuccessful (indicated as described in ARINC Specification 618), either an Untransmittable Message Assurance or an Undeliverable Message Assurance shall be returned to the internetworking function;
- f) Receipt of these messages by the internetworking function shall result in either:
 - 1. another attempt at message delivery as required by the routing logic in the internetworking function; or
 - 2. the Untransmittable Message Assurance or Undeliverable Message Assurance being forwarded to the ATS Provider, if requested.

3.3.2.2 Uplink Message Delivery Function - Operational Scenarios

The uplink routing philosophy mentioned above gives rise to a number of operational scenarios. Any number of CSPs may be supported.

3.3.2.2.1 Scenario 1 : Delivery via ATS contracted CSP

The uplink routing logic of the CSP is such that this scenario will apply under two conditions:

- a) If VHF is available then uplink delivery shall be attempted via VHF; or
- b) If VHF is available and delivery is not successful or VHF is unavailable and the aircraft is a contracted user for satellite and is logged-on to the CSPs satellite service, uplink delivery shall be attempted via satellite. If VHF and satellite are unavailable or delivery is unsuccessful, and if HF is available, uplink delivery may be attempted via HF.

3.3.2.2.2 Scenario 2: First delivery attempt via ATS contracted CSP and second attempt via an alternate CSP

This scenario will apply under the following condition:

If VHF is available for the aircraft and the attempt at delivery via VHF was not successful, uplink delivery shall be attempted via the satellite communications facilities of an alternate CSP. If VHF and satellite are unavailable or delivery is unsuccessful, and if HF is available, uplink delivery may be attempted via HF.

3.3.2.2.3 Scenario 3: Delivery attempt via an alternate CSP

This scenario will apply under the following condition:

If communication is not possible via the ATS contracted CSP and the aircraft is using the air-ground facilities of an alternate CSP, then uplink delivery shall be attempted via the alternate CSP.

3.3.2.2.4 Scenario 4: First delivery attempt via an alternate CSP and second attempt via ATS contracted CSP

This scenario will apply under the following condition:

If the first uplink delivery attempt was made via an alternate CSP (VHF) provider and was unsuccessful, the second uplink delivery attempt shall be made via the aircraft's contracted satellite datalink service provider. If VHF and satellite are unavailable or delivery is unsuccessful, and if HF is available, uplink delivery may be attempted via HF.

3.3.2.3 Uplink Internetworking Function

The internetworking function provides the logic that determines the CP to be used for delivery of uplinks to the aircraft. The internetworking function may be hosted in the CSP's CP or it may be hosted externally. [Figure 3.3-2](#) provides an overview of the internetworking architecture for uplink delivery paths.

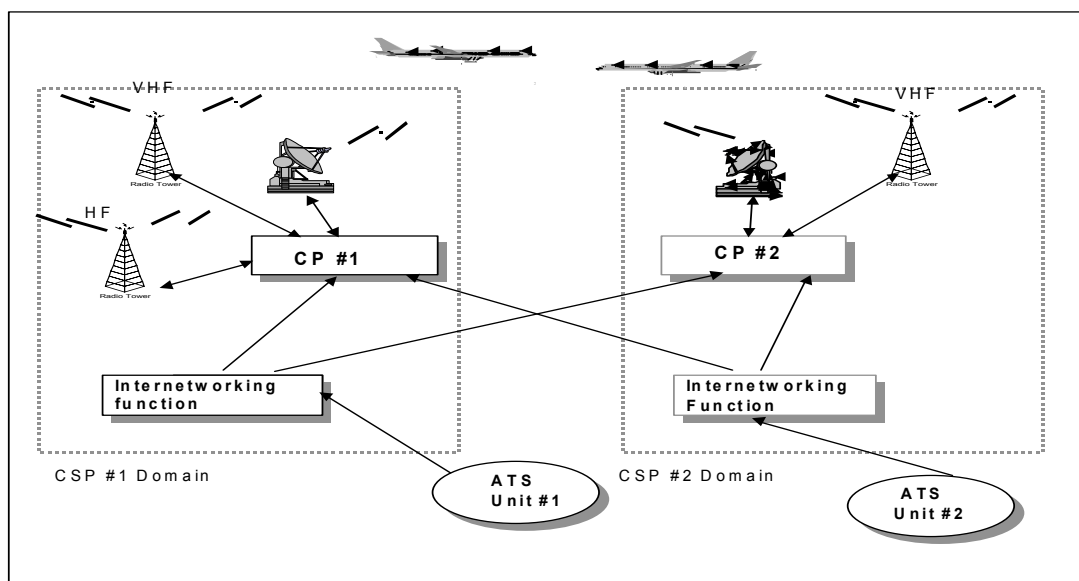


FIGURE 3.3-2 : INTERNETWORKING ARCHITECTURE – UPLINK DELIVERY PATHS

3.3.2.3.1 Media Advisory Messages

The internetworking function may make use of information regarding aircraft connectivity to CSP at any given time. This is obtained through the use of the media advisory message. These messages are transmitted by aircraft upon a change in medium and/or CSP. Within the message are flags indicating the establishment or loss of communication via each medium. When communication is established via a particular medium, the signature line of the media advisory message provides the identity of the CSP.

When media advisory messages are used, the first attempt to deliver a message is made using information derived from recently received media advisory messages. This will indicate whether VHF is in use and if so, through which CSP. It will also indicate if the aircraft has logged-on to the satellite facilities of a datalink service provider with whom it has no contract.

- a) Media Advisory downlinks shall be delivered to the internetworking functions of all CSPs, which use the media advisory message;
- b) In the absence of media advisory messages or if the first attempt to deliver a message has failed then the internetworking function shall forward the message to the next CSP as determined by contractual arrangements of the particular aircraft operator.

3.4 ATS PROVIDER REQUIREMENTS

3.4.1 Use of Message Assurance

ATS Providers shall have the capability to request notification of successful delivery for uplink messages, via the Message Assurance (MAS) function (Refer to ARINC Specification 620).

NOTE: *There is an acknowledgement for downlink messages. However, unlike the MAS, this only indicates delivery to the receiving CSP, and not to the ATS Provider.*

ATS Providers should:

- a) invoke Message Assurance, "Delivery Indication only," for all uplinks;
- b) establish procedures for handling MAS/F and MAS/X cases;
- c) establish with their contracted CSP the timers used for notification of uplink delivery success.

ATS Providers should generally not use the Reason Code found in MAS/F and MAS/X messages.

3.4.2 Addressing of Uplink Messages

- a) Every uplink message from an ATS Provider shall use the aircraft registration number which is contained within the portion of the AFN logon message (FN_CON) that is encapsulated by the Cyclical Redundancy Check (CRC).

ACARS uplink messages use a combination of label, sub-label, and MFI (if required), to identify the avionics device to which the message is being sent. The CP of the CSP converts the Standard Message Identifier (SMI) contained in the ground-ground message to the appropriate label/sub-label/MFI combination to allow the avionics to route the message to the appropriate airborne end-system. Provisions dealing with the choice of SMI are given in section [3.5](#).

Downlink SMIs and uplink SMIs have a unique 1-1 mapping as defined in ARINC Specification 622;

- b) For communication with those aircraft that use an MFI in their downlink messages, the ATS Provider shall keep track of the SMI used and use the corresponding uplink SMI (Refer to ARINC Specification 622) for all uplinks to that particular aircraft;
- c) For uplinks where an SMI of "FMD" is used, the optional MFI shall be used and will have the value "AA," "A0," or "A6" as shown in Table 3.4-1, followed by a space;
- d) For communication with those aircraft that do not use an MFI in their downlink messages, the ATS Provider shall use the appropriate uplink SMI (Refer to ARINC Specification 622) for each application;
- e) When the SMI value of "ATC," "AFU," or "RAR" is used, the optional MFI shall not be used as shown in Table 3.4-1, that is, the address will immediately follow "/" in the free text format.

The AFN Contact (FN_CON) message can be used to determine the appropriate addressing method for a particular aircraft.

TABLE 3.4-1 : VALID LABEL/MFI/IMI COMBINATIONS FOR UPLINK COMMUNICATIONS

End System Type	CPDLC (or TWDL)			AFN			ADS		
	Label	MFI	IMI	label	MFI	IMI	label	MFI	IMI
ACARS Management Function	AA	(none)	AT1 CR1 DR1	A0	(none)	AFN	A6	(none)	ADS
Flight Management System	H1/MD	AA	AT1 CR1 DR1	H1/MD	A0	AFN	H1/MD	A6	ADS

3.4.3 Message Routing

As the CSP determines the routing of FANS-1/A messages to the aircraft according to the guidelines given in this document, the following text elements (described in ARINC Specification 620, section 3.7) are not used by an ATS Provider in uplink messages; AP, GL, TP because the CSPs have the responsibility for routing of uplink messages.

