APPENDIX B*

AUTOMATIC DEPENDENT SURVEILLANCE PANEL

(ADSP)

DRAFT ICAO MANUAL OF AIR TRAFFIC SERVICES (ATS) DATA LINK APPLICATIONS

Editors' Draft

Version 0.4

Please note that this is a Working Paper circulated within the ADSP. This text mayl be passed to ICAO for publication. However, it should be noted that this text in no way replaces the ICAO version nor can it be considered of equal status. The official definitive version is that published in hardcopy by ICAO and all claims of compliance must be made against that version.

20 September 1996

* This appendix is available in English only.

Errata and Disclaimer

Please note that this document was prepared from a number of separate files prepared by different editors. The initial page numbers in these files are not completely synchronised, and we have made no attempt to change this, in order to avoid problems with references from Working Papers. You may therefore find some overlap between pages numbers, when those pages came from different files.

The preparation of this document has been on a “best efforts” basis and no warrantee is offered as to its correctness.

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F1. DOCUMENT CONFIGURATION

F1.1 The following pages will constitute the Configuration Management of the draft ICAO Manual of ATS Data Link Applications. The list of amendments on this document from one version to the next will be recorded here to provide the traceability required for configuration control audit until formal publication of the document as a Manual.

F1.2 Table A gives a summary of the revision materials which create the new version by reference to their sources. Table B gives detail of the amendments by listing the changes and the pages, sections or paragraphs affected.

Version Number	**Revision Date**	**Revision Source**	**Remarks**
0.0	1 Nov. 95	Post Montreal June/July 95 Joint WG Meeting	
0.1	8 DEC 95	Montreal Nov./DEC 95 Joint WG Meeting Output	
0.2	1 March 96	Pre Dakar March 96 WG /WHL Meeting	
0.3	29 March 96	Post Dakar March WG /WHL Meeting	
0.3.1	9 September 96	Secretariat — Pre-ADSP/4	
0.4	20 September 96	ADSP/4	

Table A: Document Status And History

Version Number	**Part/Chapter/ Appendix**	**Amended Pages**	**Remarks**

Table B: Amendments Revision Record

F2. GLOSSARY OF ACRONYMS/ABBREVIATIONS

ACARS	Aircraft Communications Addressing And Reporting System
ACAS	Airborne Collision Avoidance System
ACC	Area Control Center
ACK	Acknowledge
ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance Broadcast
ADSF	Automatic Dependent Surveillance Function
ADSP	ADS Processor
ADSU	ADS Unit
AGCS	Air-Ground Communication System
AIDC	ATS Interfacility Data Communications
AIP	Aeronautical Information Publication
ALRT	Alert
AMSS	Aeronautical Mobile-Satellite Service
APDLC	Aircraft Proximity Data Link Communication
ARM	ADS Report Message
ASM	Airspace Management
ASAS	Airborne Separation Assurance System
ASN.1	Abstract Syntax Notation One
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATCU	Air Traffic Control Unit
ATFM	Air Traffic Flow Management
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Services
ATSC	Air Traffic Services Communication
ATSU	Air Traffic Services Unit
CAA	Civil Aviation Authority
C-ATSU	Controlling ATS Unit
CCR	Cancel Contract Request
CDA	Current Data Authority
CER	Cancel Emergency Mode Request
CMU	Communications Management Unit
CNS	Communication, Navigation And Surveillance

CPDLC	Controller Pilot Data Link Communications
CPL	Current Flight Plan
CTC	Cancel All Contracts And Terminate Connection Request
D-ATSU	Downstream ATS Unit
DC	Departure Clearance
DDA	Downstream Data Authority
DFIS	Data Link Flight Information Service
DLIC	Data Link Initiation Capability
DSC	Downstream Clearance
ECR	Event Contract Request
EMG	Emergency
ETA	Estimated Time Of Arrival
ETD	Estimated Time Of Departure
FANS (Phase II)	Special Committee for the Monitoring and Co-ordination of Development and Transition Planning for the Future Air Navigation System (Phase II)
FASID	Facilities And Services Implementation Document
FDPS	Flight Data Processing System
FIR	Flight Information Region
FIS	Flight Information Service
FOM	Figure Of Merit
FPL	Filed Flight Plan
GG	Ground/Ground
GGCS	Ground/Ground Communication System
GNSS	Global Navigation Satellite System
GPWS	Ground Proximity Warning System
HF	High Frequency
HFDL	High Frequency Data Link
IAS	Indicated Air Speed
ICAO	International Civil Aviation Organization
ID	Identification
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INS	Inertial Navigation System
IRS	Inertial Reference System
LACK	Logical Acknowledgment
LAN	Local Area Network
LOA	Letter Of Agreement

MET	Meteorological or Meteorology
METAR	Aviation Routine Weather Report
Mode S	Mode Select
MOU	Memorandum Of Understanding
MSAW	Minimum Safe Altitude Warning
MSSR	Monopulse SSR
NAK	Negative Acknowledgment
NAT	North Atlantic
NATSPG	North Atlantic Systems Planning Group
NCN	Non Compliance Notification
NDA	Next Data Authority
NIM	Navigational Integrity Monitoring
NM	Nautical Miles
NOTAM	Notice To Airmen
OCM	Oceanic Clearance Message
OLDI	On-Line Data Interchange
OR	Operational Requirement
OSI	Open Systems Interconnection
PANS-RAC	Procedures for Air Navigation Services - Rules of the Air and Air Traffic Services (Document 4444)
PCR	Periodic Contract Request
PER	Packed Encoding Rules
PIREP *	Pilot Report
PSR	Primary Surveillance Radar
QOS	Quality Of Service
R-ATSU	Receiving ATS Unit
REC	Recall
RESP	Response
RGCSP	Review Of The General Concept Of Separation Panel
RNP	Required Navigation Performance
RTF	Radiotelephony
RVR	Runway Visual Range
R/T	Radio Transmission
SARPs	Standards And Recommended Practices
SATCOM	Satellite Communications

[*] not specified in other ICAO documents

SC 170	RTCA Special Committee 170
SDPS	Surveillance Data Processing System
SF	Scaling Factor
SID	Standard Instrument Departure
SSR	Secondary Surveillance Radar
STCA	Short Term Conflict Alert
TAF	Aerodrome Forecast
T-ATSU	Transferring ATS Unit
TWS	Terminal Weather Service
URG	Urgency
UTC	Coordinated Universal Time
VDL	VHF Digital Link
VDR	VHF Data Radio
VHF	Very High Frequency
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VSP	Variable System Parameter
VOR	VHF Omnidirectional Radio Range
WILCO	Will Comply
WMO	World Meteorological Organization

F.3 EXPLANATION OF TERMS

Aircraft Identification: A group of letters, figures or a combination thereof which is identical to or the code equivalent of the aircraft callsign. It is used in Field 7 of the ICAO model flight plan.

Aircraft Address: A unique combination of 24 bits available for assignment to an aircraft for the purpose of air-ground communications, navigation and surveillance.

Air Traffic Services Interfacility Data Communications (AIDC). A data link application that provides the capability to exchange data between air traffic service units during the notification, coordination, and transfer of aircraft between flight information regions.

Automatic Dependent Surveillance (ADS): A surveillance technique in which aircraft automatically provide, via a data link, data derived from on-board navigation and position-fixing systems, including aircraft identification, four-dimensional position, and additional data as appropriate. ADS is a data link application.

Automatic Dependent Surveillance-Broadcast (ADS-B): ADS-B is a surveillance application transmitting parameters, such as position, track and ground speed, via a broadcast mode data link, and at specified intervals, for utilization by any air and/or ground users requiring it. ADS-B is a data link application.

***ADS Agreement**:* An ADS agreement is an ADS reporting plan which establishes the conditions of ADS data reporting (i.e., data required by the ground system and frequency of ADS reports which have to be agreed to prior to the provision of the ADS services). The terms of the agreement will be exchanged between the ground system and the aircraft by means of a contract, or a series of contracts. An ADS contract would specify under what conditions ADS reports would be initiated, and what data would be contained in the reports. There are three types of contracts: Periodic, Event and Demand.

Availability: The ability of a system to perform its required function at the initiation of the intended operation. It is quantified as the proportion of the time the system is available to the time the system is planned to be available.

Baseline Information: Required information upon which to measure certain type of ADS events. (i.e., altitude change event, air speed change event, ground speed change event, heading change event and track angle change event).

Continuity: The probability of a system to perform its required function without unscheduled interruptions during the intended period of operations.

Controller Pilot Data Link Communications (CPDLC): A data link application that provides a means of communication between controller and pilot, using data link for ATC communications.

***Data Link Application**:* A data link application is the implementation of data link technology to achieve specific Air Traffic Management (ATM) operational functionalities. For example, in this context the current functionalities are DLIC, ADS, CPDLC, DFIS, AIDC, and ADS-B.

Data Link Initiation Capability: A data link application that provides the ability to exchange addresses, names and version numbers necessary to initiate data link applications.

Data Link Service: A data link service is a set of ATM related transactions, both system supported and manual, within a data link application, which have a clearly defined operational goal. Each data link application service is a description of its recommended use from an operational point of view.

Data Link Flight Information Services: A data link application that allows the exchange of pertinent flight data between air and ground users.

End-to-End Transfer Delay: The period elapsed from the time at which the originating user initiates the triggering event until the time the transmitted information has been received by the intended recipient.

Integrity: The probability that errors will be mis-detected. This may be when a correct message is indicated as containing one or more errors, or when a message containing one or more errors is indicated as being correct.

Note: Integrity relates to the trust which can be placed in the correctness of the information provided.

Operational Requirement (OR): A statement of the operational attributes of a system needed for the effective and/or efficient provision of air traffic services to users.

Reliability: The probability that the system will deliver a particular message without errors.

Note: Explanations of other terms are provided in the Glossary of Acronyms and in the Data Glossaries for data link applications.

PART I

OVERVIEW OF ATS DATA LINK APPLICATIONS

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

2. INTRODUCTION TO THE ICAO MANUAL

2.2 Purpose of the Document

2.2.2 The purpose of this document is to describe the elements of a data link based Air Traffic Service (ATS) and its application on a world-wide basis. The document provides guidance material for aviation authorities, airspace users and service providers in establishing a data link based service in their airspace according to regional and national plans.

2.2.4 This document has been developed to:

b) explain the concept of a data link based ATC system and associated communications requirements for the digital interchange of ATS messages;

d) identify how a data link based ATS will enhance existing air traffic services;

f) provide guidance material for aviation authorities, airspace users, and service providers on:

2) system concepts and descriptions;

4) operational requirements;

6) procedures and automation capabilities; and

8) implementation and transition strategies, including particular service description which provide guidance on ways to implement portions of an application.

2.2.6 The data link based system will be characterized by the use of Automatic Dependent Surveillance (ADS), Controller Pilot Data Link Communication (CPDLC) and the automatic provision of data link flight information services (DFIS), via data link, from an addressable database on request by the pilot. A Data Link Initiation Capability (DLIC) allowing the establishment of the necessary communications link between the aircraft and the relevant ATS ground systems will be provided. In order to support these air/ground services, an appropriate ground/ground ATS interfacility data link communications (AIDC) network will be incorporated. Initial information on ADS Broadcast (ADS-B) is included.

2.2.8 Data link applications are being developed and implemented on a regional basis. Integration of these developments into a global implementation is envisaged within the context of the future Communication Navigation Surveillance/Air Traffic Management (CNS/ATM) systems concept. Individual States and the aeronautical industry are progressing the technical specifications for aircraft, ground equipment and other system components. Equipment for related data link communications is also being developed. Consequently, and in the general interest of developing harmonized and compatible systems, the contents of this guidance material should be taken into account in those developments, designs and implementations.

2.4 Structure of the document

2.4.2 The main body of this document contains the following parts:

b) Overview of ATS Data Link Applications,

d) Data Link Initiation Capability (DLIC),

f) Automatic Dependent Surveillance (ADS),

h) Controller Pilot Data Link Communications (CPDLC),

j) Data Link Flight Information Service (DFIS),

l) ATS Interfacility Data Communications (AIDC), and

n) ADS Broadcast (ADS-B).

2.4.4 The guidance material in this document for applications using Aeronautical Telecommunications Network (ATN) should be used in conjunction with the International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPs) (ATNP), and procedures developed for the use of ADS and other data link communications, as contained in the Annexes and the *Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services* (PANS-RAC, Doc 4444).

2.4.6 This guidance material is considered part of the evolutionary process for the implementation of data link related technology. ICAO will continue its efforts in support of the timely development of all necessary material to ensure a global harmonization and standardization of future data link based ATC systems.

2.4.8 Part 1 provides an overview of data link applications being developed for use in the CNS/ATM environment, and the requirements of the overall system. Relevant technologies are briefly described, and their inter-relationship and use in the overall Air Traffic System is outlined. States concerned with the development of data link applications should ensure that the technical media to be provided fulfill the operational needs.

2.4.10 Part 2 contains guidance material for the Data Link Initiation Capability (DLIC). The DLIC provides the necessary information to enable data link communications between the ATC ground and air systems to be established.

2.4.12 Part 3 provides guidance material and information from an operational standpoint in support of technical developments relating to ADS. In this context, the guidance material represents a set of operational principles and procedures for the efficient use of ADS in ATS.

2.4.14 Part 4 explains the concept of Controller Pilot Data Link Communication (CPDLC) and its associated requirements, identifies how this will enhance air traffic services, and describes in detail the necessary message formats and their implementation.

2.4.16 Part 5 indicates how flight information services will be incorporated into the data link environment, providing the ability for the pilot to receive Data Link FIS (DFIS) on the flight deck on request or automatically. An outline of the services proposed for implementation is also given.

2.4.18 Part 6 relates to the concept of ATS Interfacility Data Communications (AIDC) and gives guidance on the implementation of ground to ground data link technology needed to support the air/ground ATC facilities.

2.4.20 Part 7 relates to ADS Broadcast (ADS-B) and provides the initial guidance on its concept.

2.4.22 Further parts may be added in later editions to reflect the introduction, development and implementation of other applications. Appendix A to this chapter provides a template for States or organizations to submit additional applications or services to ICAO. Existing service descriptions generally conform to this template.

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

CHAPTER 1 APPENDIX A

TEMPLATE FOR A DETAILED DESCRIPTION OF AIR/GROUND DATA LINK SERVICES

1A.2 Detailed Description of Selected Services

1A.2.2 This appendix describes data link applications as Services. A Service is a set of ATM related transactions, both system supported and manual, within a data link application, which have a clearly defined operational goal. Each data link service is a description of its recommended use from an operational point of view.

1A.2.4 Services are defined in gradually increasing detail, using the following sub-sections:

Scope and Objective provides a brief, two-to-three sentence description of what the Service does from an operational perspective.

Expected Benefits, Anticipated Constraints, and Associated Human Factors

Expected benefits provides a non-exhaustive list of benefits expected from implementation of the Service uniquely or particularly applicable to the Service being described.

Anticipated constraints describes the constraints which could result from implementation of the Service uniquely or particularly applicable to the Service being described.

Human Factors provides the human factors aspects considered essential for the safe and coherent operation of the service.

Operating Method Without Data Link describes how the controller, pilot, or support systems perform the Service in today's non-data link environment. As this heading describes controller and pilot actions, it will also cover procedures.

Operating Method With Data Link:

Normal Mode describes how the service would normally be conducted via the following sub-sections.

b) Service Description describes how the controller, pilot, or support system(s) will perform the Service with data link assistance. As this heading describes controller and pilot actions, it will also cover procedures and should identify optional features in addition to the standard features of the Service. This heading also describes how the data link Service is carried out, stating what messages are sent by the data link partners involved, and what operational events trigger the transmittal of the messages.

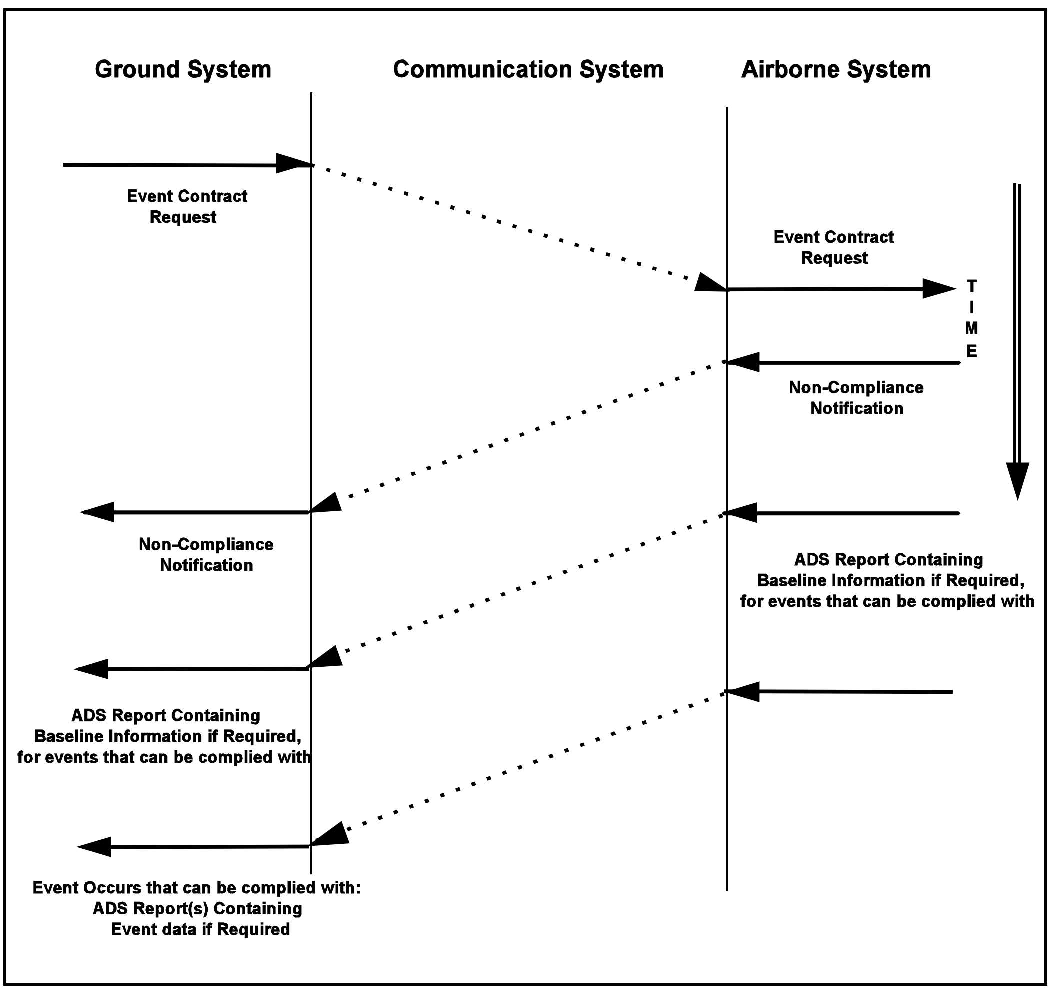
d) Initiation Conditions describes what conditions must be met prior to initiation of the data link service, to include association with operational events and manual action.

f) Sequence Of Services states what other data link services must precede the data link service, if any.

h) Additional Guidelines provide any additional features for the data link service, to include amplification of the preceding elements and any recommended enhancements that could be achieved through advanced airborne or ground equipment.

Time Sequence Diagram (TSD) is a standard method to illustrate the message flows in chronological order for the standard (nominal) execution of a Service.

An example diagram follows:



Information Exchanges provides further operational requirements for each message described in the above section. This section is set out in a table with the following entries:

b) *Message* states the name of the specific message within the exchange.

d) *Information required* includes a plain text description of the data to be transferred in the message. Descriptions should clearly separate and identify the mandatory and optional contents.

f) *Event Trigger* briefly describes the operational event that will initiate the message.

h) *Source/Destination* gives the operational source and destination of the message. These can be aircraft or one of several ATSU designators, as defined in the glossary.

j) *Alerting Requirements* describes the need for the pilot and controller alerting for the data link service. Alerting can be one of four categories:

2) H: High;
4) M: Medium;
6) L: Low;
8) N: No alerting required.

l) *Response* indicates whether a response is or is not required for the message ("Y" and "N" respectively).

An example table is as follows:

MESSAGE	INFORMATION REQUIRED	EXAMPLE OPERATIONAL MSG CONTENTS	EVENT/ TRIGGER	SOURCE/ DEST.	ALERT	RESPONSE
	Mandatory **Optional**				**Ctrlr:** **Pilot:**	

Quality Of Service Requirements (QOS): Only exceptions to the global QOS requirements (when available) need be specified.

b) *Communication Priority* establishes the priority of messages within this Service in relation to other information flows:

2) Distress, indicating grave and imminent danger;

4) Urgent, concerning the safety of the aircraft or persons on-board or within sight;

6) Flight Safety, comprising movement and control messages and meteorological or other advice of immediate concern to an aircraft in flight or about to depart, or of immediate concern to units involved in the operational control of an aircraft in flight or about to depart;

8) Routine Surveillance or Navigation;

10) Routine operational messages, comprising aircraft operator and other messages of concern to the aircraft in flight or about to depart;

12) NOTAM-Class I distribution;

14) Meteorological messages, comprising forecasts, observations and other messages exchanged between meteorological offices;

16) Low, indicating any message with a lower priority than the above.

d) *Urgency* delineates the relative relationship among messages when placed in a queue for operator access. It relates to the handling of the information by the receiving system. It dictates the order of display, processing (including deletion, modification, and shelf-life), or other action in accordance with the sequencing of essential, routine and time-expired data. Urgency does not influence communication processing, which is defined by communications priority; it applies to the end user processing application only. Valid entries are:

2) Distress: indicating grave and imminent danger;

4) Urgent: comprising movement and control messages and meteorological or other advice of immediate concern to an aircraft in flight or about to depart, or of immediate concern to units involved in the operational control of an aircraft in flight or about to depart;

6) Normal: comprising routine operational messages such as routine surveillance or navigation, meteorological messages not of an urgent nature, etc.;

8) Low: indicating any message with a lesser urgency than the above.

f) *Information Security* provides any applicable security requirements for the messages, including:

2) Data Origin Authentication, indicating how much assurance is required that the data source is as stated. Valid entries are:

i) Normal, indicating that the indicated originator must always be authentic;

ii) Low, indicating that the non-authentic originators are acceptable in some circumstances, but must be identifiable and notified to the responsible operators.

4) Access Control, indicating the confidentiality level of the data, or the requirement for the data to be restricted to only authorized recipients. Valid entries can be one or more of the following:

i) `C', indicating that the data must be protected against any unauthorized access, to include copying of the data;

ii) `M', indicating that the data must be protected against any unauthorized and undetected modification of a message;

iv) `A', indicating protection against unauthorized addition of messages;

v) `D', indicating protection against unauthorized deletion of messages.

6) Data Integrity. Valid entries are:

i) Maximum, indicating that loss or corruption of data is unacceptable;

ii) Medium, indicating that loss or corruption of data is acceptable in some circumstances, but must be identifiable and notified to the responsible operators.

iii) Minimum, indicating that loss or corruption of data is acceptable and does not require notification.

8) Availability, and

10) Service Restoration Time.

Exception handling describes what should happen if the service fails, to include error reporting, recovery needs, procedures and alternative message exchange.

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

3. THE FANS CONCEPT

3.2 Historical Background

3.2.2 In the early 1980's, ICAO recognized the increasing limitations of the present air navigation systems and the improvements needed to take civil aviation into the 21st century. In 1983, ICAO established the Special Committee on Future Air Navigation Systems (FANS) with the task of studying, identifying and assessing new concepts and new technology and making recommendations for the coordinated evolutionary development of air navigation over a time scale of the order of 25 years.

3.2.4 FANS recognized that the limitations of the present systems were intrinsic to the systems themselves and the problems could not be overcome on a global scale except by development and implementation action of new concepts and new communications, navigation and surveillance (CNS) systems to support future enhancements to Air Traffic Management (ATM). FANS proposed a new system concept, one which would evolve over a period of years, and which recognized that the pace of change cannot be the same everywhere on the globe.

3.2.6 ICAO recognized that implementation of the new systems concepts would require global coordination and planning on an unprecedented scale, and established a follow-on committee to help ensure a coherent, cost-beneficial, global implementation of the new system concept. Human factors and human/computer interfaces would also require careful consideration. Appendix A to this chapter contains further information on human factors.

3.2.8 The Tenth Air Navigation Conference (1991) endorsed the global concept proposed by the Special Committee for the Monitoring and Co-ordination of Development and Transition Planning for the Future Air Navigation System (FANS Phase II). The concept, which is contained in the Global Co-ordinated Plan for Transition to the ICAO CNS/ATM Systems (Doc 9623, Report of FANS (II)/4), included a variety of satellite-based systems along with a judicious selection of ground-based systems. An outline indication of how the various elements of the concept will be applied is given below.

3.4 The ICAO CNS/ATM System

3.4.2 Communications

3.4.2.2 In the future CNS/ATM system, air-ground communications with aircraft will increasingly be by means of digital data link. This will allow efficient communication paths between ground and airborne systems. ICAO has developed a communication systems architecture that provides a range of capabilities to suit the needs of air traffic services providers and their users, including the Aeronautical Mobile Satellite Service (AMSS). Various communications media, e.g., AMSS, Very High Frequency (VHF), data link and Secondary Surveillance Radar (SSR) Mode S data link, will be integrated through an ATN based on an Open Systems Interconnection (OSI) architecture.

3.4.2.4 Potential benefits from air-ground communications are:

b) efficient linkages between ground and airborne systems,

d) improved handling and transfer of data,

f) reduced channel congestion,

h) reduced communications errors,

j) inter-operable communication media, and

l) reduced workload.

3.4.4 Navigation

3.4.4.2 Required Navigation Performance (RNP), conceived by the FANS Committee and developed by the Review of the General Concept of Separation Panel (RGCSP), defines navigation performance accuracy required for operation within a defined airspace. The concept, in principle, allows the aircraft operator to select the type of navigation equipment to use. It is anticipated that RNP requirements could be met by the Global Navigation Satellite System (GNSS), currently being deployed. It is expected that GNSS will be able to provide a high integrity, highly accurate navigation service, suitable for sole means navigation, at least for enroute applications.

3.4.4.4 Potential benefits from GNSS are:

b) improved four-dimensional navigational accuracy;

d) high-integrity, high accuracy, worldwide navigation service;

f) cost savings from phase-out of ground-based navigational aids; and

h) improved air transport services using non-precision approaches and precision landing operations.

3.4.6 Surveillance

3.4.6.2 The data link based ATS will use a data link to provide surveillance information for ATS. Surveillance may be independent, i.e., using radar, or dependent, i.e., using on board derived information passed automatically to the ATC provider. The two systems may, where necessary, be combined.

3.4.6.4 Potential benefits from the enhanced surveillance system are:

b) enhanced flight safety;

d) improved surveillance of aircraft in non-radar areas;

f) possible reduction of separation minima in non-radar airspace;

h) reduced delays;

j) the accommodation of user-preferred flight profiles;

l) increased ATC capacity; and

n) more efficient and economic aircraft operations.

3.4.8 Air Traffic Management (ATM)

3.4.8.2 The future ATM system will make maximum use of automation to reduce or eliminate constraints imposed on ATM operations by current systems, and to derive the benefits made possible by implementation of the new CNS systems. The flexibility facilitated by the new CNS systems will allow the introduction of automation capabilities from the simplest to the most advanced, as required by the individual States, and in a globally harmonious fashion. It is expected that the early use of ATM automation will be most visible in flow and tactical management.

3.4.8.4 ATM automation will make it possible to formulate real-time flow management strategies and allow for negotiation between ATS and aircraft to enhance tactical management. Data link and voice channels, enhanced by automation aids, will be used for aircraft not capable of automated negotiation with ground systems.

3.4.8.6 Future ATM systems will significantly benefit the rapidly growing international air traffic operations. The goal is to develop flexible operations by accommodating users' preferred trajectories to the optimum extent possible. The future ATM systems will use automatic dependent surveillance, other data link applications, satellite communications, the global navigation satellite system and aviation weather system improvements to integrate ground-based automation and airborne flight management systems.

3.4.8.8 Potential benefits from improvements in ATM are:

b) enhanced safety, reduced delays and increased airport capacity;

d) more flexible ATM operations;

f) enhanced surveillance capability;

h) reduced congestion;

j) more efficient use of airspace, including more flexibility and reduced separations;

l) better accommodation of user-preferred profiles;

n) enhanced meteorological information; and

p) reduced controller workload.

3.4.10 Expected Benefits of Data Link ATS

3.4.10.2 Significant benefits are expected to accrue from the implementation of a data link ATS. These could include:

b) Increased safety by reducing the potential for erroneous receipt of messages;

d) Reduction of voice channel congestion;

f) Reduction of R/T workload for both the pilot and controller;

h) Increased communication availability;

j) Reduction of late transfer of communications;

l) Reduction of re-transmissions caused by misunderstood communications;

n) Increased flexibility in handling ATC communication tasks;

p) More efficient use of airspace due to more time being allocated to providing a better service to user aircraft, rather than routine communications tasks;

r) Reduced controller stress/memory burden;

t) Reduced controller communication time.

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

CHAPTER 2 APPENDIX A

HUMAN FACTORS

2A.2 Summary

2A.2.2 The success of the ICAO CNS/ATM systems concept will depend to a large degree upon its effective implementation into the operational environment. The effectiveness of the implementation will be affected by a number of variables. One such variable is the adoption of a systemic approach which takes into consideration facts and issues regarding all components of the CNS/ATM systems concept, rather than the technology involved exclusively. Within this systemic approach, and in order to realize the CNS/ATM systems potential, Human Factors considerations should be included early in the design stage, before the systems and their subsystems achieve full operational status.

2A.4 **Background and Justification**

2A.4.2 Lapses in human performance underlie most safety breakdowns and damage-inducing events in modern, technology-based production systems, of which air transportation is a perfect example. Measures to contain the adverse consequences of human error in aviation have traditionally followed a two-pronged approach. They have been directed, piecemeal, either to the technology employed to achieve and improve the system's production goals, and/or to the front-line users and operators of this technology. The contribution of improved technology to aviation safety and efficiency remains unparalleled in similar high-technology production systems. The renewed attention dedicated to the human element in aviation over the last ten years has caused the last decade to be dubbed “the golden era of aviation Human Factors”. Nevertheless, aviation safety levels have remained fairly constant over the last twenty-five years and as such, the search for significant potential improvements continues.

2A.4.4 From the perspective of Human Factors, three reasons explain the apparent stagnation of safety levels. The first reason can be found in what has been called an *escalation of commitment*: since World War Two, safety in civil aviation has been pursued through the introduction of new technology, supported by the training necessary to employ it in operational settings and the relevant regulations regarding both. In every instance when accident investigations identified “new” safety breakdowns and/or hazards, more technology, more training and more regulations were introduced. When “newer” safety breakdowns/hazards were further identified, more technology, further training and regulations were introduced. And so continued the escalation of commitment of international civil aviation, with respect to technology, training and regulation.

2A.4.6 Secondly, technological solutions have on occasion been designed without full consideration of how they would properly interface with *existing* operational environments. In this regard, the absence of a systemic approach to the integrated implementation of technological and Human Factors solutions has been conspicuous. Technology and Human Factors have followed independent avenues, and little dialogue has existed among technology designers and Human Factors practitioners. The industry has thus witnessed the emergence of fine technology which failed to deliver its promised potential because of serious flaws in its interface either with the human operator, with the demands of operational context, or with both. The Ground Proximity Warning System (GPWS) illustrates this point: the consequences of its piecemeal introduction are reflected in the fact that it has been necessary to change the original design seven times (latest versions of the equipment are Mk VII). Not only is this expensive, but it breeds skepticism among users and therefore a state of affairs in which technology falls short of realizing its full safety potential.

2A.4.8 This approach, known as "technology-centred automation", is being gradually phased-out in favour of a "human-centred automation", where technology is considered but a tool to assist humans in their monitoring and performing tasks. Human Factors practitioners, on the other hand, have until recently been unable to convey the notion of the relevance of Human Factors knowledge to operational environments. Understanding such relevance is essential for operational personnel and designers to include Human Factors knowledge in their professional "tool kits" and apply it in operational practice. It appears a logical corollary that CNS/ATM systems safety and efficiency would be enhanced if its design and implementation observed a systemic approach which integrates both human capabilities and limitations, and technology.

2A.4.10 Thirdly, Human Factors knowledge has conventionally been applied in a reactive mode. When investigations following accidents or safety breakdowns lead to the discovery of serious flaws in human performance due to inherent human limitations or are fostered by deficient human-technology interfaces, Human Factors knowledge is applied as a "band-aid" or "sticking plaster". Action taken in this way addresses *symptoms* (a discrete deficiency in human performance or in a discrete piece of equipment in a discrete operational environment) rather than *causes*. This reactive application of Human Factors knowledge has traditionally fought a losing battle with the latent systemic failures which characteristically remain resistant and well-hidden in opaque high-technology systems in which, like in aviation, people must closely interact with technology to achieve the system goals. The way to fight latent systemic failures is through the proactive application of Human Factors knowledge as part of prevention strategies ***to identify, assess and minimize the negative consequences of the system's potential hazards and the risks such hazards generate.***

2A.6 Automation and New Technologies

2A.6.2 Automation of tasks through the introduction of technology is an attempt to increase the production of any given system, while maintaining or enhancing existing levels of safety and protection against harm and damage. Aviation is not alone in the quest for increased production through automation, and similar endeavours have been attempted in other industries, including nuclear power generation, petrochemical, medicine and banking. Automation of tasks through new technology should allow for increased safety through the reduction of human error and increased efficiency by enabling operational personnel to "do more with less". Huge investments have been made in technological systems - in aviation as well as in other industries -which during their design stages appeared sound and appropriate to meet these objectives, and which when transported into the operational context, and interfaced with daily operations, did not deliver as expected. Technology cannot then be easily changed because of claims that incidents or accidents involving it are due to design flaws which encourage the possibility of human error. Such claims - no matter how well-founded they might be - assert their proponents, a prerogative to re-design not only the technology but also the jobs and responsibilities of operational personnel, and they involve astronomical costs which a production industry is hardly in a position to take lightly. The implication of the above is clear: technology design should be context-conscious and human-centred from its inception.

2A.6.4 The piecemeal introduction of new technologies has on occasion been self-defeating, as the GPWS example illustrates. Designers have automated what existing state of knowledge allowed to automate, leaving those tasks which could not be automated to be performed by the human. Critical in this approach is the assumption that the human operator will take and restore effective control of the system in "runaway" conditions; in unexpected operational conditions which controlling computers cannot "understand" because designers did not anticipate such operational conditions could emerge. The irony behind this approach is obvious: humans are expected to monitor the automated system and take over manually to restore the system to safety when facing operational conditions not forecast by design and for which they are neither trained nor prepared.

2A.6.6 There has also been a tendency to automate what engineers *believed* should be automated in order to better assist operational personnel. More often than not, such beliefs developed without the benefit of feedback from the final users of the technology, without proper understanding of the issues involved and without due consideration to potential inter-relationships between the automated system and the operational context limitations. From a technology-centred point of view, incidents and accidents involving high technology systems appear to be mis-operations of engineered systems that are otherwise fully functional, and are therefore labeled as human error. The typical belief is the human element is separate from the technology, and that problems reside therefore either in the human or in the technical part of the system. This view ignores, among other things, the role of human cognition and the pressures managers and oftentimes regulators impose upon operational personnel.

2A.6.8 In practice, things are different. The attribution of error is a judgment about human performance, applied only when a process (i.e., an operation) has a bad outcome (i.e., an accident or incident), and usually with the benefit of hindsight about the outcome. The role of technology in fostering human error has been often overlooked. Seldom the problem lies with the technology design in itself, most frequently it is a result of a poor mismatch between the technology, its users and the operational context. The limitations of human cognition *vis-à-vis* the use of new technology have not always been fully appreciated. It is only in the examination of these deeper issues that it is possible to learn how to improve the integrated performance of large and complex systems, and how to incorporate these lessons pro-actively during the design of technology.

2A.6.10 If new technology is to be successfully implemented, the following must be considered during design, in addition to the technology's inherent properties:

b) the operational context in which the technology will be deployed,

d) the human performance-shaping potential which technology carries, since it creates the potential for new forms of error and failure,

f) the fact that use of technology will be shared by interacting people, the organizational context with its constraints, dilemmas, trade-offs, double and multiple binds and competing goals, and

h) the role of cognitive factors which may turn otherwise efficient into "clumsy" technology.

2A.6.12 Technology and human capabilities and limitations must in fact be considered as a joint human-machine cognitive system. Designing technology without consideration of the above will yield compromise rather than optimum benefits, and may indeed become an invitation to disaster.

2A.8 Cognition and New Technologies

2A.8.2 The demands that large and complex systems place upon human performance are essentially cognitive. The "clumsy" use of new technological possibilities in the design of computer-base devices create the potential for erroneous actions and assessments by operational personnel when combined with inherent human limitations encouraged by the pressures of real-life contexts. Some of the questions to be considered in designing "joint cognitive systems" include:

b) What are the "classic" design errors in human-computer systems, computer-based advisors, and automated systems?

d) Why are they so frequently observed in operational environments?

f) How do devices with "classic" design errors shape operational personnel cognition and behaviour?

h) How do practitioners cope with "clumsy" technology?

j) What do these factors mean in terms of human error?

2A.8.4 The most frequent example of mismatches between cognition and technology is the mode error. Mode error requires a device where the same action or indication means different things in different contexts (i.e., modes), and a person who loses track of the current context. It is obvious that it is an error which can only exist at the intersection of people and technology. If the "joint cognitive system" is duly considered, mode errors can be pro-actively anticipated and taken care of during design.

2A.8.6 At any time when new technology is introduced there is potential for safety breakdowns within the system in question. Technological change is an intervention into an ongoing field of activity. Developing and introducing new technology does not preserve the old ways of doing business in the ongoing field of activity, with the simple substitution of one tool for another (i.e., replacing a typewriter for a personal computer). It represents entirely new ways of doing things, including the composition of working teams and a shift in the human role within the joint human-technology system. Failures in automated systems produce considerably more side effects than manual systems. Symptoms of faults may seem unrelated to the process taking place, making management and diagnosis more difficult and changing the kind of failures operational personnel would expect to see. When facing such a panorama, it appears obvious that the long standing hobbyhorses of aviation to support change - training and regulations - are not sufficient when introducing new technology. An integrated approach is essential.

2A.10 The Principles Of Human-Centred Automation

2A.10.2 The advantages of incorporating Human Factors considerations early in system design cannot be overstated. As mentioned elsewhere in this appendix, the principles of human-centred automation require that the industry embrace a system approach to the design of automation systems.

2A.10.4 The human bears the ultimate responsibility for the safety of the aviation system.

2A.10.4.2 In a complex system, no matter how automated, the human has the last vote in deciding a critical issue and the human is the last line of defense in case of system breakdown. The importance of people in a technological society is further reflected in the concept of pivotal people, which emphasizes the irreplaceability of pivotal people in stressful environments like flight operations, air traffic control, and power utility grid control.

2A.10.6 The human operator must be in command.

2A.10.6.2 For humans to assume ultimate responsibility for the safety of the system, they should be conferred with essentially unlimited authority to permit them to fulfill this ultimate responsibility. It has been unequivocally stated that even when the automated system is in full operation, “responsibility for safe operation of an aircraft remains with the pilot-in-command,” and “responsibility for separation between controlled aircraft remains with the controller”. If they are to retain the responsibility for safe operation or separation of aircraft, pilots and controllers must retain the authority to command and control those operations. It is the fundamental tenet of the concept of human-centred automation that aviation systems (aircraft and ATC) automation exists to assist human operators (pilots and controllers) in carrying out their responsibilities as stated above. If this principle is not strictly observed, and if decisions are made by automated systems instead of by human operators, complicated and unavoidable liability issues may arise. This will obviously lead into consideration of the human operator's share of liability, which in turn will adversely affect human performance. Thus, a question of liability becomes a Human Factors issue by default. Human operators should never be held liable for failures or erroneous decisions unless they have full control and command of the system. The reasons are very simple, like any other machine, automation is subject to failure. Further, digital devices fail unpredictably, and produce unpredictable manifestations of failures. The human's responsibilities include detecting such failures, correcting their manifestations, and continuing the operation safely until the automated systems can resume their normal functions. Since automation cannot be made failure-proof, automation must not be designed in such a way that it can subvert the exercise of the human operator's responsibilities.

2A.10.8 To command effectively, the human operator must be involved.

2A.10.8.2 To assume the ultimate responsibility and remain in command of the situation, human operators must be involved in the operation. They must have an active role, whether that role is to actively control the system or to manage the human or machine resources to which control has been delegated. If humans are not actively involved, it is likely that they will be less efficient in reacting to critical system situations. Human-centred aviation system automation must be designed and operated in such a way that it does not permit the human operator to become too remote from operational details, by requiring of that operator meaningful and relevant tasks throughout the operation.

2A.10.10 To be involved, the human must be informed.

2A.10.10.2 Without information about the conduct of the operation, involvement becomes unpredictable and decisions, if they are made, become random. To maintain meaningful involvement, the human operator must have continuing flow of essential information concerning the state and progress of the system controlled and the automation that is controlling it. The information must be consistent with the responsibilities of the human operator; it must include all the data necessary to support the human operator's involvement in the system. The human operators must be prominently informed at the level required to fulfill their responsibilities. The human operators must have enough information to be able to maintain state and situation awareness of the system. However, care must be taken not to overload them with more information than is necessary.

2A.10.12 Functions must be automated only if there is a good reason for doing so.

2A.10.12.2 There is a growing temptation to incorporate some new technology showpiece in a design just because it can be done rather than because it is necessary. In other words, designs may be driven by technological feasibility rather than the needs of the users who must operate and maintain the products of these designs. Automation of functions for no other reason except that it is technologically possible may result in the user's inability to effectively employ it for the benefit of the whole system. The question here should be “not whether a function can be automated, but whether it needs to be automated, taking into consideration the various Human Factors questions that may arise”.

2A.10.14 The human must be able to monitor the automated system.

