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MANUAL OF
AIR TRAFFIC SERVICES
DATA LINK APPLICATIONS

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INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio-visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
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Explanation of Terms

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

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

Air traffic services interfacility data communication (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 (ADS) agreement. An ADS reporting plan which establishes the conditions of ADS data reporting (i.e. data required by the air traffic services unit and frequency of ADS reports which have to be agreed to prior to the provision of the ADS services).

Note.— 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.

ADS contract. A means by which the terms of an ADS agreement will be exchanged between the ground system and the aircraft, specifying under what conditions ADS reports would be initiated, and what

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, at specified intervals, for utilization by any air and/or ground users requiring it. ADS-B is a data link application.

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 (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 flight information services (DFIS). A data link application that allows the exchange of pertinent flight data between air and ground users.

defined operational goal. Each data link application service is a description of its recommended use from an operational point of view.

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 required of a system 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 and in the Data Glossaries for data link applications.

Glossary

ACARS	Aircraft communications addressing and reporting system
ACAS	Airborne collision avoidance system
ADS	Automatic dependent surveillance
ADS-B	Automatic dependent surveillance-broadcast
AIDC	ATS interfacility data communication
AIP	Aeronautical information publication
ALRT	Alert
AMSS	Aeronautical mobile satellite service
ASM	Airspace management
ATC	Air traffic control
ATFM	Air traffic flow management
ATIS	Automatic terminal information service
ATM	Air traffic management
ATN	Aeronautical telecommunications network
ATS	Air traffic service(s)
ATSU	Air traffic services unit
C-ATSU	Controlling ATS unit
CDA	Current data authority
CNS	Communications, navigation and surveillance
CPDLC	Controller-pilot data link communications
D-ATSU	Downstream ATS unit
DC	Departure clearance
DDA	Downstream data authority
DFIS	Data link flight information services
DLIC	Data link initiation capability
DSC	Downstream clearance
EOBT	Estimated off-block time
ETA	Estimated time of arrival
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
FMS	Flight management system
FOM	Figure of merit
GNSS	Global navigation satellite system
GPWS	Ground proximity warning system
HF	High frequency
IAS	Indicated air speed
ID	Identification
IFR	Instrument flight rules
LACK	Logical acknowledgement
LOA	Letter of agreement
METAR	Aviation routine weather report
Mode S	Mode select
MOU	Memorandum of understanding
MSG	Message
NDA	Next data authority
NIM	Navigational integrity monitoring
NM	Nautical miles
NOTAM	Notice to airmen
OCM	Oceanic clearance message
OR	Operational requirement
OSI	Open systems interconnection
PANS-RAC	*Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services* (Doc 4444)
PIREP	Pilot report *Note.— Not specified in other ICAO documents.*
QOS	Quality of service
R-ATSU	Receiving ATS unit
RESP	Response
RGCSP	Review of the General Concept of Separation Panel
RNP	Required navigation performance
RVR	Runway visual range
SARPs	Standards and Recommended Practices
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
VFR	Visual flight rules
VHF	Very high frequency
VMC	Visual meteorological conditions
WILCO	Will comply
WMO	World Meteorological Organization

PART I

OVERVIEW OF ATS DATA LINK APPLICATIONS

Chapter 1

INTRODUCTION

PURPOSE OF THE DOCUMENT

1.1 The purpose of this document is to describe the elements of a data link based air traffic service (ATS) and its application on a worldwide 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.

1.2 This document has been developed to:

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

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

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

   1) system concepts and descriptions,

   2) operational requirements,

   3) procedures and automation capabilities, and

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

1.3 The data link based system will be characterized by the use of automatic dependent surveillance (ADS), controller-pilot data link communications (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 communication (AIDC) network will be incorporated. Initial information on ADS-broadcast (ADS-B) is included.

1.4 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 communications, navigation and 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.

STRUCTURE OF THE DOCUMENT

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

I. Overview of ATS data link applications
II. Data link initiation capability
III. Automatic dependent surveillance
IV. Controller-pilot data link communications
V. Data link flight information services
VI. ATS interfacility data communication
VII. ADS-broadcast

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

1.7 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.

1.8 Part I 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 interrelationship 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 fulfil the operational needs.

1.9 Part II 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.

1.10 Part III 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.

1.11 Part IV explains the concept of controller-pilot data link communications and its associated requirements, identifies how this will enhance air traffic services, and describes in detail the necessary message formats and their implementation.

1.12 Part V indicates how flight information services will be incorporated into the data link environment, providing the ability for the pilot to receive data link flight information services on the flight deck, on request or automatically. An outline of the services proposed for implementation is also given.

1.13 Part VI relates to the concept of ATS interfacility data communication and gives guidance on the implementation of ground-ground data link technology needed to support the air-ground ATC facilities.

1.14 Part VII relates to ADS-broadcast and provides the initial guidance on its concept.

1.15 Further parts may be added in later editions to reflect the introduction, development and implementation of other applications. The appendix 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.

Appendix to Chapter 1

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

1. DETAILED DESCRIPTION OF SELECTED SERVICES

1.1 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.

1.2 Services are defined in gradually increasing detail, using the following subsections:

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.

Anticipated constraints describes the constraints which could result from implementation of the service.

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 system(s) will perform the service in today's non-data link environment. As this heading describes controller and pilot actions, it also covers procedures.

Operating method with data link:

Normal mode describes how the service would normally be conducted via the following subsections:

a) *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;

b) *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;

c) *Sequence of services* states what other data link services must precede the data link service, if any;

d) *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: a standard method to illustrate the message flows in chronological order for the standard (nominal) execution of a service. Figure I-1-A1 provides an example diagram.

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:

a) *Message*: states the name of the specific message within the exchange;

b) *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;

c) *Event trigger*: briefly describes the operational event that will initiate the message;

d) *Source/destination*: gives the operational source and destination of the message. These can be aircraft or one of several air traffic services unit (ATSU) designators, as defined in the glossary;

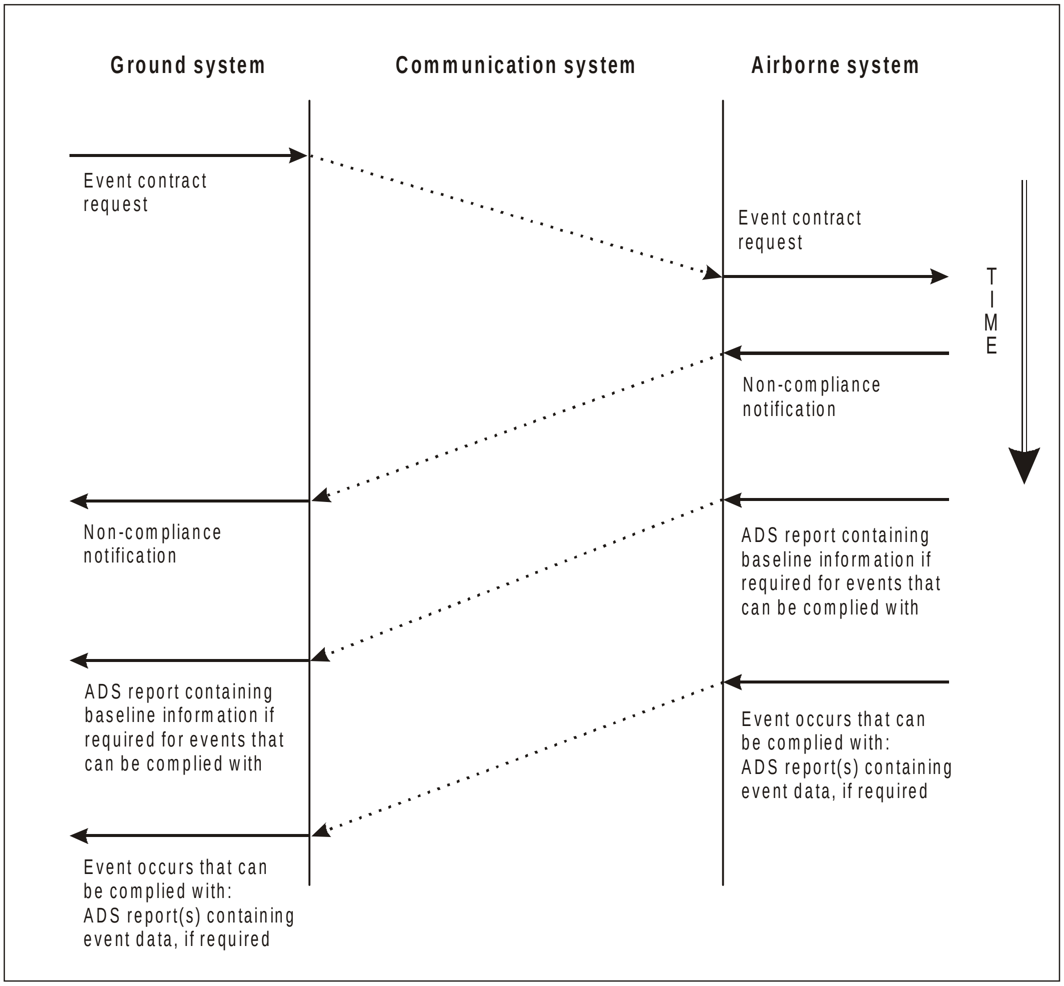


Figure I-1-A1. Time-sequence diagram

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

1) H: High,
2) M: Medium,
3) L: Low,
4) N: No alerting required;

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

Table I-1-A1 is an example table of information exchange requirements.

Quality of service (QOS) requirements: only exceptions to the global QOS requirements (when available) need to be specified.

a) *Communication priority*: establishes the priority of messages within this service in relation to other information flows:

1) Distress, indicating grave and imminent danger;

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

3) 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;

4) Routine surveillance or navigation;

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

Table I-1-A1. Information exchange requirements

Message	*Information required*	*Example operational MSG contents*	*Event/ trigger*	*Source/ destination*	*Alert*	*Response*
	Mandatory Optional				Controller Pilot	

6) NOTAM distribution;

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

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

b) *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:

1) *Distress*, indicating grave and imminent danger;

2) *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;

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

4) *Low*, indicating any message with a lesser urgency than the above.

c) *Information security:* provides any applicable security requirements for messages, including:

1) 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;

2) 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,

iii) ‘A’, indicating protection against unauthorized addition of messages,

iv) ‘D’, indicating protection against unauthorized deletion of messages;

3) 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.

4) Availability; and

5) Service restoration time.

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

Chapter 2

THE FANS CONCEPT

HISTORICAL BACKGROUND

2.1 In the early 1980s, 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.

2.2 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.

2.3 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. The appendix to this chapter contains further information on Human Factors.

2.4 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.

THE ICAO CNS/ATM SYSTEM

Communications

2.5 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.

2.6 Potential benefits from air-ground communications are:

a) efficient linkages between ground and airborne systems;

b) improved handling and transfer of data;

c) reduced channel congestion;

d) reduced communications errors;

e) inter-operable communication media; and

f) reduced workload.

Navigation

2.7 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 en-route applications.

2.8 Potential benefits from GNSS are:

a) improved four-dimensional navigational accuracy;

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

c) cost savings from phase-out of ground-based navigation aids; and

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

Surveillance

2.9 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.

2.10 Potential benefits from the enhanced surveillance system are:

a) enhanced flight safety;

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

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

d) reduced delays;

e) the accommodation of user-preferred flight profiles;

f) increased ATC capacity; and

g) more efficient and economic aircraft operations.

Air traffic management (ATM)

2.11 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 States individually, 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.

2.12 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.

2.13 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 ADS, other data link applications, satellite communications, GNSS and aviation weather system improvements to integrate ground-based automation and airborne flight management systems.

2.14 Potential benefits from improvements in ATM are:

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

b) more flexible ATM operations;

c) enhanced surveillance capability;

d) reduced congestion;

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

f) better accommodation of user-preferred profiles;

g) enhanced meteorological information; and

h) reduced controller workload.

Expected benefits of data link ATS

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

a) increased safety by reducing the potential for erroneous receipt of messages;

b) reduction of voice-channel congestion;

c) reduction of radiotelephony workload for both the pilot and controller;

d) increased communication availability;

e) reduction of late transfer of communications;

f) reduction of re-transmissions caused by misunderstood communications;

g) increased flexibility in handling ATC communication tasks;

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

i) reduced controller stress/memory burden; and

j) reduced controller communication time.

Appendix to Chapter 2

HUMAN FACTORS

1. SUMMARY

The success of the ICAO CNS/ATM systems concept will depend to a large degree upon its effective implementation within 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, instead of only the technology involved. 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.

2. BACKGROUND AND JUSTIFICATION

2.1 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 25 years and, as a consequence, the search for significant potential improvements continues.

2.2 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 the second world war, 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 where 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.

2.3 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. Not only is this expensive, but it breeds skepticism among users, which can result in a state of affairs in which technology falls short of realizing its full safety potential.

2.4 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. For operational personnel and designers to include Human Factors knowledge in their professional "tool kits" and apply it in operational practice, the understanding of this relevance is essential. It appears a logical corollary that CNS/ATM system safety and efficiency would be enhanced if its design and implementation observed a systemic approach which integrates technology with human capabilities and limitations.

2.5 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 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* (an isolated deficiency in human performance or in an isolated piece of equipment in an isolated 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, as 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)*.

3. AUTOMATION AND NEW TECHNOLOGIES

3.1 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 engineering, 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 they may be asserted by their proponents as a prerogative to re-design not only the technology but also the jobs and responsibilities of operational personnel, 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.

3.2 The piecemeal introduction of new technologies has on occasion been self-defeating, as the GPWS example illustrates. Designers have automated what the existing state of knowledge allowed to be automated, leaving those tasks which could not be automated to be performed by humans. 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 that 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 at a time when they themselves are facing operational conditions not forecast by design and for which they are neither trained nor prepared.

3.3 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 of potential interrelationships 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 misoperations of engineered systems that are otherwise fully functional, and are therefore labeled as human error. The typical belief is that 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 often regulators impose upon operational personnel.

3.4 In practice, things are different. The attribution of error is a judgement about human performance, applied only when a process (i.e. an operation) has had 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. The problem seldom 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 proactively during the design of technology.

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

a) the operational context in which the technology will be deployed;

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

c) 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

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

3.6 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.

4. COGNITION AND NEW TECHNOLOGIES

4.1 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-based 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:

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

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

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

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

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

4.2 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 proactively anticipated and taken care of during design.

4.3 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 a field of continuing activity. Developing and introducing new technology does not preserve the old ways of doing business in the continuing field of activity, with the simple substitution of one tool for another (i.e. replacing a typewriter with 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.

5. THE PRINCIPLES OF HUMAN-CENTRED AUTOMATION

5.1 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.

5.2 *The human bears the ultimate responsibility for the safety of the aviation system.* 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 defence 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.

5.3 *The human operator must be in command.* For humans to assume ultimate responsibility for the safety of the system, they should be conferred with essentially unlimited authority to permit them to fulfil 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 reason is 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.

5.4 *To command effectively, the human operator must be involved.* 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.

5.5 *To be involved, the human must be informed.* 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 a 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 fulfil 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.

5.6 *Functions must be automated only if there is a good reason for doing so.* 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 than that it is technologically possible may result in the user’s inability to effectively employ it for the benefit of the whole system. The position 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”.

5.7 *The human must be able to monitor the automated system.* The ability to monitor automated systems is necessary, not only to permit the human operator to remain on top of the situation, but 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.

5.8 *Automated systems must be predictable.* 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.

5.9 *Automated systems must also be able to monitor the human operator.* Human 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 actions that can potentially compromise safety must be designed into the system.

5.10 *Each element of the system must have knowledge of the others' intent.* 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 cooperatively 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.

5.11 *Automation must be designed to be simple to learn and operate.* 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 automated 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. 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.

6. HUMAN FACTORS ISSUES RELATED TO DATA LINK APPLICATIONS

6.1 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:

a) 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;

b) 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;

c) 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;

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

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

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

g) voice communication to supplement data link system operation should be available; and

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

Chapter 3
DATA LINK APPLICATIONS

DATA LINK BASED AIR TRAFFIC SERVICES SYSTEMS

3.1 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 communications, navigation and surveillance 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.

3.2 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 preferred flight 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.

3.3 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. 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(s) available.

3.4 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 data link system.

SYSTEM COMPONENTS

3.5 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:

a) pilot interface;

b) aircraft (including airborne automation);

c) air-ground and ground-ground data link communications;

d) communication interface;

e) ATC automation; and

f) controller interface.

Pilot interface

3.6 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.

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

Aircraft equipment

3.8 Data link applications must be supported by aircraft equipment which is able to gather the data from 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 of receiving 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.

Air-ground and ground-ground data link communications

3.9 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.

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

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

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

Ground communication interface

3.13 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.

ATC automation

3.14 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 that 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.

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

3.16 In addition, the ATC system will allow for safe recovery from response delays, non-response, system failures, system management errors, or other 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.

3.17 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.

Controller interface

3.18 The controller interface will contain the required tools for the composition of air-ground data link messages. ATS 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 the appendix to Part I, Chapter 2.

OPERATIONAL REQUIREMENTS

3.19 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".

3.20 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 3.5 above, has also to be considered. Specific operational requirements have been identified which are applicable to the global data link applications environment.

3.21 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 to this chapter.

3.22 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.

3.23 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.

3.24 A data link based ATS must include the capability of exchanging 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.

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

GENERIC OPERATIONAL REQUIREMENTS

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

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

3.28 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.

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

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

3.31 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.

3.32 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.

3.33 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.

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

3.35 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.

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

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

COMMUNICATIONS FAILURE

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

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

Appendix A to Chapter 3

COMMUNICATION SYSTEMS PERFORMANCE REQUIREMENT PARAMETERS

1. GENERAL REQUIREMENTS

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

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

b) 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

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

2. PERFORMANCE REQUIREMENTS

2.1 The figures in Tables I-3-A1 and I-3-A2 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.

2.2 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.)

Table I-3-A1. Application-specific performance requirements

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 I-3-A2. Transfer delay 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

Appendix B to Chapter 3

TRANSITION STRATEGY

1. TRANSITION PRINCIPLES AND GUIDELINES

1.1 *General principles.* The phased implementation of a data link based system will take place within an environment which places constraints and conditions on the process, namely:

a) a future system can only be implemented by means of an evolutionary process: this process has already begun;

b) the impact on the pilots and air traffic controllers of Human Factors issues must be resolved;

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

d) the system should be protected against unauthorized access and unauthorized transmission;

e) the system should be able to accommodate increased demands and future growth;

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

g) evolving systems should be able to accommodate variations in quality standards and performance characteristics.

1.2 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.

1.3 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.

1.4 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 ATS, 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.

1.5 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.

1.6 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.

2. IMPLEMENTATION PRINCIPLES

2.1 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.

2.2 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.

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

1) *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.

2) *Transition to data link based operations should initially begin in oceanic airspace and in continental en-route 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.

3) *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.

4) *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.

5) *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.

6) *States and/or regions should take actions within the ICAO framework 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.

7) *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 favour of user-preferred flight trajectories with, for example, ADS surveillance and conflict probing.

8) *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.

9) *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.

2.4 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.

2.5 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 programme must be maintained during the transition period.

3. PLANNING FOR IMPLEMENTATION

3.1 Planning for the new overall CNS system is under way on both global and regional bases. 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.

3.2 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:

a) data link media,

b) message formats,

c) separation,

d) automation,

e) ATC procedures, and

f) end-to-end verification and certification.

4. VALIDATION AND EARLY IMPLEMENTATION

4.1 The six component parts of the data link based ATS system described in Part I, Chapter 3 have for the most part 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.

4.2 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.

4.3 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.

4.4 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.

4.5 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.

Chapter 4

DATA LINK INITIATION CAPABILITY OVERVIEW AND HIGH-LEVEL OPERATIONAL REQUIREMENTS

DLIC OVERVIEW

4.1 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:

a) logon: data link application initiation and, if required, flight plan association,

b) update: updating of previously coordinated initiation information,

c) contact: instructions to perform data link initiation with another specified ground system,

d) dissemination: local dissemination of information, and

e) ground forwarding: ground-ground forwarding of logon information.

4.2 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.

DLIC HIGH-LEVEL OPERATIONAL REQUIREMENTS

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

4.4 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.

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

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

4.7 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.

4.8 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.

4.9 The ground system should be able to correlate the aircraft-unique identifier with the aircraft identification stored in its database.

4.10 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.

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

4.12 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.

DETAILED IMPLEMENTATION

4.13 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.

Chapter 5

AUTOMATIC DEPENDENT SURVEILLANCE APPLICATION OVERVIEW AND HIGH-LEVEL OPERATIONAL REQUIREMENTS

ADS APPLICATION OVERVIEW

5.1 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 radio navigation 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 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.

5.3 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 upon 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.

5.4 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.

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

5.6 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 communications.

5.7 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.

5.8 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.

5.9 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.

5.10 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.

5.11 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 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.

5.12 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.

ADS HIGH-LEVEL OPERATIONAL REQUIREMENTS

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

5.13.1 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.

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

5.13.3 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.

5.13.4 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.

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

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

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

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

5.15.1 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.

5.16 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.

5.16.1 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.

5.16.2 The aircraft system will generate and transmit the basic ADS report at a pre-set initial reporting rate together with the state of emergency and/or urgency. This pre-set reporting period will be the lesser of 50 per cent of the existing periodic contract reporting period, or 1 minute. However, the emergency reporting period will not be less than 1 second. A single default value of 1 minute may be used in initial implementations. Aircraft identification and ground vector group will be included in every fifth report.

5.16.3 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.

5.16.4 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.

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

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

5.17.1 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.

5.18 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.

5.18.1 Many operational errors today in non-radar airspace are due to waypoint 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.

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

5.19.1 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.

5.19.2 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.

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

5.20.1 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.

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

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

5.21.1 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.

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

5.22.1 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(latitude), delta(longitude), delta(level) or delta(time) are exceeded.

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

5.23.1 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.

5.23.2 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.

DETAILED IMPLEMENTATION

5.24 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.

Chapter 6

CONTROLLER-PILOT DATA LINK COMMUNICATIONS APPLICATION OVERVIEW AND HIGH-LEVEL OPERATIONAL REQUIREMENTS

CPDLC APPLICATION OVERVIEW

6.1 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. CPDLC is a means of communication between controller and pilot, using data link for ATC communications.

6.2 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 worldwide connectivity and an established quality of service which will provide optimum routing and delivery.

6.3 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.

6.4 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.

6.5 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.

6.6 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.

6.7 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.

6.8 Among others, the following aspects of CPDLC are to be taken into account in considering its application and in defining procedures:

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

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

c) the inability of the pilot to listen to other transmissions in the same area of operation;

d) unauthorized access; and

e) unauthorized transmissions.

CPDLC HIGH-LEVEL OPERATIONAL REQUIREMENTS

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

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

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

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

6.10.3 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.

DETAILED IMPLEMENTATION

6.11 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.

Chapter 7

DATA LINK FLIGHT INFORMATION SERVICES APPLICATION OVERVIEW AND HIGH-LEVEL OPERATIONAL REQUIREMENTS

DFIS APPLICATION OVERVIEW

7.1 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.

7.2 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.

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

7.4 There are multiple data link flight information services that may be provided, including:

a) automatic terminal information services (ATIS),

b) aviation routine weather report (METAR) service,

c) terminal weather service (TWS)*,

d) windshear advisory service,

e) pilot report service*,

f) notice to airmen (NOTAM) service,

g) runway visual range (RVR) service,

h) aerodrome forecast (TAF) service,

i) precipitation map service*, and

j) SIGMET service.

Note.— An asterisk (*) indicates that there is no current ICAO requirement for the provision of this service at this time.

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

DFIS HIGH-LEVEL OPERATIONAL REQUIREMENTS

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

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

DETAILED IMPLEMENTATION

7.8 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.

Chapter 8

ATS INTERFACILITY DATA COMMUNICATION OVERVIEW AND HIGH-LEVEL OPERATIONAL REQUIREMENTS

AIDC APPLICATION OVERVIEW

8.1 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.

8.2 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.

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

a) Notify phase, in which the aircraft trajectory and any changes may be conveyed to an ATSU from the current ATSU prior to coordination;

b) Coordinate phase, in which the aircraft trajectory is coordinated between two or more ATSUs when the flight approaches a common boundary; and

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

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

AIDC HIGH-LEVEL OPERATIONAL REQUIREMENTS

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

DETAILED IMPLEMENTATION

8.6 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.

Chapter 9

AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST APPLICATION OVERVIEW AND HIGH-LEVEL OPERATIONAL REQUIREMENTS

ADS-B APPLICATION OVERVIEW

9.1 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 and identification, via a broadcast-mode data link for utilization by any air and/or ground users requiring it.

9.2 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 systems are 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.

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

9.4 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 on board the aircraft and within the ground ATC automation systems.

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

9.6 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.

9.7 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:

a) ATC surveillance,

b) airborne situational awareness,

c) conflict detection (both airborne and ground based),

d) ATC conformance monitoring, and

e) ADS-B lighting control and operation.

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

ADS-B HIGH-LEVEL OPERATIONAL REQUIREMENTS

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

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

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

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

DETAILED IMPLEMENTATION

9.13 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

Chapter 1

APPLICATION OVERVIEW

INTRODUCTION

1.1 *Purpose.* This section contains guidance material for the data link initiation capability (DLIC). The DLIC process supports addressing requirements for ATS such as ADS, CPDLC, and DFIS.

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

a) *logon:* data link application initiation and, if required, flight plan association;

b) *update:* updating of previously coordinated initiation information;

c) *contact:* instructions to perform data link initiation with another specified ground system;

d) *dissemination:* local dissemination of information; and

e) *ground forwarding:* forwarding of logon information.

Chapter 2

GENERAL REQUIREMENTS

DLIC PRIORITY

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

DLIC PERFORMANCE REQUIREMENTS

Response timers

2.2 Upon receipt of a logon request from an aircraft, the ground system will generate a logon response within 0.5 second.

2.3 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.

2.4 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.

TIME REQUIREMENTS

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

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

ADDRESS MANAGEMENT

2.7 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 embedded 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.

Chapter 3

DLIC FUNCTIONAL CAPABILITIES

THE DLIC LOGON FUNCTION

Operational requirements

3.1 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.

3.2 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).

3.3 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.

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

3.5 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.

3.6 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.

3.7 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.

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

Message descriptions

3.9 The logon request message provides:

a) the aircraft's DLIC address and version number;

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

c) the application name and version number for each application which can be air-initiated; and

d) flight plan information when required.

3.10 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.

THE DLIC UPDATE FUNCTION

Operational requirements

3.11 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.

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

3.13 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.

Message descriptions

3.14 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.

THE DLIC CONTACT FUNCTION

Operational requirements

3.15 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.

Message descriptions

3.16 The contact request message provides the address of the next ground system that the initiating ground system is requesting the aircraft to logon with.

3.17 The contact response message provides the information indicating whether the requested contact with the next ground system was successful.

DLIC DISSEMINATION FUNCTION

Operational requirements

3.18 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.

Message descriptions

3.19 There is no requirement for messages to be exchanged.

DLIC GROUND FORWARDING

Operational requirements

3.20 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.

3.21 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.

Message descriptions

3.22 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.

GUIDANCE ON EXPECTED DLIC MESSAGE TRAFFIC

3.23 The appendix to this chapter provides guidance on expected DLIC message traffic in specific airspace domains.

Appendix to Chapter 3

EXPECTED DLIC MESSAGE TRAFFIC

1. EXPECTED DLIC MESSAGE TRAFFIC

Table II-3-A1 details the anticipated message exchange rate for DLIC in the environments specified. The rates shown are the expected averages, per flight.

Table II-3-A1. Exchange rates expected for DLIC messages

	Oceanic-continental en-route low density	*Oceanic high density*	*Continental high density*	*Terminal area high density*	*Aerodrome (includes approach, taxi and departure)*
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	1 250	450	250

Chapter 4

DLIC MESSAGES DESCRIPTION

DLIC MESSAGES

Logon request message

4.1 The DLIC logon request message contains the following information:

a) DLIC address,

b) aircraft address,

c) aircraft applications (optional),

d) ground applications (optional),

e) aircraft identification (as required),

f) facility designation (as required),

g) departure airport (as required),

h) destination airport (as required), and

i) estimated off-block time (EOBT) (as required).

Logon response message

4.2 The DLIC logon response message contains the following information:

a) response,

b) failure reason (optional),

c) air applications (optional), and

d) ground applications (optional).

Update message

4.3 The DLIC update message contains the following information:

a) air applications (optional), and

b) ground applications (optional).

Contact request message

4.4 The DLIC contact request message contains the following information:

a) facility designation, and

b) DLIC address.

Contact response message

4.5 The DLIC contact response message contains only a response indicating whether or not the logon was successful.

Ground-forward request message

4.6 The DLIC ground-forward request message contains the following information:

a) aircraft address,

b) air applications (if provided in logon request),

c) ground applications (if provided in logon request),

d) aircraft identification (if provided in logon request),

e) facility designation (if provided in logon request),

f) departure airport (if provided in logon request),

g) destination airport (if provided in logon request), and

h) EOBT (if provided in logon request).

Ground-forward response message

4.7 The DLIC ground-forward response message contains only a response indicating success or failure.

MESSAGE CONTENT GLOSSARY

4.8 The following data are used as the message content variables, or components of the variables, and are shown here in alphabetical order:

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

Aircraft identification. A group of letters, figures or a combination thereof which is identical to or the code equivalent of the aircraft call-sign. It is used in field 7 of the ICAO model flight plan.

Airport. Four characters that specify the ICAO four-letter location indicator for the airport.

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. Four characters that specify the ICAO four-letter location indicator for the departure airport.

Destination airport. Four characters that specify the ICAO four-letter location indicator for the destination airport.

DLIC address. *Application address* for DLIC.

EOBT. Estimated off-block time.

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

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, minute, second.

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

a) success;

b) logon not successful; or

c) 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.

DATA STRUCTURE RANGE AND RESOLUTION

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

Table II-4-1. DLIC data range and resolution

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
Facility designation	IA5	4-8 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 – 1996-2095 MM – 1-12 DD – 1-31	1 1 1

Chapter 5

OPERATIONAL MESSAGE SEQUENCE

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

SEQUENCE RULES

DLIC logon function

5.1 The sequence of messages shown in Figure II-5-1 occurs when the DLIC logon function is initiated.

DLIC update function

5.2 The sequence of messages shown in Figure II-5-2 occurs when the DLIC update function is initiated.

DLIC contact function

5.3 The sequence of messages shown in Figure II-5-3 occurs when the DLIC contact function is initiated.

5.4 *DLIC ground-forwarding function*. The sequence of messages shown in Figure II-5-4 occurs when the DLIC ground-forwarding function is initiated.