NOTE: *These text elements are used to direct the CSP to deliver a message via a specific air-ground facility i.e., VHF ground station, GES, or HF ground station.*

3.5 AIRCRAFT REQUIREMENTS

The ACARS management function complies with the requirements of ARINC Specification 618.

CHAPTER 4

REQUIREMENTS FOR ATS APPLICATIONS

4.1 INTRODUCTION

Section 2 of ARINC Specification 622 describes the ACARS Compatible System (ACS).

Section 3 of ARINC Specification 622 describes the AFN application.

Section 4 of ARINC Specification 622 describes the Application Interface for bit-oriented applications.

Subsections which are not mentioned in the tables hereafter are considered implicitly 'as specified.'

In sections [4.2](#), [4.3](#) and [4.4](#), the following terminology is used:

deviation: identifies where implementations differ from the existing standard. When 'Not applicable,' the part of the ARINC Specification 622 specified in the 1st column is ignored.

change: a change to the ARINC Specification 622 standard which was implemented for interoperability.

clarification: the text in the column 'Description' does not replace existing sections of ARINC Specification 622.

4.2 ACARS COMPATIBLE SYSTEM (ACS)

Aircraft and ATS Provider systems comply with ARINC Specification 622-2, section 2 except as noted below.

4.2.1 FANS-1/A deviations

None identified.

4.2.2 Guidance Material

ARINC 622 section	Type	Description
2.0 ACARS Compatible System	Clarification	ATS Provider systems are required to support both avionics architectures (ATS applications in ACARS management function unit or in ACARS management function peripheral) if they intend to support the aircraft types covered in this document. This implies that both routings of ATS messages will be available in ATS Providers systems.
2.2.3 ACARS Compatible System CRC	Clarification	In the event that the appended CRC does not match the calculated CRC, the message will be discarded by both the avionics and ground systems..
Attachment 2, table 2-1	Clarification	For ADS, only the following IMIs will be used: ADS and DIS.
Attachment 2, table 2-1	Clarification	For CPDLC, only the following IMIs will be used: AT1, CR1, CC1, and DR1.

4.3 ATS FACILITIES NOTIFICATION (AFN)

Aircraft and ATS Provider systems comply with ARINC Specification 622-2, section 3 except as noted below.

4.3.1 FANS-1/A deviations

ARINC 622 section	Type	Description
3.3.3 AFN-Active Flag	Deviation	The 'Active Flag' value is not significant. The aircraft shall accept FN_CAD messages from any ATS Provider system.
3.4 Timers / Reason Codes	Change	ATST1 value shall be 10 minutes.
	Change	ATST3 value shall be greater than ATST1 value. <i>Note: ATS Provider systems should use 15 minutes for ATST3.</i>
3.5.3	Clarification	Time stamp will be provided (HHMMSS).
3.5.3 (Table)	Clarification	Flt_no value shall be identical to the one in item 7 <i>Aircraft identification</i> (as defined by ICAO document 4444 PANS-ATM, Appendix 2) of the filed flight plan.. 'Flight ID' defined in ARINC Specification 620 is not used.
3.5.3 (Table)	Clarification	Where an Aircraft Registration Number is less than seven characters, the Aircraft Registration Number shall be placed in the right of the field tail_no and the remainder of the field padded out with period [.] characters.
3.5.4	Clarification	The optional FCO AIF and version number will not be used.
Attachment 2, table 2-1	Clarification	Version number shall be 01 for ADS and CPDLC.
Attachment 2, table 2-1	Clarification	The Application Name 'ATC' is used for CPDLC.

4.3.2 Guidance Material

ARINC 622 section	Type	Description
3.5.4 AFN Contact Message	clarification	[ap_name] fields will reflect the applications basically available in the aircraft and will not reflect the applications available (i.e. not failed or not off) at the time the AFN Contact Message is initiated.
3.5.5 AFN Acknowledge Message	clarification	Only the overall reason code in the FN_AK will be used to determine whether the response is positive or not (i.e. the AFN logon is successful or not).

4.4 APPLICATION INTERFACE FOR BIT-ORIENTED APPLICATIONS

Aircraft and ATS Provider systems comply with ARINC Specification 622-2, section 4 except as noted below.

4.4.1 FANS-1/A deviations

ARINC section	622	Type	Description
4.5	CMA Provisions	clarification	Not applicable.
4.6	FIS Provisions	clarification	Not applicable.

4.4.2 Guidance Material

ARINC section	622	Type	Description
4.1	ACARS-Application Interface	clarification	Application name AIF and Version number of this application will not be used.
4.3.4	ADS Disconnect Message	clarification	Use of reason code is described in the ADS section of this document.
4.4	ATCComm Provisions	clarification	ATCComm is also known as CPDLC.

4.5 AUTOMATIC DEPENDENT SURVEILLANCE (ADS)

In this section, the following terminology is used:

ADSF: ADS application peer within the aircraft.

ADSG: ADS application peer within the ATS Provider system.

4.5.1 ADS Operation

This section defines the requirements for ADS operation.

NOTE: *The ADSF is conceptually capable of three types of message contracts:*

- A periodic contract (normal and emergency) in which certain information is requested to be sent at a specified frequency;*
- An event contract in which certain information is requested at the occurrence of a specified event (or sequence of events);*
- A demand contract in which a one-time polling of the aircraft for specific information is requested.*

The Basic ADS Group that contains the aircraft latitude, longitude, altitude, time stamp and FOM will be included in all messages sent. Additional information is available and structured into on-request groups.

When the ADSG requests a capability not supported by an ADSF, the ADSF shall recognize that fact, and the Non-compliance Notification message shall inform the ADSG that this capability is not supported.

4.5.1.1 Application Interface

The ADSF and ADSG shall interface with:

- The ACARS Compatible System. (Refer to section 2 of ARINC Specification 622-2, except as noted in section [4.2](#) of this document);
- The Application Interface. (Refer to sections 4.2 and 4.3 of ARINC Specification 622-2, except as noted in section [4.4](#) of this document).

NOTE: *Data transfer (IMI= ADS) and Disconnect requests (IMI=DIS) mentioned hereafter are provided by this interface and indicated by the Imbedded Message Identifier (IMI).*

4.5.1.1.1 Connection

A connection is used to indicate an end-to-end communication between ADS application program peers. This type of communication is also known as an association.

An ADS application built to the functional capability described here shall be version number 01.

4.5.1.1.1.1 Connection Establishment

- a) Upon establishment of a connection, the ADSF shall process uplinks on this connection;

NOTE: *There is no specific message to establish an ADS connection. The first ADS request received from an ADSG will establish a connection. Each connection is identified by a unique 7-character IATA Type B address.*

- b) The ADSF shall allow the establishment of at least four ADS connections with no transport priority; and

NOTE: *There is no way to distinguish an ADS connection with an ADSG from an ADS connection with any other entity.*

1. Each connection shall be capable of supporting a periodic contract, an event contract or an event and a periodic contract;
 2. The ADSF shall support a demand contract on each connection without altering any existing contracts.
- c) Requests on one connection shall not affect requests or reports on other connections.

4.5.1.1.1.2 Connection Denial

- a) When the ADSF receives an ADS service request while the maximum number of ADS connections are established, the ADSF shall deny service by sending a Disconnect Request (IMI=DIS) with reason code 1;
- b) Application data uplinked on a connection that has been denied service shall not be processed by the ADSF.

