



ATS DATA LINK APPLICATIONS OVER ACARS AIR-GROUND NETWORK

ARINC SPECIFICATION 622-4

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FOREWORD

Activities of AERONAUTICAL RADIO, INC. (ARINC)

and the

Purpose of ARINC Reports and Specifications

Aeronautical Radio, Inc. is a corporation in which the United States scheduled airlines are the principal stockholders. Other stockholders include a variety of other air transport companies, aircraft manufacturers and non-U.S. airlines.

Activities of ARINC include the operation of an extensive system of domestic and overseas aeronautical land radio stations, the fulfillment of systems requirements to accomplish ground and airborne compatibility, the allocation and assignment of frequencies to meet those needs, the coordination incident to standard airborne compatibility, the allocation and assignment of frequencies to meet those needs, the coordination incident to standard airborne communications and electronics systems and the exchange of technical information. ARINC sponsors the Airlines Electronic Engineering Committee (AEEC), composed of airline technical personnel. The AEEC formulates standards for electronic equipment and systems for the airlines. The establishment of Equipment Characteristics is a principal function of this Committee.

It is desirable to reference certain general ARINC Specifications or Report which are applicable to more than one type of equipment. These general Specifications and Reports may be considered as supplementary to the Equipment Characteristics in which they are referenced. They are intended to set forth the desires of the airlines pertaining to components and general design, construction and test criteria, in order to insure satisfactory operation and the necessary interchangeability in airline service. The release of a Specification or Equipment Characteristics should not be construed to obligate ARINC or any airline insofar as the purchase of any components or equipment is concerned.

An ARINC Report (Specification or Characteristic) has a twofold purpose, which is:

- (1) To indicate to the prospective manufacturers of airline electronic equipment the considered opinion of the airline technical people, coordinated on an industry basis, concerning requisites of new equipment, and
- (2) To channel new equipment designs in a direction which can result in the maximum possible standardization of those physical and electrical characteristics which influence interchangeability of equipment without seriously hampering engineering initiative.

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1.0 ATS DATA LINK PROCESSES OVER ACARS**1.1 Introduction**

c-2 This document specifies processes that enhance the functionality of the ACARS system in order to meet the special communications requirements of Air Traffic Services (ATS) applications.

COMMENTARY

Airlines strongly recommend that all participating CAAs use the techniques defined herein. This will enable aircraft with a single software implementation to receive ATS applications worldwide. Airlines are free to use these same functions in support of AOC messages as they choose.

MORE COMMENTARY

c-3 This document is intended to be used in conjunction with ARINC Specification 620 which describes the Data Link Service Provider (DSP) role in the ACARS Data Link System. The processes defined herein work in concert with the protocols for air/ground communications defined in ARINC Specifications 618.

Through the course of a flight, an aircraft may be required to establish and terminate communications with different ground agencies (i.e. CAAs). This document describes a process whereby communications can be accomplished with different ground agencies according to ATS requirements. An additional function is defined which allows address information to be exchanged between the aircraft and the ground agencies.

c-2 ATS applications require communications with different ground agencies depending upon the airspace in which the aircraft is located.

COMMENTARY

The ACARS network was originally designed to **only** deliver messages from aircraft to the (airline) user's ground based computer system. This meant that only a single ground connection was needed in most cases. Expanding the ACARS communications services to CAAs at multiple ground systems inspired the expansion of addressing capabilities (defined herein) to accommodate this need.

ATS applications, because of their safety-related nature, also require an end-to-end integrity check. This document describes a suitable check which is based on an industry standard algorithm.

ATS applications may be defined as character-oriented or bit-oriented. Character-oriented data can be carried over the ACARS network without modification. Bit-oriented data must be converted to a format consistent with the ACARS system before it can successfully transit the air/ground link. This document describes the processes needed to support character-oriented applications and bit-oriented applications. The definition of the applications themselves are contained in other documents and are identified by appropriate references.

c-2 Messages generated by the ATS applications will be exchanged over data links, which use the ACARS protocol

for air/ground message transfer. Data Link Providers (DSP) may use, but are not limited, to the use of VHF, HF or satellite media to connect the aircraft to their ground network. Multiple links may be operational simultaneously. Unless limited by regulatory authorities or airframe manufacturers, ATS messages are expected to be able to transit any air/ground data link.

c-2

1.2 Purpose of this Document

The intent of this document is to provide design guidance to developers in order to ensure interoperability between the implementation of these applications.

COMMENTARY

As ACARS data link was only designed to provide a link between a user's ground based-system and the user's aircraft, message contents for most AOC applications were not standardized. ATS applications involve multiple ground agencies (i.e., CAAs) communicating with aircraft belonging to multiple users, therefore uniform worldwide message formats and procedures are essential.

c-2

1.3 Organization of this Document

Chapter 1 provides an introduction.

Chapter 2 defines the ACARS Compatible System, which provides:

- a. the necessary formatting and addressing
- b. a CRC integrity check
- c. a bit-to-hex (ISO-5) conversion process.

c-2

For bit-oriented messages the Bit-to-hex (ISO-5) conversion process is applied to the Application Data and the CRC. For character-oriented messages it is applied to the CRC only. This conversion is required to make bit-oriented data suitable for transmission over the character-oriented ACARS system. The ground-based end-system or a suitable gateway is expected to use the reverse process to restore the hex-encoded data to its original bit-oriented format.

Chapter 3 describes the ATS Facilities Notification (AFN) process which allows ACARS addresses to be exchanged between end-systems.

c-2

Chapter 4 describes the Application Interfaces needed to support various bit-oriented applications. These have been designed to facilitate migration from the current character-oriented ACARS air/ground network to the bit-oriented Aeronautical Telecommunications Network (ATN) proposed for the future without change to the applications themselves.

c-2

Chapter 5 contains specific provisions to support the character-oriented ATS applications, which are defined in ARINC Specification 623.

Appendix A contains a list of acronyms and a glossary of terms used in this specification.

Appendix B contains an example of the CRC process.

1.0 ATS DATA LINK PROCESSES OVER ACARS**1.3 Organization of this Document (cont'd)**

Appendix C contains a possible scenario showing the ATS Facilities Notification application in use.

c-2 Appendix D contains Label, Message Format Identifier (MFI) and Imbedded Message Identifier (IMI) information.

1.4 Data Link Network Components

c-2 Data link communications via ACARS involves a Data link Service Provider (DSP). The Data Link Service Provider operates ground networks and air/ground data links. Aircraft use RF media such as VHF, HF or satellite to access the DSP's ACARS ground network. The ground stations of these air/ground links are connected to the DSP's central Data Link Service Processor. The central Data Link Service Processor is connected to the user's ground end-system through a network interface.

c-2 Communications generated by the ground end-system and directed to the aircraft end-system are known as uplink messages. Communications generated by the aircraft end-system to a ground end-system are known as downlink messages.

The aircraft end-system communicates directly with the ground-based end-system. Intermediate systems, such as the DSP's central Data Link Processor that handle the message, do not affect (modify) the content of the Application Data, except by special arrangement between the user and the DSP.

The aircraft end-system may be connected to a cockpit printer to produce hard copy of uplink messages. The aircraft end system should be connected to a dedicated Control and Display Unit (CDU) or a Multi-Purpose Control and Display Unit (MCDU) for uplink message display and entry of downlink messages.

1.5 Relationship to other Documents

The systems onboard the aircraft that house the applications are described in their associated ARINC documents.

The ACARS air/ground protocol is specified in ARINC Specification 618. The interface between the ACARS [C]MU and other on-board systems is specified in ARINC Specification 619. The role of the Data Link Service Provider (DSP) is described in ARINC Specification 620.

ARINC Specification 620 illustrates the format of air/ground messages, both uplink and downlink and the format of ground/ground messages, both from the DSP to the CAA (or airline) and to the DSP from the CAA (or airline). It also provides information on the assignment and use of Labels, Sub-labels and Message Function Identifiers (MFI).

The Cyclical Redundancy Check (CRC) polynomial for the bit-oriented messages over the character-oriented network and the character-oriented applications is specified in ARINC Specification 429.

COMMENTARY

The CRC polynomial was added to ARINC Specification 429 in Supplement 12 and its

implementation was clarified in Supplement 13. This same polynomial description is carried forward in subsequent supplements; i.e., Supplements 14, 15 etc. Supplement 15 divided the document into three parts. The description of the CRC process is contained in Appendix 7 to Part 3.

Reference is also made to documents, which were not developed by AEEC (ARINC standards). For example, the interface between user systems and the DSP's ground network is specified in the ATA/IATA Interline Communications Manual (ICM).

1.5.1 References for ATS Applications

ATS applications are defined by the AEEC, RTCA, and ICAO.

Character-oriented ATS applications are described in ARINC Specification 623.

Bit-oriented ADS applications are defined by:

- a. The ADS application is specified in ARINC Characteristic 745
- b. DO-212 for Automatic Dependent Surveillance (ADS) Minimum Operational Performance Standard (MOPS) was developed by RTCA Special Committee 170
- c. Boeing and Airbus produced aircraft with ADS capability based on the ARINC and RTCA standards. These implementations were designated FANS-1 and FANS-A respectively.
- c. The ATN Panel of ICAO has nearly completed Standards and Recommended Practices (SARP) for ADS.

Bit-oriented CPDLC applications are defined by:

- a. DO-219 Minimum Operational Performance Standard (MOPS) for ATC Two-Way Data Link Communications was developed by RTCA Special Committee 169. This application was later renamed Controller/Pilot Data Link Communications (CPDLC) by ICAO
- b. The ATN Panel of ICAO has nearly completed Standards and Recommended Practices (SARP) for ADS.
- c. The ATN Panel of ICAO has nearly completed Standards and Recommended Practices (SARP) for CPDLC.

c-2

c-3

2.0 ACARS COMPATIBLE SYSTEMS

2.1 Introduction

c-2 This section deals with the provisions of the ACARS Compatible System which enable the ACARS network to support ATS applications. Detailed explanations are given on formatting/addressing, the CRC integrity check and the Bit-to-HEX conversion process. The ACARS compatible system can be used for bit-oriented and character-oriented applications.

The implementation of the bit-to-hex conversion process described herein will allow bit-oriented applications to use the character-oriented ACARS Data Link.

c-2 The operation and messaging functions of a given bit-oriented application remain the same whether it uses the bit-oriented communication process assumed in its own specification or the ACARS Compatible System combined with the Application Interface described in Chapter 4.

COMMENTARY

The use of the application interface, the formatting/addressing described herein, the CRC and the Bit-to-HEX conversion process to support bit-oriented applications has become known as the ACARS Convergence Function (ACF).

The Application Interfaces described here will fully support ATN-compliant applications as they will emulate the ISO 8072 Transport Service. The Application Interface, in effect, provides a convergence function between the connection-oriented ISO 8072 Transport Service Interface and the connectionless ACARS protocol beneath it, this entails:

- a. Providing local responses to all primitives as required by the application.
- b. Providing local initiation of all primitives as required by the underlying communication process.
- c. Mapping the Supplementary Address field to/from an emulated transport connection at the interface to the application.
- d. Mapping primitives into ACARS messages and vice-versa, to provide specific services, peculiar to each application, e.g., a DISCONNECT message for the ADS application and a DISCONNECT REQUEST message for the TWDL application.

2.1.1 Platform Requirements

In order to preserve the end-to-end integrity check, the ACARS compatible system and the applications that it supports should be hosted together in an avionics end-system. The end-system may be an ACARS peripheral (e.g. FMS, ACMS, ADSU) which routes air/ground messages via an ACARS [C]MU, an ACARS [C]MU itself, or an integrated unit typical of next generation avionics.

If they are implemented in an ACARS peripheral, the ACARS Compatible System and the application(s) will function with no modification to the ACARS MU; provided that the [C]MU supports the basic features described in ARINC Specifications 618 and 620 (as modified by Supplement 1 or above).

2.1.2 The End-to-End Communication Process

The ACARS Compatible System will support ATS applications through the use of the provisions called out in this chapter.

Bit-oriented messages may contain certain sequences the ACARS network is not designed to carry. Special processing of the bit-oriented data is needed before it can be transmitted. Since this processing is performed at the transmitting end-system, reverse processing is also needed at the receiving end-system to reconstitute the original bit stream. Intermediate systems need not change their processing. However, the DSP should recognize these new message types as being ATS messages and properly route them to the appropriate ATS provider.

For an ATS transaction to begin, the ATS facility needs to discover the existence of the aircraft, as well as the identification of the ACARS peripheral or ACARS [C]MU which contains the ATS application(s). Similarly, an aircraft needs to acquire the ground address of the ATS facility. To do this, a notification function is necessary. This function is defined as an application process, ATS Facilities Notification (AFN), in Chapter 3 of this specification. The AFN resides in the aircraft within an ATS end system and in an end system of a ground ATS facility. The AFN provides an automated mechanism to perform notification, and exchange of end-system addresses and capabilities. If this information can be discovered in other ways, then an AFN transaction is not necessary prior to using ATS services.

Once the ATS facility has been notified of an aircraft's readiness for data communication and both end-systems have acquired the necessary addresses, end-to-end communication can begin. At the transmitting end-system, the ATS Application Data is created by the appropriate ATS application. The second step is to calculate the CRC of the Application Data. The CRC is appended to the Application Data. Next, assuming that the Application Data is bit-oriented, the Application Data and the appended CRC are processed through a bit-to-hex conversion algorithm. Then the converted string is formatted into ACARS-compatible ISO-5 characters using the formatting rules of Section 2.2.1. If the Application Data is already character-oriented, the bit-to-hex conversion is applied only to the CRC.

At the receiving end-system, the character string is extracted from the ACARS message according to the rules of Section 2.2.1. The CRC and the Application Data (if bit-oriented) are processed through a hex-to-bit restoration algorithm. The resulting message contains both application data and the associated CRC value. The receiving end system is responsible for evaluating the CRC to confirm the validity of the data transfer prior to displaying or otherwise utilizing the Application Data.

2.2 ACARS Compatible System

2.2.1 ACARS Routing of ATS Application Messages

Message routing for an ACARS [C]MU is different than its peripherals. If the message source or destination is an ACARS [C]MU, the Label field is the message identifier. If the message source or destination is an ACARS peripheral, the Label and Sublabel fields serve as

2.0 ACARS COMPATIBLE SYSTEMS**2.2.1 ACARS Routing of ATS Application Messages (cont'd)**

c-2 | equipment identifiers and a Message Function Identifier (MFI) are used to identify ATS messages. Message Labels, Sub-labels and MFIs for ACARS uplinks and downlinks are documented in ARINC Specification 620.

c-2 | The DSP also uses the ACARS Labels and MFIs (if applicable) to determine the routing and/or processing for each message.

COMMENTARY

c-2 | Messages exchanged between the aircraft and DSP are in the air/ground format; messages between ground users and the DSP are in the ground/ground format. Each Label/Sublabel combination in the air/ground format has an equivalent Standard Message Identifier (SMI) in ground/ground format. See Table C-2 of Appendix C of ARINC Specification 620 for a list of peripherals and their respective SMI codes.

If no downlink was received from a particular application prior to the transmission of an uplink to it, then information on the correct SMI for use, can be obtained from the AFN application.

The DSP usually automatically delivers messages to the airline host. However messages identified as ATS messages will (in most cases) only be delivered to the addresses in the Supplementary Address field.

c-2 | **2.2.1.1 Routing of ATS Messages - ACARS [C]MU as End-System**

Upon receipt of an air/ground downlink message from an [C]MU, the DSP generates a ground/ground message to the ATC facility with an SMI that identifies the particular ATS message type.

The ACARS protocol specifies that if a downlink message was received from an ACARS [C]MU then uplink messages for that particular aircraft (and application) should be delivered to the ACARS [C]MU. This is achieved by inserting the appropriate Standard Message Identifier (SMI) in the ground-generated message to identify the ATS message type.

c-2 | **2.2.1.2 Routing of ATS Messages - ACARS Peripheral as End-System**

c-2 | The MFI, included in the message by the peripherals, identifies the message as an ATS message. Upon receipt of an air/ground downlink message from an ACARS peripheral, the DSP generates a ground/ground message to the ATC facility with an SMI, which identifies the peripheral as the message originator. The MFI is discarded in the conversion from air/ground to ground/format.

If a downlink message was received from an ACARS peripheral then uplink messages for that particular aircraft (and application) should be delivered to the same ACARS peripheral. This is achieved by checking the SMI in the downlink and then using the correct SMI to identify the ACARS peripheral in the (ground generated) uplink message. An MFI is then used to identify the message as an

ATS message. In the uplink case, the MFI is passed-through untouched.

2.2.1.3 Message Examples

The following tables show how the DSP will use the information in the message to correlate downlink and uplink messages, which pass Automatic Dependent Surveillance (ADS) data:

Downlink Examples:

Aircraft LRU	Label /Sublabel	MFI	SMI	Meaning
Left FMC	H1M1	B6	FML	Downlink from Left FMC
ACMS	H1/DF	B6	DFD	Downlink from ACMS
Left ADSU	H1/A1	B6	AUL	Downlink from ADSU
MU	B6		PAR	Downlink from MU

Uplink Examples:

Aircraft LRU	Label /Sublabel	MFI	SMI	Meaning
Left FMC	H1/MD	A6	FMD	Uplink to Active FMC
ACMS	H1/DF	A6	DFD	Uplink to ACMS
ADSU	H1/AD	A6	AUD	Uplink to Active ADSU
MU	A6		RAR	Uplink to MU

See Appendix D for a comprehensive list of ACARS labels, sublabels, SMIs and MFIs for aircraft C]MUs.

c-2 | **2.2.2 ACARS Compatible Message Formatting and Addressing**

ATS messages consist of two main elements: the Supplementary Address field and the Application Text field. The Supplementary Address field begins the ACARS free text and is followed immediately by the Application Text field, which terminates the ACARS free text.

2.2.2.1 Supplementary Address Field

For ATS downlink messages the Supplementary Address Field in the air/ground message contains the non-airline should deliver the message. In uplink messages, the Supplementary Address field contains CAA address the of the source ground end-system.

The Supplementary Address field is framed by special characters. It begins with a </> (2/15) and is terminated by a period <.> (2/14). The ACARS Compatible System in the avionics inserts the non-airline (i.e. CAA) address into the Supplementary Address field.