2A.10.14.2 The ability to monitor the automated systems is necessary both to permit the human operator to remain on top of the situation, and also because automated systems are fallible. The human can be an effective monitor only if cognitive support is provided at the control station. Cognitive support refers to the human need for information to be ready for actions or decisions that may be required. In automated aviation systems, one essential information element is information concerning the automation. The human operator must be able, from information available, to determine what that automation performance is, and in all likelihood will continue to be, appropriate to the desired system situation. In most aviation systems to date, the human operator is informed only if there is a discrepancy between or among the units responsible for a particular function, or a failure of those units sufficient to disrupt or disable the performance of the function. In those cases the operator is usually instructed to take over control of that function. To be able to do so without delay, it is necessary that the human operator be provided with information concerning the operations to date if these are not evident from the behaviour of the system controlled.

2A.10.16 Automated systems must be predictable.

2A.10.16.2 The human operator must be able to evaluate the performance of automated systems against an internal model formed through knowledge of the normal behaviour of the systems. Only if the systems normally behave in a predictable fashion can the human operator rapidly detect departures from normal behaviour and thus recognize failures in the automated systems. It is important that not only the nominal behaviour, but also the range of allowable behaviour be known. All unpredicted system behaviour must be treated as abnormal behaviour. To recognize this behaviour, the human operator must know exactly what to expect of the automation when it is performing correctly.

2A.10.18 Automated systems must also be able to monitor the human operator.

2A.10.18.2 Humans failures may likewise be unpredictable. Because human operators are prone to errors, it is necessary that error detection, diagnosis and correction be integral parts of any automated aviation system. For this reason, it is necessary that human as well as machine performance be continuously monitored. Monitoring automation capable of questioning certain classes of operator's actions that can potentially compromise safety must be designed into the system.

2A.10.20 Each element of the system must have knowledge of the others' intent.

2A.10.20.2 In highly automated operations, one way to keep the human operator actively involved is to provide information concerning the intent of the automated system. That is, given the current decisions made or about to be made by the automated systems, what will the situation look like in the future. Essentially, the system should not only identify a potential problem but also suggest alternative solutions and show the implications of the action taken. Cross-monitoring can only be effective if the monitor understands what the operator of the monitored system is trying to accomplish. To obtain the benefit of effective monitoring, the intentions of the human operator or the automated systems must be known. The communication of intent makes it possible for all involved parties to work co-operatively to solve any problem that may arise. For example, many air traffic control problems occur simply because pilots do not understand what the controller is trying to accomplish, and the converse is also true. The automation of the ATC system cannot monitor human performance effectively unless it understands the operator's intent, and this is most important when the operation departs from normality.

2A.10.22 Automation must be designed to be simple to learn and operate.

2A.10.22.2 If systems are sufficiently simple automation may not be needed. If tasks cannot be simplified, or are so time-critical that humans may not be able to perform them effectively, automation may be the solution. Even then, simpler automation will permit simpler interfaces and better human understanding of the automated systems. Systems automation to date has not always been designed to be operated under difficult conditions in an unfavourable environment by overworked and distracted human operators of below-average ability. Yet these are precisely the conditions where the assistance of the automation system may be most needed. Simplicity, clarity and intuitiveness must be among the cornerstones of automation design, for they will make it a better and effective tool. Simple, easy to learn and use design is marked by an absence of problems in the use of a system by humans and its effects are thus invisible in the final operational system.

2A.10.22.4 The principles of human-centred automation are intended to serve as a template so that every time automation is designed and introduced it can be filtered through the template rather than justified and defended anew.

2A.12 Human Factors Issues Related To Data Link Applications

2A.12.2 Human Factors issues related to specific data link applications are described under the headings of those applications. General Human Factors issues, to be considered with the guidance material listed in the reference section of this appendix, include:

b) the level of safety targeted for the future system should be defined not only with reference to various system statistics, but also with reference to error-inducing mechanisms related to human capabilities and limitations, as well as individual cases;

d) the definition of system and resource capacity should include reference to the responsibilities, capabilities and limitations of ATS personnel and pilots, who must retain situational awareness in order to discharge their responsibilities as indicated in the principles of human-centred automation;

f) the provision of large volumes of information to users should be limited to what is absolutely necessary, and should be mediated by methods that effectively package and manage such information to prevent information overload while providing pertinent information to particular operational needs;

h) the responsibilities of pilots, air traffic controllers and system designers should be clearly defined prior to the implementation of new automated systems and tools;

j) services and procedures will be provided to ensure the preservation of situational awareness for both data link and non-data link-equipped aircraft and ground facilities;

l) when operating a data link system, there should be no increase in heads-down time that would adversely affect safe operation;

n) voice communication to supplement data link system operation will be available; and

p) maximum use of data link will not impose undue competition for display or control resources.

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

4. DATA LINK APPLICATIONS

4.2 Data Link Based Air Traffic Systems

4.2.2 CNS/ATM systems for use in the future will be developed from existing systems and technologies in an evolutionary manner. One of the overall objectives is to harmonize the different air traffic control systems among the regions, irrespective of the surveillance, navigation and communications systems in use. Data link communications can support direct controller-pilot communication, the passing of automatic dependent surveillance data, the implementation of a request/reply data link flight information service to the aircraft, and exchanges between aircraft and ATC systems. This will overcome the shortcomings of the current systems by providing for global communications, navigation and surveillance coverage from (very) low to (very) high altitudes, for digital data interchange between the air-ground systems to fully exploit the automation capabilities of both, and for the development of a fully integrated CNS end-system which will operate in a normalized manner throughout the world.

4.2.4 The data link applications based system will improve the handling and transfer of information between operators, aircraft and ATS units. The system will provide extended surveillance capabilities by using ADS and advanced ground-based data processing and display systems to the controller, thus allowing advantage to be taken of the improved navigation accuracy in four dimensions and accommodating the flight's preferred profile in all phases of flight, based on the operator's objectives. The future data link based ATC system will also allow improved conflict detection and resolution, as well as the automated generation and transmission of conflict-free clearances and rapid adaptation to changing traffic and weather conditions.

4.2.6 In oceanic areas and remote land airspaces with limited ground-based air navigation facilities, surveillance of air traffic is envisioned to be provided by ADS position reporting through satellite communications. Surveillance of low-altitude traffic operations, including helicopters, will be conducted in a similar manner. In continental airspaces, surveillance of air traffic may be achieved by ADS reports integrated with ground-based radar systems. Controller Pilot Data Link Communication (CPDLC) and the interchange of ATS messages will be carried out by satellite, SSR Mode S, VHF, high frequency (HF) or other suitable data link available.

4.2.7 In order to ensure that higher priority messages, including time critical messages, will be transmitted before lower priority messages, a message priority capability will be included in the radio data link system.

4.4 System Components

4.4.2 There are six major components which combine to form an integrated data link based ATC system. Implementation of data link must allow incorporation of system enhancements to be made without any disruption to operations. The six main components of a data link based ATS are:

b) pilot interface;

d) aircraft (including airborne automation);

f) air/ground and ground/ground data link communications;

h) communication interface;

j) ATC automation; and

l) controller interface.

4.4.4 Pilot Interface

4.4.4.2 The pilot interface to the data link system must be efficient and easy to operate. Pilot-controller messages require some rapid entry mechanism. Use of data link for pilot-controller communications will result in changes to cockpit procedures, since messages currently transmitted by voice will require system input by the pilot, and receipt of a message will require reading text. Procedures and systems should be developed to minimize system input errors.

4.4.4.4 Possible impact of loss of situational awareness for pilots needs to be considered.

4.4.6 Aircraft Equipment

4.4.6.2 Data link applications must be supported by aircraft equipment which is able to gather the data from the pilot interface, appropriate sensors and flight management computers, format the data and direct it to the appropriate air-ground data link within the appropriate time scales. This on-board equipment should also have the capability to receive messages originated by the controlling and other authorized ATS units. Avionics should make maximum use of data link equipment already in place in the aircraft.

4.4.8 Air/Ground and Ground/Ground Data Link Communications

4.4.8.2 The required air-ground data link will be ATN compatible for most applications and could be either satellite data link, VHF digital data link, Mode S data link, or any other medium which meets the operational requirements. The ATC and aircraft systems will select the most suitable path based on time-varying considerations such as geographical location, cost, delay, throughput and link availability. For example, in oceanic airspace, satellite data links will most likely be used, while in domestic airspace VHF or Mode S could be used.

4.4.8.4 The resulting communications links will appear seamless from the user's perspective (i.e., independent of the communications systems in use).

4.4.8.6 Voice communication will be available to complement data link system operation.

4.4.8.8 To satisfy the operational requirements, the communications system will need to meet general performance standards. These are summarized in Appendix A of this chapter.

4.4.10 Ground Communication Interface

4.4.10.2 The air-ground data link will be connected to the ATC system through a terrestrial communications network. The network will conform to the protocol suite defined as part of the ATN concept. For messages from controller to pilot, the ground ATN routers must choose the most suitable data link device available and route the message to that transmitting station.

4.4.12 ATC Automation

4.4.12.2 The ground system must be capable of supporting position reporting and communications procedures with minimal controller input. Conformance monitoring, confliction avoidance, automatic transfer of control, controller alerting and many other functions concerned with safe and efficient ATS management will result from the incorporation of advanced levels of automation which will take advantage of the data link applications functionality. CPDLC will require some level of message processing that should be included in the ATC automation component.

4.4.12.4 Error detection and correction, and, where appropriate, alerting mechanisms should be implemented.

4.4.12.6 In addition, the ATC system will allow for safe recovery from response delays, non-response, system failures, system management errors or others errors which impede operation such as unauthorized access and unauthorized transmission. Systems will be capable of delivering messages associated with error notification and recovery within the time required for safe recovery.

4.4.12.8 Use of data link will not impose undue competition for display or control resources. Systems will not preclude access to other functions or unduly conflict with higher priority functions.

4.4.14 Controller Interface

4.4.14.2 The controller interface will contain the required tools for the composition of air-ground data link messages. Air traffic services providers will define and develop specific controller interfaces tailored to their particular needs. The human-machine interface will be left to the individual service provider. The controller interface should be efficient, easy to operate and provide a rapid message input mechanism. The interface should also provide a means to display air-ground messages. Further guidance on the Human Factor aspects which have to be taken into consideration generally is given in Part I Chapter 2 Appendix A.

4.6 Operational Requirements

4.6.2 Certain basic operational requirements need to be fulfilled to permit the effective provision of a data link based ATS. In this context, an operational requirement is defined as:

> “A statement of the operational attributes of a system needed for the effective and/or efficient provision of air traffic services to users.”

4.6.4 In deriving the operational requirements necessary for the provision of a data link based ATS, the various information needs of the pilot, aircraft, ground system and controller must be taken into account. The performance of the various components of the system, outlined in para. 3.2.1 above, has also to be considered. Specific operational requirements have been identified which are applicable to the global data link applications environment.

4.6.6 As the systems evolve, additional operational requirements may be developed to increase their efficiency and effectiveness. Currently defined requirements should not always be considered as being immediately needed to permit an initial level of a data link based ATS. In the transition towards a fully developed service, limited conformance could still provide benefits to the users and to ATC providers. This will ensure that implementation of services can proceed on an evolutionary basis. More information on a possible transition strategy is given in Appendix B of this Chapter.

4.6.8 Operational Requirements (ORs) which are generally applicable to all aspects of a data link based ATS are given in this chapter. Where ORs are specific to particular applications, they are included in the relevant chapters of this part of the document.

4.6.10 In this document an operational requirement is not a description of "how" the system need is to be met, nor should it be assumed that the solution will always be technical in nature. It may be that the requirement will be met by appropriate procedural training or staffing actions. However, when technical solutions are required, their definition remains the responsibility of the technical and engineering specialists who must ensure that the needs of the ATC system are met. Close coordination between operational and technical authorities is essential if the optimum solution is to be found.

4.6.12 A data link based ATS must include the capability to exchange messages between the pilot and the controller. A direct voice communication capability should be available for at least emergency and non-routine, safety-related communications. In order to cater for emergency situations, the system will provide for a pilot (or, exceptionally, system) initiated ADS emergency mode, which would indicate the state of emergency, and include an ADS report.

4.6.14 The ADS Panel has identified a specific operational requirement relating to the overall implementation of the data link based ATS, outlined below.

4.8 Generic Operational Requirements

4.8.2 In any data link dialogue the end-user must be able to positively identify the other end-user.

4.8.4 In any data link based ATS, provision must always be made for direct pilot-controller voice communications.

4.8.4.2 In particular, the pilot or controller must be capable of initiating direct controller pilot communication by voice in emergency or urgent, non-routine, safety-related situations.

4.8.4.4 Simple actions will be used by either the pilot or controller to initiate voice communications. Voice communications will be of high-quality intelligibility.

4.8.4.6 An emergency call must always pre-empt a lower priority call.

4.8.6 In addition to the specific requirements given above, several significant functional requirements have been identified concerning the overall level of sophistication required to permit effective implementation of data link in a CNS/ATM environment, as envisaged by FANS.

4.8.6.2 Air traffic control facilities providing a data link based ATS must be capable of receiving, storing, processing, displaying and disseminating specific flight information relating to flights equipped for and operating within environments where a data link service is provided.

4.8.6.4 Aircraft intending to fly within airspace where a data link service is available and wishing to take advantage of the service must be equipped with data link capabilities to permit the exchange of data link messages between the aircraft and the ATC facilities providing the service.

4.8.6.6 Effective human-machine interfaces must exist on the ground and in the air to permit inter-activity between the pilot, controller and ground automation.

4.8.6.8 Design of appropriate digital data interchange communications systems between ATC facilities is also significant to the effective implementation of a data link service. Effective digital data interchange communication systems, techniques and procedures should be developed in parallel with the ADS-specific requirements.

4.8.6.10 Aircraft will be under the control of only one ATC unit at a time, whether or not data link applications are being used.

4.8.6.12 The system should be capable of facilitating automatic transfer of data link authority within data link based ATS airspace using digital data interchange.

4.10 Communications Failure

4.10.2 In case of complete communications failure, procedures will be in accordance with ICAO provisions.

4.10.4 In the event of an unexpected termination of a data link application, both the aircraft and the ground will be notified of the failure.

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

CHAPTER 3 APPENDIX A

COMMUNICATION SYSTEMS PERFORMANCE REQUIREMENT PARAMETERS

3A.2 General Requirements

3A.2.2 In addition to the requirements specified in the application parts of this document, all data link applications require:

b) the probability of non-receipt of a message will be equal to or less than 10^{-6};

d) the probability that non-receipt of a message will fail to be notified to the originator will be equal to or less than 10^{-9}; and

f) the probability that a message will be mis-directed will be equal to or less than 10^{-7}.

3A.4 Performance Requirements

3A.4.2 The figures in Tables 3A-1 and 3A-2 reflect the various levels of performance that may be selected for the purpose of providing Data Link services. Depending on the level of service to be provided, a given State can determine what the performance needs are in a given domain by factors such as the separation minima being applied, traffic density, or traffic flow.

APPLICATION	AVAILABILITY	INTEGRITY	RELIABILITY	CONTINUITY
DLIC	99.9%	10^{-6}	99.9%	99.9%
ADS	99.996%	10^{-7}	99.996%	99.996%
CPDLC	99.99%	10^{-7}	99.99%	99.99%
FIS	99.9%	10^{-6}	99.9%	99.9%
AIDC	99.996%	10^{-7}	99.9%	99.9%
ADS-B	99.996%	10^{-7}	99.996%	99.996%

Table 3A-1: Application Specific Performance Requirements

Performance Levels	**Mean End-to-End Transfer Delay (Seconds)**	**95% End-to-End Transfer Delay(Seconds)**	**99.996% End-to-End Transfer Delay (Seconds)**
A	0.5	0.7	1
B	1	1.5	2.5
C	2	2.5	3.5
D	3	5	8
E	5	8	12.5
F	10	15	22
G	12	20	31.5
H	15	30	51
I	30	55	90
J	60	110	180

Table 3A-2: Transfer Delay Performance Requirements

3A.4.4 Except in catastrophic situations, no single end-to-end outage should exceed 30 seconds (End-to-end availability may be achieved through provision of alternate communications routings where feasible).

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

CHAPTER 3 APPENDIX B

TRANSITION STRATEGY

1B.2 Transition Principles and Guidelines

1B.2.2 General principles

1B.2.2.2 The phased implementation of a data link based system will take place within an environment which places constraints and conditions on the process, namely:

b) A future system can only be implemented by means of an evolutionary process. This process has already begun;

d) The impact on the pilots and air traffic controllers of human factors issues must be resolved;

f) The new system must be capable of working with a wide variety of traffic densities, aircraft types, aircraft sophistication, etc.;

h) The system should be protected against unauthorized access and unauthorized transmission;

j) The system should be able to accommodate increased demands and future growth;

l) The system should, to a practical extent, be able to accommodate aircraft which have begun transition to these technologies; and

n) Evolving systems should be able to accommodate variations in quality standards and performance characteristics.

1B.2.4 The implementation plan for a specific area will also be based on the specific requirements in that area. The benefits to be gained from the use of data link are not the same in all areas, and implementation will be based on cost-benefit considerations and the need for overall coverage and compatibility with neighbouring areas.

1B.2.6 Not all operational requirements for a data link based ATS would need to be implemented at the same time. However, an incremental level of capability, implemented in phases, would occur in many cases and would be in keeping with the established transition guidelines. For example, the simplest implementation of ADS, providing position reporting only, could be used in combination with existing communications facilities. The mere availability of a surveillance capability would provide significant safety benefits, as it would permit the detection by the controller of deviations from the cleared flight path, and thus prevent gross navigation errors.

1B.2.8 In some cases, ADS may be first introduced for specific operations in limited areas to enhance safety and efficiency, for example, for low level helicopter operations below radar coverage. In order to be compatible with more extensive data link based ATSs and to gain experience with the standardized system, these early implementations should, as much as possible, meet the operational requirements as set out in this document.

1B.2.10 Meeting the future requirements of a full data link based ATC operational system necessitates the development of automation for ATM functions. In order to derive maximum benefits for controllers, the design of the ATM system for a data link based service should pay close attention to the impact on the human factor aspects of the controller's work environment, as well as the validation methods used in the development of automated functions.

1B.2.12 It is impossible to provide a uniform environment for all users in all States and regions in the same time frame. However, criteria must be established and a phased implementation must be developed to maximize the benefits as quickly as possible, with the least disruption.

1B.4 **Implementation Principles**

1B.4.2 The global data link system should be developed in balance with other parts of the overall air navigation infrastructure. The necessary changes should be introduced in an evolutionary fashion. There should be little disparity in the level of service given to differently-equipped aircraft in order to provide an expeditious flow of air traffic. System development must be harmonized to enable future technologies to be accommodated in a consistent manner throughout the globe.

1B.4.4 Guidelines for transition to the future surveillance system should be such as to encourage early equipage by users through the earliest possible accrual of the system benefits. Although a transition period during which dual equipage, both airborne and ground, will be necessary in order to ensure the reliability and availability of the new system, the guidelines should be aimed at minimizing this period to the extent practicable.

1B.4.6 The following transition guidelines have been developed by the ICAO FANS (II) Committee and are based on the "Global Co-ordinated Plan for Transition to the ICAO CNS/ATM Systems".

b) States should begin to develop operational procedures, in accordance with ICAO SARPs and guidelines, for the implementation of ADS within airspace under their control.

    This will ensure early implementation of ADS and the most efficient use of global airspace.

d) Transition to data link based operations should initially begin in oceanic airspace and in continental enroute airspace with low-density traffic.

    In oceanic and some continental areas, position reporting is the only available means of surveillance, and ADS could provide a significant early benefit. In some oceanic areas where HF communication congestion occurs, a combination of CPDLC and ADS will provide relief.

f) States and/or regions should coordinate to ensure that, where data link ATM is to be introduced, it is introduced approximately simultaneously in each FIR where major traffic flows occur.

> This will help ensure seamless transitions through FIR boundaries, and that the benefits of data link application will be available to suitably-equipped aircraft.

h) Where differing surveillance methods are employed in adjacent States or FIRs, commonality or compatibility of systems should be developed to enable a service which is transparent to the user.

> This will help ensure seamless transition through State and FIR boundaries.

j) During the transition period, after, say, an initial ADS position reporting is introduced, the current levels of integrity, reliability and availability of existing position reporting systems must be maintained.

> This is necessary to back-up ADS and to accommodate non-ADS-equipped airspace users.

l) States and/or regions should take actions within the ICAO frame work to ensure that implementation of procedural changes due to ADS and other systems results in more efficient use of airspace.

> Procedural changes may include reduction of horizontal separation standards in oceanic airspace.

n) During the transition to data link based operations, suitably equipped aircraft should be given precedence over non equipped aircraft for preferred routes and airspace.

> For the longer term, when aircraft and ATC capabilities permit, organized track structures could be eliminated in favor of user-preferred flight trajectories with, for example, ADS surveillance and conflict probing.

p) Data link ATM should be introduced in phases.

> This will facilitate rapid introduction of data link capabilities. The first phase could introduce ADS position reporting, conflict probing and flight plan conformance monitoring by ATC, and two-way satellite communications with an initial set of pre-defined message formats. Later stages can introduce a more complete set of pre-defined message formats and further ATC automation.

r) ADS equipment, standards and procedures should be developed in such a way as to permit the use of ADS as a back-up for other surveillance methods.

> This is in accordance with the ICAO CNS/ATM systems for back-up of surveillance systems.

1B.4.8 During the transition period, towards the greater use of data link, the need for increased training in both the use of the data link message set and in the maintenance of the use of aviation specific English should not be overlooked.

1B.4.10 This is not a one time training need. In order to maintain familiarity with the message set, and to retain competence in international voice communication, a suitable training program must be maintained during the transition period.

1B.6 Planning for Implementation

1B.6.2 Planning for the new overall CNS system is underway on global and a regional basis. ICAO has developed a global plan for transition, which provides overall guidance to States and regions for their planning activities. Several States and regions are actively progressing their planning towards implementation of the CNS/ATM systems, within the framework of the global plan, to realize the anticipated benefits from safety enhancement and capacity improvements.

1B.6.4 The transition to a data link based ATS service should ideally be accompanied by improvements in ATM and should be through structural and procedural changes that will enhance the service and provide benefits to users. The structural changes involve airspace reorganization required to optimize the new service. Other areas that will need to be addressed are:

b) data link media,

d) message formats,

f) separation,

h) automation,

j) ATC procedures, and

l) end-to-end verification and certification.

1B.8 Validation and Early Implementation

1B.8.2 The six component parts of the data link based ATS system described in Part I, Chapter 3 for the most part have been adequately demonstrated as being viable. There is an urgent need for States and other organizations, in a position to do so, to undertake trials and implementation of pre-operational systems, as soon as practical, with a view to early validation and to facilitating a timely implementation of a fully operational system.

1B.8.4 It is recognized that during transition, interim systems may require some modifications to previous practices and procedures. Some States will develop ATS procedures which will support interim systems until such time as the users move to a fully ICAO compliant implementation.

1B.8.6 Timely implementation of operational data link based systems in specific areas would enable early benefits to be derived and provide further incentive to airspace users to equip their aircraft. In addition, interim regional implementation has already brought benefits to users.

1B.8.8 In continental airspace, the implementation of ADS as a back-up or complement to radar can have benefits in terms of surveillance availability and reduced need for overlapping radar coverage, but will also be an essential transition step in the process of evaluating and establishing operational requirements for using ADS as a primary means of surveillance.

1B.8.10 The regional bodies most affected by the implementation of a data link based ATM system should be provided with the necessary material. This may then be used in giving consideration to the use of ADS, including phased implementation in their forward planning. For example, the North Atlantic Facilities and Services Implementation Document (FASID) outlines the steps to a full ADS environment.

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

5. DATA LINK INITIATION CAPABILITY (DLIC) OVERVIEW AND HIGH LEVEL OPERATIONAL REQUIREMENTS

5.2 DLIC Overview

5.2.2 The DLIC provides the necessary information to enable data link communications between ATC ground and aircraft systems. It is an aircraft initiated application. The DLIC encompasses the following functions:

b) Logon: data link application initiation and, if required, flight plan association,

d) Update: updating of previously coordinated initiation information,

f) Contact: instructions to perform data link initiation with another specified ground system,

h) Dissemination: local dissemination of information, and

j) Ground Forwarding: ground-ground forwarding of logon information.

5.2.4 The ADS Panel has developed specific operational requirements for the establishment of data link communications between an aircraft and ground systems. These requirements, and the method of operation, are outlined below.

5.4 DLIC High Level Operational Requirements

5.4.2 The ground system must be able to identify an aircraft's data link capabilities from the filed flight plan.

5.4.2.2 Data link ground units need advance notification of aircraft equipage in order to assign appropriate ADS contracts. Prior to the aircraft entering ADS airspace, the relevant ATC unit's ground system database will be updated to reflect the aircraft equipage from data included in the received flight plan.

5.4.2.4 The pilot will include details about data link capabilities in the flight plan.

5.4.4 Procedures must be in place to allow timely establishment of data link between aircraft and the ground system.

5.4.4.2 Before entering an airspace where the data link applications are provided by the ATC automation system, a data link connection will need to be established between the aircraft and the ground system in order to register the aircraft and allow the start of a data link dialogue when necessary. This will be initiated from the aircraft, either automatically or by pilot intervention.

5.4.4.4 At a time parameter before a data link equipped aircraft enters data link airspace, the pilot or the aircraft will need to initiate the DLIC logon procedure. The aircraft will then generate and transmit the Logon Request message which contains the aircraft-unique identifier and the data link applications it can support. The ground system responds to the aircraft's logon request.

5.4.4.6 The ground system should be able to correlate the aircraft-unique identifier with the aircraft identification stored in its data base.

5.4.6 During the initial establishment of a data link connection with a ground system, that ground system must be able to register the data link capabilities supported by the aircraft.

5.4.6.2 The ground system will identify the communications and surveillance capabilities of aircraft in order to establish appropriate ADS contracts.

5.4.8 The ground system initially contacted by the aircraft should be able to pass the necessary aircraft address information to another ground station via ground/ground communications links.

5.6 Detailed Implementation

5.6.2 Detailed implementation and more specific operational requirements of the DLIC functionality in a data link based ATM system are given in Part II of this manual.

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

5. AUTOMATIC DEPENDENT SURVEILLANCE APPLICATION (ADS) OVERVIEW AND HIGH LEVEL OPERATIONAL REQUIREMENTS

5.2 ADS Application Overview

5.2.2 The implementation of ADS, through reliable data link communications and accurate aircraft navigation systems, will provide surveillance services in oceanic airspace and other areas where non-radar air traffic control services are currently provided. The implementation of ADS will also provide benefits in en-route continental, terminal areas and on the airport surface. The automatic transmission of the aircraft position through ADS will replace present pilot position reports. In non-radar airspace, the effective use of ADS in air traffic services will facilitate the reduction of separation minima, enhance flight safety and better accommodate user-preferred profiles. The ADS application and associated communications will have to be supported by advanced airborne and ground facilities and data link communications with proven end-to-end integrity, reliability and availability. It is recognized that safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference; it is necessary therefore to take this factor into account in the assignment and use of frequencies.

5.2.3 In addition, there is the Emergency Mode, a special periodic reporting mode of operation initiated by the pilot (or exceptionally, the aircraft system) specifically tailored to providing the essential position and information data at a specific reporting rate.

5.2.5 The ADS application allows the implementation of reporting agreements, which, with the exception of an aircraft in an emergency situation, are established exclusively by the ground. An ADS agreement is an ADS reporting plan which establishes the conditions of ADS data reporting (i.e., data required by the ATC system and the frequency of the ADS reports which have to be agreed prior to the provision of the ADS services). The terms of an ADS agreement will allow for information to be exchanged between the ground system and the aircraft by means of a contract, or a series of contracts. An ADS contract specifies under what conditions an ADS report would be initiated, and what data groups will be included in the reports. There are three types of contract — “demand”, which provides a single report, “periodic”, which provides a report at a regular periodic interval determined by the ground system, and “event”, which provides a report when or if a specified event or events take place.

5.2.7 ADS contracts necessary for the control of the aircraft will be established with each aircraft by the relevant ground system, at least for the portions of the aircraft flight over which that ground system provides ATS. The contract may include the provision of basic ADS reports at a periodic interval defined by the ground system with, optionally, one or more additional data blocks containing specific information, which may or may not be sent with each periodic report. The agreement may also provide for ADS reports at geographically-defined points such as waypoints and intermediate points, in addition to other specific event-driven reports.

5.2.9 The aircraft must be capable of supporting contracts with at least four ATSU ground systems simultaneously.

5.2.11 An ADS application can only be provided by an ATSU having appropriate automation and communication facilities. The ADS application should be supported by direct two-way controller pilot data link and voice communication.

5.2.13 The transition to the use of ADS in ATS needs careful consideration and should be based on safety, cost-benefit and feasibility studies. The transition plan should consider the time required for acquisition of ATC and communication systems, the number of aircraft suitably equipped and the time for operators to equip, and the time frames of implementation in neighbouring FIRs.

5.2.15 Implementation of ADS will overcome limitations found today in procedural ATC systems based on pilot-reported position reports. The introduction of air-ground data links through which the ADS reports and associated messages will be transmitted, together with accurate and reliable aircraft navigation systems, presents the opportunity to improve surveillance of aircraft in those airspaces. It offers the potential for increasing flight safety and airspace utilization by reducing ATC errors in air-ground communications and by providing ATC with accurate aircraft position information. The exchange of ATS messages by digital data link will alleviate the overloading of ATC radio frequencies and support ATC automation, as well as the implementation of other ATS data link applications.

5.2.17 The processing of automated position reports will result in improved automatic monitoring of aircraft operations. Automatic flight plan data validation will facilitate the early detection by ATC of on-board system flight and route data insertion errors. Conflict prediction and resolution capabilities will be enhanced. The display of the traffic situation as derived from ADS reports and the automated processing of ATS safety messages will significantly improve the ability of the controller to respond to pilot requests and to resolve traffic situations.

5.2.19 With a combination of improved ATC automation, reliable communications and accurate navigation and surveillance, it will be possible to increase the level of tactical control and to reduce separation minima on the basis of controller intervention capability and other ATM improvements, thereby leading to possible increases in airspace capacity.

5.2.21 As with current surveillance systems, the benefit of ADS for ATC purposes requires supporting complementary two-way controller pilot data and voice communication (voice for at least emergency and non-routine communication). Where VHF coverage exists, the communication requirement is envisaged to be met by VHF voice. In areas where high frequency (HF) communications are currently used (e.g., oceanic airspace), the provision of an ADS service during the en-route phase of flight will be supported by the routine use of CPDLC.

5.2.23 The ADS Panel has developed specific operational requirements to ensure that the ADS element of the overall data link service achieves the necessary performance to allow its implementation into a data link based ATS.

5.4 ADS High Level Operational Requirements

5.4.2 The ground system will be able to identify the ADS capability of the aircraft and allocate the appropriate ADS contracts.

5.4.2.2 Based on the current flight plan information obtained from the aircraft, the ADS capability of the aircraft and ATM requirements, an appropriate ADS contract will be identified by the ground system. The necessary contract requests will be transmitted to the aircraft for acceptance.

5.4.2.4 ADS reports will be made available to facilities other than the controlling ATC unit on the basis of mutual agreement and local procedures.

5.4.2.6 At a parameter time or distance prior to the ATS airspace boundary, the ground system will generate and allocate an appropriate ADS contract for the aircraft, based on the current flight plan information obtained from the aircraft and the ATM requirements in effect.

5.4.2.8 The ground system will transmit the relevant ADS contracts to the aircraft. The aircraft will confirm acceptance of the ADS contract to the ground system.

5.4.4 The aircraft must be able to provide automatic position reporting in accordance with ADS contracts allocated by the ground system.

5.4.4.2 The aircraft with ADS capability will generate and transmit ADS reports to the appropriate ground system in accordance with the ADS contracts in force.

5.4.4.4 The controller will be capable of replacing the ADS contract as required by circumstances. The ground system will generate appropriate messages to the aircraft to initiate such modifications to existing ADS contracts.

5.4.6 The aircraft must be capable of identifying any changes to position determination capability and of notifying the ground system accordingly.

5.4.6.2 Based on parameters established in the ADS contract, the aircraft will automatically report to the ground system when the aircraft's navigation capability (figure of merit) has changed.

5.4.8 Both the aircraft and the ground system must be capable of providing an emergency mode of ADS operation to support ATC alerting procedures and to assist search and rescue operations.

5.4.8.2 The system should provide for a pilot-initiated emergency. The pilot will use simple action to initiate an emergency mode. It would also be permissible for aircraft to automatically establish the emergency mode. The aircraft system will alert the pilot to an auto-establishment of the emergency mode.

5.4.8.4 The aircraft system will generate and transmit the basic ADS report at a pre-set initial reporting rate together with the state of emergency. This preset reporting rate will be the lesser of 50 per cent of the existing periodic contract reporting period, or one minute. A single default value of one minute may be used in initial implementations. Aircraft identification and ground vector group will be included in every fifth report.

5.4.8.6 The ground system will recognize the emergency mode and alert the controller. The ground system will be able to modify the emergency reporting rate if necessary.

5.4.8.8 When an emergency mode is declared, any existing periodic contract between the ground system and that aircraft should be modified to a default emergency period contract. While there is an emergency mode in effect, any request for a normal periodic contract should be deferred. An emergency mode should not affect an event contract. The periodic contract in effect when emergency mode ends should be reinstated.

5.4.8.10 The pilot will have the ability to cancel the emergency mode.

5.4.10 The controller must be provided with the most up-to-date traffic situation available using ADS derived information.

5.4.10.2 In an ADS environment, the controller must be provided with the most up-to-date ADS-derived information to permit the provision of effective air traffic control. The ground system will process the ADS position information sent by ADS-equipped aircraft. The ground system will generate warnings (and alternative clearances, where conflict resolution algorithms are incorporated) to the controller when it identifies a potential conflict.

5.4.12 The ADS application will have to allow for the comparison of the four-dimensional profile stored in the aircraft system with flight data stored in the ground system.

5.4.12.2 Many operational errors today in non-radar airspace are due to way-point insertion errors in aircraft flight management systems. To minimize the possibility of such blunders and to permit advanced strategic planning in a data link based ATS, the ground system will verify that the aircraft's planned four-dimensional profile is the same as the profile that ATC is expecting the aircraft to follow.

5.4.14 The aircraft must permit self monitoring and automatic reporting of significant flight variances, when called for by an appropriate event contract.

5.4.14.2 The ground system will determine the flight conformance criteria applicable to the airspace and phase of flight. The ground system will include within the ADS contract the values that trigger these reports.

5.4.14.4 The aircraft will recognize when one of the reporting criteria is satisfied or exceeded. The aircraft will generate and transmit an appropriate ADS report for the specific flight variance. The ground system will generate an alert to the controller if any parameter is exceeded. If a variance parameter is exceeded, the report will comprise an indication of which parameter has triggered the report, the basic plus the air or ground vector block as appropriate, based on the current ADS contract.

5.4.16 The ground system will have the ability to monitor the flight of the aircraft before it enters the airspace under its control.

5.4.16.2 As a consequence of the ADS contracts accepted by the aircraft, the aircraft will begin to send ADS reports to the appropriate ground system to initiate flight-following for planning purposes. The ground system will use ADS information to update its database to ensure entry conditions into the airspace remain acceptable.

5.4.16.4 The position information of the aircraft will be made available to the controller.

5.4.18 The ground system must be capable of recognizing that the aircraft has entered the airspace over which it has controlling authority.

5.4.18.2 In a non-radar airspace, especially when transiting from an uncontrolled airspace to an airspace where ADS applications are available, the ground system of the controlling ATC unit must recognize that the flight has entered its airspace. A set of data as specified by the ADS contract will then be sent by the aircraft to the ground system.

5.4.20 The ground system must be able to confirm that the aircraft's projected profile coincides with that stored in the ground system.

5.4.20.2 Whenever the ground system receives an aircraft's projected profile information, the ground system will check and verify that it is consistent with that already held. The ground system will generate and display an appropriate alert to the controller if any value of the specified parameters delta(lat), delta(long), delta(alt) or delta(time) are exceeded.

5.4.22 The ground system must be able to verify that the aircraft is proceeding in accordance with the ATC clearance.

5.4.22.2 In the data link based ATS, the ground system will use the ADS position reports and other ADS message group data to provide automated flight-following and conformance-monitoring.

5.4.22.4 The aircraft will generate and transmit ADS data to the appropriate ground system according to the current ADS contract. The ground system will compare the aircraft's ADS-reported position with the position predicted by the ground system. The ground system will generate and display appropriate messages to the controller if the ADS position report does not conform, within the given parameters, to the position predicted by the ground system.

5.6 Detailed Implementation

5.6.2 Detailed implementation and more specific operational requirements of the ADS functionality in a data link based ATM system are given in Part III of this manual.

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

6. CONTROLLER PILOT DATA LINK COMMUNICATIONS (CPDLC) APPLICATION OVERVIEW AND HIGH LEVEL OPERATIONAL REQUIREMENTS

6.2 CPDLC Application Overview

6.2.2 One of the keys to the future air traffic management system lies with the two-way exchange of data, both between aircraft and the ATC system and between ATC systems. Controller pilot data link communications (CPDLC) is a means of communication between controller and pilot, using data link for ATC communications.

6.2.4 ICAO has developed a communication systems architecture that provides a range of capabilities to suit the needs of ATS providers and their users. Various air/ground communication data links will be integrated through ATN based on an Open System Interconnection (OSI) architecture. Eventually, the ATN will allow world-wide connectivity and an established quality of service which will provide optimum routing and delivery.

6.2.6 During the transition towards the ICAO CNS/ATM systems, the number of data link applications which require a globally uniform approach and standardization will increase.

6.2.8 The CPDLC application provides the ATS facility with data link communications services. Sending a message by CPDLC consists of selecting the addressee, selecting and completing, if necessary, the appropriate message from a displayed menu or by other means which allow fast and efficient message selection, and executing the transmission. The messages defined herein include clearances, expected clearances, requests, reports and related ATC information. A “free-text” capability is also provided to exchange information not conforming to defined formats. Receiving the message will normally take place by display and/or printing of the message.

6.2.10 CPDLC will remedy a number of shortcomings of voice communication, such as voice channel congestion, misunderstanding due to bad voice quality and/or misinterpretation, and corruption of the signal due to simultaneous transmissions.

6.2.12 In the future, it is expected that communications with aircraft will increasingly be by means of digital data link. This will allow more direct and efficient linkages between ground and cockpit systems. At the same time, extensive data exchange between ATC systems will allow efficient and timely dissemination of relevant aircraft data, and will cater for more efficient coordination and hand-over of flights between ATC units. In turn, this will reduce controller and pilot workload and will allow an increase in capacity.

6.2.14 Implementation of CPDLC will significantly change the way pilots and controllers communicate. The effect of CPDLC on operations should be carefully studied before deciding the extent to which voice will be replaced by data link.

6.2.16 Among others, the following aspects of Controller Pilot Data Link Communications are to be taken into account in considering its application and in defining procedures:

b) the total time required for selecting a message, transmission of the message, and reading and interpretation of the message;

d) the head-down time for the pilot and controller;

f) the inability of the pilot to listen to other transmissions in the same area of operation,

h) unauthorized access, and

j) unauthorized transmissions.

6.4 CPDLC High Level Operational Requirements

6.4.2 A data link based ATS system must provide for the reduction of routine communication tasks which contribute to the saturation of voice frequencies.

6.4.4 The ADS Panel has identified specific operational requirements relating to the capabilities of the CPDLC application. These are outlined below:

6.4.4.2 The system must be capable of providing CPDLC when this application is required by the ATM system in force.

6.4.4.4 When required, the data link ATS will support the interchange of data link messages between the pilot and controller to support the effective provision of the data link based ATS service.

6.4.4.6 The pilot or controller may initiate a data link message using either the defined message set, a free-text message, or a combination of both. The ground system will make the message available to the appropriate controller, or the aircraft system will make the message available to the pilot.

6.6 Detailed Implementation

6.6.2 Detailed implementation and more specific operational requirements of the CPDLC functionality in a data link based ATM system are given in Part IV of this manual.

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

8. DATA LINK FLIGHT INFORMATION SERVICES (DFIS) APPLICATION OVERVIEW AND HIGH LEVEL OPERATIONAL REQUIREMENTS

8.2 DFIS Application Overview

8.2.2 In a data link ATS system, flight-related information (e.g., meteorological information and situational awareness) can be made available to aircraft in digital form. This information will assist the pilot by increasing flight safety and improving situational awareness.

8.2.4 Most of this information is currently delivered to the aircraft via voice. It is expected that the use of data link to transmit flight information will be implemented in an evolutionary manner. In the future, it is expected that DFIS will provide information that is not currently available to the aircraft.

8.2.6 As the system evolves, flight information may be provided through addressed (point to point) or broadcast data link media.

8.2.8 There are multiple DFIS Services that may be provided, including:

b) Automatic Terminal Information Services (ATIS),

d) Aviation Routine Weather Report (METAR) Service,

f) Terminal Weather Service (TWS),*

h) Windshear Advisory Service,

j) Pilot Report Service,*

l) Notice to Airmen (NOTAM) Service,

n) Runway Visual Range (RVR) Service,

p) Aerodrome Forecast (TAF) Service,

r) Precipitation Map Service,* and

t) SIGMET Service.

* no current ICAO requirement for the provision of this service at this time.

8.2.10 This manual describes the first two services provided through the DFIS application: ATIS Service and METAR Service. These two services are both described as addressed data link services.

8.4 DFIS High Level Operational Requirements

8.4.2 When DFIS is available, the information that is transmitted must be as accurate and up-to-date as required to meet the current operation.

8.4.4 Responses to requests for DFIS services must be provided in a timely manner.

8.6 Detailed Implementation

8.6.2 Detailed implementation and more specific operational requirements of the DFIS functionality in a data link based ATM system are given in Part V of this manual.