4.5.1.2 Processing of Uplinks

- a) The ADSF shall be capable of processing multiple requests in a single uplink;

NOTE 1: *'Multiple' is assumed to mean 'one request of each type': one Periodic Contract request, one Event Contract request, one Demand Contract request, one Cancel Contract request, one Cancel Emergency Mode request and one Cancel All Contracts and Terminate Connection Request. The maximum size of the uplink described above is 55 octets.*

- b) The first octet of an ADS request shall define the type of request being made. Valid requests shall be: Cancel All Contracts and Terminate Connection (tag value 1, see subparagraph [4.5.1.2.4](#)); Cancel Contract (tag value 2, see subparagraph [4.5.1.2.3](#)); Cancel Emergency Mode (tag value 6, see subparagraph [4.5.1.2.5](#)); Periodic Contract (including Demand Contract) (tag value 7, see subparagraph [4.5.1.2.1](#)); Event Contract (tag value 8, see subparagraph [4.5.1.2.2](#)); and Emergency Periodic Contract (tag value 9, see subparagraph [4.5.1.2.1](#)). When a valid request tag is encountered, the ADSF shall interpret the data as defined in the referenced section and operate as defined in subparagraph [4.5.1.4](#);

- c) When any errors are encountered while interpreting the request, the request shall be considered invalid, a Negative Acknowledgement shall be assembled and sent, and the request and any other unprocessed requests in the same uplink shall be ignored. Examples of errors are an invalid request tag, duplicate on-request group tag, duplicate reporting rate tag, an event request tag with no data, a request without enough data, an out-of-range input message parameter (see Table 4.5-1), or a periodic request tag for an operational mode different than the operational mode the connection is currently in. It will also be an error if a Cancel Contract Request is received when that contract is not active or a contract request is received with a contract request number the same as a contract already in effect on a particular connection. See subparagraph [4.5.1.4.2](#) for a description of the Negative Acknowledgement message;

NOTE 2: *The operational modes are normal and emergency. Any emergency Periodic Contract Request received during normal mode operation is considered an error. Any normal Periodic Contract Request received during emergency operational mode is considered an error.*

- d) Following the generation of three consecutive Negative Acknowledgements on the same connection, the ADSF shall cancel all contracts on the respective connection and terminate that connection;

NOTE 3: *Any downlinking of an Acknowledgement message or a Non-Compliance Notification message will reset the counter of consecutive Non-Acknowledgement messages.*

NOTE 4: *The three Negative Acknowledgements may be for any reason, and must be consecutive on the same connection. The AD SG should keep track of the number of consecutive Negative Acknowledgements it receives and take corrective action if it does not want the connection to be lost. This is a method for the ADSF to notify the AD SG that the AD SG is in an invalid state and that the AD SG needs to take corrective action. The termination of the transport connection by the ADSF is a last resort and is intended to stop a runaway AD SG. The number three was chosen to be consistent with the number of retry attempts before assuming the connection is lost.*

TABLE 4.5-1 : ADS INPUT MESSAGE PARAMETERS

Parameter	Valid Range	Significant Bits (See Note 5)	Defined MSB Value (See Note 6)	Approximate LSB Value
Aircraft Intent Projection Time	1 to 255 minutes	8	128 minutes	1 minute
Lateral Deviation Change Threshold	0.125 to 31.875 nautical miles	8	16 nautical miles	0.125 nautical mile
Vertical Rate Change Threshold	-8 192 to +8 128 feet per minute (See Note 7)	7 & sign	4 096 feet per minute	64 feet per minute
Ceiling Altitude	-131 072 to +131 068 feet (See Note 8)	15 & sign	65 536 feet	4 feet
Floor Altitude	-131 072 to +131 068 feet (See Note 8)	15 & sign	65 536 feet	4 feet

NOTE 5: Signed numerical values must be interpreted as two's complement notation. The MSB of the Vertical Rate Change Threshold, the Ceiling Altitude and the Floor Altitude fields will be marked as a sign bit.

NOTE 6: The value of the MSB is accurate by definition. The value of the LSB shown here is an approximation.

NOTE 7: Zero is not a valid value for the vertical rate change threshold.

NOTE 8: The ceiling altitude must be greater than the floor altitude.

e) See below;

1. When a defined on-request group tag or event tag is encountered and the ADSF cannot now, or ever, respond because of data or function unavailability, the ADSF shall send a Non-compliance Notification (this should not be confused with data that is temporarily unavailable), skip the on-request group tag or event tag and its corresponding data and continue processing with the next octet of data;
2. If the ADSF cannot comply with a particular Event Contract Request, and no other events were requested with the contract request, then the ADSE and the ADSF shall both transition to a state as if the contract request were fulfilled.

NOTE 9: *This is to avoid having the ADSF respond with a Negative Acknowledgement to a valid request that cannot be met. The Non-compliance Notification is used instead.*

NOTE 10: *There are differences between ADSF non-compliance and the aircraft's inability to meet the conditions for a requested event. If an ADSF does not have altitude as an input parameter, then the ADSF will send a Non-compliance Notification when an altitude change event is received. However, if the ADSF does have an altitude input and the ADSF receives an event request, an Acknowledgement is sent, even if the requested altitude cannot be attained. This might occur if the ceiling altitude were greater than the maximum certified altitude of the aircraft. The ADSF would have no knowledge of this limitation and would NOT respond with a Non-compliance Notification. Instead, this event would never occur.*

f) When an undefined on-request group tag or event tag is encountered in a request, the ADSF shall send a Non-compliance Notification. The data processed to that point shall be considered valid and shall be acted upon accordingly. The remaining data in the uplink shall be ignored. Table 4.5-2 defines the valid uplink tag values.

NOTE 11: *Since multiple requests may be sent in a single uplink, a valid request following a request containing an undefined on-request group tag or event tag will be ignored. The ADSE should be aware that a Non-compliance Notification of the first request in a multiple-request uplink due to an undefined tag requires that the second request be sent again. The reason that the ADSF must ignore the remainder of the uplink is the uncertainty of the format of the undefined on-request group tag or event tag. Since the data associated with the tag is an unknown number of octets, the ADSF could not, in a deterministic manner, continue processing the remainder of the uplink.*

NOTE 12: *In this section, following definitions apply:*

- 'unavailable' means 'not provided by design choice';
- 'temporarily unavailable' means 'provided in normal conditions but unavailable (for any reason) at the time the ADSF needs it'; and
- 'undefined tag' means not recognized as a valid uplink tag.

TABLE 4.5-2 : VALID UPLINK TAG VALUES

Tag Value	Tag Description
1	Cancel All Contracts and Terminate Connection
2	Cancel Contract
6	Cancel Emergency mode
7	Periodic Contract
8	Event Contract
9	Emergency Periodic Contract
10	Lateral Deviation Change
11	Reporting Rate
12	Flight Identification Group
13	Predicted Route Group
14	Earth Reference Group
15	Air Reference Group
16	Meteorological Group
17	Airframe Identification Group
18	Vertical Rate Change
19	Altitude Range Change
20	Waypoint Change
21	Aircraft Intent Group

- g) If the first ADS uplink received from an AD SG does not contain any valid ADS request, the ADSF shall:
1. establish an ADS connection with that AD SG;
 2. send the appropriate Negative Acknowledgement message;
 3. set the contract inactivity timer (see subparagraph [4.5.1.5](#)).

4.5.1.2.1 Periodic Contract Request

- a) The Periodic Contract Request shall be interpreted as a mandatory request tag octet and a mandatory contract request number octet followed by optional groups of data. The optional groups of data shall be: reporting rate tag octet followed by the reporting rate octet; on-request group tag octet followed by the on-request group modulus octet followed by zero or more octets of parameter data, as required. These optional groups of data may appear in any order following the contract request number. Figure 4.5-1 illustrates the format of a Periodic Contract Request;

NOTE: All optional data are shown in the following bit map. The only required data are the ADS-request tag and the ADS contract request number. The remaining data are optional. The format is identical for the emergency Periodic Contract Request except for the value of the ADS-request tag, which would be 9.

	MSB*							LSB
	8	7	6	5	4	3	2	1
1	ADS-request Tag (7)							
2	ADS Contract Request Number							
3	Reporting Rate Tag (11)							
4	SF			Rate				
5	Flight Id Group (12)							
6	Flight Id Group Modulus							
7	Predicted Route Group (13)							
8	Predicted Route Group Modulus							
9	Earth Reference Group (14)							
10	Earth Reference Group Modulus							
11	Meteorological Group (16)							
12	Meteorological Group Modulus							
13	Airframe ID Group (17)							
14	Airframe ID Group Modulus							
15	Air Reference Group (15)							
16	Air Reference Group Modulus							
17	Aircraft Intent Group (21)							
18	Aircraft Intent Group Modulus							
19	Aircraft Intent Projection Time							

MSB = Most Significant Bit

LSB = Least Significant Bit

SF = Scaling Factor

See Table 4.5-1 for the format of the Aircraft Intent Projection Time.