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2.0 ACARS COMPATIBLE SYSTEMS

c-2	The Supplementary address may be four or seven characters in length. For some ATS applications the Supplementary address in the downlink may be entered by the pilot. A four-character address will be translated into the standard seven-character address as per ARINC Specification 620 by the DSP.	2.2.4 <u>ACARS Bit-to-HEX (ISO-5) Conversion</u>	c-2
c-2	In addition to the address described above, the Supplementary Address field of ATS messages sent to and from ACARS peripherals contains an MFI. The MFI is a two character code which immediately follows the </> character at the beginning of the Supplementary address field and is followed by a space character (which separates it from the address). The use of MFIs by the ACARS Compatible system has been described in Section 2.2.1.	The ACARS protocol defined in ARINC Specification 618 is a character-oriented protocol. ACARS uses certain bit sequences for communication control, and also enters a parity value in the eighth bit of each octet. This precludes ACARS from transporting an unrestricted bit stream in the free text field. This section defines a symmetric conversion/restoration process to be performed on unrestricted bit streams to allow them to be transported across an air/ground link by the ACARS protocol.	c-2
	2.2.2.2 <u>Application Text Field</u>		
c-2	For bit-oriented applications, the Application text field consists of an Imbedded Message Identifier (IMI), the Aircraft Registration Number (AN), the Application data generated by the ATS application and a CRC. The AN enables the end system to confirm that the message was delivered to the correct address.	For bit-oriented applications, the initial IMI and AN in the Application text field are already coded as ISO Alphabet Number 5 (ISO-5) characters and will not require conversion. The remainder of the ATS Application data and the CRC will be an unrestricted bit stream will therefore require conversion. See Attachments 6 and 7 for a depiction of these elements of the Application text.	c-2
	The ACARS Compatible System inserts a three character IMI followed by a seven character AN at the beginning of each bit-oriented Application text field.	For character-oriented applications, only the CRC, which appears at the end of the Application text field as an unrestricted bit stream will require conversion.	c-3
c-2	For character-oriented applications, the Application text field consists of an IMI, the slash </> character, the Application data and a CRC. See Chapter 5 for further details.	The conversion process divides the unrestricted bit stream into four-bit pieces and converts these pieces to the seven-bit ISO-5 representation of their hexadecimal value. The division of the bit stream commences at the Most Significant Bit (MSB) of the binary data and ends at the Least Significant Bit (LSB).	c-2
	<u>COMMENTARY</u>	<u>COMMENTARY</u>	
c-3	The reader should note that the slash </> character follows the IMI in the character-oriented applications while the AN directly follows the IMI in the bit-oriented applications. This construction is intentional.	Discussions that follow are based on Table 3-1, Limits to ASCII (ISO-5) Code Set found in Attachment 3 ISO-5 Characters of ARINC Specification 618. References such as 3/0 or 3/9 refer to the Column/Row location within Table 3-1.	c-4
	The IMI is used to identify the specific application to which the message belongs. Where applicable the IMI also provides the Version Number of the application. The ACARS Compatible System uses this to determine if the application is bit-oriented or character-oriented.	Application data that does not divide evenly into eight-bit pieces is padded with up to seven trailing zeroes in order to complete an octet. The character resulting from the piece commencing with the MSB is the first character in the result of the conversion and the character resulting from the piece including the LSB is the last character in the result of the conversion.	c-2
c-2	2.2.3 <u>ACARS Compatible Process CRC</u>		
c-2	The CRC calculation is performed over the Application text field. The eighth bit of each character (IMI and AN) of bit-oriented messages is set to zero before calculating the CRC. If the ATS Application Data is character-oriented then the eighth bit of each character should be set to zero as well.	For message transmission preparation, the input to the conversion process is an unrestricted series of binary data. The output of the conversion process is a series of octets in the ranges 3/0 to 3/9 and 4/1 to 4/6 which, in the ISO-5, represent the hex characters "0" to "9" and "A" to "F". This output is ready for encapsulation into an ACARS block to be sent onto the ACARS network.	
c-2	The polynomial from ARINC Specification 429 is used. However, the bits are ordered so that the Most Significant Bit (MSB) of the data is the first bit of the message to be CRC'd and the Least Significant Bit (LSB) of the data is the last bit of the message to be CRC'd. See Appendix B for CRC example. The calculated CRC is attached to the end of the Application data field and becomes a part of the Application Text field.	For received message extraction, the input to the restoration process is the series of octets in the ranges 3/0 to 3/9 and 4/1 to 4/6. The restoration process extracts the binary bit stream from the ISO-5 representation of the four bit pieces.	
c-3			

2.0 ACARS COMPATIBLE SYSTEMS**2.2.4 ACARS Bit-to-HEX (ISO-5) Conversion (cont'd)****COMMENTARY**

Example: Given a binary series of Application data = 1101011001 which does not complete an octet, so it must be padded with trailing zeros, resulting in 1101011001000000. Now that it meets the boundary criteria, the Application data can be divided into four-bit pieces and the bit-to-hex conversion performed as follows:

<u>Bits Position</u>	<u>ISO-5</u>	<u>Column/Row Table 3-1</u>
1101	to 'D'	4/4
0110	to '6'	3/6
0100	to '4'	3/4
0000	to '0'	3/0

Bit-oriented Application data of size "N octets" will be converted to character-oriented Application data of length "2N characters" to be transported by ACARS. The sequence of the characters in the text field is such that the first character will contain the highest four-bit piece of the Application data, and the last character will contain the lowest four-bit piece of the CRC.

The following table gives the precise input and output bit sequences for the ACARS message conversion/restoration process:

ISO-5 Bits	Hex Char	Four-Bit Piece of Binary Bit Stream
MSB LSB		MSB LSB
0011 0000	0	0000
0011 0001	1	0001
0011 0010	2	0010
0011 0011	3	0011
0011 0100	4	0100
0011 0101	5	0101
0011 0110	6	0110
0011 0111	7	0111
0011 1000	8	1000
0011 1001	9	1001
0100 0001	A	1010
0100 0010	B	1011
0100 0011	C	1100
0100 0100	D	1101
0100 0101	E	1110
0100 0110	F	1111
ISO-5 to-bit conversion		→
←		Bit-to-ISO-5 conversion

If the received ACARS message has an ATS label, then the destination end-system is the ACARS MU. In this case, the [C]MU routes the message to its internal ACARS Compatible System instead of the normal AOC process.

If the received ACARS message contains a label/sub-label indicating that the message is destined for an ACARS Peripheral, the ACARS [C]MU routes the message to the appropriate peripheral. At the ACARS peripheral, if the message contains an MFI corresponding to an ATS label, then the ACARS peripheral directs the message to its ACARS- Compatible System, instead of the normal AOC process.

The ACARS Compatible System extracts the address from the Supplementary Address field for use as required by the addressed application.

The first step in processing the received data is to check the IMI to determine if the ATS application that generated the message was bit-oriented or character-oriented.

- If the message is bit-oriented then it must be passed through the hex-to-bit restoration process.
- If the message is character-oriented the hex-to-bit restoration process must be performed on the CRC only.

All bit-oriented applications will use a CRC. Therefore, all bit-oriented uplink messages will require the hex-to-bit restoration and a CRC check.

The ACARS Compatible System calculates a CRC over the Application text field as described in Section 2.2.3. The ACARS Compatible System compares the result with the one contained in the message. If the computed CRC does not equal the extracted CRC, the entire message is discarded and the Application data is not passed to the application. The Application protocol is expected to be able to recover from this problem as ACARS Protocol has already responded to the message with a Technical Acknowledgment. If the computed CRC equals the extracted CRC, the message is valid.

COMMENTARY

No error recovery action is taken by the ACARS Compatible System as a result of a failed CRC check, because:

- the ADS and AFN application definitions contain commentaries' describing timers that initiate the timely retransmission of a discarded message by the ground-based application;
- the ACARS network performs error recovery in the event of a failed 'communication' CRC check, hence it is very unlikely that messages will fail the ACARS Compatible CRC.

MORE COMMENTARY

The end system application on the aircraft is encouraged to retain a record of the occurrence of messages discarded due to failed CRC. Time and aircraft location information may be helpful to

2.2.5 Uplink ACARS Message Processing

The avionics end-system receives as input a message which follows the format described in the preceding sections.

2.0 ACARS COMPATIBLE SYSTEMS

c-2	establish correlation with ground application records to perform diagnostics.	2.2.6.1 <u>Downlink Procedure at Avionics</u>	c-2
	The IMI located at the beginning of the data field is used to determine which application should receive this message.	The step-by-step procedure for a downlink transmission by the avionics end system is:	
c-2	Then the message with the aircraft registration is passed to the application process.	a1. The character-oriented Application passes the application data to its internal ACARS Compatible System.	
c-2	2.2.5.1 <u>Uplink Procedure at Avionics</u>	or	c-2
	The step-by-step procedure for an uplink received by the avionics end system is:	a2. The bit-oriented Application passes the AN and application data to its internal ACARS Compatible System.	
	a. The MFI or label, directs the message to the ACARS Compatible System (instead of normal AOC processing).	b. The ACARS Compatible System affixes the IMI of the source application to the beginning of the message.	
	b. The Supplementary address is saved.	c. A CRC is computed as specified in Section 2.2.3.	
	c. If the IMI shows it to be necessary, a (hex-to-bit) restoration is performed over the (ISO-5) character representation of the Application text field (less the AN if present); the resulting data is passed to the next process. Messages with unknown or invalid IMI are discarded.	d. A (bit-to-hex) conversion is performed over the CRC and, if necessary, over the Application data.	
c-2	d. A CRC calculation is performed from the first character of the IMI to the end of the Application data and compared with the CRC value in the message for validation.	e1. The Supplementary address is added to the front of the message. The message for a character-oriented application now consists of the address, IMI, application data, and CRC (all in ISO-5 compatible coding).	
	e. The IMI is used to route the resulting data through the ACARS Compatible System interface to the application for processing.	or	c-2
	f. The application processes the received data.	e2. The Supplementary address is added to the front of the message. The message for a bit-oriented application now consists of the address, IMI, AN, application data, and CRC (all in ISO-5 compatible coding).	
c-2	2.2.6 <u>Downlink ACARS Message Processing</u>	f. ACARS routing information in the form of: 1) a Label (if the message is generated by the [C]MU) or 2) an MFI (if the message is generated by a peripheral) is added to the message.	
	The ACARS Compatible System receives messages from user applications and encodes them for downlinking according to the following procedure.		
c-2	A character-oriented application passes data to the ACARS Compatible System whereas a bit-oriented application passes the AN and the data to the ACARS Compatible System. The ACARS Compatible System affixes the IMI of the source application to the beginning of the message. A CRC is computed as specified in Section 2.2.3. The CRC value is then appended to the message. The contents Section 2.2.4.		

COMMENTARY

In the case of bit-oriented applications, the application passes the AN and the application contents to the ACARS Compatible System.

- c-2 | The Supplementary Address field is filled with the address of the ground system to which the message should be delivered. If this process is resident in an ACARS peripheral, the appropriate MFI is affixed to the beginning of the message. The resulting text is placed in the free text field of an ACARS message and sent to the ground system.

3.0 ATS FACILITIES NOTIFICATION

3.1 ATS Facilities Notification

The ATS Facilities Notification (AFN) procedure enables an ATS facility to become aware of an aircraft's data link capabilities and provides an exchange of address information. The AFN does not actually establish communications between the applications that use the ACARS Compatible System; this is done by the applications themselves. However to establish communications the ground users and the aircraft need the addressing information which the AFN can provide. The facilities notification messages have no function related to the direct control of the aircraft by an Air Traffic Management Center.

COMMENTARY

The AFN provides similar functionality over the character-oriented ACARS network that the Context Management application will provide over the future bit-oriented ATN.

The AFN is a character-oriented ATS application, which uses the existing ACARS network to communicate with its peer AFN application on the ground. The ground AFN peer is expected to reside at the ATS authority or facility.

Although a single AFN per aircraft is preferred, when multiple applications are distributed across multiple LRUs, there will be more than one AFN. However, only one ground AFN application is expected per ground FIR.

3.2 ATS Facilities Notification Messages

The basic ATS Facilities Notification AFN procedures uses the following messages:

FN_CON: Downlink AFN Contact message.
 FN_AK: Uplink AFN Acknowledgement message.
 FN_CAD: Uplink AFN Contact advisory message.
 FN_RESP: Downlink AFN Response message.
 FN_COMP: Downlink ATS Facilities Notification Complete

3.3 AFN Procedures

This section describes the two basic AFN procedures:

- 'Initial Notification' shown in Figure 4-1 of Attachment 4.
- 'Request for Notification' shown in Figure 4-2 of Attachment 4.

Also described are operations relating to the handling of the Active Flag and closure at the End of Flight.

3.3.1 Initial Notification

3.3.1.1 Purpose

The Initial Notification procedure allows an aircraft to introduce itself to the ground end-system in a chosen ATS

Facility and to make that end-system aware of its aircraft registration and the ATS data link applications that it supports.

COMMENTARY

This procedure has also become known as the AFN LOG-ON.

The Initial Notification procedure may be initiated by flight crew action or by an automatic trigger.

COMMENTARY

Following the commencement of flight, flight crew initiation of the procedure will be required to accommodate pop-up conditions, a change in Flight ID and to allow manual over-ride of the ATS facility address.

If the Initial Notification procedure is successful the ground end-system responds with the full seven character address that should be used in all subsequent AFN communications.

If there is more than one AFN application resident in an aircraft then the Initial Notification procedure should be carried out by each AFN application.

The pilot-entered address may be the four-letter ICAO code. If so, it will be translated to a seven-letter address by the DSP.

c-2

3.3.1.2 Initial Notification - Basic Procedure

When initiated either by flight crew action or an automatic trigger, an ATS Facilities Notification Contact message is sent and Avionics Timer ATST1 is set. The aircraft AFN application then awaits an AFN Acknowledgement message from the ground.

Subject to prior agreement with the service provider, the supplementary address field of the ATS Facilities Notification Contact message may contain an abbreviation of the ATC center address to which the message should be delivered (such as the corresponding IATA or ICAO code).

If a successful AFN Acknowledgement message is received within the period of ATST1, a positive indication is given to the flight crew and timer ATST1 cancelled. The AFN Acknowledgement message will contain the full 7-character address of the ground AFN end-system. This address should be used in all subsequent AFN communication with the particular ATS facility.

c-2

COMMENTARY

This specification does not define the man/machine interface. The reference above to providing a positive indication to the aircrew may be accomplished in a variety of ways and is subject to user/airframe installation design and certification considerations. Implementations may differ.

If the aircraft AFN receives an AFN Acknowledgment message with a non-zero Reason code or timer ATST1 expires, an error indication is given to the flight crew.

3.0 ATS FACILITIES NOTIFICATION

3.3.2 Request For Notification

3.3.2.1 Purpose

An AFN Contact Advisory message requests the aircraft to notify a new ground facility. If communication has already been established between an airborne application and a ground AFN application (using the Initial Notification procedure), the ground application may send an AFN Contact Advisory message to the aircraft AFN application requesting that an AFN Contact message be sent to another ground AFN application (presumably at another ATS facility).

3.3.2.2 Request for Notification - Basic Procedure

c-2 | Once an AFN Contact Advisory message is sent, the ground AFN application sets ground timer ATST2 and awaits an AFN Response message.

Upon receipt of the AFN contact advisory message the aircraft AFN transmits an AFN Response message to the ground AFN and then performs an Initial Notification procedure with the ground AFN application whose address appeared in the next ATC Center field of the AFN Contact Advisory message. The aircraft AFN application will ignore subsequent AFN Contact Advisory messages until an AFN Acknowledgement is received or ATST1 expires.

Upon receipt of a “successful” AFN Response message by the ground AFN, ground timer ATST2 is cancelled, ground timer ATST3 is set and the ground AFN awaits an AFN Complete message.

Upon expiration of ground timer ATST2, the ground AFN may attempt to retransmit the AFN Contact Advisory message up to three times. At the end of these attempts or the receipt of an AFN Response message with a non-zero reason code an error indication should be given to the air traffic controller. The air traffic controller is then expected to contact the aircraft through other means.

Upon successful completion of the Initial Notification with the next ATS facility, the aircraft AFN transmits an AFN Complete message to the first ground AFN.

Upon receipt of a successful AFN Complete message, ground timer ATST3 is cancelled and a positive indication should be given to the air traffic controller.

Upon expiry of ground timer ATST3 or receipt of an AFN Complete message with an error code an error indication should be given to the air traffic controller. The air traffic controller is then expected to contact the aircraft through other means.

3.3.3 AFN - Active Flag

3.3.3.1 Purpose

Certain AFN messages contain an Active Flag that can be used to indicate which ATC Center is the ACTIVE facility; i.e. that which has control or is about to assume control of an aircraft.

3.3.3.2 Procedures for Active Flag

All FN_CON messages initiated by crew input will have the

Active Flag set to one, indicating to the addressed ATC Center that it is the Active Center.

If FN_AK is received in response to an FN_CON which had the Active Flag set to one, the 7-character address it contains will be stored as the Active Center address, overwriting any previous Active Center address.

FN_CON messages initiated in response to an FN_CAD message will have the Active Flag set to one only if both of the following conditions are met:

- The Active Flag in the FN_CAD message is set to one.
- The address of the center that sent the FN_CAD message matches the Active Center address.

COMMENTARY

The active status is kept at the current facility by setting the active flag to zero. The active status is passed to the next center by setting the active flag to one. When an ATS facility receives an FN_CON message with the Active Flag set, it becomes the active center. The ground facility should remain active if it will be sending additional FN_CAD messages to the avionics AFN. If the ground facility will not have future contact with the aircraft, it should pass the active flag to the next facility.

3.3.4 Procedure at End of Flight

At the end of a complete flight, all AFN ground end-system addresses (including the Active Center) will be cleared. c-2

COMMENTARY

The complete flight may consist of multiple flight legs. Some applications may continue even when the aircraft makes intermediate stops. c-2

3.4 Timers/Reason Codes

Timer values are follows:

Timer	Interval
ATST1: avionics timer	5 minutes
ATST2: ground timer	5 minutes
ATST3: ground timer	7.5 minutes

Certain AFN messages will contain the following reason codes either indicating the success of a message exchange or providing a reason for its failure.

Reason Code	Report
0	Successful
1	Protocol error
2	Version mismatch
3	Maximum number of resources exceed
4	Could not match ID/position to flight plan
5	Unknown

3.0 ATS FACILITIES NOTIFICATION**3.5 AFN Message Formats****3.5.1 Labels/MFIs**

c-3 The MFI (or label) B0 is used for AFN (ATS Facilities Notification) downlink and the MFI (or label) A0 is used for AFN uplinks. See ARINC Specification 620 for a description of the translation of air/ground messages to the ground/ground formats used between DSP and user.

COMMENTARY

c-3 The AFN is formatted as a character-oriented application. It contains the slash </> character following the IMI.

3.5.2 Cyclic Redundancy Check

As described in Section 2.2.3 of this specification, a 16-bit CRC is calculated over the IMI and the AFN message (including the Header) and then appended to the message.

c-2 The CRCs shown in the sample messages in Chapter 3 are not exact because they do not include the AFN message header.

3.5.3 AFN Message Header

An AFN Message Header that has the following format prefixes each AFN message:

For an ACARS MU:

c-2 **/ctr_addr.IMI/MTIfit_no,tail_no,icao_id (optionl), time(optionl)**

For an ACARS Peripheral:

c-2 **/MFI ctr_addr.IMI/MTIfit_no,tail_no,icao_id (optionl), time(optionl)**

Where the fields are:

Field	Value
c-3	Slash </>
c-2	MFI A0 or B0 (if used)
c-3	ctr_addr 4 or 7 character ATC center address
c-3	IMI AFx
c-2	Slash </>
c-2	MTI FMH
c-2	flt_no Flight ID
c-2	tail_no Aircraft Registration
c-2	icao_id ICAO 24-bit Identifier (optional)
c-2	time Time Stamp in HHMMSS format (optional)
c-2	Comma Used as a field delimiter

The detailed formats of the ATS message fields are defined in Table 3-1 of Attachment 3, while the Message Type Identifiers (MTI) are defined in Table 3-2 of Attachment 3.