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

9. ATS INTERFACILITY DATA COMMUNICATION OVERVIEW (AIDC) AND HIGH LEVEL OPERATIONAL REQUIREMENTS

9.2 AIDC Application Overview

9.2.2 One of the keys to the future air traffic management system lies with the two-way exchange of data between aircraft and the ATC system, and between ATC systems. Communications with aircraft will increasingly employ digital data link. At the same time, automated data exchange between ATC systems will support timely dissemination of relevant flight data, particularly in regard to coordination and transfer of flights between ATS units.

9.2.4 The AIDC application exchanges information between ATS units in support of critical ATC functions, including notification of flights approaching a Flight Information Region (FIR) boundary, coordination of boundary crossing conditions, and transfer of control.

9.2.6 AIDC defines messages which are related to three phases of coordination as perceived by an ATSU.

b) Notify phase, in which the aircraft trajectory and any changes may be conveyed to an ATSU from the current ATSU prior to co-ordination;

d) Co-ordinate phase, in which the aircraft trajectory is co-ordinated between two or more ATSUs when the flight approaches a common boundary; and

f) Transfer phase, in which communications and executive control authority is transferred from one ATSU to another.

9.2.8 Other AIDC messages support ancillary ATC data exchanges between ATSUs, including the exchange of free-text messages.

9.4 AIDC High Level Operational Requirements

9.4.2 The system should be capable of facilitating automatic transfer of control and communications between ATS Units using digital data interchange.

9.6 Detailed Implementation

9.6.2 Detailed implementation and more specific operational requirements of the AIDC functionality in a data link based ATM system are given in Part VI of this manual.

PART I — OVERVIEW OF ATS DATA LINK APPLICATIONS

10. AUTOMATIC DEPENDENT SURVEILLANCE BROADCAST (ADS-B) APPLICATION OVERVIEW AND HIGH LEVEL OPERATIONAL REQUIREMENTS

10.2 ADS-B Application Overview

10.2.2 The capability for aircraft to provide aircraft position and other information to airborne and ground based systems is expected to be a part of the future ATS system. ADS-B is a surveillance application transmitting parameters, such as position, track and ground speed, via a broadcast mode data link for utilization by any air and/or ground users requiring it.

10.2.4 Each ADS-B capable emitter will periodically broadcast its position and other required data. Any user, either airborne or ground-based, within range of this broadcast may choose to receive and process this information. The emitter originating the broadcast need have no knowledge of what system(s) is receiving its broadcast. Because broadcast data might be received by the ground station at a rate in excess of the requirements of the ATC system, some filtering and/or tracking may be necessary.

10.2.6 ADS-B will permit enhanced airborne and ground situational awareness to provide for specific surveillance functions and cooperative pilot-controller and pilot-pilot ATM.

10.2.8 ADS-B will not be limited to the traditional roles associated with ground-based radar systems. ADS-B will provide opportunities for new functionality both onboard the aircraft and within the ground ATC automation systems.

10.2.10 ADS-B will have many benefits in extending the range beyond that of secondary surveillance radar, particularly in airport surface and low altitude airspace, and in air-to-air situational awareness.

10.2.12 The ADS-B application supports improved use of airspace, reduced ceiling/visibility restrictions, improved surface surveillance, and enhanced safety. ADS-B equipage may be extended to vehicles on the airport surface movement area, uncharted obstacles not identified by a current NOTAM, and non powered airborne vehicles or obstacles.

10.2.14 Depending on the implementation, ADS-B may encompass both air-ground and air-air surveillance functionality, as well as applications between and among aircraft on the ground and ground vehicles, including:

b) ATC surveillance,

d) Airborne situational awareness,

f) Conflict detection (both airborne and ground based),

h) ATC conformance monitoring, and

j) ADS-B lighting control and operation.

10.2.16 ADS-B services are expected to be implemented in an evolutionary manner. This manual addresses one of these services: ATC Surveillance.

10.4 ADS-B High Level Operational Requirements

10.4.2 An ATSU will be capable of knowing that an aircraft is ADS-B equipped.

10.4.4 All aircraft operating in an ADS-B airspace will broadcast as required by the ATS provider.

10.4.6 The ground system will receive, process, and display the ADS-B information.

10.4.8 Procedures and/or systems must be in place to validate the ADS-B information.

10.6 Detailed Implementation

10.6.2 Detailed implementation and more specific operational requirements of the ADS-B functionality in a data link based ATM system are given in Part VII of this manual.

PART II

DATA LINK INITIATION CAPABILITY (DLIC)

PART II — DATA LINK INITIATION CAPABILITY

2. APPLICATION OVERVIEW

2.2 Introduction

2.2.2 Purpose

2.2.2.2 This section contains guidance material for the Data Link Initiation Capability (DLIC). The DLIC process supports addressing requirements for Air Traffic Services such as Automatic Dependent Surveillance (ADS), Controller Pilot Data Link Communications (CPDLC), and Data Link Flight Information Services (DFIS).

2.2.4 Background

2.2.4.2 The DLIC provides the necessary information to enable data link communications between ATC ground and aircraft systems. The DLIC encompasses the following functions:

b) Logon: data link application initiation and, if required, flight plan association,

d) Update: updating of previously coordinated initiation information,

f) Contact: instructions to perform data link initiation with another specified ground system,

h) Dissemination: local dissemination of information, and

j) Ground Forwarding: forwarding of logon information.

PART II — DATA LINK INITIATION CAPABILITY

3. GENERAL REQUIREMENTS

3.2 DLIC Priority

3.2.2 The priority for DLIC will be "flight regularity communications", as determined by the ATN Internet Protocol Priority categorization.

3.4 DLIC Performance Requirements

3.4.2 Response Timers

3.4.2.2 Upon receipt of a Logon Request from an aircraft the ground system will generate a Logon Response within 0.5 second.

3.4.2.4 Upon receipt of a Contact Request from a ground system the aircraft will generate a Logon Request within 0.5 second to the indicated ground system.

3.4.2.6 Upon receipt of a Logon Response from a ground system, during the operation of a Contact function, the aircraft will generate a Contact Response within 0.5 second to the initiating ground system.

3.6 Time Requirements

3.6.2 Wherever time is indicated in the DLIC, it will be accurate to within 1 second of UTC.

3.6.4 Time stamping is required for all messages. The time stamp will consist of the date (YYMMDD) and time (HHMMSS).

3.8 Address Management

3.8.2 Procedures need to be in place to allow dissemination of DLIC ground addresses to aircraft. It is recommended that each ground facility supporting air-ground data link applications have DLIC addresses published in State AIPs. This would allow look-up tables to be imbedded in the flight deck avionics implementation, reducing pilot input.

Note.— A given FIR may have multiple DLIC addresses; and more than one FIR may share the same DLIC address.

PART II — DATA LINK INITIATION CAPABILITY

5. DLIC FUNCTIONAL CAPABILITIES

5.2 The DLIC Logon Function

5.2.2 Operational Requirements

5.2.2.2 The DLIC logon function must provide a method for an airborne system to initiate data link service with a ground system. The DLIC logon function must also provide the ground system with the capability to terminate a DLIC link.

5.2.2.4 The airborne system provides information on each application (e.g., ADS, CPDLC, and DFIS) for which it requires a data link service. Where ground initiated data link application services are requested, additional information may be provided to allow unambiguous association of the aircraft with flight plan information stored on the ground. Where service for exclusively air initiated applications is requested, the airborne system provides only the application information (i.e., name, and version).

5.2.2.6 The ground system responds indicating whether or not the data link initiation was successful, and indicates whether to terminate or maintain a DLIC link. If successful, the ground system response includes information on each data link application it can support. Unsuccessful logon will be handled by local procedures.

5.2.2.8 Up to a maximum of 256 applications must be supported.

5.2.2.10 Each time a logon is accomplished between a given aircraft and a ground system the latest exchanged information replaces any previous information for the indicated application.

5.2.2.12 When initiating the DLIC logon function the airborne system must provide its DLIC name, address, and version number as part of the Logon Request message.

5.2.2.14 The DLIC logon function will provide the capability for the ground system to accept any logon request. If the ground system does not have a flight plan for the aircraft requesting a logon, or the flight plan information from the aircraft does not correlate with the ground flight plan information appropriate to that aircraft, the ground system may not be capable of supplying information for a requested application.

5.2.2.16 The DLIC logon function will provide the capability to indicate a reason for rejecting a DLIC logon request.

5.2.4 Message Descriptions

5.2.4.2 The Logon Request message provides:

b) the aircraft*s DLIC address and version number,

d) the application name, version number and address, for each application that can be ground-initiated for which the aircraft requires service,

f) the application name and version number for each application which can be air-initiated, and

h) flight plan information when required.

5.2.4.4 The Logon Response message provides an indication of success or failure of the logon and if failure, may provide a reason for the failure. For each desired air-initiated application the ground provides the application name, version number, and address. For each ground-initiated application, the ground provides the application name and version number.

5.4 The DLIC Update Function

5.4.2 Operational Requirements

5.4.2.2 The DLIC update function must provide a method for the ground system to provide updated ground addressing information to an aircraft system for applications previously coordinated in the logon function.

5.4.2.4 Up to a maximum of 256 applications can be updated.

5.4.2.6 Each time an update function is accomplished between a given ground system and an aircraft, only the affected information is altered; other previously coordinated data remains valid.

5.4.3 Message Descriptions

5.4.3.1 An Update message can provide updated ground information for up to 256 applications. For each updated application the ground provides the air-initiated application*s name, version number and address. For each ground-initiated application, the ground provides the application name and version number.

5.6 The DLIC Contact Function

5.6.2 Operational Requirements

5.6.2.2 The DLIC contact function must provide a method for the ground system to request the aircraft system to initiate the logon function with another designated ground system. It is expected that the contact function will only be used when ground connectivity is not available between respective ground system applications. This function presumes that the logon function has been accomplished with the ground system initiating the contact function. After completing the requested logon process, or if unable to do so, the airborne system provides the ground system that issued the contact request a contact status that indicates the success or lack of success of the requested contact.

5.6.4 Message Descriptions

5.6.4.2 The Contact Request message provides the address of the next ground system that the initiating ground system is requesting the aircraft to logon with.

5.6.4.4 The Contact Response message provides the information indicating whether the requested contact with the next ground system was successful.

5.8 DLIC Dissemination Function

5.8.2 Operational Requirements

5.8.2.2 The DLIC dissemination function is a means of making application information available to other applications in the air or ground systems. It must make available the application name, address, and version number for each application exchanged in the logon, update or ground forwarding functions to other applications in the aircraft or on the ground.

5.8.4 Message Descriptions

5.8.4.2 There is no requirement for messages to be exchanged.

5.10 DLIC Ground Forwarding

5.10.2 Operational Requirements

5.10.2.2 Where ground-ground connectivity is available between ground systems, the DLIC ground forwarding function must provide a method for a ground system that has accomplished data link initiation to pass the airborne information to other data link ground system(s). Where this capability is implemented, an aircraft only has to perform an initial logon, and each subsequent ground system can use the DLIC update function to accomplish data link initiation.

5.10.2.4 The identical Logon Request message received by the ground system (from either an aircraft or another ground system via a previous DLIC ground forwarding), is used to ground forward data link initiation information between ground systems.

5.10.4 Message Descriptions

5.10.4.2 The Ground Forwarding message contains the airframe identification to which the information pertains and the same application and flight plan information as was contained in the initial Logon Request message.

5.12 Guidance on Expected DLIC Message Traffic

5.12.2 Appendix A to Part II Chapter 3 provides guidance on expected DLIC message traffic in specific airspace domains.

PART II — DATA LINK INITIATION CAPABILITY

CHAPTER 3 APPENDIX A

EXPECTED DLIC MESSAGE TRAFFIC

3A.2 Expected DLIC Message Traffic

3A.2.2 Table 3A-1 details the anticipated message exchange rate for DLIC in the environments specified. The rates shown are the expected averages, per flight.

PARAMETER	OCEANIC-CONTINENTAL ENROUTE LOW DENSITY	OCEANIC HIGH-DENSITY	CONTINENTAL HIGH-DENSITY	TERMINAL AREA HIGH-DENSITY	AERODROME (INCLUDING: APPROACH/ DEPARTURE/ TAXI)
DLIC message exchange per aircraft	2 per ATSU	2 per ATSU	2 per ATSU	2 per ATSU	2 per flight
Instantaneous number of aircraft to be supported per ATSU	300	750	1250	450	250

Table 3A-1. Exchange Rates Expected for DLIC Messages

PART II — DATA LINK INITIATION CAPABILITY

5. DLIC MESSAGES DESCRIPTION

5.2 DLIC Messages

5.2.2 Logon Request Message

5.2.2.2 The DLIC Logon Request message contains the following information:

b) DLIC address,

d) aircraft address,

f) aircraft applications (optional),

h) ground applications (optional),

j) aircraft identification (as required),

l) ICAO facility designation (as required),

n) Departure airport (as required),

p) Destination airport (as required), and

r) ETD (as required).

5.2.4 Logon Response Message

5.2.4.2 The DLIC Logon Response message contains the following information:

b) response,

d) failure reason (optional),

f) air applications (optional), and

h) ground applications (optional).

5.2.6 Update Message

5.2.6.2 The DLIC Update message contains the following information:

b) air applications (optional), and

d) ground applications (optional).

5.2.8 Contact Request Message

5.2.8.2 The DLIC Contact Request message contains the following information:

b) ICAO facility designation, and

d) DLIC address.

5.2.10 Contact Response Message

b) The DLIC Contact Response message contains only a response indicating whether or not the logon was successful.

5.2.12 Ground Forward Request Message

5.2.12.2 The DLIC Forward Request message contains the following information:

b) aircraft address,

d) air applications (if provided in Logon Request),

f) ground applications (if provided in Logon Request),

h) aircraft identification (if provided in Logon Request),

j) ICAO facility designation (if provided in Logon Request),

l) Departure airport (if provided in Logon Request),

n) Destination airport (if provided in Logon Request), and

p) ETD (if provided in Logon Request).

5.2.14 Ground Forward Response Message

5.2.14.2 The DLIC Ground Forward Response message contains only a response indicating success or failure.

5.4 Message Content Glossary

Air Applications: An indication of 1-256 airborne data link applications. Consists of *Application Name*, *Version Number*, and, when required for ground initiated applications, *Application Address* data.

Aircraft Identification: A group of letters, figures or a combination thereof which is identical to or the code equivalent of the aircraft callsign. It is used in Field 7 of the ICAO Model flight plan.

Aircraft Address: A unique combination of 24 bits available for assignment to an aircraft for the purpose of air-ground communications navigation and surveillance.

Airport: An IA5 string of 4 characters indicating an airport*s identification.

Application Address: An application*s unique technical communications address.

Application Name: An IA5 string of 3 characters indicating an application name (e.g., ADS, CPC, FIS, or CMA.)

Departure Airport: Name of departure airport.

Destination Airport: Name of destination airport.

DLIC Address: *Application Address* for DLIC.

ETD: Estimated time of departure.

Ground Applications: An indication of 1-256 ground data link applications. Consists of *Application Name*, *Version Number*, and, when required for air initiated applications, *Application Address* data.

HHMMSS: Hour, minutes, seconds.

Facility Designation: Specifies the ICAO four-letter location indicator or the ICAO eight-letter combined location indicator, three letters designator and an additional letter.

Response: An indication of whether the requested action was successful. The values are as specified:

b) success,

d) logon not successful, or

f) contact not successful.

Response Reason: Reason for logon failure.

Time: Time in hours and minutes.

Time Hours: Time as hours of day.

Time Minutes: Time as minutes of an hour.

Version Number: Version number of the specified application.

YYMMDD: Date in year, month, day

5.6 Data Structure Range and Resolution

5.6.2 Table 4-1 provides the range and resolution of the data structures used in DLIC.

DATA STRUCTURE	TYPE	RANGE	RESOLUTION
Aircraft Identification	IA5	2-7	N/A
Aircraft Address	Bit String	24 bits	N/A
Airport	IA5	4 characters	N/A
Application Name	IA5	3 characters	N/A
HHMMSS	Integer	HH - 00-23 MM - 00-59 SS - 00-59	1 1 1
ICAO Facility Designation	IA5	8 characters	N/A
Time Hours	Integer	0-23	1 hour
Time Minutes	Integer	0-59	1 minute
Version Number	Integer	0-255	1
YYMMDD	Integer	YY - 0-99 MM - 1-12 DD - 1-31	1 1 1

Table 4-1: DLIC Data Range and Resolution

PART II — DATA LINK INITIATION CAPABILITY

6. OPERATIONAL MESSAGE SEQUENCE

Note.— These sequence diagrams illustrate the expected message sequence for each DLIC function, and do not include exception handling.

6.2 Sequence Rules

6.2.2 DLIC Logon Function

6.2.2.2 The following sequence of messages, shown in Figure 5-1, occurs when the DLIC logon function is initiated.

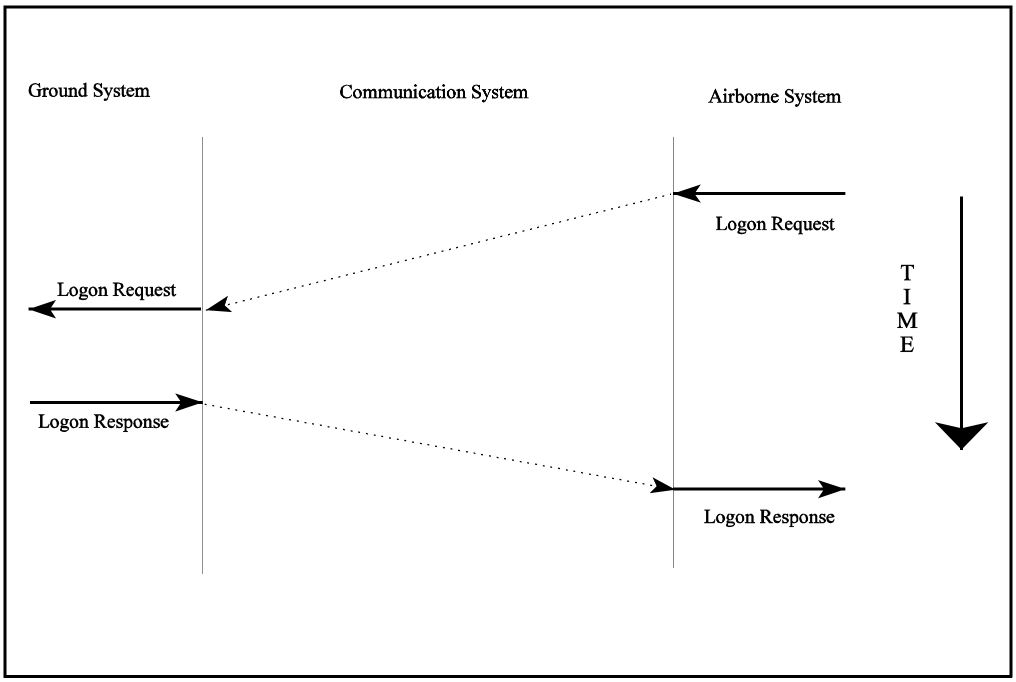


Figure 5-1: Sequence Diagram for DLIC Logon Function

6.2.4 DLIC Update Function

6.2.4.2 The following sequence of messages, shown in Figure 5-2, occurs when the DLIC update function is initiated.

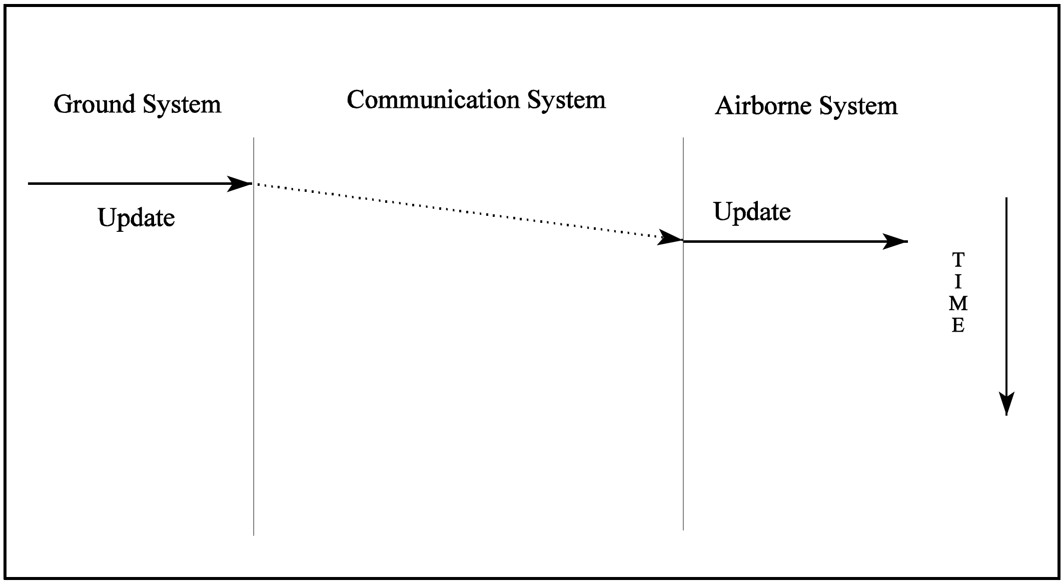


Figure 5-2: Sequence Diagram for DLIC Update Function

6.2.6 DLIC Contact Function

6.2.6.2 The following sequence of messages, shown in Figure 5-3, occurs when the DLIC contact function is initiated.

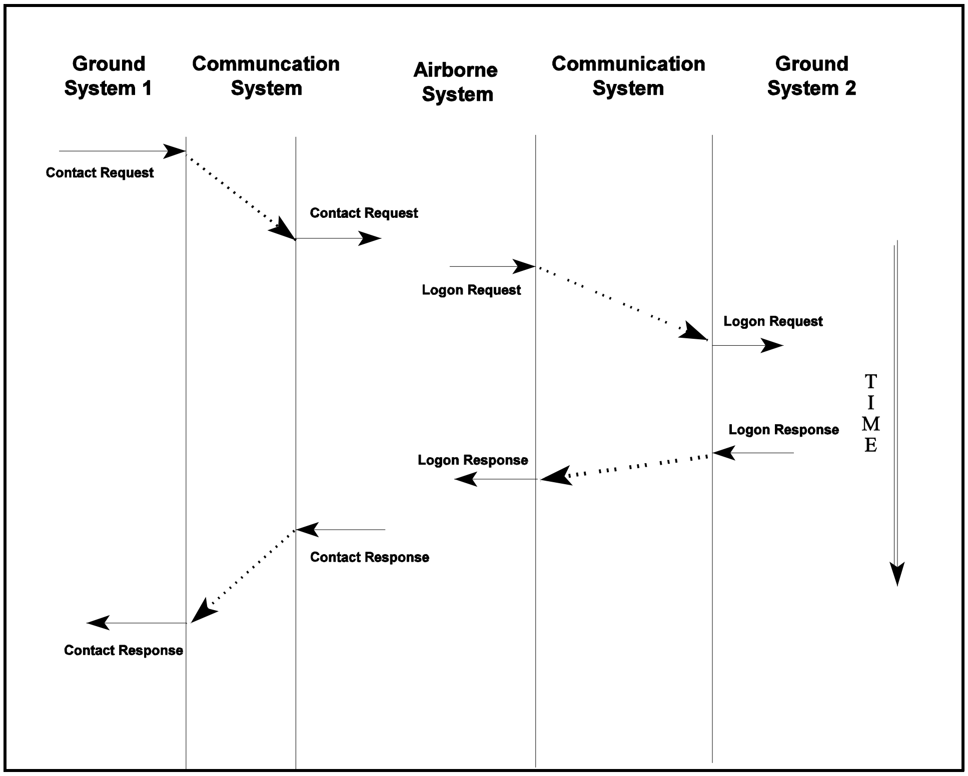


Figure 5-3: Sequence Diagram for DLIC contact function

6.2.6.4 DLIC Ground Forwarding Function

6.2.6.4.2 The following sequence of messages, shown in Figure 5-4, occurs when the DLIC ground forwarding function is initiated.

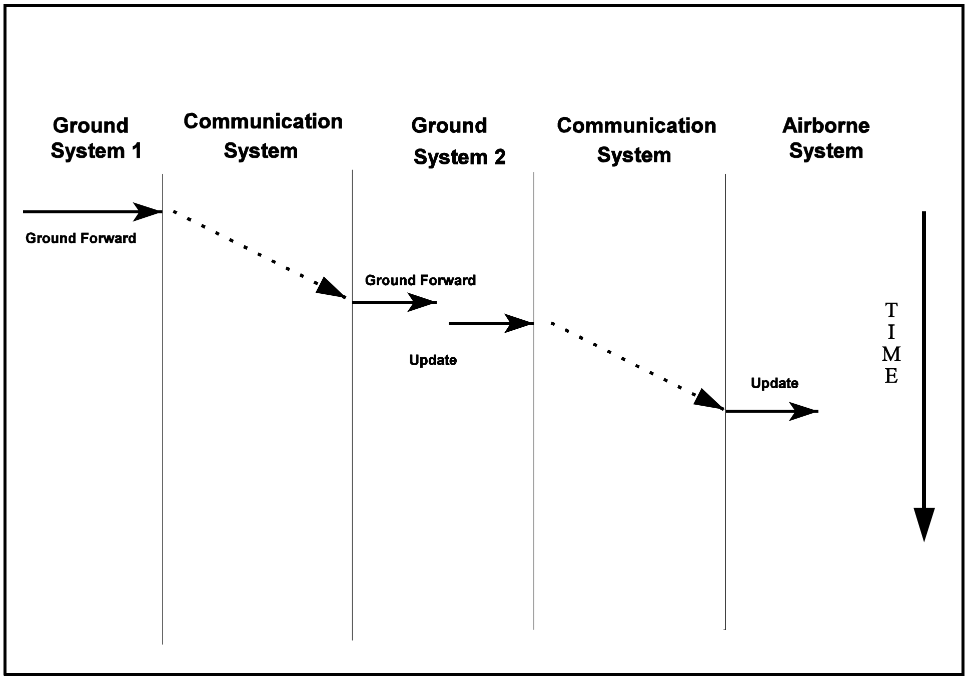


Figure 5-4: Sequence Diagram for DLIC Ground Forwarding Function

Note.— This diagram includes ground forwarding of addresses and subsequent update to an aircraft.

PART II — DATA LINK INITIATION CAPABILITY

7. DLIC PROCEDURES

7.2 Procedures

7.2.2 The procedures described here are the minimum required for initiation of data link services.

7.2.4 Sufficient procedures will be required for the airborne and ground system users to initiate the capability to provide and receive services via data link applications.

7.2.6 These procedures may be performed by automation, or manually by the pilot or controller depending upon the implementation.

7.2.8 The system will provide the pilot, controller, or automation with the capability to access initiation data for the purposes of conducting data link services. The information to an ATSU pair with regard to a specific aircraft must be unique.

7.4 Sequence of Events

7.4.2 An aircraft will inform a ground system of its requirement to participate in data link services by providing the information as outlined in 6.3 below.

7.4.4 A ground system will in turn provide that aircraft with the necessary information to establish a link with the desired application(s), (e.g., ADS, CPDLC, DFIS, etc.).

7.4.6 The DLIC application will make the initiation information available to other applications as required.

7.4.8 In the event that the initiation process fails, the airborne system/pilot will be informed.

7.6 Required Information

7.6.2 States will provide information regarding DLIC addresses and version numbers. This information should be published in Aeronautical Information Publications (AIPs).

7.8 DLIC Link Procedural Requirements

7.8.1 Whenever a DLIC link has been maintained by a ground system, it must later be closed by the same ground system.

Note.— An operational requirement for maintaining a DLIC link has been identified for small FIRs.

PART III

AUTOMATIC DEPENDENT SURVEILLANCE (ADS)

PART III AUTOMATIC DEPENDENT SURVEILLANCE

2. APPLICATION OVERVIEW

2.2 Introduction

2.2.2 This part of the manual contains guidance material for the Automatic Dependent Surveillance (ADS) application. ADS is a surveillance technique for use by air traffic services in which aircraft automatically provide, via a data link, data derived from on-board position-fixing and navigation systems. ADS will allow controllers to obtain position data and other information from ADS equipped aircraft in a timely manner in accordance with their requirements, and will allow the aircraft to be tracked in non-radar airspace.

2.2.4 The primary objective of the ADS application is to provide automated aircraft position data for ATC. The ADS application may also be useful in air traffic flow management (ATFM) and airspace management (ASM).

2.2.6 ATM benefits from the use of the ADS application may include separation minima reduction, and more efficient use of airspace.

2.2.8 Although the application of ADS does not specifically encompass ATC communications, automation or procedures, all of these elements must be tailored to support the ADS application and to make meaningful use of the data. Thus, it is critical to consider the ATC automation and communications systems as the foundation upon which an ADS-based ATC system is built. The implementation of ADS into air traffic systems will be an evolving process. There will be a gradual transition from procedurally-oriented strategic air traffic control towards a more tactical control environment.

2.2.10 The ADS application and associated communications will have to be supported by advanced airborne and ground facilities and data link communications with proven end-to-end integrity, reliability and availability.

2.2.12 ADS is one of the applications supported by the ATN.

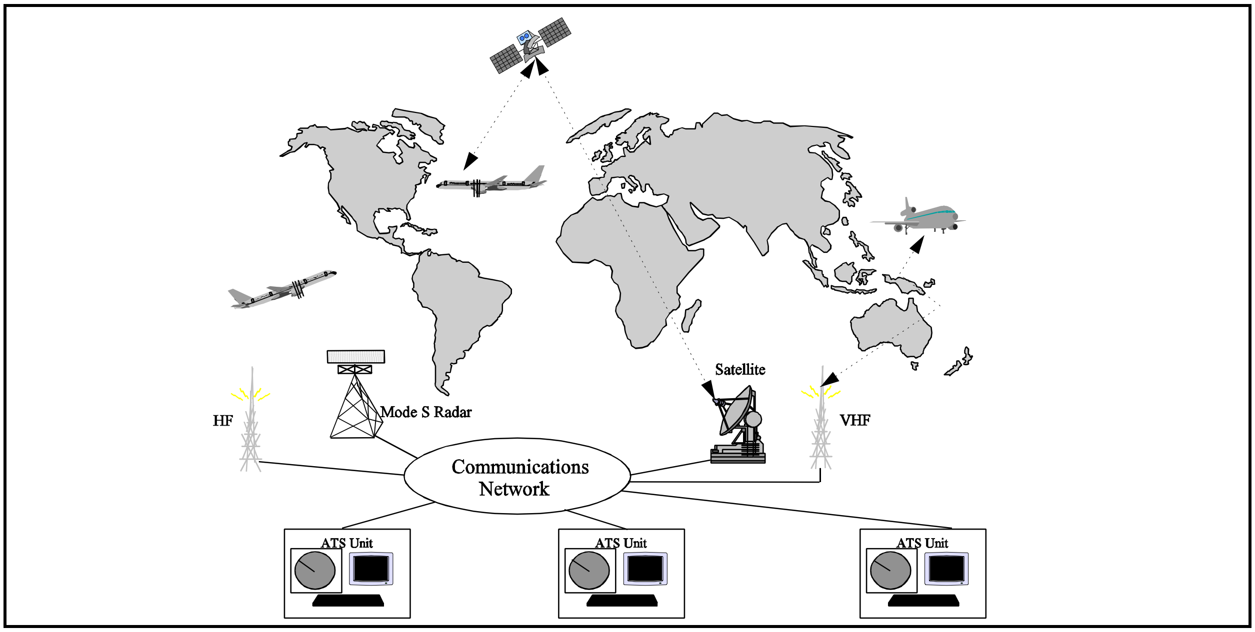


Figure 1-1 ADS System Concept

2.2.14 Figure 1-1 depicts a general overview of several components of an ADS system.

2.4 Use of ADS in ATS

2.4.2 The implementation of ADS, through reliable data link communications and accurate aircraft navigation systems, will provide surveillance services in oceanic airspace and other areas where non-radar air traffic control services are currently provided. The implementation of ADS will also provide benefits in en-route continental, terminal areas and on the airport surface. The automatic transmission of the aircraft position through ADS will replace present pilot position reports. The content and frequency of reporting will be determined by the controlling ATC unit. In non-radar airspace, the effective use of ADS in air traffic services will facilitate the reduction of separation minima, enhance flight safety and better accommodate user-preferred profiles.

2.4.4 Use of ADS Outside of Radar Coverage

2.4.4.2 In oceanic and other areas which are beyond the coverage of land-based radar, ADS reports will be used by ATS to improve position determination, resulting in improvements in safety, efficient utilization of airspace and improved controller efficiency. This is expected to increase airspace capacity and allow more economical routing and spacing of aircraft.

2.4.4.4 The introduction of ADS in non-radar airspace will better enable controllers to identify potential losses of separation or non-conformance with the flight plan and to take the appropriate action.

2.4.6 ADS Transition Airspace

2.4.6.2 In transition airspace where other means of surveillance become available, provisions are required to integrate ADS and other surveillance information. Further information is provided in Part III Chapter 1 Appendix A.

2.4.8 Within Radar Coverage

2.4.8.2 ADS will be beneficial in areas where it may serve as a supplement to or for back-up for radar. Further information is provided in Part III Chapter 1 Appendix A.

2.6 Functional Description

2.6.2 ADS information can assist ATC in performing the following functions:

b) *Position monitoring*. The ground system processes the incoming ADS Information to verify its validity and to compare the information with that held for the aircraft.

d) *Conformance monitoring*. The ADS reported position is compared to the expected aircraft position, which is based on the current flight plan. Longitudinal variations which exceed a pre-defined tolerance limit will be used to adjust expected arrival times at subsequent fixes. Horizontal and vertical deviations which exceed a pre-defined tolerance limit will permit an out-of-conformance alert to be issued to the controller.

f) *Conflict detection*, The ADS data can be used by the ground system automation to identify violation of separation minima.

h) *Conflict prediction*. The ADS position data can be used by the automation system to identify potential violations of separation minima.

j) *Conflict resolution*. ADS reports may be used by the automation system to develop possible solutions to potential conflicts when they are detected.

l) *Clearance validation*. Data contained in ADS reports are compared with the current clearance and discrepancies are identified.

n) *Tracking*. The tracking function is intended to extrapolate the current position of the aircraft based on ADS reports.

p) *Wind estimation*. ADS reports containing wind data may be used to update wind forecasts and hence expected arrival times at way-points.

r) *Flight management*. ADS reports may assist automation in generating optimum conflict-free clearances to support possible fuel-saving techniques such as cruise climbs requested by the operators.

2.6.4 ADS Agreements

2.6.4.2 The ATC unit controlling the aircraft should establish the composition and requirements for the transmission of ADS reports through an ADS agreement with the aircraft. This ADS agreement will be fulfilled by one or more contracts.

2.6.4.4 Where possible an ADS agreement should be established between an aircraft and the ground system prior to the entry into ADS airspace. An ADS agreement may also remain in effect for a period of time after an aircraft has exited ADS airspace.

2.6.4.6 Termination of an ADS agreement may be achieved automatically by the ground system.

PART III — AUTOMATIC DEPENDENT SURVEILLANCE

CHAPTER 1 APPENDIX A

INTEGRATION OF ADS AND SSR DATA

1A.2 Application Overview

1A.2.2 Introduction

1A.2.2.2 The safe operation of aircraft at close proximity requires an increase in the availability of very accurate positional data in order to apply separation closer to the minima and increase the airspace capacity. This material concerning the ADS/SSR integration offers guidance in order to achieve a single estimation of aircraft position, by processing both ADS and radar data (data fusion). Consequently, an enhancement of tracking algorithms is necessary in order to take advantage of all available surveillance sources as well as processing new parameters related to aircraft motion.

1A.2.2.4 The primary objective of the ADS/SSR integration technique is to take advantage of the surveillance concept of ADS, within areas covered by radar surveillance as well as transition areas between radar and ADS only coverage. Complete radar coverage in ADS/SSR airspace is not required, although outer horizontal limits should normally be coincident. In addition an ADS transition buffer zone is advisable. In areas where duplicate radar coverage is currently mandatory the integration of ADS might lead to a mitigation of that requirement, as well as for the provision of single radar coverage in areas where the installation of radar system is not feasible or economically justifiable.

1A.2.2.6 The use of the ADS/SSR integration in areas already having multiple radar coverage will provide the system with the capability of making track quality as uniform as possible within radar covered airspace, thus overcoming residual radar shortcomings. ADS/SSR integration will result in the augmentation of surveillance performance in existing radar environments, as well as beyond radar coverage. The ADS/SSR integration will result also in a more reliable data availability for conflict detection and conformance monitoring function thus reducing the probability of false alarms of this function. This will be essentially due to kinematic data measured on-board and availability of aircraft intent.

1A.2.2.8 Since the ADS technique relies upon the capability of an ADS facility to set up a contract with the aircraft to send reports with appropriate content and periodicity, the contract management function will play a key role in defining the most appropriate periodicity and content to optimize the ADS/SSR integration. The strategy to define the best contract for this function should take into account constraints on airspace and traffic scenario, as well as aircraft flight plan and communication infrastructure performances.

1A.4 Scope and Benefits

1A.4.2 The ADS/SSR data integration can provide the following improvements to the surveillance function:

b) automatic acquisition of certain airborne data containing parameters such as true track, speed, etc., which will improve the ground tracking of aircraft.

d) availability of surveillance data also when the radar limitations occur. These limitations are:

   2) mechanical rotation of the radar antenna, and

   4) garbling, fruit and splitting

f) coding of the altitude data in 25 feet increments and the availability of the vertical rate, as provided by Ground Vector or Air Vector, which will improve the ability of ATC to monitor and make high quality predictions of aircraft trajectories in the vertical plane, thus improving the Short-Term Conflict Alert (STCA) function to significantly reduce the number of false alarms;

h) automatic acquisition of aircraft call signs by ATC system, thus overcoming current problems connected with SSR code-call sign correlation and with radar identification and transfer procedures;

j) acquisition of surveillance data, when satellite data link is used to support the ADS function, also when radar shortcomings such as line of sight propagation limitations (e.g., shadowing by orography, earth curvature, low level flight) become apparent;

l) minimization of the number of SSRs required to supply mono-radar coverage, since ADS fills in the small areas not covered by them (“gap filler”);

n) increase of the level of availability using the ADS as one more level of redundancy;

p) availability of a means for a cross-check of ADS/Navigation data or radar integrity (NIM, Navigational Integrity Monitoring);

r) possibility of adapting the degree of surveillance redundancy for each aircraft according to instantaneous ATC needs, thus providing redundancy in a very cost effective manner.

1A.4.4 In general the improvements in a) to i) above are applicable to integration between ADS and Mode A/C conventional and monopulse SSR. In addition the improvements in e) to i) are applicable also to integrated systems using SSR Mode-S.

1A.6 Performance Considerations

1A.6.2 When considering ADS/SSR integration, the following should be taken into account:

b) performance requirements for ADS, including availability and integrity,

d) accuracy of both Radar and ADS position reports,

f) use of ADS data for example, as part of a data fusion and not just as back-up,

h) trajectory prediction requirements,

j) the development of a common surveillance processing system, where both the ADS and Radar tracks may be amalgamated to generate a single system track, and

l) the synchronization of both radar and ADS update rates.

1A.8 Additional Operational Considerations

1A.8.2 In addition to position information, the ADS/SSR integration process could benefit from aircraft periodically reporting further information such as:

b) Ground Vector, containing track, ground speed and vertical rate; and

d) Event ADS reports including lateral deviation, altitude, speed and FOM change.

1A.8.4 The use of this other data could substantially reduce the need for ADS periodic position reports.

1A.10 ADS Contract Considerations

1A.10.2 The following criteria may have to be taken into account when defining an optimal ADS contract strategy:

b) flight plans and related airspace information,

d) radar coverage maps,

f) communication network capabilities,

h) aircraft capabilities,

j) accuracy requirements, and

l) tracking needs

1A.10.4 It may be necessary to define a contract assignment for each phase of operations namely:

b) En-route navigation,

d) Terminal Area operations, and

f) Ground movements.

1A.12 En-Route Operations

1A.12.2 For this phase of operation the main ADS contract could be a periodic contract (Basic or Basic plus Ground Vector or Air Vector, depending on aircraft capability) with low reporting rate, since when the aircraft are flying straight and level, ground processing systems are able to achieve accurate position estimates.

1A.12.4 Use of ADS periodic reports containing basic information and Ground Vector when available, may allow a reduction in the data rate and an improvement in tracking.

1A.12.6 In addition, event contracts with the aircraft could allow the detection of the start of a manoeuvre. Such event contracts could indicate a change in one or more of the following kinematic parameters:

b) Lateral deviation,

d) Altitude,

f) Vertical rate,

h) Ground speed

j) FOM, and

l) Heading

1A.12.8 Extensive use of event reporting could minimize the number of required periodic reports.

1A.14 Terminal Area Operations

1A.14.2 For this phase of operation the main ADS contract is a periodic contract (Basic plus additional data, depending on aircraft capability) with high reporting rate, since this may be necessary to satisfy the required tracking accuracy.

1A.14.4 Use of ADS periodic reports with additional data (Ground Vector) when available, may help to minimize the reporting frequency of the required data.

1A.14.6 It is unlikely that in this phase of operations, event reports would be necessary, since the high periodic rate would already provide a good track reconstruction capability.

1A.16 Ground Movement Operations

1A.16.2 When the aircraft are moving on the airport surface the ADS contract could be a periodic contract with very high reporting rate, to insure that the required tracking accuracy is met.

1A.18 Transition

1A.18.2 During transition phases and while ADS separations equivalent to radar separations are not yet achievable, ADS information could be employed as an assistance and back-up to radar control service. If it is used as back-up appropriate large separations may need to be taken into account.

PART III — AUTOMATIC DEPENDENT SURVEILLANCE

3. GENERAL REQUIREMENTS

3.2 Performance Requirements

3.2.2 Systems developed to support ADS will be capable of meeting the communication performance appropriate for the phase of operation.

3.4 Message Handling

3.4.2 In addition to the general performance requirements in Part 1, the ADS application requires:

b) that messages are generated and sent in the time ordered sequence, and

d) that messages are delivered in the order that they are sent.

3.4.4 When ADS messages are queued by the ground system they will be handled in the following order:

b) emergency mode ADS reports,

d) event or demand ADS reports, and then

f) periodic ADS reports.