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

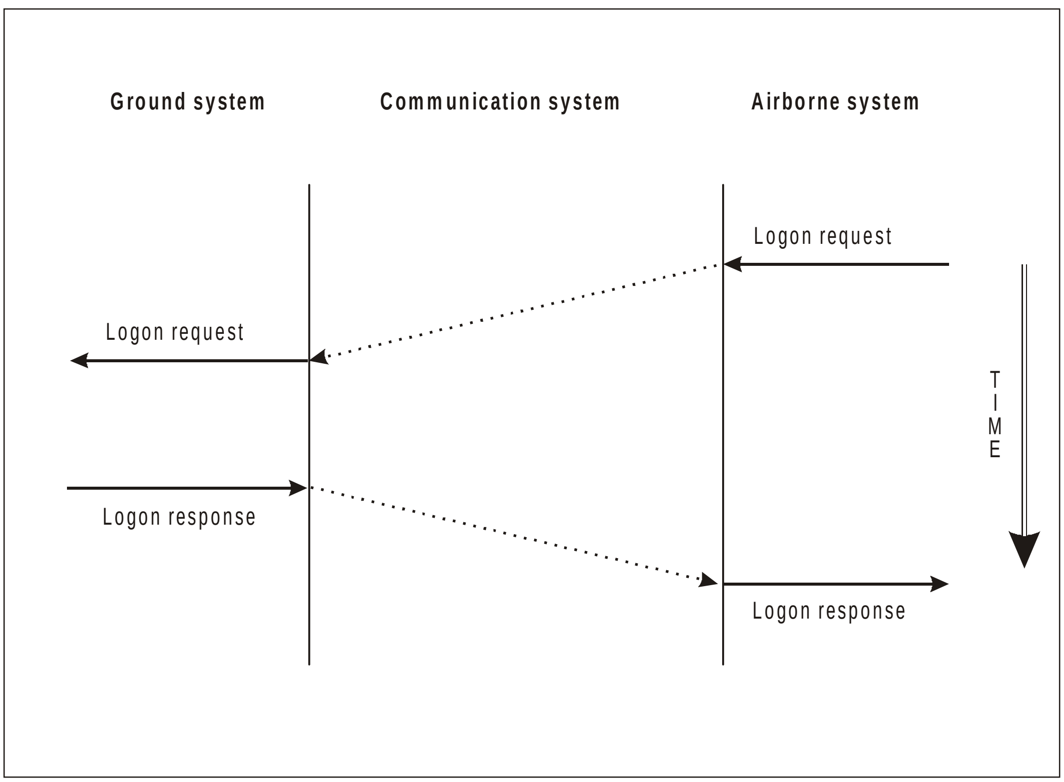


Figure II-5-1. Sequence diagram for DLIC logon function

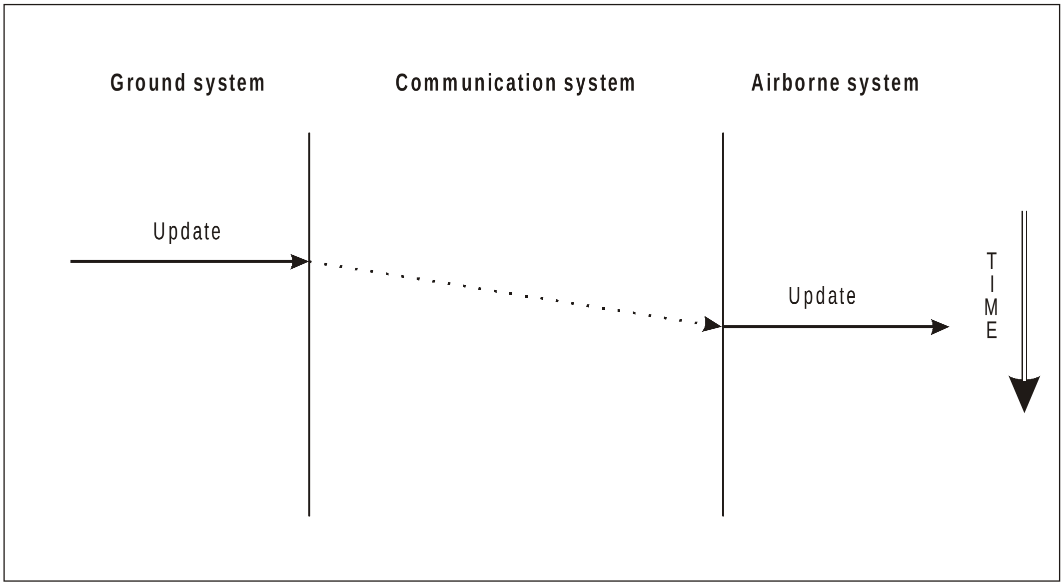


Figure II-5-2. Sequence diagram for DLIC update function

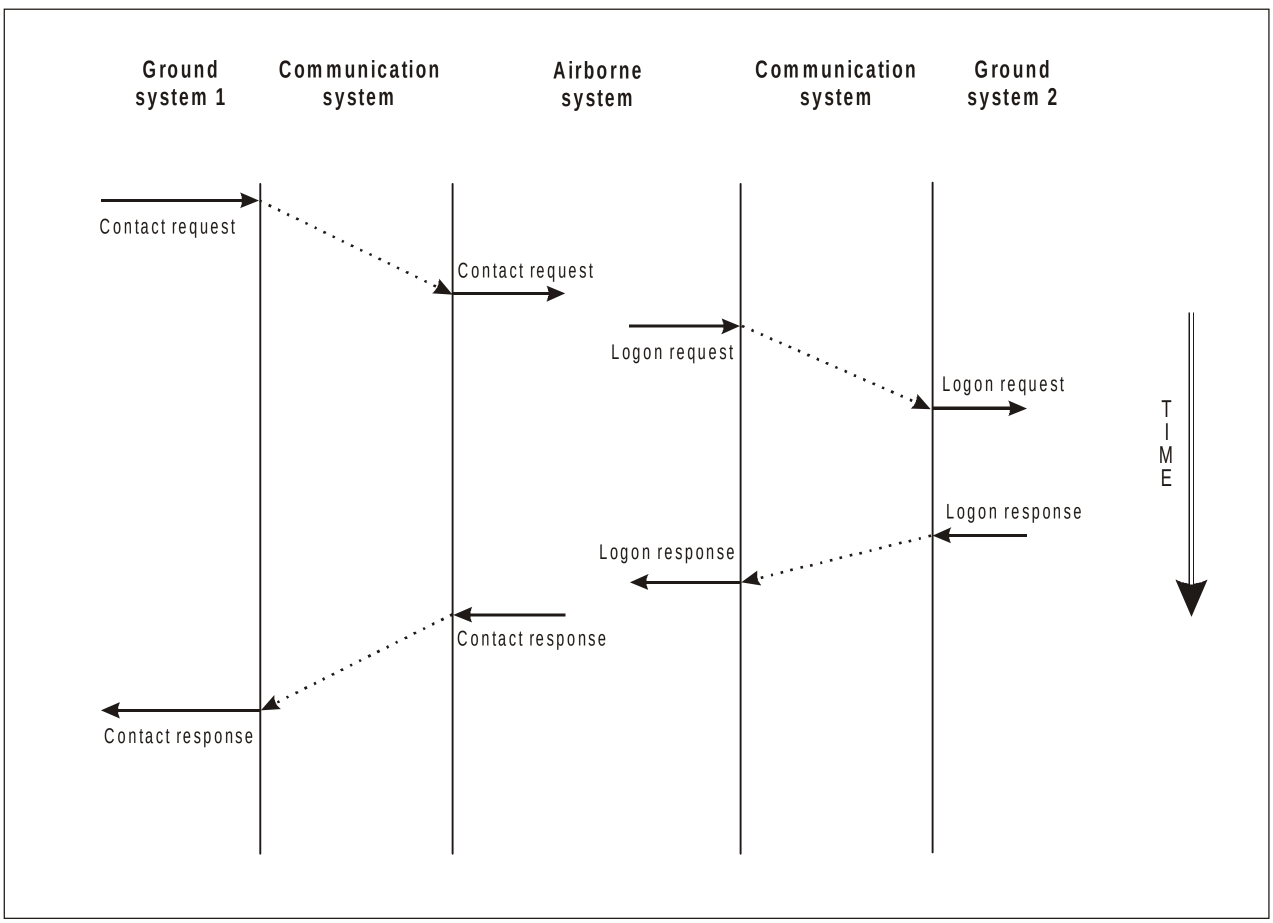


Figure II-5-3. Sequence diagram for DLIC contact function

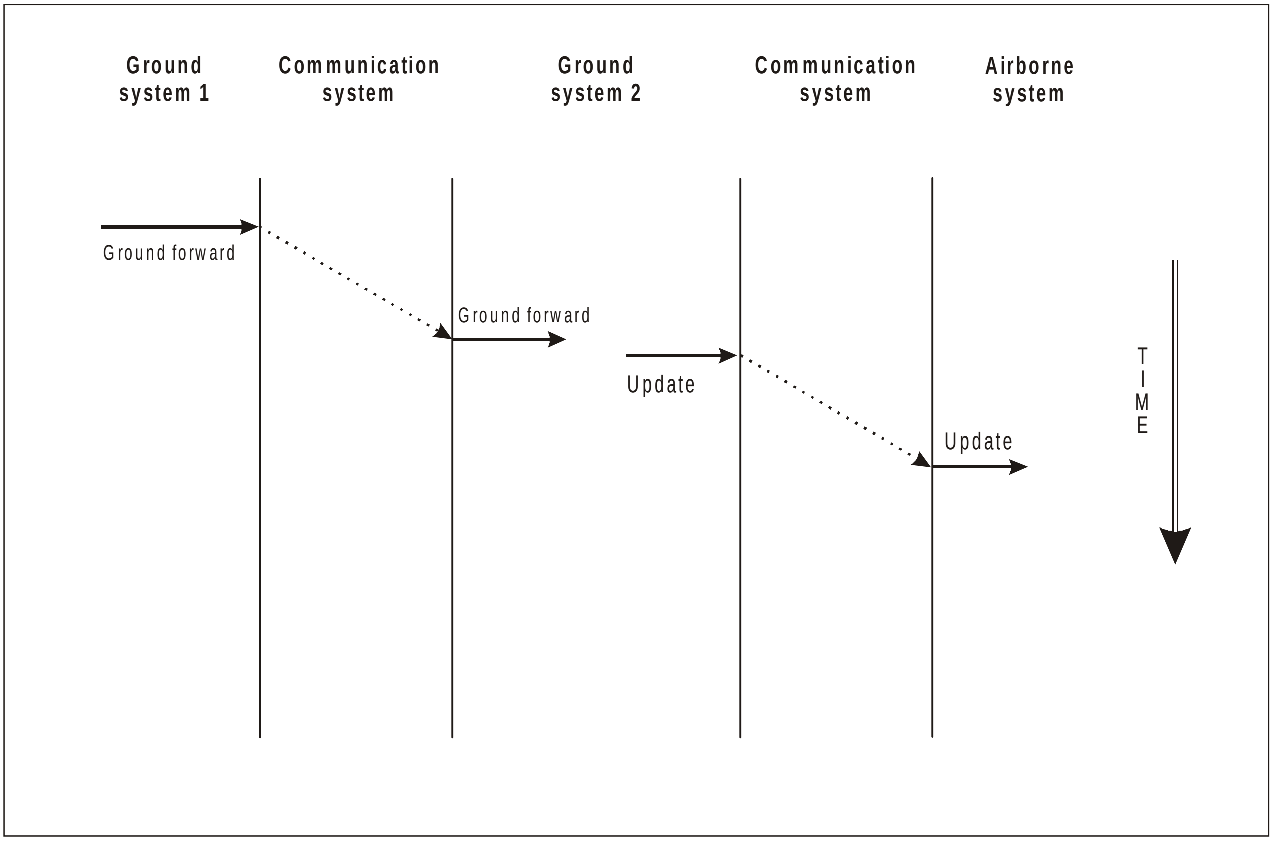


Figure II-5-4. Sequence diagram for DLIC ground-forwarding function

Chapter 6

DLIC PROCEDURES

PROCEDURES

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

6.2 Sufficient procedures will be required for the airborne and ground system users to initiate the capability of providing and receiving services via data link applications.

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

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

SEQUENCE OF EVENTS

6.5 An aircraft will inform a ground system of its requirement to participate in data link services by providing the information as outlined in 6.9 below.

6.6 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.

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

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

REQUIRED INFORMATION

6.9 States will provide information regarding DLIC addresses and version numbers. This information should be published in aeronautical information publications (AIPs).

DLIC LINK PROCEDURAL REQUIREMENTS

6.10 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

Chapter 1

APPLICATION OVERVIEW

INTRODUCTION

1.1 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.

1.2 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).

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

1.4 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.

1.5 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.

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

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

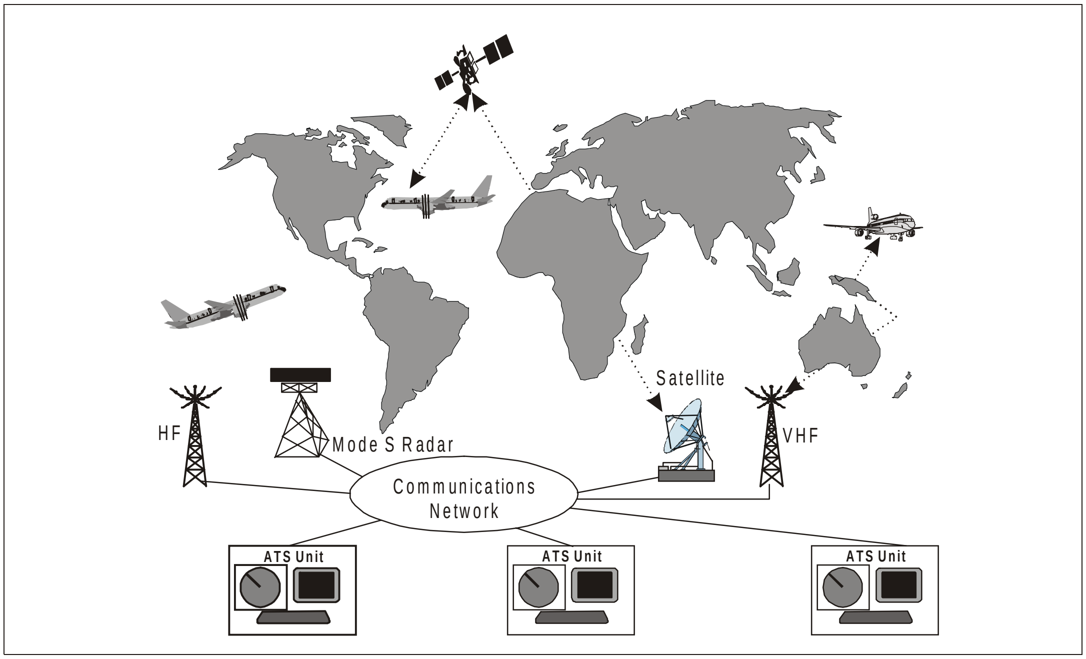


Figure III-1-1. ADS System Concept

USE OF ADS IN ATS

1.8 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.

Use of ADS outside of radar coverage

1.9 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.

1.10 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.

ADS transition airspace

1.11 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 the appendix to this chapter.

Within radar coverage

1.12 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 the appendix to this chapter.

FUNCTIONAL DESCRIPTION

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

1) *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.

2) *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.

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

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

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

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

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

8) *Wind estimation*. ADS reports containing wind data may be used to update wind forecasts and hence expected arrival times at waypoints.

9) *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.

ADS agreements

1.14 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.

1.15 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.

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

Appendix to Chapter 1

INTEGRATION OF ADS AND SSR DATA

1. APPLICATION OVERVIEW

1.1 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 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 process new parameters related to aircraft motion.

1.2 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 that for the provision of single radar coverage in areas where the installation of radar systems is not feasible or economically justifiable.

1.3 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 the 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.

1.4 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.

2. SCOPE AND BENEFITS

2.1 The ADS-SSR data integration can provide the following improvements to the surveillance function:

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

b) availability of surveillance data when radar limitations occur. These limitations are:

   1) mechanical rotation of the radar antenna, and

   2) garbling, fruit and splitting;

c) coding of the altitude data in 25-foot 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;

d) 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;

e) 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;

f) 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”);

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

h) availability of a means for a cross-check of ADS with navigation data or radar integrity navigational integrity monitoring (NIM);

i) 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.

2.2 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.

3. PERFORMANCE CONSIDERATIONS

When considering ADS-SSR integration, the following should be taken into account:

a) performance requirements for ADS, including availability and integrity;

b) accuracy of both radar and ADS position reports;

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

d) trajectory prediction requirements;

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

f) synchronization of both radar and ADS update rates.

4. ADDITIONAL OPERATIONAL CONSIDERATIONS

4.1 In addition to position information, the ADS-SSR integration process could benefit from aircraft periodically reporting further information, such as:

a) ground vector: containing track, ground speed and vertical rate; and

b) event ADS reports: including lateral deviation, altitude, speed and FOM change.

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

5. ADS CONTRACT CONSIDERATIONS

5.1 The following criteria may have to be taken into account when defining an optimal ADS contract strategy:

a) flight plans and related airspace information;

b) radar coverage maps;

c) communication network capabilities;

d) aircraft capabilities;

e) accuracy requirements; and

f) tracking needs.

5.2 It may be necessary to define a contract assignment for each phase of operations namely:

a) en-route navigation;

b) terminal area operations; and

c) ground movements.

6. EN-ROUTE OPERATIONS

6.1 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 a low reporting rate, because when the aircraft are flying straight and level, ground processing systems are able to achieve accurate position estimates.

6.2 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.

6.3 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:

a) lateral deviation;

b) altitude;

c) vertical rate;

d) ground speed;

e) FOM; and

f) heading.

6.4 Extensive use of event reporting could minimize the number of required periodic reports.

7. TERMINAL AREA OPERATIONS

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

7.2 Use of ADS periodic reports with additional data (ground vector), when available, may help to minimize the reporting frequency of the required data.

7.3 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.

8. GROUND MOVEMENT OPERATIONS

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

9. TRANSITION

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.

Chapter 2

GENERAL REQUIREMENTS

PERFORMANCE REQUIREMENTS

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

MESSAGE HANDLING

2.2 In addition to the general performance requirements in Part I, the ADS application requires:

a) that messages are generated and sent in the time-ordered sequence; and

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

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

a) emergency mode ADS reports;

b) event or demand ADS reports; and then

c) periodic ADS reports.

2.4 If more than one message is queued in a), b), or c) in 2.3 above, each will be handled in the order received.

QUALITY OF SERVICE

2.5 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.

TIME REQUIREMENTS

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

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

ADS PRIORITY

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

ADS OPERATIONAL TIMERS

2.9 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.

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

SOURCE OF ADS DATA

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

2.12 Information contained within an ADS report should be no less recent than 2 seconds or ten per cent of the periodic contract rate, if applicable, whichever is the shorter.

ADS REPORT AVAILABILITY

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

ADS CONTRACT REQUIREMENTS

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

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

2.16 The avionics must be capable of supporting a 60-second periodic contract reporting rate with each ground system simultaneously.

2.17 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.

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

2.19 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.

2.20 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.

Chapter 3

ADS FUNCTIONAL CAPABILITIES

BACKGROUND

3.1 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:

a) on demand;

b) when triggered by an event;

c) on a periodic basis; and

d) in an emergency.

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

OPERATING METHOD

3.3 The ADS application comprises the following functions:

a) establishment and operation of a demand contract;

b) establishment and operation of an event contract;

c) establishment and operation of a periodic contract;

d) cancellation of contract(s);

e) establishment and operation of emergency mode;

f) modification of the emergency mode; and

g) cancellation of the emergency mode.

ESTABLISHMENT AND OPERATION OF A DEMAND CONTRACT

3.4 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.

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

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

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

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

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

b) the basic ADS report; and

c) the information requested which can be supplied.

3.9 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.

3.10 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 points to be provided is to be included in the contract request.

ESTABLISHMENT AND OPERATION OF AN EVENT CONTRACT

3.11 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.

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

3.13 An ADS event report consists of a basic ADS report and any additional information required by the triggering agent.

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

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

3.16 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 acknowledgement. Should the contracted event occur, the required ADS report(s) is/are sent.

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

3.18 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 with which the aircraft can comply.

3.19 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.

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

Event types

3.21 The following event types have been defined for ADS:

a) vertical rate change;

b) waypoint change;

c) lateral deviation change;

d) level change;

e) level range deviation;

f) airspeed change;

g) ground speed change;

h) heading change;

i) extended projected profile change;

j) FOM (Figure of Merit) field change; and

k) track angle change.

Vertical rate change

3.22 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.

3.23 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.

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

3.25 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.

3.26 Figure III-3-1 illustrates a vertical rate change event.

Waypoint change

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

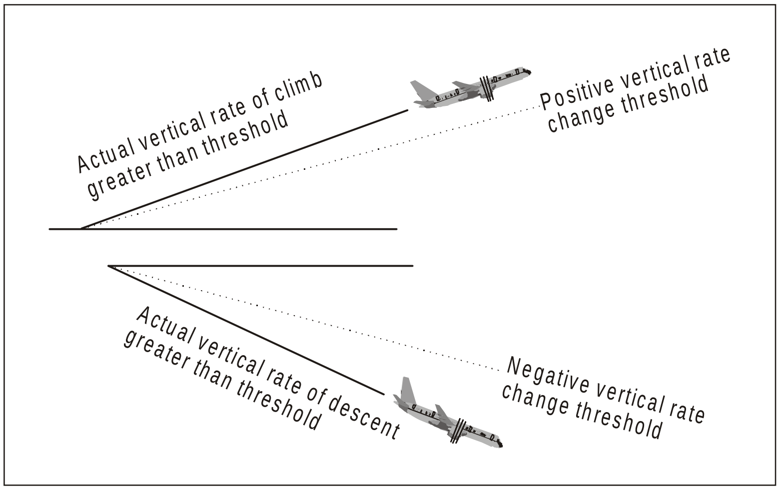


Figure III-3-1. Illustration of vertical rate change event

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

3.29 An ADS report sent as a result of the occurrence of a waypoint change event contains the basic ADS information and the projected profile information.

3.30 Figure III-3-2 illustrates the waypoint change event.

Lateral deviation change

3.31 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.

3.32 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.

3.33 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.

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

3.35 Figure III-3-3 illustrates the lateral deviation change event.

Level change

3.36 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.

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

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

3.39 Figure III-3-4 illustrates a level change event.

Level range deviation

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

3.41 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.

3.42 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.

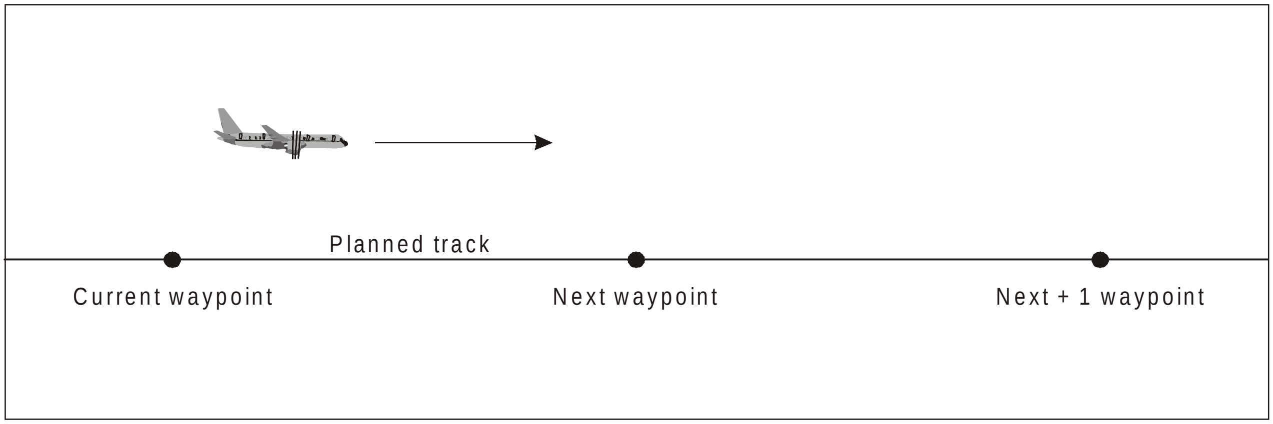


Figure III-3-2. Illustration of waypoint change event

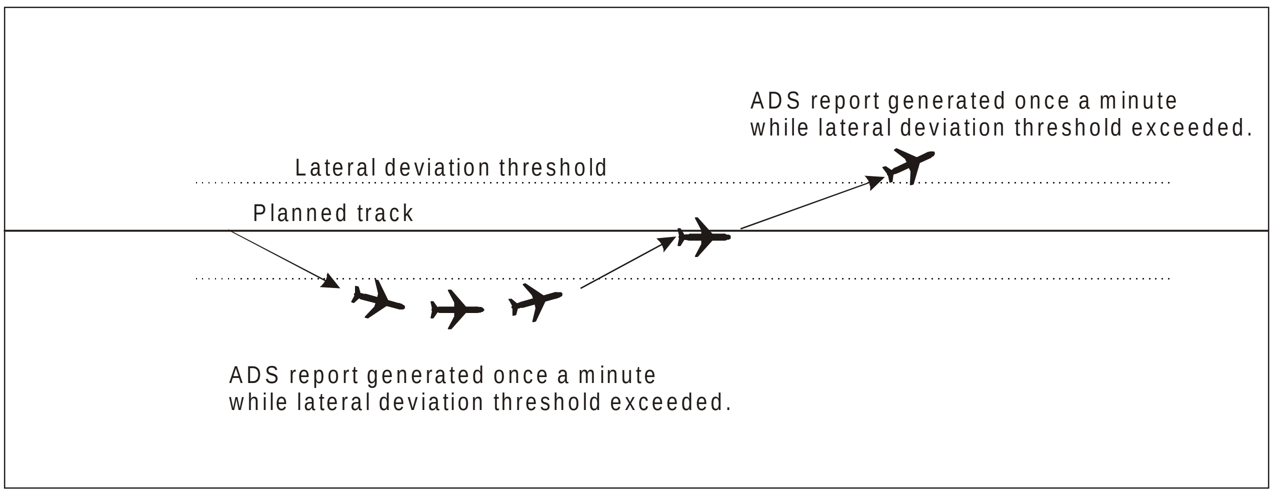


Figure III-3-3. Illustration of lateral deviation change event

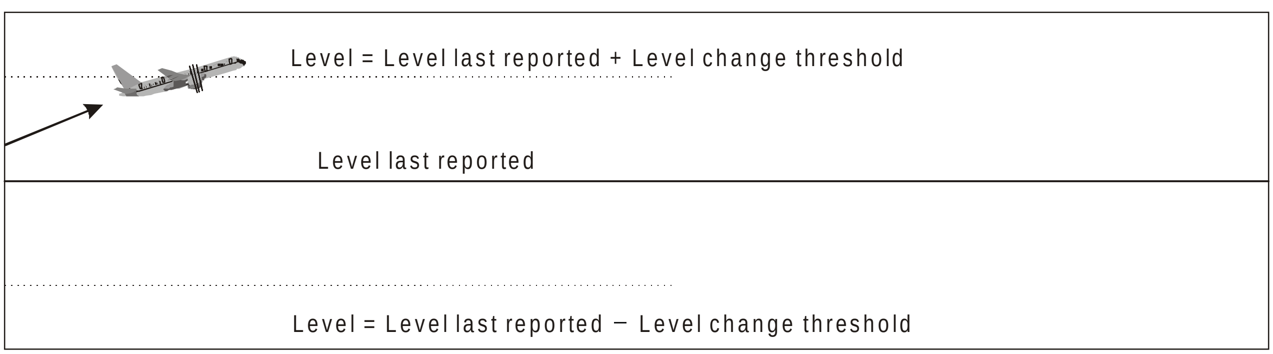


Figure III-3-4. Illustration of level change event

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

3.44 Figure III-3-5 illustrates a level range deviation event.

Airspeed change

3.45 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.

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

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

Ground speed change

3.48 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.

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

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

Heading change

3.51 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.

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

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

3.54 Figure III-3-6 illustrates the heading change event.

Extended projected profile change

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

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

3.57 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.

Figure of merit (FOM) field change

3.58 The FOM field change event is triggered by change in the navigational accuracy, navigational system redundancy or in the airborne collision avoidance system (ACAS) availability.

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

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

Track angle change

3.61 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

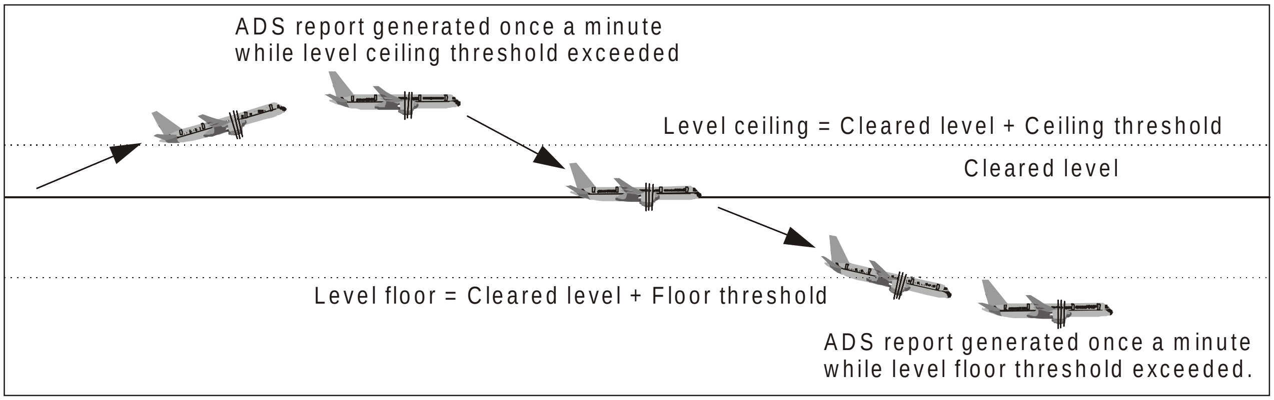


Figure III-3-5. Illustration of level range deviation event

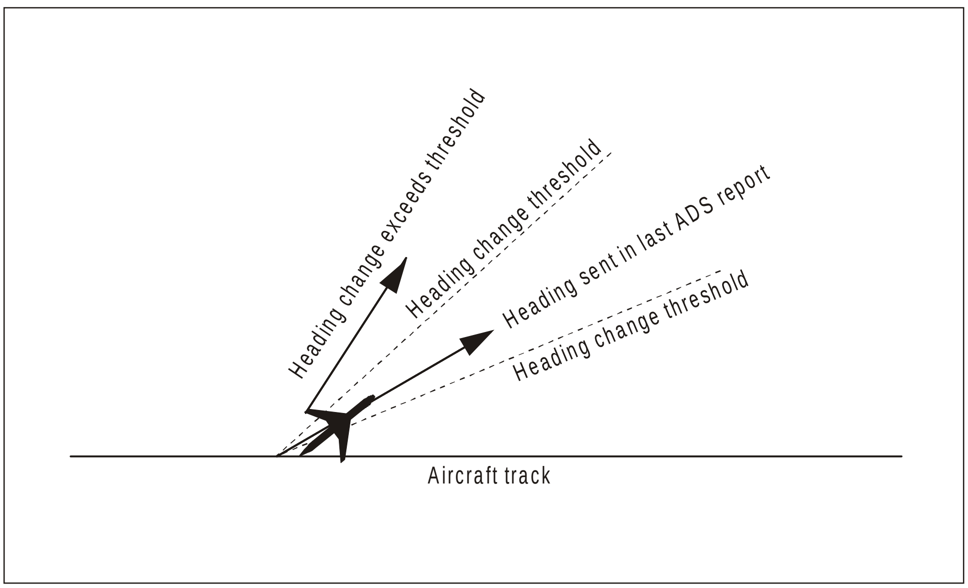


Figure III-3-6. Illustration of heading change event

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.

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

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

3.64 Figure III-3-7 illustrates the track angle change event.

ESTABLISHMENT AND OPERATION OF A PERIODIC CONTRACT

3.65 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.

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

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

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

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

3.70 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.

3.71 If the avionics cannot meet the requested report rate, it will send periodic reports.

3.72 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.

3.73 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 points to be provided is to be included in the contract request.

CANCELLATION OF CONTRACT(S) OPERATION

3.74 Cancellation of contracts allows the ground system to cancel a contract or all contracts currently in

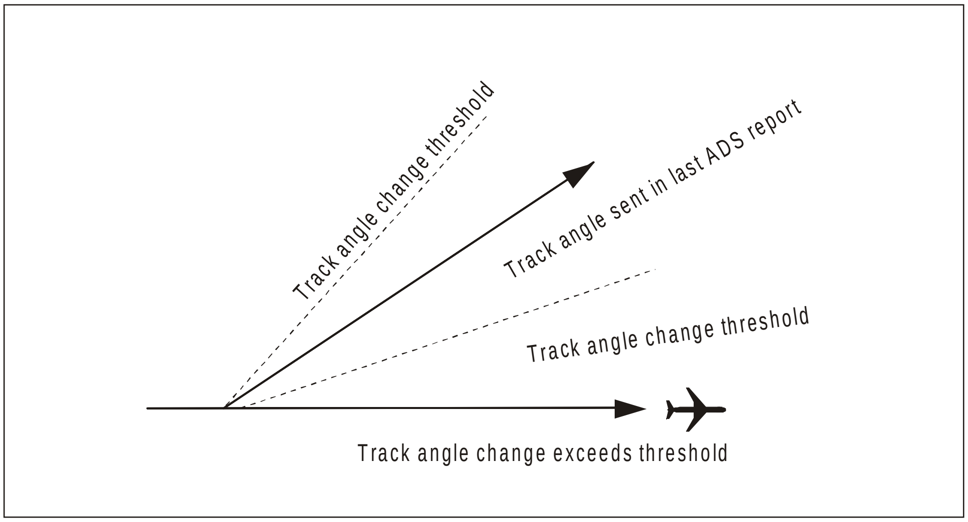


Figure III-3-7. Illustration of track angle change event

operation. The ground system specifies which contracts will be cancelled. The avionics acknowledges the cancellation and ceases sending the ADS reports for the cancelled contract(s).

ESTABLISHMENT AND OPERATION OF EMERGENCY MODE

3.75 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.

3.76 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 1 minute or half of any existing periodic contract rate.

3.77 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.

MODIFYING AN EMERGENCY MODE

3.78 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.

CANCELLATION OF EMERGENCY MODE

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

3.80 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.

3.81 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.

SUMMARY TABLE OF ADS FUNCTIONS

3.82 Table III-3-1 summarizes ADS functionality described above.

APPENDIX TO CHAPTER 3

3.83 The appendix to this chapter provides guidance on expected ADS message traffic in specific airspace domains.

Table III-3-1. ADS functionality summary

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
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 cancelled emergency mode	Air-ground
Negative acknowledgement	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
Acknowledgement	Indicates that avionics can comply with contract, however the avionics is unable to send the initial report within 0.5 second	Contract establishment, cancellation, cancel emergency mode indication	Air-ground

Appendix to Chapter 3

ADS MESSAGE EXCHANGE RATES

Table III-3-A1 details the possible message exchange rate for ATS purposes in the environments specified. The rates shown are the expected averages, per flight.

Table III-3-A1. Exchange rates expected for ADS messages

	Oceanic-continental en-route low density	*Oceanic high density*	*Continental high density*	*Terminal area high density*	*Aerodrome (includes approach, taxi and departure)*
Demand contract	1-3 per FIR/sector	1-2 per FIR/sector	1-2 per FIR/sector	1-2 per FIR/sector	3-6
Periodic contract request	1-3 per FIR/sector	1-2 per FIR/sector	1-2 per FIR/sector	1-2 per FIR/sector	3
Event contract request	1-3 per FIR/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 15-30 min.	1 every 5-15 min.	1 every 10 s-5 min.	1 every 3-10 s	1 every 0.5-5 s
Air and/or ground vector in ADS periodic report	1-3 per FIR/sector	1 every fourth report	1 every fourth report	1 every fourth report	1 every second 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
Instantaneous number of aircraft to be supported per ATSU	300	750	1 250	450	250

Chapter 4

ADS MESSAGES DESCRIPTION

MESSAGES DESCRIPTION

4.1 *Basic ADS information*. Every ADS report contains the following information:

a) the 3-D position of the aircraft (latitude, longitude, and level);

b) the time; and

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

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

a) aircraft identification;

b) ground vector;

c) air vector;

d) projected profile;

e) meteorological information;

f) short-term intent;

g) intermediate intent; and

h) extended projected profile.

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

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

a) track;

b) ground speed; and

c) rate of climb or descent.

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

a) heading;

b) Mach or IAS; and

c) rate of climb or descent.

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

a) next waypoint;

b) estimated level at next waypoint;

c) estimated time at next waypoint;

d) (next + 1) waypoint;

e) estimated level at (next + 1) waypoint; and

f) estimated time at (next + 1) waypoint.

4.7 The ADS meteorological information is composed of the following:

a) wind direction;

b) wind speed;

c) temperature; and

d) turbulence.

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

a) latitude at projected position;

b) longitude at projected position;

c) level at projected position; and

d) time of projection.

4.9 If a level, 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:

a) distance from current point to change point;

b) track from current point to change point;

c) level at change point; and

d) predicted time to change point.

4.10 The ADS extended projected profile is composed of the following information:

a) next waypoint;

b) estimated level at next waypoint;

c) estimated time at next waypoint;

d) (next + 1) waypoint;

e) estimated level at (next + 1) waypoint;

f) estimated time at (next + 1) waypoint;

g) (next + 2) waypoint;

h) estimated level at (next + 2) waypoint;

i) estimated time at (next + 2) waypoint ...

j) ... [repeated for up to (next + 128) waypoints].

4.11 A *positive acknowledgement* indicates acceptance of a requested contract and contains no further information.

4.12 A *negative acknowledgement* indicates rejection of the requested contract and may contain information on the cause for rejection.

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

4.14 A *demand contract message* indicates the contract type and which of the optional ADS information is to be included in the ADS report.

4.15 A *demand ADS response message* contains the basic ADS data and the optional ADS data required in the demand contract.

4.16 An *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.

4.17 An *event contract response message* contains an identification of the event type and the required ADS data for the particular event.

4.18 A *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.

4.19 A *periodic ADS response message* contains the basic ADS data and the optional ADS data required in the periodic contract.

4.20 A *cancel contract message* contains an indication of the contract (i.e. periodic or event) to be cancelled. A cancel contract message without a contract type parameter indicates that all ADS contracts with the ground system are to be cancelled.

4.21 An *emergency mode message* indicates the position, time and FOM. In addition to the above, the aircraft identification and ground vector are sent with every fifth message.

4.22 A *modify emergency mode message* contains only a new reporting rate.

4.23 A *cancel emergency mode message* indicates that the pilot has cancelled the emergency mode.

4.24 ADS message data glossary is provided in Appendix A to this chapter. The range and resolution for variables used in ADS messages is presented in Appendix B to this chapter.

Appendix A to Chapter 4

ADS MESSAGE DATA GLOSSARY

1. ADS MESSAGE DATA GLOSSARY

1.1 The following data are used as the ADS message variables, or components of the variables, and are shown here in alphabetical order:

ADS emergency report. ADS information consisting of the following sequence:

— *position*;
— *time*;
— *FOM*;
— *aircraft identification* (optional); and
— *ground vector* (optional).

ADS event report. ADS information consisting of a sequence of *event type* and *ADS report*.

ADS report. ADS information consisting of the following sequence:

— *position*;
— *time*;
— *FOM*;
— *aircraft identification* (optional);
— *projected profile* (optional);
— *ground vector* (optional);
— *air vector* (optional);
— *meteorological information* (optional);
— *short-term intent* (optional); and
— *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 call-sign. 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*.