FIGURE 4.5-1 : PERIODIC CONTRACT REQUEST

- b) See below;
1. The reporting rate, or interval, octet shall define how often the Basic ADS Group is sent;
 2. When the Periodic Contract Request does not contain a reporting rate tag, then a default reporting interval is applied: 64 seconds for an emergency Periodic Contract Request; 304 seconds for a normal Periodic Contract Request;
 3. The format of the reporting rate octet shall be defined as follows. Bits 6 through 1 shall define the rate, in binary format. Bits 8 and 7 shall define the Scaling Factor (SF) to be used when computing the reporting interval, using the following table:

BITS		Scaling Factor
8	7	
0	0	0 seconds, used for demand contract
0	1	1 second
1	0	8 seconds
1	1	64 seconds

- c) The following algorithm shall be used to determine the reporting interval (with the exception called out in section [4.5.1.3.2.c](#)):

$$\text{Reporting Interval} = (1 + \text{Rate}) * \text{SF}$$

Where:

SF is the scaling factor in bits 8-7

Rate is the value in bits 6-1

When a Periodic Contract Request contains a reporting rate octet with a scaling factor of zero, the request is for a demand contract request;

- d) See below;
1. The ADSF shall support a periodic reporting interval of 64 seconds on any or all connections;
 2. If a periodic reporting interval which is less than 64 seconds is requested, the ADSF shall respond with a Non-compliance Notification and shall establish a periodic contract with a 64-second reporting period.
- e) Each on-request group may have a unique modulus, e.g., a modulus of seven indicates that an on-request group would be included with every seventh Basic ADS Group sent. The on-request group modulus octet shall define how often the on-request group is included with the Basic ADS Group;
- f) Once a periodic contract has been established, it shall remain in effect until it is canceled or modified. Subparagraphs [4.5.1.2.3](#), [4.5.1.2.4](#), and [4.5.1.5](#) describe contract cancellation, and subparagraphs [4.5.1.2.5](#) and [4.5.1.3.1](#) describe contract modification due to creation of emergency mode;

- g) See below;
1. When a periodic contract has been established on a connection that receives another valid Periodic Contract Request of the same operational mode, the existing contract shall be modified based upon the optional data contained in the new Periodic Contract Request. The reporting rate shall be modified based upon the new reporting rate, or the default, if a reporting rate is not included. The contract number shall be modified based upon the new contract number;
 2. If the answer to the Periodic Contract Request is Negative Acknowledgement, the ADSF shall not modify the periodic contract in effect;
 3. If the answer to the Periodic Contract Request is Non-Compliance Notification, the ADSF shall modify the contract in effect, on the basis of the elements of the request that can be complied with.
- h) See below;
1. When an on-request group tag is included that was not already in the existing periodic contract, that group shall be added;
 2. When an on-request group tag is included that was already in the existing periodic contract, the modulus for that on-request group shall be modified based upon the new value;
 3. A modulus of zero shall cause that on-request group to no longer be reported.
- NOTE:** *A Demand Contract Request will not cancel or modify (as described in subparagraph [4.5.1.2.1.c](#)) a periodic contract already established.*
- See subparagraph [4.5.1.4](#) for the ADSF response to a periodic contract request.
- i) When responding to a Demand Contract Request and if no other contract is in effect on the connection, the ADSF shall set the inactivity timer.

4.5.1.2.2

Event Contract Request

- a) The Event Contract Request shall be interpreted as a mandatory request tag octet and a mandatory contract request number octet followed by optional groups of data. These optional groups of data shall be: vertical rate change tag octet followed by vertical rate change threshold octet; waypoint change tag octet; lateral deviation change tag octet followed by the lateral deviation change threshold octet; and altitude range tag octet followed by the ceiling and floor altitude data, each two octets in length. These optional groups of data may appear in any order following the mandatory contract request number. Figure 4.5-2 illustrates the format of an Event Contract Request;

NOTE: All optional data are shown in the following bit map. The only required data are the ADS-request tag, ADS contract request number, and one optional data group.

	MSB							LSB
	8	7	6	5	4	3	2	1
1	ADS-request Tag (8)							
2	ADS Contract Request Number							
3	Vertical Rate Change Tag (18)							
4	Vertical Rate Change Threshold							
5	Altitude Range Tag (19)							
6	Ceiling							
7								
8	Floor							
9								
10	Waypoint Change Tag (20)							
11	Lateral Deviation Tag (10)							
12	Lateral Deviation Threshold							

See [Table 4.5-1](#) for the format of the Vertical Rate Change Threshold, Lateral Deviation Threshold, and Ceiling and Floor Altitudes.

FIGURE 4.5-2 : EVENT CONTRACT REQUEST

- a) See below;
1. The optional data shall define the event that is used to generate an event report;
 2. The vertical rate change event shall be triggered in two ways. If the vertical rate threshold is positive, then the event shall be triggered when the aircraft's rate of climb is greater than the vertical rate threshold. If the vertical rate threshold is negative, then the event shall be triggered when the aircraft's rate of climb is less than the vertical rate threshold (i.e. the aircraft is descending);
 3. The altitude range event shall be triggered when the aircraft's altitude is greater than the altitude ceiling or less than the altitude floor;
 4. The lateral deviation change event shall be triggered when the absolute value of the lateral distance between the aircraft's actual position and the aircraft's expected position on the active flight plan is greater than the lateral deviation threshold; and
 5. Once a vertical rate change, lateral deviation change, or altitude range event trigger occurs, the occurrence of this event shall no longer trigger an event report for this event contract.

- b) See below;
 - 1. The waypoint change event shall be triggered by a change to the next or next- plus-one waypoint (due to a flight plan change or waypoint sequence);
 - 2. The waypoint change event trigger shall remain in effect for all waypoint changes.
- c) See below;
 - 1. Once an event contract has been established, it shall remain in effect until it is canceled or all event requests are fulfilled. Subparagraphs [4.5.1.2.3](#), [4.5.1.2.4](#), and [4.5.1.5](#) describe contract cancellation;
 - 2. Event contracts shall not be modifiable. When an event contract has been established on a connection that receives another Event Contract Request, the existing event contract shall be replaced with the new event contract;
 - 3. When the event contract is cancelled after all event requests are fulfilled and if no other contract is in effect on the connection, the ADSF shall set the inactivity timer.

See subparagraph [4.5.1.4](#) for the ADSF response to an event contract request.

4.5.1.2.3 Cancel Contract Request

- a) When the ADSF receives a Cancel Contract Request with a contract request number matching the contract request number of an active contract on this connection, the ADSF shall:
 - 1. Cancel the respective contract;
 - 2. Send an Acknowledgement to the Cancel Contract Request; and
 - 3. If there is no other contracts in effect on the connection, set the inactivity timer;
- b) When the ADSF receives a Cancel Contract Request with a contract request number that does not match the contract request number of an active contract on this connection, a Negative Acknowledgement with a negative acknowledgement reason of 5 shall be sent. Figure 4.5-3 illustrates the format of a Cancel Contract Request.

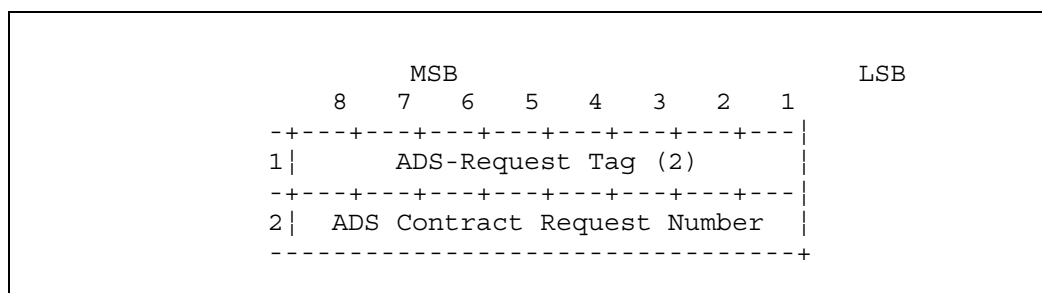


FIGURE 4.5-3 : ADS CANCEL CONTRACT REQUEST

4.5.1.2.4 Cancel All Contracts and Terminate Connection Request

When the ADSF receives a Cancel All Contracts and Terminate Connection Request, all contracts on that connection shall be canceled and the connection shall be terminated. Figure 4.5-4 illustrates the format of the Cancel All Contracts and Terminate Connection Request. The ADSF shall send the Disconnect Request with reason code 8.