3.4.6 If more than one message is queued in a, b, or c in 2.2.2 above it will be handled in the order received.

3.6 Quality of Service

3.6.2 The ground system must have the ability to specify the required QOS based on a user preferred combination of message delay, cost, and permissible error rate.

3.8 Time Requirements

3.8.2 Wherever time is used in the ADS application, it will be accurate to within 1 second of UTC.

3.8.4 Time stamping will be available for all messages. The time stamp will consist of the date (YYMMDD) and time (HHMMSS).

3.10 ADS Priority

3.10.2 The priority for ADS will be “high priority flight safety messages” as determined by the ATN Internet Protocol Priority categorization.

3.12 ADS Operational Timers

3.12.2 In order to meet the more stringent of the performance requirements in Part I, the aircraft system should be capable of responding to a request for information within 0.5 second.

3.12.4 If the aircraft cannot respond with a reply message containing the requested information within 0.5 second, it sends a positive acknowledgment of receipt of the request, and must send the information within 30 seconds.

3.14 Source of ADS Data

3.14.2 ADS navigational data must be supplied by the on-board navigational equipment actually navigating the aircraft

3.14.4 Information contained within an ADS report should be no less recent than two seconds or ten percent of the periodic contract rate, if applicable, whichever is the shorter.

3.16 ADS Report Availability

3.16.2 ADS reports will be made available to facilities other than the controlling ATC unit on the basis of ICAO provisions or mutual agreement.

3.18 ADS Contract Requirements

3.18.2 The avionics will be capable of supporting contracts with at least four ATS ground systems simultaneously.

3.18.4 The avionics will be capable of supporting one demand, one event and one periodic contract with each ground system simultaneously.

3.18.6 The avionics must be capable of supporting a 60 seconds periodic contract reporting rate with each ground system simultaneously.

3.18.8 If a ground system requests a contract with an aircraft, and the aircraft cannot support any additional contracts the aircraft will reply with the ICAO facility designators of the ground systems with which it currently has contracts.

3.18.10 Procedures will be established to ensure that only appropriate ATC ground systems initiate ADS contracts with a given aircraft.

3.18.12 In the event of an unexpected termination of the ADS application, both the avionics and the ground system will be notified of the failure. The resumption of the ADS application is incumbent on the ground system.

3.18.14 An existing contract will remain in place until any new contract of the same type is accepted by both the avionics and the ground system, or until the contract type is terminated.

PART III — AUTOMATIC DEPENDENT SURVEILLANCE

4. ADS FUNCTIONAL CAPABILITIES

4.2 Background

4.2.2 The ADS application is designed to give automatic reports from an aircraft to a ground system. The aircraft provides the information to the ground system in four ways:

b) on demand,

d) when triggered by an event,

f) on a periodic basis, and

h) in an emergency.

4.2.4 The system will be capable of distinguishing each of the four ways listed above.

4.4 Operating Method

4.4.2 The ADS application comprises the following functions:

b) establishment and operation of a Demand Contract,

d) establishment and operation of an Event Contract,

f) establishment and operation of a Periodic Contract,

h) cancellation of all contract(s),

j) establishment and operation of Emergency Mode,

l) modification of the Emergency Mode, and

n) cancellation of the Emergency Mode.

4.6 Establishment and Operation of a Demand Contract

4.6.2 The Demand Contract provides the capability for a ground system to request a single ADS report from an aircraft and specify which optional ADS data is required (if any) in addition to the basic ADS report.

4.6.4 Any number of demand contracts may be sequentially established with an aircraft.

4.6.6 If the avionics can comply with the demand contract request it sends the requested report.

4.6.8 If there are errors in the contract request, or if the avionics cannot comply with the request, it sends a negative acknowledgment indicating the reason for rejection.

4.6.10 If the avionics can partially comply with the contract request, it sends a message which includes;

b) a non-compliance notification indicating those parts of the contract it cannot comply with,

d) the basic ADS report, and

f) the information requested which can be supplied.

4.6.12 If the Short Term Intent data block is to be requested as part of the contract request, then a projected time is to be included in the contract request.

4.6.14 If the Extended Projected Profile data block is to be requested as part of the contract request, then either a time interval or the number of prints to be provided is to be included in the contract request.

4.8 Establishment and Operation of an Event Contract

4.8.2 The event contract allows the ground system to request the avionics to send ADS reports when the specified events occur, principally for the purpose of conformance monitoring by ATC.

4.8.4 The event contract states the event types that are to trigger reports and also any required threshold values delimiting the event types.

4.8.6 An ADS event report comprises a basic ADS report and, if required by the triggering event, additional information may also be included.

4.8.8 Only one event contract may exist between a ground system and an aircraft at any one time, but this may contain multiple event types.

4.8.10 Each time an event contract is established it replaces any event contract already in place.

4.8.12 If the avionics can comply with the event contract request it sends an ADS report with basic information, any additional required information if required by the event type, and a positive acknowledgment. Should the contracted event occur, the required ADS report(s) is sent.

4.8.14 If there are errors in the event contract request, or if the avionics cannot comply with the request, it sends a negative acknowledgment to the ground system indicating the reason for its inability to accept the contract.

4.8.16 If the avionics can partially comply with the request, it sends a non-compliance notification indicating those parts of the contract with which it cannot comply. Event reports are subsequently sent only for those events that the aircraft can comply with.

4.8.18 Should an event for lateral deviation change, altitude range deviation, or vertical rate change occur, a report is sent once every minute while the limit(s) specified in the contract are exceeded. The reports will cease when the event parameters return within the specified thresholds. However, they will resume as soon as the event parameters are exceeded again. For all other events, a single report is sent every time the event occurs.

4.8.20 If more than one of the events described below occurs at the same time, the avionics sends separate ADS event reports for each event.

4.8.22 Event Types:

4.8.22.2 The following event types have been defined for ADS:

b) Vertical rate change,

d) Way-point change,

f) Lateral deviation change,

h) Level change,

j) Level range deviation,

l) Airspeed change,

n) Ground speed change,

p) Heading change,

r) Extended projected profile change,

t) FOM (Figure of Merit) field change, and

v) Track angle change.

4.8.22.4 Vertical Rate Change

4.8.22.4.2 The vertical rate change event can be triggered in two ways. For positive vertical rate, the event is triggered when the aircraft's rate of climb is greater than the vertical rate threshold i.e., its rate of climb is greater than planned. For negative vertical rate, the event is triggered when the aircraft's rate of descent is greater than the vertical rate threshold i.e., its rate of descent is greater than expected.

4.8.22.4.4 The ADS vertical rate event report is sent once every minute whenever the aircraft's rate of climb/descent exceeds the value of the vertical rate change threshold.

4.8.22.4.6 The avionics will cease sending ADS reports when the aircraft's rate of climb/decent is less than or equal to the value of vertical rate change threshold.

4.8.22.4.8 An ADS report sent as a result of the occurrence of a vertical rate change event will contain the basic ADS information and ground vector information.

4.8.22.4.10 Figure 3-1 illustrates a vertical rate change event.

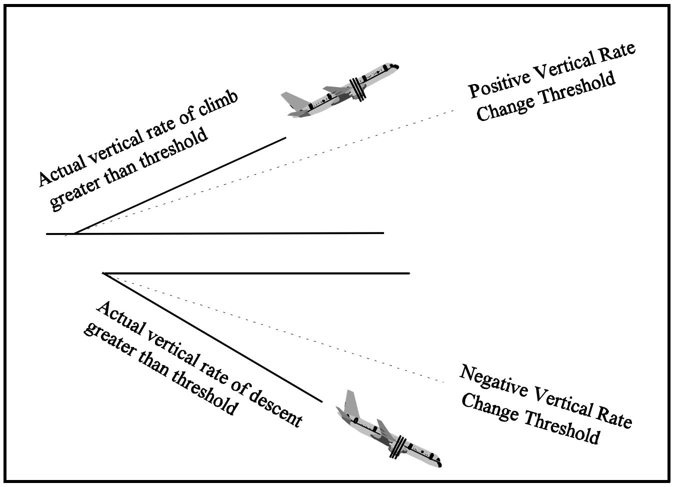


Figure 3-1: Illustration of Vertical Rate Event

4.8.22.6 Way-Point Change

4.8.22.6.2 The way-point change event is triggered by a change in the next way-point. This change is normally due to routine way point sequencing. However, it will also be triggered by a change in a way point which is not part of the ATC clearance but is entered by the pilot for operational reasons.

4.8.22.6.4 The ADS report resulting from a way-point change event is sent once each time the event occurs.

4.8.22.6.6 An ADS report sent as a result of the occurrence of a way-point change event contains the basic ADS information and the projected profile information.

4.8.22.6.8 Figure 3-2 illustrates the way-point change event.

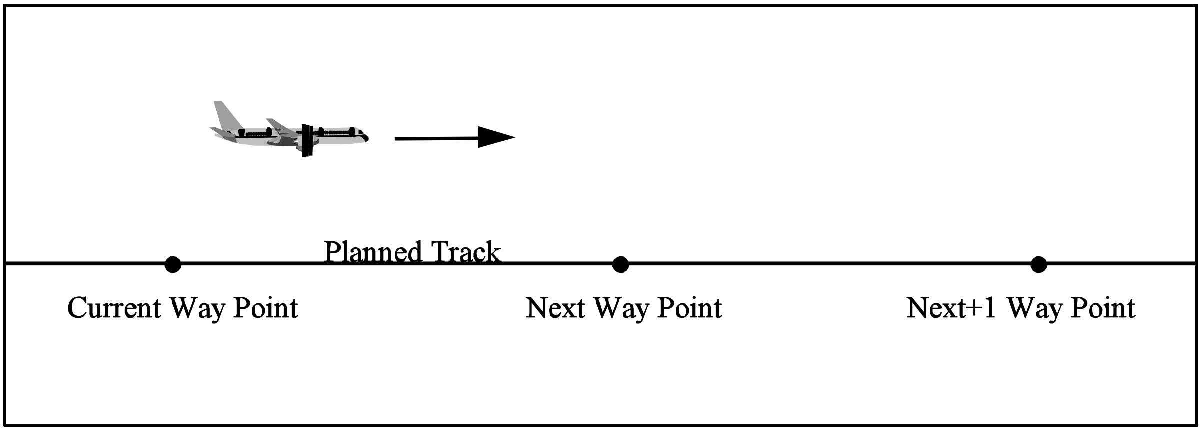


Figure 3-2: Illustration of Way-Point Change Event

4.8.22.8 Lateral Deviation Change

4.8.22.8.2 The lateral deviation change event is 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 becomes greater than the lateral deviation threshold.

4.8.22.8.4 The ADS lateral deviation change report is sent once every minute while the aircraft's lateral deviation is greater than the value of the lateral deviation threshold.

4.8.22.8.6 The avionics will cease sending ADS reports when the lateral deviation of the aircraft is less than or equal to the value of lateral deviation change threshold.

4.8.22.8.8 An ADS report sent as a result of the occurrence of a lateral deviation change event contains basic ADS information and ground vector information.

4.8.22.8.10 Figure 3-3 illustrates the lateral deviation change event.

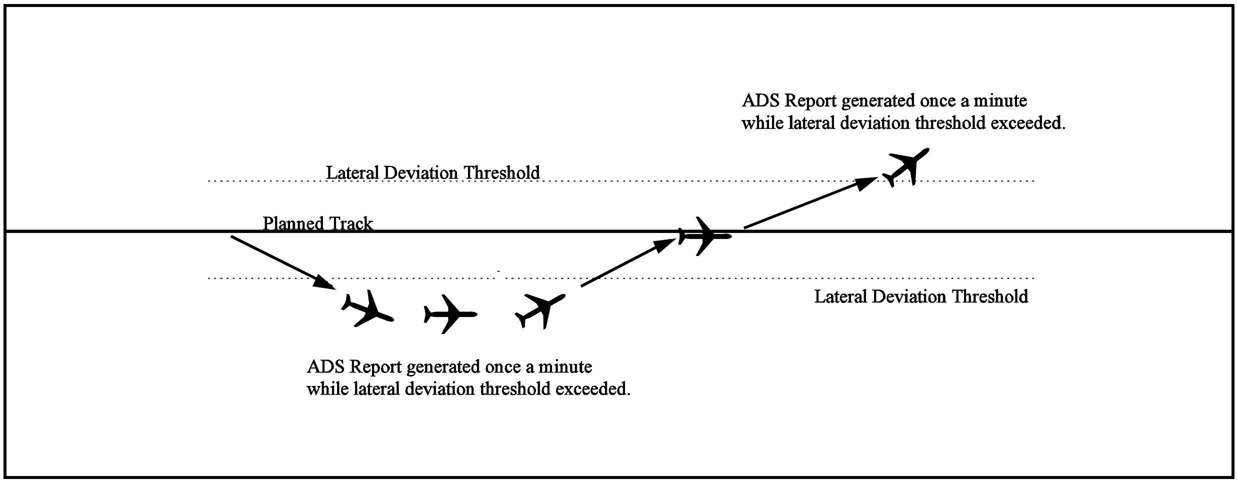


Figure 3-3: Illustration of Lateral Deviation Change Event

4.8.22.10 Level Change

4.8.22.10.2 The level change event report is triggered when the aircraft's level differs negatively or positively from its value in the previous ADS report, by an amount exceeding the level change threshold specified in the event contract request. If there has been no previous report, a basic ADS report is sent.

4.8.22.10.4 The ADS report resulting from an level change event is sent once each time the event occurs.

4.8.22.10.6 An ADS report sent as a result of the occurrence of an level change event contains basic ADS information and ground vector information.

4.8.22.10.8 Figure 3-4 illustrates an level change event.

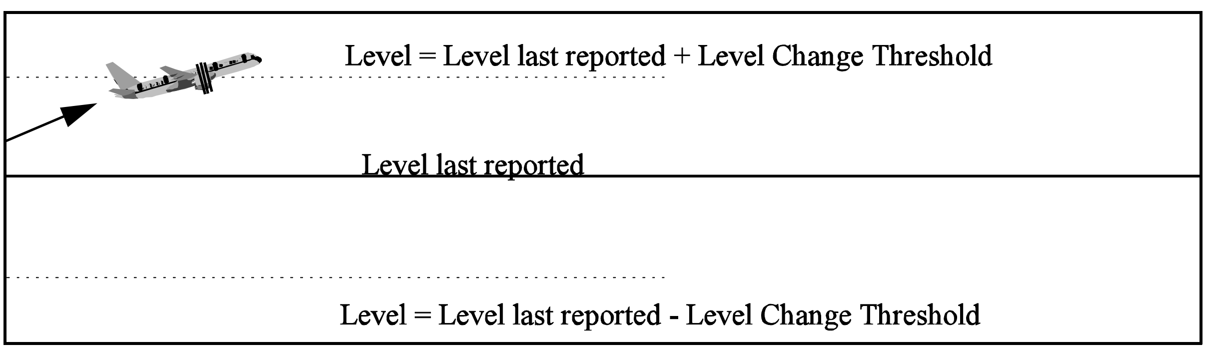


Figure 3-4: Illustration of Level Change Event

4.8.22.12 Level Range Deviation

4.8.22.12.2 The level range deviation is triggered when the aircraft's level is higher than the level ceiling or lower than the level floor.

4.8.22.12.4 The ADS level range deviation event report is sent once every minute when the aircraft's level is greater than the value of the level ceiling or less than the value of the level floor.

4.8.22.12.6 The avionics will cease sending ADS reports when its level is less than or equal to the value of level ceiling and greater than or equal to the value of the level floor.

4.8.22.12.8 An ADS report sent as a result of the occurrence of an level range deviation event report contains basic ADS information and ground vector information.

4.8.22.12.10 Figure 3-5 illustrates an level range deviation event.

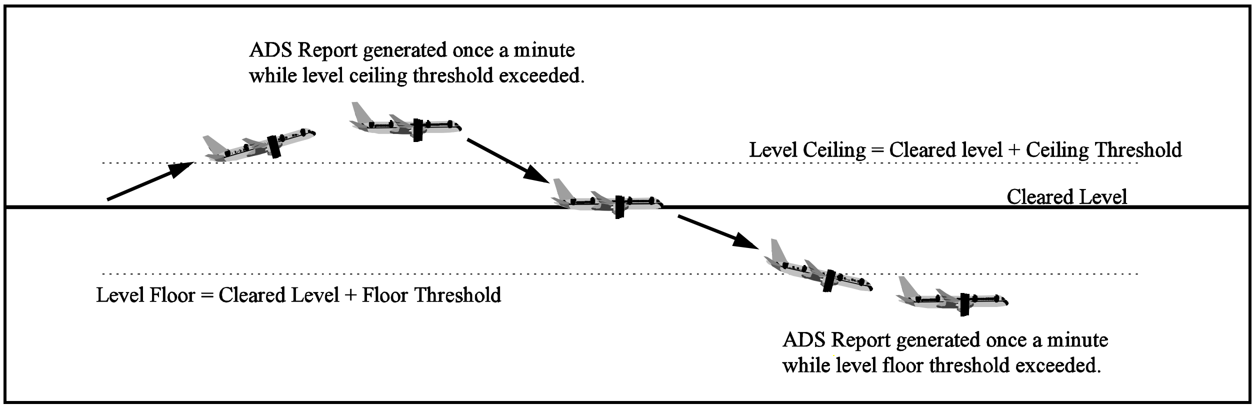


Figure 3-5: Illustration of a Level Range Deviation Event

4.8.22.14 Airspeed Change

4.8.22.14.2 The airspeed change event is triggered when the aircraft's airspeed differs negatively or positively from its value at the time of the previous ADS report containing an air vector, by an amount exceeding the airspeed change threshold specified in the event contract request. If there has been no previous report containing an air vector, a report is sent.

4.8.22.14.4 The ADS report resulting from an airspeed change event is sent once each time the event occurs.

4.8.22.14.6 An ADS report sent as a result of the occurrence of an airspeed change event contains basic ADS information and air vector information.

4.8.22.16 Ground Speed Change

4.8.22.16.2 The ground speed change event is triggered when the aircraft's ground speed differs negatively or positively from its value at the time of the previous ADS report containing a ground vector, by an amount exceeding the ground speed threshold specified in the event contract request. If there has been no such previous report containing a ground vector, a report is sent.

4.8.22.16.4 The ADS report resulting from a ground speed change event is sent once each time the event occurs.

4.8.22.16.6 An ADS report sent as a result of the occurrence of a ground speed change event contains basic ADS information and ground vector information.

4.8.22.18 Heading Change

4.8.22.18.2 The heading change event is triggered when the aircraft's heading differs negatively or positively from its value at the time of the previous ADS report containing an air vector, by an amount exceeding the heading change threshold specified in the event contract request. If there has been no previous report containing an air vector, a report is sent.

4.8.22.18.4 The ADS report resulting from a heading change event is sent once each time the event occurs.

4.8.22.18.6 An ADS report sent as a result of the occurrence of a heading change event contains basic ADS information and air vector information.

4.8.22.18.8 Figure 3-6 illustrates the heading change event.

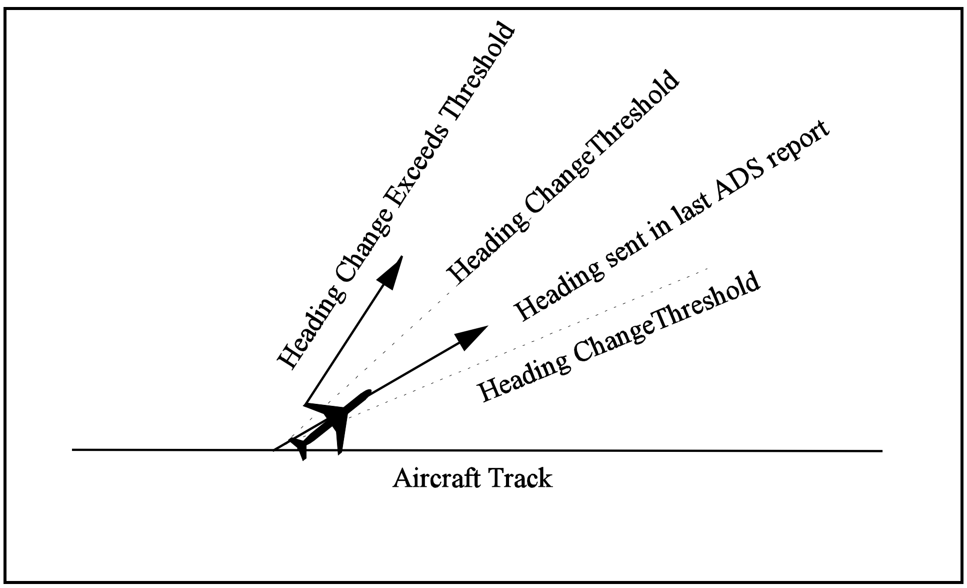


Figure 3-6: Illustration of Heading Change Event

4.8.22.20 Extended Projected Profile Change

4.8.22.20.2 The extended projected profile change event report is triggered by a change to any of the set of future way points that define the active route of flight. The number of way points covered in the contract is either defined by a specified time interval or a by selected number from the time of the request.

4.8.22.20.4 The ADS report resulting from an extended projected profile change event is sent once each time the event occurs.

4.8.22.20.6 An ADS report sent as a result of the occurrence of an extended projected profile change event contains basic ADS information and extended projected profile information with the waypoints covered by either the specified time interval or within the specified number of future waypoints.

4.8.22.22 FOM (Figure of Merit) Field Change

4.8.22.22.2 The FOM (Figure of Merit) field change event is triggered by change in the navigational accuracy, navigational system redundancy or in the Airborne Collision Avoidance System (ACAS) availability.

4.8.22.22.4 The ADS report resulting from a FOM field change event is sent once each time the event occurs.

4.8.22.22.6 An ADS report sent as a result of the occurrence of a FOM field change event contains only basic ADS information.

4.8.22.24 Track Angle Change

4.8.22.24.2 The track angle change event is triggered when the aircraft's track angle differs negatively or positively from its value at the time of the previous ADS report containing a ground vector, by an amount exceeding the track angle change threshold specified in the event contract request. If there has been no previous report containing a ground vector, a report is sent.

4.8.22.24.4 The ADS report resulting from a track angle change event is sent once each time the event occurs.

4.8.22.24.6 An ADS report sent as a result of the occurrence of a track angle change event contains basic ADS information and ground vector information.

4.8.22.24.8 Figure 3-7 illustrates the track angle change event.

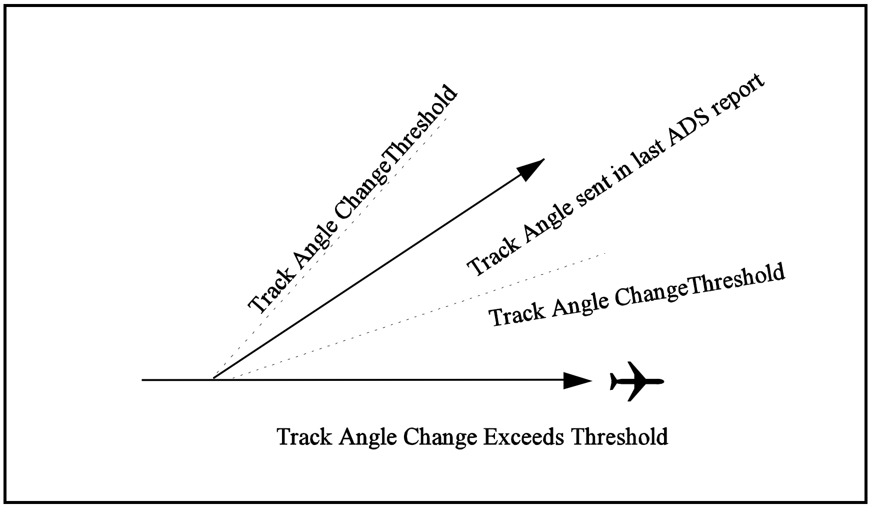


Figure 3-7: Illustration of Track Angle Change Event

4.10 Establishment and Operation of a Periodic Contract

4.10.2 The Periodic Contract provides the capability for a ground system to request periodic reports from an aircraft. The ground specifies which optional ADS data is required (if any) in addition to the basic ADS data. It also specifies the rate at which the basic ADS information is required and a modulus (multiple of the basic reporting rate) on the basic rate for each (if any) optional data required.

4.10.4 Only one periodic contract may exist between a given ground system and a given aircraft at any one time.

4.10.6 Each time a periodic contract is established, it replaces any periodic contract already in place.

4.10.8 If the avionics can comply with the periodic contract request it sends the requested ADS reports.

4.10.10 If there are errors in the periodic contract request, or if the avionics cannot comply with the periodic contract request, it sends a negative acknowledgment to the ground system indicating the reason for its inability to accept the contract.

4.10.12 If the avionics can partially comply with the request, it sends a non-compliance notification indicating which parts of the periodic contract cannot be complied with. Periodic reports are subsequently sent containing only the requested information that the avionics can supply.

4.10.14 If the avionics cannot meet the requested report rate it will send periodic reports at 1 minute intervals.

4.10.16 If the Short Term Intent data block is to be requested as part of the contract request, then a projected time is to be included in the contract request.

4.10.18 If the Extended Projected Profile data block is to be requested as part of the contract request, then either a time interval or the number of prints to be provided is to be included in the contract request.

4.12 Cancellation of Contract(s) Operation

4.12.2 Cancellation of Contracts allows the ground system to cancel a contract or all contracts that is (are) in operation. The ground system specifies what contracts will be canceled. The avionics acknowledges the cancellation and ceases sending the ADS reports for the canceled contract(s).

4.14 Establishment and Operation of Emergency Mode

4.14.2 This function allows the avionics to initiate emergency mode, either on instruction from the pilot or automatically. Emergency mode is entered between the aircraft and all ground systems that currently have periodic or event contracts established with that aircraft.

4.14.4 Any existing periodic contract is suspended during operation of the emergency mode. Neither an event nor a demand contract is affected. The emergency reporting rate on initiation of the emergency mode is the lesser of one minute or half of any existing periodic contract rate.

4.14.6 The position, time and FOM are sent with each ADS emergency mode report, and the aircraft identification and ground vector sent with every fifth message.

4.16 Modifying an Emergency Mode

4.16.2 This capability allows the ground system to send an emergency mode modification message to the avionics. The avionics modifies the reporting rate of the emergency mode, and then sends the emergency reports at the new interval. This only affects the emergency mode reports to the ground system making the request.

4.18 Cancellation of Emergency Mode

4.18.2 This function allows the pilot to cancel the emergency mode, or the ground system to cancel the emergency mode indication.

4.18.4 When the pilot cancels emergency mode , the avionics sends a cancel emergency mode message to each ground station receiving the emergency mode reports. If there was a periodic contract in place before the emergency was declared, it is reinstated.

4.18.6 When the ground system cancels the emergency mode indication, the avionics continues to send ADS reports to the ground system as in emergency mode, but the reports are no longer designated as emergency reports by the ground system.

4.20 Summary Table of ADS Functions

4.20.2 Table 3-1 summarizes ADS functionality described above.

MESSAGE	**PURPOSE**	**TRIGGERING CONDITIONS**	**SOURCE/ DESTINATION**
Demand Contract Request	Obtain single ADS report on demand, specifying what data are to be reported	Controller/FDPS request	Ground/Air
Periodic contract request	Request establishment of routine ADS reporting contract; specifying what data are to be reported and at what rate	Airspace proximity, changing airspace conditions	Ground/Air

MESSAGE	PURPOSE	TRIGGERING CONDITIONS	SOURCE/ DESTINATION
Event contract request	Request establishment of event ADS contract; specifying certain flight conditions under which relevant data will be reported	Airspace proximity, changing airspace conditions	Ground/Air
Non-compliance notification	Indicates which data cannot be complied with for a given contract	Contract establishment	Air/Ground
ADS report	Provide ADS data according to contract request	Contract conditions for initiating a report are met	Air/Ground
Cancel contract request	Request cancellation of a specific contract	Air traffic conditions no longer require certain reporting	Ground/Air
Cancel all contracts	Request cancellation of all contracts	Air traffic conditions no longer require any ADS reports from the avionics	Ground/Air
Cancel emergency mode	Indicates cancellation of previously declared emergency state	Pilot canceled emergency mode	Air/Ground
Negative acknowledgment	Indicates that an error has been detected or that the avionics cannot comply with any part of the contract, indicating reason	Contract establishment, cancellation	Air/Ground
Modify Emergency Mode	To change Emergency Mode Reporting Rate	Controller/FDPS request	Ground/Air
Acknowledgment	Indicates that avionics can comply with contract, however the avionics is unable to send the initial report within 0.5 seconds	Contract establishment, cancellation, Cancel emergency mode indication	Air/Ground

Table 3-1. ADS Functionality Summary

4.22 Appendices to Chapter 3

4.22.2 Appendix A to Part III Chapter 3 provides guidance on expected ADS message traffic in specific airspace domains.

PART III — AUTOMATIC DEPENDENT SURVEILLANCE

CHAPTER 3 APPENDIX A

ADS MESSAGE EXCHANGE RATES

1A.2 Table 3.A-1 details the possible message exchange rate in the environments specified. The rates shown are the expected averages, per flight, for ATS purposes.

	Oceanic-continental en route low density	Oceanic high-density	Continental high-density	Terminal area high-density	Aerodrome (includes approach, taxi and departure)
Demand Contract	1 to 3 per FIR/Sector	1 to 2 per FIR/Sector	1 to 2 per FIR/Sector	1 to 2 per FIR/Sector	3 - 6
Periodic contract request	1 to 3 per FIR/Sector	1 to 2 per FIR/Sector	1 to 2 per FIR/Sector	1 to 2 per FIR/Sector	3
Event contract request	1 - 3 perFIR/Sector	1 - 2 per FIR/Sector	1 per FIR/Sector	1 per FIR/Sector	2
Cancel contract request	2 per FIR	2 per FIR	2 per FIR	2 per FIR	2
ADS periodic report (with basic ADS)	1 every 15 to 30 min	1 every 5 to 15 min.	1 every 10 s. to 5 min.	1 every 3 to 10 s.	1 every 0.5 to 5 s.
Air and/or ground vector in ADS periodic report	1 - 3 perFIR/Sector	1 every 4th report	1 every 4th report	1 every 4th report	1 every 2nd report
Meteorological information in ADS periodic report	1 per waypoint, or 1 per hour	1 per waypoint, or 1 per hour	1 per waypoint, or 1 per hour	Negligible	Negligible
ADS event report with projected profile	1 per waypoint	1 per waypoint	1 per waypoint	1 per waypoint	1 per waypoint
ADS demand report with extended projected profile	1 per FIR	1 per FIR	1 per FIR	1 per FIR	1
Other ADS Messages	Under exceptional conditions	Under exceptional conditions	Under exceptional conditions	Under exceptional conditions	Under exceptional conditions

	Oceanic-continental en route low density	Oceanic high-density	Continental high-density	Terminal area high-density	Aerodrome (includes approach, taxi and departure)
Instantaneous number of aircraft to be supported per ATSU	300	750	1250	450	250

Table 3A-1. Exchange Rates Expected for ADS Messages

PART III — AUTOMATIC DEPENDENT SURVEILLANCE

5. ADS MESSAGES DESCRIPTION

5.2 Messages Description

5.2.2 Basic ADS Information

5.2.2.2 Every ADS report contains the following information:

b) the 3-D position of the aircraft (latitude, longitude, and altitude);

d) the time; and

f) an indication of the accuracy of the position data information (figure of merit).

5.2.4 Optional ADS Information

5.2.4.2 In addition to the basic information included in each ADS report, an ADS report may contain any (or all) of the following information:

b) aircraft identification,

d) ground vector,

f) air vector,

h) projected profile,

j) meteorological information,

l) short term intent,

n) intermediate intent, and

p) extended projected profile.

5.2.4.4 The aircraft identification is contained in field 7 of the ICAO flight plan.

5.2.4.6 The ADS ground vector is composed of the following information:

b) Track,

d) Ground speed, and

f) Rate of climb or descent.

5.2.4.8 The ADS air vector is composed of the following information:

b) Heading,

d) Mach or IAS, and

f) Rate of climb or descent.

5.2.4.10 The ADS projected profile is composed of the following information:

b) Next way-point;

d) Estimated altitude at next way-point;

f) Estimated time at next way-point;

h) (Next + 1) way-point;

j) Estimated altitude at (next + 1) way-point; and

l) Estimated time at (next + 1) way-point.

5.2.4.12 The ADS meteorological information is composed of the following:

b) Wind direction,

d) Wind speed,

f) Temperature, and

h) Turbulence.

5.2.4.14 The ADS short-term intent is composed of the following information:

b) Latitude at projected position,

d) Longitude at projected position,

f) Altitude at projected position, and

h) Time of projection.

5.2.4.14.2 If an altitude, track or speed change is predicted to occur between the aircraft's current position and the projected position (indicated above), additional information to the short term intent data would be provided as intermediate intent (repeated as necessary) as follows:

b) Distance from current point to change point,

d) Track from current point to change point,

f) Altitude at change point, and

h) Predicted time to change point.

5.2.4.16 The ADS Extended projected profile is composed of the following information:

b) Next way-point

d) Estimated altitude at next way-point

f) Estimated time at next way-point

h) (Next + 1) way-point,

j) Estimated altitude at (next + 1) way-point,

l) Estimated time at (next + 1) way-point,

n) (Next + 2) way-point,

p) Estimated altitude at (next + 2) way-point,

r) Estimated time at (next + 2) way-point...

t) ...[repeated for up to (next + 128) way-points]

5.2.6 Positive Acknowledgment

5.2.6.2 A positive acknowledgment indicates acceptance of a requested contract and contains no further information.

5.2.8 Negative Acknowledgment

5.2.8.2 A negative acknowledgment indicates rejection of the requested contract and may contain information on the cause for rejection.

5.2.10 Non-Compliance Notification

5.2.10.2 A non-compliance notification contains an indication on which part of a requested contract cannot be complied with.

5.2.12 Demand Contract Message

5.2.12.2 The demand contract message indicates the contract type and which of the optional ADS information is to be included in the ADS report.

5.2.14 Demand ADS Response Message

5.2.14.2 A demand ADS report contains the basic ADS data and the optional ADS data required in the demand contract.

5.2.16 Event Contract Message

5.2.16.2 The event contract message indicates the contract type, contains an indication of the events to be reported on, together with thresholds (as required) for each event specified.

5.2.18 ADS Event Response Messages

5.2.18.2 The event contract response message contains an identification of the event type and the required ADS data for the particular event.

5.2.20 Periodic Contract Message

5.2.20.2 The periodic contract message indicates the contract type, the required report interval, an indication of which of the optional ADS information is to be included in the periodic reports, and the modulus from the basic interval for each optional field to be included.

5.2.22 Periodic ADS Response Message

5.2.22.2 A periodic ADS report contains the basic ADS data and the optional ADS data required in the periodic contract.

5.2.24 Cancel Contract Message

5.2.24.2 The cancel contract message contains an indication of the contract (i.e., periodic, or event) to be canceled.

5.2.24.4 A cancel contract message without a contract type parameter indicates that all ADS contracts with the ground system are to be canceled.

5.2.26 Emergency Mode Messages

5.2.26.2 The position, time and FOM are sent with each ADS emergency mode report. In addition to the above, the aircraft identification and ground vector are sent with every fifth message.

5.2.28 Modify Emergency Mode Message

5.2.28.2 The emergency mode modification message contains only a new reporting rate.

5.2.30 Cancel Emergency Mode Message

5.2.30.2 The cancel emergency mode message indicates that the pilot has canceled the emergency mode.

5.2.32 ADS Message Glossary and Message Variable Range and Resolution

5.2.32.2 An ADS data glossary is provided in Appendix A to this chapter.

5.2.32.4 The range and resolution for variables used in ADS messages is presented in Appendix B to this chapter.

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CHAPTER 4 APPENDIX A

ADS MESSAGE DATA GLOSSARY

4A.2 ADS Message Data Glossary

4A.2.2 The following data are used as the ADS message variables, or component of the variables, and are shown here in alphabetical order:

ADS Event Report*:* ADS information consisting of a sequence of *Event Type* and *ADS Report*.

ADS Emergency Report: ADS information consisting of the following sequence:

b) Position,

d) Time Stamp,

f) FOM,

h) Aircraft Identification (optional), and

j) Ground Vector (optional).

ADS Report: ADS information consisting of the following sequence:

b) Position,

d) Time Stamp,

f) FOM,

h) Aircraft Identification (optional),

j) Projected Profile (optional),

l) Ground Vector (optional),

n) Air Vector (optional),

p) Meteorological Information (optional),

r) Short Term Intent (optional), and

t) Extended Projected Profile (optional).

Aircraft Identification: A group of letters, figures or a combination thereof which is identical to or the code equivalent of the aircraft callsign. It is used in Field 7 of the ICAO model flight plan.

Air Speed*:* Provides airspeed as a choice of the following*: Mach, IAS,* or *Mach* and *IAS.*

Air Speed Change: Provides the threshold of change for either Mach speed or indicated air speed that requires that the avionics generates an ADS report when the current aircraft speed differs more than the specified threshold from the air speed in the last ADS report.

Air Vector: Provides the air vector as a sequence of *Heading, Air Speed,* and *Vertical Rate*.

Altitude*:* Specifies altitude.

Level Ceiling: The altitude above which an Level Deviation Event is triggered. Provided as a *Level.*

Level Change*:* Provides the threshold of change for level that requires the avionics to generate an ADS report when the current level differs by more than the specified threshold from the level in the last ADS report.

Level Floor: The level below which an Level Deviation Event is triggered. Provided as a *Level*.

Level Range Change: Threshold of change permissible between levels in consecutive ADS reports.

Cancel Contract: Allow the ground to cancel event and/or periodic contracts in effect.

Contract Type*:* Indicates which type of ADS contract is specified: demand, event, or periodic.

Demand Contract: Indicates that an avionics is to generate an ADS report containing the indicated data upon receipt of the contract. The data that can be indicated includes: aircraft identification, projected profile, ground vector, air vector, meteorological information, short term intent, and extended projected profile.

Distance: Distance.

ETA: Estimated time of arrival at a waypoint.

Event Contract: Indicates *Event Types* and the threshold for the specified event types.

Event Type: An indication of what type of ADS event is specified,

b) Vertical rate change,

d) Way-point change,

f) Lateral deviation change,

h) Level change,

j) Level range deviation,

l) Airspeed change,

n) Ground speed change,

p) Heading change,

r) Extended projected profile change,

t) FOM (Figure of Merit) field change, and

v) Track angle change.

Extended Projected Profile*:* Provides a sequence (1-128) of waypoint position data and ETA at the specified waypoint.

Extended Projected Profile Change*:* Indicates that an ADS report be generated when there is a change in the extended projected profile.

Extended Projected Profile Modulus: Sequence of *Modulus* and *Extended Projected Profile Request.*

Extended Projected Profile Request*:* a choice indicating whether the extended projected profile information is to be provided on a time or waypoint interval, and the interval of the specified choice.

Following Way Point: Indicates the waypoint after the next way point.

FOM: Indicates the figure of merit of the current ADS data. The information consists of the *Position Accuracy* and indications 1) whether or not multiple navigational units are operating, and 2) whether or not ACAS is available.

FOM Field Change: Indicates that an ADS report be generated when any FOM field changes.

Ground Speed*:* Provides ground speed.

Ground Speed Change: Provides the threshold of change for ground speed that requires the avionics to generate an ADS report when the current aircraft ground speed has differed by more than the specified threshold from the last ADS report.

Ground Vector: Provides the ground vector of an aircraft provided as a sequence of *Track, Ground Speed*, and *Vertical Rate*.

Heading*:* Provides aircraft heading in degrees.

Heading Change: Provides the threshold of change for heading in degrees that requires the avionics to generate an ADS report when the current heading has differed by more than the specified threshold from the last ADS report.

IAS*:* Indicated air speed.

ICAO Facility Designator*:* The 8 letter code which uniquely defines an ICAO ATSU facility.

Intermediate Intent: Set of points between current position and the time indicated in *the Short Term Intent*. Consists of a sequence of the following: *Distance*, *Track*, *Altitude* and *Projected Time.*

Lateral Deviation Change: Provides the threshold of change for lateral value that requires the avionics to generate an ADS report when the current lateral deviation exceeds the specified threshold.

Latitude*:* Latitude in degrees, minutes, and seconds.

Longitude*:* Longitude in degrees, minutes, and seconds.

Mach*:* Air speed given as a Mach number.

Mach and IAS: Air speed provided as both *Mach* and *Indicated Air Speed*.

Meteorological Information: A sequence of *Wind Direction*, *Wind Speed*, *Temperature* and *Turbulence*.

Modulus*:* Provides a multiplier on the basic ADS report interval.

Next Time: Time at next waypoint.

Next Way Point: Specifies the next waypoint in the avionics.

Non-Compliance Notification: Used to indicate partial compliance to a contract.

Periodic Contract: Provides the requirements for the generation of ADS reports. The periodic contract provides the reporting interval, and the modulus for when and what optional data is included in an ADS periodic report.

Position: Provides aircraft position information using a sequence of *Latitude*, *Longitude*, and *Altitude.*

Position Accuracy: An indication of the navigational accuracy.

Projected Profile: A sequence of *Next Way Point*, *Next Time*, and *Following Waypoint*.

Projected Time: Predicted time at a particular point.

Reporting Interval: Provides the required ADS reporting interval.

Report Type: Indicates which type of ADS report is provided: demand, event or periodic.

Request Type: A choice indicating which type of ADS request is being uplinked. The choices are as indicated below:

b) cancel event contract,

d) cancel periodic contract,

f) demand contract,

h) event contract,

j) modify emergency reporting rate,

l) periodic contract, or

n) cancel all contracts.

Short Term Intent*:* A sequence of *Position, ETA,* and *Intermediate Intent (optional)* data structures.

Temperature*:* Temperature in degrees Celsius.

Track: Provides track angle in degrees.

Track Angle Change: Provides the threshold of change for track angle in degrees which triggers avionics to generate an ADS report when the current track angle differs by more than the specified threshold from the track angle in the last ADS report.

Turbulence*:* Indicates severity of turbulence.

Vertical Rate: Rate of climb/descent (climb positive, descent negative).