The ICAO 24-bit Aircraft Address field is provided, as an option, to facilitate migration to the ATN for systems being developed to use the AFN application. See ARINC Specification 429, "Mark 33 Digital Information Transfer System, Part 1, Functional Description, Electrical Interface, Label Assignments and Word Formats" for the format of these (Label 214 and 216) broadcast data words. c-2 c-3

The address information (tail_no, and flt_no, or tail_no, flt_no and icao_id) of incoming messages should be compared with the corresponding address of the aircraft to ensure that the message should be accepted. If there is not a match, the message should be discarded. This same test should be exercised on the ground for downlinks. c-2

For example, an uplink message (with Header) from the Oakland center (OAK) to an ACARS peripheral on aircraft tail number N678DL flying flight DL001 at time 121212 could be: c-2

/A0 OAKXGXA.AFN/FMHDL001,.N6 78DL,,121212

Note that if the ICAO 24-bit Address field is not used, the field is still prefixed by a comma to separate it from the Aircraft Registration Number (AN) of .N678DL and the time stamp of 121212. Therefore, there are two commas between the AN and the time stamp in the above example.

In the next example, aircraft N678DL has the ICAO 24-bit Address '1010 1000 1111 1001 1100 0110' which is translated to 'A8F9C6' in ISO-5 characters. If the Header of a downlink to Oakland Center includes the optional ICAO 24-bit Address, the format will be: c-2

/B0 OAKXGXA.AFN/FMHDL001,.N678DL,A8F9C6, 121515

When time information is not available, the message is sent without the Time Stamp field. Note that if the time stamp is not used the proceeding comma is omitted. Similarly if the ICAO 24-bit address and the time stamp are omitted then the commas that would precede these fields are omitted also.

The AFN Header must be prefixed to the application message data given in the remainder of this Chapter. c-2

The names and field descriptions of AFN messages are provided in the following Sections.

3.5.4 AFN Contact Message

An AFN Contact Message (FN_CON) message provides notification to the ground AFN application that the aircraft supports ATS data communications. It further provides the necessary addressing, position and function set so that communication is possible. The function set for the FN CON message consists of the application name and version number of all ATS applications and the application interfaces (AIF) that are accessible to the aircraft AFN application.

Aircraft end-system routing addresses are not explicitly passed in the FN_CON message. The end-system address is decoded from the ACARS network header.

The format of the AFN Contact Message (Header not shown) is: c-2

3.0 ATS FACILITIES NOTIFICATION

/FPOposition,act_fl/FCOap_name,vers/FCOap_name,
vers .../FCOap_name,versCRC

(where “...” indicates more fields are allowed) The characters ‘XXXX’ are used as a placeholder for the CRC values in Chapter 3 since the AFN header is not included in the example messages.

An example of an AFN Contact Message (Header not shown) downlink from an aircraft at 38°44.1’N, 77°22.1’W with the capability to support ADS (ARINC 745) Version 2 and ATCComm Version 3 and Application Interface Version 0 follows:

**/FPON38441W077221,1/FCOADS,02/FCOATC,03/
FCOAIF,00XXXX**

Field	Interpretation
FPO	MTI for FN_CON message
N38441 W077221	Aircraft position
1	Active flag
FCO	Message Type Identifier
ADS	Application name indicating ADS
02	Version number two
FCO	Message Type Identifier
ATC	Application name indicating ATC Comm
03	Version number three
FCO	Message Type Identifier
AIF	Application name indicating Application Interface
00	Version number zero
XXXX	Hex character representation of CRC for the FN_CON message

Specific application names and version numbers for bit-oriented ATS applications are found in Table 2-1 of Attachment 2. The application name and version number for the application interface are found in Section 4.1. See Table 3-1 for detailed formats for the message fields.

3.5.4.1 Additional Information

Additional information is transmitted as a part of the FN_CON message. The order of the Message Type Identifiers, FPO and FCO is not important. Only one FPO (containing position and active flag) is expected, while multiple FCOs (containing a single function set each) are expected.

The initial ATC center address used in the AFN header may be obtained from user input, an automated trigger, or from the previous FN_CAD message. If the user enters this address, it may be the 4-character ICAO code of the ATS facility. This 4-character address is expanded by the DSP, and the appropriate 7-character address is passed back up to the avionics in the corresponding FN_AK message.

Details on the use of the Active Flag are given in Section 3.3.3.2.

3.5.5 AFN Acknowledge Message

An AFN Acknowledge (FN_AK) message acknowledges the AFN Contact (FN_CON) message. It further provides the reason codes, ICAO code and function set to give the aircraft AFN some indication of the level of service that will be available to it. The function set for the AFN Acknowledge message consists of application name, reason code, and where required the ATC Center address for the ATS applications received in the AFN Contact downlink message.

The format of the AFN Acknowledge message (header not shown) is:

/FAKreason,ICAO_cd/FARap_name,reason,ctr_ addr/FARap_name,reason.../FARap_name,reason,ctr_addr CRC

(where “...” indicates more fields allowed)

Example 1:

An example of an AFN Acknowledge Message from an ATC center that is not the active center when this message was created follows:

**/FAK0,KZAK/FARADS,0/FARATC,0/FARAIF,0,
OAKXGXAXXX**

This indicates that the notification was successful and the ground system supports the aircraft’s version of ADS, ATC and Application Interface requested.

Field	Interpretation
FAK	MTI for FN_AK message
0	Overall Reason code
KZAK	ICAO code
FAR	Message Type Identifier
ADS	Application name indicating ADS
0	Reason code for Application
FAR	Message Type Identifier
ATC	Application name indicating ATC Comm
0	Reason code for Application
FAR	Message Type Identifier
AIF	Application name indicating Application Interface
0	Reason code for Application Interface
OAKXGXA	Originating ATC center address
XXXX	Hex character representation of CRC for FN_AK message.

Specific application names and version numbers for bit-oriented ATS applications are found in Table 2-1 of Attachment 2. See Table 3-1 for detailed formats for the message fields.

3.0 ATS FACILITIES NOTIFICATION**3.5.5.1 Additional Information**

- c-2 Additional information can be transmitted using the FN_AK message. The order of the Message Type Identifiers is not important. The format of this message follows the rules: one FAK (containing a reason code and ICAO code), and zero or more FARs (containing a single function set each). Within an FAR segment, the application address field is only mandatory if the ATS center is the active center.

COMMENTARY

The function set in this message is expected to contain no more than the function set that was sent in the FN_CON message (if the FN_AK reason code is 0).

FAR reason codes apply specifically to that application. It is possible for a ground center to support a different set of applications than the aircraft, therefore the application reason code indicates a successful or unsuccessful match.

- c-2 Version numbers are not sent by the ground AFN application to the aircraft AFN application. This is because only the ground system can match the aircraft version numbers. If the requested version is not supported by the ground center, then as per Example 3 below, the version mismatch reason code is given.

It is possible for the FN_AK message to contain only the overall reason code, and no application responses. The avionics AFN will interpret an FN_AK of this format to mean that the AFN transaction was successful, but none of the requested applications of the indicated version are available at this ATS facility.

- c-2 Within an FIR Sector, if the ATC center is the active center, then the application address field(s) is mandatory. If a 4-character ICAO code was sent in the downlink FN_CON, then the FN_AK must contain the 7-character address (in the AFN header) to be used by the avionics for future communication with this center. The ICAO code field is used by the avionics AFN to correlate the FN_AK to the FN_CON.

COMMENTARY

The ICAO code may also be used as an indication to the flight crew that a notification has occurred. For example, after an automatic request for notification and successful receipt of an FN_AK, the 4-character ICAO address contained in the message may be displayed to the flight crew as an indication of the approaching FIR/Sector.

Example 2:

c-2 /FAK3,KZAK42A6XXXX

- c-2 In this example, the ATC center is not the active center and the ground AFN application has transmitted a fail indication. The ground AFN application has exceeded its resources and is unable to process the request. The aircraft AFN application should re-transmit the FN_CON at a later time.

Example 3:

/FAK0,KZAK/FARADS,0/FARATC,2/FARAIF,0,OAKXGXAXXXX

In this example, the ATC center is not the active center and the notification was successful and the ground system supports ADS and the application interface successfully but the ATC version could not be matched (possibly because the aircraft has a newer version than the ground system).

3.5.6 AFN Contact Advisory (FN_CAD) Message

An FN_CAD message requests the aircraft to notify a new ground facility. It is generated by the ground AFN application and sent to the aircraft AFN application. This message consists of one Message Type Identifier and contains the address of the next ATS facility that should be notified, and the active status to be assigned to that center.

The format of Contact Advisory Message is:

/FCAnext_ctr_addr,act_flgrc

Example 1:

/FCAHNLXGXA,1XXXX

This example shows that the ground wishes the aircraft to notify the Honolulu (HNL) ground center and that the active status is being passed to the Honolulu center.

Field	Interpretation
FCA	MT1 for FN_CAD Message
HNLXGXA	Next ATC Center Address
1	Active Flag, set to 1
XXXX	Hex character representation of the CRC for FN_CAD message.

Specific application names and version numbers for bit-oriented ATS applications are found in Table 2-1 of Attachment 2. See Table 3-1 for detailed formats for the message fields.

3.5.6.1 Additional Information

Additional information can be transmitted using the FN_CAD message. The avionics AFN will generate an FN_CON message in response to an FN_CAD.

The next ATC center address is used by the avionics AFN in the FN_CON message for notification to the next ATS facility.

Example 2:

/FCAHNLXGXA,0XXXX

This message indicates that the ground AFN application wishes the aircraft to notify the Honolulu (HNL) ground center and the active status is not changing. This time the ground center will keep the ability to send additional FN_CAD messages to the avionics AFN.

3.0 ATS FACILITIES NOTIFICATION**3.5.7 AFN Response Message**

An AFN Response (FN_RESP) message indicates acceptance or rejection of the FN_CAD. The aircraft AFN application generates the AFN Response. This message consists of a single Message Type Identifier (MTI), which contains a Reason code.

c-2 | The format of AFN Response message is:

/FRPreasonCRC

Example:

c-2 | **/FRP0XXXX**

This message indicates that the aircraft understands the FN_CAD and will perform the notification transaction with the next ground facility. This message does not indicate whether or not the notification transaction was successful.

c-2 |

Field	Interpretation
FRP	MT1 for FN-RESP Message
0	“Successful” Reason Code
XXXX	Hex Character Representation of CRC for FN_RESP Message

c-2 |

c-2 |

See Table 3-1 for detailed formats for the message fields.

3.5.8 AFN Complete Message

An AFN Complete (FN_COMP) message conveys the outcome of the remote notification procedure to the originating facility. It is generated by the aircraft, but includes the reason code obtained from the FN_AK message from the remote ground AFN application. As such, the aircraft acts as a “go-between” for the two ground AFN applications. This message consists of a single Message Type Identifier, which contains the next facility’s address and next ATC center’s reason code.

c-2 | The format of the AFN Complete message is:

/FCPnext_ctr_addr,reasonCRC

Example 1:

c-2 | **/FCPHNLXGXA,0XXXX**

This indicates that the aircraft AFN application has successfully notified the Honolulu ground AFN application.

c-2 |

Field	Interpretation
FCP	MT1 for FN_COMP Message
HNLXGXA	Next ATC Center Address
0	“Successful” Reason Code
XXXX	Hex Character Representation of the CRC for the FN_COMP Message.

See Table 3-1 for detailed formats for the message fields.

3.5.8.1 Additional Information

Additional information can be transmitted using the FN_COMP message. A FN_COMP message containing a non-zero reason code indicates that the aircraft AFN was not successful in notifying the next ATS facility. Additionally, the avionics AFN has not changed the active ATS facility. The currently active facility is expected to contact the aircraft through another means.

c-2

Example 2:

/FCPOAKXGXA,4XXXX

Example 2 indicates that the aircraft AFN application failed to establish a connection with the Oakland ground AFN application because Oakland could not match the Flight ID and position to a flight plan.

c-2

3.6 Procedures for Invalid Messages

For all uplink AFN messages received, if the label or MFI is not “A0”, the message is ignored. If the label or MFI is “A0”, then the IMI must be “AFN” or the message is invalid and ignored.

In each uplink message received, the first three characters following a slash </> character should be one of the recognized MTIs. If an unrecognized MTI is received, the entire message is ignored.

All elements following a given MTI must be in the order specified herein. If the type, length, format and/or defined values of these elements is not as specified, the entire message is ignored.

In each uplink received, if the CRC check fails, the entire message is ignored.

3.7 Aircraft State Machine

The extended finite state machine for the aircraft AFN application is shown in Table 5-1 of Attachment 5. Figure 5-1 of Attachment 5 provides an SDL Representation of the AFN application.

c-2

3.8 AFN - Working Example

Appendix C, provides a working example of the AFN application in use on hypothetical flight between Oakland and Sydney.

3.0 ATS FACILITIES NOTIFICATION

3.5.7 AFN Response Message

An AFN Response (FN_RESP) message indicates acceptance or rejection of the FN_CAD. The aircraft AFN application generates the AFN Response. This message consists of a single Message Type Identifier (MTI), which contains a Reason code.

The format of AFN Response message is:

/FRPreasonCRC

Example:

/FRP0XXXX

This message indicates that the aircraft understands the FN_CAD and will perform the notification transaction with the next ground facility. **This message does not indicate whether or not the notification transaction was successful.**

Field	Interpretation
FRP	MT1 for FN-RESP Message
0	“Successful” Reason Code
XXXX	Hex Character Representation of CRC for FN_RESP Message

See Table 3-1 for detailed formats for the message fields.

3.5.8 AFN Complete Message

An AFN Complete (FN_COMP) message conveys the outcome of the remote notification procedure to the originating facility. It is generated by the aircraft, but includes the reason code obtained from the FN_AK message from the remote ground AFN application. As such, the aircraft acts as a “go-between” for the two ground AFN applications. This message consists of a single Message Type Identifier, which contains the next facility’s address and next ATC center’s reason code.

The format of the AFN Complete message is:

/FCPnext_ctr_addr,reasonCRC

Example 1:

/FCPHNLXGXA,0XXXX

This indicates that the aircraft AFN application has successfully notified the Honolulu ground AFN application.

Field	Interpretation
FCP	MT1 for FN_COMP Message
HNLXGXA	Next ATC Center Address
0	“Successful” Reason Code
XXXX	Hex Character Representation of the CRC for the FN_COMP Message.

See Table 3-1 for detailed formats for the message fields.

3.5.8.1 Additional Information

Additional information can be transmitted using the FN_COMP message. A FN_COMP message containing a non-zero reason code indicates that the aircraft AFN was not successful in notifying the next ATS facility. Additionally, the avionics AFN has not changed the active ATS facility. The currently active facility is expected to contact the aircraft through another means.

Example 2:

/FCPOAKXGXA,4XXXX

Example 2 indicates that the aircraft AFN application failed to establish a connection with the Oakland ground AFN application because Oakland could not match the Flight ID and position to a flight plan.

3.6 Procedures for Invalid Messages

For all uplink AFN messages received, if the label or MFI is not “A0”, the message is ignored. If the label or MFI is “A0”, then the IMI must be “AFN” or the message is invalid and ignored.

In each uplink message received, the first three characters following a slash </> character should be one of the recognized MTIs. If an unrecognized MTI is received, the entire message is ignored.

All elements following a given MTI must be in the order specified herein. If the type, length, format and/or defined values of these elements is not as specified, the entire message is ignored.

In each uplink received, if the CRC check fails, the entire message is ignored.

3.7 Aircraft State Machine

The extended finite state machine for the aircraft AFN application is shown in Table 5-1 of Attachment 5. Figure 5-1 of Attachment 5 provides an SDL Representation of the AFN application.

3.8 AFN - Working Example

Appendix C, provides a working example of the AFN application in use on hypothetical flight between Oakland and Sydney.

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c-2

c-2

4.0 SUPPORT FOR BIT-ORIENTED APPLICATIONS**4.1 ACARS - Application Interface**

In addition to the general conversion/restoration functions described in Chapter 2, bit-oriented applications require functions specific to each application. This section documents the “Application Interface” which provides the specific functions that allow each bit-oriented application to transparently interact with the ACARS connectionless network service.

c-2 The use of an Application Interface and the ACARS Compatible System described in Chapter 2 is known as the ACARS Convergence Function (ACF). Application section (i.e., designed to Supplement 2 of this specification) have application name AIF, and Version number 0.

c-2 The processes described in this Chapter have been designed to facilitate migration from the current ACARS air/ground network to the bit-oriented Aeronautical Communications Network (ATN) without changes to the applications themselves. Figure 6-1 of Attachment 6 below depicts the relationship of the material defined herein to that defined in related AEEC Specifications.

c-2 **4.2 Address Verification**

c-2 The Aircraft Registration Number is provided in bit-oriented uplink and downlink messages for verification purposes. It is located between the IMI and application data. The Aircraft Registration Number field is a fixed length field of seven characters. These characters may be [A-Z], [0-9], a period <.> or a dash <->. Where an Aircraft Registration Number is less than seven characters, the Aircraft Registration Number should be placed in the right of the field and the remainder of the field padded-out with period <.> characters as specified in Specification 618.

If the Aircraft Registration Number received in an uplink message does not match that of the aircraft itself, the aircraft End System should discard the message.

The Application Interfaces described here will fully support ATN-compliant applications as they will emulate the ISO 8072 Transport Service. The Application Interface provides a convergence function between the connection-oriented ISO 8072 Transport Service Interface and the connectionless ACARS protocol beneath it, this entails:

- Providing local responses to all primitives as required by the application.
- Providing local initiation of all primitives supported by TP4. (Except the EXPEDITED DATA primitives as these are not supported by the ATN).
- Mapping the Supplementary Address field to/from an emulated transport connection at the interface to the application.
- Mapping primitives into ACARS messages and vice-versa, to provide specific services, peculiar to each application, e.g., a DISCONNECT message for the ADS application and a DISCONNECT REQUEST message for the TWDL (ATCComm) application.

COMMENTARY

If the ground End System receives a message containing an Aircraft Registration Number that does not match the Aircraft Registration Number used in the AFN or ATS Inter-facility Data Communication (AIDC) messages relevant to that aircraft, the air traffic controller should be alerted.

4.3 ADS Provisions

For a full definition of the ADS message formats and the procedures to support them refer to ARINC Characteristic 745 and the DO-212 Minimum Operational Performance Standard (MOPS).

The IMI for the Automatic Dependent Surveillance application process is ‘ADx’ (where x indicates version). The Automatic Dependent Surveillance (ADS) application is defined in ARINC Characteristic 745 and RTCA DO-212.

4.3.1 ADS Contracts

In the terminology of Characteristic 745, the ADS system consists of an airborne ADS Function (ADSF), an application, communicating with one or more ground based ADS Processors (ADSPs).

In the ADS system, contracts are established by the ADSPs with the ADSF to obtain downlink data. Two basic ADS message categories exist:

- contract management messages, (uplink and downlink) and
- downlink ADS reports.

It is vital that the Supplementary Address (or address list) remain static throughout the lifetime of an ADS contract. An ADS contract begins with a “CONTRACT REQUEST” message, and ends with a DISCONNECT (Cancel all contracts and terminate connection) message. ADS contracts that were initiated with a ground based message containing a given Supplementary Address field may only be altered or terminated by messages containing the same Supplementary Address field (with the addresses listed in the same order). ADS messages containing anything other than a perfect match of the Supplementary Address field will result in a new, separate ADS contract being formed.