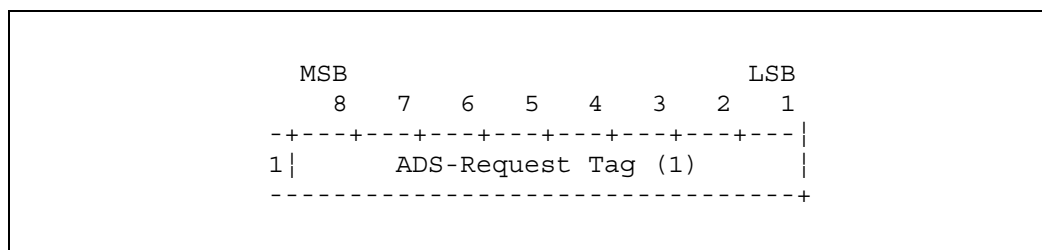


FIGURE 4.5-4 : CANCEL ALL CONTRACTS AND TERMINATE CONNECTION REQUEST

4.5.1.2.5 Cancel Emergency Mode Request

- c) See below;
- d) When the ADSF receives a Cancel Emergency Mode Request while the connection is in emergency mode, the connection shall transition to normal mode;
 - 1. When an emergency periodic contract exists and the ADSF receives a Cancel Emergency Mode Request, the ADSF shall perform the following in the listed order:
 - i. cancel the emergency periodic contract,
 - ii. send immediately an Acknowledgement message to the Cancel Emergency Mode Request,
 - iii. establish a normal periodic contract with the same reporting rate and the same on-request groups as existed before the emergency mode was canceled,
 - iv. send the first normal periodic report with respect to the period.
- e) When the ADSF receives a Cancel Emergency Mode Request while the connection is not in emergency mode, a Negative Acknowledgement with a negative acknowledgement reason of 4 shall be sent. Figure 4.5-5 illustrates the format of the Cancel Emergency Mode Request;
- f) When the ADSF receives a Cancel Emergency Mode Request with a contract number that matches the contract request number of an active emergency periodic contract on that connection, a Negative Acknowledgement with a negative acknowledgement reason of 6 shall be sent (i.e., the contract number in a Cancel Emergency Mode Request cannot be the same as the contract number of an existing contract on that connection).

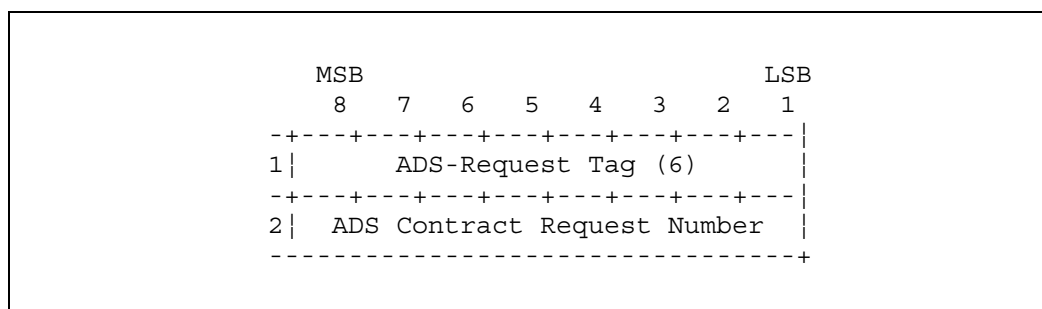


FIGURE 4.5-5 : CANCEL EMERGENCY MODE REQUEST

4.5.1.3 ADSF Interfaces

4.5.1.3.1 Flight Crew Interface

The flight crew shall have the means to initiate/terminate the ADSF's emergency mode and to terminate all ADS connections.

4.5.1.3.2 Create Emergency Mode Indication

- a) When the ADSF receives an indication to create emergency mode, each connection shall transition from normal mode to emergency mode and each connection shall be modified to contain a default emergency periodic contract with an associated contract request number of 255. The default emergency periodic contract shall replace existing periodic contracts. Creation of emergency mode shall have no effect upon event contracts;

NOTE 1: *'receives an indication' refers to the flight crew control specified in subparagraph 4.5.1.3.1.*

NOTE 2: *255 is a contract number used by the ADSF as a default value for emergency periodic contract. Although a normal periodic contract or an event contract request with that contract number may be accepted by the ADSF, ADSGs should avoid using it for such contract requests.*

- b) See below;
1. A default emergency periodic contract shall be defined as a periodic contract containing the Basic ADS Group and the Flight Identification and Earth Reference Groups included with every fifth report, beginning with the first emergency report sent;
 2. When a normal periodic contract exists before the creation of emergency mode, its reporting rate shall be retained and applied to the default emergency periodic contract;
 3. When a normal periodic contract does not exist before the creation of emergency mode, the ADSF shall establish a default emergency periodic contract with a default reporting interval;
 4. When a default emergency periodic contract is created, the first emergency periodic report shall be sent immediately.
- c) If a new connection is established while the ADSF is in emergency mode, then a normal periodic contract request during connection establishment shall result in a Negative Acknowledgement of the contract request. However, a default emergency periodic contract shall be applied to this connection. Therefore, the response to the uplink request shall be a Negative Acknowledgement message and an emergency periodic report;
- d) If a new connection is established while the ADSF is in emergency mode, then an event contract request during connection establishment shall result in an event contract only. The connection shall be in emergency mode and no default emergency periodic contract shall be established;
- e) If a new connection is established while the ADSF is in emergency mode, then a normal demand contract request during connection establishment shall result in a Negative Acknowledgement with a negative acknowledgement reason of 4.

4.5.1.3.3 Cancel Emergency Mode Indication

- a) When the ADSF receives an indication to cancel emergency mode, the ADSF shall, for each emergency periodic contract in effect, transition that connection from emergency mode to normal mode. This shall be accomplished by sending a Cancel Emergency Mode Indication with the next report sent and changing the ADS report tag to be non-emergency. The reporting rate and the on-request groups of the reports shall not be modified. Figure 4.5-6 indicates the format of the Cancel Emergency Mode Indication;

NOTE 1: 'receives an indication' refers to the flight crew control specified in paragraph [4.5.1.3.1](#).

- b) When no emergency periodic contract exists on a connection which is in emergency mode, the transition to normal mode shall not create a normal periodic contract;
- c) When the ADSF receives an indication to cancel emergency mode, contracts established on a connection that is not in emergency mode shall remain unchanged.

NOTE 2: This situation can happen when an AD SG has previously sent a Cancel Emergency Mode Request on its ADS connection.

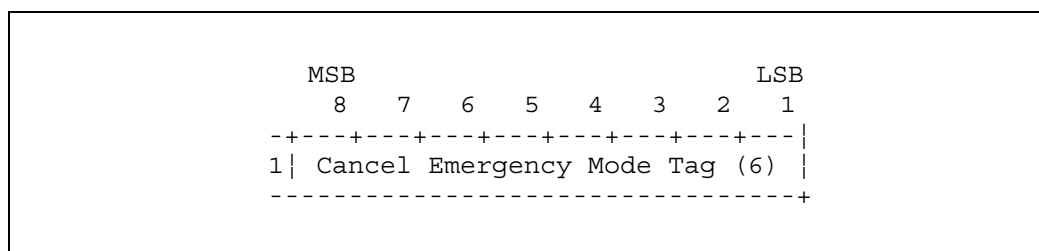


FIGURE 4.5-6 : CANCEL EMERGENCY MODE INDICATION

4.5.1.4 Message Generation

- a) See below;
 - 1. The ADSF shall assemble the ADS message data as depicted in [Figure 4.5-7](#) through [Figure 4.5-18](#), [Table 4.5-3](#) and [Table 4.5-4](#) and subparagraphs [4.5.1.4.1](#), [4.5.1.4.2](#), and [4.5.1.4.3](#);
 - 2. The Basic ADS Group shall be included in every ADS report;
 - 3. The ADS-report tag contained in the Basic ADS Group shall define the type of report generated: emergency periodic (including demand), normal periodic (including demand) or event;
 - 4. The ADSF shall use the source of valid position data consistent with the highest FOM outlined in [Table 4.5-5](#).