Cancel contract. Allows 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 in non-SI units.

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:

— *vertical rate change*;
— *waypoint change*;
— *lateral deviation change*;
— *level change*;
— *level range deviation*;
— *airspeed change*;
— *ground speed change*;
— *heading change*;
— *extended projected profile change*;
— *FOM field change*; and
— *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 is to 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.

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

Following waypoint. Indicates the waypoint after the next waypoint as a *Position.*

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 is to be generated when any FOM field changes.

Ground speed. Provides ground speed in non-SI units.

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.

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*, *level* and *projection 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.

Level. Specifies level in non-SI units.

Level ceiling. The level above which a 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 a level deviation event is triggered. Provided as a *level*.

Level range change. Threshold of change permissible between levels in consecutive ADS reports.

Longitude. Longitude in degrees, minutes, and seconds.

Mach. Airspeed given as a Mach number.

Mach and IAS. Airspeed provided as both *Mach* and *indicated airspeed*.

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 waypoint. 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 to be included in an ADS periodic report.

Position. Provides aircraft position information using a sequence of *latitude*, *longitude*, and *level.*

Position accuracy. An indication of the navigational accuracy.

Projected profile. A sequence of *next waypoint*, *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:

— cancel event contract;
— cancel periodic contract;
— demand contract;
— event contract;
— modify emergency reporting rate;
— periodic contract; or
— cancel all contracts.

Short-term intent. A sequence of *position*, *ETA*, and *intermediate intent* (optional) data structures.

Temperature. Temperature in degrees Celsius.

Time. Time at position in HHMMSS format.

Time stamp. In every report in YYMMDD and HHMMSS format.

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.

waypoint change. Change in the next waypoint information.

Wind direction. Wind direction in degrees.

Wind speed. Wind speed in knots.

Appendix B to Chapter 4

ADS VARIABLES RANGE AND RESOLUTION

1. ADS VARIABLES RANGE AND RESOLUTION

Table III-4-B1 provides the required range and resolution for the message variables used in the ADS application.

Table III-4-B1. ADS variables range and resolution

Category	*Variables/parameters*	*Unit*	*Range*	*Resolution*
Aircraft identification		IA5	2 to 7 characters	N/A
Airspeed	Mach IAS (non-SI)	Mach number Knots	0.5 to 4.0 0 to 400	0.001 1
Date	Year Month Day	Year Month of year Day of month	1996 to 2095 1 to 12 1 to 31	1 1 1
Distance	Distance (non-SI)	Nautical miles	1 to 8 000	1
Extended projected profile	Time interval Number of waypoints	Minutes Integer	15 minutes to 20 hours 1 to 128	1 1
Facility designator		Character string	4 to 8	N/A
FOM (position accuracy)		Integer	0 to 7	1
Ground speed	Ground speed (non-SI)	Knots	–50 to +2 200	1
Ground speed change	Ground speed (non-SI)	Knots	0 to 300	1
Heading	—	Degrees	0.1 to 359.9	0.1
Heading change	—	Degrees	1 to 359	1
IAS		Knots	0 to 1 100	1
Lateral deviation change	Distance (non-SI)	Nautical miles	0.5 to 150	0.5
Latitude	Latitude degrees Latitude minutes Latitude seconds	Degrees Minutes Seconds	±90 0 to 59 0 to 59.9	1 1 0.1
Level	Level (non-SI)	Feet	–600 to +100 000	10
Level range change	Level (non-SI)	Feet	10 to 5 000	10
Longitude	Longitude degrees Longitude minutes Longitude seconds	Degrees Minutes Seconds	±180 0 to 59 0 to 59.9	1 1 0.1
Mach		Mach speed	0.5 to 4	0.001
Modulus		Integer	1 to 255	1
Reporting interval		Seconds Minutes	1 to 59 1 to 120	1 1
Temperature		Degrees Celsius	–100 to +100	1

Category	*Variables/parameters*	*Unit*	*Range*	*Resolution*
Time	Hours Minutes Seconds	Hours of day Minutes of hour Seconds of minute	0 to 23 0 to 59 0 to 59	1 1 1
Track	Angle	Degrees	0.1 to 360	0.1
Track angle change		Degrees	1 to 359	1
Turbulence	Relative measure	Bit string	0 to 15*	N/A
Vertical rate	Level (non-SI)	Feet/minute	±30 000	10
Vertical rate change		Feet/minute	±30 000	10
Wind	Wind direction Wind speed (non-SI)	Degrees True North Knots	1 to 360 0 to 300	1 1
* To be decided.				

Chapter 5

ADS MESSAGE SEQUENCES

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

ADS DEMAND CONTRACT

5.1 The sequence of messages shown in Figure III-5-1 occurs when the ADS demand contract is sent and the avionics can comply with the request.

5.2 The sequence of messages shown in Figure III-5-2 occurs when the ADS demand contract is sent and the avionics cannot comply with the request.

5.3 The sequence of messages shown in Figure III-5-3 occurs when the ADS demand contract is sent and the avionics cannot comply fully with the request.

ADS EVENT CONTRACT

5.4 The sequence of messages shown in Figure III-5-4 occurs when an ADS event contract is sent and the avionics can comply with the request.

5.5 The sequence of messages shown in Figure III-5-5 occurs when the ADS event contract is sent and the avionics cannot comply with the request.

5.6 The sequence of messages shown in Figure III-5-6 occurs when the ADS event contract is sent and the avionics cannot comply fully with the request.

ADS PERIODIC CONTRACT

5.7 The sequence of messages shown in Figure III-5-7 occurs when an ADS periodic contract is sent and the avionics can comply with the request.

5.8 The sequence of messages shown in Figure III-5-8 occurs when the ADS periodic contract is sent and the avionics cannot comply with the request.

5.9 The sequence of messages shown in Figure III-5-9 occurs when the ADS periodic contract is sent and the avionics cannot comply fully with the request.

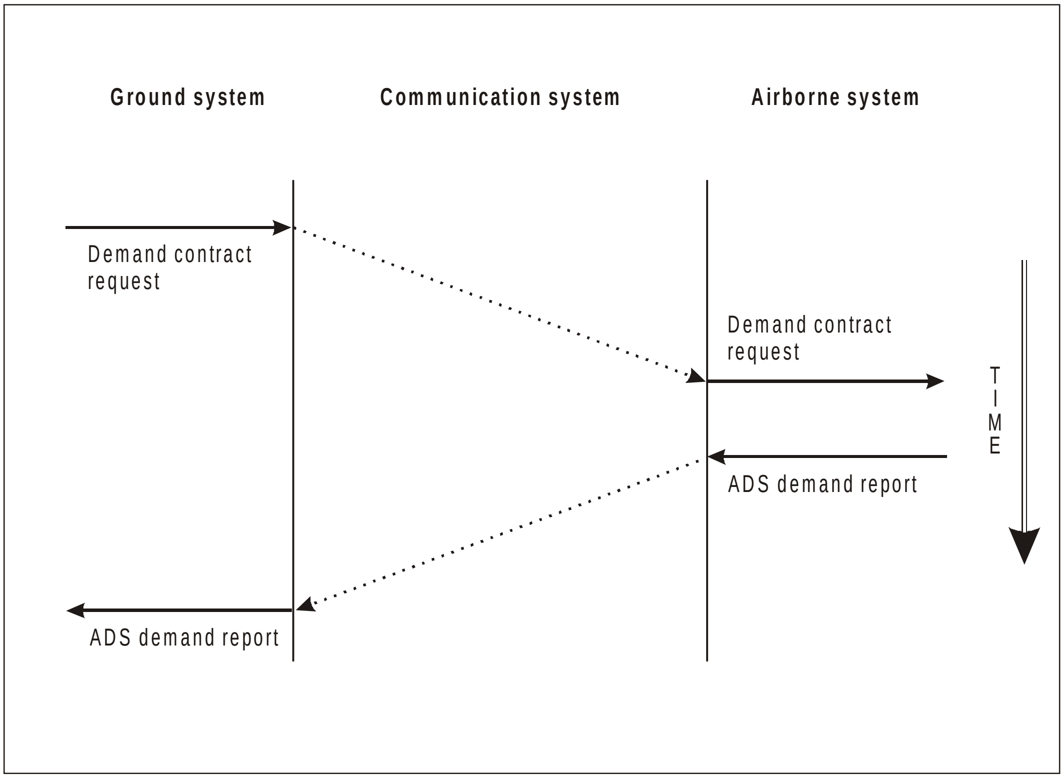


Figure III-5-1. Demand contract request with ADS demand report

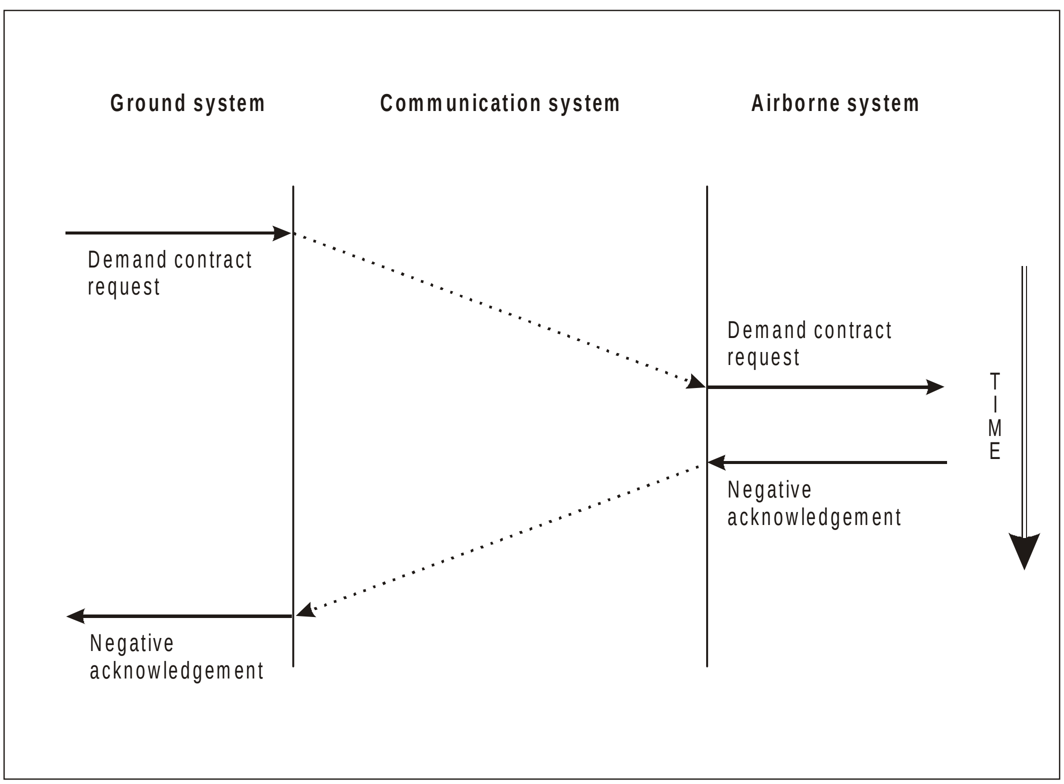


Figure III-5-2. Demand contract request with negative acknowledgement

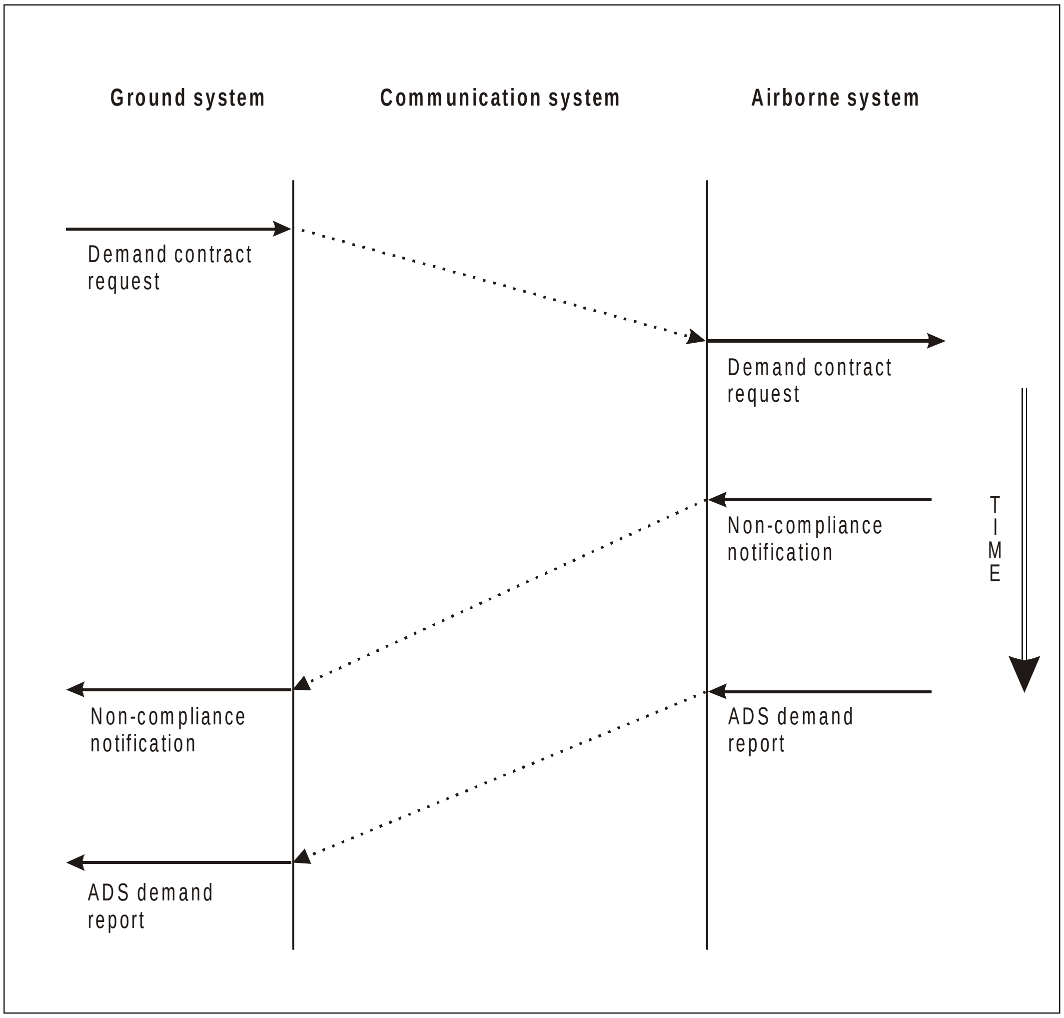


Figure III-5-3. Demand contract request with non-compliance notification

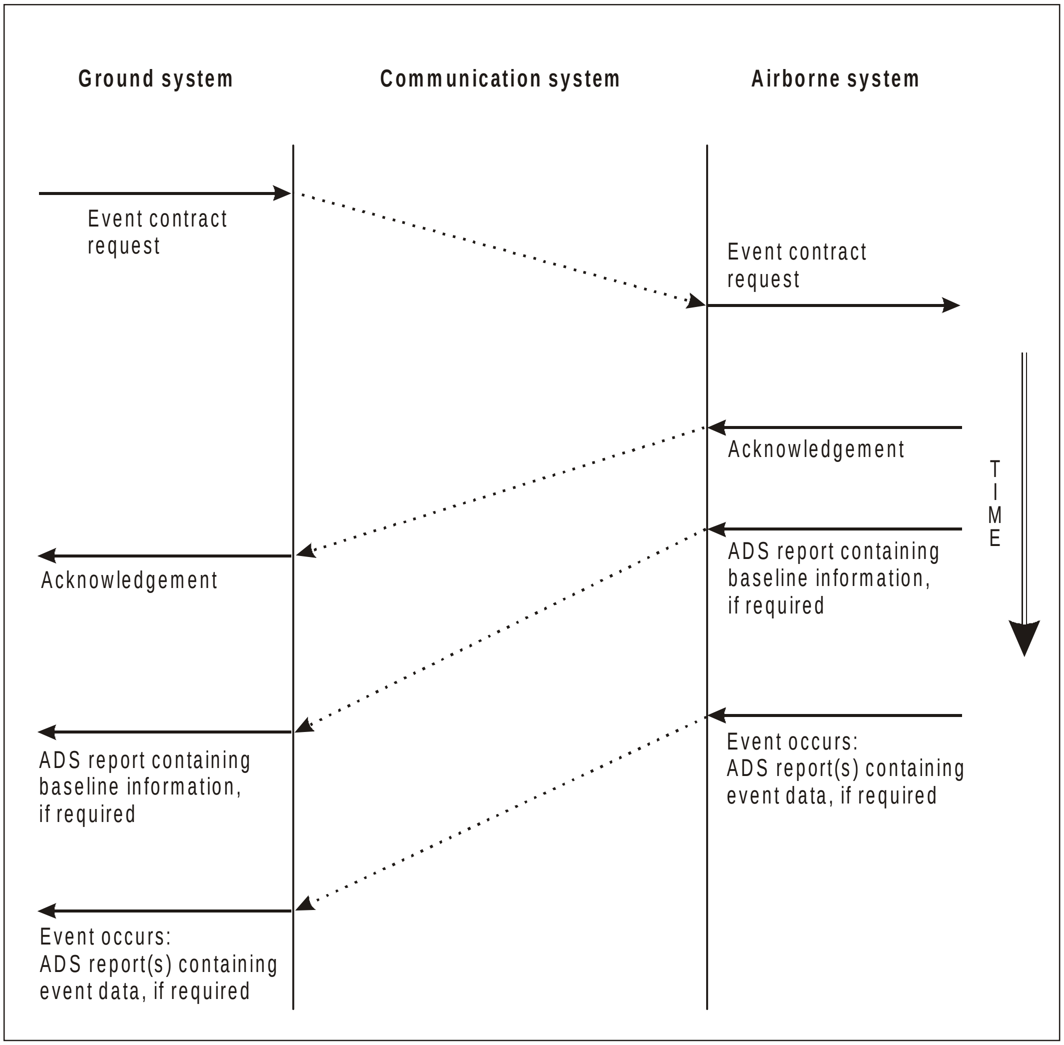


Figure III-5-4. Event contract request, aircraft can comply

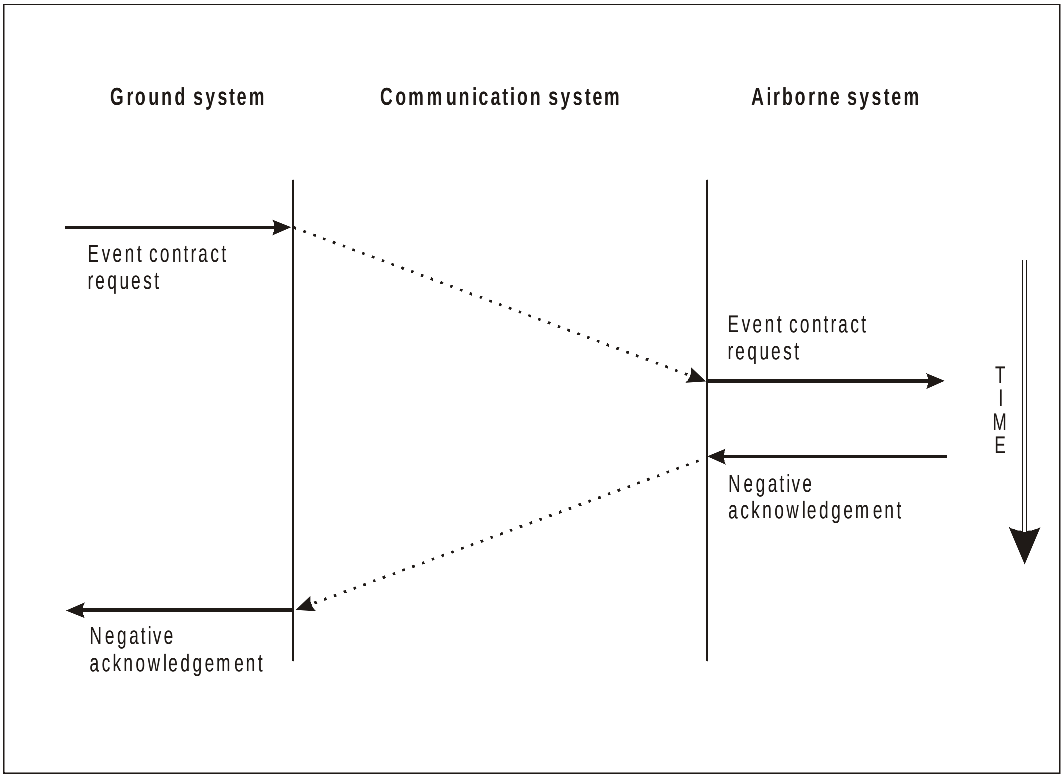


Figure III-5-5. Event contract request with negative acknowledgement

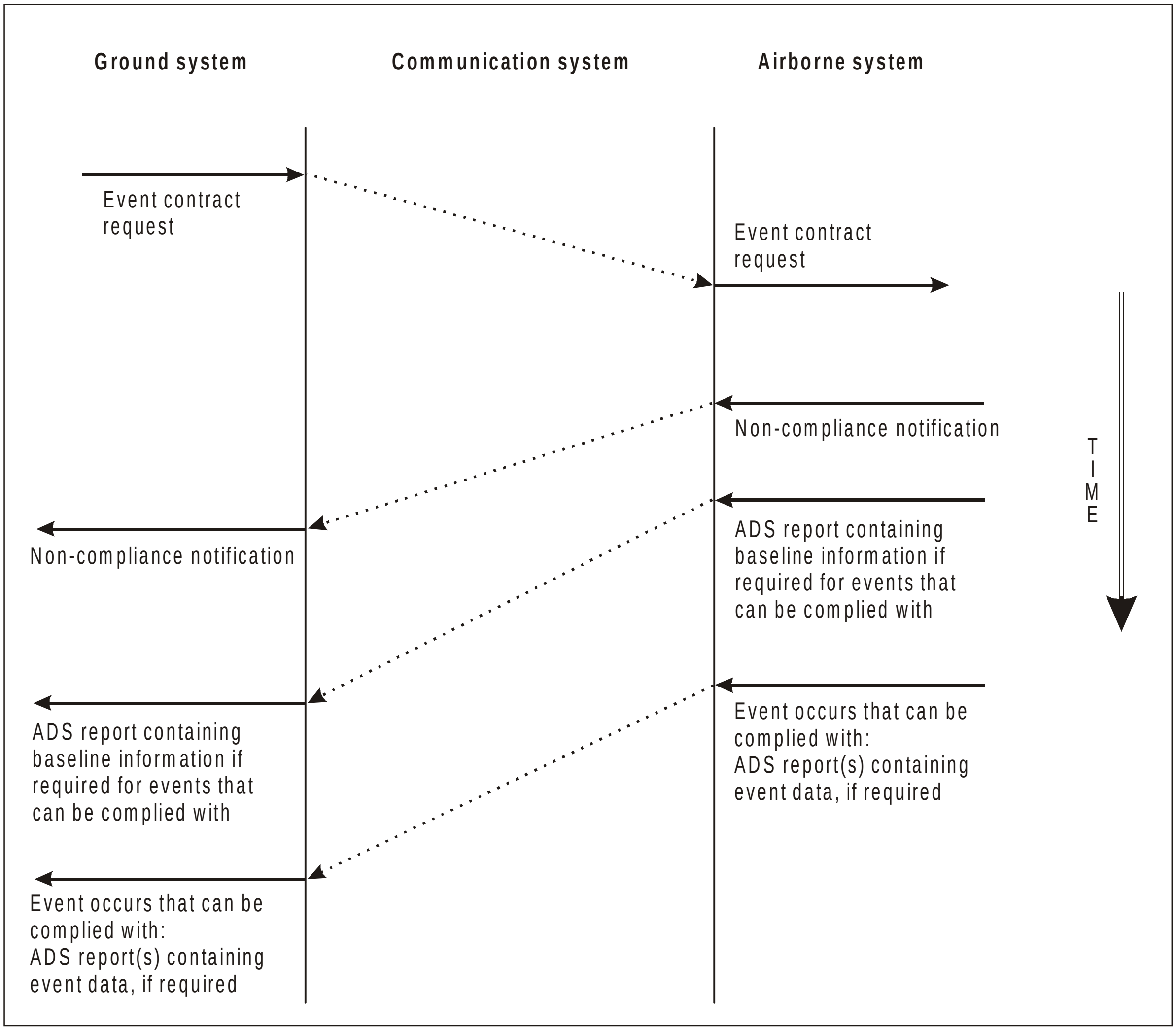


Figure III-5-6. Even contract request with non-compliance notification

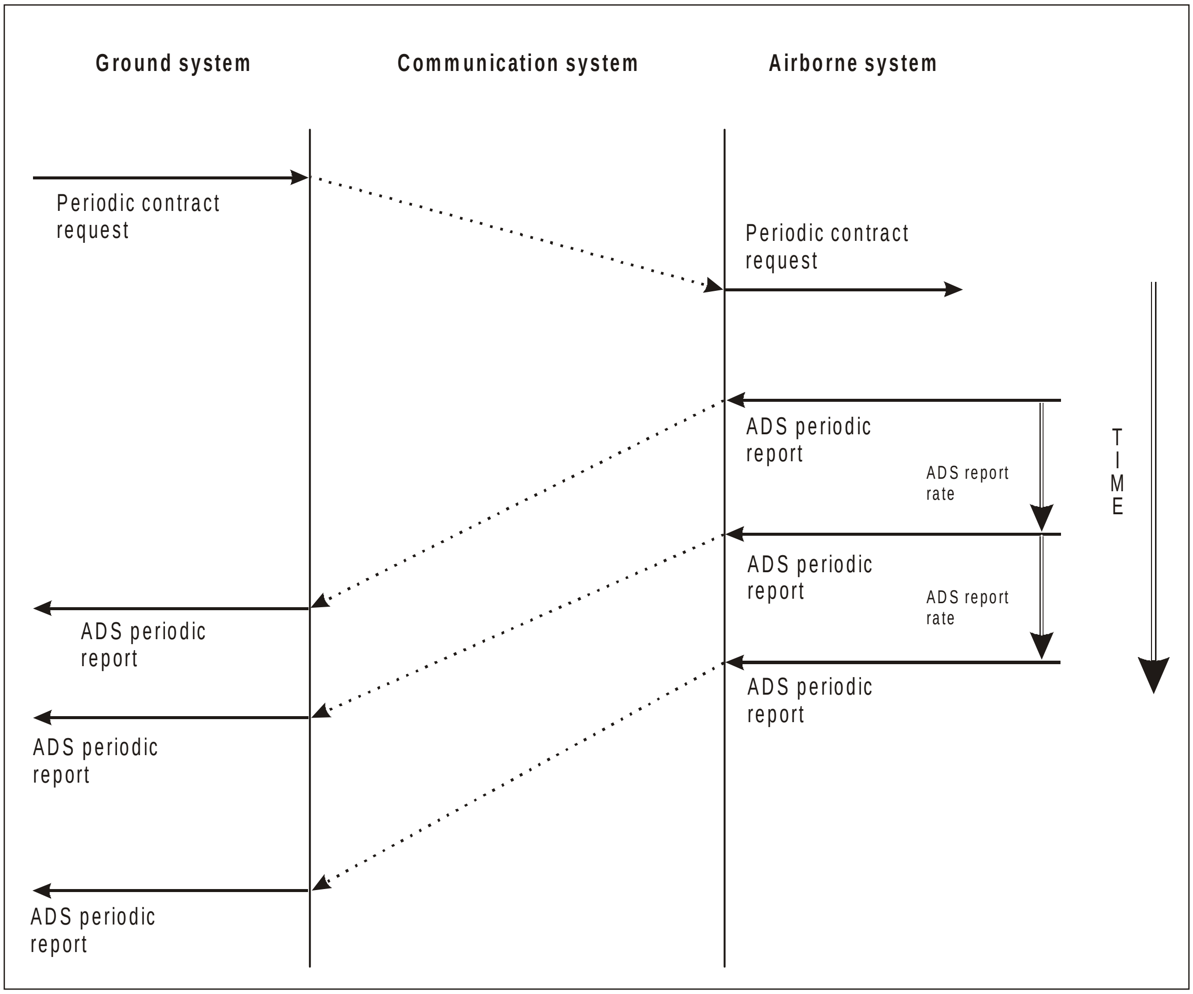


Figure III-5-7. Periodic contract request, aircraft can comply

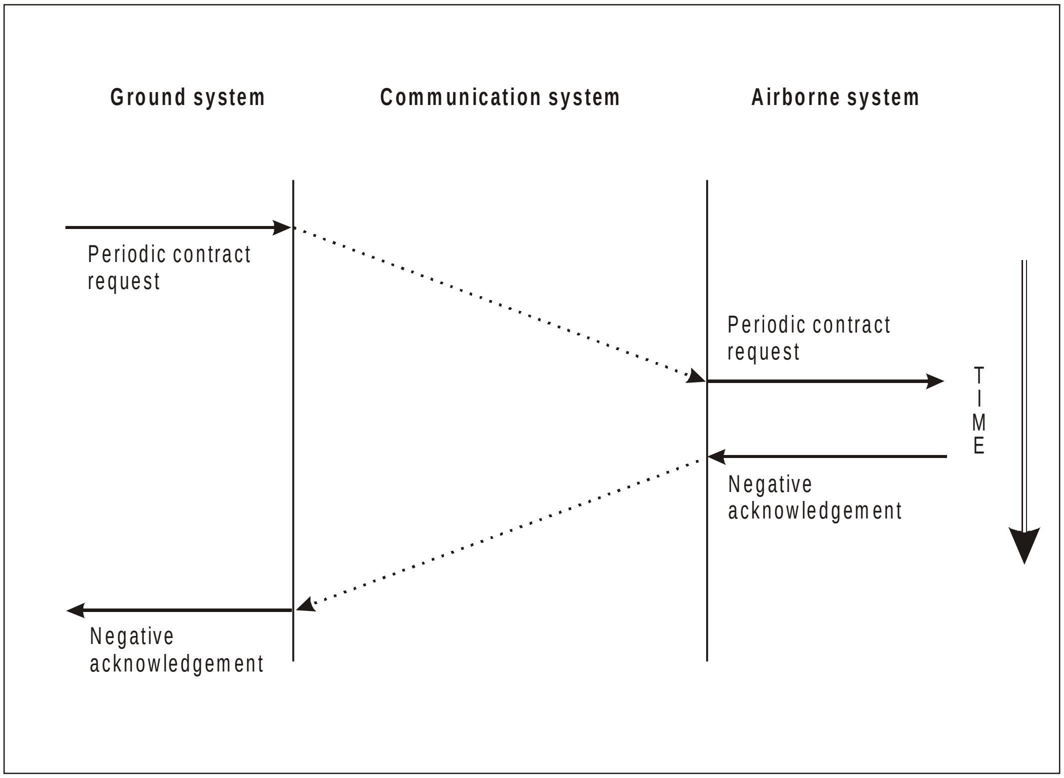


Figure III-5-8. Periodic contract request with negative acknowledgement

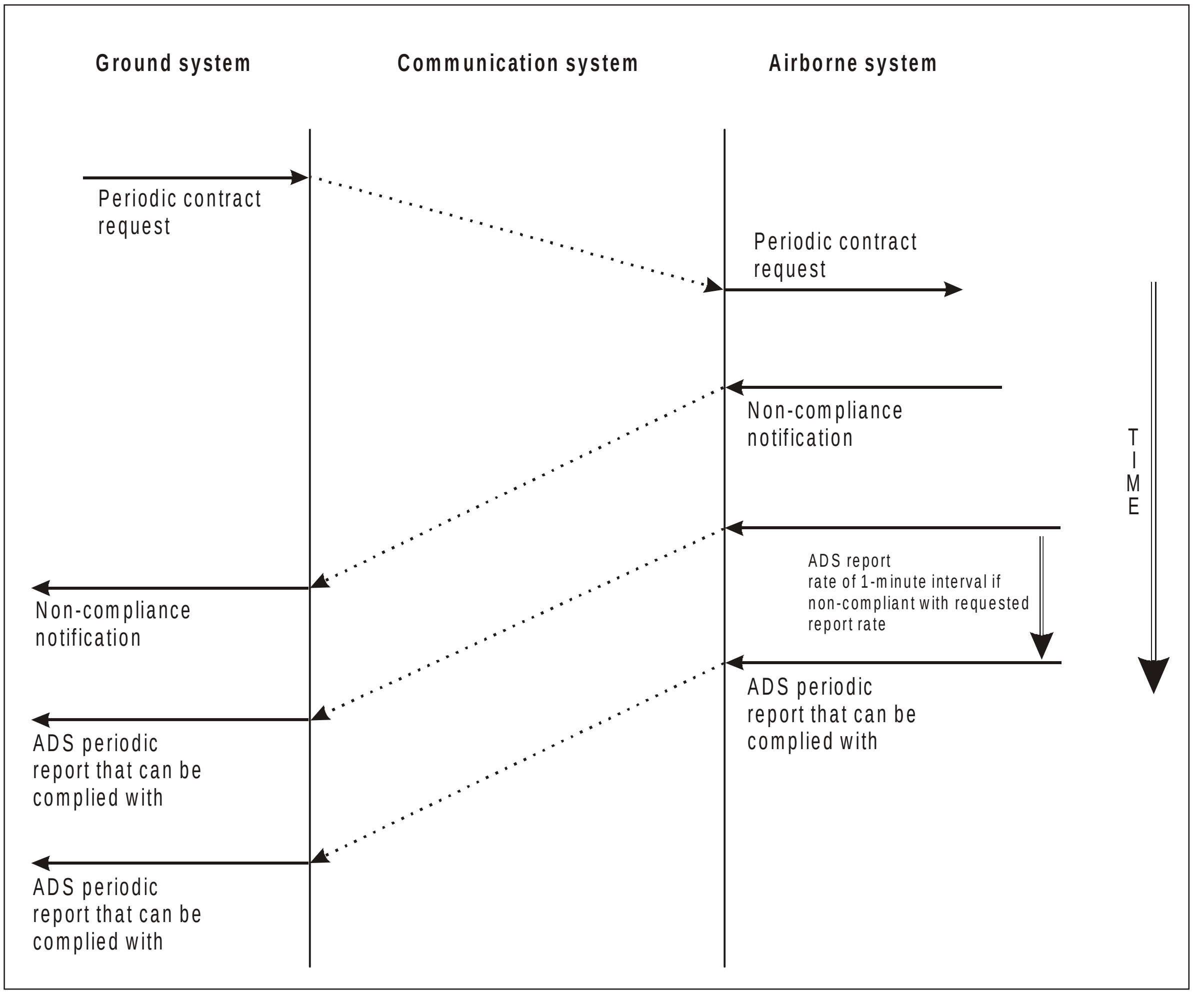


Figure III-5-9. Periodic contract request with non-compliance notification

Chapter 6

ADS PROCEDURES

INTRODUCTION

6.1 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 interfacility procedures.

PROCEDURES FOR EFFECTIVE USE OF ADS

6.2 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.

6.3 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.

6.4 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.

6.5 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.

6.6 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.

6.7 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.

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

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

6.10 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.