4.3.2 ADS Uplink Message Format

The ground-based ADS application in the ADSP generates the data to be uplinked. The data is translated into ISO-5 characters for transit across the ACARS network by the ACF. A bit-oriented ADS application message (0000 0111 0010 1101) is used in the examples in the following subsections. It is generated and translated to ISO-5 for transit over the ACARS network as follows:

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4.0 SUPPORT FOR BIT-ORIENTED APPLICATIONS

Application Message		Hex Character	ISO-5 Bits	
MSB	LSB		MSB	LSB
0000		0	0011	0000
0011		7	0011	0111
0010		2	0011	0010
1101		D	0100	

Text	Interpretation
OAKXGXA	Originating ATC Center address
ADS	IMI indicating Automatic Dependent Surveillance (ADS)
.N678DL	Aircraft Registration
072D	Hex-character representation of the ADS application data
EAF7	Hex-character representation of the CRC calculated on 'ADS.N768DL072D'

c-2 | which yields, when decoded, the resultant ADS Periodic Contract Request containing:

Normal Periodic Request Tag = 7

ADS Contract Request Number = 45

ADS application data is interpreted (using Attachment 8-2 of ARINC Characteristic 745)

4.3.3 ADS Downlink Message Format

The airborne ADS application (ADSF) will generate downlink messages to report the aircraft's position based on the parameters specified in the uplink command of Section 4.3.2.

An example of ADS downlink application message data that corresponds to the uplink example above, contains:

Acknowledgement tag = 3

ADS Contract Request Number = 45

and is coded into ISO-5 characters as:

Application Message		Hex Character	ISO-5 Bits	
MSB	LSB		MSB	LSB
0000		0	0011	0000
0011		3	0011	
0010		2	0011	0010
1101		D	0100	

4.3.3.1 ADS Downlink from an ACARS Peripheral

The format of the character-encoded ADS message, when created by an ACARS peripheral is:

/MFI ctr_addr.IMItail_noapp_messageCRC

An example downlink, to be routed to Oakland Center, is as follows:

/B6 OAKXGXA.ADS.N678DL032D2633

Field	Interpretation
B6	MFI that points to ACF for ADS
OAKXGXA	Destination ATC Center address
ADS	IMI indicating Automatic Dependent Surveillance (ADS)
.N678DL	Aircraft Registration
032D	Hex-character representation of the ADS application data
2633	Hex-character representation of the CRC calculated on 'ADS.N678DL032D'

c-2 | 4.3.2.1 ADS Uplink to an ACARS Peripheral

The format of an ADS uplink to an ACARS peripheral is:

/MFI ctr_addr.IMItail_noapp_messageCRC

An example of an ADS uplink to an ACARS peripheral is as follows:

c-2 | /A6 OAKXGXA.ADS.N678DL072DEAF7

where the fields have the following meaning:

Text	Interpretation
A6	MFI that points to ACF for ADS
OAKXGXA	Originating ATC Center address
ADS	IMI indicating Automatic Dependent Surveillance (ADS)
.N678DL	Aircraft Registration
072D	Hex-character representation of the ADS application data
EAF7	Hex-character representation of the CRC calculated on 'ADS.N678DL072D'

c-2 | 4.3.2.2 ADS Uplink to an ACARS MU

The format of an ADS uplink to an ACARS MU is:

/ctr_addr.IMItail_noapp_messageCRC

An example of an ADS uplink to an ACARS MU operating as an End System is as follows:

/OAKXGXA.ADS.N678DL072DEAF7

where the fields have the following meaning:

4.0 SUPPORT FOR BIT-ORIENTED APPLICATIONS**4.3.3.2 ADS Downlink from an ACARS MU**

The format of the character-encoded ADS message, when created by an ACARS [C]MU is:

/ctr_addr.IMItail_noapp_messageCRC

An example downlink, to be routed to Oakland Center, is as follows:

/OAKXGXA.ADS.N678DL032D2633

Field	Interpretation
OAKXGXA	Destination ATC Center address
ADS	IMI indicating Automatic Dependent Surveillance (ADS)
N678DL	Aircraft Registration
032D	Hex-character representation of the ADS application data
2633	Hex-character representation of the CRC calculated on 'ADS.N678DL032D'

generates a (T_Disconnect.req) primitive (Disconnect reason 8).

- d. Expiration of the ADS Contract Inactivity timer prompts the ADS application to clear ADS tables, and generates the (T_Disconnect.req) primitive (Disconnect reason 0).
- e. When three consecutive applications NAKs on the same connection are generated, the ADS application clears ADS tables, and generates the (T_Disconnect.req) primitive (Disconnect reason 0).

The ACF Application Interface receives the (T_Disconnect.req) primitive and generates an ADS DISCONNECT message. The ADS DISCONNECT message contains the IMI of 'DIS', a binary Reason code, and a CRC. The ADS DISCONNECT message is sent to the same address as the ADS application messages.

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COMMENTARY

This message is interpreted by the Ground-Based ACF Application Interface peers. Upon receiving this message, the ground-based peers should generate a T_Disconnect.ind to their ADS applications and clear their own connection tables.

As the 'Supplementary Address Field' can support a number of addresses, ADS DISCONNECT messages can be sent to one or more ground-based ADSPs, any of which can terminate the current ADS contract. It is important (from an ATC-user perspective) that all other ADSPs also receive the resultant DISCONNECT message, to inform them that the current contract has been terminated.

Binary Reason codes for the DISCONNECT message are as follows:

Code Base-10	Code Binary	Meaning
0	0000	Reason not specified
1	0001	Congestion
2	0010	Application not available
8	1000	Normal Disconnect

COMMENTARY

The Reason codes were chosen to match the Disconnect Reason codes specified in ISO 8073 Transport Protocol Specification.

Since the reason code is a 4-bit field, it is padded to the right with trailing zeros to form a complete octet. For example, a reason code of "1" is represented as 0001 0000 in binary and translates into the ASCII characters '10'.

The binary form of the Reason code is processed through the bit-to-hex conversion function in the same manner as an ADS message.

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4.3.4 ADS DISCONNECT Message

Release of the connection between a ground-based ADS application and an aircraft ADS application is accomplished through the use of an ADS DISCONNECT message.

Because the ADS application was designed to reside over the ISO 8073 Transport layer, it expects certain services to be performed in the case of connection termination. In the ATN, a Transport Protocol DISCONNECT REQUEST message would be sent to the ground ADSP. At the Application Interface, a character-encoded ACF message provides this capability. See Figure 1-1 in Attachment 1, which depicts the peer to peer relationship of the ADS Disconnect message. This message preserves the functionality of ARINC Characteristic 745, and provides the explicit DISCONNECT downlink message similar to a Transport protocol.

In the following text, the use of the T_Disconnect.req primitive means that a local "function call" took place that informed the protocol software that ADS has terminated.

The following circumstances will result in the termination of ADS processing with explicit ground End System notification through the use of the ACF Application Interface ADS DISCONNECT message:

- a. When its resources are exceeded, the ADS Function (ADSF) responds to new ADS association start-up messages by generating a (T_Disconnect.req) primitive to its ACF Application Interface (Disconnect reason 1).
- b. Non-error termination of ADS processing on the aircraft halts ADSF processing, generating a (T_Disconnect.req) primitive (Disconnect reason 2).
- c. When a given Supplementary Address field sends a "Cancel All Contracts and Terminate Connection" message, the ADS application clears its tables, and

4.0 SUPPORT FOR BIT-ORIENTED APPLICATIONS**4.3.4.1 ADS DISCONNECT from an ACARS Peripheral**

The format of an ADS DISCONNECT Message generated by an ACARS peripheral is:

/MFI ctr_addr.IMItail_noxCRC

An example of a DISCONNECT message from an ACARS peripheral is as follows:

/B6 OAKXGXA.DIS.N678DL208FDB

where the fields have the following meaning:

Text	Interpretation
B6	MFI for ACF for ADS downlinks (The same MFI is used for both ADS Reports and DISCONNECT messages)
OAKXGXA	Destination ATC Center address
DIS	IMI pointing to the ACARS Compatible Process
.N678DL	Aircraft Registration
20	Disconnect Reason code 2 in ISO-5 representation
8FDB	Hex-character representation of the CRC calculated on 'DIS.N678DL0'.

The Disconnect Reason code is padded to complete an octet (ISO-5).

4.3.4.2 ADS DISCONNECT from an ACARS MU

The format of an ADS DISCONNECT Message generated by an ACARS [C]MU is:

/ctr_addr.IMI.tail_noxCRC

An example of an ADS DISCONNECT message from an ACARS [C]MU operating as an End System is as follows:

/OAKXGXA.DIS.N678DL208FDB

where the fields have the following meaning:

Field	Interpretation
OAKXGXA	Destination ATC Center address
DIS	IMI pointing to the ACARS Compatible Process
.N678DL	Aircraft Registration
20	Disconnect Reason code 2 in ISO-5 representation
8FDB	Hex-character representation of the CRC calculated on 'DIS.N678DL0'

4.4 ATCComm Provisions

The Air Traffic Control Communication (ATCComm) application is defined in the RTCA Minimum Operational Performance Standards (MOPS) for ATC Two-way Data Link Communications, DO-219.

COMMENTARY

ATCComm was previously known as Two-Way Data Link, or TWDL. Currently the term used by ICAO is Controller/Pilot Data Link Communications (CPDLC).

4.4.1 ATCComm ACF Processing

The ATC ground system establishes the connection and sends the first ATCComm message to the aircraft (as required by the ATCComm MOPS DO-219). The ACARS Convergence Function (ACF) uses the address received in the first ATCComm message for all further communications with that ATC ground system.

The ATCComm application is designed to reside atop the OSI Transport layer, using the connection-oriented ISO 8073 Transport Profile Class 4 (TP4) primitives to communicate with its communication stack. The ATCComm application has specific functions, which were designed around these Transport layer primitives. These functions are Connection Establishment and Handoff of Control. To allow the ATCComm application to perform these functions in an ACARS environment without changing the ATCComm application requirements, the ACF interface must emulate the operation of the Transport layer primitives in a manner that provides reliable end-to-end state synchronization between the ATCComm air and ground applications.

The ACF provides mapping of Transport layer primitives to ACARS messages and ACARS messages to Transport layer primitives. To provide the Transport layer functions required by the ATCComm application, four IMIs are used with the MFI or label ('AA' for uplinks, 'BA' for downlinks) that points to the ACF for ATCComm.

The IMIs and their respective primitives are as follows:

IMI	Primitive
CRx	Connect Indication Transport Layer Primitives (Uplink Only)
CCx	Connect Response Transport Layer Primitives. (Downlink Only).
ATx	Data Indication and Data Request Transport Layer Primitives
DRx	Disconnect Request Transport Layer Primitives

where 'x' indicates version number.

There are three ATCComm functional areas covered: connection establishment, communication transactions and connection termination. Connection establishment uses the IMIs 'CRx' and 'CCx'. Communication transactions use the IMI 'ATx'. Connection termination uses the IMI 'DRx'.

4.4.2 ATCComm Connection Establishment

A "connection" is established as follows. When ATCComm service is desired, the ground ATC application forwards a CONNECT REQUEST Transport layer primitive to the ground ACF with ATCComm information in the ATS

4.0 SUPPORT FOR BIT-ORIENTED APPLICATIONS**4.4.2 ATCComm Connection Establishment (cont'd)**

c-2 Application Data field. The ground ACF forms an ACARS message with the user data in the CONNECT REQUEST Transport primitive and sends the message to the aircraft using the 'CRx' IMI.

The aircraft ACF receives this message and checks its connection table based on the Supplementary Address in the message. Since the aircraft ACF has no entry for this Supplementary Address, the aircraft ACF converts the data received, as defined in Section 2.2.4, and puts it into the ATS Application Data field of a CONNECT INDICATION Transport primitive and forwards the primitive to the aircraft ATCComm application. The aircraft ATCComm application then processes this data per its criteria. If the CONNECT REQUEST is valid, the aircraft ATCComm application generates a CONNECT RESPONSE Transport primitive and passes it to the aircraft ACF. The aircraft ACF forms an ACARS message with the user data in the CONNECT RESPONSE Transport primitive and sends the message to the ground using the 'CCx' IMI.

Application Message	Hex Character	ISO-5 Bits
MSB LSB		MSB LSB
0000	0	0011 0000
0000	0	0011 0000
1010	A	0100 0001
0011	3	0011 0011
1000	8	0011 1000
0010	2	0011 0010
1101	D	0100 0100
0010	2	0011 0010
0111	7	0011 0111
1010	A	0100 0001
0000	0	0011 0000
1000	8	0011 1000
0000	0	0011 0000
0000	0	0011 0000

c-2 If the CONNECT REQUEST is invalid (for reasons described in the RTCA Minimum Operational Performance Standard for ATCComm DO-219), the aircraft ATCComm application generates a DISCONNECT REQUEST Transport layer primitive and passes it to the aircraft ACF. The aircraft ACF forms an ACARS message with the user data in the DISCONNECT REQUEST Transport layer primitive and sends the message to the ground using the 'DRx' IMI as described in Section 4.4.4.2.

If the avionics ATCComm ACF receives a message under the following conditions, then the message will be ignored:

- a. other than one Supplementary Address is in the Supplementary Address field;
- b. an 'ATx' IMI is received prior to receiving a message with a 'CRx' IMI with the same Supplementary Address;
- c. an 'ATx' IMI is received following the sending of a message with a 'DRx' IMI with the same Supplementary Address;
- d. an IMI other than 'ATx', 'CRx' or 'DRx';
- e. an 'ATx' or 'DRx' IMI with a version different than its corresponding 'CRx' IMI version.

It is vital that the Supplementary Address remain static throughout the lifetime of an ATCComm association. (A typical ATCComm association begins with a valid Transport CONNECT REQUEST primitive and ends with an "End Service" message element.) ATCComm associations that were begun with a ground-based message containing a given Supplementary Address may only be altered or terminated by messages containing the same Supplementary Address.

4.4.2.1 ATCComm Connection Establishment Uplink

c-2 An example hex-character application uplink message received as:

Would yield, when decoded, the resultant ATCComm message:

Description	Code Value	Binary Value
Preamble ATC uplink message	0	0
Preamble ATC message header	0	0
Message identification number	0	00 0000
ATC uplink message element ID	163	1010 0011
ICAO ID CHOICE	1	1
ICAO facility name SIZE (3-3)	0	0000
ICAO facility name	Z	0101 1010
	O	0100 1111
	A	0100 0001
ICAO facility function	Center	000
ICAO unit name Tp4 table	Table A	0
Pad bits		000 0000

producing: **[Oakland Center] [Table A]**
(when translated by the TWDL application per DO-219).

COMMENTARY

The astute reader will observe that the reference in Table A is to the Oakland Oceanic center, designated ZOA, rather than the Oakland domestic center, designated OAK, used frequently in this document.

4.4.2.1.1 Connection Establishment Uplink to an ACARS Peripheral

An ATCComm uplink message to an ACARS peripheral (an End System) using the 'CRx' IMI has the following format:

/MFI ctr_addr.IMItail_noapp_messageCRC

An example of Version 1 of the 'CRx' ATCComm uplink

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message to an ACARS peripheral follows:

/AA OAKXGXA.CR1.N678DL00A382D27A08009D1F

where the fields have the following meaning:

Field	Interpretation
AA	MFI which means ACF for ATCComm
OAKXGXA	Originating ATC Center address
CR1	IMI indicating ATCComm Application CONNECT REQUEST, Version 1
.N678DL	Aircraft Registration
00A382D2 7A0800	Hex-character representation of the ATCComm application data
9D1F	Hex-character representation of the CRC calculated on the IMI, aircraft registration and Application Data

Description	Code Value	Binary Value
Preamble ATC downlink message	0	0
Preamble ATC message header	0	0
Message identification number	2	00 0000
Message reference number	0	1010 0011
ATC downlink message element ID	73	0100 1001
Version number	1	0001
Pad bits	---	0000000

and is coded into ISO-5 characters represented as:

Application Message MSB LSB	Hex Character	ISO-5 Bits MSB LSB
0100	4	0011 0100
0010	2	0011 0010
0000	0	0011 0000
0001	1	0011 0001
0010	2	0011 0010
0100	4	0011 0100
0100	4	0011 0100
0000	0	0011 0000

4.4.2.1.2 Connection Establishment Uplink to an ACARS MU

An ATCComm uplink message to an ACARS [C]MU (as an End System) using the 'CRx' IMI has the following format:

/ctr_addr.IMItail_noapp_messageCRC

An example ATCComm Version 1 uplink message to an ACARS [C]MU follows:

/OAKXGXA.CR1.N678DL00A382D27A08009D1F

where the fields have the following meaning:

Field	Interpretation
OAKXGXA	Originating ATC Center address
CR1	IMI indicating ATCComm Application CONNECT REQUEST, Version 1
.N678DL	Aircraft Registration
00A382D2 7A0800	Hex-character representation of the ATCComm application data
9D1F	Hex-character representation of the CRC calculated on the IMI, aircraft registration and application data

4.4.2.2 ATCComm Connection Establishment Downlink

The ATCComm application prepares the Connection Establishment message [ATCComm Version Number 1] using the IMI of 'CC1'. An example of how the ATCComm downlink message (which responds to the uplink 'CR1' IMI example in Section 4.4.2.1.1) is generated follows:

4.4.2.2.1 ATCComm Connection Establishment Downlink from an ACARS Peripheral

The character-encoded ACF message, when created by an ACARS peripheral (as an End System) has the format:

/MFI ctr_addr.IMItail_noapp_messageCRC

An example of ATCComm communications transactions downlink message created by an ACARS peripheral sent to the Oakland Center follows:

/BA OAKXGXA.CC1.N678DL42012440A829

where the fields have the following meaning:

Field	Interpretation
BA	MFI which means ACF for ATCComm
OAKXGXA	Destination ATC Center address
CC1	IMI indicating ATCComm Application CONNECT CONFIRM, Version 1
.N678DL	Aircraft Registration
42012440	Hex-character representation of the ATCComm application data
A829	Hex-character representation of the CRC calculated on the IMI, aircraft registration and application data

4.0 SUPPORT FOR BIT-ORIENTED APPLICATIONSc-2 | 4.4.2.2.2 ATCComm Connection Establishment
Downlink from an ACARS MU

The resultant character-encoded ACF message, when created by an ACARS [C]MU (as an End System) has the format:

/ctr_addr.IMItail_noapp_messageCRC

c-2 | An example downlink, based on the application data in Section 4.4.2.2, sent to Oakland Center follows:

/OAKXGXA.CC1.N678DL42012440A829

where the fields have the following meaning:

Field	Interpretation
OAKXGXA	Destination ATC Center address
CC1	IMI indicating ATCComm Application CONNECT CONFIRM, Version 1
.N678DL	Aircraft Registration
42012440	Hex-character representation of the ATCComm application data
A829	Hex-character representation of the CRC calculated on the IMI, aircraft registration and application data

4.4.3 Data Transactions

After the “connection” has been established, either the ground or aircraft ATC applications can generate messages, based on the ATCComm application. Such a message would be sent to the ACF as part of a Data Request Transport primitive. The ACF forms an ACARS message with the user data and sends the message to its peer using the ‘ATx’ IMI. The peer ACF receives this message and checks its connection table based on the Supplementary Address in the message. Since an entry exists for this Supplementary Address, the ACF puts the data received into the Data Field of a Data Indication Transport primitive and forwards the primitive to the ATCComm application. The ATCComm application then processes this data per its specification.