Vertical Rate Change: The threshold of change for vertical rate that requires the avionics to generate an ADS report when the current vertical rate differs by more than the specified threshold from the vertical rate in the last ADS report.

Way Point Change*:* Change in the next waypoint information.

Wind Direction: Wind direction in degrees.

Wind Speed: Wind speed.

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CHAPTER 4 APPENDIX B

ADS VARIABLES RANGE AND RESOLUTION

1B.2 ADS Variables Range and Resolution

1B.4 Table 4B-1 provides the required range and resolution for the message variables used in the ADS application.

Note 1. – Different States have different requirements with respect to units of measurement. The units described below have been defined to meet this need. Conversion from the local measurement to units, should be made by the transmitting application. Conversion from units to the local measurement should be made by the receiving application.

Unit of altitude = 1 altitude-unit = 3.02400 metres = 9.92126 feet (midway between 3 metres and 10 feet)

a) to convert from altitude-unit to metres, multiply by: 3.02400
b) to convert from altitude-unit to feet, multiply by: 9.92126
c) to convert from metres to altitude-unit, multiply by: 0.33069
d) to convert from feet to altitude-unit, multiply by: 0.10079

Unit of speed = 1 speed-unit = 0.9633 km/hour = 0.51980 knots (midway between half a knot and one kilometre per hour)

a) to convert from speed-unit to km/hour, multiply by: 0.96330
b) to convert from speed-unit to knots, multiply by: 0.51980
c) to convert from km/hour to speed-unit, multiply by: 1.03801
d) to convert from knots to speed-unit, multiply by: 1.92382

Unit of Distance = 1 dist-unit = 0.769813 NM = 1.426568 km (midway between 1 NM and 1 km, assuming a value of 1 NM = 6079.935ft)

a) to convert from dist-units to km, multiply by: 1.42657
b) to convert from dist-units to NM, multiply by: 0.769813
c) to convert from km to dist-units, multiply by: 0.700983
d) to convert from NM to dist-units, multiply by: 1.299801

Note 2. – Where units indicate directional information, the value is given relative to true North. If magnetic information is required, this will be a matter for local ground implementation.

Category	Variables/Parameters	Unit	Range	Resolution
Aircraft identification		IA5	2-7 characters	N/A
Level		LevelUnits	-10 to +10 000	1
Level Range Change		LevelUnits	1 - 110	1
Airspeed	Mach	Mach number	0.5 - 4.0	0.001
	IAS	Speed-unit	-110 - + 4200	1
Date	Year	Year of Century	0 - 99	1
	Month	Month of Year	1 - 12	1
	Day	Day of Month	1 - 31	1
Distance		Distance Units	1-8000	1
FOM		Integer	0-7	1
Ground Speed		Speed-unit	-110 - + 4200	1
Ground Speed Change		Speed-unit	0-500	1
Heading		Degrees	0.1 - 360	0.1
Heading Change		Degrees	1 - 359	1

Category	Variables/Parameters	Unit	Range	Resolution
ICAO Facility Designator		Character string	8	N/A
Lateral Deviation Change		Distance Units	1-200	1
Latitude	Latitude Degrees	Degrees	± 90	1
	Latitude Minutes	Minutes	0 - 59	1
	Latitude Seconds	Seconds	0 - 59.9	0.1
Longitude	Longitude Degrees	Degrees	± 180	1
	Longitude Minutes	Minutes	0 - 59	1
	Longitude Seconds	Seconds	0 - 59.9	0.1
Modulus		Integer	1-100	1
Reporting Interval		Second	1-59	1
		Minutes	1-120	1
Temperature	Temperature Celsius	Degrees Celsius	- 100 to + 100	1
Time	Time Hours	Hours of Day	0 - 23	1
	Time Minutes	Minutes of Hour	0 - 59	1
	Time Seconds	Seconds of Minute	0 - 59	1

Category	Variables/Parameters	Unit	Range	Resolution
Track	Track Angle	Degrees	0.1 - 360	0.1
Track Angle Change		Degrees	1 - 359	1
Turbulence	Relative measure	Bit string	0 - 15*	N/A
Vertical Rate		Altitude Units/Minute	-3310 to +3310	1
Wind	Wind direction	Degrees	1 - 360	1
	Wind Speed	Speed Units	0 - 600	1

Table 4B-1: ADS Variables Range and Resolution

* To be decided

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6. ADS MESSAGE SEQUENCES

Note.— These sequence diagrams illustrate the expected message sequence for each ADS function, and do not illustrate exception handling.

6.2 ADS Demand Contract

6.2.2 The following sequence of messages, shown in Figure 5-1, occurs when the ADS Demand Contract is sent and the avionics can comply with the request.

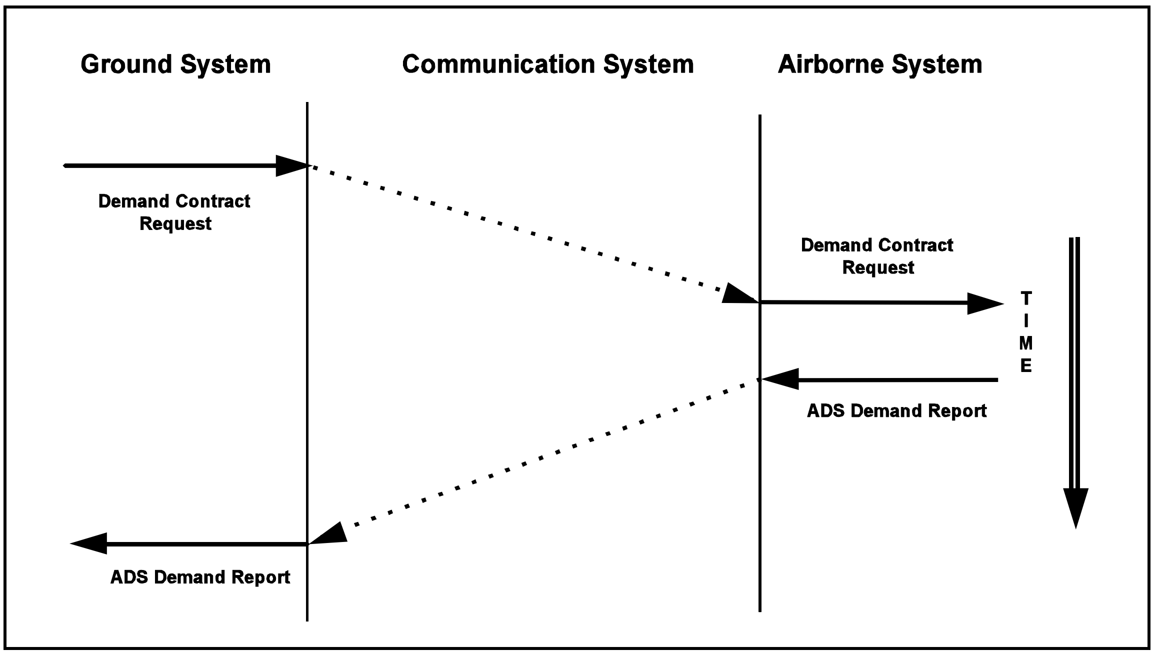


Figure 5-1: Demand Contract Request with ADS Demand Report

6.2.4 The following sequence of messages, shown in Figure 5-2, occurs when the ADS Demand Contract is sent and the avionics cannot comply with the request.

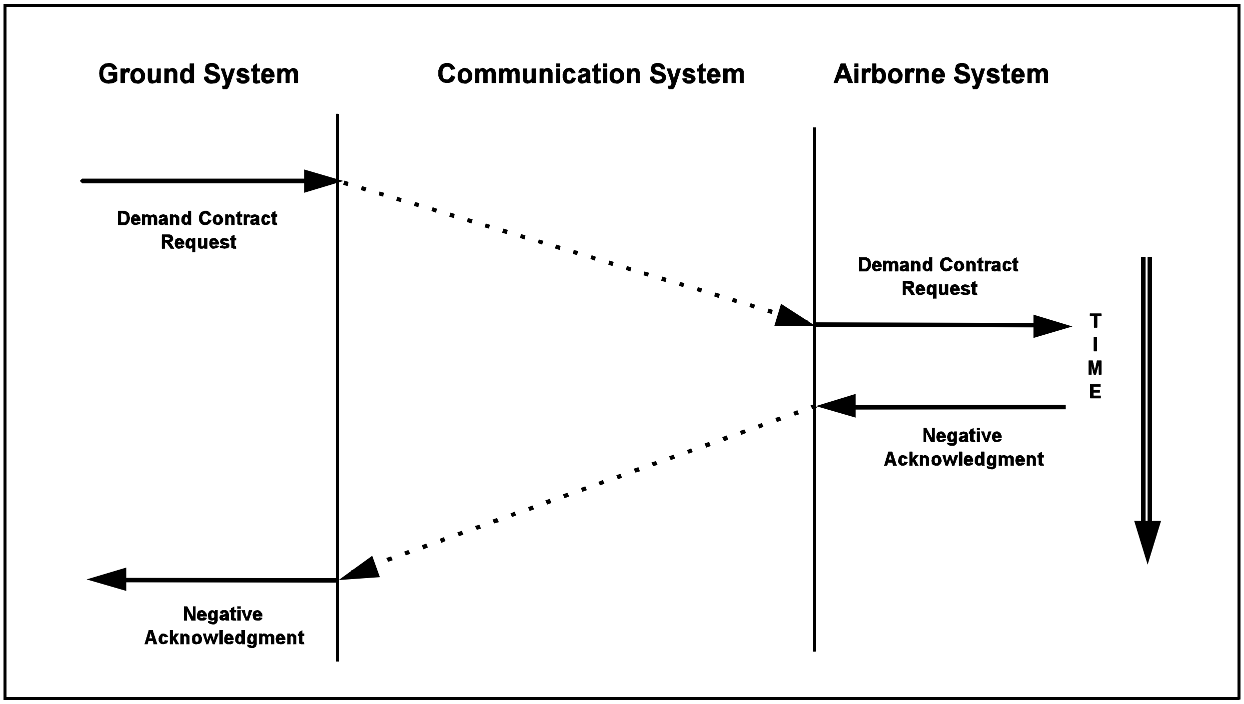


Figure 5-2: Demand Contract Request with Negative Acknowledgment

6.2.6 The following sequence of messages, shown in Figure 5-3, occurs when the ADS Demand Contract is sent and the avionics cannot comply fully with the request.

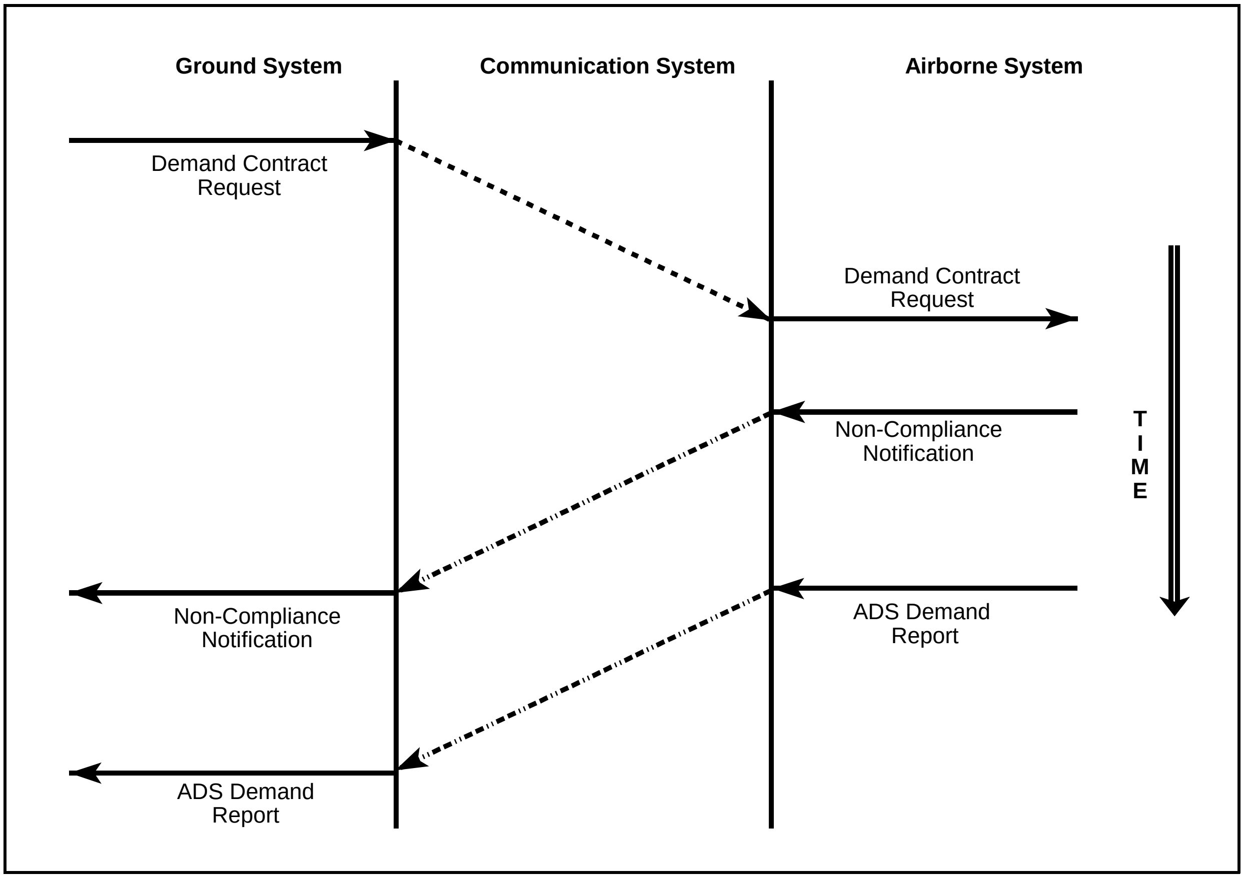


Figure 5-3: Demand Contract Request with Non-Compliance Notification

6.4 ADS Event Contract

6.4.2 The following sequence of messages, shown in Figure 5-4, occurs when an ADS Event Contract is sent and the avionics can comply with the request.

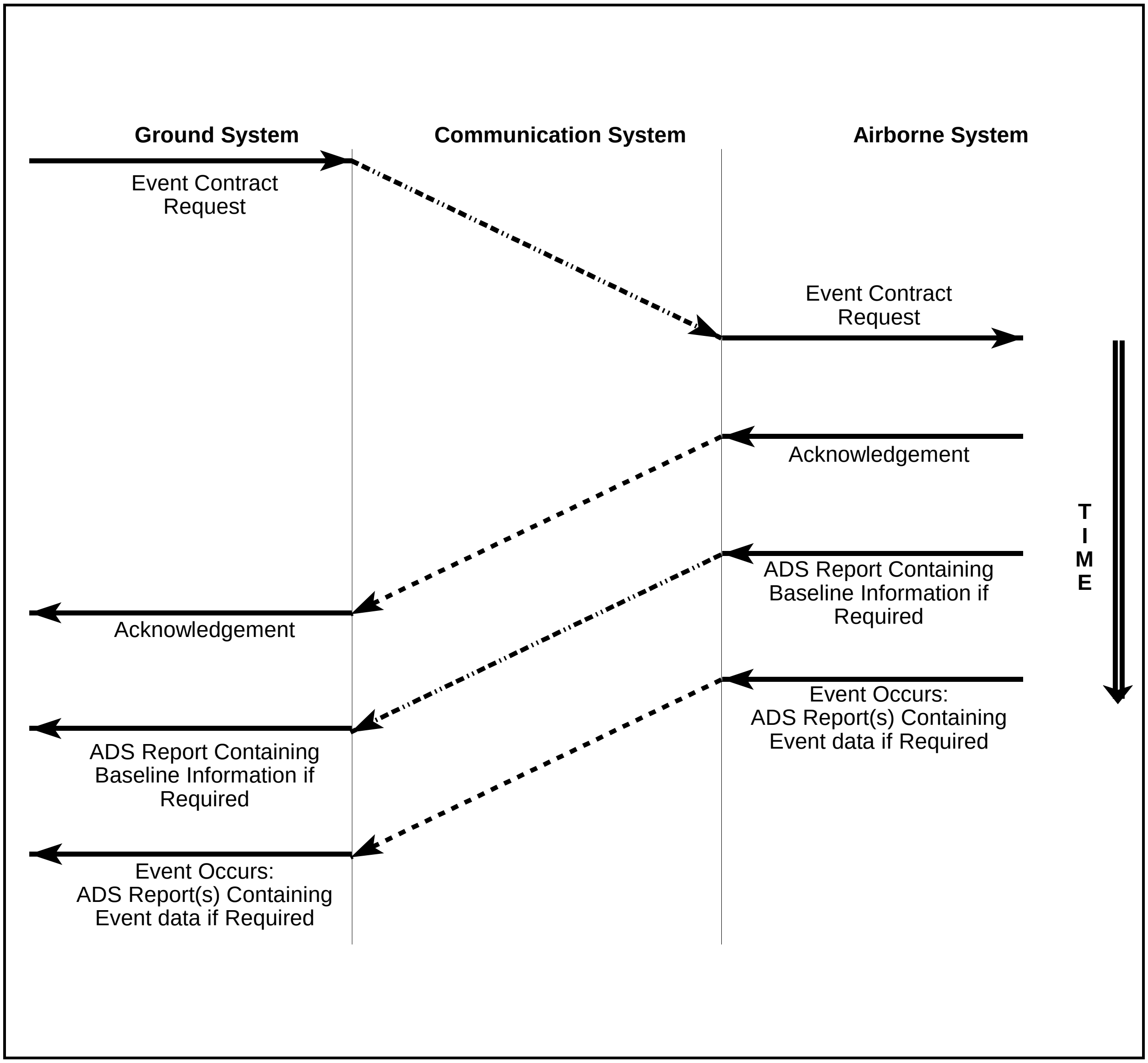


Figure 5-4: Event Contract Request, Aircraft can Comply

6.4.4 The following sequence of messages, shown in Figure 5-5, occurs when the ADS Event Contract is sent and the avionics cannot comply with the request.

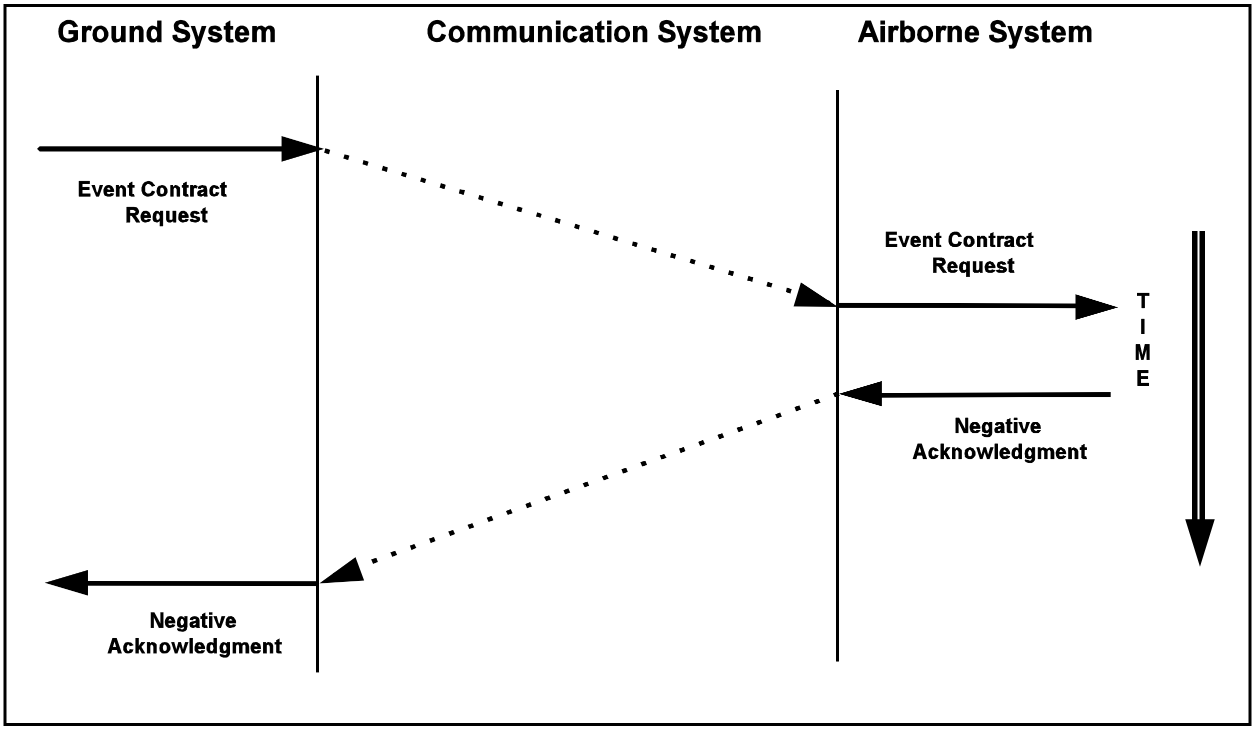


Figure 5-5: Event Contract Request with Negative Acknowledgment

6.4.6 The following sequence of messages, shown in Figure 5-6 occurs when the ADS Event Contract is sent and the avionics cannot comply fully with the request.

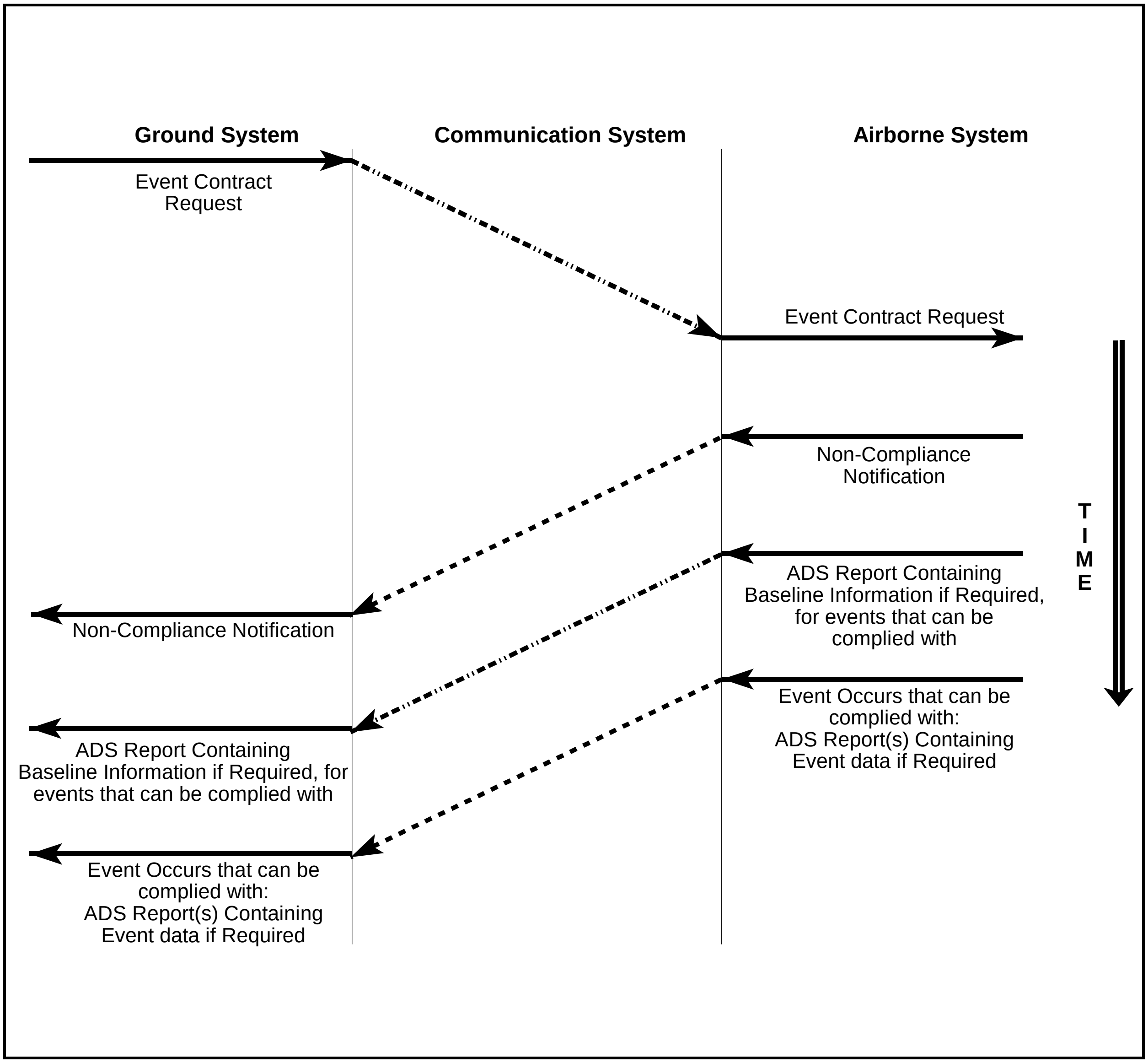


Figure 5-6: Event Contract Request with Non-Compliance Notification

6.6 ADS Periodic Contract

6.6.2 The following sequence of messages, shown in Figure 5-7, occurs when an ADS Periodic Contract is sent and the avionics can comply with the request.

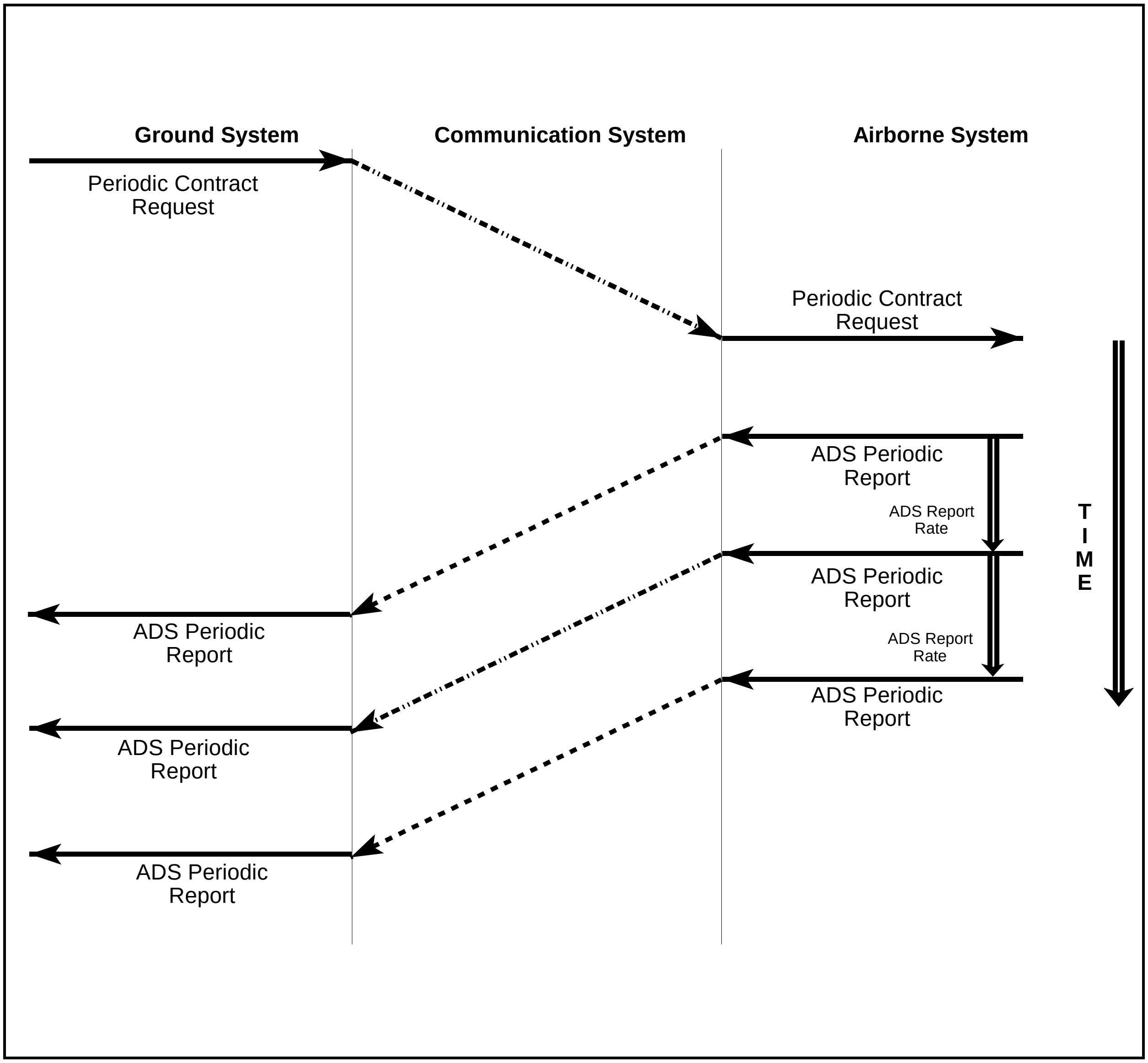


Figure 5-7: Periodic Contract Request, Aircraft can Comply

6.6.4 The following sequence of messages, shown in Figure 5-8, occurs when the ADS Periodic Contract is sent and the avionics cannot comply with the request.

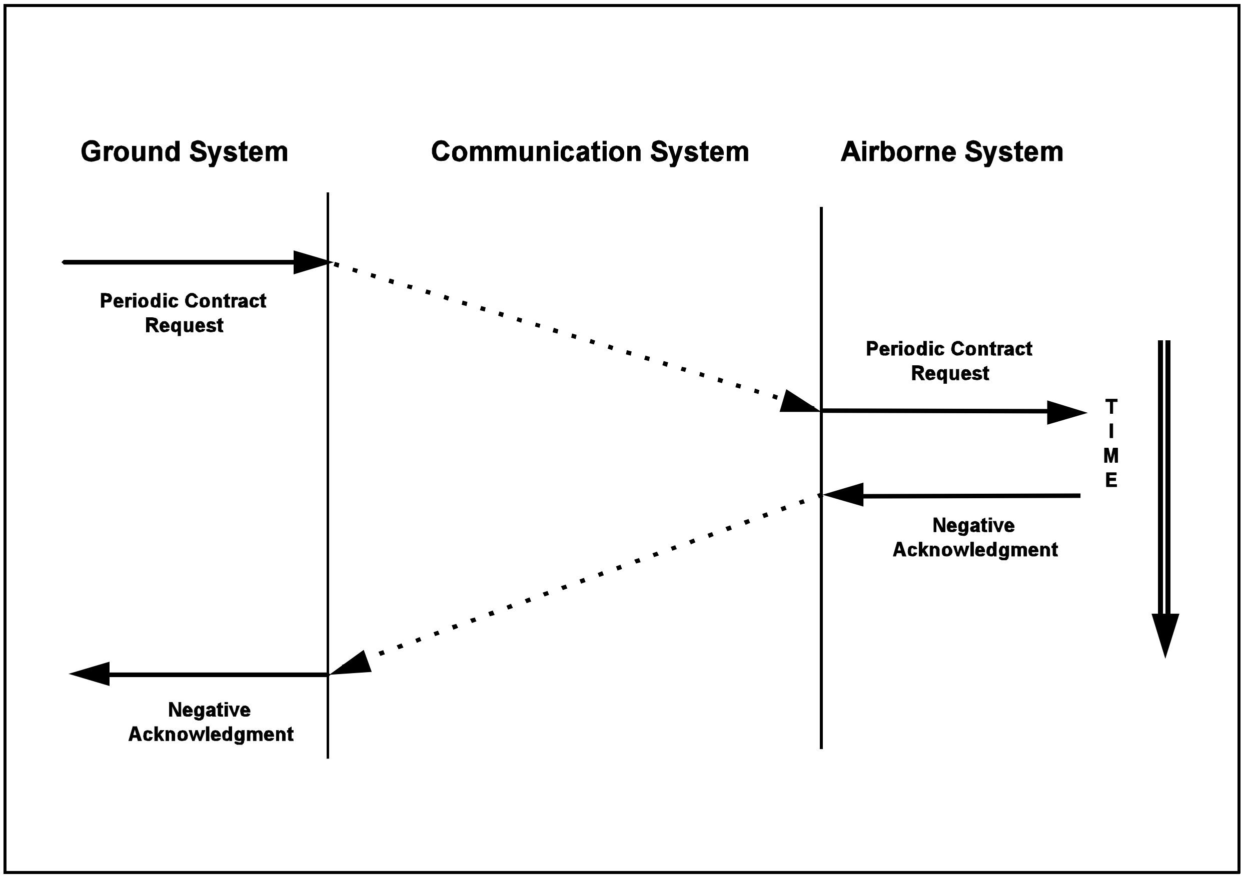


Figure 5-8: Periodic Contract Request with Negative Acknowledgment

6.6.6 The following sequence of messages, shown in Figure 5-9 occurs when the ADS Periodic Contract is sent and the avionics cannot comply fully with the request.

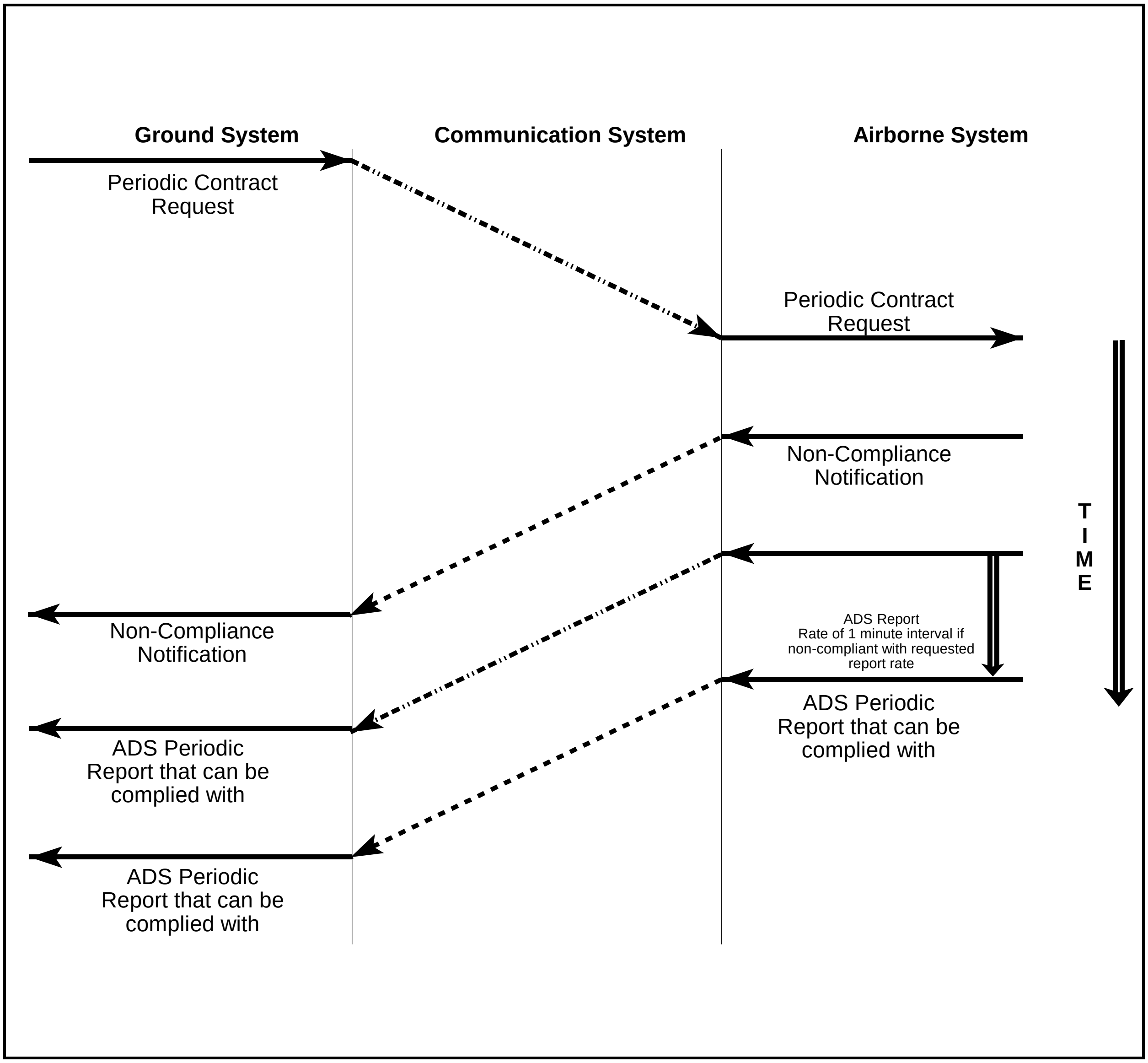


Figure 5-9: Periodic Contract Request with Non-Compliance Notification

PART III — AUTOMATIC DEPENDENT SURVEILLANCE

7. ADS PROCEDURES

7.2 Introduction

7.2.2 As stated earlier in the document, operational requirements do not necessarily need a technical solution, but may be satisfied by the institution of suitable local or inter-facility procedures.

7.4 Procedures for Effective use of ADS

7.4.2 Advance information on the data link capabilities of participating aircraft needs to be known to the appropriate ground facilities. While this is envisaged as being contained in the flight plan, procedures must be in place to enable this information to be exchanged between units in areas where other methods of indicating aircraft intent are used.

7.4.4 In line with current practice, the transferring ground system will advise the receiving ground system of the capabilities and intent of the aircraft wishing to enter the receiving ground system airspace to permit proper entry of the information into the receiving ground system automation.

7.4.6 While at least four ADS contracts may be simultaneously in force, appropriate local procedures will need to be in place to ensure that non-current contracts are dropped in sufficient time to allow the receiving ground system to set up the controlling ADS contract. Such procedures will also take care of the case where aircraft are crossing from airspace where ADS service is provided into non-ADS airspace, to ensure closure of all ADS contracts, and thus efficient use of resources.

7.4.8 The probability exists that errors may be input into the aircraft navigation system prior to departure. Since ADS is by definition dependent on the on-board navigation system, procedures will be required to ensure pre-departure conformance checking in order to correct these errors.

7.4.10 As ADS will be implemented regionally to different levels of capability, with a mixed-equipage aircraft fleet, procedures will be necessary between adjacent ATS facilities to ensure efficient levels of service to all aircraft users.

7.4.12 It is anticipated that specific ATC procedures will be developed as experience is gained with the system, and as appropriate separation minima are developed for global use.

7.4.14 ATS providers should ensure that the number of separation standards applied in a given airspace are kept to a minimum.

7.4.16 In a mixed environment, the source of surveillance data should be readily apparent to the controller.

7.4.18 In a mixed environment, procedures must be in place to ensure that all sources of the display refresh rate will be synchronous regardless of the source of surveillance information data.

PART III — AUTOMATIC DEPENDENT SURVEILLANCE

8. EXCEPTION HANDLING

8.2 Handling of Messages Received Out of Sequence

8.2.2 The sequencing of messages between an airborne system and a ground system is dependent on the type of contract established.

8.2.4 If the ground system receives messages of the same contract type out of sequence, as determined by the time stamping of the messages, the ground system will terminate that contract and notify both the controller and the airborne system.

8.4 Non Receipt of Messages

8.4.2 Non receipt of requested demand and periodic contracts reports will be a matter for local implementation.

8.4.4 Non receipt of requested baseline information as part of an event contract will be a matter for local implementation.

Note: Non receipt of event contract reports may be undetectable.

8.6 Invalid Data and Logical Errors

8.6.2 Ground systems will be capable of detecting logical errors and invalid data. In these circumstances the controller will be notified.

PART IV

CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC)

PART IV — CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC)

2. APPLICATION OVERVIEW

2.2 Introduction

2.2.2 Controller pilot data link communication (CPDLC) is a means of communication between controller and pilot, using data link for ATC communication.

2.2.4 The CPDLC application provides air-ground data communication for ATC service. This includes a set of clearance/information/request message elements which correspond to voice phraseology employed by Air Traffic Control procedures. The controller is provided with the capability to issue level 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. The pilot is, in addition, provided with capability to request conditional clearances (downstream) and information from a downstream ATSU. A “free text” capability is also provided to exchange information not conforming to defined formats. An auxiliary capability is provided to allow a ground system to use data link to forward a CPDLC message to another ground system.

2.2.6 Controllers and pilots will use CPDLC in conjunction with the existing voice communication. It is expected to be used for routine or frequent types of transactions. Although initial implementation is intended to conform to existing procedures, it is anticipated that future evolution of the system and procedures will result in the greater automation of functions for both aircraft and ground systems.

2.2.8 The introduction of CPDLC does not affect the principle that there is only one controlling authority for a given aircraft at a given time. The capability for the pilot to request downstream clearances does not affect this principle.

2.2.10 Sending a message by CPDLC consists of selecting the recipient, selecting the appropriate message from a displayed menu or by other means which allow fast and efficient message selection, and executing the transmission. The received message may be displayed and/or printed. A message sent by a downstream ATSU will be distinguishable from a CPDLC message sent by the current ATS unit.

2.2.12 CPDLC may be used to remedy a number of shortcomings of voice communication, such as voice channel congestion, misunderstanding due to poor voice quality and/or misinterpretation, and corruption of the signal due to simultaneous transmissions.

2.2.14 Implementation of CPDLC will significantly change the way pilots and controllers communicate. The effect of CPDLC on operations should be carefully studied before deciding the extent to which voice will be replaced by data link.

2.2.16 The following aspects of CPDLC should be taken into account in considering its application and in defining procedures:

b) the total time required for selecting a message, transmission of the message, and reading and interpretation of the message;

d) the head-down time for the pilot and controller; and

f) the inability of the pilot to monitor other data link transmissions to and from other aircraft in the same area of operation.

2.4 CPDLC Definitions

Current Data Authority (CDA): The ground system which is permitted to conduct a CPDLC dialogue with an aircraft.

Downstream Data Authority (DDA): The ground system which is permitted to conduct a DSC dialogue with an aircraft.

Downstream Clearance (DSC): A clearance issued to an aircraft by an air traffic control unit that is not the current controlling authority of the aircraft. Unless coordinated, downstream clearances shall not affect the aircraft's original flight profile in any airspace, other than that of the air traffic control unit responsible for the delivery of the downstream clearance.