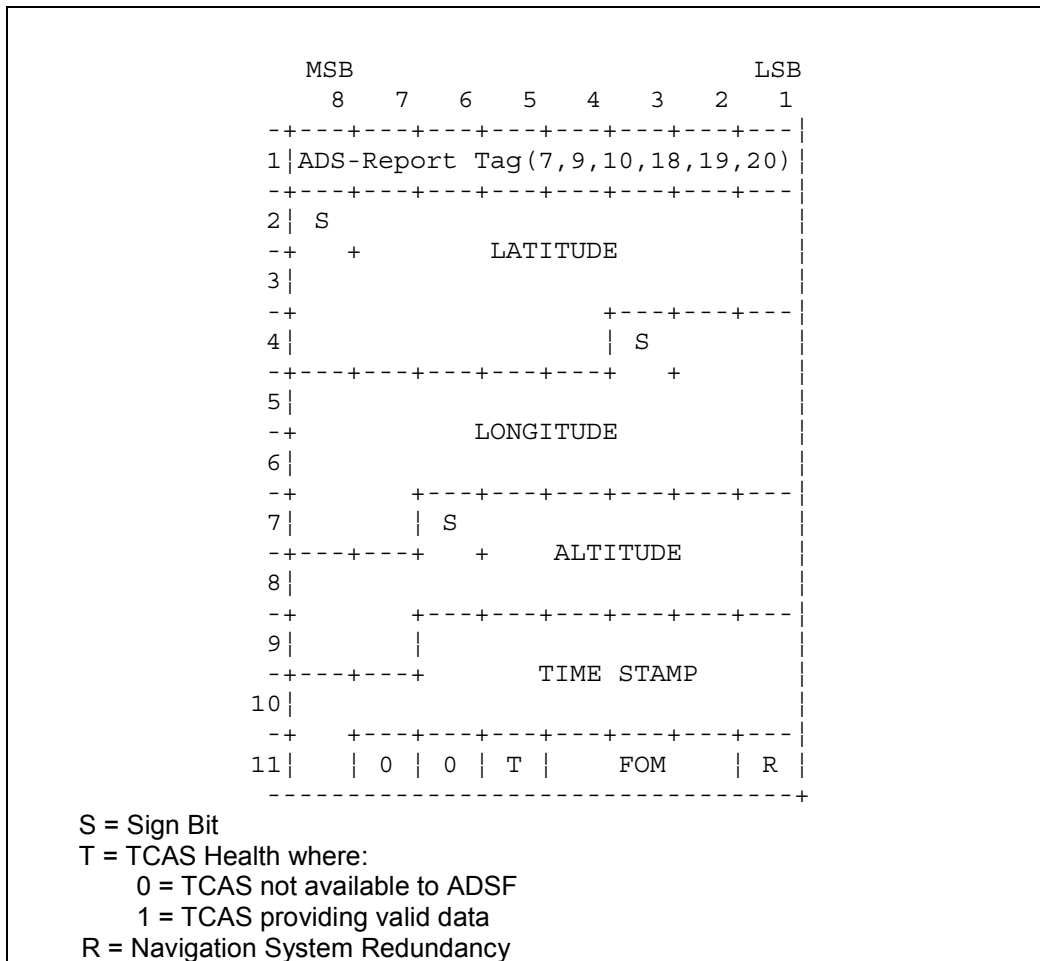


FIGURE 4.5-7 : BASIC ADS GROUP (REQUIRED)

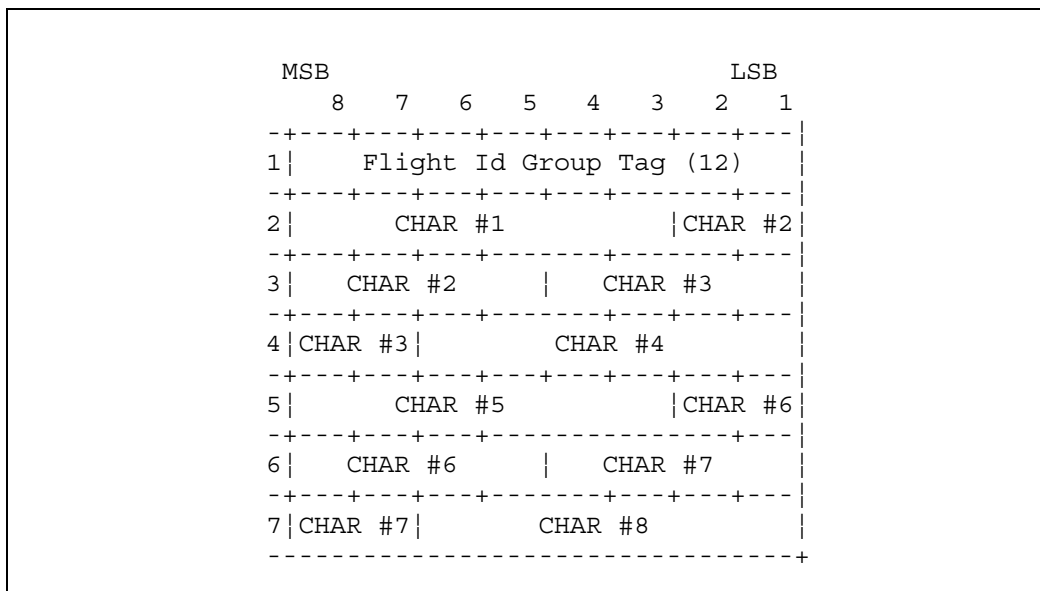


FIGURE 4.5-8 : FLIGHT IDENTIFICATION GROUP (ON-REQUEST)

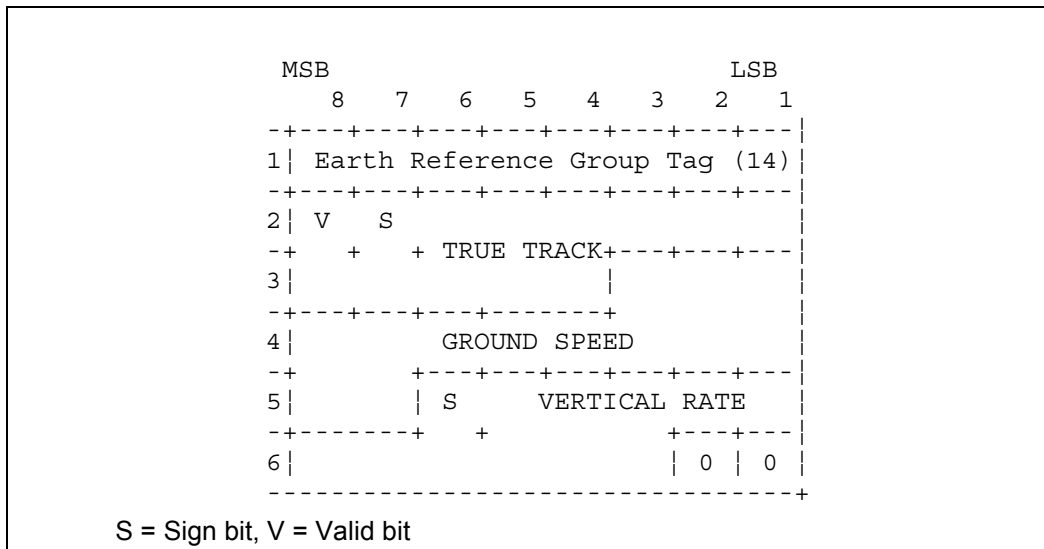


FIGURE 4.5-9 : EARTH REFERENCE GROUP (ON-REQUEST)

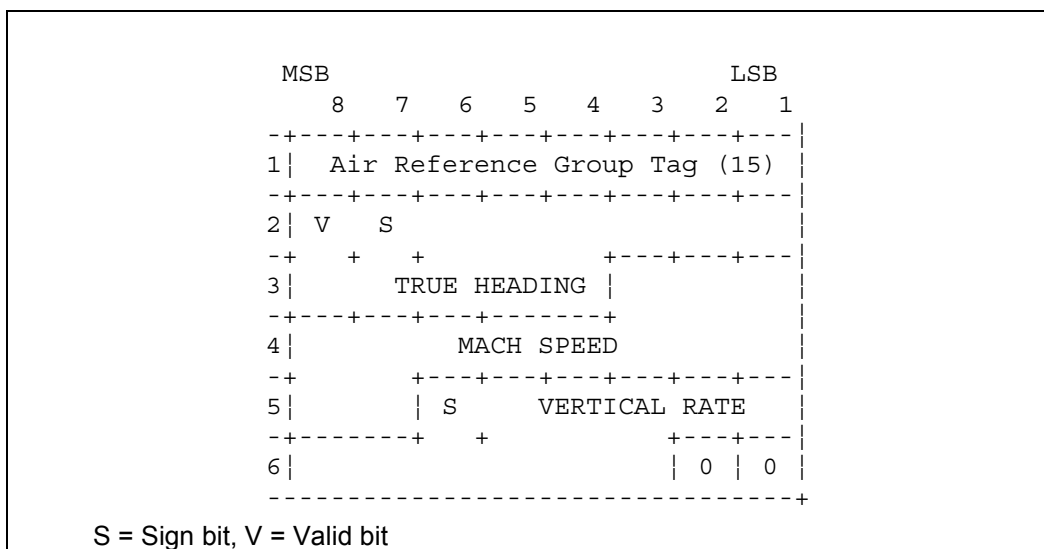


FIGURE 4.5-10 : AIR REFERENCE GROUP (ON-REQUEST)