4.4.3.1 Transaction Uplinks

c-2 | ATCComm communication transactions carry TWDL exchanges as defined by RTCA DO-219. The ACF translates the DO-219 data to a form consistent with the capabilities of the ACARS network.

c-2 | For example, the hex-character ATCComm application uplink message ‘CLIMB TO AND MAINTAIN [FL310]’ received from the ground is translated as follows:

Application Message MSB LSB	Hex Character	ISO-5 Bits MSB LSB
0100	4	0011 0100
0001	1	0011 0001
0000	0	0011 0000
0100	4	0011 0100
0101	5	0011 0101
0011	3	0011 0011
0010	2	0011 0010
0011	3	0011 0011
0000	0	0011 0000
0000	0	0011 0000

which yields, when decoded, the resultant ATCComm message:

c-2

Description	Code Value	Binary Value
Preamble ATC uplink message	0	0
Preamble ATC message header	1	1
Message identification number	1	00 0001
Message reference number	1	00 0001
ATC uplink message element ID	20	0001 0100
Altitude CHOICE	6	110
Altitude flight level (310-30)	280	01 0001 1000
Pad bits	---	000 0000

producing: CLIMB TO AND MAINTAIN [FL310]
(when translated by the TWDL application per DO-219).

c-2

4.4.3.1.1 Transaction Uplinks to an ACARS Peripheral

An ATCComm uplink message to an ACARS peripheral (as an End System) using the ‘ATx’ IMI has the following format:

/MFI ctr_addr.IMItail_noapp_messageCRC

c-2

An example of the uplink to an ACARS peripheral using the ‘ATx’ IMI follows:

/AA OAKXGXA.AT1.N678DL4104532300A9B3

c-2

where the fields have the following meaning:

4.0 SUPPORT FOR BIT-ORIENTED APPLICATIONS

Field	Interpretation
AA	MFI which means ACF for ATCComm
OAKXGXA	Originating ATC Center address
AT1	IMI indicating ATCComm Application, Version 1
.N678DL	Aircraft Registration
4104532300	Hex-character representation of the ATCComm application data
A9B3	CRC calculated on the IMI, aircraft registration and application data

Application Message MSB	LSB	Hex Character	ISO-5 Bits MSB	LSB
0100		4	0011	0100
0010		2	0011	0010
0000		0	0011	0000
0100		4	0011	0100
0000		0	0011	0000
0000		0	0011	0000

4.4.3.2.1 Transaction Downlinks to an ACARS Peripheral

The resultant character-encoded ACF message, when created by an ACARS peripheral (as an End System), sent to Oakland Center has the following format:

/MFI ctr_addr.IMItail_noapp_messageCRC

/BA OAKXGXA.AT1.N678DL4204008604

where the fields have the following meaning:

Field	Interpretation
BA	MFI which means ACF for ATCComm
OAKXGXA	Destination ATC Center address
AT1	IMI indicating ATCComm Application, Version 1
.N678DL	Aircraft Registration
420400	Hex-character representation of the ATCComm application data
8604	Hex-character representation of the CRC calculated on the IMI, aircraft registration and application data

4.4.3.2.2 Transaction Downlinks to an ACARS MU

The resultant character-encoded ACF message, when created by an ACARS [C]MU (as an End System) has the following format:

/ctr_addr.IMI.tail.noapp_messageCRC

An example downlink, sent to Oakland Center, follows:

/OAKXGXA.AT1.N678DL4204008604

where the fields have the following meaning:

Field	Interpretation
OAKXGXA	Destination ATC Center address
AT1	IMI indicating ATCComm Application, Version 1
.N678DL	Aircraft Registration
420400	Hex-character representation of the ATCComm application data
8604	Hex-character representation of the CRC calculated on the IMI, aircraft registration and application data

4.4.3.1.2 Transaction Uplinks to an ACARS MU

An ATCComm uplink message to an ACARS [C]MU (as an End System) has the following format:

/ctr_addr.IMItail_noapp_messageCRC

An example of the uplink to an ACARS [C]MU using the 'ATx' IMI follows:

/OAKXGXA.AT1.N678DL4104532300A9B3

where the fields have the following meaning:

Field	Interpretation
OAKXGXA	Originating ATC Center address
AT1	IMI indicating ATCComm Application, Version 1
.N678DL	Aircraft Registration
4104532300	Hex-character representation of the ATCComm application data
A9B3	CRC calculated on the IMI, aircraft registration and application data

4.4.3.2 Transaction Downlinks

ATCComm data downlink messages use the IMI of 'AT1'. An example ATCComm 'WILCO' downlink message (which responds to the uplink 'AT1' IMI example in Section 4.4.3.1) follows:

Description	Code Value	Binary Value
Preamble ATC downlink message	0	0
Preamble ATC message header	1	1
Message identification number	2	00 0010
Message reference number	1	00 0001
ATC downlink message element ID	0	0000
Pad bits	---	00

and is coded into ISO-5 characters as:

4.0 SUPPORT FOR BIT-ORIENTED APPLICATIONS**4.4.4 Connection Termination**

c-2

An ATCComm connection is terminated by the generation or receipt of a DISCONNECT REQUEST Transport layer primitive. The ATCComm application generates DISCONNECT REQUEST Transport layer primitives for several reasons, which are defined by its specification. Some reasons require Termination Reason information to be given in DISCONNECT REQUEST Transport layer primitive whereas others (such as, Handoff of Control) do not.

If the aircraft ACF receives a message with a 'DRx' IMI over a valid connection then the aircraft will delete the Supplementary Address from its connection table and forward a DISCONNECT REQUEST Transport primitive and any user data (converted as per Section 2.3), to the aircraft ATCComm application.

The format for these messages is the IMI 'DRx', followed by the reason information (if required) and the CRC.

4.4.4.1 ATCComm Connection Disconnect Uplink

c-2

The ground ATCComm application can generate a Disconnect message to terminate a connection using the IMI of 'DRx'. An ATCComm uplink message example 'ERROR [Commanded Termination]' which terminates service as a result of air traffic controller action (hence no message reference number) follows:

Description	Decimal Value	Binary Value
Preamble ATC uplink message	0	0
Preamble ATC message header	0	0
Message identification number	3	00 0011
ATC uplink message element ID	159	1001 1111
Error information	7	0111
Pad bits	---	0000

c-2

and is delivered in ISO-5 as:

Application Message MSB LSB	Hex Character	ISO-5 Bits MSB LSB
0000	0	0011 0000
0011	3	0011 0011
1001	9	0011 1001
1111	F	0100 0110
0111	7	0011 0111
0000	0	0011 0000

c-2

4.4.4.1.1 ATCComm Connection Disconnect Uplink to an ACARS Peripheral

c-2

The resultant character-encoded uplink ACF message, when destined for an ACARS peripheral has the following format:

/MFI ctr_addr.IMItail_noapp_messageCRC

An example of the 'DRx' ATCComm uplink message, sent by the Oakland Center, follows:

/AA OAKXGXA.DR1 .N678DL039F705DEF

where the fields have the following meaning:

Field	Interpretation
AA	MFI which means ACF for ATCComm
OAKXGXA	Destination ATC Center address
DR1	IMI indicating ATCComm Application DISCONNECT REQUEST, Version 1
.N678DL	Aircraft Registration
039F70	Hex-character representation of the ATCComm application data
5DEF	Hex-character representation of the CRC calculated on the IMI, aircraft registration and application data

c-2

c-2

4.4.4.1.2 ATCComm Connection Disconnect Uplink to an ACARS MU

c-2

The resultant character-encoded ACF message, when destined for an ACARS [C]MU has the following format:

/ctr_addr.IMItail_noapp_messageCRC

An example of the 'DRx' ATCComm uplink message, sent by the Oakland Center, follows:

/OAKXGXA.DR1.N678DL039F705DEF

where the fields have the following meaning:

Field	Interpretation
OAKXGXA	Destination ATC Center address
DR1	IMI indicating ATCComm Application DISCONNECT REQUEST, Version 1
.N678DL	Aircraft Registration
039F70	Hex-character representation of the ATCComm application data
5DEF	Hex-character representation of the CRC calculated on the IMI, aircraft registration and application data

c-2

c-2

4.4.4.2 ATCComm Connection Termination Downlink

c-2

The ATCComm application can generate a message to terminate connection with the ATC using the IMI of 'DRx'.

4.0 SUPPORT FOR BIT-ORIENTED APPLICATIONS

c-2

An example 'ERROR [Commanded Termination]' ATCComm downlink message, which terminates service as a result of pilot action (hence no message reference number), follows:

Description	Decimal Value	Binary Value
Preamble ATC downlink message	0	0
Preamble ATC message header	0	0
Message identification number	3	00 0011
ATC downlink message element ID	159	1001 111
Error information	7	0111
Pad bits	---	0000

4.4.4.2.2 ATCComm Connection Termination Downlink from an ACARS MU

The resultant character-encoded ACF message, when created by an ACARS [C]MU (as an End System), sent to Oakland Center has the following format:

c-2

/ctr_addr.IMITAIL_noapp_messageCRC

An example of the 'DRx' ATCComm downlink message sent to Oakland Center, follows:

/OAKXGXA.DR1.N678DL039F705DEF

c-2

where the fields have the following meaning:

Field	Interpretation
OAKXGXA	Destination ATC Center address
DR1	IMI indicating ATCComm Application DISCONNECT REQUEST, Version 1
.N678DL	Aircraft Registration
039F70	Hex-character representation of the ATCComm application data
5DEF	Hex-character representation of the CRC calculated on the IMI, aircraft registration and application data

c-2

c-2

c-2 and is coded into ISO-5 characters as:

Application Message MSB LSB	Hex Character	ISO-5 Bits MSB LSB
0000	0	0011 0000
0011	3	0011 0011
1001	9	0011 1001
1111	F	0100 0110
0111	7	0011 0111
0000	0	0011 0000

c-2

4.4.4.2.1 ATCComm Connection Termination Downlink from an ACARS Peripheral

The resultant character-encoded ACF message, when created by an ACARS peripheral (as an End System), sent to Oakland Center has the following format:

/MFI ctr_addr.IMItail_noapp_messageCRC

c-2

An example of the 'DRx' ATCComm downlink message sent to Oakland Center, follows:

/BA OAKXGXA.DR1.N678DL039F705DEF

where the fields have the following meaning:

Field	Interpretation
BA	MFI which means ACF for ATCComm
OAKXGXA	Destination ATC Center address
DR1	IMI indicating ATCComm Application DISCONNECT REQUEST, Version 1
.N678DL	Aircraft Registration
039F70	Hex-character representation of the ATCComm application data
5DEF	Hex-character representation of the CRC calculated on the IMI, aircraft registration and application data

c-2

c-2

4.5 Context Management (CMA) Provisions

Within the ACARS Convergence Function - Application Interface the IMI for the Context Manager Application is 'CMx' (where x indicates version number).

COMMENTARY

The CMA bit-oriented application is immature as of this draft. Specific requirements for the Application Interface will be identified at a later date.

c-2

4.6 Flight Information Service Provisions Within the ACARS Convergence Function - Application Interface

This is a placeholder for the provisions to support bit-oriented Flight Information Services which include weather messages.

5.0 SUPPORT FOR CHARACTER-ORIENTED APPLICATIONS**5.1 Introduction**

This chapter defines specific provisions for the support of character-oriented ATS applications.

COMMENTARY

c-2

Clearance and Flight Systems messages are also supported by the bit-oriented Two Way Data Link application, defined by the RTCA (and, at some future date, by ICAO); see Chapter 4.

This chapter describes the additional processing required to construct a comprehensive Air/Ground message replete with labels, IMIs, CRCs, ATC addresses, etc. around the Application text.

Unless otherwise stated, the applications described in this Chapter conform to the requirements of and use the functions of the ACARS Compatible System described in Chapter 2. (i.e., addressing, formatting and the CRC (including Bit/Hex Conversion)).

The airlines have recommended that all CAAs consider installation of the capabilities defined in Chapter 5 of Specification 622 when implementing character-oriented ATS applications.

c-3

COMMENTARY

The airlines favor uniformity in ATS applications to promote worldwide use of a single standard to minimize the number of unique software implementations in avionics.

5.2 Envelope for Character Applications

c-2

Figure 7-1 of Attachment 7 illustrates the relationship between ARINC characteristics 620, 622 and 623 for the character oriented ATS applications. Each characteristic defines a different layer of complete message format.

The ACARS compatible system calculates a CRC according to Section 2.2.3. The CRC calculation is performed over all of the characters from the beginning of the IMI to the end of the ATS Application Text. The eighth bit of each character should be set to zero before calculating the CRC. The ACARS compatible system converts the CRC to characters according to Section 2.2.4. The CRC characters are appended to the Character oriented ATS application text. The originator of the message calculates the CRC and includes it in the message. The recipient of the message calculates the CRC and compares it to the value contained in the message. If the two CRC values are equal then message is passed to the application otherwise it is discarded.

5.2.1 Downlinks

The supplementary address field in the character oriented ATS application downlink message should contain the address of the ATC facility to which the message should be delivered.

Each character oriented ATS application message contains a supplementary address field as described in Section 2.2.1 herein. The supplementary address field should contain the

address of the ATC facility which contains the peer ATS application.

When the ACARS compatible system for the character application resides in an ACARS peripheral then the supplementary address field also contains a two character MFI. Refer to Section 2.2.1 for rules governing the use of Labels and MFIs.

The ACARS compatible system adds a three character IMI and a slash "/" character at the start of the Character oriented ATS application text. The IMI is used to identify the specific application to which the message belongs. Where applicable, the IMI also provides the version number of the application which created the message. The ACARS compatible system uses this to determine if the application is bit-oriented or character-oriented. The Slash character (/) serves as a Field Separator between the IMI and the application message.

5.2.2 Uplinks

The supplementary address field in the character oriented ATS application Uplink message should contain the address of the ATC facility that created the message.

The IMI and Field Separator ("/") are not intended for presentation on the display/printout device.

5.3 Automatic Terminal Information Service (ATIS)

Two ATIS messages have been defined. A downlink message has been defined to request ATIS information from a ground ATS facility. An uplink message has been defined to deliver ATIS information to the aircraft.

5.3.1 Labels and MFIs

The Downlink ATIS Request message uses a Label or MFI value of B9.

The Uplink Deliver ATIS message uses a Label or MFI value of A9.

5.3.2 Imbedded Message Identifier

Version 1 of ATIS does not use an IMI.

In Version 2, the IMI for ATIS Messages is Tlx. The third character of the IMI is used to indicate the version number. | c-2

5.3.3 ATIS Application Text

ARINC Specification 623 contains the definition of the format of the application text for the ATIS messages. | c-2

5.4 Oceanic Clearance

Three Oceanic Clearance messages have been defined. A downlink message has been defined to request Oceanic Clearance information from a ground ATS facility. An uplink message has been defined to deliver Oceanic Clearance information to the aircraft. A second downlink message has been defined to indicate pilot acceptance of the Oceanic Clearance information.

5.0 SUPPORT FOR CHARACTER-ORIENTED ATS APPLICATIONSCOMMENTARY

CAA interpretation of the aircrew downlink is not yet uniform. One CAA may interpret the downlink as showing that the uplink clearance has been read. Another CAA may interpret the downlink as confirming the aircrew's intent to comply (WILCO).

c-2 The controller may choose to supplement these exchanges by generating a Flight Systems message to provide status information concerning the clearance or initiate alternate procedures. See Section 5.6.

5.4.1 Labels and MFIs

The downlink Oceanic Clearance Request message uses a Label or MFI value of B1.

The Uplink Oceanic Clearance message uses a Label or MFI value of A1.

The Downlink Oceanic Clearance Readback message uses a Label or MFI value of B2.

5.4.2 Imbedded Message Identifier

The IMI value for Oceanic Clearance Messages is OCx. The third character of the IMI is used to indicate the version number.

5.4.3 Oceanic Clearance Application Text

ARINC Specification 623 contains the definition of the format of the application text for the Three Oceanic Clearance messages that have been defined.

5.5 Departure Clearance

Three Departure Clearance messages have been defined. A downlink message has been defined to request Departure Clearance information from a ground ATS facility. An uplink message has been defined to deliver Departure Clearance information to the aircraft. A second downlink message has been defined to indicate pilot acceptance of the Departure Clearance information.

COMMENTARY

CAA interpretation of the aircrew downlink is not yet uniform. One CAA may interpret the downlink as showing that the uplink clearance has been read. Another CAA may interpret the downlink as confirming the aircrew's intent to comply (WILCO).

c-2 The controller may choose to supplement these exchanges by generating a Flight Systems message to provide status information concerning the clearance or initiate alternate procedures. See Section 5.6.

5.5.1 Labels and MFIs

The downlink Departure Clearance Request message uses a Label or MFI value of B3.

The Uplink Departure Clearance message uses a Label or MFI value of A3.

The Downlink Departure Clearance Readback message uses a Label or MFI value of B4.

5.5.2 Imbedded Message Identifier

The IMI value for Departure Clearance Messages is DCx. The third character of the IMI is used to indicate the version number.

5.5.3 Departure Clearance Application Text

ARINC Specification 623 contains the definition of the format of the application text for the Departure Clearance messages.

5.6 Flight System Message

The Flight system message uplink has been defined to deliver clearance status information to the aircraft.

5.6.1 Labels and MFIs

The uplink Flight system message Request message uses a Label or MFI value of A4.

5.6.2 Imbedded Message Identifier

The IMI value for Flight system message Messages is FSx. The third character of the IMI is used to indicate the version number.

5.6.3 Flight System Message Application Text

ARINC Specification 623 contains the definition of the format of the application text for the Flight system message messages.

5.7 Terminal Weather Information for Pilots (TWIP)

Two Terminal Weather Information for Pilots (TWIP) messages have been defined. A downlink TWIP message has been defined to request TWIP information from the ground ATS facility. A response TWIP uplink message has been defined to deliver the TWIP information to the aircraft.

5.7.1 Labels and MFI

The downlink TWIP Request message uses a Label or MFI value of BB.

The Uplink Deliver TWIP Report message uses a Label or MFI value of AB.

5.7.2 Imbedded Message Identifier

The IMI for TWIP message is TWx. The third character of the IMI is used to indicate the version number.

5.7.3 TWIP Application Data

ARINC Specification 623 contains the definition of the format of the Application data for TWIP message.

5.0 SUPPORT FOR CHARACTER-ORIENTED APPLICATIONS**5.8 Reserved****5.9 Digital Delivery of Taxi Clearance (DDTC)**

Two Digital Delivery of Taxi Clearance (DDTC) Request/Response sets have been defined: Pushback Clearance and Expected Taxi Clearance.

A downlink DDTC message has been defined to request Pushback Clearance. A DDTC uplink has been defined for the controller to send the Pushback Clearance message to the crew.

COMMENTARY

ARINC Specification 623 also defines a Pushback Request Acknowledgment uplink message to be sent using the Flight Systems message label. See Section 5.6. Therefore the entire sequence is:

Downlink Pushback Request
Uplink Pushback Request Acknowledgment
Uplink Pushback Clearance.

A second downlink DDTC message has been defined to permit the crew to request an Expected Taxi Clearance. There is an associated DDTC uplink to carry the Expected Taxi Clearance message from the controller to the aircrew.

COMMENTARY

The controller has the discretion to respond to requests in the positive or the negative. The controller may also elect to use the Flight Systems message to send exception messages such as a delay advisory or request for voice contact.

5.9.1 Labels and MFIs

The downlink DDTC Pushback Clearance Request message uses a Label or MFI value of BC. The responding Pushback Clearance Acknowledgment uses the Flight Systems Message or MFI of A4. The subsequent Pushback Clearance uplink message uses the Label or MFI value of AC.