Next Data Authority (NDA): The ground system so designated by the Current Data Authority.

2.6 Use of CPDLC In ATS

2.6.2 CPDLC is expected to be used for routine operations in areas where the use of voice communication is considered not efficient or unnecessary, thereby reducing voice channel use and possibly reducing the number of required voice channels.

2.6.4 Where CPDLC is used as the primary method of communication between an aircraft and the CDA, voice communication will continue to be required. Voice is still particularly suited where a rapid exchange, short transactions communication style is required. It is recognized however, that the use of voice alone negates the capability of simultaneously updating the FDPS or FMS coincident with the entry and acknowledgement of CPDLC messages.

2.6.6 CPDLC messages are classified according to uplink and downlink categories. Each message has associated urgency, alerting and response attributes.

2.6.8 The CPDLC application has three primary functions:

b) the exchange of controller/pilot messages with the current data authority,

d) the transfer of data authority involving current and next data authority, and

f) downstream clearance delivery with a downstream data authority.

2.6.10 CPDLC Links

2.6.10.2 To accomplish the CPDLC application three CPDLC links are defined:

b) CDA link; the CPDLC link with the Current Data Authority,

d) NDA link; the CPDLC link with the Next Data Authority, and

f) DDA link; the CPDLC link with a Downstream Data Authority.

PART IV — CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC)

3. GENERAL REQUIREMENTS

3.2 Message Handling

3.2.2 Message Transmission

3.2.2.2 The CPDLC application requires:

b) that messages are generated and sent in a time ordered sequence, and

d) that messages are delivered in the order that they are sent.

3.2.2.4 The system will ensure that messages are sent to the specified recipient.

3.2.2.6 When a ground system receives a message requesting an unsupported function or service, the ground system will respond indicating that the requested service is unsupported.

3.2.2.8 The system will be capable of supporting up to 64 unfinished message exchanges between one ground system and each of the aircraft with which it is linked.

3.4 Quality of Service

3.4.2 The ground system will have the ability to specify its required QOS based on a user preferred combination of message delay, cost, and permissible error rate.

3.6 Time Requirements

3.6.2 Wherever time is used in the CPDLC application, it will be accurate to within 1 second of UTC.

3.6.4 Time stamping will be available for all messages. The time stamp will consist of the date (YYMMDD) and time (HHMMSS). The time stamp will be the time the message is dispatched by the originating user.

3.8 CPDLC Priority

3.8.2 The priority for all CPDLC messages will be “high priority flight safety messages” as determined by the ATN Internet Protocol Priority categorization.

PART IV — CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC)

4. CPDLC FUNCTIONAL CAPABILITIES

4.2 Data Link Requirements for CPDLC

4.2.2 Controller Pilot Message Exchange With The Current Data Authority (CDA)

4.2.2.2 This function allows the establishment of a CDA link between an aircraft and the CDA for the exchange of CPDLC messages. This function provides messages for the following:

b) general information exchange;

d) clearance:

  2) delivery,

  4) request, and

  6) response;

f) level/identity surveillance;

h) monitoring of current/planned position;

j) advisories:

  2) request and

  4) delivery;

l) system management functions; and

n) emergency situations.

4.2.4 Transfer of Data Authority

4.2.4.2 The Transfer of Data Authority function provides the capability for the CDA to designate another ground system as the Next Data Authority (NDA). Once a ground system becomes the NDA, a NDA link can be established. This capability is intended to prevent a loss of communication that would occur if the NDA were prevented from actually establishing any CPDLC link with an aircraft until it became the CDA.

4.2.6 Down Stream Clearance Message Exchange

4.2.6.2 The Down Stream Clearance (DSC) function provides the capability for the aircraft to establish a Downstream Data Authority (DDA) link with an air traffic service unit which is not the current data authority for the purpose of receiving a down stream clearance.

4.2.6.4 Although the entire CPDLC message set will be available for the DSC function, it is recommended that regional agreements be established to govern the use of the CPDLC message elements for the DSC function. It is expected that the primary use of the DSC function will be for clearance delivery messages. Other uses of the DSC function may be identified.

4.2.6.6 There will be procedures that prevent the pilot from executing a clearance received on a DDA link until the aircraft enters the airspace of that DDA. If the information a pilot receives on the DDA link requires action while still in the airspace of the CDA, the clearance for such action must be obtained from the CDA.

4.4 Composition of a CPDLC Message

4.4.2 A CPDLC message is composed of a message header, and from one to five message elements.

4.4.4 The message header for air/ground message exchange is composed of a message identification number, a message reference number if required, a time stamp, and an indication if a logical acknowledgment is required (optional).

4.4.6 A message element consists of a message element identifier, data as indicated by the specified message element, and associated message element attributes.

4.4.8 Free text messages may contain the IA5 character set, consisting only of the following characters: (0...9) (A..Z) (,) (.) (/) (-) (+) (() ()) and the space character.

4.4.10 Message Identification Numbers

4.4.10.2 Message identification numbers provided by a CPDLC ground system for messages to/from an aircraft have no relationship to the message identification numbers provided by the same ground system for another aircraft.

4.4.10.4 Similarly, message identification numbers provided by an aircraft on a given CPDLC link for messages to/from a ground system have no relationship to the message identification numbers provided by the same aircraft with another ground system.

4.4.10.6 The message identification number provided by the ground user will be different from any other message identification number currently in use with that particular aircraft.

4.4.10.8 The aircraft identification number provided by the avionics will be different from any other message identification number currently in use with that particular ground system.

4.4.10.10 A message identification number will be deemed currently in use until:

Scenario a) the message does not require a response: The message has been sent.

Scenario b) the message requires a response: The closure response has been received.

4.4.10.12 When a CDA or DDA link is established, all message identification numbers will be considered available.

4.4.10.14 Message identification numbers should be provided sequentially.

4.4.12 Message Reference Numbers

4.4.12.2 All response messages will contain a message reference number.

4.4.12.4 The message reference number will be identical to the message identification number of the initiating message to which it refers.

4.4.14 Message Attributes

4.4.14.2 Message attributes dictate certain message handling requirements for the CPDLC user receiving a message. Each CPDLC message has three attributes: Urgency, Alert and Response attributes.

4.4.14.4 Urgency

4.4.14.4.2 The Urgency (URG) attribute delineates the queuing requirements for received messages that are displayed to the end-user. Urgency types are presented in Table 3-1.

Type	Description	Precedence
D	Distress	1
U	Urgent	2
N	Normal	3
L	Low	4

Table 3-1: Urgency Attribute (Uplink and Downlink)

4.4.14.6 Alert

4.4.14.6.2 The alert (ALRT) attribute delineates the type of alerting required upon message receipt. Alert types are presented in Table 3-2.

Type	Description	Precedence
H	High	1
M	Medium	2
L	Low	3
N	No alerting required	4

Table 3-2: Alert Attribute (Uplink and Downlink)

4.4.14.8 Response

4.4.14.8.2 The response (RESP) attribute mandates response requirements for a given message element. Response types are presented in Table 3-3 for uplink messages and Table 3-4 for downlink messages.

Type	Response Required	Valid Responses	Precedence
W/U	Yes	WILCO, UNABLE, STANDBY permitted, LOGICAL ACKNOWLEDGMENT (only if required), ERROR (if necessary)	1
A/N	Yes	AFFIRM, NEGATIVE, STANDBY permitted, LOGICAL ACKNOWLEDGMENT (only if required), ERROR (if necessary)	2
R	Yes	ROGER, UNABLE, STANDBY permitted LOGICAL ACKNOWLEDGMENT (only if required), ERROR (if necessary)	3
Y	Yes	Any CPDLC downlink message, LOGICAL ACKNOWLEDGMENT (only if required)	4
N	No, unless logical acknowledgment required	LOGICAL ACKNOWLEDGMENT (only if required), ERROR (if necessary, only when logical acknowledgment is required)	5

Table 3-3: Response Attribute (Up-Link)

Type	**Response Required**	**Valid Responses**	**Precedence**
Y	Yes	Any CPDLC uplink message, LOGICAL ACKNOWLEDGMENT (only if required),	1
N	No, unless logical acknowledgment required	LOGICAL ACKNOWLEDGMENT (only if required), ERROR (if necessary, only when logical acknowledgment is required)	2

Table 3-4: Response Attribute (Down-Link)

4.4.14.10 Attribute Association

4.4.14.10.2 For each message element, Urgency, Alert, and Response attribute types are associated with it as specified in Appendix A to this chapter.

4.4.14.10.4 When a message contains a single message element, the message attributes are the message element attributes.

4.4.14.10.6 When a message contains multiple message elements, the highest precedence message element attribute type becomes the attribute type for the entire message. Message element attribute table entries are listed in order of precedence (i.e. a precedence value of 1 is highest followed by 2, etc.) For example, this means that a message containing multiple message elements, where at least one element has a W/U attribute, the whole message then has a W/U attribute.

4.4.16 Response Messages

4.4.16.2 A message containing the ERROR message element will always be permitted as a response message.

4.4.16.4 Any message that is considered a response message (i.e., it contains a message reference number) will have message urgency and alert attributes not less than the message to which it refers.

4.4.16.6 If the CPDLC user sends a message containing the ERROR message element instead of the expected response message, the ERROR message will contain the initiating message identification number as the message reference number. This ERROR message will be a closure response message.

4.4.18 Logical Acknowledgment Messages

4.4.18.2 The logical acknowledgment provides confirmation from a receiving system to the message originator, that the message has been successfully received and is acceptable for display to the responsible person, if this is required. The logical acknowledgment in no way replaces any required operational response.

4.4.18.4 A ground system will determine if the use of the logical acknowledgment (either air or ground) is permitted/required within its airspace.

4.4.18.6 The logical acknowledgment message element must not be combined with any other message element in a message.

4.4.18.8 A logical acknowledgment response message, if required, will be sent prior to sending any other related response message(s), other than an ERROR message, if necessary.

4.4.20 Message Differentiation

4.4.20.2 A CPDLC message intended for transmission on a DDA link must be clearly distinguishable from a CPDLC message intended for transmission on a CDA link.

4.6 CPDLC Message Receipt Requirements

4.6.2 CDA/DDA Link Messages

4.6.2.2 When a CPDLC user places all messages received from both a CDA and a DDA in the same queue, the messages from a CDA will be placed ahead of message from a DDA regardless of message urgency.

4.6.2.4 A CPDLC message received on a DDA link must be clearly distinguishable from a CPDLC message received on a CDA link.

4.6.4 Logical Acknowledgment Prohibited

4.6.4.2 Upon receipt of the CPDLC message USE OF LOGICAL ACKNOWLEDGMENT PROHIBITED the aircraft will be prohibited from requiring a logical acknowledgment for any message exchanged with that ground system for the duration of a CDA or DDA link.

4.6.6 Urgency Requirements

4.6.6.2 When a CPDLC user queues received messages, messages with the highest Urgency type will be placed at the beginning of the queue.

4.6.6.4 When a CPDLC user queues received messages, messages with the same Urgency type, will be queued in order of receipt.

4.6.8 Alerting Requirements

4.6.8.2 CPDLC will provide three distinct alerts determined by the received message alert attribute.

4.6.10 Message Response Requirements

4.6.10.2 A CPDLC user will only respond to a received message in its entirety. This means for example, that if 3 message elements are concatenated in a single message, any response given applies to the whole message, and not to any individual message element.

4.6.10.4 If a message is received that requires a response the CPDLC user will:

b) be allowed to send any permitted response messages, and

d) send one and only one closure response message.

4.6.10.6 For a given message, once the CPDLC user has sent the closure response message, no other response messages will be sent.

4.6.10.8 Table 3-5 contains the closure response messages permitted for each message response category.

Permitted Response	**Closure Response**
W/U	A response message containing at least a WILCO, UNABLE, or ERROR message element
A/N	A response message containing at least an AFFIRM, NEGATIVE, or ERROR message element
R	A response message containing at least a ROGER, UNABLE or ERROR message element
Y	The first response message sent from the aircraft that does not contain a STANDBY or, (only when required), a LOGICAL ACKNOWLEDGMENT The first response message sent by the ground that does not contain a STANDBY, (only when required), a LOGICAL ACKNOWLEDGMENT or REQUEST DEFERRED message element from the ground system.
N	The only permitted response will be a closure response message that contains a LOGICAL ACKNOWLEDGMENT when this has been required or an ERROR message element when a logical acknowledgment is required..

Table 3-5: Permitted Closure Responses by Response Category

4.6.10.8.2 The CPDLC application must provide the message initiator the capability to provide closure for a CPDLC message, independent of CPDLC closure message receipt.

4.8 Establishment of the CDA or NDA Link

4.8.2 Either the airborne system or the ground system can request CPDLC. Acceptance by either the airborne system or the ground system of a request for CPDLC establishes a CDA or NDA link.

4.8.4 Upon acceptance of a CDA or NDA link, the CPDLC application will have the capability to inform both the controller and pilot of this link establishment.

4.8.6 An aircraft will be permitted to request CPDLC with any ground system, if the aircraft has no existing CDA or NDA link. If the ground system accepts the CPDLC request, that ground system will become the CDA.

4.8.8 Only if an aircraft has received a message from the Current Data Authority designating a Next Data Authority, will the aircraft be permitted to request CPDLC with the specified ground system.

4.8.8.2 In general, ground acceptance of an airborne request for CPDLC is determined by local procedures.

4.8.8.4 However, if a ground system receives a request for CPDLC from an aircraft, for which it currently has a CDA or NDA link, it will:

b) accept the request, and

d) cancel the first NDA or CDA link.

Note.— The aircraft could realize that a CDA or NDA link has been lost, and request CPDLC before the ground is aware of the loss of the CDA or NDA link. By allowing the ground to accept a “second” CDA or NDA link from the aircraft, the potential for loss of communication is minimized.

4.8.10 If the ground requests CPDLC with an aircraft and the aircraft does not have a CDA or NDA link, then the aircraft will accept the CPDLC request and consider the ground system as the Current Data Authority.

4.8.12 If the ground requests CPDLC with an aircraft and the aircraft already has a CDA link, the aircraft will accept the CPDLC request if

b) the request is from the ground system that is the CDA, or

d) the request is from the Next Data Authority.

4.8.14 If the aircraft accepts a “second” CDA or NDA link, the “first” CDA or NDA link with that ground system will be terminated.

Note.— The ground could realize that a CDA or NDA link has been lost, and request CPDLC before the aircraft is aware of the loss of the CDA or NDA link. By allowing the aircraft to accept a “second” CDA or NDA link from the ground, the potential for loss of communication is minimized.

4.8.14.2 The aircraft will reject a request for CPDLC from any other ground system, and will indicate to the requesting ground system what ground system is the Current Data Authority.

4.8.16 The aircraft will disregard CPDLC messages over the NDA link and indicate to the originator that it is not the Current Data Authority.

4.8.18 Only the Current Data Authority can designate a ground system as the Next Data Authority.

4.8.20 The Current Data Authority can designate only one ground system as the Next Data Authority at a time (i.e., only one per CPDLC message).

4.8.22 An airborne system will only consider a ground system as the Next Data Authority if it has received such an indication from the Current Data Authority.

4.8.24 Any indication from the Current Data Authority designating a Next Data Authority will replace any previously received Next Data Authority designation for another ground system.

4.8.26 If the ground system rejects a request for CPDLC it will provide a reason for the rejection using a CPDLC message.

4.10 Establishment of the DDA Link

4.10.2 Only the airborne system can request DSC. Acceptance by the ground system of a request for DSC establishes a DDA link.

4.10.4 Upon acceptance of a DDA link the CPDLC application will have the capability to inform both the controller and pilot of this link establishment.

4.10.6 If an aircraft has no DDA link, that aircraft will be permitted to request DSC with any ground system that is not its CDA. The ground system may only accept a request for DSC if it has a filed flight plan for the requesting aircraft. If the ground system accepts the DSC request, that ground system will become the Downstream Data Authority.

4.10.8 Generally, ground acceptance of an airborne request for DSC even when the ground has a filed flight plan for that aircraft is determined by local procedures.

4.10.8.2 However, if a ground system receives a request for DSC from an aircraft, for which it currently has a DDA link, it will:

b) accept the request, and

d) cancel the first DDA link.

Note.— The aircraft could realize that a DDA link has been lost, and request DSC before the ground is aware of the loss of the DDA link. By allowing the ground to accept a “second” DDA link from the aircraft, the potential for loss of communication is minimized.

4.10.10 If the ground system rejects a request for DSC it will provide a reason for the rejection using a CPDLC message.

4.12 Link Termination and Transfer

4.12.2 Once normal link termination is initiated, only CPDLC closure response messages may be exchanged over the CDA or DDA link being terminated.

4.12.4 Once termination is initiated, the system will have the capability of informing the pilot or controller of this action.

4.12.6 When normal link termination is initiated and there are still outstanding responses required, the pilot and controller will be informed of any message for which closure is outstanding.

4.12.8 If a CDA or NDA link is terminated for any reason, any DDA link will not be affected.

4.12.10 Normally, CPDLC service termination with the Current Data Authority is initiated by the ground system to end service or transfer service to the next ATS facility.

4.12.12 The ground system will not perform a normal termination of the CDA or DDA link while there are any CPDLC messages for which closure is outstanding.

4.12.14 Any NDA link will be terminated by the aircraft if it receives a subsequent designation of Next Data Authority. When terminating a NDA link in this situation the aircraft will indicate to the ground system being terminated that it is no longer the Next Data Authority.

4.12.16 When the CDA link is terminated normally, the aircraft will recognize the ground system currently designated Next Data Authority as the Current Data Authority.

4.12.18 If the CDA link is terminated for any reason other than under instruction from the Current Data Authority, any designation of a ground system as a Next Data Authority will be deleted, and any NDA link in place will be terminated.

4.12.20 Only an aircraft can normally terminate a DDA link.

4.12.22 DDA normal link termination will be automatically initiated if a DDA becomes a CDA, and the pilot will be informed of this action.

4.14 Message Presentation

4.14.2 The presentation of messages is a local implementation.

4.14.4 The CPDLC message element description is presented in Appendix A to this chapter. Appendix B to this chapter contains a data glossary. Appendix C to this chapter provides data range and resolution.

4.16 Message Errors

4.16.2 When an error is detected in a received message, a response message indicating an error and providing the reason for the error will be sent if the message permits a response message. Error reasons are provided as part of the Data Glossary in Appendix B to this chapter.

4.18 Service Descriptions

4.18.2 Service descriptions for some functions using the CPDLC message set are included in this part of the manual. Chapter 6 contains a description of the Departure Clearance. Chapter 7 contains a description of the Transfer of Data Authority. Chapter 8 contains a description of the Downstream Clearance.

PART IV — CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC)

CHAPTER 3 APPENDIX A

CPDLC MESSAGE SET

3A.2 Introduction

3A.2.2 In the interest of maintaining continuity, message numbers have not been deleted as proposed changes have been accepted. Instead new message elements have been allocated sequential numbers.

3A.2.4 This Appendix defines the allowed message elements from which CPDLC messages can be composed.

3A.2.6 Where the message elements are consistent with those already in PANS-RAC for the purposes of voice communications, the message intent/uses are also consistent with PANS-RAC.

3A.2.8 The column headed Message Element is a suggested text for presentation to the pilot or controller.

3A.4 Up-Link Messages

3A.4.2 Uplink messages for CPDLC are presented in this section.

	Message Intent/Use	Message Element	URG	ALRT	RESP
0	Indicates that ATS cannot comply with the request.	UNABLE	N	M	N
1	Indicates that ATS has received the message and will respond.	STANDBY	N	L	N
2	Indicates that ATS has received the request but it has been deferred until later.	REQUEST DEFERRED	N	L	N
3	Indicates that ATS has received and understood the message.	ROGER	N	L	N
4	Yes.	AFFIRM	N	L	N
5	No.	NEGATIVE	N	L	N
235	Notification of receipt of unlawful interference message.	ROGER 7500	U	H	N
211	Indicates that the ATS has received the request and has passed it to the Next Control Authority.	REQUEST FORWARDED	N	L	N
218	Indicates to the pilot that the request has already been received on the ground.	REQUEST ALREADY RECEIVED	L	N	N

Table A-1: Responses/Acknowledgments (uplink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
6	Notification that a level change instruction should be expected.	EXPECT [level]	L	L	R
7	Notification that an instruction should be expected for the aircraft to commence climb at the specified time.	EXPECT CLIMB AT [time]	L	L	R
8	Notification that an instruction should be expected for the aircraft to commence climb at the specified position.	EXPECT CLIMB AT [position]	L	L	R
9	Notification that an instruction should be expected for the aircraft to commence descent at the specified time.	EXPECT DESCENT AT [time]	L	L	R
10	Notification that an instruction should be expected for the aircraft to commence descent at the specified position.	EXPECT DESCENT AT [position]	L	L	R
11	Notification that an instruction should be expected for the aircraft to commence cruise climb at the specified time.	EXPECT CRUISE CLIMB AT [time]	L	L	R
12	Notification that an instruction should be expected for the aircraft to commence cruise climb at the specified position.	EXPECT CRUISE CLIMB AT [position]	L	L	R
13	Notification that an instruction should be expected for the aircraft to commence climb at the specified time to the specified level.	AT [time] EXPECT CLIMB TO [level]	L	L	R
14	Notification that an instruction should be expected for the aircraft to commence climb at the specified position to the specified level.	AT [position] EXPECT CLIMB TO [level]	L	L	R
15	Notification that an instruction should be expected for the aircraft to commence descent at the specified time to the specified level.	AT [time] EXPECT DESCENT TO [level]	L	L	R
16	Notification that an instruction should be expected for the aircraft to commence descent at the specified position to the specified level.	AT [position] EXPECT DESCENT TO [level]	L	L	R

	Message Intent/Use	Message Element	URG	ALRT	RESP
17	Notification that an instruction should be expected for the aircraft to commence cruise climb at the specified time to the specified level.	AT [time] EXPECT CRUISE CLIMB TO [level]	L	L	R
18	Notification that an instruction should be expected for the aircraft to commence cruise climb at the specified position to the specified level.	AT [position] EXPECT CRUISE CLIMB TO [level]	L	L	R
19	Instruction to maintain the specified level.	MAINTAIN [level]	N	M	W/U
20	Instruction that a climb to a specified level is to commence and the level is to be maintained when reached.	CLIMB TO [level]	N	M	W/U
21	Instruction that at the specified time, a climb to the specified level is to commence and once reached the specified level is to be maintained.	AT [time] CLIMB TO [level]	N	M	W/U
22	Instruction that at the specified position, a climb to the specified level is to commence and once reached the specified level is to be maintained.	AT [position] CLIMB TO [level]	N	M	W/U
185	Instruction that after passing the specified position, a climb to the specified level is to commence and once reached the specified level is to be maintained.	AFTER PASSING [position] CLIMB TO [level]	N	M	W/U
23	Instruction that a descent to a specified level is to commence and the level is to be maintained when reached.	DESCEND TO [level]	N	M	W/U
24	Instruction that at a specified time a descent to a specified level is to commence and once reached the specified level is to be maintained.	AT [time] DESCEND TO [level]	N	M	W/U
25	Instruction that at the specified position a descent to the specified level is to commence and when the specified level is reached it is to be maintained.	AT [position] DESCEND TO [level]	N	M	W/U

	Message Intent/Use	Message Element	URG	ALRT	RESP
186	Instruction that after passing the specified position, a descent to the specified level is to commence and once reached the specified level is to be maintained.	AFTER PASSING [position] DESCEND TO [level]	N	M	W/U
26	Instruction that a climb is to commence at a rate such that the specified level is reached at or before the specified time.	CLIMB TO REACH [level] BY [time]	N	M	W/U
27	Instruction that a climb is to commence at a rate such that the specified level is reached at or before the specified position.	CLIMB TO REACH [level] BY [position]	N	M	W/U
28	Instruction that a descent is to commence at a rate such that the specified level is reached at or before the specified time.	DESCEND TO REACH [level] BY [time]	N	M	W/U
29	Instruction that a descent is to commence at a rate such that the specified level is reached at or before the specified position.	DESCEND TO REACH [level] BY [position]	N	M	W/U
192	Instruction that a change of level is to continue, but at a rate such that the specified level is reached at or before the specified time.	REACH [level] BY [time]	N	M	W/U
209	Instruction that a change of level is to continue, but at a rate such that the specified level is reached at or before the specified position.	REACH [level] BY [position]	N	M	W/U
30	A level within the defined vertical range specified is to be maintained.	MAINTAIN BLOCK [level] TO [level]	N	M	W/U
31	Instruction that a climb to a level within the vertical range defined is to commence.	CLIMB TO AND MAINTAIN BLOCK [level] TO [level]	N	M	W/U
32	Instruction that a descent to a level within the vertical range defined is to commence.	DESCEND TO AND MAINTAIN BLOCK [level] TO [level]	N	M	W/U
34	A cruise climb is to commence and continue until the specified level is reached.	CRUISE CLIMB TO [level]	N	M	W/U
35	A cruise climb can commence once above the specified level.	CRUISE CLIMB ABOVE [level]	N	M	W/U
219	Instruction to stop the climb below the previously assigned level.	STOP CLIMB AT [level]	U	M	W/U
220	Instruction to stop the descent above the previously assigned level.	STOP DESCENT AT [level]	U	M	W/U

	Message Intent/Use	Message Element	URG	ALRT	RESP
36	The climb to the specified level should be made at the aircraft*s best rate.	EXPEDITE CLIMB TO [level]	U	M	W/U
37	The descent to the specified level should be made at the aircraft*s best rate.	EXPEDITE DESCENT TO [level]	U	M	W/U
38	Urgent instruction to immediately climb to the specified level.	IMMEDIATELY CLIMB TO [level]	D	H	W/U
39	Urgent instruction to immediately descend to the specified level.	IMMEDIATELY DESCEND TO [level]	D	H	W/U
40	Urgent instruction to immediately stop a climb once the specified level is reached.	IMMEDIATELY STOP CLIMB AT [level]	D	H	W/U
41	Urgent instruction to immediately stop a descent once the specified level is reached.	IMMEDIATELY STOP DESCENT AT [level]	D	H	W/U
171	Instruction to climb at not less than the specified rate.	CLIMB AT [vertical rate] MINIMUM	N	M	W/U
172	Instruction to climb at not above the specified rate.	CLIMB AT [vertical rate] MAXIMUM	N	M	W/U
173	Instruction to descend at not less than the specified rate.	DESCEND AT [vertical rate] MINIMUM	N	M	W/U
174	Instruction to descend at not above the specified rate.	DESCEND AT [vertical rate] MAXIMUM	N	M	W/U
33	(reserved)				

Table A-2: Vertical Clearances (uplink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
42	Notification that a level change instruction should be expected which will require the specified position to be crossed at the specified level.	EXPECT TO CROSS [position] AT [level]	L	L	R
43	Notification that a level change instruction should be expected which will require the specified position to be crossed at or above the specified level.	EXPECT TO CROSS [position] AT OR ABOVE [level]	L	L	R
44	Notification that a level change instruction should be expected which will require the specified position to be crossed at or below the specified level.	EXPECT TO CROSS [position] AT OR BELOW [level]	L	L	R
45	Notification that a level change instruction should be expected which will require the specified position to be crossed at the specified level which is to be maintained subsequently.	EXPECT TO CROSS [position] AT AND MAINTAIN [level]	L	L	R
46	The specified position is to be crossed at the specified level. This may require the aircraft to modify its climb or descent profile.	CROSS [position] AT [level]	N	M	W/U
47	The specified position is to be crossed at or above the specified level.	CROSS [position] AT OR ABOVE [level]	N	M	W/U
48	The specified position is to be crossed at or below the specified level.	CROSS [position] AT OR BELOW [level]	N	M	W/U
49	Instruction that the specified position is to be crossed at the specified level and that level is to be maintained when reached.	CROSS [position] AT AND MAINTAIN [level]	N	M	W/U
50	The specified position is to be crossed at a level between the specified levels.	CROSS [position] BETWEEN [level] AND [level]	N	M	W/U
51	The specified position is to be crossed at the specified time.	CROSS [position] AT [time]	N	M	W/U
52	The specified position is to be crossed at or before the specified time.	CROSS [position] AT OR BEFORE [time]	N	M	W/U

	Message Intent/Use	Message Element	URG	ALRT	RESP
53	The specified position is to be crossed at or after the specified time.	CROSS [position] AT OR AFTER [time]	N	M	W/U
54	The specified position is to be crossed at a time between the specified times.	CROSS [position] BETWEEN [time] AND [time]	N	M	W/U
55	The specified position is to be crossed at the specified speed and the specified speed is to be maintained until further advised.	CROSS [position] AT [speed]	N	M	W/U
56	The specified position is to be crossed at a speed equal to or less than the specified speed and the specified speed or less is to be maintained until further advised.	CROSS [position] AT OR LESS THAN [speed]	N	M	W/U
57	The specified position is to be crossed at a speed equal to or greater than the specified speed and the specified speed or greater is to be maintained until further advised.	CROSS [position] AT OR GREATER THAN [speed]	N	M	W/U
58	The specified position is to be crossed at the specified time and at the specified level.	CROSS [position] AT [time] AT [level]	N	M	W/U
59	The specified position is to be crossed at or before the specified time and at the specified level.	CROSS [position] AT OR BEFORE [time] AT [level]	N	M	W/U
60	The specified position is to be crossed at or after the specified time and at the specified level.	CROSS [position] AT OR AFTER [time] AT [level]	N	M	W/U
61	Instruction that the specified position is to be crossed at the specified level and speed and the level and speed are to be maintained.	CROSS [position] AT AND MAINTAIN [level] AT [speed]	N	M	W/U
62	Instruction that at the specified time the specified position is to be crossed at the specified level and the level is to be maintained.	AT [time] CROSS [position] AT AND MAINTAIN [level]	N	M	W/U

	Message Intent/Use	Message Element	URG	ALRT	RESP
63	Instruction that at the specified time the specified position is to be crossed at the specified level and speed and the level and speed are to be maintained.	AT [time] CROSS [position] AT AND MAINTAIN [level] AT [speed]	N	M	W/U

Table A-3: Crossing Constraints (uplink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
64	Instruction to fly a parallel track to the cleared route at a displacement of the specified distance in the specified direction.	OFFSET [distance offset] [direction] OF ROUTE	N	M	W/U
65	Instruction to fly a parallel track to the cleared route at a displacement of the specified distance in the specified direction and commencing at the specified position.	AT [position] OFFSET [distance offset] [direction] OF ROUTE	N	M	W/U
66	Instruction to fly a parallel track to the cleared route at a displacement of the specified distance in the specified direction and commencing at the specified time.	AT [time] OFFSET [distance offset] [direction] OF ROUTE	N	M	W/U
67	The cleared flight route is to be rejoined.	PROCEED BACK ON ROUTE	N	M	W/U
68	The cleared flight route is to be rejoined at or before the specified position.	REJOIN ROUTE BY [position]	N	M	W/U
69	The cleared flight route is to be rejoined at or before the specified time.	REJOIN ROUTE BY [time]	N	M	W/U
70	Notification that a clearance may be issued to enable the aircraft to rejoin the cleared route at or before the specified position.	EXPECT BACK ON ROUTE BY [position]	L	L	R
71	Notification that a clearance may be issued to enable the aircraft to rejoin the cleared route at or before the specified time.	EXPECT BACK ON ROUTE BY [time]	L	L	R

	Message Intent/Use	Message Element	URG	ALRT	RESP
72	Instruction to resume own navigation following a period of tracking or heading clearances. May be used in conjunction with an instruction on how or where to rejoin the cleared route.	RESUME OWN NAVIGATION	N	M	W/U

Table A-4: Lateral Offsets (uplink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
73	Notification to the aircraft of the instructions to be followed from departure until the specified clearance limit.	[departure clearance]	N	M	W/U
74	Instruction to proceed directly from its present position to the specified position.	PROCEED DIRECT TO [position]	N	M	W/U
75	Instruction to proceed, when able, directly to the specified position.	WHEN ABLE PROCEED DIRECT TO [position]	N	M	W/U
76	Instruction to proceed, at the specified time, directly to the specified position.	AT [time] PROCEED DIRECT TO [position]	N	M	W/U
77	Instruction to proceed, at the specified position, directly to the next specified position.	AT [position] PROCEED DIRECT TO [position]	N	M	W/U
78	Instruction to proceed, upon reaching the specified level, directly to the specified position.	AT [level] PROCEED DIRECT TO [position]	N	M	W/U
79	Instruction to proceed to the specified position via the specified route.	CLEARED TO [position] VIA [route clearance]	N	M	W/U
80	Instruction to proceed via the specified route.	CLEARED [route clearance]	N	M	W/U
81	Instruction to proceed in accordance with the specified procedure.	CLEARED [procedure name]	N	M	W/U
236	Instruction to leave controlled airspace.	LEAVE CONTROLLED AIRSPACE	N	M	W/U
82	Approval to deviate up to the specified distance from the cleared route in the specified direction.	CLEARED TO DEVIATE UP TO [distance offset] [direction] OF ROUTE	N	M	W/U
83	Instruction to proceed from the specified position via the specified route.	AT [position] CLEARED [route clearance]	N	M	W/U

	Message Intent/Use	Message Element	URG	ALRT	RESP
84	Instruction to proceed from the specified position via the specified procedure.	AT [position] CLEARED [procedure name]	N	M	W/U
85	Notification that a clearance to fly on the specified route may be issued.	EXPECT [route clearance]	L	L	R
86	Notification that a clearance to fly on the specified route from the specified position may be issued.	AT [position] EXPECT [route clearance]	L	L	R
87	Notification that a clearance to fly directly to the specified position may be issued.	EXPECT DIRECT TO [position]	L	L	R
88	Notification that a clearance to fly directly from the first specified position to the next specified position may be issued.	AT [position] EXPECT DIRECT TO [position]	L	L	R
89	Notification that a clearance to fly directly to the specified position commencing at the specified time may be issued.	AT [time] EXPECT DIRECT TO [position]	L	L	R
90	Notification that a clearance to fly directly to the specified position commencing when the specified level is reached may be issued.	AT [level] EXPECT DIRECT TO [position]	L	L	R
91	Instruction to enter a holding pattern with the specified characteristics at the specified position and level.	HOLD AT [position] MAINTAIN [level] INBOUND TRACK [degrees] [direction] TURNS [leg type]	N	M	W/U
92	Instruction to enter a holding pattern with the published characteristics at the specified position and level.	HOLD AT [position] AS PUBLISHED MAINTAIN [level]	N	M	W/U
93	Notification that an onwards clearance may be issued at the specified time.	EXPECT FURTHER CLEARANCE AT [time]	L	L	R
94	Instruction to turn left or right as specified onto the specified heading.	TURN [direction] HEADING [degrees]	N	M	W/U
95	Instruction to turn left or right as specified onto the specified track.	TURN [direction] GROUND TRACK [degrees]	N	M	W/U
215	Instruction to turn a specified number of degrees left or right.	TURN [direction][degrees]	N	M	W/U

	Message Intent/Use	Message Element	URG	ALRT	RESP
190	Instruction to fly on the specified heading.	FLY HEADING [degrees]	N	M	W/U
96	Instruction to continue to fly on the current heading.	CONTINUE PRESENT HEADING	N	M	W/U
97	Instruction to fly on the specified heading from the specified position.	AT [position] FLY HEADING [degrees]	N	M	W/U
221	Instruction to stop turn at the specified heading prior to reaching the previously assigned heading.	STOP TURN HEADING [degrees]	U	M	W/U
98	Instruction to turn immediately left or right as specified onto the specified heading.	IMMEDIATELY TURN [direction] HEADING [degrees]	D	H	W/U
99	Notification that a clearance may be issued for the aircraft to fly the specified procedure.	EXPECT [procedure name]	L	L	R

Table A-5: Route Modifications (uplink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
100	Notification that a speed instruction may be issued to be effective at the specified time.	AT [time] EXPECT [speed]	L	L	R
101	Notification that a speed instruction may be issued to be effective at the specified position.	AT [position] EXPECT [speed]	L	L	R
102	Notification that a speed instruction may be issued to be effective at the specified level.	AT [level] EXPECT [speed]	L	L	R
103	Notification that a speed range instruction may be issued to be effective at the specified time.	AT [time] EXPECT [speed] TO [speed]	L	L	R
104	Notification that a speed range instruction may be issued to be effective at the specified position.	AT [position] EXPECT [speed] TO [speed]	L	L	R
105	Notification that a speed range instruction may be issued to be effective at the specified level.	AT [level] EXPECT [speed] TO [speed]	L	L	R
106	The specified speed is to be maintained.	MAINTAIN [speed]	N	M	W/U
188	After passing the specified position the specified speed is to be maintained.	AFTER PASSING [position] MAINTAIN [speed]	N	M	W/U

	Message Intent/Use	Message Element	URG	ALRT	RESP
107	The present speed is to be maintained.	MAINTAIN PRESENT SPEED	N	M	W/U
108	The specified speed or a greater speed is to be maintained.	MAINTAIN [speed] OR GREATER	N	M	W/U
109	The specified speed or a lesser speed is to be maintained.	MAINTAIN [speed] OR LESS	N	M	W/U
110	A speed within the specified range is to be maintained.	MAINTAIN [speed] TO [speed]	N	M	W/U
111	The present speed is to be increased to the specified speed and maintained until further advised.	INCREASE SPEED TO [speed]	N	M	W/U
112	The present speed is to be increased to the specified speed or greater, and maintained at or above the specified speed until further advised.	INCREASE SPEED TO [speed] OR GREATER	N	M	W/U
113	The present speed is to be reduced to the specified speed and maintained until further advised.	REDUCE SPEED TO [speed]	N	M	W/U
114	The present speed is to be reduced to the specified speed or less and maintained at or below the specified speed until further advised.	REDUCE SPEED TO [speed] OR LESS	N	M	W/U
115	The specified speed is not to be exceeded.	DO NOT EXCEED [speed]	N	M	W/U
116	Notification that the aircraft need no longer comply with the previously issued speed restriction.	RESUME NORMAL SPEED	N	M	W/U
189	The present speed is to be changed to the specified speed.	ADJUST SPEED TO [speed]	N	M	W/U
222	Notification that the aircraft may keep its preferred speed without restriction.	NO SPEED RESTRICTION	L	L	R
223	Instruction to reduce present speed to the minimum safe approach speed	REDUCE TO MINIMUM APPROACH SPEED	N	M	W/U

Table A-6: Speed Changes (uplink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
117	The ATS unit with the specified ATS unit name is to be contacted on the specified frequency.	CONTACT [unit name] [frequency]	N	M	W/U

	Message Intent/Use	Message Element	URG	ALRT	RESP
118	At the specified position the ATS unit with the specified ATS unit name is to be contacted on the specified frequency.	AT [position] CONTACT [unit name] [frequency]	N	M	W/U
119	At the specified time the ATS unit with the specified ATS unit name is to be contacted on the specified frequency.	AT [time] CONTACT [unit name] [frequency]	N	M	W/U
120	The ATS unit with the specified ATS unit name is to be monitored on the specified frequency.	MONITOR [unit name] [frequency]	N	M	W/U
121	At the specified position the ATS unit with the specified ATS unit name is to be monitored on the specified frequency.	AT [position] MONITOR [unit name] [frequency]	N	M	W/U
122	At the specified time the ATS unit with the specified ATS unit name is to be monitored on the specified frequency.	AT [time] MONITOR [unit name] [frequency]	N	M	W/U
123	The specified code (SSR code) is to be selected.	SQUAWK [code]	N	M	W/U
124	The SSR transponder responses are to be disabled.	STOP SQUAWK	N	M	W/U
125	The SSR transponder responses should include level information.	SQUAWK MODE CHARLIE	N	M	W/U
126	The SSR transponder responses should no longer include level information.	STOP SQUAWK MODE CHARLIE	N	M	W/U
179	The `ident* function on the SSR transponder is to be actuated.	SQUAWK IDENT	N	M	W/U

Table A-7: Contact/Monitor/Surveillance Requests (uplink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
127	Instruction to report when the aircraft is back on the cleared route.	REPORT BACK ON ROUTE	N	L	W/U
128	Instruction to report when the aircraft has left the specified level.	REPORT LEAVING [level]	N	L	W/U
129	Instruction to report when the aircraft is in level flight at the specified level.	REPORT MAINTAINING [level]	N	L	W/U
175	Instruction to report when the aircraft has reached the specified level.	REPORT REACHING [level]	N	L	W/U
180	Instruction to report when the aircraft is within the specified vertical range.	REPORT REACHING BLOCK [level] TO [level]	N	L	W/U
130	Instruction to report when the aircraft has passed the specified position.	REPORT PASSING [position]	N	L	W/U
181	Instruction to report the present distance to or from the specified position.	REPORT DISTANCE [to/from] [position]	N	M	Y
184	Instruction to report at the specified time the distance to or from the specified position.	AT TIME [time] REPORT DISTANCE [to/from] [position]	N	L	Y
228	Instruction to report the estimated time of arrival at the specified position.	REPORT ETA [position]	L	L	Y
131	Instruction to report the amount of fuel remaining and the number of persons on board.	REPORT REMAINING FUEL AND PERSONS ON BOARD	U	M	Y
132	Instruction to report the present position.	REPORT POSITION	N	M	Y
133	Instruction to report the present level.	REPORT PRESENT LEVEL	N	M	Y
134	Instruction to report the requested speed.	REPORT [speed type] [speed type] [speed type] SPEED	N	M	Y
135	Instruction to confirm and acknowledge the currently assigned level.	CONFIRM ASSIGNED LEVEL	N	L	Y
136	Instruction to confirm and acknowledge the currently assigned speed.	CONFIRM ASSIGNED SPEED	N	L	Y
137	Instruction to confirm and acknowledge the currently assigned route.	CONFIRM ASSIGNED ROUTE	N	L	Y