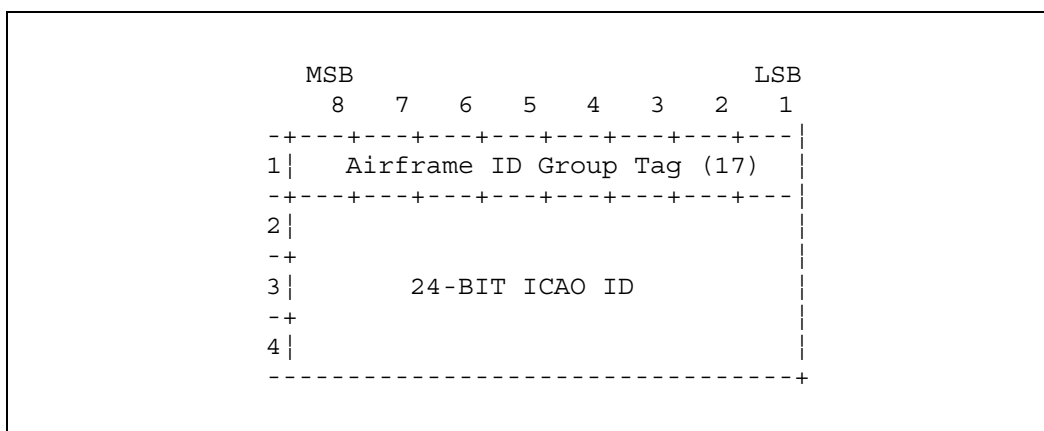


FIGURE 4.5-11 : AIRFRAME IDENTIFICATION GROUP (ON-REQUEST)

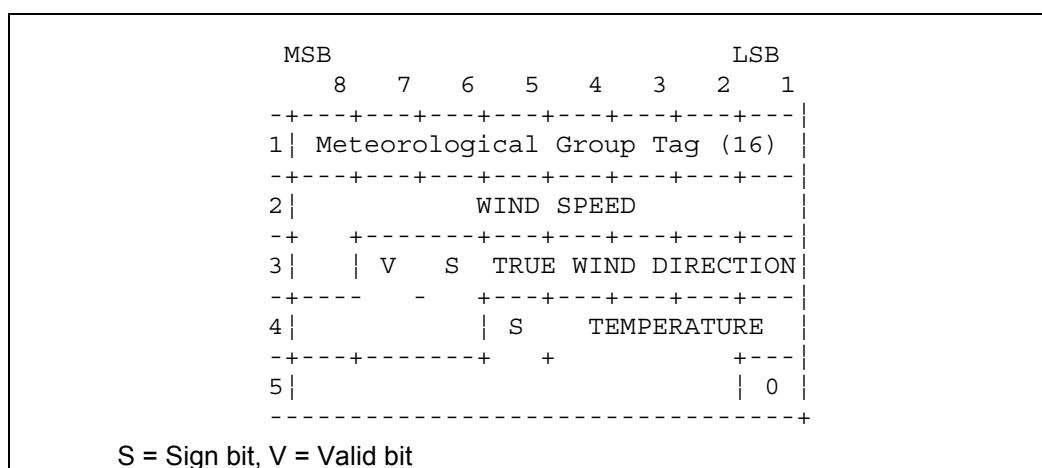


FIGURE 4.5-12 : METEOROLOGICAL GROUP (ON-REQUEST)

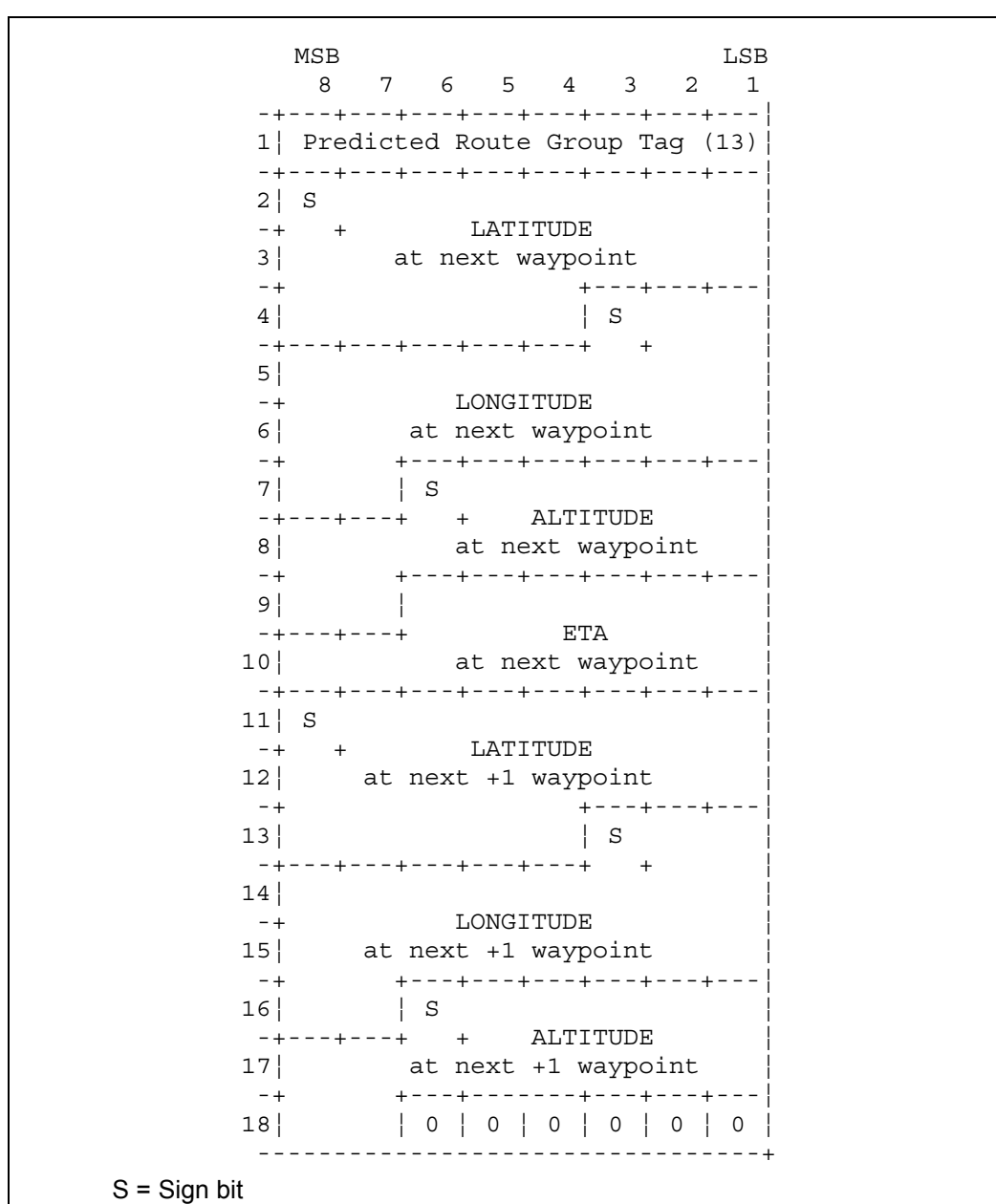


FIGURE 4.5-13 : PREDICTED ROUTE GROUP (ON-REQUEST)

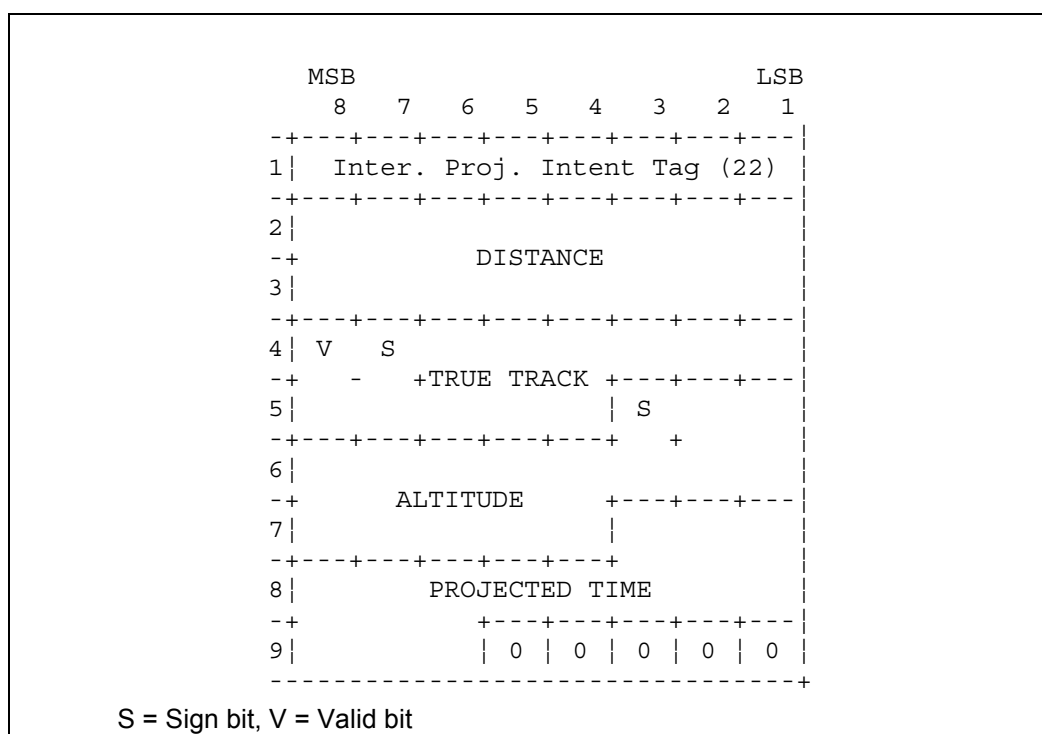


FIGURE 4.5-14 : INTERMEDIATE PROJECTED INTENT GROUP (ON-REQUEST)