The downlink DDTC Expected Taxi Clearance Request message uses a Label or MFI value of BD. The responding Pushback Clearance uplink message uses the Label or MFI value of AD.

5.9.2 Imbedded Message Identifier

The IMI for DDTC Pushback Clearance Request downlink message is PCx. The IMI for DDTC Pushback Clearance uplink is PCx. The IMI for DDTC Expected Taxi Clearance Request downlink is ETx. The third character of the IMI is used to indicate the version number.

5.9.3 DDTC Application Data

ARINC Specification 623 contains the definition of Application data for the Digital Delivery of Taxi Clearance (DDTC) messages. The version number for each DDTC message is specified in ARINC Specification 623.

5.10 Controller to Pilot Communication (CPC)

Three CPC messages have been defined. The CPC application includes 1) Initial Contact (IC), 2) Transfer of Communications (TOC), Barometric Altimeter Setting (ASM), and several Pre-Defined Messages (PDM) and 3) Aircrew compliance (or unable) declaration.

A downlink CPC message has been defined to Log On and Log Off the ATS CPC service. A CPC uplink has been defined for the controller to send predefined messages to the crew. A second downlink CPC message has been defined to permit the crew to respond to the CPC uplink messages.

COMMENTARY

One of the actions of the RTCA Free Flight Steering Committee has been the development of ATS applications and message sets that are referred to as “NOW” applications. One of these applications is referred to as Controller-to-Pilot Communications (CPC). This application is intended to provide early benefits to CAAs and the airline community by using the ACARS data link as the communications media for ATS applications. Early CPC applications are expected to support the development of operational concepts that are applicable to future systems. This section defines the message set intended for the CPC application.

5.10.1 Labels and MFI

The downlink CPC Aircraft Log-On/Log-Off Request message uses a Label or MFI value of BE.

The uplink CPC Command/Response uplink message uses a Label or MFI value of AF.

The downlink CPC WILCO/UNABLE Response message uses a Label or MFI value of BF.

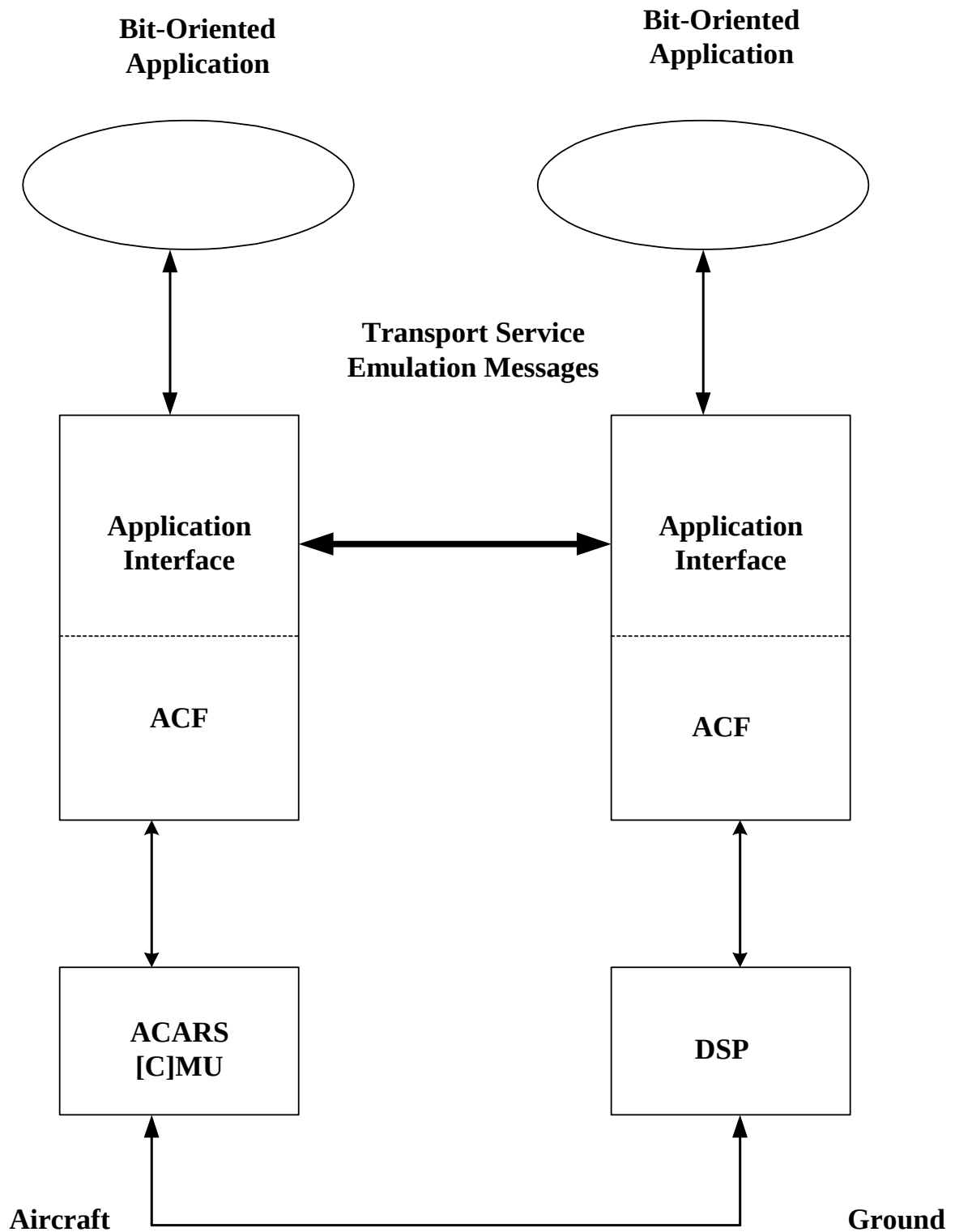
5.10.2 Imbedded Message Identifier

The IMI for CPC uplink messages is CPx. The IMI for CPC Log-On/Log-Off downlink is CLx and the IMI for CPC WILCO/UNABLE downlink is CPx. The third character of the IMI is used to indicate the version number. The version number for each CPC message is specified in ARINC Specification 623.

5.10.3 CPC Application Text

ARINC Specification 623 contains the definition of the format of the application text for all CPC messages.

ATTACHMENT 1
ACARS COMPATIBLE SYSTEM



c-2

Figure 1-1 ACARS Convergence Function for Bit-Oriented Applications

ATTACHMENT 2
ACF IMI TABLE

Table 2-1 IMI Table for Bit-Oriented Applications which use the ACF

Application Name	Version Number	IMI	Application Reference	Notes
ADS	00	AD1	Automatic Dependent Surveillance, ARINC Characteristic 745-1	
ADS	01	ADS	Automatic Dependent Surveillance, ARINC Characteristic 745-2	
ADS	00/01	DIS	Automatic Dependent Surveillance, ARINC Characteristics 745-1/2	
ATC	00	AT0	Air Traffic Control Communication, Preceding RTCA DO-219	1
ATC	01	AT1	Air Traffic Control Communication, RTCA DO-219	
ATC	01	CR1	Air Traffic Control Communication, RTCA DO-219	
ATC	01	CC1	Air Traffic Control Communication, RTCA DO-219	
ATC	01	DR1	Air Traffic Control Communication, RTCA DO-219	
CMA	--	---	Context Management, RTCA SC-169 MOPS DO-2XX	

[1] Also known as "Wayne's World".

ATTACHMENT 3
AIR TRAFFIC SERVICES TABLES

A3.1 AFN Application Field Definition

This table documents the valid field lengths and contents for the AFN application defined by this specification.

Table 3-1 Air Traffic Services Data Table

Parameter	Symbolic Name	Length	Format	Notes	
7 alpha-numeric center address	ctr_addr	4 or 7	AAAA or XXXXXXXX	4	c-2
7 alpha-numeric next center address	next_ctr_addr	7	XXXXXXX		
3-character application name (or application interface name)	ap_name	3	AAA		
4-character ICAO code	ICAO_cd	4	AAAA		
version number	vers	2	NN		c-3
time stamp	time	6	HHMMSS		c-2
current position	position	13	YDDMMT'ZDDMMT		
flight number	flt_no	V	XXXXXXXXXX	5	
aircraft tail number	tail_no	7	CCCCCCC		
reason code	reason	1	N	3	c-2
active flag	act_fl	1	B		
24 bit ICAO Identifier (converted to Hex)	icao_id	6	JJJJJ	1, 2	c-2

where:

Parameter	Code	Range	
Length	V	Variable (1 - max length shown)	
Format	A	A .. Z	
	B	Boolean (0, 1)	
	C	(A .. Z) + (0 .. 9) + (.) + (-)	
	DD, DDD	Degrees (00 .. 90) or (000 .. 180)	
	HH	Hours (00 .. 23)	
	J	Hex (0 ..9) + (A .. F)	c-2
	MM	Minutes (00 .. 59)	
	N	0 ..9	
	SS	Seconds (00 .. 59)	c-2
	T	Tenths of Minutes (0 ..9)	
	X	(A ..Z) + (0 ..9)	
	Y	Direction (N, S)	
	Z	Direction (E, W)	

ATTACHMENT 3
AIR TRAFFIC SERVICES TABLES

- [1] This field is optional.
- [2] The 24-bit ICAO identifier is broken into 6 groups of 4-bits each for encoding purposes. Each group is coded as a character representing the hexadecimal value. Refer to Section 2.3.1.2.

Example 1:

Label... /ctr_addr.AFN/FMH,flt_no,tail_no,,HHMMSS

Example 2:

Label... /ctr_addr.AFN/FMH,flt_no,tail_no,icao_id,HHMMSS

Within each MTI dataset, fields are separated by commas. Because the 24-bit ICAO Identifier field is optional, if it is not present in this message, then 2 commas, as shown in Example 1, are inserted.

- [3] See Section 3.4 for a Table of Reason Codes.
- [4] The 4 character version is only allowed in the initial downlink.
- [5] ICAO 4444 requires that the flight number be at least 3 characters in length. However, there are systems in use that allow for a single character for the flight number. These should also be accommodated.

A3.2 Message Type Identifier Definition

The following table lists the Message Type Identifiers (MTIs) used by the avionics end systems to implement the AFN application defined in this specification.

Table 3-2 Air Traffic Services MTI Table

MTI	Description	Elements	Notes
FMH	Facilities Notification Message Header	Time Stamp Flight number Aircraft tail number ICAO ID (optional)	
FCO	Facilities Notification Contact	3-character application name version number	
FPO	Facilities Notification Current Position	13-character position active flag	
FAK	Facilities Notification Acknowledgement	reason code 4-character ICAO code	
FAR	Application Response	3-character application name reason code 7-character address	1
FCA	Facilities Notification Contact Advisory	7-character center address active flag	
FRP	Facilities Notification Response	reason code	
FCP	Facilities Notification Complete	7-character address reason code	

- [1] See Section 3.5.5.1 for assignment and utilization of center addresses.

ATTACHMENT 4
AFN PROCEDURE

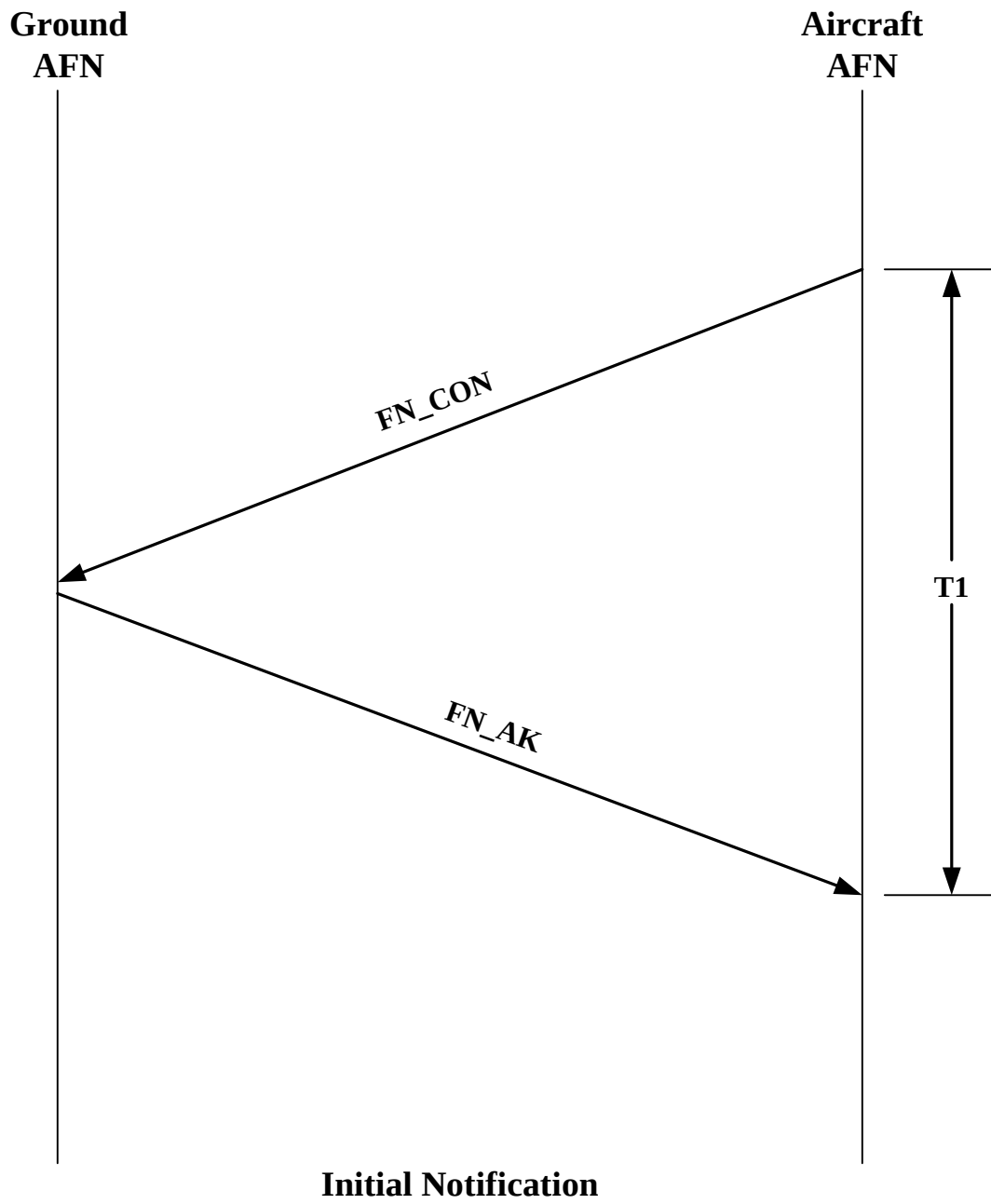


Figure 4-1 Initial Notification

ATTACHMENT 4
AFN PROCEDURE

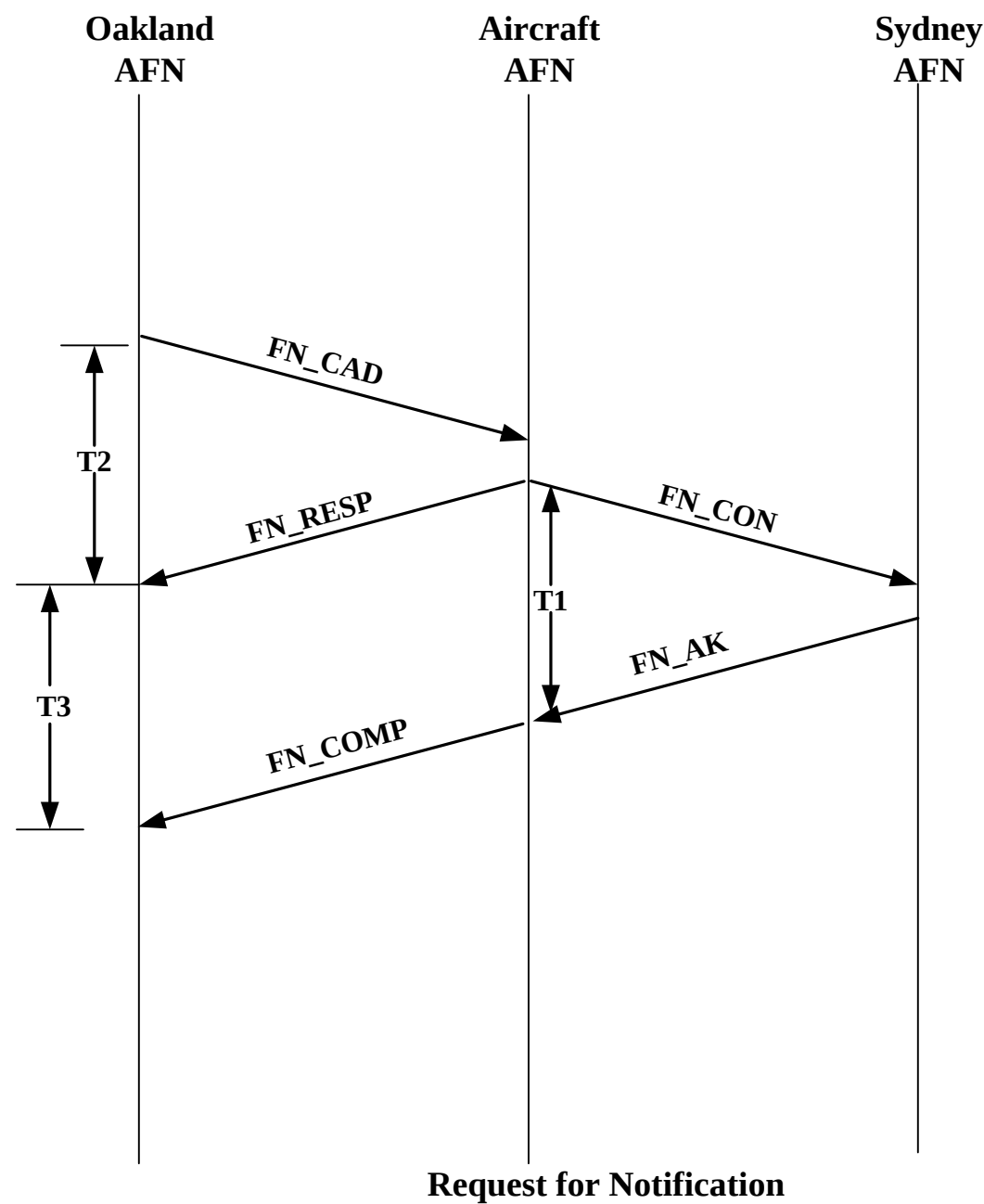


Figure 4-2 Request for Notification

ATTACHMENT 5
SDL REPRESENTATION OF ATS FACILITIES NOTIFICATION

Table 5-1 AIRCRAFT STATE MACHINE

Event \ State	Idle	Notify	Ack	Advis	Notify2
User input to AFN		send CON [1] clear active, set T1 [1] st: Ack	send CON [1] clear active, set T1 [1] st: Ack	send CON [1] clear active, set T1 [1] st: Ack	send CON [1] clear active, set T1 [1] st: Ack
timer T1 expires [1]			(B) st: Notify		
Rcvd FN_AK [1]			clear T1 [1] if P1: set new active, (A), st: Advis if not P1: (B), st: Notify		
Rcvd FN_CAD [1]				if P2: send RES [1], send CON [2], set T1 [2], st: Notify2 if not P2: send RES [1] w/non-zero reason code, st: Advis	
Rcvd FN_AK [2]					clear T1 [2] if P1 and P3: set new active, send COMP [1] w/zero reason code, (A) st: Advis if P1 and not P3: send COMP [1] w/zero reason code, (A) st: ADVIS if not P1: send COMP [1] w/non-zero reason code, (B) st: Advis
Timer T1 expires [2]					(B) send COMP fail on [1] st: Advis
User enters Flight Number	st: Notify		st: Notify	st:Notify	st:Notify