	Message Intent/Use	Message Element	URG	ALRT	RESP
138	Instruction to confirm the previously reported time over the last reported waypoint.	CONFIRM TIME OVER REPORTED WAYPOINT	N	L	Y
139	Instruction to confirm the identity of the previously reported waypoint.	CONFIRM REPORTED WAYPOINT	N	L	Y
140	Instruction to confirm the identity of the next waypoint.	CONFIRM NEXT WAYPOINT	N	L	Y
141	Instruction to confirm the previously reported estimated time at the next waypoint.	CONFIRM NEXT WAYPOINT ETA	N	L	Y
142	Instruction to confirm the identity of the next but one waypoint.	CONFIRM ENSUING WAYPOINT	N	L	Y
143	The request was not understood. It should be clarified and resubmitted.	CONFIRM REQUEST	N	L	Y
144	Instruction to report the selected (SSR) code.	CONFIRM SQUAWK	N	L	Y
145	Instruction to report the present heading.	REPORT HEADING	N	M	Y
146	Instruction to report the present ground track.	REPORT GROUND TRACK	N	M	Y
182	Instruction to report the identification code of the last ATIS received.	CONFIRM ATIS CODE	N	L	Y
147	Instruction to make a position report.	REQUEST POSITION REPORT	N	M	Y
216	Instruction to file a flight plan.	REQUEST FLIGHT PLAN	N	M	Y
217	Instruction to report that the aircraft has landed.	REPORT ARRIVAL	N	M	Y
229	Instruction to report the preferred alternate aerodrome for landing.	REPORT ALTERNATE AERODROME	L	L	Y
231	Instruction to indicate the pilot*s preferred level.	STATE PREFERRED LEVEL	L	L	Y
232	Instruction to indicate the pilot*s preferred time and/ or position to commence descent to the aerodrome of intended arrival.	STATE TOP OF DESCENT	L	L	Y

Table A-8: Report/Confirmation Requests (uplink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
148	Request for the earliest time at which the specified level can be accepted.	WHEN CAN YOU ACCEPT [level]	N	L	Y

	Message Intent/Use	Message Element	URG	ALRT	RESP
149	Instruction to report whether or not the specified level can be accepted at the specified position.	CAN YOU ACCEPT [level] AT [position]	N	L	A/N
150	Instruction to report whether or not the specified level can be accepted at the specified time.	CAN YOU ACCEPT [level] AT [time]	N	L	A/N
151	Instruction to report the earliest time when the specified speed can be accepted.	WHEN CAN YOU ACCEPT [speed]	N	L	Y
152	Instruction to report the earliest time when the specified offset track can be accepted.	WHEN CAN YOU ACCEPT [distance offset] [direction] OFFSET	N	L	Y

Table A-9: Negotiation Requests (uplink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
153	ATS advisory that the altimeter setting should be the specified setting.	ALTIMETER [altimeter]	N	L	R
213	ATS advisory that the specified altimeter setting relates to the specified facility.	[facility designation] ALTIMETER [altimeter]	N	L	R
154	ATS advisory that the radar service is terminated.	RADAR SERVICE TERMINATED	N	L	R
191	ATS advisory that the aircraft is entering airspace in which no air traffic services are provided and all existing air traffic services are terminated.	ALL ATS TERMINATED	N	M	R
155	ATS advisory that radar contact has been established at the specified position.	RADAR CONTACT [position]	N	M	R
156	ATS advisory that radar contact has been lost.	RADAR CONTACT LOST	N	M	R
210	ATS advisory that the aircraft has been identified on radar at the specified position.	IDENTIFIED [position]	N	M	R
193	Indication that radar identification has been lost.	IDENTIFICATION LOST	N	M	R
157	A continuous transmission is detected on the specified frequency. Check the microphone button.	CHECK STUCK MICROPHONE [frequency]	U	M	N

	Message Intent/Use	Message Element	URG	ALRT	RESP
158	ATS advisory that the ATIS information identified by the specified code is the current ATIS information.	ATIS [atis code]	N	L	R
212	ATS advisory that the specified ATIS information at the specified airport is current.	[facility designation] ATIS [atis code] CURRENT	N	L	R
214	ATS advisory that indicates the RVR value for the specified runway.	RUNWAY [runway] VISUAL RANGE [rvr]	N	M	R
224	ATS advisory that no delay is expected.	NO DELAY EXPECTED	N	L	R
225	ATS advisory that the expected delay has not been determined.	DELAY NOT DETERMINED	N	L	R
226	ATS advisory that the aircraft may expect to be cleared to commence its approach procedure at the specified time.	EXPECTED APPROACH TIME [time]	N	L	R

Table A-10: Air Traffic Advisories (uplink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
159	A system generated message that the ground system has detected an error.	ERROR [error information]	U	M	N
160	Notification to the avionics that the next data authority is the specified ATSU.	NEXT DATA AUTHORITY [facility designation]	L	N	N
161	Notification to the avionics that the data link connection with the current data authority is being terminated.	END SERVICE	L	N	N
162	Notification that the ground system does not support this message.	SERVICE UNAVAILABLE	L	L	N
234	Notification that the ground system does not have a flight plan for that aircraft.	FLIGHT PLAN NOT HELD	L	L	N
163	Notification to the pilot of an ATSU identifier.	[facility designation]	L	N	N

	Message Intent/Use	Message Element	URG	ALRT	RESP
227	Confirmation to the aircraft system that the ground system has received the message to which the logical acknowledgment refers and found it acceptable for display to the responsible person.	LOGICAL ACKNOWLEDGMENT	N	M	N
233	Notification to the pilot that messages sent requiring a logical acknowledgment will not be accepted by this ground system.	USE OF LOGICAL ACKNOWLEDGMENT PROHIBITED	N	M	N

Table A-11: System Management Messages (uplink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
164	The associated instruction may be complied with at any future time.	WHEN READY	L	N	N
230	The associated instruction is to be complied with immediately.	IMMEDIATELY	D	H	N
165	Used to link two messages, indicating the proper order of execution of clearances/ instructions.	THEN	L	N	N
166	The associated instruction is issued due to traffic considerations.	DUE TO [traffic type] TRAFFIC	L	N	N
167	The associated instruction is issued due to airspace restrictions.	DUE TO AIRSPACE RESTRICTION	L	N	N
168	The indicated communication should be ignored.	DISREGARD	U	M	R
176	Notification that the operator is responsible for maintaining separation from other traffic and is also responsible for maintaining Visual Meteorological Conditions.	MAINTAIN OWN SEPARATION AND VMC	N	M	W/U
177	Used in conjunction with a clearance/instruction to indicate that the operator may execute when prepared to do so.	AT PILOTS DISCRETION	L	L	N
169		[free text]	N	L	R
170		[free text]	D	H	R
194		[free text]	N	L	Y
178		[free text]	N	L	N
195		[free text]	L	L	R
196		[free text]	N	M	W/U

	Message Intent/Use	Message Element	URG	ALRT	RESP
197		[free text]	U	M	W/U
198		[free text]	D	H	W/U
199		[free text]	N	M	W/U
200		[free text]	L	L	R
201		[free text]	N	M	W/U
202		[free text]	D	H	W/U
203		[free text]	N	M	R
204		[free text]	N	M	Y
183		[free text]	N	M	N
205		[free text]	N	M	A/N
206		[free text]	L	N	Y
187		[free text]	L	N	N
207		[free text]	L	L	Y
208		[free text]	L	L	N

Table A-12: Additional Messages (uplink)

3A.3 Downlink Messages

3A.3.1 Downlink messages for CPDLC are presented in this section.

	Message Intent/Use	Message Element	URG	ALRT	RESP
0	The instruction is understood and will be complied with.	WILCO	N	M	N
1	The instruction cannot be complied with.	UNABLE	N	M	N
2	Wait for a reply.	STANDBY	N	M	N
3	Message received and understood.	ROGER	N	M	N
4	Yes.	AFFIRM	N	M	N
5	No.	NEGATIVE	N	M	N

Table A-13: Responses (downlink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
6	Request to fly at the specified level.	REQUEST [level]	N	L	Y
7	Request to fly at a level within the specified vertical range.	REQUEST BLOCK [level] TO [level]	N	L	Y
8	Request to cruise climb to the specified level.	REQUEST CRUISE CLIMB TO [level]	N	L	Y
9	Request to climb to the specified level.	REQUEST CLIMB TO [level]	N	L	Y
10	Request to descend to the specified level.	REQUEST DESCENT TO [level]	N	L	Y
11	Request that at the specified position a climb to the specified level be approved.	AT [position] REQUEST CLIMB TO [level]	N	L	Y
12	Request that at the specified position a descent to the specified level be approved.	AT [position] REQUEST DESCENT TO [level]	N	L	Y
13	Request that at the specified time a climb to the specified level be approved.	AT [time] REQUEST CLIMB TO [level]	N	L	Y
14	Request that at the specified time a descent to the specified level be approved.	AT [time] REQUEST DESCENT TO [level]	N	L	Y
69	Request that a descent be approved on a see-and-avoid basis.	REQUEST VMC DESCENT	N	L	Y

Table A-14: Vertical Requests (downlink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
15	Request that a parallel track, offset from the cleared track by the specified distance in the specified direction, be approved.	REQUEST OFFSET [distance offset] [direction] OF ROUTE	N	L	Y
16	Request that a parallel track, offset from the cleared track by the specified distance in the specified direction, be approved from the specified position.	AT [position] REQUEST OFFSET [distance offset] [direction] OF ROUTE	N	L	Y
17	Request that a parallel track, offset from the cleared track by the specified distance in the specified direction, be approved from the specified time.	AT [time] REQUEST OFFSET [distance offset] [direction] OF ROUTE	N	L	Y

Table A-15: Lateral Off-Set Requests (downlink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
18	Request to fly at the specified speed.	REQUEST [speed]	N	L	Y
19	Request to fly within the specified speed range.	REQUEST [speed] TO [speed]	N	L	Y

Table A-16: Speed Requests (downlink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
20	Request for voice contact.	REQUEST VOICE CONTACT	N	L	Y
21	Request for voice contact on the specified frequency.	REQUEST VOICE CONTACT [frequency]	N	L	Y

Table A-17: Voice Contact Requests (downlink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
22	Request to track from the present position direct to the specified position.	REQUEST DIRECT TO [position]	N	L	Y
23	Request for the specified procedure clearance.	REQUEST [procedure name]	N	L	Y
24	Request for a route clearance.	REQUEST CLEARANCE [route clearance]	N	L	Y
25	Request for a clearance.	REQUEST [clearance type] CLEARANCE	N	L	Y
26	Request for a weather deviation to the specified position via the specified route.	REQUEST WEATHER DEVIATION TO [position] VIA [route clearance]	N	M	Y
27	Request for a weather deviation up to the specified distance off track in the specified direction.	REQUEST WEATHER DEVIATION UP TO [distance offset] [direction] OF ROUTE	N	M	Y
70	Request a clearance to adopt the specified heading.	REQUEST HEADING [degrees]	N	L	Y
71	Request a clearance to adopt the specified ground track.	REQUEST GROUND TRACK [degrees]	N	L	Y

Table A-18: Route Modification Requests (downlink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
28	Notification of leaving the specified level.	LEAVING [level]	N	L	N
29	Notification of climbing to the specified level.	CLIMBING TO [level]	N	L	N

	Message Intent/Use	Message Element	URG	ALRT	RESP
30	Notification of descending to the specified level.	DESCENDING TO [level]	N	L	N
31	Notification of passing the specified position.	PASSING [position]	N	L	N
78	At the specified time, the aircraft*s position was as specified.	AT [time] [distance] [to/from] [position]	N	L	N
32	Notification of the present level.	PRESENT LEVEL [level]	N	L	N
33	Notification of the present position.	PRESENT POSITION [position]	N	L	N
34	Notification of the present speed.	PRESENT SPEED [speed]	N	L	N
113	Notification of the requested speed.	[speed type] [speed type] [speed type] SPEED [speed]	N	L	N
35	Notification of the present heading in degrees.	PRESENT HEADING [degrees]	N	L	N
36	Notification of the present ground track in degrees.	PRESENT GROUND TRACK [degrees]	N	L	N
37	Notification that the aircraft is maintaining the specified level.	LEVEL [level]	N	L	N
72	Notification that the aircraft has reached the specified level.	REACHING [level]	N	L	N
76	Notification that the aircraft has reached a level within the specified vertical range.	REACHING BLOCK [level] TO [level]	N	L	N
38	Read-back of the assigned level.	ASSIGNED LEVEL [level]	N	M	N
77	Read-back of the assigned vertical range.	ASSIGNED BLOCK [level] TO [level]	N	M	N
39	Read-back of the assigned speed.	ASSIGNED SPEED [speed]	N	M	N
40	Read-back of the assigned route.	ASSIGNED ROUTE [route clearance]	N	M	N
41	The aircraft has regained the cleared route.	BACK ON ROUTE	N	M	N
42	The next waypoint is the specified position.	NEXT WAYPOINT [position]	N	L	N
43	The ETA at the next waypoint is as specified.	NEXT WAYPOINT ETA [time]	N	L	N
44	The next but one waypoint is the specified position.	ENSUING WAYPOINT [position]	N	L	N
45	Clarification of previously reported waypoint passage.	REPORTED WAYPOINT [position]	N	L	N

	Message Intent/Use	Message Element	URG	ALRT	RESP
46	Clarification of time over previously reported waypoint.	REPORTED WAYPOINT [time]	N	L	N
47	The specified (SSR) code has been selected.	SQUAWKING [code]	N	L	N
48	Position report.	POSITION REPORT [position report]	N	M	N
79	The code of the latest ATIS received is as specified.	ATIS [atis code]	N	L	N
89	The specified ICAO unit is being monitored on the specified frequency.	MONITORING [unit name] [frequency]	U	M	N
102	Used to report that an aircraft has landed.	LANDING REPORT	N	N	N
104	Notification of estimated time of arrival at the specified position.	ETA [position][time]	L	L	N
105	Notification of the alternative aerodrome for landing.	ALTERNATE AERODROME [airport]	L	L	N
106	Notification of the preferred level.	PREFERRED LEVEL [level]	L	L	N
109	Notification of the preferred time to commence descent for approach.	TOP OF DESCENT [time]	L	L	N
110	Notification of the preferred position to commence descent for approach.	TOP OF DESCENT [position]	L	L	N
111	Notification of the preferred time and position to commence descent for approach.	TOP OF DESCENT [time] [position]	L	L	N

Table A-19: Reports (downlink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
49	Request for the earliest time at which a clearance to the specified speed can be expected.	WHEN CAN WE EXPECT [speed]	L	L	Y
50	Request for the earliest time at which a clearance to a speed within the specified range can be expected.	WHEN CAN WE EXPECT [speed] TO [speed]	L	L	Y
51	Request for the earliest time at which a clearance to regain the planned route can be expected.	WHEN CAN WE EXPECT BACK ON ROUTE	L	L	Y

	Message Intent/Use	Message Element	URG	ALRT	RESP
52	Request for the earliest time at which a clearance to descend can be expected.	WHEN CAN WE EXPECT LOWER LEVEL	L	L	Y
53	Request for the earliest time at which a clearance to climb can be expected.	WHEN CAN WE EXPECT HIGHER LEVEL	L	L	Y
54	Request for the earliest time at which a clearance to cruise climb to the specified level can be expected.	WHEN CAN WE EXPECT CRUISE CLIMB TO [level]	L	L	Y
87	Request for the earliest time at which a clearance to climb to the specified level can be expected.	WHEN CAN WE EXPECT CLIMB TO [level]	L	L	Y
88	Request for the earliest time at which a clearance to descend to the specified level can be expected.	WHEN CAN WE EXPECT DESCENT TO [level]	L	L	Y

Table A-20: Negotiation Requests (downlink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
55	Urgency prefix.	PAN PAN PAN	U	H	N
56	Distress prefix.	MAYDAY MAYDAY MAYDAY	D	H	N
112	Indicates specifically that the aircraft is being subjected to unlawful interference.	SQUAWKING 7500	U	H	N
57	Notification of fuel remaining and number of persons on board.	[remaining fuel] OF FUEL REMAINING AND [persons on board] PERSONS ON BOARD	U	H	N
58	Notification that the pilot wishes to cancel the emergency condition.	CANCEL EMERGENCY	U	M	N
59	Notification that the aircraft is diverting to the specified position via the specified route.	DIVERTING TO [position] VIA [route clearance]	U	H	N
60	Notification that the aircraft is deviating the specified distance in the specified direction off the cleared route and maintaining a parallel track.	OFFSETTING [distance offset] [direction] OF ROUTE	U	H	N
61	Notification that the aircraft is descending to the specified level.	DESCENDING TO [level]	U	H	N

	Message Intent/Use	Message Element	URG	ALRT	RESP
80	Notification that the aircraft is deviating from the cleared route by the specified distance in the specified direction.	DEVIATING [distance offset] [direction] OFF ROUTE	U	H	N

Table A-21: Emergency Messages (downlink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
62	A system generated message that the avionics has detected an error.	ERROR [error information]	U	L	N
63	A system generated denial to any CPDLC message sent from a ground facility that is not the Current Data Authority.	NOT CURRENT DATA AUTHORITY	L	L	N
99	A system generated message to inform a ground facility that it is now the Current Data Authority.	CURRENT DATA AUTHORITY	L	L	N
64	Notification to the ground system that the specified ATSU is the Current Data Authority.	[facility designation]	L	L	N
107	A system generated message sent to a ground system that tries to connect to an aircraft when a Current Data Authority has not designated the ground system as the NDA.	NOT AUTHORIZED NEXT DATA AUTHORITY	L	L	N
73	A system generated message indicating the software version number.	[version number]	L	L	N
100	Confirmation to the aircraft system that the ground system has received the message to which the logical acknowledgment refers and found it acceptable for display to the responsible person.	LOGICAL ACKNOWLEDGMENT	N	M	N

Table A-22: System Management Messages (downlink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
65	Used to explain reasons for aircraft operator*s message.	DUE TO WEATHER	L	L	N
66	Used to explain reasons for aircraft operator*s message.	DUE TO AIRCRAFT PERFORMANCE	L	L	N

	Message Intent/Use	Message Element	URG	ALRT	RESP
74	States a desire by the aircraft operator to provide his/her own separation and remain in VMC.	REQUEST TO MAINTAIN OWN SEPARATION AND VMC	L	L	Y
75	Used in conjunction with another message to indicate that the operator wishes to execute request when the pilot is prepared to do so.	AT PILOTS DISCRETION	L	L	N
101	Allows the aircraft operator to indicate a desire for termination of CPDLC service with the Current Data Authority.	REQUEST END OF SERVICE	L	L	Y
103	Allows the aircraft operator to indicate that he has cancelled IFR flight plan.	CANCELLING IFR	N	L	Y
108	Notification that de-icing action has been completed.	DE-ICING COMPLETE	L	L	N
67		[free text]	N	L	N
68		[free text]	D	H	Y
90		[free text]	N	M	N
91		[free text]	N	L	Y
92		[free text]	L	L	Y
93		[free text]	U	H	N
94		[free text]	D	H	N
95		[free text]	U	M	N
96		[free text]	U	L	N
97		[free text]	L	L	N
98		[free text]	N	N	N

Table A-23: Additional Messages (downlink)

	Message Intent/Use	Message Element	URG	ALRT	RESP
81	We can accept the specified level at the specified time.	WE CAN ACCEPT [level] AT [time]	L	L	N
82	We cannot accept the specified level.	WE CANNOT ACCEPT [level]	L	L	N
83	We can accept the specified speed at the specified time.	WE CAN ACCEPT [speed] AT [time]	L	L	N
84	We cannot accept the specified speed.	WE CANNOT ACCEPT [speed]	L	L	N

	Message Intent/Use	Message Element	URG	ALRT	RESP
85	We can accept a parallel track offset the specified distance in the specified direction at the specified time.	WE CAN ACCEPT [distance offset] [direction] at [time]	L	L	N
86	We cannot accept a parallel track offset the specified distance in the specified direction.	WE CANNOT ACCEPT [distance offset] [direction]	L	L	N

Table A-24: Negotiation Responses (downlink)

PART IV — CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC)

CHAPTER 3 APPENDIX B

CPDLC MESSAGE DATA GLOSSARY

3B.1 CPDLC Data Glossary

3B.1.1 The following data are used as the CPDLC message variables, or component of the variables, and are shown here in alphabetical order:

Aircraft Identification: A group of letters, figures or a combination thereof which is identical to or the code equivalent of the aircraft callsign. It is used in Field 7 of the ICAO Model flight plan.

Airport: Four characters that specifies the ICAO four-letter identifier for the airport.

Airway Identifier: Specifies the particular airway to be used within the route of the aircraft. (IA5 string of 2-5 characters.)

Airway Intercept: Specifies the airway which will be intercepted and followed in the aircraft route of flight.

Altimeter: Indicates the aircraft altimeter setting in SI or non-SI units.

Approved Departure Time: Departure time issued by ATC or ATFM.

ATIS Code: Specifies the alphanumeric value for the current version of the automatic terminal information service (ATIS) in effect at a given location.

ATW Along Track Waypoint: Sequence of information used to compute additional way-points to an aircraft*s route of flight. The following data composes the *ATW Along Track Waypoint:*

b) *Position*,

d) *ATW Distance*,

f) *Speed* (optional), and

h) *ATW Level Sequence* (optional).

ATW Level: Contains ATW Level Tolerance and Level.

ATW Level Sequence: Sequence of 1 or 2 ATW Levels.

ATW Level Tolerance: Indicates the vertical tolerance factor for level clearances. Used in level clearances to indicate the acceptable vertical clearance of an aircraft relative to a particular level. Indicates:

b) at,

d) at or above, or

f) at or below.

ATW Distance: Used to specify the distance along a route of flight at which point to add the fix. Composed of *ATW Distance Tolerance* and *Distance*.

ATW Distance Tolerance: Indicates whether a distance can be plus or minus.

Clearance Expiry Time*:* Time after which a given clearance is no longer valid.

Code (SSR): Specifies the Mode A value for the aircraft.

Clearance Limit: The point to which an aircraft is granted an air traffic control clearance. Specified as a *Position*.

Clearance Type: Specifies a particular type of clearance. Where specified, the following clearance types are permitted:

b) approach,

d) departure,

f) further,

h) start-up,

j) pushback

l) taxi,

n) take-off,

p) landing,

r) oceanic,

t) en-route, or

v) downstream.

Date: Gives the date in YYMMDD format using *Year*, *Month*, and *Day* data.

Date Time Track Generated: Date and time of the creation of a track.

Date Time Group: Provides date and time as YYMMDD and HHMMSS.

Date Time Track Start: Date and time of the track activation.

Date Time Track Stop: Date and time of the track termination.

Day: Day of the month.

Degree Increment: Specifies the number of degrees (of latitude or longitude) separating reporting points.

Degree Minutes: Provides minutes of a latitude or longitude degree.

Degree Seconds: Provides seconds of a latitude or longitude degree.

Degrees: Indicates the degree value in degrees magnetic or degrees true.

Departure Airport: Flight plan departure airport.

Departure Clearance: Sequence of data structures necessary to provide a departure clearance. The sequence of data structures that compose a departure clearance data structure are:

b) *Aircraft Identification*

d) *Clearance Limit,*

f) *Flight Information,*

h) *Further Instructions (optional).*

Departure Expected Clearance Time: Indicates time when a clearance is expected. Associated with flow management program in effect.

Departure Frequency: Provides departure frequency as a Frequency and ICAO Unit Name.

Departure Minimum Interval: Specifies the minimum interval of time to depart behind the preceding aircraft.

Departure Runway: Runway of departure.

Departure Time: Sequence of Approved Departure Time (optional), Departure Time Controlled (optional), Departure Expected Clearance Time (optional) data, Departure Minimum Interval (optional).

Departure Time Controlled: Specifies the time the aircraft is allowed to depart within a time window.

Destination Airport: Flight plan destination airport.

Direction: Indicates the horizontal direction specified in terms of the current direction relative to the aircraft or in terms of the cardinal points of the compass. Values are as indicated:

b) left,

d) right

f) either side,

h) north,

j) south,

l) east,

n) west,

p) north east,

r) north west,

t) south east, or

v) south west.

Distance: Provides the distance in SI or non-SI units.

Distance Offset Direction: Sequence of Distance Offset and Direction data.

Distance Offset: Specifies the offset distance from the aircraft*s route in SI or non-SI units.

Distance To Next Point: Indicates the distance to the next way-point in SI or non-SI units.

Error Information: Indicates the error conditions as follows:

b) unrecognized message reference number,

d) end service with pending messages,

f) logical acknowledgment not accepted,

h) more than one next data authority element, or

j) insufficient message storage capacity.

EFC Time: Specifies the time when a further clearance is expected.

Fix Name: Specifies the ICAO identifier for a given fix.

Fix Next: Indicates the next point in the aircraft*s route as a *Position*.

Fix Next Plus One: Specifies the point after the next point in the aircraft*s route as a *Position*.

Flight Information: Information for a route of flight. Specified as:

b) *Route of Flight*, or

d) *Levels of Flight*, or

f) *Route of Flight* and *Levels of Flight.*

Flight Level: As defined in PANS/RAC (Doc 4444).

Flight Plan Segment: Indicates the type of information used to define a particular point in the aircraft route of flight.

Free Text: Used to convey unstructured information.

Frequency: Specifies the frequency and an indicator of the RF spectrum used for the given frequency. The types of frequency that can be provided include:

b) *Frequency HF*,

d) *Frequency VHF*,

f) *Frequency UHF*,

h) *Frequency Sat Channel*, or

j) *Frequency VHF Channel*.

Frequency Sat Channel: Specifies the appropriate address for use with a satellite voice system.

Frequency VHF Channel: Specifies the VHF channel to permit the use of a resolution of 8.33 kHz.

Further Instructions: Provides additional information in a departure clearance as follows:

b) *Code (SSR)* (optional),

d) *Departure Frequency* (optional),

f) *Clearance Expiry Time* (optional),

h) *Departure Airport* (optional),

j) *Destination Airport* (optional),

l) *Departure Time* (optional),

n) *Departure Runway* (optional)

p) *Revision Number* (optional), or

r) *ATIS Code* (optional).

Hold At Waypoint: Sequence of data structures used to define the holding procedure to be used at a particular point. The *Hold At Waypoint* consists of an sequence of the following:

b) *Position*,

d) *Hold At Waypoint Speed Low* (optional),

f) *ATW Level* (optional),

h) *Hold At Waypoint Speed High* (optional),

j) *Direction* (optional),

l) *Degrees* (optional),

n) *EFC Time* (optional), and

p) *Legtype* (optional).

Hold At Waypoint Speed Low: Specifies a holding speed. When used with *Hold At Waypoint Speed High*, specifies the lower value for a holding speed range.

Hold At Waypoint Speed High: Specifies the upper value for a holding speed range.

Hold Clearance: Provides a holding clearance to the aircraft. The *Hold Clearance* is provided using:

b) *Position*,

d) *Level*,

f) *Degrees*,

h) *Direction*, and

j) *Legtype* (optional).

Hours: Specifies the hour in 24-hour notation.

Facility Designation: Specifies the ICAO four-letter location indicator or the ICAO eight-letter combined location indicator, three letters designator and an additional letter.

Facility Identification: Provides a facility identification as either aFacility Designation or a Location Name.

ICAO Callsign Suffix: Indicates the ATC function performed by the ICAO facility as follows:

b) center,

d) approach,

f) tower,

h) final,

j) ground control,

l) clearance delivery,

n) departure, or

p) control.

Location Name: Specifies the name of the aeronautical station.

Unit Name: Sequence of Facility Identification and ICAO Callsign Suffix (if required).

Unit Name Frequency: Sequence of Unit Name and Frequency.

Unit Name Of Departure Frequency: Specifies the location name for the departure frequency.

Intercept Course From: The *Intercept Course From* is used to specify a fix and a bearing from that fix needed to intercept a route using *Intercept Course From Selection* and *Degrees*.

Intercept Course From Selection. Used to specify the point from which the intercept course originates and an indication of which type of fix is specified. Provided as one of the following:

b) *Published Identifier*,

d) *Latitude Longitude*,

f) *Place Bearing Place Bearing*, or

h) *Place Bearing Distance*.

Latitude: Provides latitude as *Latitude Degrees*, *Degree Minutes* (optional), and *Degree Seconds* (optional).

Latitude Degrees: Degrees of latitude.

Latitude Direction: Indicates whether north or south latitude is specified.

Latitude Longitude: Sequence of Latitude and Longitude.

Latitude Reporting Points: Indicates the latitude on which to base incremental reporting points. Provided as of *Latitude Direction* and *Latitude Degrees*.

Latlon Reporting Points: Provides either Latitude Reporting Points or Longitude Reporting Points.

Leg Distance: Indicates the aircraft leg in SI or non-SI units.

Leg Time: Specifies aircraft leg in terms of minutes.

Leg Type: Provides either Leg Distance or Leg Time.

Level: Allows level to be omitted, or specified as a single level, or vertical range in one of the following ways:

b) *Altitude* in metres or feet, or

d) *Flight Level* in metres or feet.

Level Current: Specifies the current aircraft level.

Level Tolerance: Choice to indicate at, at or above, or at or below, concerning the related level value.

Levels of Flight: Specified as a choice of:

b) *Level*, or

d) *Procedure Name*, or

f) *Level* and *Procedure Name*.

Longitude: *Provides longitude as Longitude Degrees, Degree Minutes (optional), and Degree Seconds (optional).*

Longitude Degrees: Degrees of longitude.

Longitude Direction: Indicates whether east or west longitude is specified.

Longitude Reporting Points: Indicates the longitude on which to base incremental reporting points. Provided as *Longitude Direction* and *Longitude Degrees*.

Month: Month of the year.

Navaid: Specifies a particular navigation aid.

Persons On Board: Specifies the number of persons on the aircraft.

Place Bearing: Sequence of Fix Name, Latitude Longitude (optional), and Degrees.

Place Bearing Distance: Used to indicate a location based on the degrees and distance from a known point. Provided using *Place Bearing* and *Distance* data.

Place Bearing Place Bearing: Used to define a point as the intersection formed by two bearings from two known points. Provided as two *Place Bearing*.

Point Level: Specifies level related details concerning a given point. Provided using *Flight Level* and *ATW Level Tolerance*.

Point Level Block: Provides a level range using two *Levels*.

Position: Information used to specify a location. Position can be specified as:

b) *Fix Name*,

d) *Navaid*,

f) *Airport*,

h) *Latitude Longitude*, or

j) *Place Bearing Distance*.

Position Current: Specifies the current location of the aircraft as a *Position*.

Position Report: Uses the following data necessary to provide an aircraft position report as follows:

b) *Position Current*,

d) *Time At Position Current*,

f) *Level*,

h) *Fix Next* (optional),

j) *Time ETA At Fix Next* (optional),

l) *Fix Next Plus One* (optional),

n) *Time ETA destination* (optional),

p) *Remaining Fuel* (optional),

r) *Temperature* (optional),

t) *Winds* (optional),,

v) *Turbulence* (optional),

x) *Icing* (optional),

z) *Speed* (optional),

ab) *Speed Ground* (optional),

ad) *Vertical Change* (optional),

af) *Track Angle* (optional),

ah) *True Heading* (optional),

aj) *Distance* (optional),

al) *Supplementary Information* (optional),

an) *Reported Waypoint Position* (optional),

ap) *Reported Waypoint Time* (optional), and

ar) *Reported Waypoint Level* (optional).

Procedure: Specifies the name of the procedure.

Procedure Approach: Specifies a procedure as an approach procedure.

Procedure Arrival: Specifies a procedure as an arrival procedure.

Procedure Departure: Specifies a procedure as a departure procedure.

Procedure Name: Used to uniquely identify the standard arrival, approach or departure procedure using the following:

b) *Procedure Type*,

d) *Procedure*, and

f) *Procedure Transition* (optional).

Procedure Type: Specifies the type of procedure as arrival, approach, or departure.

Procedure Transition: Specifies the name of the procedure transition.

Published Identifier: Used to provide the location of the specified fix. Provided using *Fix Name* and *Latitude Longitude*.

Remaining Fuel: Specifies the amount of fuel remaining on the aircraft using *Time* data.

Reported Waypoint Position: The position of the waypoint for which the report is being made.

Reported Waypoint Time: The time of the waypoint for which the report is being made.

Reported Waypoint Level: The level of the waypoint for which the report is being made.

Reporting Points: Used to indicate reporting points along a route of flight based on a specific Latitude and/or Longitude increment expressed in degrees.

Revision Number: Specifies the revision number of the departure clearance. Used to differentiate different revisions of the departure clearance for a given aircraft flight.

Route Clearance: Data necessary to provide a route clearance. Provided using the following data:

b) *Aircraft Identification* (optional),

d) *Departure Airport* (optional),

f) *Destination* Airport (optional),

h) *Gate* (optional),

j) *Runway Departure* (optional),

l) *Procedure Departure* (optional),

n) *Runway Arrival* (optional),

p) *Procedure Approach* (optional),

r) *Procedure Arrival* (optional),

t) *Airway Intercept* (optional),

v) *Route Information Sequence* (optional), and

x) *Route Information Additional* (optional).

Route Information: Indicate the method used to define the aircraft route of flight. The actual aircraft route of flight will probably consist of multiple *Route Information* sequences as follows:

b) *Published Identifier* (optional)

d) *Latitude Longitude* (optional),

f) *Place Bearing Place Bearing* (optional),

h) *Place Bearing Distance* (optional),

j) *Airway Identifier* (optional), and

l) *Track Detail* (optional).

Route Information Additional: Additional data used to further specify a route clearance. Provided using the following:

b) *ATW Along Track Waypoint Sequence* (optional),

d) *Reporting Points* (optional),

f) *Intercept Course From Sequence* (optional),

h) *Hold At Waypoint Sequence* (optional),

j) *Waypoint Speed Level Sequence* (optional), and

l) *RTA Required Time Arrival Sequence* (optional).

Route Of Flight: Specifies route of flight using Route Information

RTA Required Time Arrival: Sequence used to associate an estimated time of arrival with a specific point along a route of flight. The *RTA Required Time Arrival* consists of:

b) *Position*,

d) *RTA Time*, and

f) *RTA Tolerance* (optional).

RTA Time: Used to specify the required time of arrival for an aircraft at a specific point.

RTA Tolerance: Specifies the possible tolerance expressed in minutes in the RTA time.

Runway: Specifies a runway using Runway Direction and Runway Configuration.

Runway Arrival: Specifies the arrival runway.

Runway Configuration: Used to specifically identify one runway in a group of parallel runways. Can be specified as left, right, or center.

Runway Departure: Specifies the departure runway.

Runway Direction: Specifies the direction of the runway.

RVR: Runway Visual Range as distance.

Speed: Provides the aircraft speed as one of the following:

b) *Speed Indicated*,

d) *Speed True*,

f) *Speed Ground*, or

h) *Speed Mach*.

Speed Ground: Ground speed expressed in either SI or non-SI units.

Speed Indicated: Indicated aircraft speed expressed in either SI or non-SI units.

Speed Mach: Aircraft speed specified as a Mach value.

Speed True: Aircraft true speed expressed in either SI or non-SI units.

Speed Type: Indicates what type of speed is to be provided:

b) Indicated,

d) True,

f) Ground,

h) Mach,

j) Approach,

l) Cruise,

n) Minimum,

p) Maximum, or

r) Not specified.

Temperature: Temperature specified in degrees Celsius.

Time: Sequence of *Hours* and *Time Minutes*.

Time At Position Current: Specifies the time that the current location of the aircraft was indicated.

Time ETA Destination: Specifies the time an aircraft is expecting to land at the destination airport.

Time ETA At Fix Next: Specifies the time an aircraft is expecting to cross the next point in the route.

Time HHMMSS: Provides time as HHMMSS.

Time Minutes: Specifies time in minutes of an hour.

Time Seconds: Specifies time in seconds of a minute.

To From: Specifies to or from.

Time Tolerance: Provides a time tolerance as: at, at or before, or at or after.

To From Position: Used to indicate a “to” or “from” relative to a specified position.

Track Angle: Specifies the aircraft ground track in degrees.

Track Detail: Associates a sequence of fixes with a particular track name. Specified using *Track Name* and *Latitude Longitude.*

Track Name: Specifies the name of an identified group of points which make up a section of a route.

Traffic Type: Indicates what type of traffic is present. Permitted types:

b) opposite direction,

d) same direction,

f) converging, or

h) crossing.

True Heading: Specifies the aircraft true heading in degrees.

True Track Angle: Specifies true track angle to the next way-point using degrees.

Turbulence: Specifies the severity of turbulence. Can be one of the following: "light", "moderate", or "severe".

Vertical Change: Sequence of Vertical Direction and Vertical Rate.

Vertical Direction: Specifies whether the rate of vertical change is in the upward or downward direction.

Vertical Rate: Specifies the vertical rate of change in SI or non-SI units.

Waypoint Speed Level: Used to associate levels and speeds with particular points in a route clearance. It is composed using the following:

b) *Position*,

d) *Speed* (optional), and

f) *ATW Level Sequence* (optional).

Winds: Provides wind using *Wind Direction* and *Wind Speed*.

Wind Direction: Specifies the direction of the wind using *Degree Value*.

Wind Speed: Provides wind speed in SI or non-SI units.

Year: Provides year as last two digits of a year.

PART IV — CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC)

CHAPTER 3 APPENDIX C

CPDLC VARIABLES RANGE AND RESOLUTION

1C.2 CPDLC Variables Range and Resolution

1C.2.2 Table 3C-1 provides the required range and resolution for the message variables used in the CPDLC application.

VARIABLES	PARAMETERS	Unit	Range/Size	Resolution
Aircraft Identification		IA5 Character String	2-7 characters	N/A
Airport		IA5 Character String	4 characters	N/A
Airway Identifier		IA5 Character String	1-5 characters	N/A
Altimeter	Altimeter SI	Hecto Pascal	750.0 - 1250.0	0.1
	Altimeter *	Inches Hg	22.00 - 32.00	0.01
Level	Flight Level SI	1 level (10 m)	100 - 2 500	1
	Flight Level non-SI	1 level (100 ft)	30 - 700	1
	Level SI	Metres	-30 to +25 000	1
	Level non-SI	Feet	-600 - +70 000	10
ATIS Code		IA5 Character	1 character	N/A
Bearing		Degrees	1 - 360	1
Code (SSR)		Integer	4 octal digits	N/A
Date	Year	Year of Century	0 - 99	1
	Month	Month Of Year	1 - 12	1
	Day	Day Of Month	1 - 31	1
Degrees	Degrees Magnetic	Degrees	1 - 360	1
	Degrees True	Degrees	1 - 360	1
Departure Minimum Interval		Minutes	0.1 - 15.0	0.1

* Unit of measurement not specified in Annex 5

VARIABLES	PARAMETERS	Unit	Range/Size	Resolution
Distance	Distance SI units	Kilometres	0 - 2000	0.25
	Distance non-SI units	Nautical Miles	0 - 1000	0.1
Distance Offset	Distance Offset SI	Kilometres	1 - 500	1
	Distance Offset non-SI	Nautical Miles	1 - 250	1
Distance to Next Point	Distance To Next Waypoint SI units	Kilometres	1 - 2000	0.1
	Distance To Next Waypoint non-SI units	Nautical Miles	1 - 1000	0.1
Fix Name		IA5 Character String	1-5 characters	N/A
Free Text		IA5 Character String	1 - 200 characters	N/A
Frequency	Frequency HF	kHz	2 850 - 28 000	1
	Frequency VHF	MHz	117.975 - 137.000	0.025
	Frequency UHF	MHz	225.000 - 399.975	0.025
	Frequency VHF Channel	Numerical	117.975 - 137.000	0.005
	Satellite Channel	Digit string	12 digits	N/A
Facility	Facility Designation	IA5 Character String	4-8 characters	N/A
	Location Name	IA5 Character String	3 - 18 characters	N/A
	Navaid	IA5 Character String	1 - 4 characters	N/A
Latitude	Longitude Degrees	Degrees	0 - 90	0.001
	Degree Minutes	Minutes	0 - 59.99	0.01
	Degree Seconds	Seconds	0 - 59	1
Longitude	Longitude Degrees	Degrees	0 - 180	0.001
	Degree Minutes	Minutes	0 - 59.99	0.01
	Longitude Seconds	Seconds	0 - 59	1
Leg Distance	Leg Distance SI units	Kilometres	0-100	1

VARIABLES	**PARAMETERS**	**Unit**	**Range/Size**	**Resolution**
	Leg Distance non-SI units	Nautical Miles	0-50	1
Leg Time		Minutes	0-10	1
Persons On Board		Integer	1 - 1000	1
Procedure Transition		IA5 Character String	1 - 5 characters	N/A
Revision Number		Integer	1 - 16	1
RTA Tolerance		Minutes	0.1-15.0	0.1
Runway Direction		Integer	1 - 36	1
RVR	RVR SI units	Metres	0-1500	1
	RVR *	Feet	0-6100	1
Speed	Ground Speed SI	Kilometres/Hour	- 100 to + 4000	1
	Ground Speed non-SI	Knots	- 50 to + 2000	1
	Mach	Mach Number	0.5 - 4.0	0.001
	Indicated SI	Kilometres/Hour	0-800	1
	Indicated non-SI	Knots	0-400	1
	Speed True SI	Kilometres/Hour	0-4000	1
	Speed True non-SI	Knots	0-2000	1

* Unit measurement not specified in Annex 5

Temperature	Temperature Celsius	Degrees Celsius	- 100 to + 100	1
Time	Time Hours	Hours of Day	0 - 23	1
	Time Minutes	Minutes of Hour	0 - 59	1
	Time Seconds	Seconds of Minute	0 - 59	1
Track Name		IA5 Character String	1-6 characters	N/A
Version Number	Version number	Integer	0 - 15	N/A
Vertical Rate	Vertical Rate SI	Metres/ Second	± 1 000	1
	Vertical Rate non-SI	Feet/Minute	± 30 000	10

VARIABLES	PARAMETERS	Unit	Range/Size	Resolution
Wind Speed	Wind Speed SI	Kilometres/Hour	0 - 500	1
	Wind Speed non-SI	Knots	0 - 250	1

Table 3C-1: CPDLC Variables Range and Resolution

PART IV — CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC)

5. CPDLC PROCEDURES

5.2 General procedures

5.2.2 CPDLC will use standard pilot/controller messages, as defined in Appendix A to Chapter 3 of this part, with free text messages used when required.

5.2.4 When a required response is not successfully delivered, the message initiator is responsible for querying the state of the response via an appropriate medium.