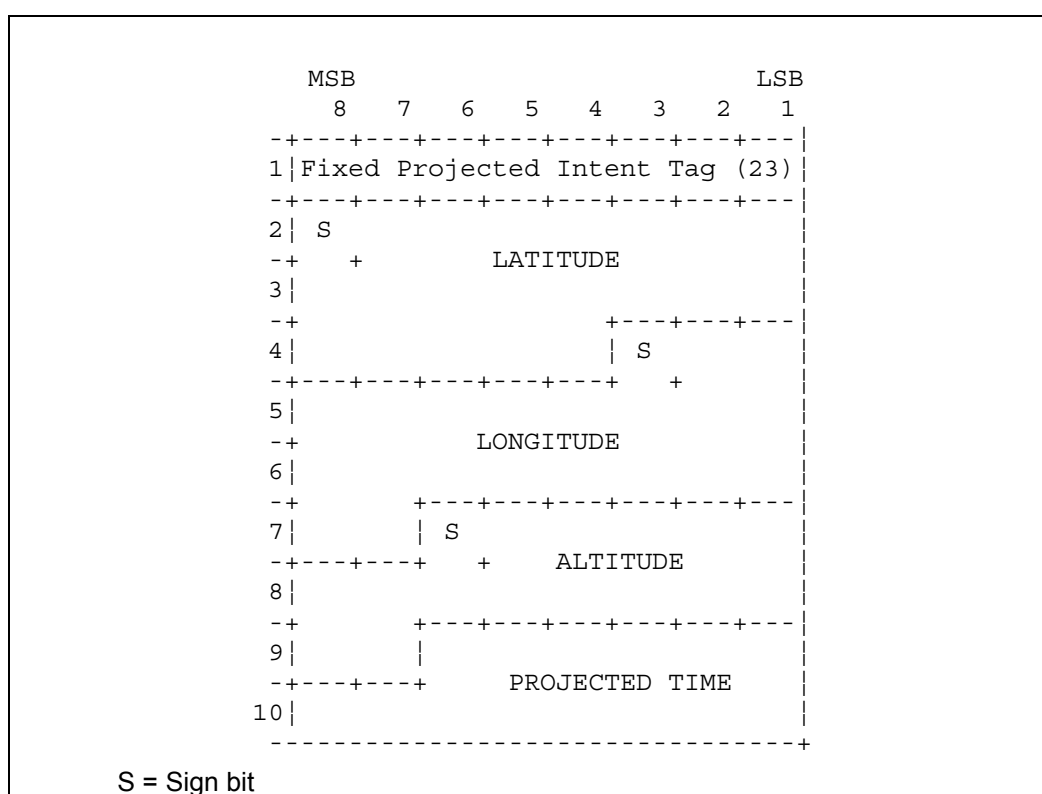


FIGURE 4.5-15 : FIXED PROJECTED INTENT GROUP (ON-REQUEST)

TABLE 4.5-3 : DOWNLINK TAG VALUES

Tag Value	Tag Description
3	Acknowledgement
4	Negative Acknowledgement
5	Noncompliance Notification
6	Cancel Emergency Mode Indication
7	Periodic Report
9	Emergency Periodic Report
10	Lateral Deviation Change Event
12	Flight Identification Group
13	Predicted Route Group
14	Earth Reference Group
15	Air Reference Group
16	Meteorological Group
17	Airframe Identification Group
18	Vertical Rate Change Event
19	Altitude Range Change Event
20	Waypoint Change Event
22	Intermediate Projected Intent Group
23	Fixed Projected Intent Group

TABLE 4.5-4 : ADS OUTPUT MESSAGE PARAMETERS

PARAMETER	VALID RANGE	DEFAULT VALUE	SIGNIFICANT BITS	DEFINED MSB VALUE	APPROX. LSB VALUE
Latitude	±90°	See subparagraph 4.5.1.4.b	20 & sign	90°	0.000172°
Longitude	±180°		20 & sign	90°	0.000172°
Altitude	±131 068 feet	-131 072 feet	15 & sign	65 536 feet	4 feet
Time Stamp	0 - 3 599.875 sec	See subparagraph 4.5.1.4.b	15	2 048 sec.	0.125 sec.
Flight Identification	Alphanumeric	Space	6 per character	N/A	N/A
Mach	0 - 4.095 mach	4.0955 mach	13	2.048 mach	0.0005 mach
Ground Speed	0 - 4 095 knots	4095.5 knots	13	2048 knots	0.5 knots
Wind Speed	0 - 255 knots	255.5 knots	9	128 knots	0.5 knots
True Wind Direction	-180 - +179.296875°	Valid bit = 1	8 & sign & valid	90°	.703125°
Vertical Rate	±32 752 ft/min	-32 768 ft/min	11 & sign	16 384 ft/min	16 ft/min
Temperature	±511.75°C	-512°C	11 & sign	256°C	0.25°C
True Track Angle	-180 - +179.912°	Valid bit = 1	11 & sign & valid	90°	0.08789°
True Heading	-180 - +179.912°	Valid bit = 1	11 & sign & valid	90°	0.08789°
Distance	0 - 8 191.750 NM	8 191.875 NM	16	4 096 NM	0.125 NM
ETA	0 - 16 382 sec	16 383 sec	14	8 192 sec	1 sec
Projected Time	0 - 16 382 sec	16 383 sec	14	8 192 sec	1 sec

NOTE 1: The value of the Most Significant Bit (MSB) is accurate by definition. The value of the Least Significant Bit (LSB) shown here is an approximation.

b) See below;

1. When no value is available or the value available to the ADSF is invalid, a default value shall be inserted in the field;

NOTE 2: The default values shown in Table 4.5-4 reflect a coding of all “ones.”

2. When either the latitude or the longitude for a position are invalid, both shall be set to -180° . In the Basic ADS Group, the FOM shall also be set to 0;
3. When the Flight Identification is invalid, all characters shall be encoded as spaces. When the Flight Identification is less than seven characters, the Flight Identification shall be encoded left justified and the unused characters shall be encoded as spaces;
4. The character set for the Flight Identification Group shall be ISO 5, without the most significant bit. This allows the characters to be encoded using only six bits. Valid characters are contained in the following sets: (A..Z), (0..9) and ();
5. The validation of the direction parameter shall be indicated by the immediately preceding bit, where 0 = valid and 1 = invalid;
6. Signed numerical values shall be represented in two's complement notation;
7. The time stamp shall be expressed as the time elapsed since the most recent hour. Time shall be rounded, not truncated, to accurately yield the value loaded into the time stamp field. When the time stamp is invalid, any value could be expected (see Annex A for recommended value); in the Basic ADS Group, the FOM shall also be set to 0.

TABLE 4.5-5 : FIGURE OF MERIT - MINIMUM POSITION ACCURACY

Figure of Merit Level	Accuracy of Position Determination (within 95% Probability)	Reason Navigation Accuracy Value Was Chosen
0	Complete loss of navigational capabilities	Inability to determine position within 30 nautical miles is considered total loss of navigation.
1	< 30 nautical miles	Consistent with INS on long flight without updates.
2	< 15 nautical miles	Consistent with INS on intermediate length flight without updates.
3	< 8 nautical miles	Consistent with INS on short length flight and beyond 50 nautical miles from VOR.
4	< 4 nautical miles	Consistent with VOR accuracies at 50 or less nautical miles and with GPS worldwide.
5	< 1 nautical mile	Consistent with RHO-RHO applications of ground-based DME, RNAV using multiple DME or GPS position updates.
6	< 0.25 nautical mile	Consistent with RNAV with GPS.
7	< 0.05 nautical mile	Consistent with augmented GPS accuracies.

- c) The on-request groups may be appended to the Basic ADS Group in any order, with the exception of the Aircraft Intent Group. When the Aircraft Intent Group is included in a report, the Intermediate Projected Intent Group(s), if any, shall follow the Basic ADS Group and the Fixed Projected Intent Group shall follow the last Intermediate Projected Intent Group. When there are no Intermediate Projected Intent Groups, the Fixed Projected Intent Group shall follow the Basic ADS Group;