[1] Event with original source

[2] Event with secondary source

ATTACHMENT 5
SDL REPRESENTATION OF ATS FACILITIES NOTIFICATION

Table 5-1 AIRCRAFT STATE MACHINE (cont'd)**CONDITION**

- (A) User message normal
 (B) User message error

MESSAGE DEFINITIONS

- | | |
|------|--------------------|
| CON | FN Contact Message |
| RESP | FN Response Msg |
| COMP | FN Complete Msg |

STATE DEFINITIONS (st):

State	Description	Notes
Idle	Waiting for flight number entry	
Notify	Waiting for User Notification Input	
Ack	Waiting for FN_AK	1
Advis	Waiting for FN_CAD	
Notify2	Waiting for FN_AK from Secondary Center	2

NOTES:

- [1] Event with original source
 [2] Event with secondary source

PREDICATES

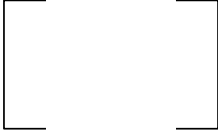
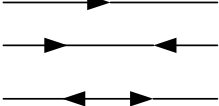
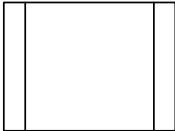
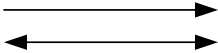
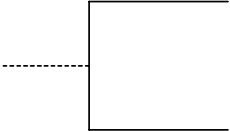
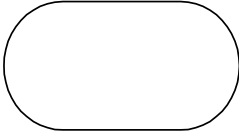
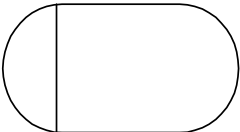
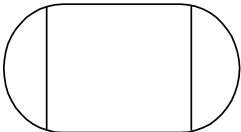
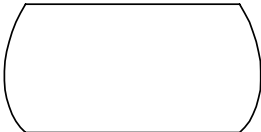
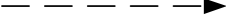
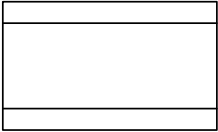
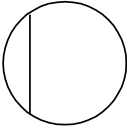
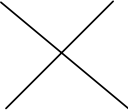
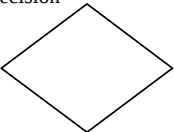
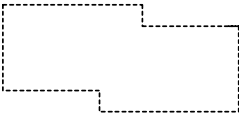
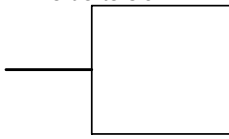
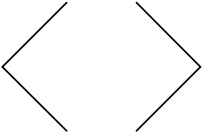
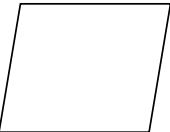
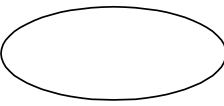
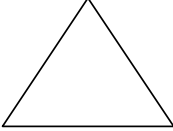
- P1: reason code received was zero
 P2: valid message received
 P3: active flag was set in previously received FN_CON

TIMERS

- T1: avionics timer = 5 minutes
 T2: ground timer = 5 minutes
 T3: ground timer = 7.5 minutes

ATTACHMENT 5
SDL REPRESENTATION OF ATS FACILITIES NOTIFICATION

Table 5-2 SDL SYMBOLS

Block Reference 	Frame 	Priority output 	Signal list 
Channel 	Input 	Procedure call 	Signal route 
Comment 	Macro Call 	Procedure reference 	Start 
Connector 	Macro Inlet 	Procedure start 	State 
Create line 	-		
Create request 	Macro outlet 	Process reference 	Stop 
Decision 	Option 	Return 	Text extension 
Enabling Condition 	Output 	Save 	Text 
Flow Line 	Priority input 	Service reference 	Transition option 

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ATTACHMENT 5
SDL REPRESENTATION OF ATS FACILITIES NOTIFICATION

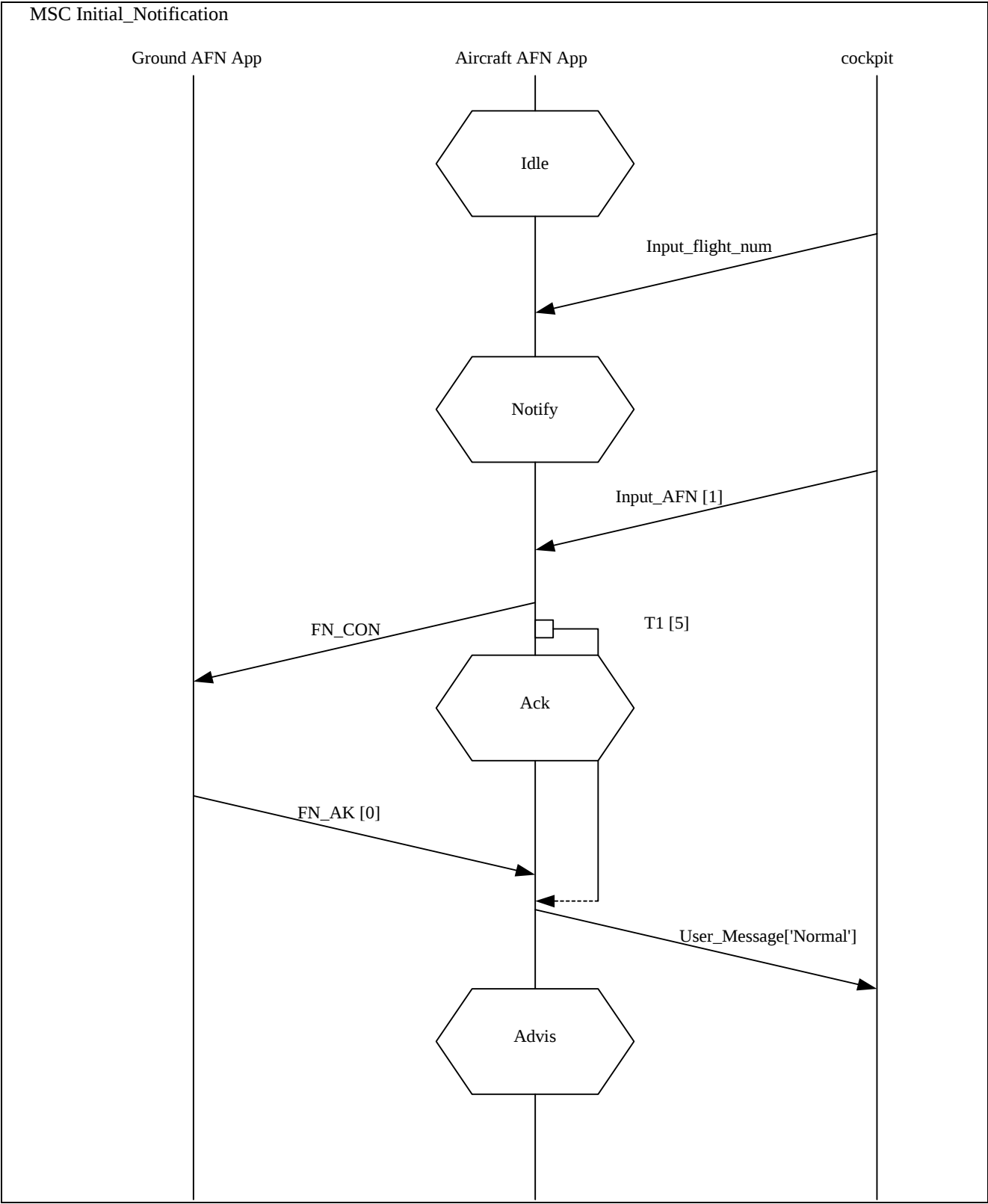
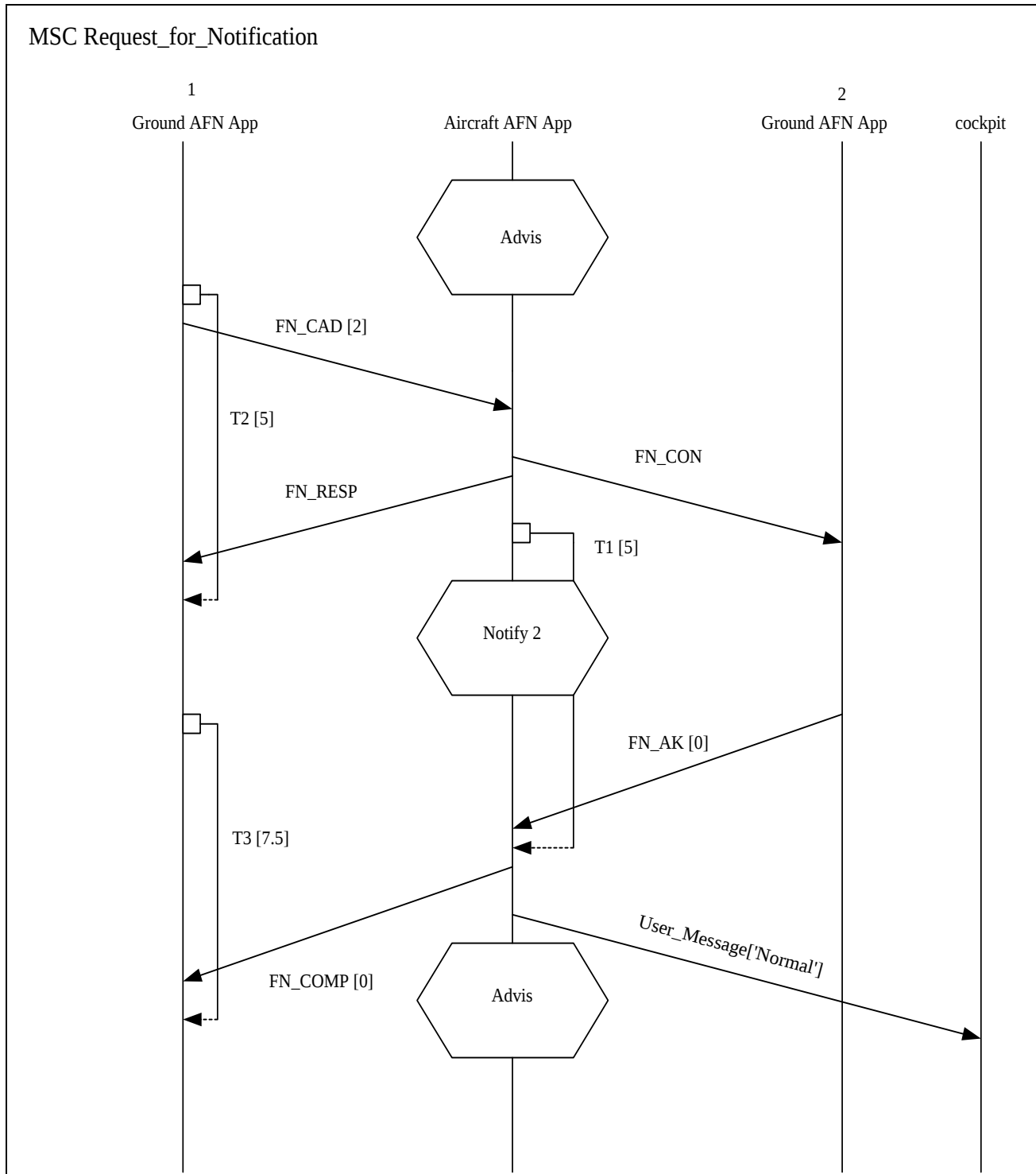


Figure 5-1 Initial Notification

Note: These SDL diagrams have not been validated.

ATTACHMENT 5
SDL REPRESENTATION OF ATS FACILITIES NOTIFICATION

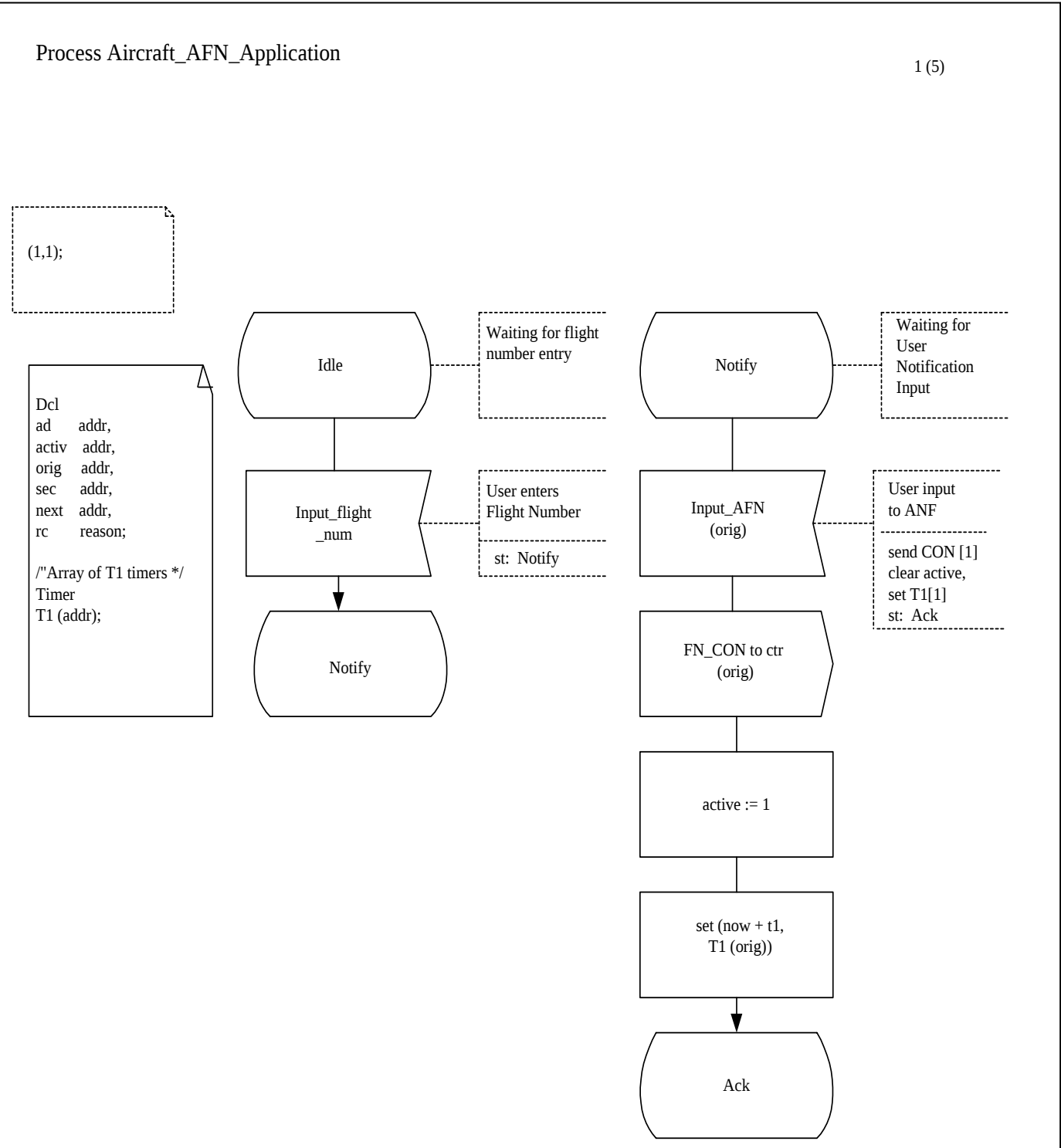


c-2

Figure 5-2 Request for Notification

Note: These SDL diagrams have not been validated.

ATTACHMENT 5
SDL REPRESENTATION OF ATS FACILITIES NOTIFICATION



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Figure 5-3 Aircraft ATC Facilities Notification Application

Note: These SDL diagrams have not been validated.

ATTACHMENT 5
SDL REPRESENTATION OF ATS FACILITIES NOTIFICATION

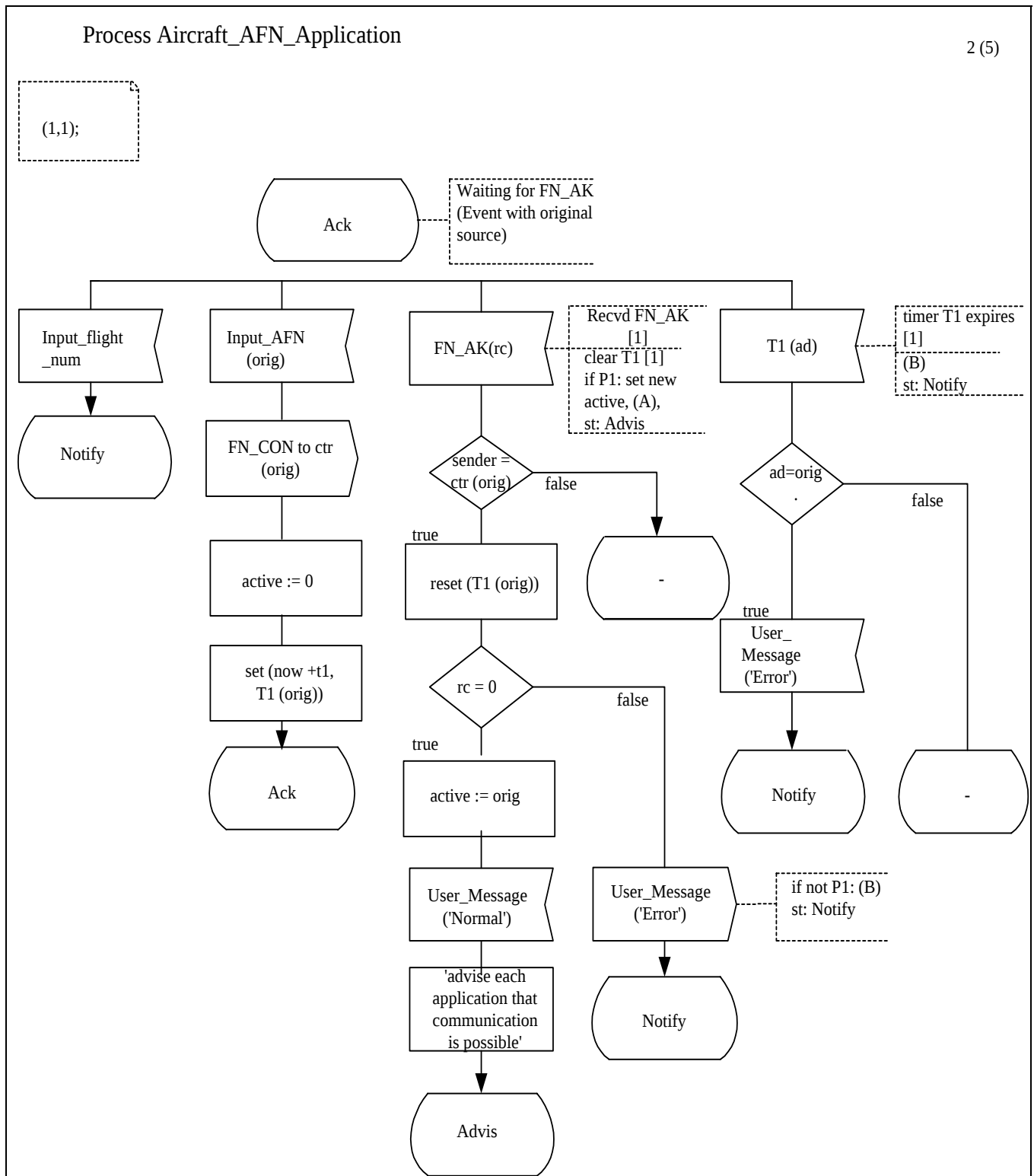


Figure 5-3 Aircraft ATC Facilities Notification Application (cont'd)

Note: These SDL diagrams have not been validated.