Chapter 7

EXCEPTION HANDLING

HANDLING OF MESSAGES RECEIVED OUT OF SEQUENCE

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

7.2 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.

NON-RECEIPT OF MESSAGES

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

7.4 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.

INVALID DATA AND LOGICAL ERRORS

7.5 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 COMMUNICATIONS

Chapter 1

APPLICATION OVERVIEW

INTRODUCTION

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

1.2 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 ATC 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.

1.3 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.

1.4 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.

1.5 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.

1.6 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.

1.7 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.

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

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

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

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

CPDLC DEFINITIONS

Current data authority (CDA). The ground system which is permitted to conduct a CPDLC dialogue with an aircraft.

Downstream clearance (DSC). A clearance issued to an aircraft by an ATC 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 ATC unit responsible for the delivery of the downstream clearance.

Downstream data authority (DDA). The ground system which is permitted to conduct a DSC dialogue with an aircraft.

Next data authority (NDA). The ground system so designated by the CDA.

USE OF CPDLC IN ATS

1.9 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.

1.10 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-transaction communication style is required. It is recognized however, that the use of voice alone negates the capability of simultaneously updating the flight data processing system (FDPS) or flight management system (FMS) coincident with the entry and acknowledgement of CPDLC messages.

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

1.12 The CPDLC application has three primary functions:

a) the exchange of controller-pilot messages with the current data authority;

b) the transfer of data authority involving current and next data authority; and

c) downstream clearance delivery with a downstream data authority.

CPDLC links

1.13 To accomplish the CPDLC application, three CPDLC links are defined:

— *CDA link:* the CPDLC link with the current data authority;

— *NDA link:* the CPDLC link with the next data authority; and

— *DDA link:* the CPDLC link with a downstream data authority.

Chapter 2

GENERAL REQUIREMENTS

MESSAGE HANDLING

Message transmission

2.1 The CPDLC application requires:

a) that messages are generated and sent in a time-ordered sequence; and

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

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

2.3 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.

2.4 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.

QUALITY OF SERVICE

2.5 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.

TIME REQUIREMENTS

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

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

CPDLC PRIORITY

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

Chapter 3

CPDLC FUNCTIONAL CAPABILITIES

DATA-LINK REQUIREMENTS FOR CPDLC

Controller pilot message exchange with the current data authority

3.1 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:

a) general information exchange;

b) clearance:

1) delivery,

2) request, and

3) response;

c) level/identity surveillance;

d) monitoring of current/planned position;

e) advisories:

1) request, and

2) delivery;

f) system management functions; and

g) emergency situations.

Transfer of data authority

3.2 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, an 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.

Downstream clearance message exchange

3.3 The DSC function provides the capability for the aircraft to establish a DDA link with an ATS unit which is not the current data authority for the purpose of receiving a downstream clearance.

3.4 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.

3.5 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.

COMPOSITION OF A CPDLC MESSAGE

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

3.7 The message header for air-ground message exchange is composed of a message identification number, a message reference number if required, a timestamp, and an indication if a logical acknowledgement is required (optional).

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

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

Message identification numbers

3.10 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.

3.11 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.

3.12 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.

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

3.14 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; or

Scenario b): the message requires a response: the closure response has been received.

3.15 When a CDA or DDA link is established, all message identification numbers will be considered available.

3.16 Message identification numbers should be provided sequentially.

Message reference numbers

3.17 All response messages will contain a message reference number.

3.18 The message reference number will be identical to the message identification number of the initiating message to which it refers.

Message attributes

3.19 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.

Urgency

3.20 The urgency (URG) attribute delineates the queuing requirements for received messages that are displayed to the end-user. Urgency types are presented in Table IV-3-1.

Alert

3.21 The alert (ALRT) attribute delineates the type of alerting required upon message receipt. Alert types are presented in Table IV-3-2.

Response

3.22 The response (RESP) attribute mandates response requirements for a given message element. Response types are presented in Table IV-3-3 for uplink messages and Table IV-3-4 for downlink messages.

Attribute association

3.23 For each message element, urgency, alert, and response attribute types are associated with it as specified in Appendix A to this chapter.

3.24 When a message contains a single message element, the message attributes are the message element attributes.

3.25 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.

Response messages

3.26 A message containing the ERROR message element will always be permitted as a response message.

Table IV-3-1. Urgency attribute (uplink and downlink)

Type	*Description*	*Precedence*
D	Distress	1
U	Urgent	2
N	Normal	3
L	Low	4

Table IV-3-2. Alert attribute (uplink and downlink)

Type	*Description*	*Precedence*
H	High	1
M	Medium	2
L	Low	3
N	No alerting required	4

Table IV-3-3. Response attribute (uplink)

Type	*Response required*	*Valid responses*	*Precedence*
W/U	Yes	WILCO, UNABLE, STANDBY permitted, LOGICAL ACKNOWLEDGEMENT (only if required), ERROR (if necessary)	1
A/N	Yes	AFFIRM, NEGATIVE, STANDBY permitted, LOGICAL ACKNOWLEDGEMENT (only if required), ERROR (if necessary)	2
R	Yes	ROGER, UNABLE, STANDBY permitted LOGICAL ACKNOWLEDGEMENT (only if required), ERROR (if necessary)	3
Y	Yes	Any CPDLC downlink message, LOGICAL ACKNOWLEDGEMENT (only if required)	4
N	No, unless logical acknowledgement required	LOGICAL ACKNOWLEDGEMENT (only if required), ERROR (if necessary, only when logical acknowledgement is required)	5

Table IV-3-4. Response attribute (downlink)

Type	*Response required*	*Valid responses*	*Precedence*
Y	Yes	Any CPDLC uplink message, LOGICAL ACKNOWLEDGEMENT (only if required)	1
N	No, unless logical acknowledgement required	LOGICAL ACKNOWLEDGEMENT (only if required), ERROR (if necessary, only when logical acknowledgement is required)	2

3.27 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.

3.28 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.

Logical acknowledgement messages

3.29 The logical acknowledgement 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 acknowledgement in no way replaces any required operational response.

3.30 A ground system will determine if the use of the logical acknowledgement (either air or ground) is permitted/required within its airspace.

3.31 The logical acknowledgement message element must not be combined with any other message element in a message.

3.32 A logical acknowledgement response message, if required, will be sent prior to sending any other related response message(s), other than an ERROR message, if necessary.

Message differentiation

3.33 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.

CPDLC MESSAGE RECEIPT REQUIREMENTS

CDA/DDA link messages

3.34 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 messages from a DDA, regardless of message urgency.

3.35 A CPDLC message received on a DDA link must be clearly distinguishable from a CPDLC message received on a CDA link.

Logical acknowledgement prohibited

3.36 Upon receipt of the CPDLC message USE OF LOGICAL ACKNOWLEDGEMENT PROHIBITED the aircraft will be prohibited from requiring a logical acknowledgement for any message exchanged with that ground system for the duration of a CDA or DDA link.

Urgency requirements

3.37 When a CPDLC user queues received messages, messages with the highest urgency type will be placed at the beginning of the queue.

3.38 When a CPDLC user queues received messages, messages with the same urgency type will be queued in order of receipt.

Alerting requirements

3.39 CPDLC will provide three distinct alerts determined by the received message alert attribute.

Message response requirements

3.40 A CPDLC user will only respond to a received message in its entirety. This means, for example, that if three message elements are concatenated in a single message, any response given applies to the whole message, and not to any individual message element.

3.41 If a message is received that requires a response, the CPDLC user will:

a) be allowed to send any permitted response messages; and

b) send one and only one closure response message.

3.42 For a given message, once the CPDLC user has sent the closure response message, no other response messages will be sent.

3.43 Table IV-3-5 contains the closure response messages permitted for each message response category.

Table IV-3-5. Permitted closure responses by response category

Permitted response	*Closure response*
W/U	A response message containing one of the following: WILCO, UNABLE, STANDBY, NOT CURRENT DATA AUTHORITY, NOT AUTHORIZED NEXT DATA AUTHORITY, LOGICAL ACKNOWLEDGEMENT (only if required), ERROR
A/N	A response message containing one of the following: AFFIRM, NEGATIVE, STANDBY, NOT CURRENT DATA AUTHORITY, NOT AUTHORIZED NEXT DATA AUTHORITY, LOGICAL ACKNOWLEDGEMENT (only if required), ERROR
R	A response message containing one of the following: ROGER, UNABLE, STANDBY, NOT CURRENT DATA AUTHORITY, NOT AUTHORIZED NEXT DATA AUTHORITY, LOGICAL ACKNOWLEDGEMENT (only if required), ERROR
Y	The first response message sent from the aircraft that does not contain a STANDBY or a LOGICAL ACKNOWLEDGEMENT (only when required) The first response message sent by the ground that does not contain a STANDBY, a LOGICAL ACKNOWLEDGEMENT (only when required), or REQUEST DEFERRED message element from the ground system.
N	The only permitted response from the aircraft will be one of the following: LOGICAL ACKNOWLEDGEMENT (only if required), NOT CURRENT DATA AUTHORITY, NOT AUTHORIZED NEXT DATA AUTHORITY, or ERROR The only permitted response from the ground will be one of the following: LOGICAL ACKNOWLEDGMENT (only if required), SERVICE UNAVAILABLE, FLIGHT PLAN NOT HELD, or ERROR

3.44 The CPDLC application must provide the message initiator the capability to provide closure for a CPDLC message, independent of CPDLC closure message receipt.

ESTABLISHMENT OF THE CDA OR NDA LINK

3.45 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.

3.46 Upon acceptance of a CDA or NDA link, the CPDLC application will have the capability of informing both the controller and pilot of this link establishment.

3.47 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.

3.48 Only if an aircraft has received a message from the CDA designating an NDA will the aircraft be permitted to request CPDLC with the specified ground system.

3.48.1 In general, ground acceptance of an airborne request for CPDLC is determined by local procedures.

3.48.2 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:

a) accept the request; and

b) 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.

3.49 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 CDA.

3.50 If the ground requests CPDLC with an aircraft and the aircraft already has a CDA link, the aircraft will accept the CPDLC request if

a) the request is from the ground system that is the CDA; or

b) the request is from the NDA.

3.51 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.

3.51.1 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 CDA.

3.52 The aircraft will disregard CPDLC messages over the NDA link and indicate to the originator that it is not the CDA.

3.53 Only the CDA can designate a ground system as the NDA.

3.54 The CDA can designate only one ground system as the NDA at a time (i.e. only one per CPDLC message).

3.55 An airborne system will only consider a ground system as the NDA if it has received such an indication from the CDA.

3.56 Any indication from the CDA designating an NDA will replace any previously received NDA designation for another ground system.

3.56.1 If an NDA message element is received without specifying a facility (null), any previously specified NDA is no longer valid.

3.57 If the ground system rejects a request for CPDLC, it will provide a reason for the rejection using a CPDLC message.

ESTABLISHMENT OF THE DDA LINK

3.58 Only the airborne system can request DSC. Acceptance by the ground system of a request for DSC establishes a DDA link.

3.59 Upon acceptance of a DDA link the CPDLC application will have the capability of informing both the controller and pilot of this link establishment.

3.60 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 DDA.

3.61 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.

3.61.1 However, if a ground system receives a request for DSC from an aircraft, for which it currently has a DDA link, it will:

a) accept the request, and

b) 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.

3.62 If the ground system rejects a request for DSC, it will provide a reason for the rejection using a CPDLC message.

LINK TERMINATION AND TRANSFER

3.63 Once normal link termination is initiated, only CPDLC closure response messages may be exchanged over the CDA or DDA link being terminated.

3.64 Once termination is initiated, the system will have the capability of informing the pilot or controller of this action.

3.65 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.

3.66 If a CDA or NDA link is terminated for any reason, any DDA link will not be affected.

3.67 Normally, CPDLC service termination with the CDA is initiated by the ground system to end service or transfer service to the next ATS facility.

3.68 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.

3.69 Any NDA link will be terminated by the aircraft if it receives a subsequent designation of NDA. When terminating an NDA link in this situation the aircraft will indicate to the ground system being terminated that it is no longer the NDA.

3.70 When the CDA link is terminated normally, the aircraft will recognize the ground system currently designated NDA as the CDA.

3.71 If the CDA link is terminated for any reason other than under instruction from the CDA, any designation of a ground system as an NDA will be deleted, and any NDA link in place will be terminated.

3.72 In the event of an unexpected termination of the CDA link, the CDA should again send the NDA information to the aircraft, if an NDA is in place.

3.73 Only an aircraft can normally terminate a DDA link.

3.74 DDA normal link termination will be automatically initiated if a DDA becomes a CDA, and the pilot will be informed of this action.

MESSAGE PRESENTATION

3.75 The presentation of messages is a local implementation.

3.76 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.

MESSAGE ERRORS

3.77 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.

SERVICE DESCRIPTIONS

3.78 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.

Appendix A to Chapter 3

CPDLC MESSAGE SET

1. INTRODUCTION

1.1 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.

1.2 This appendix defines the allowed message elements from which CPDLC messages can be composed.

1.3 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.

1.4 The column headed Message element is a suggested text for presentation to the pilot or controller.

2. UPLINK MESSAGES

Uplink messages for CPDLC are presented in Tables IV-3-A1 to IV-3-A12.

3. DOWNLINK MESSAGES

Downlink messages for CPDLC are presented in Tables IV-3-A13 to IV-3-A24.

Table IV-3-A1. Responses/acknowledgements (uplink)

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
0	Indicates that ATC cannot comply with the request.	UNABLE	N	M	N
1	Indicates that ATC has received the message and will respond.	STANDBY	N	L	N
2	Indicates that ATC has received the request but it has been deferred until later.	REQUEST DEFERRED	N	L	N
3	Indicates that ATC 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 ATC 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 IV-3-A2. Vertical clearances (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
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

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
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 once reached the specified level is to be maintained.	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 once reached the specified level is to be maintained.	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 once reached the specified level is to be maintained.	AT *(position)* DESCEND TO *(level)*	N	M	W/U
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

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
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	Instruction that 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	Instruction that a cruise climb is to commence and continue until the specified level is reached.	CRUISE CLIMB TO *(level)*	N	M	W/U
35	Instruction that 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
36	Instruction that the climb to the specified level should be made at the aircraft's best rate.	EXPEDITE CLIMB TO *(level)*	U	M	W/U
37	Instruction that 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	(reserved)		L	L	Y
41	(reserved)		L	L	Y
171	Instruction to climb at not less than the specified rate.	CLIMB AT *(vertical rate)* MINIMUM	N	M	W/U

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
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)		L	L	Y

Note.— Wherever the variable "level" is specified, the message can specify either a single level or a vertical range, i.e. block level.

Table IV-3-A3. Crossing constraints (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	Instruction that 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	Instruction that the specified position is to be crossed at or above the specified level.	CROSS *(position)* AT OR ABOVE *(level)*	N	M	W/U
48	Instruction that 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

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
50	Instruction that 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	Instruction that the specified position is to be crossed at the specified time.	CROSS *(position)* AT *(time)*	N	M	W/U
52	Instruction that the specified position is to be crossed at or before the specified time.	CROSS *(position)* AT OR BEFORE *(time)*	N	M	W/U
53	Instruction that the specified position is to be crossed at or after the specified time.	CROSS *(position)* AT OR AFTER *(time)*	N	M	W/U
54	Instruction that 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	Instruction that 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	Instruction that 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	Instruction that 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	Instruction that 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	Instruction that 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	Instruction that 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

Note.— Wherever the variable "level" is specified, the message can specify either a single level or a vertical range, i.e. block level.

Table IV-3-A4. Lateral offsets (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 *(specified distance)* *(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 *(specified distance)* *(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 *(specified distance)* *(direction)* OF ROUTE	N	M	W/U
67	Instruction that the cleared flight route is to be rejoined.	PROCEED BACK ON ROUTE	N	M	W/U
68	Instruction that the cleared flight route is to be rejoined at or before the specified position.	REJOIN ROUTE BY *(position)*	N	M	W/U
69	Instruction that 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
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 IV-3-A5. Route modifications (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 *(specified distance)* *(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
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

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
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 on to the specified heading.	TURN *(direction)* HEADING *(degrees)*	N	M	W/U
95	Instruction to turn left or right as specified on to 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
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 on to 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

Note.— Wherever the variable "level" is specified, the message can specify either a single level or a vertical range, i.e. block level.

Table IV-3-A6. Speed changes (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	Instruction that the specified speed is to be maintained.	MAINTAIN *(speed)*	N	M	W/U
188	Instruction that after passing the specified position the specified speed is to be maintained.	AFTER PASSING *(position)* MAINTAIN *(speed)*	N	M	W/U
107	Instruction that the present speed is to be maintained.	MAINTAIN PRESENT SPEED	N	M	W/U
108	Instruction that the specified speed or a greater speed is to be maintained.	MAINTAIN *(speed)* OR GREATER	N	M	W/U
109	Instruction that the specified speed or a lesser speed is to be maintained.	MAINTAIN *(speed)* OR LESS	N	M	W/U
110	Instruction that a speed within the specified range is to be maintained.	MAINTAIN *(speed)* TO *(speed)*	N	M	W/U
111	Instruction that 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	Instruction that 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	Instruction that 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	Instruction that 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

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
115	Instruction that 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	Instruction that 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

Note.— Wherever the variable "level" is specified, the message can specify either a single level or a vertical range, i.e. block level.

Table IV-3-A7. Contact/monitor/surveillance requests (uplink)

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
117	Instruction that 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
118	Instruction that 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	Instruction that 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	Instruction that 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	Instruction that 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	Instruction that 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	Instruction that the specified code (SSR code) is to be selected.	SQUAWK *(code)*	N	M	W/U
124	Instruction that the SSR transponder responses are to be disabled.	STOP SQUAWK	N	M	W/U

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
125	Instruction that the SSR transponder responses should include level information.	SQUAWK MODE CHARLIE	N	M	W/U
126	Instruction that the SSR transponder responses should no longer include level information.	STOP SQUAWK MODE CHARLIE	N	M	W/U
179	Instruction that the ‘ident’ function on the SSR transponder is to be actuated.	SQUAWK IDENT	N	M	W/U

Table IV-3-A8. Report/confirmation 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 maintaining 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
200	Instruction used in conjunction with a level clearance to report reaching the level assigned.	REPORT REACHING	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)* 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

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
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
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

Note.— Wherever the variable "level" is specified, the message can specify either a single level or a vertical range, i.e. block level.

Table IV-3-A9. Negotiation 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
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 *(specified distance)* *(direction)* OFFSET	N	L	Y

Note.— Wherever the variable "level" is specified, the message can specify either a single level or a vertical range, i.e. block level.

Table IV-3-A10. Air traffic advisories (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	Notification that radar identification has been lost.	IDENTIFICATION LOST	N	M	R

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
157	Notification that a continuous transmission is detected on the specified frequency. Check the microphone button.	CHECK STUCK MICROPHONE *(frequency)*	U	M	N
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.	RVR RUNWAY *(runway) (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 IV-3-A11. System management messages (uplink)

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
159	A system-generated message notifying that the ground system has detected an error.	ERROR *(error information)*	U	M	N
160	Notification to the avionics that the specified data authority is the next data authority. If no data authority is specified, this indicates that any previously specified next data authority is no longer valid.	NEXT DATA AUTHORITY *(facility)*	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 acknowledgement refers and found it acceptable for display to the responsible person.	LOGICAL ACKNOWLEDGEMENT	N	M	N
233	Notification to the pilot that messages sent requiring a logical acknowledgement will not be accepted by this ground system.	USE OF LOGICAL ACKNOWLEDGEMENT PROHIBITED	N	M	N

Table IV-3-A12. Additional 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 pilot 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 pilot may execute when prepared to do so.	AT PILOTS DISCRETION	L	L	N
178	(reserved)		L	L	Y
169		*(free text)*	N	L	R
170		*(free text)*	D	H	R
183		*(free text)*	N	M	N
187		*(free text)*	L	N	N
194		*(free text)*	N	L	Y
195		*(free text)*	L	L	R
196		*(free text)*	N	M	W/U
197		*(free text)*	U	M	W/U
198		*(free text)*	D	H	W/U

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
199		*(free text)*	N	L	N
201	Not used		L	L	N
202	Not used		L	L	N
203		*(free text)*	N	M	R
204		*(free text)*	N	M	Y
205		*(free text)*	N	M	A/N
206		*(free text)*	L	N	Y
207		*(free text)*	L	L	Y
208		*(free text)*	L	L	N

Note.— Free text message elements have no associated message intent. The capability to send a free text message with any of the attribute combinations already used in the message set has been provided for in the technical requirements of the ATN (Annex 10, Volume III, Part I, Chapter 3).

Table IV-3-A13. Responses (downlink)

	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 IV-3-A14. Vertical requests (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

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
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

Note.— Wherever the variable "level" is specified, the message can specify either a single level or a vertical range, i.e. block level.

Table IV-3-A15. Lateral offset 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 *(specified distance)* *(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 *(specified distance)* *(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 *(specified distance)* *(direction)* OF ROUTE	N	L	Y

Table IV-3-A16. Speed 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 IV-3-A17. Voice contact 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 IV-3-A18. Route modification 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 *(specified distance)* *(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 IV-3-A19. Reports (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
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

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
78	Notification that 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.	MAINTAINING *(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
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 ATS unit is being monitored on the specified frequency.	MONITORING *(unit name) (frequency)*	U	M	N

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
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

Note.— Wherever the variable "level" is specified, the message can specify either a single level or a vertical range, i.e. block level.

Table IV-3-A20. Negotiation requests (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
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

Note.— Wherever the variable "level" is specified, the message can specify either a single level or a vertical range, i.e. block level.

Table IV-3-A21. Emergency and urgent messages (downlink)

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
55	Urgency prefix.	PAN PAN PAN	U	H	Y
56	Distress prefix.	MAYDAY MAYDAY MAYDAY	D	H	Y
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	Y
58	Notification that the pilot wishes to cancel the emergency condition.	CANCEL EMERGENCY	U	M	Y
59	Notification that the aircraft is diverting to the specified position via the specified route due to an urgent need.	DIVERTING TO *(position)* VIA *(route clearance)*	U	H	Y
60	Notification that the aircraft is deviating the specified distance in the specified direction off the cleared route and maintaining a parallel track due to an urgent need.	OFFSETTING *(specified distance) (direction)* OF ROUTE	U	H	Y
61	Notification that the aircraft is descending to the specified level due to an urgent need.	DESCENDING TO *(level)*	U	H	Y
80	Notification that the aircraft is deviating up to the specified distance from the cleared route in the specified direction due to an urgent need.	DEVIATING UP TO *(specified distance) (direction)* OF ROUTE	U	H	Y

Note.— Wherever the variable "level" is specified, the message can specify either a single level or a vertical range, i.e. block level.

Table IV-3-A22. System management 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

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
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 ground system that the aircraft system has received the message to which the logical acknowledgement refers and found it acceptable for display to the responsible person.	LOGICAL ACKNOWLEDGEMENT	N	M	N

Table IV-3-A23. Additional messages (downlink)

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
65	Used to explain reasons for pilot’s message.	DUE TO WEATHER	L	L	N
66	Used to explain reasons for pilot’s message.	DUE TO AIRCRAFT PERFORMANCE	L	L	N
74	States a desire by the pilot 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 pilot wishes to execute request when the pilot is prepared to do so.	AT PILOTS DISCRETION	L	L	N
101	Allows the pilot to indicate a desire for termination of CPDLC service with the current data authority.	REQUEST END OF SERVICE	L	L	Y
103	Allows the pilot to indicate that he/she 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

	Message intent/use	*Message element*	*URG*	*ALRT*	*RESP*
95		*(free text)*	U	M	N
96		*(free text)*	U	L	N
97		*(free text)*	L	L	N
98		*(free text)*	N	N	N

Note.— Free text message elements have no associated message intent. The capability to send a free text message with any of the attribute combinations already used in the message set has been provided for in the technical requirements of the ATN (Annex 10, Volume III, Part I, Chapter 3).

Table IV-3-A24. Negotiation responses (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
85	We can accept a parallel track offset the specified distance in the specified direction at the specified time.	WE CAN ACCEPT *(specified distance)* *(direction)* AT *(time)*	L	L	N
86	We cannot accept a parallel track offset the specified distance in the specified direction.	WE CANNOT ACCEPT *(specified distance)* *(direction)*	L	L	N

Note.— Wherever the variable "level" is specified, the message can specify either a single level or a vertical range, i.e. block level.

Appendix B to Chapter 3

CPDLC MESSAGE DATA GLOSSARY

1. CPDLC DATA GLOSSARY

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 call-sign. It is used in field 7 of the ICAO model flight plan.

Airport. Four characters that specify the ICAO four-letter identifier for the airport.

Along track waypoint (ATW). Sequence of information used to compute additional waypoints to an aircraft's route of flight. The following data composes the along track waypoint:

— *Position*;

— *ATW distance*;

— *Speed* (optional); and

— *ATW level sequence* (optional).

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.

ATS route designator. Specifies a particular route or route segment to be used by the aircraft. (IA5 string of 2-6 characters.)

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.

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:

— at;
— at or above; or
— at or below.

Clearance expiry time. *Time* after which a given clearance is no longer valid.

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:

— approach;
— departure;
— further;
— start-up;
— push-back;
— taxi;
— take-off;
— landing;
— oceanic;
— en-route; or
— downstream.

Code (SSR). Specifies the Mode A value for the aircraft.

Date. Gives the date in YYMMDD format using *Year*, *Month*, and *Day* data.

Date time group. Provides date and time as YYMMDD and HHMMSS.

Date time track generated. Date and time of the creation of a track.

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 degree for latitude or longitude.

Degree seconds. Provides seconds of a minute for latitude or longitude.

Degrees. Indicates the degree value in degrees magnetic or degrees true.

Departure airport. Four characters that specify the ICAO four-letter location indicator for the 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:

1) *Aircraft identification;*

2) *Clearance limit;*

3) *Flight information*; and

4) *Further instructions* (optional).

Departure expected clearance time. Indicates *Time* when a clearance is expected. Associated with flow management programme in effect.

Departure frequency. Provides departure frequency as a *Frequency* and *Unit name*.

Departure minimum interval. Specifies the minimum interval of time to depart behind the preceding aircraft in minutes.

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. Four characters that specify the ICAO four-letter location indicator for the 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:

— left;
— right;
— either side;
— north;
— south;
— east;
— west;
— north-east;
— north-west;
— south-east; or
— south-west.

Distance. Provides the distance in SI or non-SI units.

Distance to fix next. Indicates the distance to fix next in SI or non-SI units.

EFC time. Specifies the *Time* when a further clearance is expected.

Error information. Indicates the error conditions as follows:

— unrecognized message reference number;
— invalid message element;
— logical acknowledgement not accepted;
— invalid message element combination; or
— insufficient resources.

Facility. Allows a facility to be specified as NULL or a *Facility designation*.

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

Facility function. Specifies the facility function as:

— centre;
— approach;
— tower;
— final;
— ground control;
— clearance delivery;

— departure;
— control; or
— radio.

Facility identification. Provides a facility identification as either a *Facility designation* or a *Facility name*.

Facility name. Specifies the name of the aeronautical station.

Fix. Specifies the ICAO identifier for a given fix.

Fix name. Used to specify a location as a sequence of *Fix* and *Latitude longitude* (optional).

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:

— *Route of flight*; or
— *Levels of flight*; or
— *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:

— HF;
— VHF;
— UHF; or
— *Frequency Sat channel*.

Frequency Sat channel. Specifies the appropriate address for use with a satellite voice system.

Further instructions. Provides additional information in a departure clearance as follows:

— *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); or
— *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 a sequence of the following:

— *Position*;
— *Hold at waypoint speed low* (optional);
— *ATW level* (optional);
— *Hold at waypoint speed high* (optional);
— *Direction* (optional);
— *Degrees* (optional);
— *EFC time* (optional); and
— *Leg type* (optional).

Hold at waypoint speed high. Specifies the upper value for a holding-speed range.

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 clearance. Provides a holding clearance to the aircraft. The hold clearance is provided using:

— *Position*;
— *Level*;
— *Degrees*;
— *Direction*; and
— *Leg type* (optional).

Humidity. Specifies the humidity in per cent.

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:

— *Published identifier*;
— *Latitude and Longitude*;
— *Place bearing place bearing*; or
— *Place bearing distance*.

Latitude. Provides latitude as:

a) *Latitude degrees;*

b) *Latitude degrees* and *Degree minutes; or*

c) *Latitude degrees, Degree minutes* and *Degree seconds.*

Latitude degrees. Degrees of latitude.

Latitude longitude. Sequence of *Latitude* and *Longitude*, either of which is optional.

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 specified as a single level, or vertical range using:

— *Altitude* in metres or feet; and/or
— *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:

— *Level*; or
— *Procedure name*; or
— *Level* and *Procedure name.*

Longitude. Provides longitude as:

a) *Longitude degrees*;

b) *Longitude degrees* and *Degree minutes; or*

c) *Longitude degrees, Degree minutes* and *Degree seconds.*

Longitude degrees. Degrees of longitude.

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 *Published identifier* 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* data.

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 *Level* data.

Position. Information used to specify a location. Position can be specified as:

— *Fix name*;
— *Navaid*;
— *Airport*;
— *Latitude longitude* (either of which is optional); or
— *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:

— *Position current*;
— *Time at position current*;
— *Level*;
— *Fix next* (optional);
— *Time ETA at fix next* (optional);
— *Fix next plus one* (optional);
— *Time ETA destination* (optional);
— *Remaining fuel* (optional);
— *Temperature* (optional);
— *Winds* (optional);
— *Turbulence* (optional);
— *Icing* (optional);
— *Humidity* (optional);
— *Speed* (optional);
— *Speed ground* (optional);
— *Vertical change* (optional);
— *Track angle* (optional);
— *True heading* (optional);
— *Distance to fix next* (optional);
— *Reported waypoint position* (optional);
— *Reported waypoint time* (optional); and
— *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:

— *Procedure type*;
— *Procedure*; and
— *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* and/or *Latitude* and *Longitude*.

Remaining fuel. Specifies the amount of fuel remaining on the aircraft using *Time* data.

Reported waypoint level. The level of the waypoint for which the report is being made.

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.

Reporting points. Used to indicate reporting points along a route of flight based on a specific Latitude and/or Longitude increment expressed in degrees.

Required time arrival (RTA). 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:

— *Position*;
— *RTA time*; and
— *RTA tolerance* (optional).

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:

— *Aircraft identification* (optional);
— *Departure airport* (optional);
— *Destination airport* (optional);
— *Gate* (optional);
— *Runway departure* (optional);
— *Procedure departure* (optional);
— *Runway arrival* (optional);
— *Procedure approach* (optional);
— *Procedure arrival* (optional);
— *Route information* (optional); and
— *Route information additional* (optional).

Route information. Indicates 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:

— *Published identifier* (optional);
— *Latitude* and *Longitude*;
— *Place bearing place bearing* (optional);
— *Place bearing distance* (optional); and
— *ATS route designator* (optional).

Route information additional. Additional data used to further specify a route clearance. Provided using the following:

— *Along track waypoint* sequence (optional);
— *Reporting points* (optional);
— *Intercept course from* sequence (optional);
— *Hold at waypoint* sequence (optional);
— *Waypoint speed level* sequence (optional); and
— *RTA required time arrival* sequence (optional).

Route of flight. Specifies route of flight using *Route information*.

RTA time: Used to specify the required *Time* of arrival for an aircraft at a specific point.

RTA tolerance. Specifies the possible tolerance of the RTA time in minutes.

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 centre.

Runway departure. Specifies the departure runway.

Runway direction. Specifies the direction of the runway.

RVR. Runway visual range in SI or non-SI units.

Specified distance. Specifies the offset distance from the aircraft's route in SI or non-SI units.

Specified distance direction. Sequence of *Specified distance* and *Direction* data.

Speed. Provides the aircraft speed as one of the following:

— *Speed indicated*;
— *Speed true*;
— *Speed ground*; or
— *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:

— indicated;
— true;
— ground;
— Mach;
— approach;
— cruise;
— minimum;
— maximum; or
— not specified.

Temperature. Temperature specified in degrees Celsius.

Time. Sequence of *Time hours* and *Time minutes*.

Time at position current. Specifies the *Time* that the current location of the aircraft was indicated.

Time ETA at fix next. Specifies the *Time* an aircraft is expecting to cross the next point in the route.

Time ETA destination. Specifies the *Time* an aircraft is expecting to land at the destination airport.

Time HHMMSS. Provides time as HHMMSS.

Time hours. Specifies the hour in 24-hour notation.

Time minutes. Specifies time in minutes of an hour.

To from. Specifies to or from.

To from position. Used to indicate a "to" or "from" relative to a specified position.

Track angle. Specifies the aircraft ground track in degrees.

Traffic type. Indicates what type of traffic is present. Permitted types:

— opposite direction;
— same direction;
— converging;
— crossing; or
— diverging.

True heading. Specifies the aircraft true heading in degrees.

True track angle. Specifies true track angle to the next waypoint using degrees.

Turbulence. Specifies the severity of turbulence. Can be one of the following: light, moderate, or severe.

Unit name. Sequence of *Facility designation*, *Facility name* and *Facility function* (optional).

Unit name frequency. Sequence of *Unit name* and *Frequency.*

Unit name of departure frequency. Specifies the *Facility name* for the *Departure frequency.*

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

- *Position*;
- *Speed* (optional); and
- *ATW level sequence* (optional).

Wind direction. Specifies the direction of the wind using *Degrees* value.

Winds. Provides wind using *Wind direction* and *Wind speed*.

Wind speed. Provides wind speed in SI or non-SI units.

Year. Provides year as last two digits of a year.

Appendix C to Chapter 3

CPDLC VARIABLES RANGE AND RESOLUTION

CPDLC VARIABLES RANGE AND RESOLUTION

Table IV-3-C1 provides the required range and resolution for the message variables used in the CPDLC application.