5.2.6 Except when the clearance specifies otherwise, execution of a clearance received via data link may begin upon pilot initiation of the action which sends the acceptance message.

5.2.8 Messages are to be reviewed and responded to in a timely manner upon receipt. If messages are queued, they are to be displayed sequentially in the order of receipt, with the exception that messages with a higher urgency will be displayed first.

5.2.10 When a controller or pilot communicates via voice, the response should be via voice.

5.2.12 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.— Even though a voice response may have been provided, a data link response is necessary to ensure proper synchronization of ground and aircraft systems.

5.2.14 Pilot CPDLC message alerts may be suppressed during take-off, approach, and landing. If a message requiring an alert is received during the suppression period and is still pending at the end of the period, the alert will be re-initiated when the suppression period is over.

5.2.16 Procedures should accommodate mixed data link and voice capability.

5.2.18 Aircraft operating procedures for CPDLC should be consistent and independent of the flight phase or ATS facility.

PART IV — CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC)

6. EXCEPTION HANDLING

6.2 Error conditions

6.2.2 Messages Received Out of Order

6.2.2.2 The recipient will be informed when a message is received out of order.

6.2.4 Duplicate Message Identification Numbers

6.2.4.2 If a CPDLC message is received containing an identification number identical to that of an identification number currently in use, the CPDLC link will be terminated and both users will be informed indicating duplicate message identifiers.

6.2.4.4 Duplicate message identification numbers are only detectable by the recipient system. Detection will result in the second message being unavailable for display, as a CPDLC link abnormal termination will be initiated by the recipient system. Both end users will be informed of the reason for the abnormal termination, specifically Duplicate Message Identification Numbers.

6.2.4.6 The originator system has no knowledge of which messages have resulted in Duplicate Message Identification Numbers in the recipient system, but the originator system must be aware of all messages within a particular link for which closures are pending. In the event of a CPDLC link abnormal termination, these messages must be available for display to the originating end user. Because the originating end user may not be aware of which of these messages have been received by the recipient, procedures must be in place stating that the originating end user will coordinate with the recipient end user as to the status and resolution of these messages.

Note.— The generation of Duplicate Message Identification Numbers is a catastrophic system failure.

6.2.6 Invalid Reference Number

6.2.6.2 If the CPDLC user receives a message containing a message reference number which is not identical to any message identification number currently in use, the CPDLC user responds indicating the error.

6.2.8 Unauthorized Use of Logical Acknowledgment

6.2.8.2 When the ground system receives a message requiring a logical acknowledgment where the use of logical acknowledgment has been prohibited, the ground system will:

b) send a message containing an ERROR message element with the [errorinformation] parameter set to the value [logicalAcknowledgmentNot Accepted].

d) discard the message requiring a logical acknowledgment.

PART IV — CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC)

7. DEPARTURE CLEARANCE SERVICE DESCRIPTION

7.2 Scope and Objective

7.2.2 A flight due to depart from an airfield must first obtain departure information and clearance from the Controlling ATS Unit (ATSU). The Departure Clearance (DC) Service provides automated assistance for requesting and delivering clearances, with the objective of reducing pilot and controller workload and diminishing clearance delivery delays.

7.4 Expected Benefits, Anticipated Constraints, and Associated Human Factors

7.4.2 Benefits

b) reduction of the potential for communication errors between a pilot and controller;

d) reduction of channel load;

f) reduction of ground delays;

h) reduction in pilot workload (e.g., reduced hand-copy of clearances and information, reduced radiotelephony monitoring and use);

j) reduction in controller workload (e.g., reduced radiotelephony and monitoring);

l) automatic validation of flight plan in the ATSU; and

n) automatic preparation of departure clearance and information elements for controller validation.

7.4.4 Constraints

b) reduction of voice induced situational awareness for pilots; and

d) reduced dialogue flexibility in case of non-routine communication.

7.4.6 Human factors

7.4.6.2 Regardless of the level of automation of the system in use, it must be ensured that controllers and pilots have the opportunity to review, validate and acknowledge any clearances being delivered or received.

7.6 Operating Method Without Data Link

7.6.2 Where local procedures or flight category require, flights intending to depart from an airport must first obtain a departure clearance (DC) from the ATSU. This process can only be accomplished if the flight operator has filed a flight plan with the appropriate ATM authority. The DC may contain information relative to the take off phase of flight (e.g., take-off runway and SID, SSR code, departure slot, next contact frequency).

7.6.4 The departure clearance procedure normally consists of the following chronological steps:

b) The pilot calls and requests a departure clearance using R/T, generally prior to start-up.

d) The controller acknowledges the request and formulates the clearance based on available flight plan data and in accordance with the allocated slot time of departure, if any. The clearance is merged with existing flight plan data, either at the controller*s workstation or within local flight data processing systems.

f) The controller delivers the clearance to the pilot using R/T.

h) The pilot acknowledges the clearance via a full readback on R/T.

Note.— The pilot may negotiate a revised clearance after stage c) above.

7.8 Operating Method With Data Link

7.8.2 The departure clearance service will be available after data link communication initiation until the time the aircraft commences movement under its own power. If local procedures permit, the departure clearance service should also be available from the time the aircraft commences movement under its own power until the aircraft is cleared to enter the flight*s take-off runway. The use will be restricted to revisions of granted clearances normally initiated by the ATSU.

7.8.4 The DC is processed directly between ATSU and aircraft. Due to the use of digital communication and information representation, further automation is possible; some of these possibilities are included as supplementary information in the DC Service Description:

a) When the flight is within a parameter time of its estimated time of departure, the pilot transmits a DC Request to the ATSU using data communication.

b) If the DC Request is valid and a corresponding flight plan is available in the ATSU, the ATSU transfers a response to the aircraft accepting the request.

c) A DC is composed and/or verified by the controller based on flight plan related data. The ATSU transmits the DC to the aircraft. In the event of a revised clearance, the DC Clearance will contain the Version Number data field containing the clearance version number applicable to this aircraft.

d) The pilot will verify the operational contents of the DC, and if the pilot accepts and can comply with the operational contents, he will transmit a "WILCO" indication. If the pilot is unable to accept the operational contents, he will transmit an "UNABLE" indication.

e) A controller may send another clearance (reclearance) at any time before take-off (e.g., in the case of pilot re-negotiation or due to a change of runway) via this operating method beginning with (c). An appropriate pilot alerting mechanism must be in place.

Note.— The pilot may re-negotiate the clearance following the transmission of a pilot acknowledgment, by R/T if required.

7.8.6 Initiation Conditions

7.8.6.2 The DC service is invoked on pilot input initiating the DC request, a suitable time prior to departure.

7.8.8 Sequence of Services

7.8.8.2 This service will be capable of being invoked independently of other services.

Note.— There is a dependency on the data link initiation service having been completed, for address provision.

7.8.10 Additional Guidelines

7.8.10.2 The service should not be available to the aircraft after take-off.

7.8.10.4 Since the delivery of the DC will be subject to local procedures, the time from the request for a DC to its delivery to the aircraft is a local variable.

7.8.10.6 Free text can be appended to either the DC request or the clearance as required.

7.8.10.8 Both the aircraft and the ATSU will have the capability to map a response with a request.

7.8.10.10 Ground and airborne systems will be updated with the operational contents of any R/T transactions.

7.8.12 Error Handling

7.8.12.2 If an error message is received, instead of the expected response to a DC request, and the error is correctable, the DC request may be corrected and re-sent. In other cases, the pilot will initiate R/T.

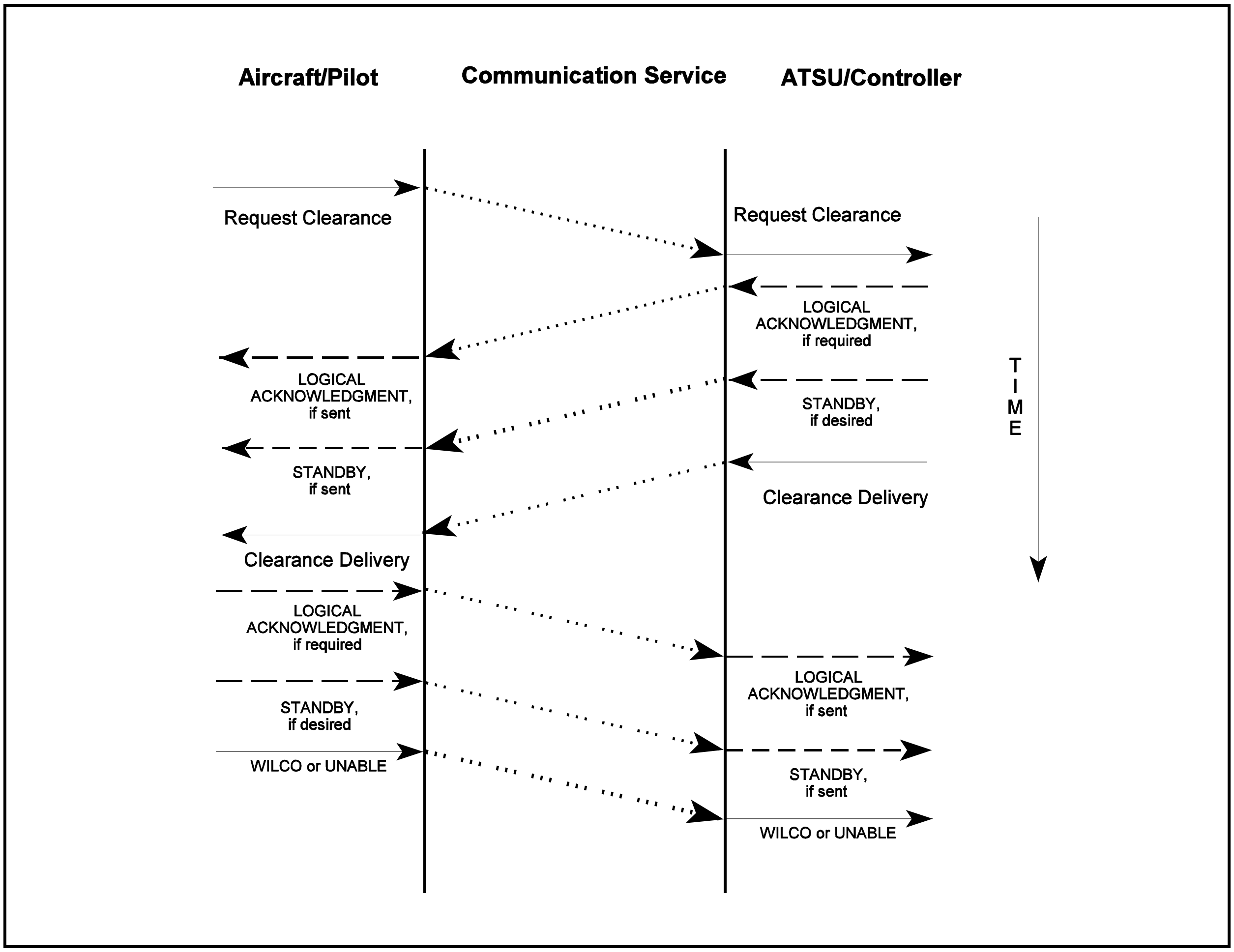
Note.— In the event of any doubt or ambiguity, the negotiation will be carried out by R/T.

7.8.14 Closure Conditions

7.8.14.2 Closure conditions, if required, should be the subject of local implementation.

7.8.16 Time Sequence Diagram

7.8.16.2 Figure 6-1 shows the normal sequence of messages in the DC.



6.4.9.1.1 Figure 6-1: Time Sequence Diagram for Departure Clearance

7.10 Information Exchanges

7.10.2 Table 6-1 shows the information exchanged to effect a departure clearance.

Note. The numbers in the "Message Element" column refer to uplink and downlink messages elements in accordance with Chapter 3, Appendix A: CPDLC Message Set.

Message Element	Information required	Event/Trigger	Source/ Destination	Alert	Response Required
25: REQUEST [clearance type] CLEARANCE	Indication that the clearance type is [departure], optional	Pilot input.	Aircraft/ ATSU	Low	Yes
73: [departure clearance]	Aircraft Identification, Clearance Limit, Flight Information, Route of Flight, or Published Identifier, or Latitude Longitude, or Place Bearing Place Bearing, or Place Bearing Distance, or Airway Identifier, or Track Detail. Levels of Flight, or Level, or Procedure Name, or Level and Procedure Name. Route of Flight and Levels of Flight. Published Identifier, or Latitude Longitude, or Place Bearing Place Bearing, or Place Bearing Distance, or Airway Identifier, or Track Detail, and Level, or Procedure Name, or Level and Procedure Name. Further Instructions (optional). Code (SSR) (optional), Departure Frequency (optional), Clearance Expiry Time (optional), Departure Airport (optional), Destination Airport (optional), Departure Time (optional), Departure Runway (optional), Revision Number (optional), ATIS Code (optional).	Receipt of a request for a clearance (in appropriate domain) or of a request for a departure clearance.	ATSU/ aircraft	Medium	W/U

Table 6-1: Departure Clearance Service Information Exchange

PART IV — CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC)

8. TRANSFER OF DATA AUTHORITY SERVICE DESCRIPTION

8.2 Transfer of Data Authority

8.2.2 Requirements For Transfer of Data Authority

8.2.2.2 CPDLC airborne and ground systems, and supporting procedures, will ensure that Transfer of Data Authority using the CPDLC application messages can be carried out in the following circumstances:

b) independent of the transferring and receiving ATSUs ground/ground data communication capability;

d) when both the transferring and receiving ATSUs are equipped for air/ground data link; and

f) when only the transferring ATSU is equipped for air/ground data link.

8.2.2.4 ATSUs may elect to use ground/ground data exchanges in support of the transfer of data authority, subject to bilateral agreements, local procedures and local infrastructure. Such ground/ground exchanges are not required for successful completion of the transfer.

8.2.2.6 Ground/ground data communication in support of ATC transfer of data authority, if applied, will be in accordance with the ICAO Manual for ATS Data Link Applications, ATS Inter-facility Data Communication (AIDC) section, and any applicable regional supplementary material.

8.2.4 Transfer of Data Authority and Voice Communication in Conjunction

8.2.4.2 Transfer of the CPDLC link, can be carried out in conjunction with the transfer of voice ATC communication. This process involves the transfer of all controller/pilot communication, between the CDA and the NDA, both the voice channel and the CPDLC link.

Note.— ATC voice channel changes which do not involve a change in CPDLC data authority (e.g., sector/sector transfers in the same ATSU), are not covered in this section. Such transfers are handled as standard CPDLC exchanges, using the appropriate messages.

8.2.4.4 Sequence Diagram for Transfer of Data and Voice Concurrently

b) If the CDA notifies the aircraft its NDA the establishment of a NDA link is permitted.

d) A NDA link is established.

f) The CDA instructs the aircraft to monitor or contact the NDA on the appropriate voice channel using the CONTACT and/or MONITOR messages

h) The pilot acknowledges the instruction to transfer voice and activates the new voice channel.

j) The CDA link is terminated normally.

l) The NDA now becomes the CDA and CPDLC messages can be exchanged.

8.2.4.6 Figures 7-1a and 7-1b illustrates transfer of data authority <u>without</u> supporting ground/ground connectivity.

Note.— No Context Management or Log-On/Off functionality reflected in any of the following drawings.

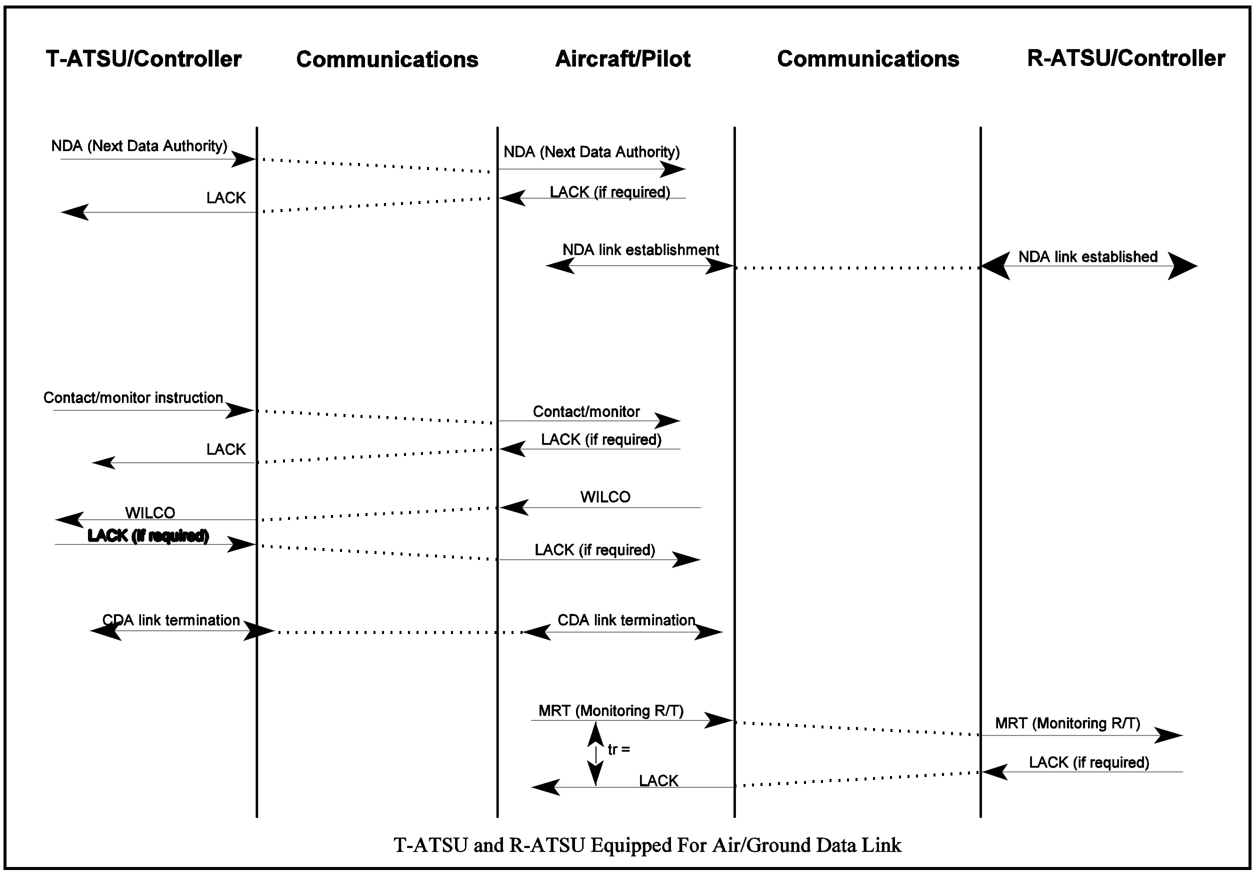


Figure 7-1a: Transfer of Data Authority and Communication Without Ground/Ground Connectivity: <u>T-ATSU Initiated</u>

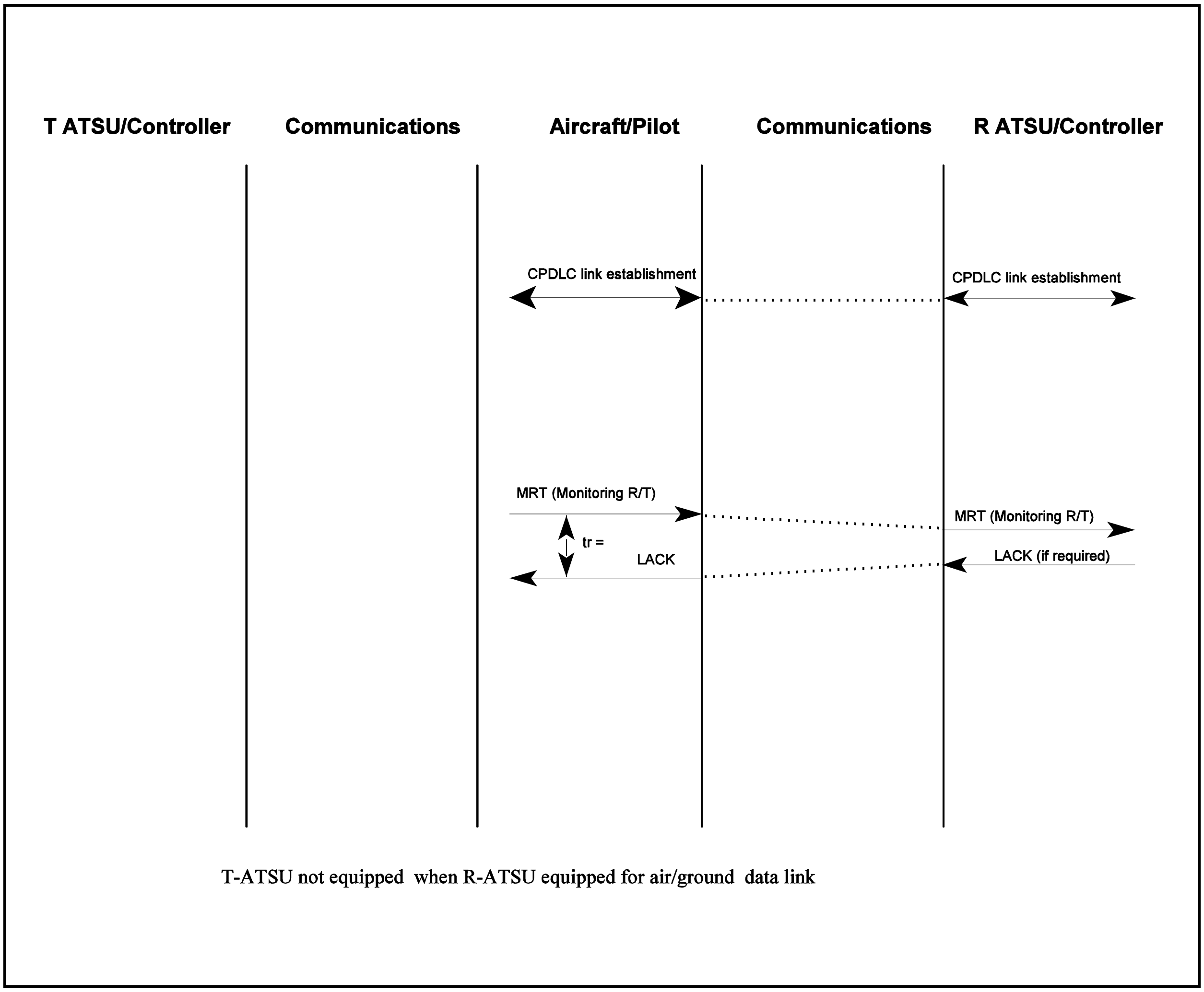
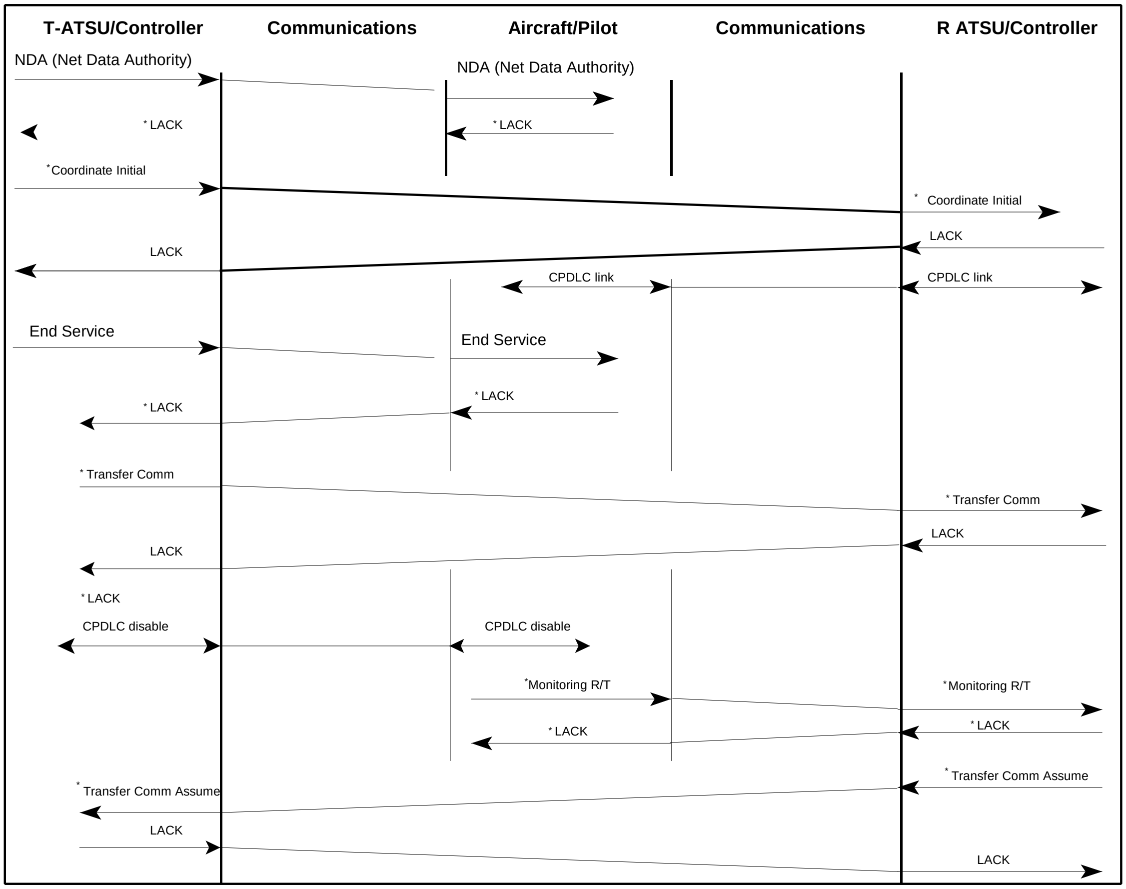


Figure 7-1b: Transfer of Data Authority and Communication Without Ground/Ground Connectivity: *<u>Aircraft ir</u>*

8.2.4.8 Figures 7-2a and 7-2b illustrates transfer of data authority with supporting ground/ground connectivity.



*Indicates an optional message

Figure 7-2a: Transfer of Data Authority and Communication With Ground/Ground Connectivity: Automatic CPDLC Link Transfer (i.e., without contact/monitor instruction and associated pilot acknowledgment)

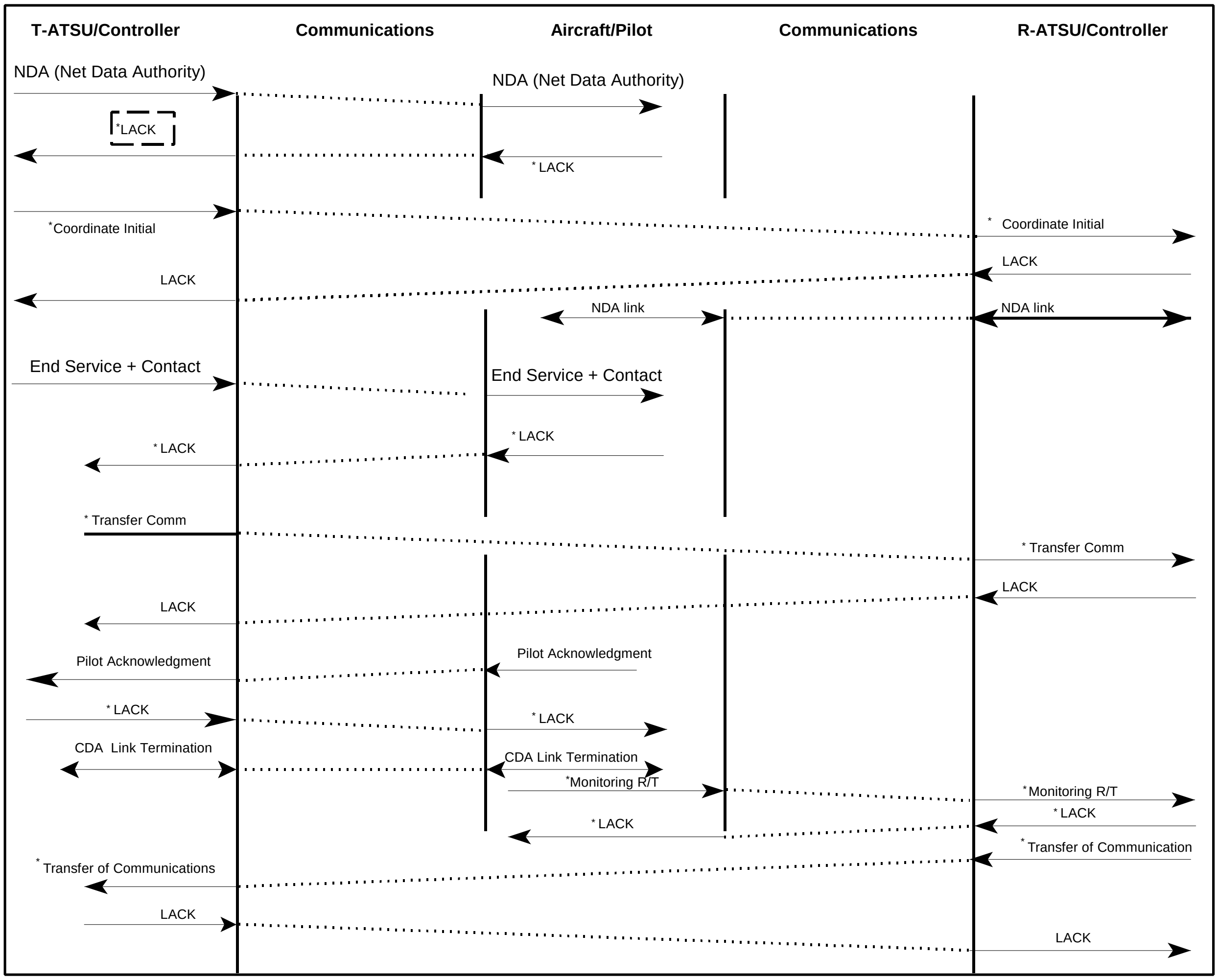


Figure 7-2b: Transfer of Data Authority and Communication With AIDC Ground/Ground Connectivity :
Manual CPDLC Link Transfer (i.e., contact/monitor instruction with pilot WILCO)

8.2.6 Transfer of communications without change of data authority

8.2.6.2 The transfer of communications within sectors of one ATSU does not require a change of Data Authority and the same CPDLC link can be used to communicate with the transferring and receiving sectors.

a) the C-ATSU instructs the aircraft to monitor or contact the next sector on the appropriate voice channel;

b) the pilot acknowledges the instruction to transfer voice and activates the new voice channel.

PART IV — CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC)

9. DOWNSTREAM CLEARANCE SERVICE DESCRIPTION

9.2 Scope and Objective

9.2.2 The pilot, in specific instances, need to obtain clearances or information from ATSUs which may be responsible for control of the aircraft in the future, but are not yet in control of the aircraft. Such "downstream" clearances and information are often provided through ground/ground coordination, but are also obtained via direct contact with the `Downstream* ATSU (D-ATSU) in certain circumstances (e.g., when ground/ground communication are unavailable or inefficient, due to the size of the airspace, due to the complexity of the route structure, or due to meteorological conditions).

9.2.4 Unless otherwise coordinated, downstream clearances or information have no effect on the aircraft*s profile within the current and any later controlling ATSU (C-ATSU) airspaces, prior to actual transfer of control to the D-ATSU. If established, direct contact with the C-ATSU is maintained by the pilot, and is unaffected by communication with the D-ATSU. The need for the C-ATSU to be made aware of the information obtained from the D-ATSU will be governed by local procedures.

9.2.6 The Downstream Clearance (DSC) Service provides assistance for requesting and obtaining D-ATSU clearances or information, using air/ground data link.

9.2.8 The DSC service can only be initiated by the pilot.

9.2.10 The DSC is a service within the CPDLC application. Unless specifically indicated, DSC uses all generic CPDLC functionality, including message handling as well as operational and performance requirements.

9.4 Expected Benefits, Anticipated Constraints, and Associated Human Factors

9.4.2 Expected Benefits

9.4.2.2 The expected benefits of DSC include:

b) reduction of voice channel load (voice frequency congestion);

d) reduction of R/T workload for both pilot and controller;

f) added pilot flexibility for requesting and receiving clearances or information;

h) better, more flexible pacing of communication tasks for aircrew;

j) improved support for aircrew flight planning and task management;

l) provision of an enhanced planning capability for the D-ATSU.

9.4.4 Anticipated Constraints

9.4.4.2 Operational responsibility

9.4.4.2.2 Procedures and system support must be put in place to permit the pilot to have controlled data link access to an ATSU other than the C-ATSU. This capability will be based on the following two levels of ATSU operational access to controller/pilot data link exchanges:

b) *Current ATSU (C-ATSU)*: The ATSU currently responsible for control of the aircraft has authority to exchange **all** CPDLC messages with that aircraft;

d) *Downstream ATSU (D-ATSU)*: An ATSU which is expected to be responsible for control of the aircraft in the future, but which is not yet responsible for its control, has authority to exchange a **limited sub-set** of CPDLC messages with that aircraft, none of which could be construed by either the pilot or the avionics as affecting the immediate control of the aircraft.

9.4.4.2.3 The C-ATSU and the D-ATSU must not be the same Data Authority.

9.4.4.4 Operational Procedures and System Support

9.4.4.4.2 D-ATSU operational access to controller/pilot exchanges will be strictly controlled through operational procedures. The following operational principles will be observed in relation to D-ATSU operational access to controller/pilot data link exchanges:

b) There can be only one Downstream clearance link at any one time.

d) To maintain pilot situational awareness and communication access security, avionics will provide the pilot with the ability to:

    2) Maintain control and awareness over C-ATSU access, including transfer of that access from one ATSU to another. According to procedures, this transfer will be conducted in accordance with C-ATSU directives.

    4) Maintain control and awareness over D-ATSU access. D-ATSU controller/pilot data link access will only be established via pilot request, and will concern exchanges specifically initiated by the pilot (i.e. only the D-ATSU authorized clearances or information requested by the pilot will be accepted).

    6) Clearly and unambiguously differentiate between messages from the C-ATSU and messages from a D-ATSU.

f) Any data link message sent via a DSC link must be readily identifiable as such on the display of both the sender and the recipient of the message.

h) D-ATSU controller/pilot message use should be controlled through ICAO regional operational procedures and published in AIPs for each case

j) There will be procedures that prevent the pilot from executing a clearance received via a Downstream clearance link until the aircraft enters the airspace of the control authority from which the Downstream clearance was received. If the information received by an airborne user via a Downstream Clearance link requires action while still in the airspace of the current control authority, the clearance for such action must be obtained from that current control authority.

l) The ground system must have the ability to reject any request for DSC.

9.4.6 Associated Human Factors

9.4.6.2 See section Operational Procedures and System Support above.

9.4.6.4 Message elements available for this service should be restricted by the end user systems in accordance with the Service Description.

9.6 Operating Method Without Data Link

9.6.2 In the current operational ATC environment, the pilot contacts a D-ATSU, while maintaining communication contact with the C-ATSU, in order to obtain a clearance or information concerning the aircraft*s future flight profile. Such contacts are always initiated by the pilot, and can be conducted either via a second voice channel or, where suitable facilities are available, via air/ground data link (i.e., Oceanic Clearance Message (OCM)).

Step	Operating Method Without Data Link	Operating Method With Data Link
1	The pilot contacts the D-ATSU to request the clearance or information related to D-ATSU airspace, advising any applicable preferences.	The pilot contacts the D-ATSU via data link to request the clearance or information related to D-ATSU airspace, advising any applicable preferences.
2	The D-ATSU provides the pilot with the requested clearance or information, according to the method used for the request.	The D-ATSU provides the pilot with the requested clearance or information, via data link.
3	The pilot acknowledges the clearance or information according to the method used for the clearance or information.	The pilot acknowledges the clearance or information via data link.

Table 8-1: Operating Method With and Without Data Link

9.8 Operating Method With Data Link

9.8.2 Normal Mode

9.8.2.2 Service Description

9.8.2.2.2 DSC will be available in all flight phases. Use of the Service will be restricted to pilot-initiated requests, and the directly associated responses.

9.8.2.2.4 The DSC operating method conforms to the existing operating method. The normal sequence of events is:

b) The pilot triggers a DSC request to the D-ATSU.

d) If a Logical Acknowledgment (LACK) is required in accordance with local procedures, the D-ATSU transmits a LACK to the aircraft.

f) Based on flight related data and data received in the DSC Request, the D-ATSU composes the requested DSC or information and transmits it to the aircraft.

h) If a LACK is required by the D-ATSU in accordance with local procedures, the aircraft transmits a LACK to the D-ATSU.

j) The pilot verifies the D-ATSU Response containing the proposed DSC and:

    2) If they can accept and comply with the operational contents, without any change being required to its current clearance, the pilot transmits a WILCO;

    4) If the proposed DSC affects the current cleared trajectory, the pilot transmits a STANDBY. The pilot will inform the C-ATSU requesting the necessary coordination. When this is confirmed, the pilot transmits a WILCO to the D-ATSU.

    6) If the pilot is unable to accept the operational contents, they will transmit an UNABLE.

9.8.4 Initiation Conditions

9.8.4.2 The DSC Service is invoked exclusively on pilot-initiation of the request to the D-ATSU.

9.8.4.4 The DSC will be completed prior to the aircraft entering the D-ATSU airspace

9.8.6 Termination conditions

9.8.6.2 The DSC link is normally terminated by the pilot after completion of the final response to a receipt of a DSC.

9.8.6.4 DSC link termination procedures will be initiated if the D-ATSU becomes the C-ATSU. In these circumstances, only closure and termination messages can be sent over the DSC link.

9.8.8 Sequence of Services

9.8.8.2 The DSC service can operate independently of any other service.

9.8.10 Additional Guidelines

9.8.10.2 The DSC Service requires flight plan information at the D-ATSU.

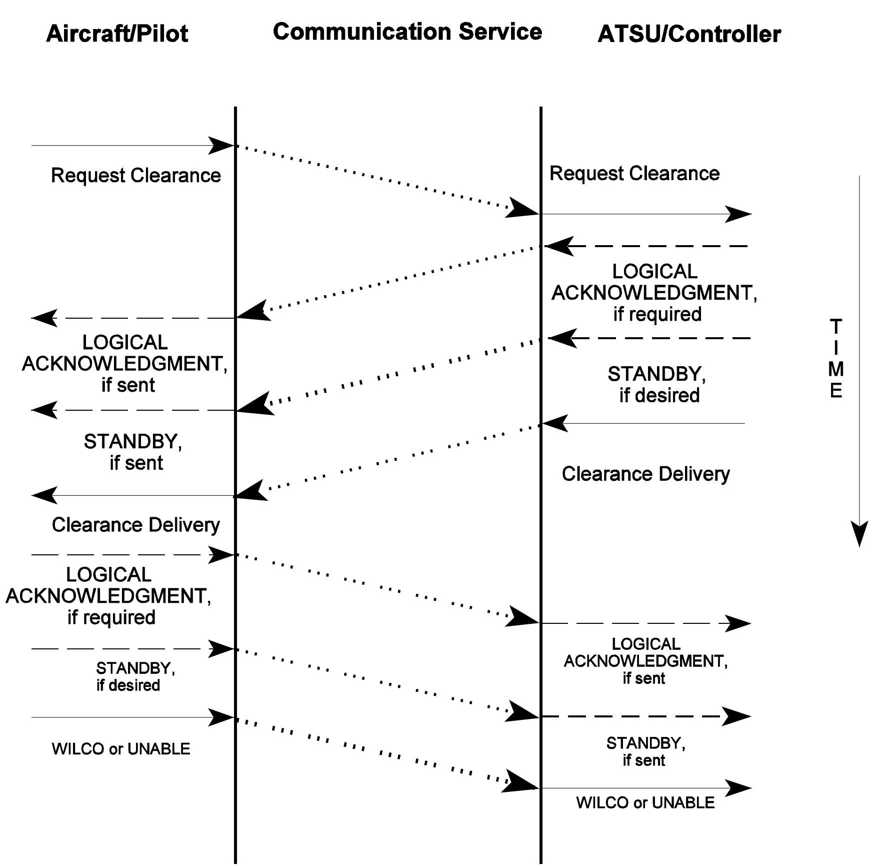
9.8.10.4 Table 8-2 indicates the message elements from the CPDLC message set (Part IV, Chapter 3, Appendix A) which must be prohibited from inclusion in isolation in any DSC related data link dialogue. They may be concatenated with appropriate DSC message elements with caution.

Message Type	**Table Number**	**Message Element Number**
Uplink	A2: Vertical Clearances (Uplink)	19, 20, 23, 26, 27, 28, 29, 30, 192, 209, 31, 32, 34, 36, 37, 38, 39, 40, 41
	A4: Lateral Offsets (Uplink)	67, 68, 69, 72
	A5: Route Modifications (Uplink)	74, 75, 33, 236, 82, 94, 95, 215, 190, 96, 97, 221, 98
	A6: Speed Changes (Uplink)	106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 189, 223, 222
	A7: Contact/Monitor Surveillance Requests (Uplink)	123, 124, 125, 126, 179
	A11: System Management Messages (Uplink)	154, 155, 156, 210, 193, 160, 161, 191
	A12: Additional Messages (Uplink)	164, 230, 176, 177
Downlink	A14: Vertical Requests (Downlink)	6, 7, 8, 9, 10, 69
	A15: Lateral Offset Requests (Downlink)	15
	A18: Route Modification Requests (Downlink)	26, 27, 70, 71
	A22: System Management Messages (Downlink)	63,99,107
	A23: Additional Messages	74, 103

Table 8-2: Message Elements Prohibited from use, in isolation, for Downstream clearance delivery

9.10 Time Sequence Diagram

9.10.2 Figure 8-1 shows the normal sequence of messages in the DSC.



9.10.2.2 Figure 8-1: Time Sequence Diagram For Downstream Clearance Request

9.12 Information Exchanges

9.12.2 Applicable CPDLC Message Elements

9.12.2.2 Although the entire CPDLC message set will be available for DSC, it is recommended that regional agreements be established to govern the use of the CPDLC message elements for DSC. It is expected that the primary use will be for the message elements required to effect requests and deliveries of oceanic clearances. Other uses of DSC may be identified.