Table IV-3-C1. CPDLC variables range and resolution

Variables	*Parameters*	*Unit*	*Range/size*	*Resolution*
Aircraft identification		IA5 character string	2 to 7 characters	N/A
Airport		IA5 character string	4 characters	N/A
Altimeter	Altimeter SI Altimeter*	Hectopascal Inches Hg.	750.0 to 1 250.0 22.00 to 32.00	0.1 0.01
ATIS code		IA5 character	1 character	N/A
ATS route designator		IA5 character string	2 to 6 characters	N/A
Code (SSR)		Integer	4 octal digits	N/A
Date	Year Month Day	Year Month of year Day of month	1996 to 2 095 1 to 12 1 to 31	1 1 1
Degrees	Degrees magnetic Degrees true	Degrees Degrees	1 to 360 1 to 360	1 1
Departure minimum interval		Minutes	0.1 to 15.0	0.1
Distance	Distance SI units Distance non-SI units	Kilometres Nautical miles	0 to 2 000 1 to 999.9	0.25 0.1
Distance to fix next point	Distance to next waypoint SI units Distance to next waypoint non-SI units	Kilometres Nautical miles	1 to 2 000 1 to 1 000	0.1 0.1
Facility	Facility designation Facility name Navaid	IA5 character string IA5 character string IA5 character string	4 to 8 characters 3 to 18 characters 1 to 4 characters	N/A N/A N/A
Fix		IA5 character string	1 to 5 characters	N/A
Free text		IA5 character string	1 to 256 characters	N/A
Frequency	Frequency HF Frequency VHF Frequency UHF Frequency Sat channel	kHz MHz MHz Digit string	2 850 to 28 000 117.975 to 137.000 225.000 to 399.975 12 digits	1 0.005 0.025 N/A
Humidity		Per cent	1 to 100	1

Variables	*Parameters*	*Unit*	*Range/size*	*Resolution*
Latitude	Latitude degrees Degree minutes Degree seconds	Degrees Minutes Seconds	0 to 90 0 to 59.99 0 to 59	0.001 0.01 1
Leg distance	Leg distance SI units Leg distance non-SI units	Kilometres Nautical miles	0 to 100 0 to 50	1 1
Leg time		Minutes	0 to 10	1
Level	Flight level SI Flight level non-SI Level SI Level non-SI	1 level (10 m) 1 level (100 ft) Metres Feet	100 to 2 500 30 to 700 –30 to +25 000 –600 to +70 000	1 1 1 10
Longitude	Longitude degrees Degree minutes Longitude seconds	Degrees Minutes Seconds	0 to 180 0 to 59.99 0 to 59	0.001 0.01 1
Month		Month of year	1 to 12	1
Persons on board		Integer	1 to 1 000	1
Procedure transition		IA5 character string	1 to 5 characters	N/A
Revision number		Integer	1 to 16	1
RTA tolerance		Minutes	0.1 to 15.0	0.1
Runway direction		Integer	1 to 36	1
RVR	RVR SI units RVR*	Metres Feet	0 to 1 500 0 to 6 100	1 1
Specified distance	SI non-SI	Kilometres Nautical miles	1 to 500 1 to 250	1 1
Speed	Ground speed SI Ground speed non-SI Mach Indicated SI Indicated non-SI Speed true SI Speed true non-SI	Kilometres/hour Knots Mach number Kilometres/hour Knots Kilometres/hour Knots	–100 to +4 000 –50 to +2 000 0.5 to 4.0 0 to 800 0 to 400 0 to 4 000 0 to 2 000	1 1 0.001 1 1 1 1
Temperature	Temperature Celsius	Degrees Celsius	–100 to +100	1
Time	Time hours Time minutes	Hours of day Minutes of hour	0 to 23 0 to 59	1 1
Version number	Version number	Integer	0 to 15	N/A
Vertical rate	Vertical rate SI Vertical rate non-SI	Metres/second Feet/minute	±1 000 ±30 000	1 10
Wind speed	Wind speed SI Wind speed non-SI	Kilometres/hour Knots	0 to 500 0 to 250	1 1

* Unit of measurement not specified in Annex 5.

Chapter 4

CPDLC PROCEDURES

GENERAL PROCEDURES

4.1 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.

4.2 When a required response is not successfully delivered, the message initiator is responsible for querying the state of the response via an appropriate medium.

4.3 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.

4.4 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.

4.5 When a controller or pilot communicates via voice, the response should be via voice.

4.6 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.

4.7 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.

4.8 Procedures should accommodate mixed data link and voice capability.

4.9 Aircraft operating procedures for CPDLC should be consistent and independent of the flight phase or ATS facility.

4.10 A CPDLC message should contain no more than two message elements with the “route clearance” variable.

Chapter 5

EXCEPTION HANDLING

ERROR CONDITIONS

Messages received out of order

5.1 The recipient will be informed when a message is received out of order.

Duplicate message identification numbers

5.2 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.

5.3 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.

5.4 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.

Invalid reference number

5.5 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.

Unauthorized use of logical acknowledgement

5.6 When the ground system receives a message requiring a logical acknowledgement where the use of logical acknowledgement has been prohibited, the ground system will:

a) send a message containing an ERROR message element with the [error information] parameter set to the value [logical acknowledgement not accepted]; and

b) discard the message requiring a logical acknowledgement.

Chapter 6

DEPARTURE CLEARANCE SERVICE DESCRIPTION

SCOPE AND OBJECTIVE

6.1 A flight due to depart from an airfield must first obtain departure information and clearance from the controlling ATS unit (C-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.

EXPECTED BENEFITS, ANTICIPATED CONSTRAINTS, AND ASSOCIATED HUMAN FACTORS

6.2 *Benefits:*

a) reduction of the potential for communication errors between a pilot and controller;

b) reduction of channel load;

c) reduction of ground delays;

d) reduction in pilot workload (e.g. reduced hand-copy of clearances and information, reduced radio-telephony monitoring and use);

e) reduction in controller workload (e.g. reduced radiotelephony and monitoring);

f) automatic validation of flight plan in the ATSU; and

g) automatic preparation of departure clearance and information elements for controller validation.

6.3 *Constraints:*

a) reduction of voice-induced situational awareness for pilots; and

b) reduced dialogue flexibility in case of non-routine communication.

6.4 *Human Factors.* 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.

OPERATING METHOD WITHOUT DATA LINK

6.5 Where local procedures or flight category require, flights intending to depart from an airport must first obtain a departure clearance 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).

6.6 The departure clearance procedure normally consists of the following chronological steps:

1) The pilot calls and requests a departure clearance using radiotelephony, generally prior to start-up.

2) 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.

3) The controller delivers the clearance to the pilot using radiotelephony.

4) The pilot acknowledges the clearance via a full readback on radiotelephony.

Note.— The pilot may negotiate a revised clearance after step 3 above.

OPERATING METHOD WITH DATA LINK

6.7 The DC 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 DC 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.

6.8 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 off-block time, 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 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/she will transmit a WILCO indication. If the pilot is unable to accept the operational contents, he/she 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 renegotiation 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 renegotiate the clearance following the transmission of a pilot acknowledgement, by radiotelephony if required.

6.9 *Initiation conditions.* The DC service is invoked on pilot input initiating the DC request, at a suitable time prior to departure.

6.10 *Sequence of services.* 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.

Additional guidelines

6.11 The service should not be available to the aircraft after take-off.

6.12 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.

6.13 Free text can be appended to either the DC request or the clearance as required.

6.14 Both the aircraft and the ATSU will have the capability to map a response with a request.

6.15 Ground and airborne systems will be updated with the operational contents of any radiotelephony transactions.

6.16 *Error handling.* 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 radiotelephony.

Note.— In the event of any doubt or ambiguity, the negotiation will be carried out by radiotelephony.

6.17 *Closure conditions.* Closure conditions, if required, should be the subject of local implementation.

6.18 *Time sequence diagram.* Figure IV-6-1 shows the normal sequence of messages in the DC.

INFORMATION EXCHANGES

6.19 Table IV-6-1 shows the information exchanged to effect a departure clearance.

Note.— The numbers in the message element column refer to uplink and downlink message elements in accordance with Chapter 3, Appendix A.

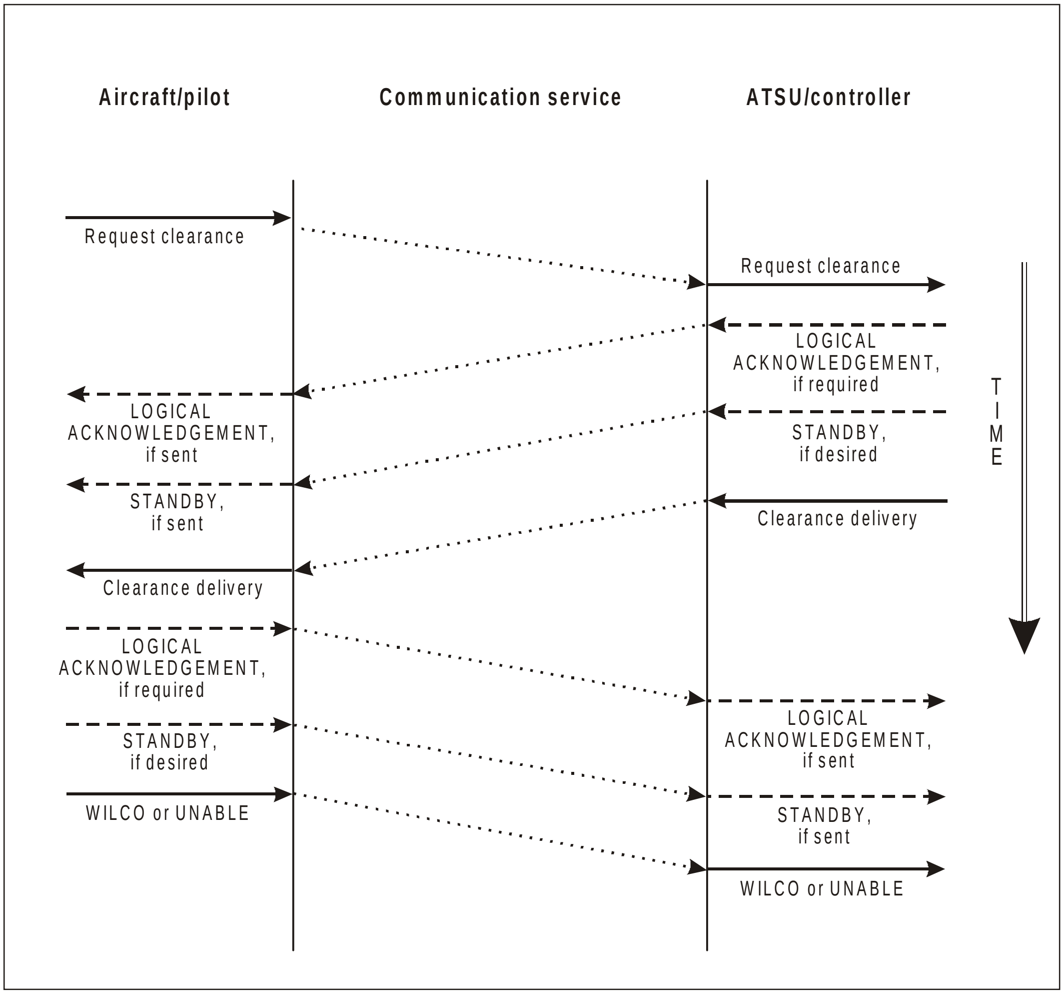


Figure IV-6-1. Time Sequence Diagram for Departure Clearance

Table IV-6-1. Departure clearance service information exchange

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 and Longitude, or Place bearing place bearing, or Place bearing distance, or ATS route designator. Levels of flight, or Level, or Procedure name, or Level and Procedure name. Route of flight and levels of flight. Published identifier, or Latitude and Longitude, or Place bearing place bearing, or Place bearing distance, or ATS route designator, 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

Chapter 7

TRANSFER OF DATA AUTHORITY SERVICE DESCRIPTION

TRANSFER OF DATA AUTHORITY

Requirements for transfer of data authority

7.1 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:

a) independent of the transferring and receiving ATSUs ground-ground data communication capability;

b) when both the transferring and receiving ATSUs are equipped for air-ground data link; and

c) when only the transferring ATSU is equipped for air-ground data link.

7.2 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.

7.3 Ground-ground data communication in support of ATC transfer of data authority, if applied, will be in accordance with Part VI of this manual, and any applicable regional supplementary material.

Transfer of data authority and voice communication in conjunction

7.4 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.

7.5 Sequence diagram for transfer of data and voice concurrently:

1) If the CDA notifies the aircraft of its NDA, the establishment of an NDA link is permitted.

2) An NDA link is established.

3) The CDA instructs the aircraft to monitor or contact the NDA on the appropriate voice channel using the CONTACT and/or MONITOR messages.

4) The pilot acknowledges the instruction to transfer voice and activates the new voice channel.

5) The CDA link is terminated normally.

6) The NDA now becomes the CDA and CPDLC messages can be exchanged.

7.6 Figures IV-7-1a and IV-7-1b illustrate transfer of data authority *without* supporting ground-ground connectivity.

Note.— No context management or log-on/off functionality reflected in any of the following drawings.

7.7 Figures IV-7-2a and IV-7-2b illustrate transfer of data authority *with* supporting ground-ground connectivity.

Transfer of communications without change of data authority

7.8 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.

1) The C-ATSU instructs the aircraft to monitor or contact the next sector on the appropriate voice channel.

2) The pilot acknowledges the instruction to transfer voice and activates the new voice channel.

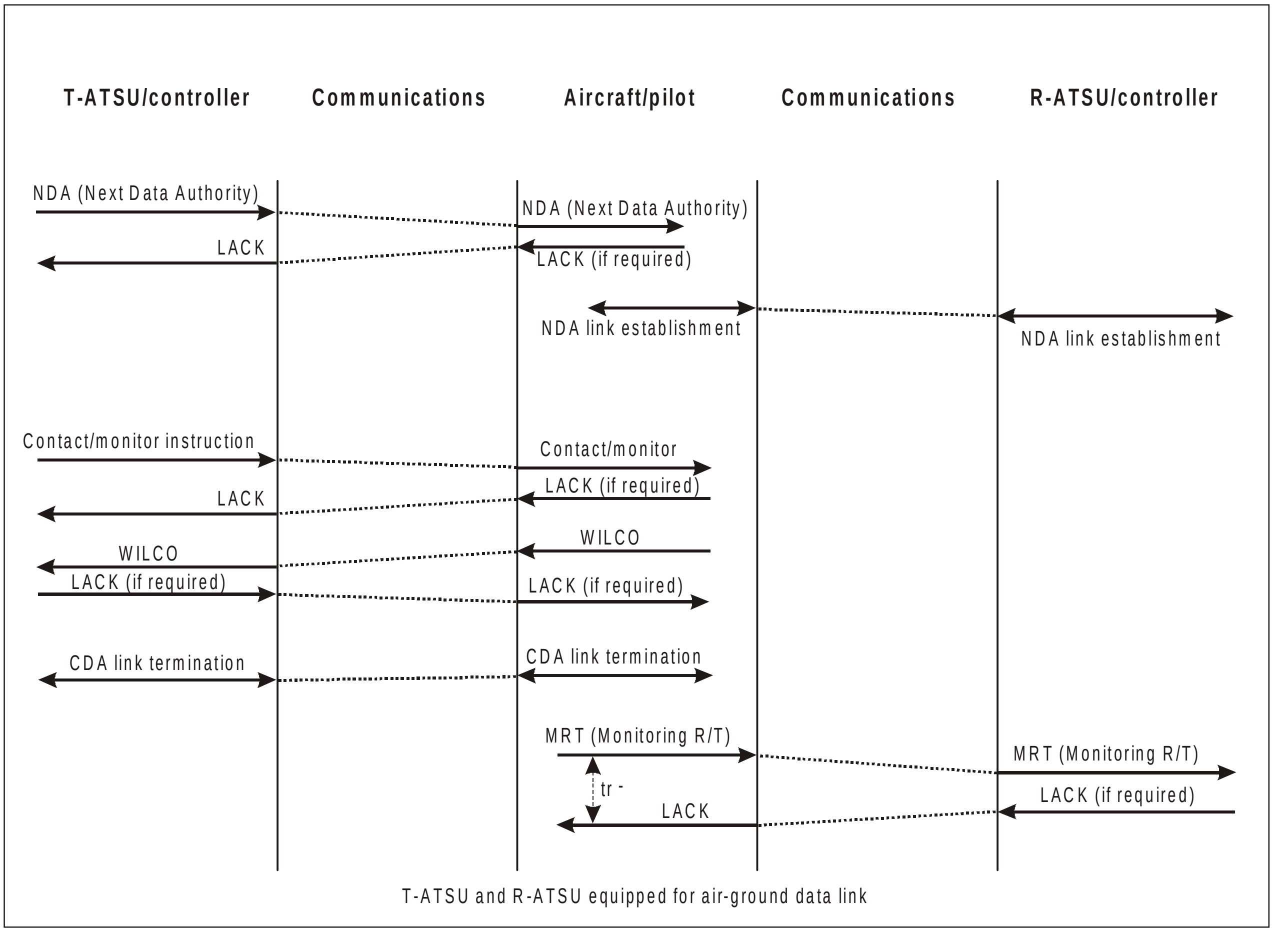


Figure IV-7-1a. Transfer of data authority and communication without ground-ground connectivity: T-ATSU initiated

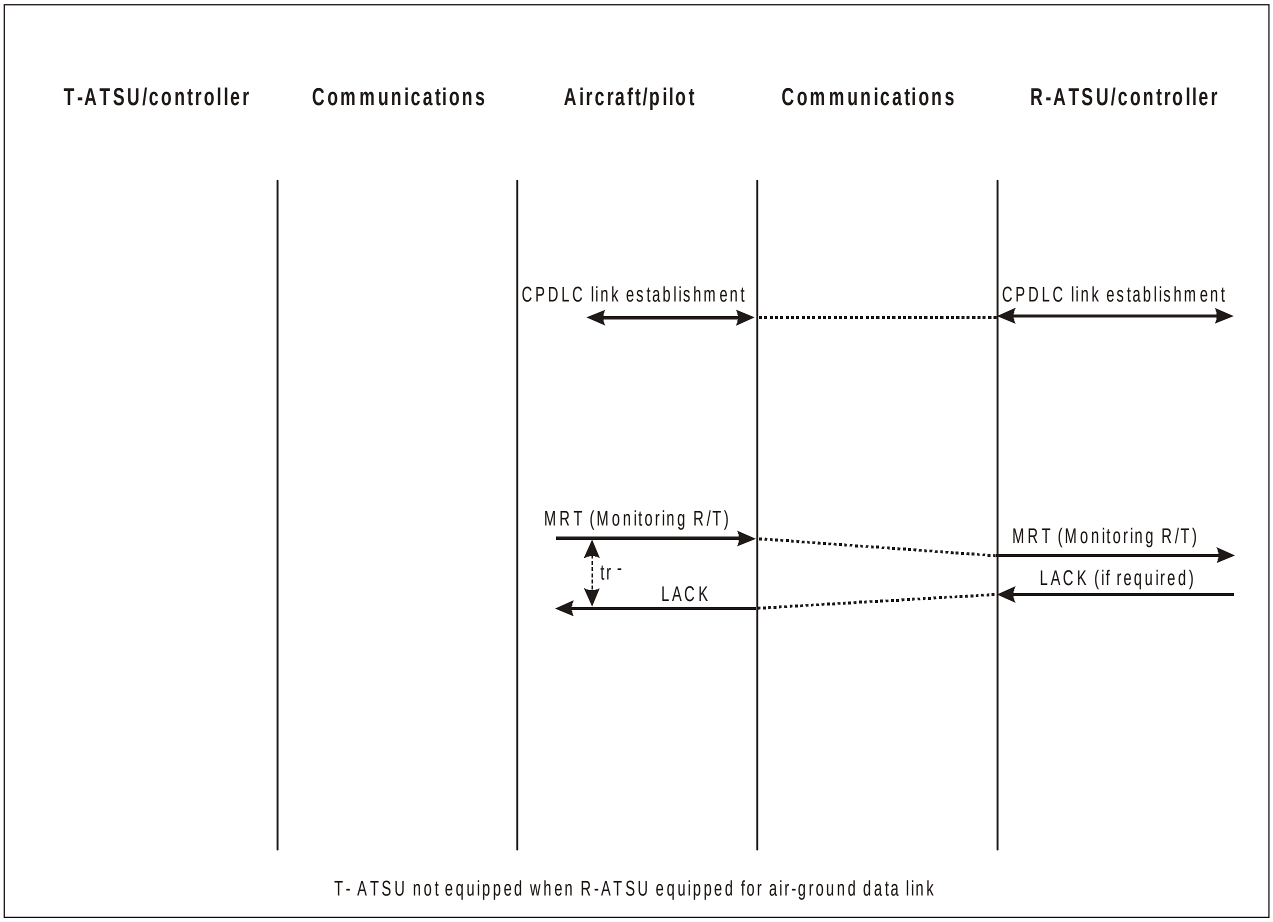
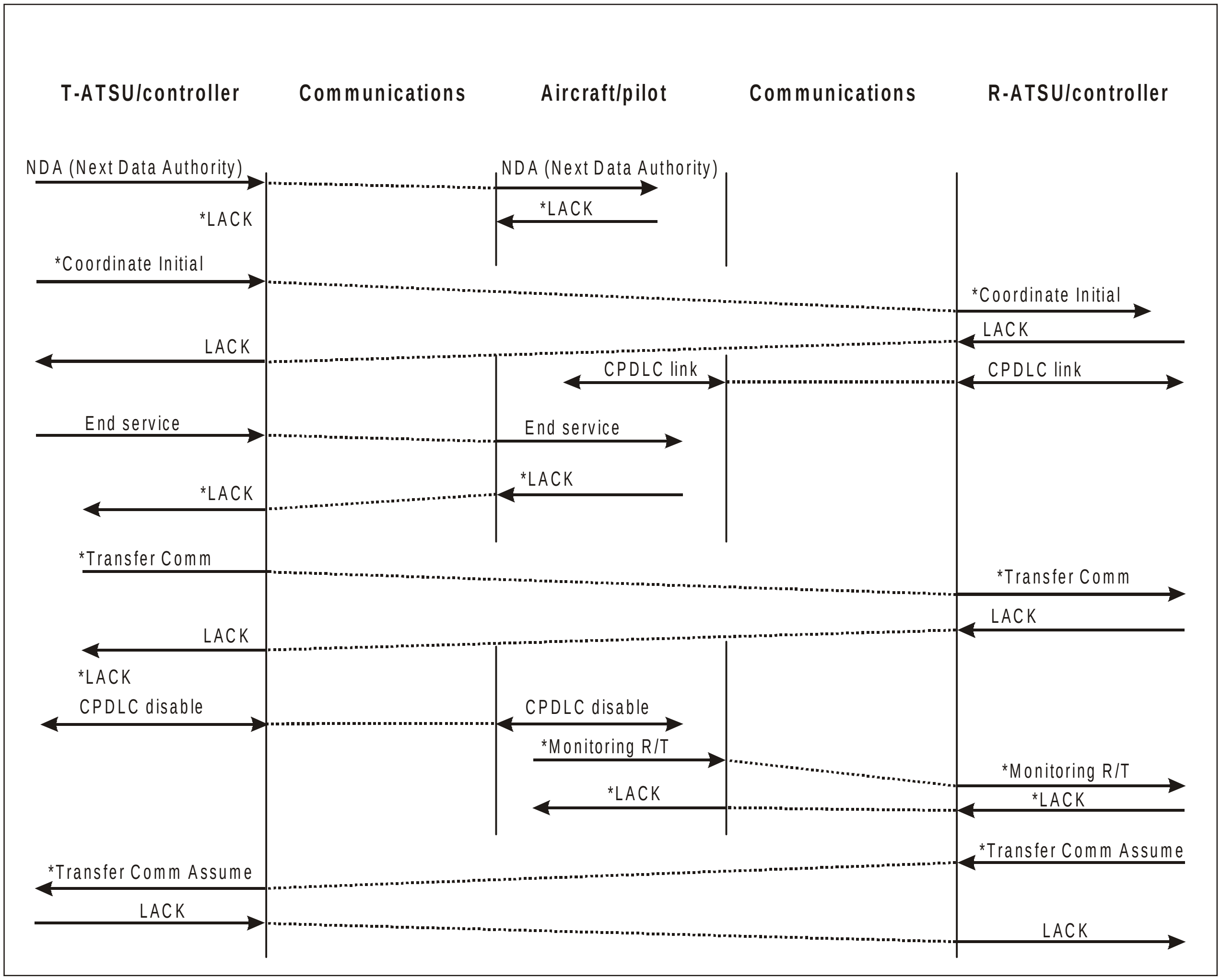
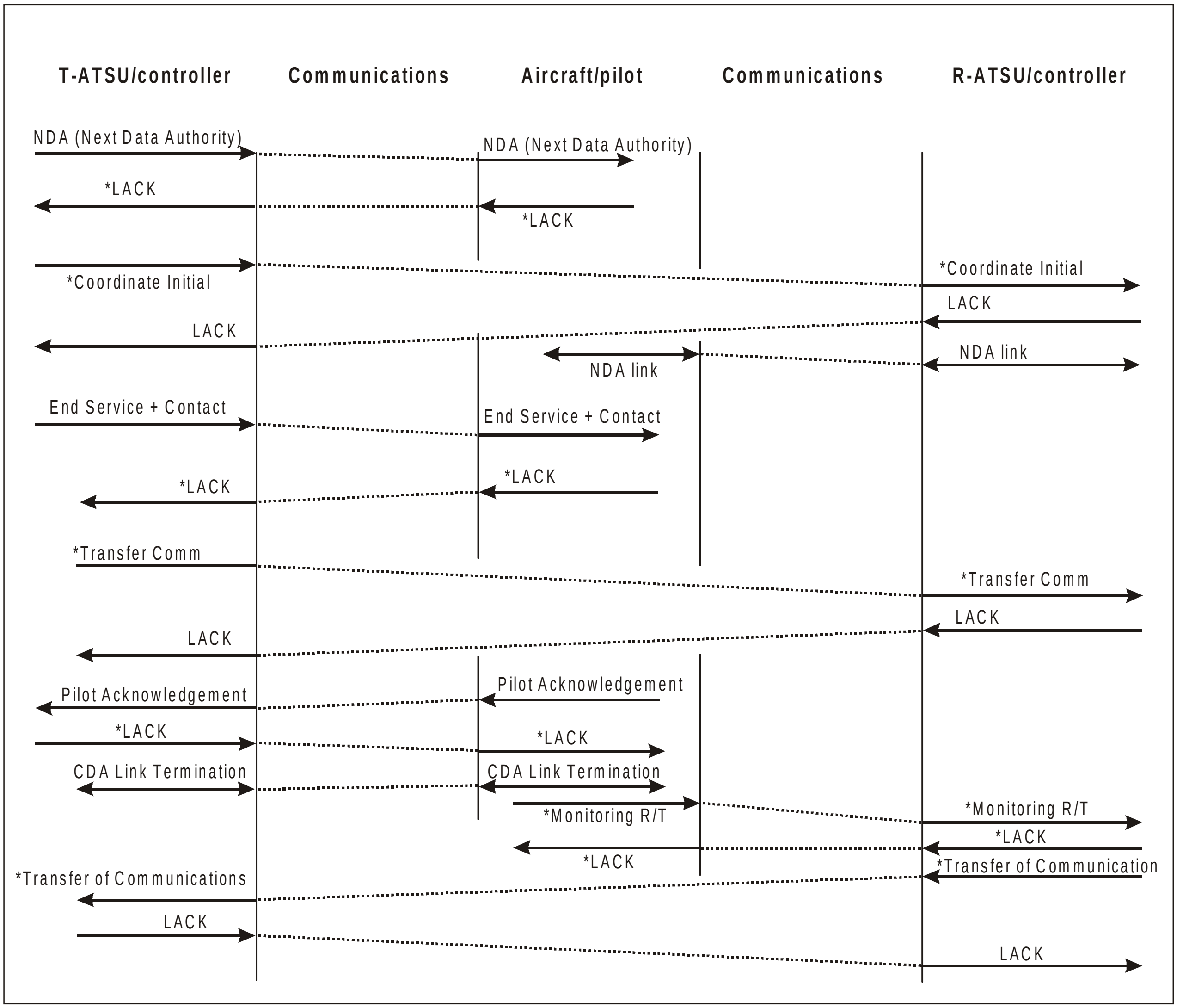


Figure IV-7-1b. Transfer of data authority and communication without ground-ground connectivity: aircraft initiated



*Indicates an optional message

Figure IV-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 acknowledgement)



*Indicates an optional message

Figure IV-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)

Chapter 8

DOWNSTREAM CLEARANCE SERVICE DESCRIPTION

SCOPE AND OBJECTIVE

8.1 The pilot, in specific instances, needs to obtain clearances or information from ATSUs which may be responsible for control of the aircraft in the future, but which 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 communications are unavailable or inefficient, due to the size of the airspace, the complexity of the route structure, or meteorological conditions).

8.2 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.

8.3 The downstream clearance (DSC) service provides assistance for requesting and obtaining D-ATSU clearances or information, using air-ground data link.

8.4 The DSC service can only be initiated by the pilot.

8.5 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.

EXPECTED BENEFITS, ANTICIPATED CONSTRAINTS, AND ASSOCIATED HUMAN FACTORS

8.6 *Expected benefits.* The expected benefits of DSC include:

— reduction of voice channel load (voice frequency congestion);

— reduction of radiotelephony workload for both pilot and controller;

— added pilot flexibility for requesting and receiving clearances or information;

— better, more flexible pacing of communication tasks for aircrew;

— improved support for aircrew flight planning and task management; and

— provision of an enhanced planning capability for the D-ATSU.

Anticipated constraints

8.7 *Operational responsibility.* 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:

a) *Current ATSU*: The ATSU currently responsible for control of the aircraft has authority to exchange *all* CPDLC messages with that aircraft;

b) *Downstream 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.

The C-ATSU and the D-ATSU must not be the same data authority.

8.8 *Operational procedures and system support.* 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:

a) There can be only one DSC link at any one time.

b) To maintain pilot situational awareness and communication access security, avionics will provide the pilot with the ability to:

   1) 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;

   2) 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); and

   3) clearly and unambiguously differentiate between messages from the C-ATSU and messages from a D-ATSU.

c) 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.

d) D-ATSU controller-pilot message use should be controlled through ICAO regional operational procedures and published in AIPs for each case.

e) There will be procedures that prevent the pilot from executing a clearance received via a DSC link until the aircraft enters the airspace of the control authority from which the DSC was received. If the information received by an airborne user via a DSC 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.

f) The ground system must have the ability to reject any request for DSC.

Associated Human Factors

8.9 See operational procedures and system support above.

8.10 Message elements available for this service should be restricted by the end user systems in accordance with the service description.

OPERATING METHOD WITHOUT DATA LINK

8.11 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). (See Table IV-8-1.)

OPERATING METHOD WITH DATA LINK

Normal mode

Service description

8.12 DSC will be available in all flight phases. Use of the service will be restricted to pilot-initiated requests, and the directly associated responses.

8.13 The DSC operating method conforms to the existing operating method. The normal sequence of events is:

a) The pilot triggers a DSC request to the D-ATSU.

b) If a logical acknowledgement (LACK) is required in accordance with local procedures, the D-ATSU transmits a LACK to the aircraft.

c) 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.

d) If a LACK is required by the D-ATSU in accordance with local procedures, the aircraft transmits a LACK to the D-ATSU.

e) The pilot verifies the D-ATSU response containing the proposed DSC and:

1) If he/she can accept and comply with the operational contents, without any change being required to its current clearance, the pilot transmits a WILCO.

2) 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.

3) If the pilot is unable to accept the operational contents, he/she will transmit an UNABLE.

Initiation conditions

8.14 The DSC service is invoked exclusively on pilot initiation of the request to the D-ATSU.

8.15 The DSC will be completed prior to the aircraft entering the D-ATSU airspace.

Termination conditions

8.16 The DSC link is normally terminated by the pilot after completion of the final response to a receipt of a DSC.

8.17 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.

Sequence of services

8.18 The DSC service can operate independently of any other service.

Additional guidelines

8.19 The DSC service requires flight plan information at the D-ATSU.

8.20 Table IV-8-2 indicates the message elements from the CPDLC message set (Part IV, Appendix A to Chapter 3) 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.

TIME SEQUENCE DIAGRAM

8.21 Figure IV-8-1 shows the normal sequence of messages in the DSC.

INFORMATION EXCHANGES

8.22 *Applicable CPDLC message elements.* 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.

Table IV-8-1. Operating method with and without data link

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 IV-8-2. Message elements prohibited from use, in isolation, for downstream clearance delivery

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, 35, 36, 37, 38, 39, 40, 41, 219, 220, 171, 172, 173, 174
	A3: Crossing constraints (uplink)	46, 47, 49, 50, 51, 52, 53, 54, 58, 59, 60, 61, 62, 63
	A4: Lateral offsets (uplink)	64, 67, 68, 69, 72
	A5: Route modifications (uplink)	74, 75, 78, 79, 80, 81, 236, 82, 91, 92, 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
	A10: Air traffic advisories (uplink)	154, 191, 155, 156, 210, 193
	A11: System management messages (uplink)	160, 161
	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
	A16: Speed requests (downlink)	18, 19
	A18: Route modification requests (downlink)	22, 26, 27, 70, 71
	A22: System management messages (downlink)	63, 99, 107
	A23: Additional messages	74, 103

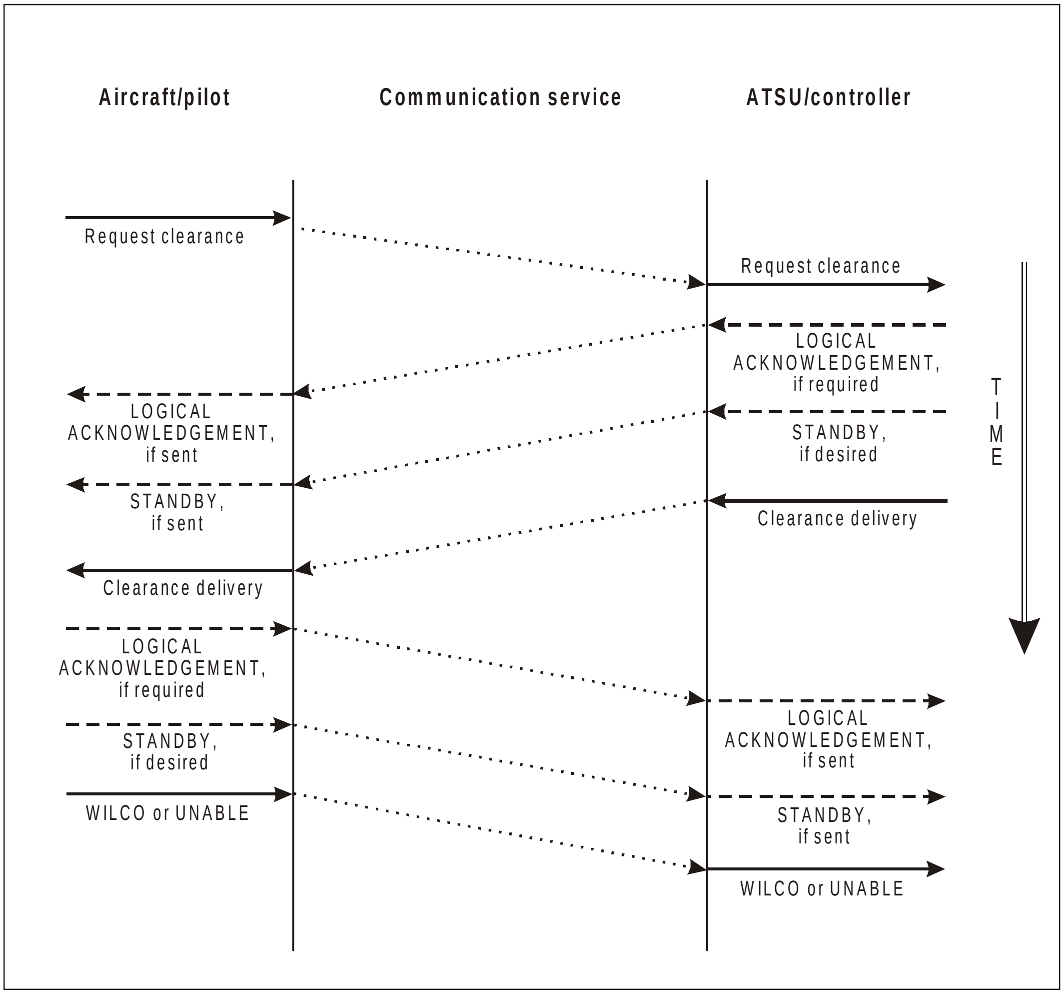


Figure IV-8-1. Time sequence diagram for downstream clearance request

PART V

DATA LINK FLIGHT INFORMATION SERVICES

Chapter 1

APPLICATION OVERVIEW

INTRODUCTION

1.1 Flight information services (FIS) are provided to the pilot to increase situational awareness and to enhance safety of flight. Currently FIS is provided primarily through voice channels. The data link FIS (DFIS) application allows a pilot to request and receive FIS from ground systems via data link.

Background

1.2 DFIS are comprised of both airborne and ground-based components. DFIS systems enable information to be provided to aircraft via messages between aircraft avionics and ground systems.

1.3 It is anticipated that the DFIS application will develop in an evolutionary manner. In the future DFIS may include services provided by both addressed and broadcast methods. This version of the manual outlines only initial services, which are provided upon request via addressed systems.

1.4 In these services, the aircraft (pilot and/or avionics) requests the service by generating a request message for transmission to a DFIS ground system.

1.5 Each of these services should be accessed and used independently of the others and are initiated by the aircraft.

USE OF DFIS IN ATS

1.6 DFIS will be used to provide information to airborne users. Much of this information is currently provided to pilots via radio transmissions or voice broadcasts (e.g. meteorological reports, ATIS). In the future, additional information not available to pilots via voice may be provided via data link.

1.7 Pilots (and/or aircraft avionics) can request DFIS services as desired during pre-flight or in-flight operations.

1.8 There are multiple DFIS services which may be supported by DFIS systems. These services include but are not limited to:

— automatic terminal information services (ATIS);

— aviation routine weather report (METAR) service;

— terminal weather service (TWS)*;

— windshear advisory service;

— pilot report (PIREP) service*;

— notice to airmen (NOTAM) service;

— runway visual range (RVR) service;

— aerodrome forecast (TAF) service;

— precipitation map service*; and

— SIGMET service.

Note.— An asterisk (*) indicates that there is no current ICAO requirement for the provision of this service at this time.

1.9 This version of the manual includes requirements for two of these services: ATIS and METAR. These services are described in Chapters 6 and 7 respectively of this part of the document.

Chapter 2

GENERAL REQUIREMENTS

MESSAGE HANDLING

Message transmission

2.1 The DFIS application requires:

a) that messages are generated and sent in the time-ordered sequence; and

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

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

QUALITY OF SERVICE

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

TIME REQUIREMENTS

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

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

DFIS PRIORITY

2.6 The priority for DFIS messages will be as described in the service descriptions associated with the remaining parts of this section of the manual.

DFIS PERFORMANCE REQUIREMENTS

2.7 Systems developed to support DFIS should be capable of meeting the communication performance appropriate for the phase of operation, for example en-route weather information may not be required as rapidly as ATIS information in the approach phase of flight.

Chapter 3

FUNCTIONAL REQUIREMENTS

DFIS PROVISION MODES

3.1 There are two types of DFIS delivery: the information may be provided upon demand, or by the establishment of a contract.

DFIS demand mode

3.2 The DFIS Demand mode defines a method for the aircraft to request specific DFIS information and for the ground DFIS system to provide the aircraft with the requested information.

Message descriptions

3.3 There are six messages used by the demand mode:

— Request message;
— Delivery message;
— Processing message;
— Reject message;
— Error message; and
— Abort message.

3.4 The Request message provides the following information:

— the type of information requested;
— the type of mode; and
— the parameters of the requested information.

3.5 The Delivery message provides the following information:

— the type of information returned;
— the requested information formatted as specified for each service; and
— appended free text as required.

3.6 The Processing message indicates that the requested information is being processed.

3.7 The Reject message provides the following information:

— the type of request rejected; and
— the reason for the rejection of the request.

3.8 The Error message is sent when an error is detected and provides the following information:

— the type of error; and
— the reason for the error.

3.9 The Abort message is sent when either the air or ground system abnormally terminates a DFIS link. The Abort message allows the abort initiator to indicate a reason for issuing the abort.

DFIS Contract mode

3.10 The DFIS Contract mode defines a method for the aircraft to request specific DFIS information and for the ground DFIS system to provide the aircraft with this information and any updates to this information.

Message descriptions

3.11 There are seven messages that are used by the DFIS Contract mode.

— Request message;
— Delivery message;
— Processing message;
— Reject message;
— Cancel contract message;
— Error message; and
— Abort message.

3.12 The Request message provides the following information:

— the type of DFIS information requested;
— the type of mode; and
— the parameters of the requested information.

3.13 In Contract mode the Delivery message is sent initially upon receipt, and subsequently whenever the DFIS information is updated and provides the following information:

— the type of DFIS information returned;
— the requested information formatted as specified for each service; and
— appended free text as required.

3.14 The Processing message indicates that the requested information is being processed.

3.15 The Reject message provides the following information:

— the type of DFIS request rejected;
— the DFIS information requested, if available; and
— the reason for the rejection of the DFIS request.

Note.— This message can be used to indicate that the ground system does not support the DFIS Contract mode.

3.16 The Error message is sent when an error is detected and provides the following information:

— the type of error; and
— the reason for the error.

3.17 The Cancel contract message is sent either by the airborne DFIS system or the ground DFIS system.

ESTABLISHMENT OF A DFIS LINK

3.18 The aircraft DFIS application enables the request for the transfer of DFIS information by first establishing a link with a ground DFIS application. The aircraft specifies either demand or Contract mode.

Establishment and operation of a Demand mode

3.19 Demand mode can work in two ways: information can be provided immediately or the reply can be deferred.

3.20 Immediate demand mode message sequence:

1) The airborne system sends a request message.

2) Upon receipt of a request message, the ground system sends the appropriate Delivery message within the required response time.

3.21 Deferred demand mode message sequence:

1) The airborne system sends a request message.

2) Upon receipt of a request message, the ground system detects that the requested DFIS information can be retrieved, but is not yet available or cannot be sent within the required response time, then:

— sends a processing message, and
— when the information becomes available, sends a delivery message.

3.22 Requested information not available or Non-Compliance message sequence:

1) The airborne system sends a request message.

2) Upon receipt of a request message, the ground system detects that the requested DFIS information cannot be retrieved, and sends a reject message.

Establishment and operation of Contract mode

3.23 Upon receipt of a valid request message indicating a Contract mode, the ground system:

a) if the Contract mode is supported:

1) sends the appropriate delivery message within the required response time and continues to send updates when available until the contract is terminated,

or

2) detects that the requested DFIS information can be retrieved but is not yet available or cannot be sent within the required response time, then

— sends a Processing message, and
— when the information becomes available, sends a Delivery message and continues to send updates when available until the contract is terminated,

or

3) detects that the requested DFIS information cannot be retrieved and sends a reject message;

b) if the Contract mode is not supported:

1) sends the appropriate delivery message within the required response time indicating that the Contract mode is not supported,

or

2) detects that the requested DFIS information can be retrieved but is not yet available or cannot be sent within the required response time, then

— sends a Processing message, and
— when the information becomes available, sends a Delivery message indicating that Contract mode is not supported,

or

3) detects that the requested DFIS information cannot be retrieved and sends a Reject message.

DFIS LINK TERMINATION

3.24 For the Demand mode, the link is closed on receipt of the Delivery, Reject, or Error reply.

3.25 For the Contract mode, the ground system sends updated DFIS information or update indications until the link is closed explicitly by either the ground or aircraft.

3.26 Either an airborne or a ground system will have the capability to terminate the service.

Chapter 4

DFIS PROCEDURES

[to be developed]

Chapter 5

EXCEPTION HANDLING

ABNORMAL TERMINATION OF THE DFIS SERVICE

5.1 When an error situation is detected by either an airborne or a ground system, that system indicates an error. If the system cannot recover from the error, the service is terminated.

5.2 In the event of an unintended interruption of the DFIS Contract mode, the contract will be terminated and the pilot will be informed.

Chapter 6

AUTOMATIC TERMINAL INFORMATION SERVICE DESCRIPTION

SCOPE AND OBJECTIVES

6.1 The ATIS data link service supplements the existing availability of ATIS as a voice broadcast service, provided at aerodromes worldwide. All types of ATIS currently in use are encompassed (i.e. arrival, departure and combined).

6.2 The data link ATIS message will be used to provide an alternative means of transmitting the service to those equipped aircraft which request the message.

EXPECTED BENEFITS, ANTICIPATED CONSTRAINTS AND ASSOCIATED HUMAN FACTORS

6.3 *Benefits:*

a) *reduced flight crew workload:* ATIS information does not need to be copied by the flight crew if the message is printed on a cockpit printer or is recallable on a data link display. Also, the flight crew does not have to divert attention from ATS operational channels to listen to the ATIS broadcast;

b) *reduced ambiguity in the transmitted information:* data link implementation eliminates potential misinterpretation resulting from poor transmission quality; and

c) *potential for increased accessibility to ATIS information:* flight crews should be able to request timely ATIS information from any aerodrome capable of providing data link information.

6.4 *Anticipated constraints:* reduced dialogue flexibility in case of complex meteorological conditions.

6.5 *Associated Human Factors:*

a) error detection and correction mechanisms will be implemented to ensure message integrity. Technical and procedural mechanisms will be considered;

b) maximum use of data link will not impose undue competition for display or control resources. Systems should not preclude access to other functions or conflict with higher priority functions;

c) when operating the data link system, there will not be any increase in head-down time that would adversely affect the safe operation of the aircraft. Aircraft system implementation will adhere to recognized Human Factors practices and design criteria; and

d) voice communication will be available to supplement data link system operation.

OPERATING METHOD IN A VOICE ENVIRONMENT

6.6 ATIS is predominantly a voice broadcast service intended to relieve frequency congestion and air traffic controller workload by providing pertinent information to aircraft operations in the terminal area through a local broadcast, eliminating the need for a controller to transmit the information to each aircraft individually. This is normally accomplished through the use of a voice recording of the information which is continuously broadcast over a published VHF frequency in the vicinity of the aerodrome.

Note.— Some States also provide ATIS through various forms of data link service.

6.7 The information broadcast usually lasts less than one minute, and includes meteorological conditions, operating procedures, runways and approaches in use, and various other information which may affect the departure, approach and landing phases of flight.

6.8 The recorded ATIS message is updated upon the issuance of a new weather report, or when conditions or procedures affecting various components of the ATIS message change substantially.

6.9 Individual ATIS messages are identified by a designator from the ICAO alphabet, alpha through zulu, on a cyclical basis.

6.10 ATIS is received by the pilot tuning to the published VHF frequency for a particular ATIS broadcast, and listening to the recorded message until all pertinent information is understood. The pilot usually copies the information.

6.11 In many States, it is an operational requirement that pilots obtain ATIS information prior to contacting the associated ATS facility, and confirm having obtained the current ATIS by repeating the ATIS designator to the controller.

OPERATING METHOD IN A DATA LINK ENVIRONMENT

Service description

6.12 Content of voice and data link ATIS will be identical and updated simultaneously.

6.13 ATIS should support the Demand and Contract modes.

6.14 The pilot transmits an ATIS request message to the appropriate ground system. The request indicates the DFIS mode, Demand or Contract.

6.15 Upon receipt of a valid ATIS request message indicating Demand mode, the ground system:

a) sends the appropriate ATIS delivery message within the required response time,

or

b) detects that the requested ATIS information can be retrieved, but is not yet available or cannot be sent within the required response time, then

1) sends a processing message, and

2) when the information becomes available, sends an ATIS delivery message,

or

c) detects that the requested ATIS information cannot be retrieved and sends a Reject message.

6.16 Upon receipt of a valid ATIS request message indicating Contract mode, the ground system:

a) if the Contract mode is supported:

1) sends the appropriate ATIS delivery message within the required response time and continues to send updates when available until the contract is terminated,

or

2) detects that the requested ATIS information can be retrieved, but is not yet available or cannot be sent within the required response time, then:

— sends a processing message, and

— when the information becomes available, sends an ATIS delivery message and continues to send updates when available until the contract is terminated,

or

3) detects that the requested ATIS information cannot be retrieved and sends a reject message;

b) if the Contract mode is not supported:

1) sends the appropriate ATIS delivery message within the required response time indicating that Contract mode is not supported,

or

2) detects that the requested ATIS information can be retrieved, but is not yet available or cannot be sent within the required response time, then:

— sends a processing message, and

— when the information becomes available, sends an ATIS Delivery message indicating that Contract mode is not supported,

or

3) detects that the requested ATIS information cannot be retrieved and sends a reject message.

Initiation conditions

6.17 The ATIS service may be solicited by the pilot during any phase of operation.

Sequence of services

6.18 This service is capable of being solicited by the pilot independently of any other service.

Additional guidelines

6.19 The priority for ATIS messages will be "aeronautical information service messages" as determined by the ATN Internet Protocol Priority categorization.

6.20 If the aircraft does not specify Contract or Demand mode, the ground system will transmit a demand ATIS.

6.21 Contract ATIS updates will include entire contents of the new ATIS.

6.22 The ground system, operating in Contract mode, will be capable of detecting that it cannot continue to provide updates of the requested ATIS information and will inform the aircraft of this condition.

6.23 The ground system will be able to support multiple concurrent ATIS Contracts with the same aircraft or with several aircraft.

6.24 An aircraft with an ATIS contract should not be precluded from initiating an ATIS request for any aerodrome.

6.25 An aircraft may request ATIS information for more than one aerodrome.

6.26 Each ATIS request should be related to a single aerodrome.

6.27 If a pilot requests an arrival or departure ATIS and if the ground system only provides combined ATIS, combined ATIS will be sent with a combined indication.

6.28 If a pilot requests arrival and departure ATIS for an aerodrome, or if the pilot does not indicate which type of ATIS (arrival, departure or combined) is requested, then the ground system will:

a) if available, provide combined ATIS with a combined indication; or

b) if both arrival and departure ATIS are available, but combined ATIS is not available, provide an arrival and a departure ATIS; or

c) if only arrival ATIS is available, provide arrival ATIS and indicate departure ATIS is unavailable; or

d) if only departure ATIS is available, provide departure and indicate arrival ATIS is unavailable; or

e) send a reject message indicating ATIS is unavailable.

Exception handling

6.29 *No response*. If the pilot does not receive a valid message response within the specified time, the aircraft system will alert the pilot.

6.30 *No ATIS delivery after receiving a processing message.* If an ATIS processing message has been received by the aircraft, and an ATIS delivery is not received within a specified time, the aircraft system will alert the pilot.

6.31 *Discontinuation of ATIS update during a Contract mode.* In the event of unintended discontinuation of ATIS updates during Contract mode, the contract terminates and the pilot will be notified.

Termination conditions

6.32 ATIS data link service will be terminated by the aircraft system upon receipt of one of the following:

a) an ATIS delivery message if in Demand mode;

b) a reject message; or

c) an ATIS cancel contract message if in Contract mode.

ATIS MESSAGE SEQUENCE DIAGRAM

6.33 Figure V-6-1 illustrates an ATIS Demand mode message sequence with an ATIS request and response. Figure V-6-2 illustrates an ATIS Demand mode message sequence with a deferred ATIS response. Figure V-6-3 illustrates an ATIS Contract mode message sequence with an ATIS request and response.

ATIS MESSAGES

6.34 Table V-6-1 presents ATIS message requirements.

ATIS DATA GLOSSARY

6.35 The appendix to this chapter contains the ATIS data glossary.

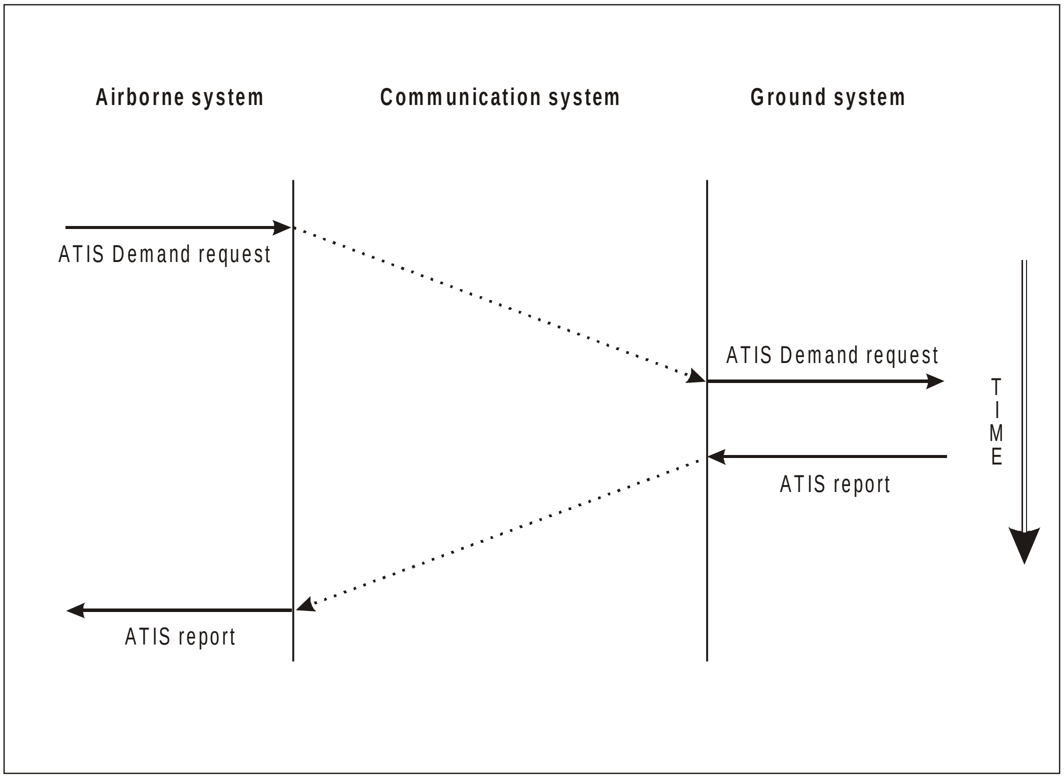


Figure V-6-1. ATIS Demand request and ATIS Report sequence diagram

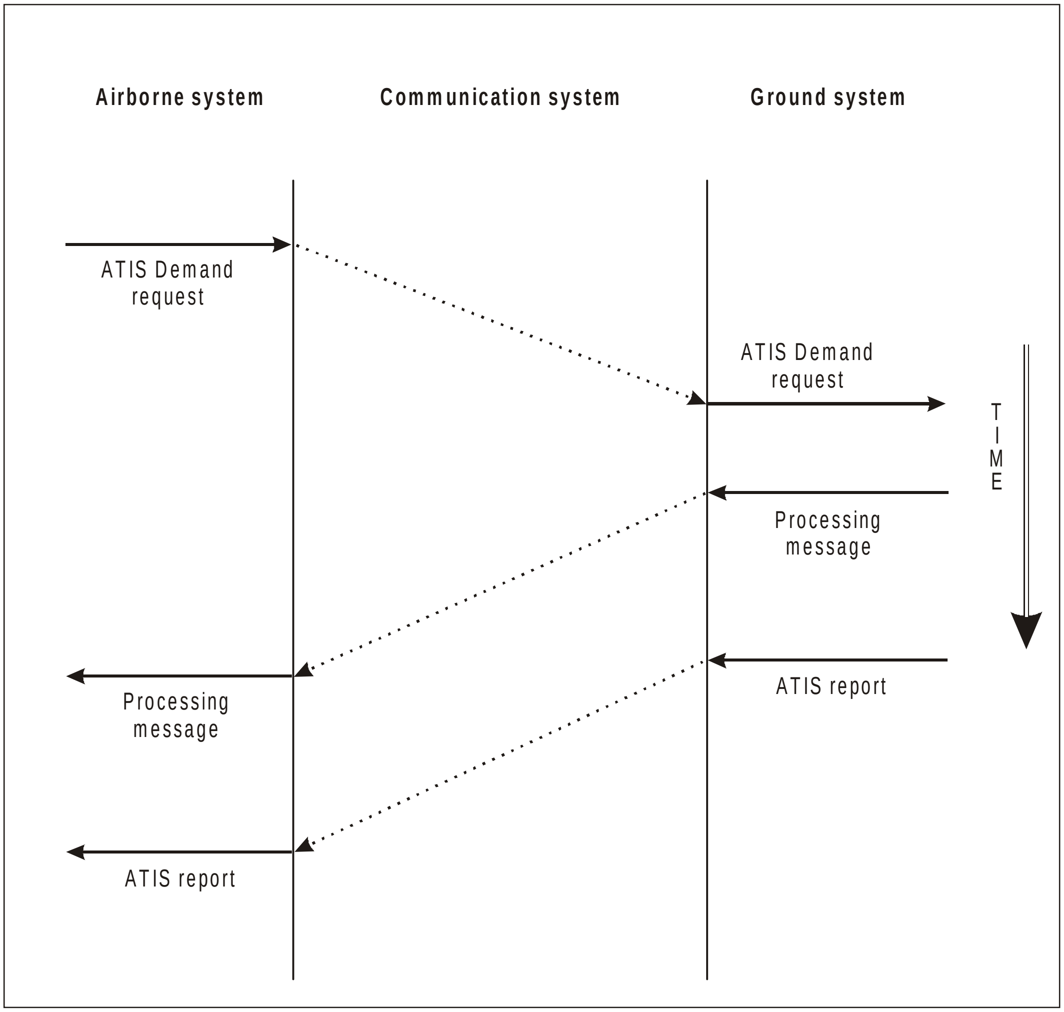


Figure V-6-2. ATIS Demand request and ATIS Deferred report sequence diagram

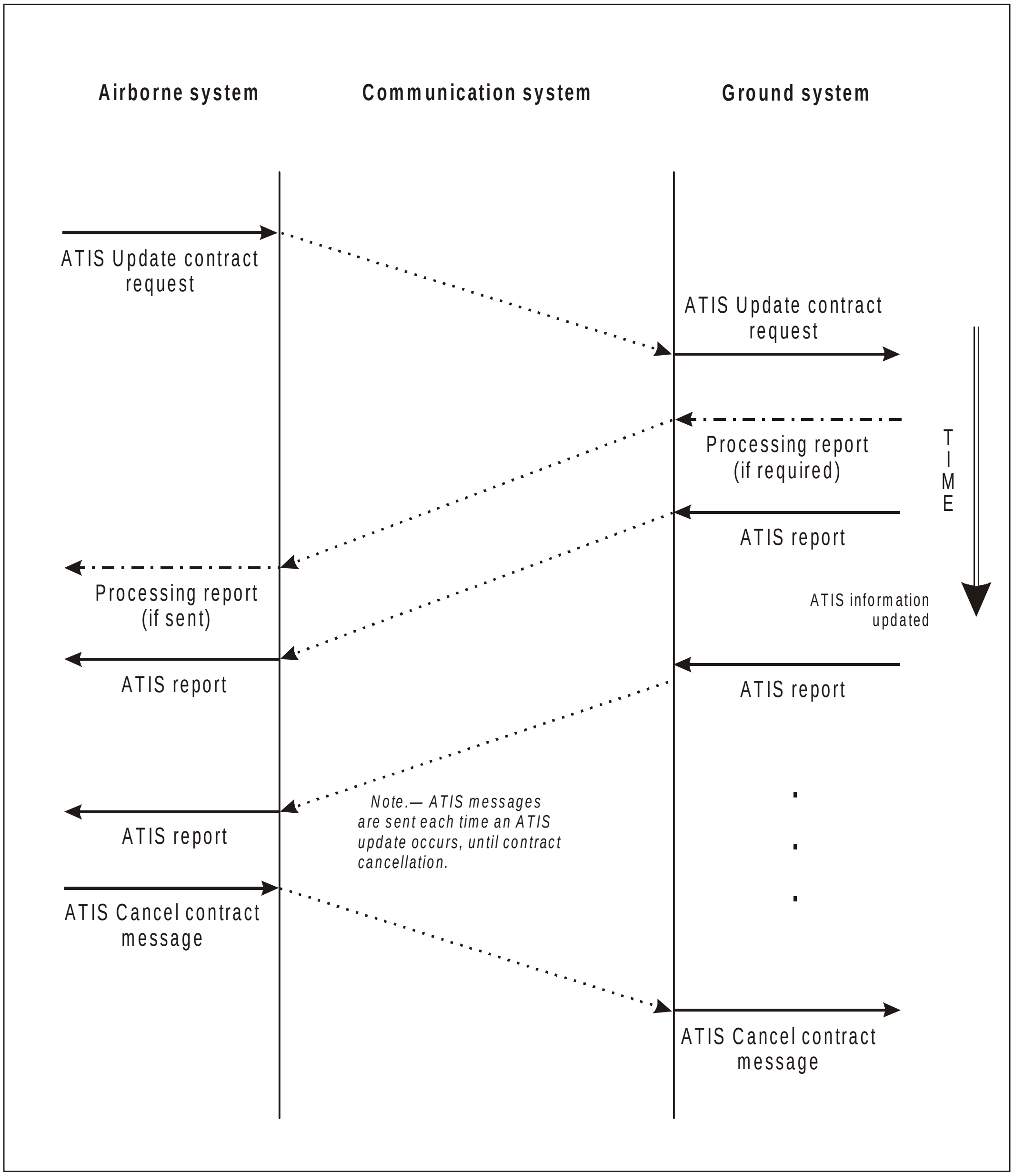


Figure V-6-3. ATIS Contract request and ATIS Report sequence diagram

Table V-6-1. ATIS message requirements

Message	*Information required*	*Type* *A*	*D*	*C*	*Event/ trigger*	*Source/ destination*	*Alert*	*Response required*
ATIS request	Message type Aerodrome identification Departure and/or arrival indicator Contract type	M M M O	M M M O	M M O O	Pilot input	Aircraft/ground system	None required	Yes
ATIS delivery	Aerodrome identification Departure and/or arrival indicator	M M	M M	M M	Receipt of a valid ATIS request	Ground system/ aircraft	Medium	No
	Contract type	M	M	M				
	ATIS designator	M	M	M				
	Time of observation	O	O	O				
	Type of approach	M		M				
	Arrival runways in use	M		M				
	Status of arresting system	O	O	O				
	Departure runway		M	M				
	Significant runway surface conditions	M	M	M				
	Braking action	O	O	O				
	Holding delay	O	O	O				
	Transition level	O	O	O				
	Other operational information	O	O	O				
	Surface wind direction and speed	M	M	M				
	Visibility	M	M	M				
	RVR	O	O	O				
	Present weather	O	O	O				
	Cloud	M	M	M				
	Air temperature	M	M	M				
	Dew-point temperature	M	M	M				
	Altimeter setting	M	M	M				
	Significant meteorological phenomena	O	O	O				
	Trend type landing forecast	O		O				
	Specific ATIS instructions	O	O	O				
ATIS termination	Aerodrome identification	M	M	M	Aircraft or ground system termination	Aircraft/ground system or ground system/aircraft	Pilot: medium; ground system: none required	No
	Contract termination	O	O	O				

Table key:

A: Arrival ATIS
D: Departure ATIS
C: Combined ATIS
M: Mandatory
O: Mandatory, if applicable

Appendix to Chapter 6

ATIS MESSAGE DATA GLOSSARY

Air temperature. Indicates the outside air temperature taken adjacent to the runway (in degrees Celsius).

Altimeter setting. Gives QNH of the aerodrome and the runway QFE when available (in hectopascal or inches of mercury).

Note.— This unit of measurement is not specified in Annex 5.

Arrival and/or Departure indicator. Indicates which type of ATIS information is provided (i.e. arrival, departure, or combined).

Arrival runways in use. Indicates landing runways expressed as left, centre or right when there are more than one.

Braking action. Indicates the braking action in case of contaminated runway conditions.

Cloud. Indicates the cloud below 1 500 m (5 000 ft) or below the highest minimum sector altitude, whichever is greater, or any cumulonimbus, expressed as few, scattered, broken or overcast; if the sky is obscured and vertical visibility when available.

Contract termination. Indicates that the ATIS contract is terminated.

Contract type. Distinguishes between the types of ATIS provided (demand or contract).

Departure runways in use. Indicates departure runways expressed as left, centre or right when there are more than one.

Dew point. Indicates the dew-point temperature.

Holding delay. Indicates an unplanned delay prior to the initiation of the next phase of flight.

Other operational information. Describes other pertinent operational information.

Present weather. Gives the present weather occurring at or near the aerodrome which may affect visibility.

RVR. Indicates the runway visual range (in metres or feet).

Note.— This unit of measurement is not specified in Annex 5.

Significant meteorological phenomena. Gives significant meteorological phenomena occurring in the approach, take-off and climb-out areas.

Significant runway surface conditions. Indicates significant runway surface conditions.

Specific ATIS instructions. Gives instruction to the pilot to acknowledge the receipt of the ATIS message upon initial contact.

Status of arresting system. Indicates when an arresting system constitutes a potential hazard.

Surface wind direction and speed. Indicates surface wind direction (in degrees) and speed (in km/hr or knots) from the aerodrome reference point.

Time of observation. Time at which the weather was observed expressed in hours, minutes.

Transition level. Indicates a change from the published transition level.

Trend-type landing forecast. Concise statement of the expected trend of the meteorological conditions at the aerodrome.

Type of approach. Indicates the type of approach to be expected.

Visibility. Indicates the ability, as determined by atmospheric conditions and expressed in units of distance (in km, m, statute miles or 1/16 statute mile) to see and identify prominent unlighted objects by day and prominent objects by night.

Note.— The unit of measurement "statute mile" is not specified in Annex 5.

Chapter 7

DFIS AVIATION ROUTINE WEATHER REPORT (METAR) SERVICE DESCRIPTION

SCOPE AND OBJECTIVE

7.1 Pilots are required to maintain awareness of the meteorological conditions at aerodromes of interest throughout the planned flight, including departure, en-route, destination and alternate locations. The METAR data link service provides automation assistance in requesting and delivering reports of meteorological conditions at aerodromes worldwide; specifically those reports encoded in the METAR format.

EXPECTED BENEFITS, ANTICIPATED CONSTRAINTS AND ASSOCIATED HUMAN FACTORS

7.2 Expected benefits:

a) reduced flight crew workload: METAR information will not need to be copied by the flight crew if the message is printed on a cockpit printer or is able to be recalled on a data link display. Also, the flight crew will not have to divert attention from ATS operations to request voice relay of METAR reports by air traffic controllers (or flight service specialists where available);

b) reduced air traffic controller workload: data link implementation will reduce need for controller response to pilot voice requests for status and updates of meteorological conditions at specific aerodromes;

c) reduced ambiguity in the transmitted information: data link implementation will eliminate potential misinterpretation resulting from poor voice transmission quality and transcription errors during hand-copy of voice transmissions;

d) potential increased accessibility to METAR information: flight crews will be able to request METAR information from any specified site available within the accessible data base; and

e) potential reduced congestion on voice channels: data link implementation will reduce voice requests and responses for relay of METAR reports.

7.3 Anticipated constraints: reduced dialogue flexibility in case of complex meteorological conditions.

7.4 Associated Human Factors:

a) error detection and correction mechanisms will be implemented to ensure message integrity. Technical and procedural mechanisms will be considered;

b) maximum use of data link will not impose undue competition for display or control resources. Systems will not preclude access to other functions or conflict with higher priority functions;

c) when operating the data link system, there will not be any increase in head-down time that would adversely affect the safe operation of the aircraft. Aircraft system implementation will adhere to recognized Human Factors practices and design criteria; and

d) voice communication will be available to supplement data link system operation.

OPERATING METHOD WITHOUT DATA LINK

7.5 Reports of meteorological conditions at aerodromes are officially recorded and communicated, as specified in the applicable ICAO/World Meteorological Organization (WMO) publications and supplemented by Contracting States' requirements as necessary. Special observations are also recorded and communicated when the meteorological conditions change sufficiently to affect aviation operations as defined by agreed specific meteorological threshold criteria.

7.6 These meteorological aerodrome reports are encoded in the METAR code format and are made available to all ATSUs, and to all other aviation weather users (public and private) via local and international telecommunications networks.

7.7 Individual METAR reports are identified by the specific ICAO aerodrome designator and the appropriate date and UTC time.

7.8 METAR reports are received by the pilot by requesting and receiving voice transmissions from air traffic controllers (or flight service specialists where available). At some aerodromes, continuous VHF voice broadcasts of automated weather observations are available. Also, most airline operators provide access to METAR reports through their flight dispatch support, either through voice communications and/or aircraft communications addressing and reporting system (ACARS) data link service.

7.9 In many States, it is an operational requirement that the pilot maintain awareness of meteorological conditions that may affect the planned flight, including METAR reports for aerodromes of interest.

OPERATING METHOD WITH DATA LINK

Service description

7.10 The METAR report contains the latest available weather report for the specified aerodrome.

7.11 The pilot transmits a METAR request message to the appropriate ground system.

7.12 If the METAR request is valid, and the METAR information is available, the ground system initiates a reply using the most current data available in the METAR data base and transmits a METAR message to the aircraft.

7.13 If the METAR request is valid, but the METAR information is not available, the ground system transmits a service not available response to the aircraft.

Initiation conditions

7.14 The METAR service may be solicited by the pilot during any phase of operation.

Sequence of services

7.15 This service is capable of being solicited by the pilot independently of any other service.

Additional guidelines

7.16 The priority for METAR messages will be "aeronautical information service messages" as determined by the ATN Internet Protocol Priority categorization.

7.17 An aircraft may request METAR information for more than one airport.

7.18 Each METAR request should be related to a single airport.

Exception handling

7.19 *No response*. If the pilot does not receive a valid message response within the required time, the aircraft system will alert the pilot.

7.20 *No METAR delivery after receiving a processing message.* If after receipt of a processing message, a METAR reply message response is not received within the required time, the aircraft system will alert the pilot.

Termination conditions

7.21 Use of the METAR data link service is closed by the aircraft system:

a) upon receipt of the METAR reply message; or

b) upon receipt of the service not available message.

TIME SEQUENCE DIAGRAM

7.22 Figure V-7-1 illustrates a METAR service message sequence with a METAR request and response.

INFORMATION EXCHANGES

7.23 Table V-7-1 contains the required METAR data.

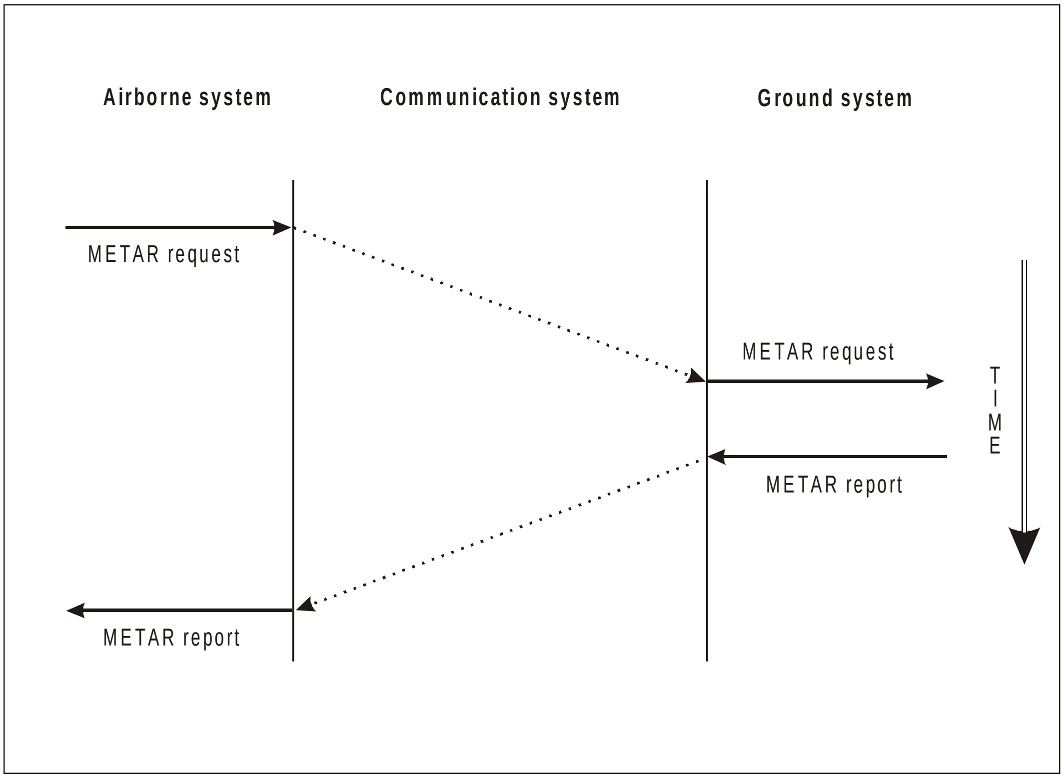


Figure V-7-1. METAR request and METAR report sequence diagram

Table V-7-1. METAR service information exchange

Message	*Information required*	*Event/trigger*	*Source/destination*	*Alert*	*Response required*
METAR request	**Mandatory**: Message type Airport identification	Pilot input	Aircraft/ground system	None required	Yes
METAR reply	**Mandatory**: Airport identification Date and time (UTC) METAR report type METAR-coded weather elements **Mandatory, if applicable**:* Free text remarks modifying or expanding on METAR-coded weather elements.	Receipt of a valid METAR Request	Ground system/ aircraft	Medium	No
METAR termination	Airport identification	Aircraft or ground system	Aircraft/ground system Ground system/aircraft	Pilot: medium; ground system: none required	No

* Shall not be disseminated internationally.

Note.— Specific content will vary depending on weather conditions and the METAR report type. For more detailed information on METAR contents, refer to ICAO Annex 3 — Meteorological Service for International Air Navigation and *WMO Publication No. 306,* Manual on Codes, *Volume I.*

PART VI

ATS INTERFACILITY DATA COMMUNICATION

Chapter 1

APPLICATION OVERVIEW

INTRODUCTION

1.1 The ATS interfacility data communication (AIDC) application exchanges ATC information between ATSUs in support of ATC functions, including notification of flights approaching a flight information region (FIR) boundary, coordination of boundary-crossing conditions, and transfer of control.

1.2 The AIDC application will use ATN.

1.3 The appendix to this chapter provides guidance to assist in the transition from character-based, interfacility data interchange to bit-oriented AIDC message exchanges.

1.4 The following abbreviations and definitions are used in this application:

C-ATSU: The ATS unit currently responsible for control (i.e. the controlling ATS unit);

D-ATSU: A downstream ATS unit is defined as an ATS unit responsible for control of an airspace region through or near which the aircraft will progress at some future time;

R-ATSU: The ATS unit that will assume control responsibility (i.e. the receiving ATS unit);

ATSU1: Used to denote an arbitrary ATS unit;

ATSU2: Used to denote an arbitrary ATS unit, other than ATSU1; and

A dialogue is a sequence of one or more related message exchanges.

OPERATIONAL CONCEPT

Phases of coordination

1.5 The AIDC message set is based upon the concept of *phases of coordination*. Each flight, from an individual ATSU's perspective, progresses sequentially through a series of phases. Each flight, as it proceeds from one FIR to another, transits through three phases of coordination. The phases encompassing AIDC are listed in sequential order as follows:

a) *notify phase*, in which the trajectory and any changes may be conveyed to one ATSU from the C-ATSU prior to coordination using a notification dialogue;

b) *coordinate phase*, in which the flight's trajectory is coordinated between two or more ATSUs when the flight approaches a common boundary using coordination dialogue; and

c) *transfer phase*, in which communications and executive control authority are transferred from one ATSU to another using a transfer dialogue.

1.6 Once a flight is airborne, the trajectory may be changed by the C-ATSU. The trajectory and any changes may be sent to affected D-ATSUs using a notification dialogue. A flight does not actually have to enter an FIR for notification to be relevant; it need only pass within the lateral separation minima associated with an FIR. Notification messages are transmitted in advance of actual coordination with a D-ATSU.

1.7 The coordination phase begins when the flight is a parameter time or distance from a common boundary between FIRs controlled by two or more ATSUs. A flight does not actually have to enter an FIR for coordination to be required: it need only pass within the lateral separation minima associated with an FIR. The cleared flight trajectory and boundary-crossing conditions (if the flight actually crosses the boundary) are negotiated between the ATSUs using an initial coordination dialogue until mutually agreed upon conditions are obtained. A re-coordination dialogue provides a mechanism for modifying an existing coordination, and may be invoked while the aircraft remains in the border areas of two or more FIRs.

1.8 Transfers of communications and control authority normally occur when the flight is about to enter a new FIR. However, these may occur at any point subsequent to initial coordination subject to approval of both ATSUs. Transfer dialogues are employed to perform these functions.

1.9 A unique subset of AIDC messages is associated with each phase of coordination.

1.10 Several messages are included within the AIDC message set to support simultaneous coordination between three or more ATSUs.

1.11 Other AIDC messages support ancillary ATC data exchanges between ATSUs, including:

— transfer of surveillance data, including ADS and radar reports; and

— exchange of free text messages.

AIDC APPLICATION FEATURES

1.12 The AIDC application will use the ATN to ensure that ATC data are exchanged in a reliable and timely manner between ATSUs.

1.13 The AIDC service itself also provides several features that support reliable and timely data exchange:

a) *Application response*: an ATSU receiving a message must acknowledge receipt of that message to the ATSU which transmitted it. This acknowledgement indicates whether the message was validated and accepted for further processing (the AppAccept message), or the message was rejected due to errors (the AppError message). Such an acknowledgement is referred to as an application response, and is performed by the ATSU receiving the message. Non-receipt of the application response within the required time will result in exception processing.

b) *Operational response*: many AIDC messages require an operational response. For example, a CoordinateInitial message, which describes the aircraft's current cleared flight trajectory and boundary-crossing information, requires either a CoordinateAccept, acceptance of the trajectory as proposed, or a CoordinateNegotiate, negotiation of the coordination conditions, response. Such a response is referred to as an operational response, and may be generated by the ATC automation system or via human interaction. Non-receipt of an operational response within the required time will result in exception processing. The operational response and the application response can be combined as one message.

c) *Application status monitoring*: a warning is issued to an ATSU if the ATN detects that an existing AIDC link with another ATSU has failed.

REGIONAL ADAPTATION

1.14 Regional adaptation of the AIDC application may be accomplished by mutual agreement.

Appendix to Chapter 1

TRANSITION

1. This material is provided as guidance to assist in the transition from character-based, interfacility data interchange to bit-oriented AIDC message exchange.

2. The relationship between the AIDC message set and existing messages currently in use within different ATS regions is expressed in Table VI-1-A1.

Table VI-1-A1. Relationship between AIDC messages and existing ATS messages

AIDC message	*Related existing ATS messages*
Notify	ABI (Europe, NAT & A/P)
CoordinateInitial	CPL (ICAO, NAT & A/P) EST (ICAO & A/P) PAC, ACT & RAP (Europe)
CoordinateNegotiate	CDN (ICAO, NAT, Europe & A/P)
CoordinateAccept	ACP (ICAO, NAT, Europe & A/P) LAM (Europe)
CoordinateReject	REJ (NAT & A/P) RJC (Europe)
CoordinateCancel	MAC (Europe, NAT & A/P)
CoordinateReady	RDY (NAT)
CoordinateCommit	CMT (NAT)
CoordinateRollback	ROL (NAT)
CoordinateUpdate	CUR (NAT) unsolicited CDN, REV & RRV (Europe)
CoordinateStandby	SBY (Europe & NAT)
TransferInitiate	TIM (Europe)
TransferConditionsProposal	HOP (Europe)
TransferConditionsAccept	ROF (Europe)
TransferRequest	ROF (Europe)
TransferControl	TOC (NAT & A/P)
TransferControlAssume	AOC (NAT & A/P)
TransferComm	COF (Europe)
TransferCommAssume	MAS (Europe)
GeneralPoint	point INF (Europe)
GeneralExecData	SDM (Europe)
FreetextEmergency	EMG (NAT & A/P)
FreetextGeneral	MIS (NAT & A/P)
AppStatus	ASM (NAT)
AppAccept	LAM (ICAO, NAT, Europe & A/P)
AppError	LRM (NAT & A/P)

Chapter 2

GENERAL REQUIREMENTS

MESSAGE HANDLING

2.1 *Message transmission.* The AIDC application requires:

a) that messages are generated and sent in the time-ordered sequence; and

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

2.2 *Message urgency attributes.* When an ATSU queues received AIDC messages, messages with the highest urgency type will be placed at the beginning of the queue.

2.3 *Message urgency.* AIDC messages will be assigned one of the following urgency attributes:

a) normal;

b) urgent; or

c) distress.

Free text messages have an urgency attribute of either normal or distress. Surveillance data transfer messages have an urgency attribute of urgent. All other AIDC messages have an urgency attribute of normal.

2.4 *AIDC message priority.* The priority for all AIDC messages will be “normal priority flight safety messages” as determined by the ATN Internet Protocol Priority categorization.

2.5 *Time requirements.* Wherever time is used in the AIDC application, it will be accurate to within 1 second of UTC. Timestamping will be mandatory for all messages. The timestamp will consist of the date (YYMMDD) and time (HHMMSS). The timestamp will be the time the message is dispatched by the originating user.

2.6 *Message identification.* Every AIDC message will contain a unique ID. An AIDC message may also contain a reference to a previously sent AIDC message. This reference shall contain the ID of the referenced message, along with an identification of the source of the referenced message (i.e. a unique identifier for the ATSU which transmitted the referenced message).

Chapter 3

AIDC FUNCTIONAL CAPABILITIES

DIALOGUES

3.1 A dialogue is a sequence of one or more related message exchange sequences. All exchanges of AIDC messages between ATSUs may be viewed as dialogues. AIDC dialogues support the following functions:

— notification;
— coordination;
— transfer;
— general information interchange; and
— surveillance data transfer.

3.2 Most dialogues consist of one message exchange sequence. However, coordination and transfer dialogues involve multiple messages exchange sequences. The structure and sequence of AIDC dialogues is discussed further in Chapter 5 of this part.

OPERATING METHOD

3.3 A dialogue is typically initiated when one of several events, such as the following, occurs:

— proximity to an airspace boundary;
— controller action;
— a change in a flight's cleared trajectory affecting a D-ATSU; or
— surveillance data update.

3.4 Confirmation that an ATSU has received a message is accomplished by that ATSU transmitting an AppAccept or AppError response to any received message, other than an AppAccept or AppError.

Chapter 4

MESSAGE DESCRIPTIONS

INTRODUCTION

4.1 Tables VI-4-1 to VI-4-6 describe in general terms the contents of each AIDC message.

Table VI-4-1. AIDC notification message contents

Message	*Purpose*	*Message contents*
Notify	Updates the information a D-ATSU maintains on a flight that is expected to enter its area of interest at some future time.	Aircraft identification Selcal . . . . Optional Registration . . . . Optional Aircraft address . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . Optional Flight rules . . . . Optional Code (SSR) . . . . Optional Type of flight. . . . . Optional Number of aircraft. . . . . Optional Aircraft type Wake turbulence category . . . . Optional CNS equipment, including data link equipage. . . . . Optional Boundary estimate data (boundary fix, crossing time, crossing level, ATW level (optional)) Route . . . . Optional Other information . . . . Optional

Table VI-4-2. AIDC coordination message contents

Message	*Purpose*	*Message contents*
CoordinateInitial	Begins an initial coordination dialogue between ATSUs.	Aircraft identification Selcal . . . . Optional Registration . . . . Optional Aircraft address . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . Optional Flight rules . . . . Optional Code (SSR) . . . . Optional Type of flight. . . . . Optional Number of aircraft. . . . . Optional Aircraft type Wake turbulence category . . . . Optional CNS equipment, including data link equipage. . . . . Optional Boundary estimate data (boundary fix, crossing time, crossing level, ATW level (optional)) and/or Route . . . . Optional Other information . . . . Optional
CoordinateNegotiate	Used to negotiate the coordination conditions.	Aircraft identification Selcal . . . . Optional Registration . . . . Optional Aircraft address . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . Optional Boundary estimate data (boundary fix, crossing time, crossing level, ATW level (optional)) and/or Route . . . . Optional
CoordinateAccept	Signifies acceptance of the proposed coordination conditions.	Aircraft identification Selcal . . . . Optional Registration . . . . Optional Aircraft address . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . Optional Frequency . . . . Optional
CoordinateCancel	Notifies a D-ATSU that a flight previously expected to enter its area of interest will no longer do so.	Aircraft identification Selcal . . . . Optional Registration . . . . Optional Aircraft address . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . Optional Boundary fix . . . . Optional Other information . . . . Optional

Message	*Purpose*	*Message contents*
CoordinateReject	Immediately terminates a coordination dialogue. Any previous coordination conditions shall remain as agreed.	Aircraft identification Selcal . . . . . Optional Registration . . . . . Optional Aircraft address . . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . . Optional
CoordinateReady	Signals that an ATSU is ready to update its flight database with the agreed upon coordination conditions.	Aircraft identification Selcal . . . . . Optional Registration . . . . . Optional Aircraft address . . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . . Optional
CoordinateCommit	Causes an ATSU to update its flight database with the agreed upon coordination conditions.	Aircraft identification Selcal . . . . . Optional Registration . . . . . Optional Aircraft address . . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . . Optional
CoordinateUpdate	Used to initiate the re-negotiation of coordination conditions, after the initial coordination dialogue has been completed.	Aircraft identification Selcal . . . . . Optional Registration . . . . . Optional Aircraft address . . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . . Optional Code (SSR) . . . . . Optional Boundary estimate data (boundary fix, crossing time, or crossing level, ATW level (optional)) and/or Route . . . . . Optional
CoordinateRollback	Causes an ATSU to revert to the previously agreed upon coordination conditions for a flight.	Aircraft identification Selcal . . . . . Optional Registration . . . . . Optional Aircraft address . . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . . Optional
CoordinateStandby	Extends the coordination time-out values. This is typically needed when a controller or another ATSU must be consulted before responding to a coordination message.	Aircraft identification Selcal . . . . . Optional Registration . . . . . Optional Aircraft address . . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . . Optional

4.2 CoordinateReady, CoordinateCommit; and CoordinateRollback messages are to be used exclusively with the multi-coordination procedure. Note that other coordination messages are also employed by this procedure.

Table VI-4-3. AIDC transfer of control message contents

Message	*Purpose*	*Message contents*
TransferInitiate	Initiates a transfer of control information and track data.	Aircraft identification Selcal . . . . . Optional Registration . . . . . Optional Aircraft address . . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . . Optional Executive data, including clearance restrictions . . . . . Optional Track data (position, time, level) . . . . . Optional
TransferConditions Proposal	Offers control conditions and communications responsibility to an adjacent ATSU.	Aircraft identification Selcal . . . . . Optional Registration . . . . . Optional Aircraft address . . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . . Optional Executive data, including clearance restrictions . . . . . Optional
TransferConditions Accept	Indicates willingness to accept proposed control conditions.	Aircraft identification Selcal . . . . . Optional Registration . . . . . Optional Aircraft address . . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . . Optional Frequency . . . . . Optional
TransferRequest	Requests transfer of control and communication responsibility.	Aircraft identification Selcal . . . . . Optional Registration . . . . . Optional Aircraft address . . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . . Optional Frequency . . . . . Optional
TransferControl	Indicates that the C-ATSU wishes to relinquish control responsibility.	Aircraft identification Selcal . . . . . Optional Registration . . . . . Optional Aircraft address . . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . . Optional Executive data . . . . . Optional

Message	*Purpose*	*Message contents*
TransferControl Assume	Indicates acceptance of control authority for a flight.	Aircraft identification Selcal . . . . Optional Registration . . . . Optional Aircraft address . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . Optional
TransferControl Reject	Indicates refusal to accept control authority for a flight.	Aircraft identification Selcal . . . . Optional Registration . . . . Optional Aircraft address . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . Optional
TransferComm	Indicates that C-ATSU is relinquishing communications with a flight.	Aircraft identification Selcal . . . . Optional Registration . . . . Optional Aircraft address . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . Optional Executive data . . . . Optional Release indicator . . . . Optional
TransferComm Assume	Indicates that communications with a flight have been established.	Aircraft identification Selcal . . . . Optional Registration . . . . Optional Aircraft address . . . . Optional Departure aerodrome Departure time Destination aerodrome . . . . Optional

Table VI-4-4. AIDC surveillance message contents

Message	*Purpose*	*Message contents*
SurvGeneral	Transfers surveillance data to an adjacent ATS unit.	Aircraft identification Selcal . . . . Optional Registration . . . . Optional Aircraft address . . . . Optional Departure aerodrome. . . . . Optional Departure time. . . . . Optional Destination aerodrome . . . . Optional Track data (position, time, level and, if known, ground speed and true track angle)

Table VI-4-5. AIDC general information message contents

Message	*Purpose*	*Message contents*
GeneralPoint	Indicates a flight to an adjacent ATS unit.	Functional address . . . . Optional Aircraft identification Selcal . . . . Optional Registration . . . . Optional Aircraft address . . . . Optional Departure aerodrome . . . . Optional Departure time . . . . Optional Destination aerodrome . . . . Optional Flight rules . . . . Optional Code (SSR) . . . . Optional Type of flight . . . . Optional Number of aircraft . . . . Optional Aircraft type Wake turbulence category . . . . Optional CNS equipment, including data link equipage Boundary fix, ATW level (optional) and/or Route . . . . Optional Other information . . . . Optional
GeneralExecData	Transfers control information to an adjacent ATSU.	Aircraft identification Executive data, including clearance restrictions Frequency
FreetextEmergency	Supports free text information exchange in an emergency condition.	Aircraft identification or Functional address Free text
FreetextGeneral	Supports free text information exchange in a non-emergency condition.	Aircraft identification or Functional address Free text

Table VI-4-6. AIDC application management message contents

Message	*Purpose*	*Message contents*
AppAccept	Acknowledges acceptance of a received message.	Nil
AppError	Signals that a received message contained an error.	Message type Component type Error code Error data

Appendix A to Chapter 4

AIDC MESSAGE DATA GLOSSARY

1. AIDC DATA GLOSSARY

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

Aircraft identification. A group of letters, figures or a combination thereof which is identical to or the code equivalent of the aircraft call-sign. It is used in field 7 of the ICAO model flight plan.

Aircraft type. An IA5 string consisting of 2-4 characters used to identify the aircraft type as defined in *Aircraft Type Designators* (ICAO Doc 8643). The aircraft type can be optionally preceded by the number of aircraft if more than one.

ATS route designator. Specifies the particular route or route segment to be used by the aircraft (IA5 string of 2-6 characters).

ATW level. Contains *ATW level tolerance* and *level*.

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:

a) at;

b) at or above; or

c) at or below.

Boundary estimate data. Specifies information related to the boundary crossing. Boundary fix consists of the following sequence of information:

a) *Boundary fix;*

b) *Crossing time;* and

c) *Crossing level.*

Boundary fix. Specifies the fix at the boundary between the two ATSUs as a *Position*.

CNS equipment. Component variable used to indicate the type of communication, navigation and approach aid equipment on an aircraft as defined in ICAO Doc 4444, *Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services* (PANS-RAC). Aircraft equipment code consists of the following sequence of information:

a) an indication of whether or not *COM NAV approach equipment* is available;

b) optionally, a sequence containing 1-24 *COM NAV equipment status*; and

c) *SSR equipment available*.

Code (SSR). Specifies the Mode A value for the aircraft.

COM NAV approach equipment available. Indicates the presence or absence of communication, navigation and approach aid equipment.

COM NAV equipment status. Indicates which communication, navigation and approach aid equipment is available for use as defined in ICAO Doc 4444, *Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services* (PANS-RAC).

Crossing level. Specifies the boundary crossing level in *Level*.

Crossing time. Specifies the Boundary crossing time in *Time*.

Degree minutes. Provides minutes of a latitude or longitude degree.

Degree seconds. Provides seconds of a latitude or longitude minute.

Departure aerodrome. Four characters that specify the ICAO four-letter location indicator for the departure aerodrome.

Departure time. Specifies the time of departure in *Time*.

Destination aerodrome. Four characters that specify the ICAO four-letter location indicator for the destination aerodrome.

Direct routing. A sequence of *Next waypoint* and *Following waypoint*.

Distance. Provides the distance in SI or non-SI units.

Error code. Specifies the type of error found in a received message.

Error data. Specifies the erroneous data found in a received message.

Executive data. Specifies the intended clearance to be passed to the next controller who will be in charge of the aircraft. Consists of one or more of the following:

a) *Speed*;

b) *Level*;

c) *Heading*;

d) *Vertical rate*;

e) *Direct routing*; or

f) *Current cleared level*.

Fix name. Specifies the ICAO identifier for a given fix.

Flight level. As defined in PANS-RAC (Doc 4444).

Flight rules. Specifies the flight rules. Can be one of the following:

a) IFR;

b) VFR;

c) IFR first; or

d) VFR first.

Following waypoint. Indicates the waypoint after the *Next waypoint* as a *Position*.

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:

a) Frequency HF;

b) Frequency VHF;

c) Frequency UHF; or

d) Frequency Sat channel.

Frequency Sat channel. Specifies the appropriate address for use with a satellite voice system.

Functional address. Specifies an identifier used to direct the message to a locally defined position used instead of associating the message with a flight.

Heading. Provides aircraft heading in degrees.

Hours. Specifies the hour in 24-hour notation.

Latitude. Provides latitude as:

a) *Latitude degrees*;

b) *Latitude degrees* and *Degree minutes*; or

c) *Latitude degrees*, *Degree minutes* and *Degree seconds.*

Latitude degrees. Degrees of latitude.

Latitude longitude. Sequence of *Latitude* and *Longitude*.

Level. Specifies the level in one of the following ways:

a) *Altitude* in metres or feet;

b) *Flight level* in metres or feet.

Level current. Specifies the current aircraft level.

Longitude. Provides longitude as:

a) *Longitude degrees*;

b) *Longitude degrees* and *Degree minutes*; or

c) *Longitude degrees*, *Degree minutes* and *Degree seconds.*

Longitude degrees. Degrees of longitude.

Next waypoint. Specifies the next waypoint as a *Position*.

Number of aircraft. Number of aircraft concerned by the message (as in the ICAO flight plan).

Other information. Used to provide additional information in *Free text*.

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*.

Position. Information used to specify a location. Position can be specified as:

a) *Fix name*;

b) Navaid;

c) Aerodrome;

d) *Latitude longitude*; or

e) *Place bearing distance*.

Published identifier. Used to provide the location of the specified fix. Provided using *Fix name* and *Latitude longitude*.

Registration. Provides the aircraft registration.

Route. Specifies route of flight using *Route information*.

Route information. Indicates 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:

a) *Published identifier* (optional);

b) *Latitude longitude* (optional);

c) *Place bearing place bearing* (optional);

d) *Place bearing distance* (optional); and

e) *ATS route designator* (optional).

Selcal. Provides the Selcal of the aircraft.

Speed. Provides the aircraft speed as one of the following:

a) *Speed indicated*;

b) *Speed true*;

c) *Speed ground*; or

d) *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.

SSR equipment available. Indicates which surveillance equipment is available for use as defined in ICAO Doc 4444, *Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services* (PANS-RAC).

Time. Sequence of *Hours* and *Time minutes*.

Time minutes. Specifies time in minutes of an hour.

Track data. Specifies the current position of the aircraft. Contains the following:

a) *Position*;

b) *Time*;

c) *Level* (optional);

d) *Speed ground* (optional); or

e) *True track angle* (optional).

Track name. Specifies the name of an identified group of points which make up a section of a route.

True track angle. Specifies true track angle to the next waypoint using degrees.

Type of flight. Specifies the type of flight. Can be one of the following:

a) scheduled air transport;

b) non-scheduled air transport;

c) general aviation;

d) military; and

e) other flights.

Vertical rate. Rate of climb/descent (climb positive, descent negative) in SI or non-SI units.

Wake turbulence category. One character used to specify the wake turbulence category.

Appendix B to Chapter 4

AIDC VARIABLES RANGE AND RESOLUTION

1. AIDC VARIABLES RANGE AND RESOLUTION

1.1 Table VI-4-B1 provides the required range and resolution for the message variables used in the AIDC application.

Table VI-4-B1. AIDC variables range and resolution

Variables	*Parameters*	*Unit*	*Range/size*	*Resolution*
Aircraft identification		IA5 character string	2 to 7 characters	N/A
Aircraft type		IA5 character string	2 to 4 characters	N/A
Aircraft address		Bit string	24 bits	N/A
ATS route designator		IA5 character string	2 to 6 characters	N/A
Code (SSR)		Integer	4 octal digits	N/A
Degrees	Degrees magnetic Degrees true	Degrees Degrees	1 to 360 1 to 360	1 1
Distance	Distance SI Distance non-SI	Kilometres Nautical miles	1 to 2 000 1 to 1 000	1 1
Fix name		IA5 character string	1 to 5 characters	N/A
Free text		IA5 character string	1 to 200 characters	N/A
Functional address		IA5 character string	1 to 18 characters	1
Latitude	Latitude degrees Degree minutes Degree seconds	Degrees Minutes Seconds	0 to 90 0 to 59.99 0 to 59	0.001 0.01 1
Level	Flight level SI Flight level non-SI Level SI Level non-SI	1 level (10 m) 1 level (100 ft) Metres Feet	100 to 2 500 30 to 700 –30 to +25 000 –600 to +70 000	1 1 1 10
Longitude	Longitude degrees Degree minutes Longitude seconds	Degrees Minutes Seconds	0 to 180 0 to 59.99 0 to 59	0.001 0.01 1
Registration		IA5 character string	2 to 7 characters	N/A
Selcal		IA5 character string	4 characters	N/A
Speed	Ground speed SI Ground speed non-SI Mach Indicated SI Indicated non-SI Speed true SI Speed true non-SI	Kilometres/hour Knots Mach number Kilometres/hour Knots Kilometres/hour Knots	–100 to +4 000 –50 to +2 000 0.5 to 4.0 0 to 800 0 to 400 0 to 4 000 0 to 2 000	1 1 0.001 1 1 1 1
Time	Time hours Time minutes	Hours of day Minutes of hour	0 to 23 0 to 59	1 1

Variables	*Parameters*	*Unit*	*Range/size*	*Resolution*
Track name		IA5 character string	1 to 6 characters	N/A
Vertical rate	Vertical rate SI Vertical rate non-SI	Metres/second Feet/minute	±1 000 ±30 000	1 10

Chapter 5

OPERATIONAL MESSAGE SEQUENCES

AIDC STATE TRANSITIONS

5.1 There are three principal states associated with a flight corresponding to the phases of flight. A fourth state, Pre-notify, represents the initial Coordinate state. Note that a flight does not, from the AIDC service perspective, have to enter in the Notify state; it may go directly to the Coordinate state without any Notification messages being sent. This situation typically arises where the flight becomes active very close to an FIR boundary and will enter the neighbouring FIR before normal notification takes place. Figure VI-5-1 shows the interrelationship between the AIDC operational states and the messages associated with each state change. The states shown as dotted circles are expanded in subsequent figures along with the messages associated with them.

Coordinate state

5.2 Figure VI-5-2 shows the expanded Coordinate state. The dotted line labelled "Transfer messages" is further expanded in the subsequent figures related to the Transfer state.

Transfer state

Full surveillance (radar and/or ADS) coverage at an FIR boundary

5.3 When there is full surveillance coverage (radar and/or ADS) at an FIR boundary, regional agreements will choose between which method of transfer, described in the following sections, is to be used to effect the transfer of a flight.

5.4 Figure VI-5-3 shows the initialization of the transfer phase and the transfer of full control authority and communications authority for a flight when it is offered by the C-ATSU and accepted by the R-ATSU. The transfer of the flight is initiated with the C-ATSU sending a TransferInitiate message. If required, the TransferConditionsProposal message may be sent by the C-ATSU to the R-ATSU to propose the transfer conditions for a flight. The R-ATSU may respond with a TransferConditionsAccept message, indicating the acceptance of the proposed transfer conditions. The transfer of full control authority and communications authority for the flight is initiated with the C-ATSU sending the TransferComm message. The R-ATSU accepts communications authority and control authority for the flight within the terms of the letter of agreement (LOA) by sending a TransferCommAssume message.

5.5 Figure VI-5-4 shows the initialization of the transfer phase and the transfer of full control authority and communications authority for a flight when it is taken by the R-ATSU. The transfer of the flight is initiated with the C-ATSU sending a TransferInitiate message. If required, the TransferConditionsProposal message may be sent by the C-ATSU to the R-ATSU to propose the transfer conditions for a flight. The R-ATSU may respond with a TransferConditionsAccept message, indicating the acceptance of the proposed transfer conditions. The transfer of full control authority and communications authority for the flight is taken by the R-ATSU by sending a TransferCommAssume message.

5.6 Figure VI-5-5 is a pictorial representation of the transfer boundary condition for the transfer state, when full surveillance (radar and/or ADS) coverage exists. Under this condition, the transfer of full control and communications authority for a flight is complete when it is offered by the C-ATSU, and accepted by the R-ATSU using the TransferComm and TransferCommAssume messages, or when it is taken by the R-ATSU through the use of the TransferCommAssume message only.

Partial or no surveillance coverage at an FIR boundary

5.7 Where an FIR boundary has only partial or no surveillance (radar or ADS), i.e. there is procedural control, a region is defined, by memorandum of understanding (MOU) or LOA, in which any changes to a flight's profile must be coordinated between the C-ATSU and the R-ATSU (see Figure VI-5-6).

5.8 Figure VI-5-7 shows the implicit initialization of the transfer phase, and the transfer of control authority when it is offered by the C-ATSU and accepted by the R-ATSU. The initialization of the transfer phase and the offering transfer of control authority is effected by the C-ATSU sending a TransferControl message to the R-ATSU. The R-ATSU responds with a TransferControlAssume message to accept control authority for the flight. If the R-ATSU cannot accept the flight, a TransferControlReject message is sent. After the flight has been transferred, no changes to its agreed profile may be made by the R-ATSU unless the changes are backward coordinated with the C-ATSU. This is done by the sending of the CoordinateUpdate, CoordinateNegotiate, and CoordinateAccept message. Full control authority, where the new C-ATSU (previously the R-ATSU) no longer needs to coordinate any changes to the flight's profile with what was the C-ATSU, only occurs after the flight leaves the region.

5.9 Note that the transfer of communications authority for a flight under the above circumstances may occur independently of the transfer of control authority.

DIALOGUE SEQUENCES

5.10 The exchange of AIDC messages for each flight is centred around the concept of dialogues, as mentioned in 3.1.1. There is a sequencing order imposed upon dialogues themselves, and upon the messages contained within a dialogue, as described in Table VI-5-1.

5.11 Several dialogues identified above consist of multiple AIDC message exchanges (excluding AppAccept and AppError). Tables VI-5-2 to VI-5-6 identify the message sequences within these dialogues. The remaining dialogues consist of a single message exchange sequence only.

5.12 Every message has an AIDC dialogue associated with it. For example, the CoordinateInitial message has a corresponding Initial Coordination dialogue. In addition, there is a CancelNotification dialogue which is equivalent to the CancelCoordination (which employs the CoordinateCancel message) dialogue.

MESSAGE EVENT TRIGGERS AND VALID RESPONSES

5.13 Tables VI-5-7 to VI-5-12 provide additional information on when a message is transmitted, the message-source ATSU and message-destination ATSU, and the valid response to a received message.

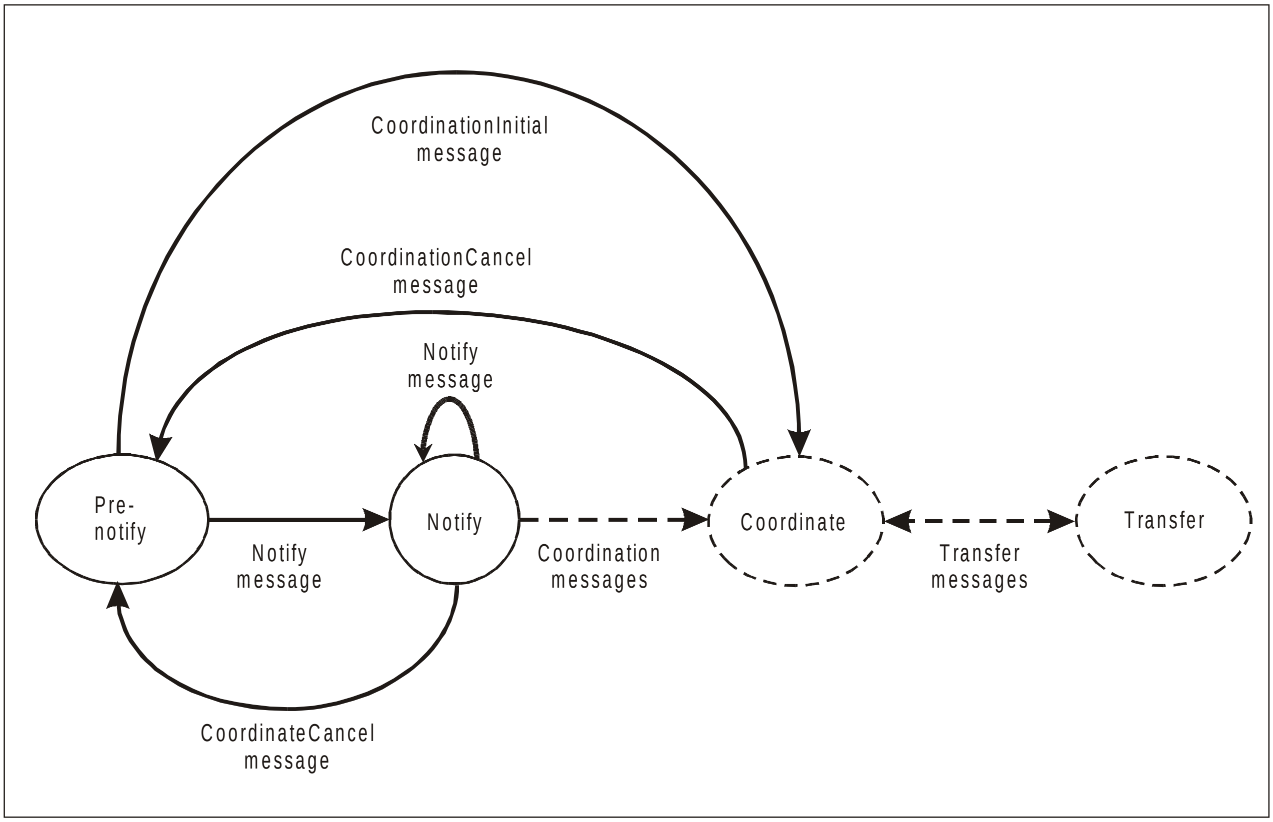


Figure VI-5-1. AIDC operational state transition diagram

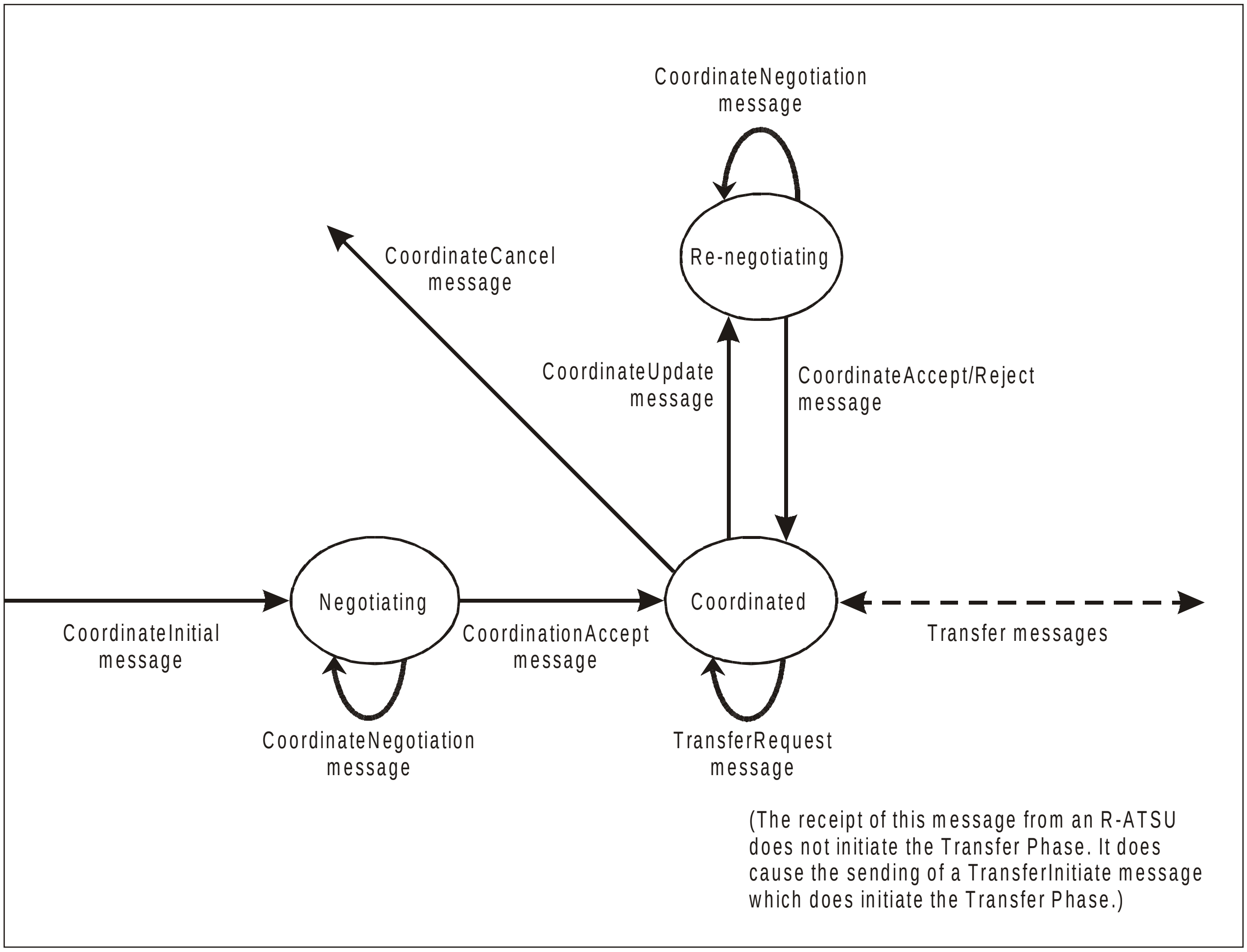


Figure VI-5-2. Coordinate state

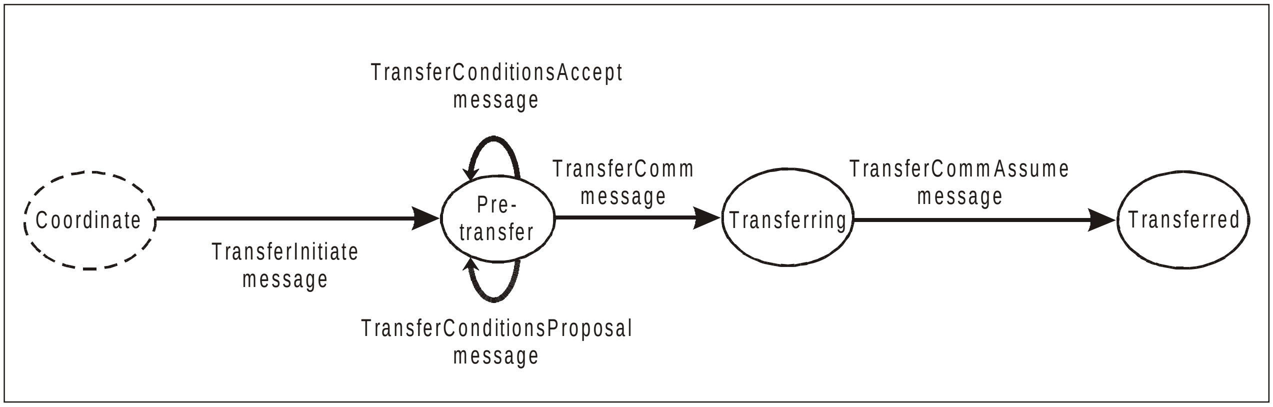


Figure VI-5-3. Transfer state — transfer of full control and communication authority for a flight using the TransferComm and TransferCommAssume messages

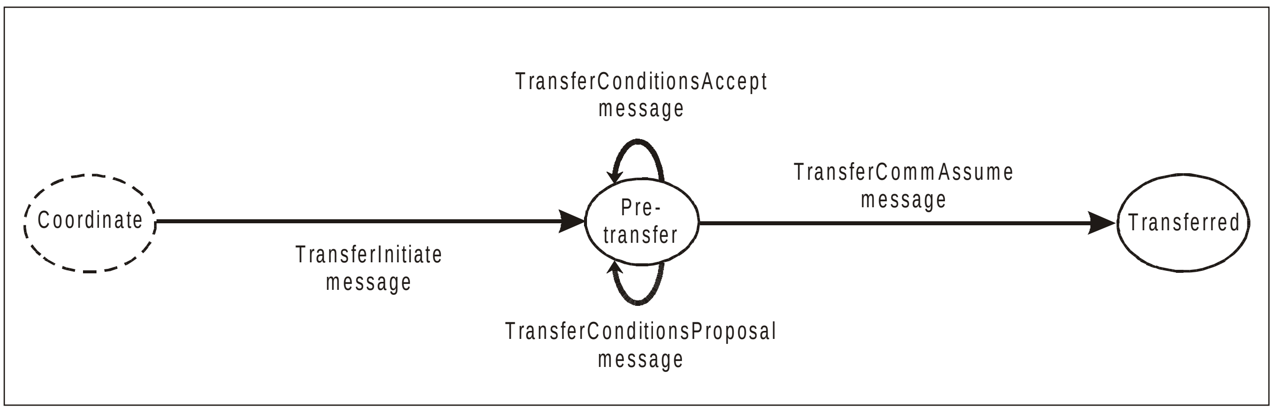


Figure VI-5-4. Transfer state — transfer of full control and communication authority for a flight using the TransferCommAssume message

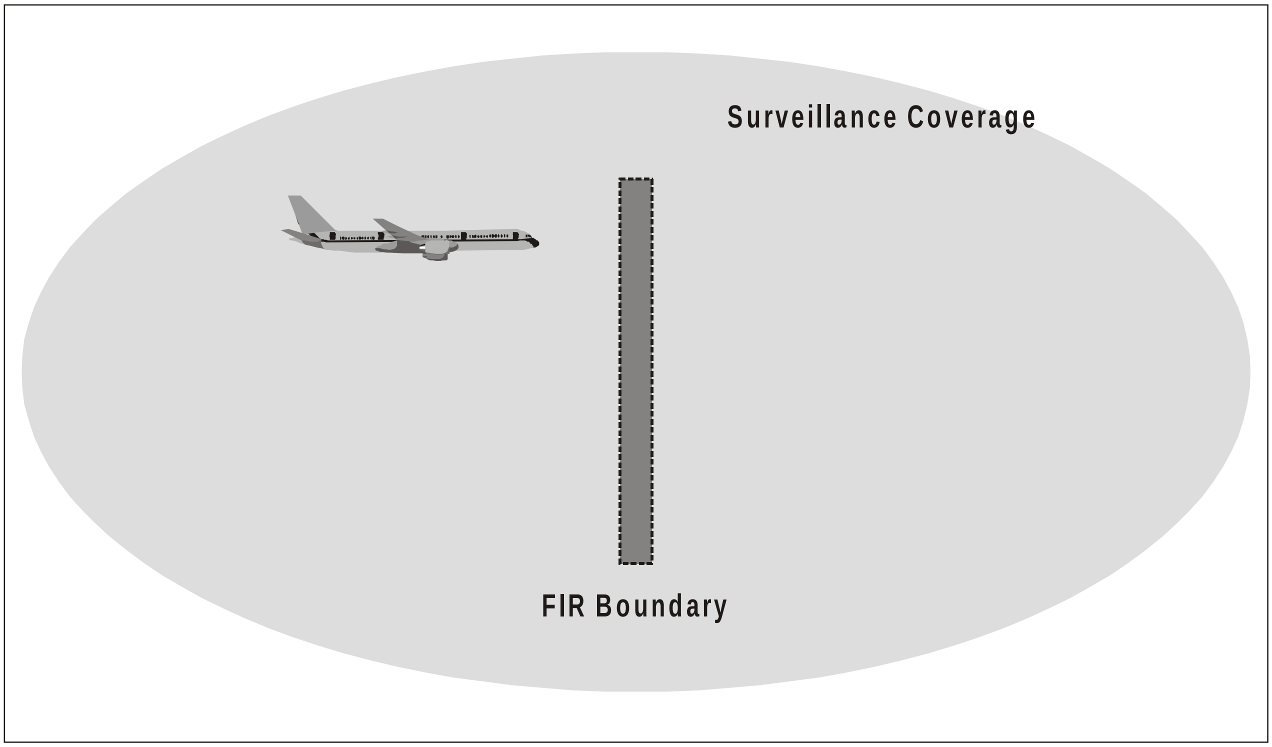


Figure VI-5-5. Transfer boundary conditions with full surveillance coverage

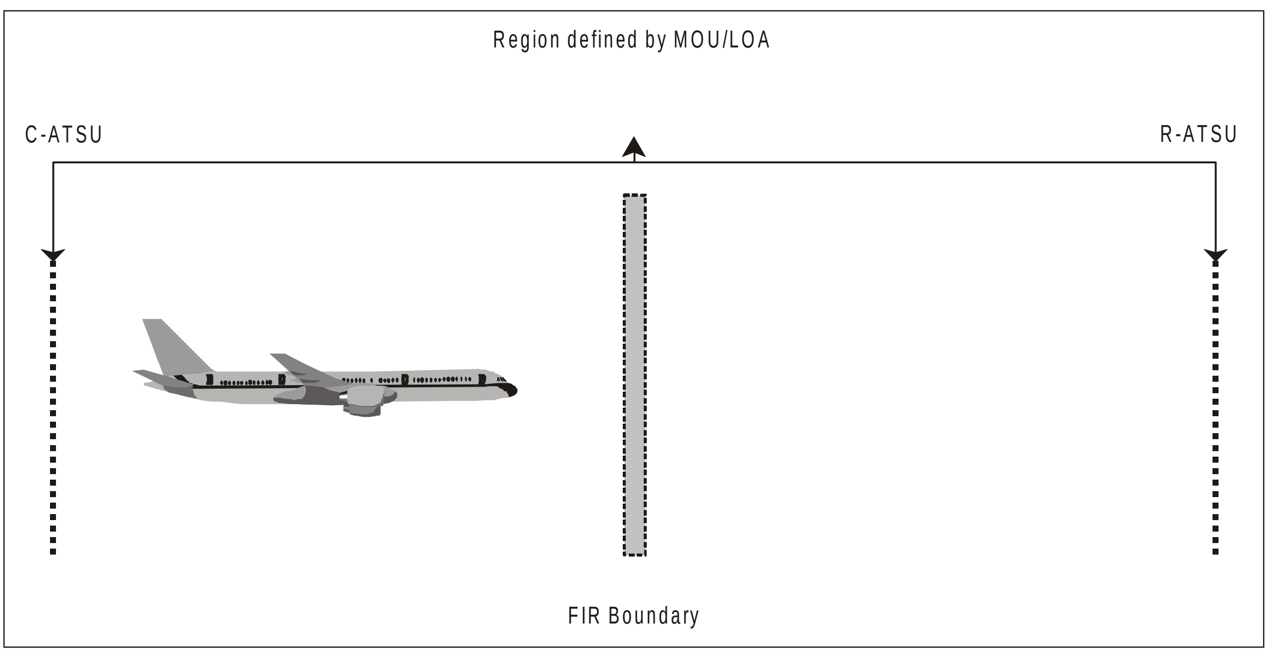


Figure VI-5-6. Transfer boundary conditions with partial or no surveillance coverage

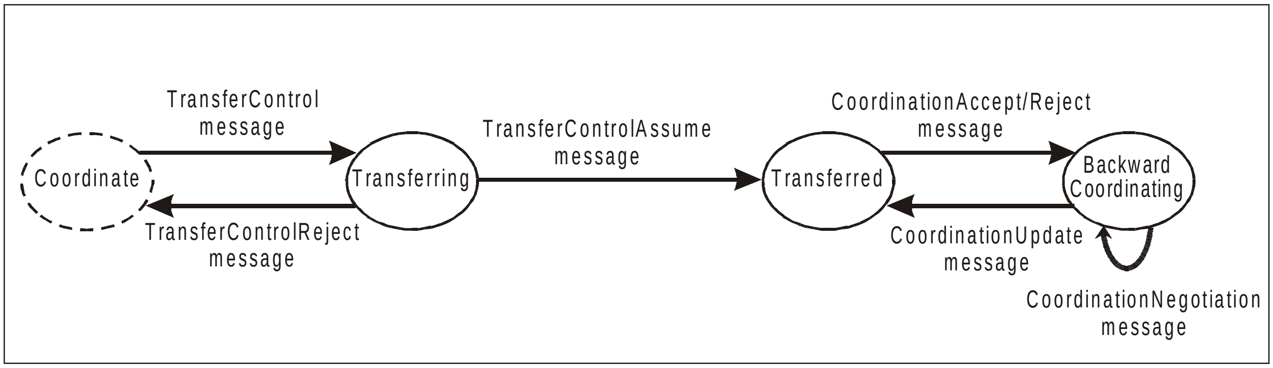


Figure VI-5-7. Transfer state — transfer of control authority for a flight using the TransferControl and TransferControlAssume messages

Table VI-5-1. AIDC dialogue sequence

Dialogue	*Sequencing rules*
Notification	May only occur prior to the initial coordination dialogue.
Notification cancellation	May only occur during the notification phase of coordination.
Initial coordination	This is the key dialogue which must be successfully completed for each flight.
Re-coordination	May occur any time after the initial coordination dialogue has been successfully completed.
Coordination cancellation	May occur after the initial coordination dialogue has been completed and before the start of a transfer dialogue.
Transfer of executive conditions	May occur any time after the initial coordination dialogue has been successfully completed.
Transfer of control	May occur any time after the initial coordination dialogue has been successfully completed.
Transfer of communications	May occur any time after the initial coordination dialogue has been successfully completed.
Free text	May occur at any time, but typically after the initial coordination dialogue.
Surveillance data transfer	May occur at any time, but typically after the initial coordination dialogue.
Point-out	May occur at any time.
Executive information transfer	May occur at any time after initial coordination is completed.

Table VI-5-2. Initial coordination dialogue sequence.

Message	*Comments*
CoordinateInitial	Begins the initial coordination of a flight.
CoordinateNegotiate	Supports negotiation of coordination conditions between ATSUs. May be exchanged zero or more times.
CoordinateAccept	Closes the initial coordination dialogue. All initial coordination dialogues must be closed using this message, indicating that coordination conditions have been mutually agreed upon by the ATSUs involved.

Table VI-5-3. Recoordination dialogue sequence

Message	*Comments*
CoordinateUpdate	Begins the re-coordination of a flight.
CoordinateNegotiate	Supports negotiation of coordination conditions between ATSUs. May be exchanged zero or more times.
either CoordinateAccept or CoordinateReject	Closes the re-coordination dialogue. All re-coordination dialogues must be closed using one of these messages. A CoordinateAccept indicates that coordination conditions have been mutually agreed upon by the ATSUs involved, while a CoordinateReject indicates that the previously agreed upon coordination conditions remain in effect.

Table VI-5-4. Transfer of executive conditions dialogue sequence

Message	*Comments*
TransferInitiate	Initiate control information exchange.
TransferConditionsProposal	Proposes executive control conditions (assigned heading, assigned speed, etc.).
TransferConditionsAccept	Accept proposed executive control conditions and close dialogue.

Table VI-5-5. Transfer of control dialogue sequence

Message	*Comments*
TransferControl	Initiates a dialogue to transfer Executive control authority from C-ATSU to R-ATSU.
(either) TransferControlAssume (or) TransferControlReject	Closes the Transfer of control dialogue. All Transfer of Control dialogues must be closed using one of these messages. A TransferControlAssume indicates that the sending ATSU accepts executive control authority for the flight. A TransferControlReject indicates that the sending ATSU is refusing to accept executive control authority for the flight.

Table VI-5-6. Transfer of communications dialogue sequence

Message	*Comments*
TransferComm	Initiates the transfer of communications.
TransferCommAssume	Closes the transfer of communications dialogue and terminates the transfer phase.

Table VI-5-7. AIDC notification messages

AIDC message	*Event trigger*	*Source/destination*	*Valid response*
Notify	Defined time from ATS boundary, or change in flight trajectory.	C-ATSU/ATSU	None required

Table VI-5-8. AIDC coordination messages

Received message	*Event trigger*	*Source/destination*	*Valid response*
CoordinateInitial	Proximity to an ATS boundary.	C-ATSU/D-ATSU	CoordinateAccept CoordinateNegotiate
CoordinateNegotiate	Proposed coordination conditions must be changed for some reason.	ATSU1/ATSU2	CoordinateNegotiate CoordinateAccept CoordinateReject
CoordinateAccept	Coordination conditions are acceptable.	ATSU1/ATSU2	None required
CoordinateCancel	Change in flight trajectory causes a flight not to enter or fly near an ATS boundary.	C-ATSU/D-ATSU	None required
CoordinateReject	Proposed coordination conditions are unacceptable.	ATSU1/ATSU2	None required
CoordinateUpdate	Propose revised coordination conditions after termination of an initial coordination dialogue.	ATSU1/ATSU2	CoordinateNegotiate CoordinateAccept CoordinateReject
CoordinateReady	D-ATSU is ready to accept the proposed coordination conditions.	D-ATSU/C-ATSU	CoordinateCommit CoordinateRollback
CoordinateCommit	C-ATSU has agreement from all affected D-ATSUs on the coordination conditions.	C-ATSU/D-ATSU	CoordinateAccept
CoordinateRollback	Existing coordination conditions must be changed.	C-ATSU/D-ATSU	None required
CoordinateStandby	Coordination with one or more downstream ATSUs, or referral to the controller, must be completed before continuing the current coordination dialogue.	ATSU1/ATSU2	None required

Table VI-5-9. AIDC transfer of control messages

Received message	*Event trigger*	*Source/destination*	*Valid response*
TransferInitiate	Flight is near an airspace boundary.	C-ATSU/R-ATSU	None required
TransferConditionsProposal	Manual hand-off initiation by C-ATSU.	C-ATSU/R-ATSU	None required TransferAccept
TransferConditionsAccept	Manual acceptance of proposed transfer conditions by R-ATSU.	R-ATSU/C-ATSU	None required
TransferRequest	Manual request for transfer by R-ATSU.	R-ATSU/C-ATSU	None required
TransferControl	Manual or automatic relinquishing of control at C-ATSU.	C-ATSU/R-ATSU	TransferControlAssume TransferControlReject
TransferControlAssume	Manual or automatic assumption of control at R-ATSU.	R-ATSU/C-ATSU	None required
TransferControlReject	Manual rejection of control at R-ATSU.	R-ATSU/C-ATSU	None required

Received message	*Event trigger*	*Source/destination*	*Valid response*
TransferComm	Manual relinquishing of communications at C-ATSU.	C-ATSU/R-ATSU	NonerequiredTransfer CommAssume
TransferCommAssume	Aircraft in communications with R-ATSU.	R-ATSU/C-ATSU	None required

Table VI-5-10. AIDC surveillance messages

Received message	*Event trigger*	*Source/destination*	*Valid response*
SurvGeneral	Track update calculated.	ATSU1/ATSU2	None required

Table VI-5-11. AIDC general information messages

Received message	*Event trigger*	*Source/destination*	*Valid response*
GeneralPoint	Controller-triggered to some adjacent ATS Unit.	ATSU1/ATSU2	None required
GeneralExecData	A change in executive control information.	ATSU1/ATSU2	None required
FreeTextEmergency	Emergency condition.	ATSU1/ATSU2	None required
FreeTextGeneral	Controller action.	ATSU1/ATSU2	None required

Table VI-5-12. AIDC application management messages

Received message	*Event trigger*	*Source/destination*	*Valid response*
AppAccept	Receipt of valid message by the ATC application at ATSU1.	ATSU1/ATSU2	None required
AppError	Receipt of an invalid message by the ATC application at ATSU1.	ATSU1/ATSU2	None required

PART VII

AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST

Chapter 1

APPLICATION OVERVIEW

INTRODUCTION

1.1 ADS-B is a surveillance application that allows the transmission of parameters, such as position and identification, via a broadcast-mode data link for use by any air and/or ground users requiring it. This capability will permit enhanced airborne and ground situational awareness to provide for specific surveillance functions and cooperative pilot-controller and pilot-pilot ATM.

1.2 The ADS-B application is not limited to the traditional roles associated with ground-based radar systems. ADS-B will provide opportunities for new functionality both on board the aircraft and within the ground ATC automation systems. 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. 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.

1.3 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, and non-powered airborne vehicles or obstacles.

1.4 For the purpose of this document, the following definitions have been adopted:

a) ADS-B emitter is a source, which is equipped with an ADS-B transmitter and continually broadcasts its identification, position, and other defined parameters via a data link.

b) ADS-B receiver receives and processes ADS-B data.

c) Air-ground operation is a transmission from an ADS-B emitter used by a ground receiver for the purpose of surveillance and monitoring.

d) Air to air operation is a transmission from an ADS-B emitter used by another ADS-B air receiver.

1.5 Each ADS-B capable emitter will periodically broadcast its position and other required data provided by the on-board navigation system. 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 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.

1.6 The requirements and performance characteristics for ADS-B information may differ between airborne emitters and emitters on the airport surface. They may also differ depending on the class of airspace within which the emitters are intended to operate, and the level of service offered in such classes of airspace. This will enable appropriate benefits to be offered to all categories of users in a cost-effective manner, and will minimize the requirement for over-sophistication of equipage for general aviation and other non-revenue producing users.

SCOPE

1.7 ADS-B consists of several services, including those designed for both air-ground and air-air use. This version of the manual addresses ATC surveillance only. Other potential services using ADS-B derived data are being investigated including:

a) airborne situational awareness;

b) conflict detection (both airborne and ground based);

c) ATC conformance monitoring; and

d) ADS-B lighting control and operation.

1.8 It is anticipated that other services will be added in future.

1.9 Many other forms of broadcast data may become available, including flight information services (e.g. NOTAM and weather information). These services are inherently different from ADS-B in that they require sources of data external to the aircraft or broadcasting unit, broadcast information other than encompassed in ADS-B, and independently defined performance requirements. These types of broadcast services are outside the scope of this document.

Chapter 2

GENERAL REQUIREMENTS

PERFORMANCE REQUIREMENTS

2.1 Systems developed to support ADS-B will be capable of meeting the communications performance appropriate for the service provided.

MESSAGE HANDLING

2.2 The ADS-B application requires:

a) message delivery at a rate appropriate to the service;

b) message generation and transmission in a time-ordered sequence; and

c) message delivery in the order sent.

TIME REQUIREMENTS

2.3 Time used in the ADS-B service shall be accurate to within 1 second of UTC.

2.4 Each ADS-B message will allow time stamping by an ADS-B receiver. The timestamp applied by the ADS-B received will consist of time (HHMMSS) and optionally date (YYMMDD).

PRIORITY

2.5 When messages are forwarded for surveillance purposes, the priority will be "normal priority flight safety messages" as determined by the ATN Internet Protocol Priority categorization.

QUALITY OF SERVICE (QOS)

2.6 Where messages are forwarded for surveillance purposes, ATS providers will specify the required QOS.

Chapter 3

FUNCTIONAL CAPABILITIES

BROADCAST REQUIREMENTS

3.1 Each ADS-B emitter will periodically broadcast its position and other required data. Any receiver within range of the broadcast may receive and process the information. The emitter originating the broadcast need have no knowledge of what system is receiving its broadcast.

MESSAGE ELEMENTS

3.2 The following message elements shall comprise the minimum set of information to be transmitted by an ADS-B emitter:

— emitter category;
— emitter identifier;
— latitude;
— longitude;
— level;
— aircraft identification, if applicable; and
— FOM.

3.3 System design should allow for inclusion of additional message elements for future use in airspace where air-to-air applications of ADS-B are envisaged. This will also entail appropriate enhancement of aircraft equipment. Potential message elements may include:

— ground vector, containing ground track, ground speed and vertical rate; or
— air vector, containing heading, IAS or Mach, and vertical rate; and
— short-term intent, containing next waypoint and target altitude;
— rate of turn; and
— aircraft type.

ADS-B DATA GLOSSARY

3.4 Appendix A to this chapter contains the ADS-B data glossary.

ADS-B VARIABLES RANGES AND RESOLUTIONS

3.5 Appendix B to this chapter provides the ranges and resolutions for the various ADS-B message elements. The information provided to the ADS-B emitter will support the ranges and resolutions provided in Table VII-3-B1.

Appendix A to Chapter 3

ADS-B MESSAGE DATA GLOSSARY

1. ADS-B DATA GLOSSARY

The following data are used as the ADS-B message element 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 call-sign. It is used in field 7 of the ICAO model flight plan.

Aircraft type. Refers to the particular classification of the aircraft, as defined by ICAO.

Air speed. Provides air speed as a choice of the following. *Mach, IAS,* or *Mach* and *IAS*.

Air vector. A sequence of *Heading, Air speed* and *Vertical rate*.

Distance. Specifies distance.

Emitter category. Refers to the characteristics of the originating ADS-B unit. It should be listed as one of the following:

1. Light aircraft — 7 000 kg (15 500 lb) or less
2. Reserved
3. Medium aircraft — more than 7 000 kg (15 500 lb) but less than 136 000 kg (300 000 lbs)
4. Reserved
5. Heavy aircraft — 136 000 kg (300 000 lb) or more
6. High performance (larger than 5G acceleration capability)
7. Reserved
8. Reserved
9. Reserved
10. Rotocraft
11. Glider/sailplane
12. Lighter-than-air
13. Unmanned aerial vehicle
14. Space/transatmospheric vehicle
15. Ultralight/handglider/paraglider
16. Parachutist/skydiver
17. Reserved
18. Reserved
19. Reserved
20. Surface vehicle — emergency vehicle
21. Surface vehicle — service vehicle
22. Fixed ground or tethered obstruction
23. Reserved
24. Reserved

Note.— 2, 4, 7-9, 17-19, 23 and 24 reserved for future assignment.

Emitter identifier. Refers to the unique 24-bit address specific to an airframe, vehicle or other emitter.

ETA. Estimated time of arrival at a waypoint.

Figure of Merit (FOM). Indicates the FOM of the current ADS-B 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.

Ground speed. Provides ground speed.

Ground vector. A sequence of *Track, Ground speed* and *Vertical rate*.

IAS. Indicated air speed.

Intermediate intent. Set of points between current position and the time indicated in the S*hort-term intent*. Consists of a sequence of the following: *Distance, Track, Level* and *Projected time*.

Latitude. Latitude in degrees, minutes and seconds.

Level. Specifies level as either altitude or flight level in feet.

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 *IAS*.

Next waypoint. Specifies the next waypoint in the avionics.

Position accuracy. An indication of the navigational accuracy.

Projected time. Predicted time at a particular point.

Short-term intent. A sequence of *Latitude, Longitude, ETA,* and *Intermediate intent* (optional) data structures.

Timestamp. Date and time that an ADS-B message is generated.

Track. Provides track angle in degrees.

Turn rate. Refers to the aircraft rate of turn.

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

Appendix B to Chapter 3

ADS-B VARIABLES RANGE AND RESOLUTION

1. ADS-B VARIABLES RANGE AND RESOLUTION

Table VII-3-B1 provides the required range and resolution for the message variables used in the ADS-B application.

Table VII-3-B1. ADS-B variables range and resolution

Message element	*Variables/parameters*	*Unit*	*Range*	*Resolution*
Aircraft identification		IA5 string	2 to 7	N/A
Airspeed	Mach IAS (non-SI)	Mach number Knots	0.5 to 4.0 0 to 400	0.001 1
Date	Year Month Day	Year of century Month of year Day of month	0 to 99 1 to 12 1 to 31	1 1 1
Emitter category		Integer	1 to 24	1
Emitter identifier		Bit string	24	N/A
FOM		Integer	0 to 7	1
Ground speed	Ground speed (non-SI)	Knots	–50 to +2 000	1
Heading		Degrees	0.1 to 360	0.1
Latitude	Latitude degrees Latitude minutes Latitude seconds	Degrees Minutes Seconds	±90 0 to 59 0 to 59.9	1 1 0.1
Level	Flight level (non-SI) Level (non-SI)	1 level (100 ft) Feet	30 to 700 –600 to +70 000	1 10
Longitude	Longitude degrees Longitude minutes Longitude seconds	Degrees Minutes Seconds	±180 0 to 59 0 to 59.9	1 1 0.1
Time	Time hours Time minutes Time seconds	Hours of day Minutes Seconds	0 to 2 300 0 to 59 0 to 59	1 1 1
Track	Track angle	Degrees	0.1 to 360	0.1
Turn rate		Degrees/minute	0 to 360	5
Vertical rate	Level (non-SI)	Feet/minute	±30 000	10

Chapter 4

AIR TRAFFIC SURVEILLANCE

SCOPE AND OBJECTIVE

4.1 Enhanced navigation and communication capabilities will permit the use of aircraft-derived position information to be transmitted to the ground. These data will be used as surveillance data to supplement ground-based ATC surveillance, and may also be used as a sole means of surveillance data, particularly in areas in which there is no radar coverage.

4.2 This chapter describes the use and requirements of ADS-B for ATC surveillance in en-route, terminal and airport environments.

EXPECTED BENEFITS, ANTICIPATED CONSTRAINTS AND ASSOCIATED HUMAN FACTORS

Expected benefits

4.3 Once the ground infrastructure is deployed, the increased accuracy, the update rate and additional parameters available with ADS-B should result in the following benefits:

a) improved services in airspace not having radar coverage;

b) improved airspace utilization;

c) improved conflict prediction and detection;

d) improved airport surface movement, guidance, and control;

e) improved runway incursion prevention; and

f) improved automated conformance monitoring.

Some benefits can be realized even before full aircraft equipage.

Anticipated constraints

4.4 In order to provide surveillance based exclusively on ADS-B information, all aircraft operating in the airspace must be ADS-B equipped.

4.5 ATS providers will require an independent means of validation of the ADS-B position information.

OPERATING ENVIRONMENT WITHOUT ADS-B

4.6 The surveillance environment comprises primary/secondary radar, with differing update rates, which support the provision of specified separation minima.

4.7 The nature and expense of radar limits the area of coverage where these surveillance services can be provided. As a result, large separation minima and procedural methods of air traffic control are used where no surveillance coverage is available.

OPERATING ENVIRONMENT WITH ADS-B

4.8 ADS-B will enhance ATC surveillance in the following ways:

a) in a mixed ADS-B/radar surveillance environment, ADS-B data will complement or supplement radar data; and

b) ADS-B will extend surveillance services into non-radar airspace, such as low-altitude airspace, remote airspace and coastal waters.

4.9 At such time that an airspace is fully populated with aircraft equipped with ADS-B, ATS providers may evaluate the necessity of replacing or maintaining other ground-based surveillance equipment.

4.10 As ADS-B is implemented to different initial levels of capability, with mixed aircraft equipage, ATS providers must ensure efficient levels of service to all airspace users.

General operational requirements

4.11 To provide a basis for the design of ADS-B systems for ATC surveillance, the following general operational requirements have been determined:

a) an ATSU will be capable of knowing that an aircraft is ADS-B equipped;

b) all aircraft operating in an ADS-B airspace will broadcast as required by the ATS provider;

c) the ground system will receive, process and display the ADS-B information; and

d) procedures and/or systems must be in place to validate the ADS-B information.

4.12 In addition to the parameter requirements in Part I of this manual, a summary of ATC specific performance requirements using ADS-B is presented in Table III-4-1.

ATC procedures

4.13 ATC procedures for the use of ADS-B will be dependent on the phase of flight and the communications infrastructure of the ATS provider. Procedures for the use of ADS (Part III, Chapter 6) and the procedures for the use of CPDLC (Part IV, Chapter 4) may be applicable, along with procedures given in the PANS-RAC (Doc 4444) and *Regional Supplementary Procedures* (Doc 7030). It is anticipated that specific ATC procedures will be developed as experience is gained with the systems and as appropriate separation minima are developed for global use.

4.14 The probability exists that errors may be input into the aircraft navigation system prior to departure. Since ADS-B 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.

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

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

4.17 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.

Exception handling

4.18 The ADS-B application will be capable of providing a warning to pilot and controller whenever the navigation accuracy is degraded below that required to operate in the airspace, as this will affect the application of separation.

4.19 Back-up procedures should be developed for ADS-B complete and partial system failure.

Table VII-4-1. ATC specific surveillance requirements using ADS-B

	Operational domain		
Parameter	*En route*	*Terminal*	*Airport surface/vicinity*
Maximum update period	10 seconds	5 seconds	1 second (see Note)
Probability of update within period	98 per cent	98 per cent	98 per cent
Position accuracy	350 m	150 m	3 m
Instantaneous number of aircraft to be supported per ATSU	1 250	450 in a 60 NM radius	100 in motion; 150 stationary
Message latency	2 seconds	1 second	1 second
Note.— A less frequent update rate may be permissible for stationary emitters.			

— END —