ATTACHMENT 5
SDL REPRESENTATION OF ATS FACILITIES NOTIFICATION

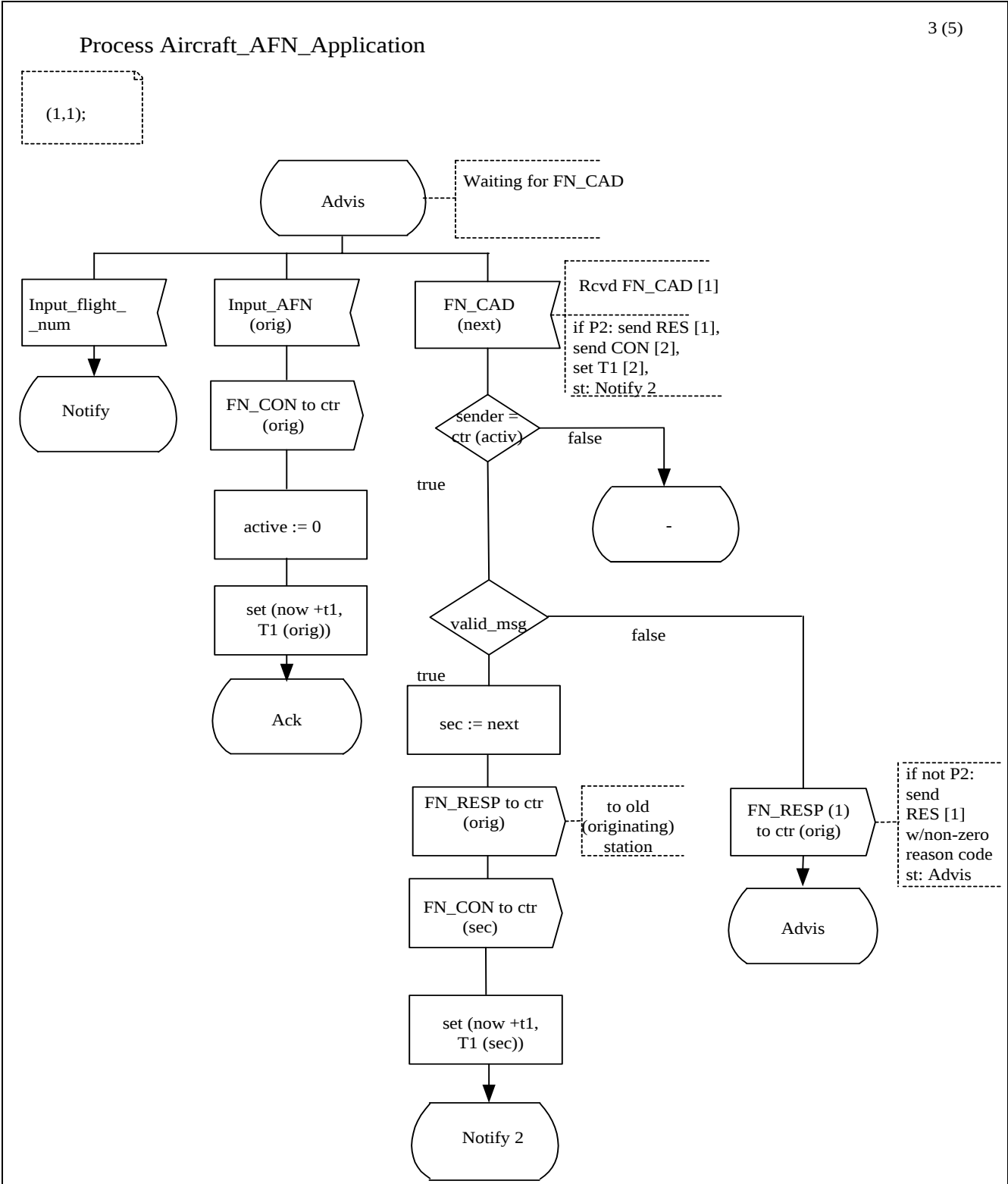


Figure 5-3 Aircraft ATC Facilities Notification Appliaction (cont'd)

Note: These SDL diagrams have not been validated.

ATTACHMENT 5
SDL REPRESENTATION OF ATS FACILITIES NOTIFICATION

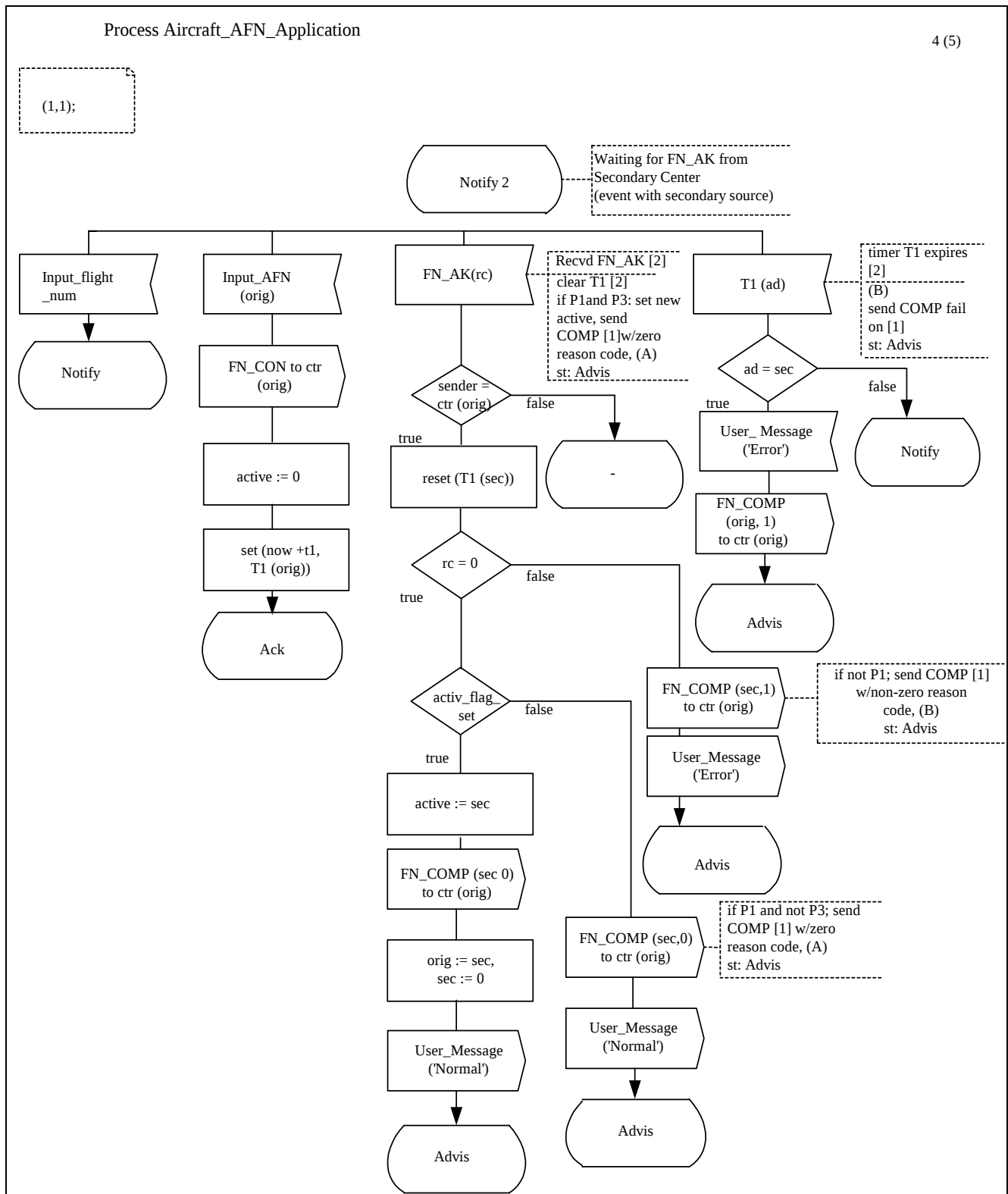


Figure 5-3 Aircraft ATC Facilities Notification Application (cont'd)

Note: These SDL Diagrams have not been validated.

ATTACHMENT 5
SDL REPRESENTATION OF ATS FACILITIES NOTIFICATION

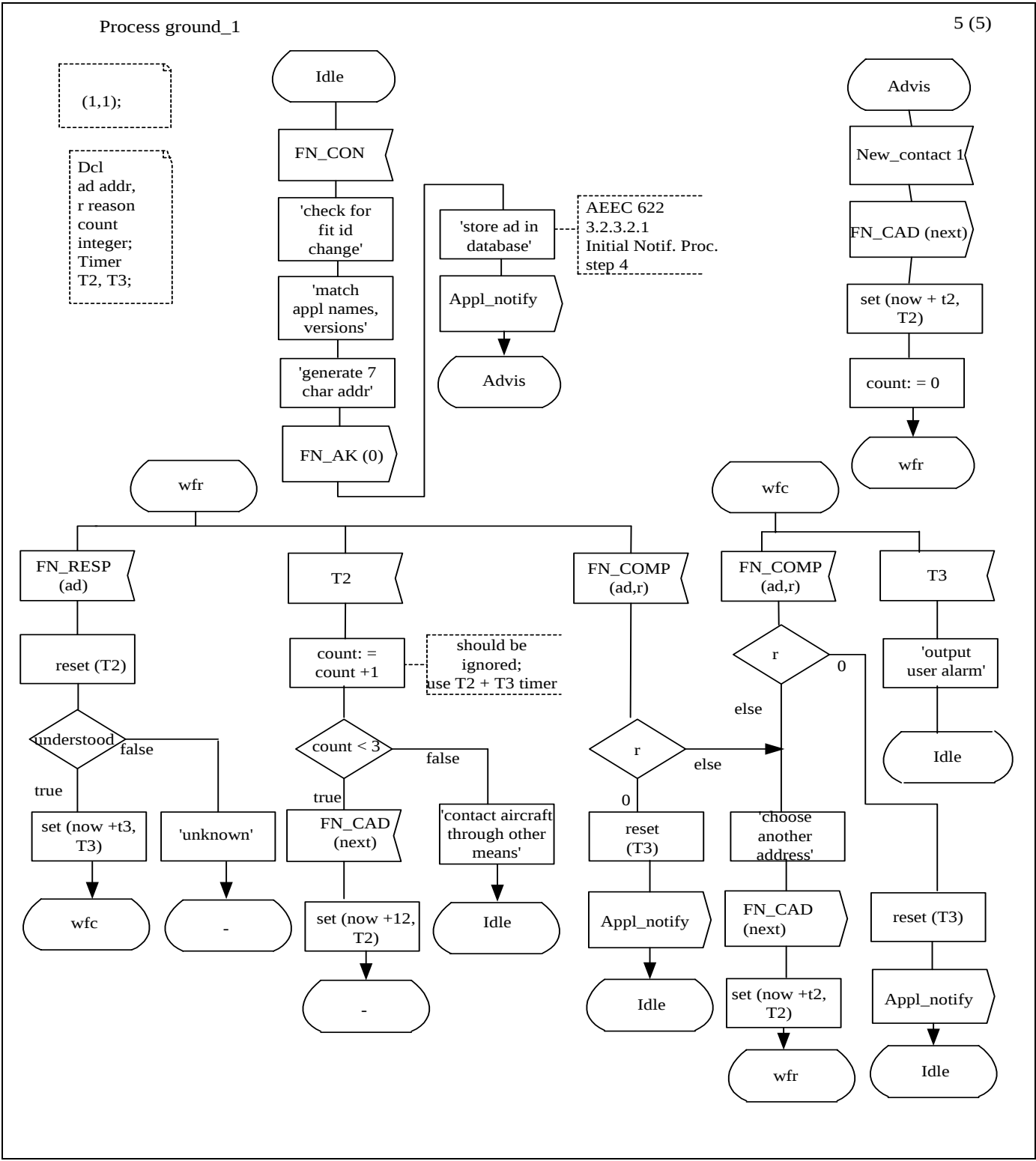


Figure 5-4 Ground ATC Facilities Notification Application

Note: These SDL diagrams have not been validated.

ATTACHMENT 6
BIT-ORIENTED ATS MESSAGES

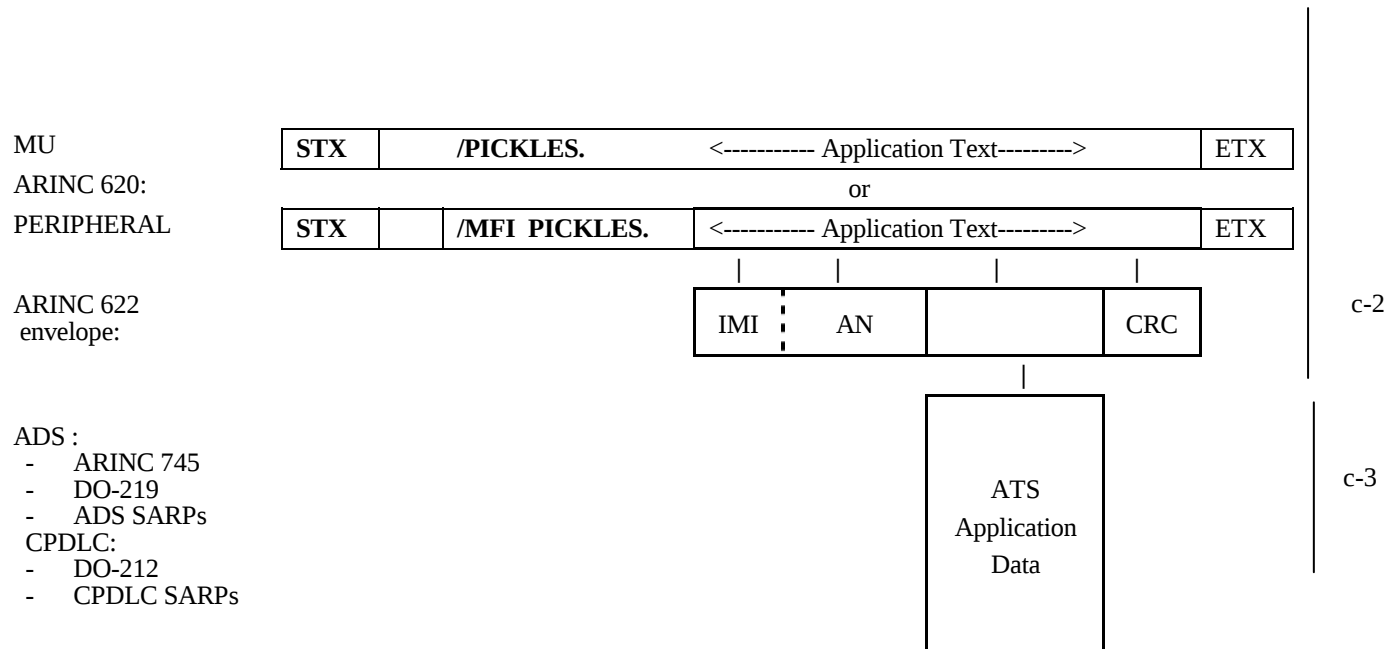


Figure 6-1 ATS MESSAGE ENCAPSULATION FOR BIT-ORIENTED MESSAGE APPLICATIONS

Note:

- [1] Boeing and Airbus Industries have produced aircraft carrying ACARS MUs that were programmed to generate a subset of RTCA's DO-219 bit-oriented CPDLC message. These systems were designated "FANS-1" by Boeing and "FANS-A" by Airbus. Subsequently, an expanded (and slightly different) set of controller/pilot phrases were developed by ICAO. Any of these bit-oriented applications [ADS: ARINC 745, DO-212 or ATN SARPs] and [CPDLC: DO-219, FANS-1/A or ATN SARPs] can constitute the ATS Application Data.

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ATTACHMENT 7
CHARACTER-ORIENTED ATS MESSAGES

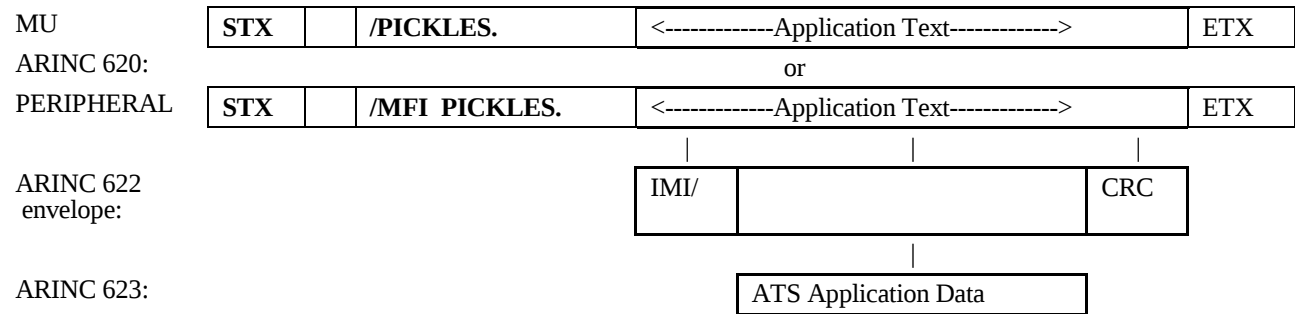


Figure 7-1 ATS MESSAGE ENCAPSULATION FOR CHARACTER-ORIENTED APPLICATIONS

Notes:

- [1] The “ATS Application Data” is referred to as “Message Text” in ARINC Specification 623. Typically, the ATS Application Data (Message Text) has the format of: Message Type Identifier, Avionics Indicator, character-based text fields containing the ATS information.
- [2] Observe that the ATS Application Data, when enveloped by the IMI and slash characters at the beginning and the CRC at the end, becomes the Application Text.
- [3] At the airline user’s discretion, the process described here for ATS message transfer may be used by the airline when exchanging AOC messages between its aircraft and its host system(s).

APPENDIX A
ACRONYMS AND GLOSSARY

A1.1 Introduction

The terms and acronyms presented here are not intended to be an all inclusive list, but rather to reflect terms used in this document. The following acronyms are used within this document:

ACARS	Aircraft Communications Addressing and Reporting System
ACF	ACARS Convergence Function
ACMS	Aircraft Condition Monitoring System
ADS	Automatic Dependent Surveillance
ADSP	(Ground-based) ADS Processor
ADSU	Automatic Dependent Surveillance Unit
AFN	Air Traffic Services Facilities Notification
AIDC	ATS Interfacility Data Communication
AK	Acknowledgement
AN	Aircraft Registration Number
AP	Application Process
ATCComm	Air Traffic Control Communication
ATIS	Automatic Terminal Information Service
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Services
CAA	Civil Aviation Authority
CRC	Cyclical Redundancy Check
CLNS	Connectionless Network Service
DDTC	Digital Delivery of Taxi Clearance
DSP	Data Link Service Provider
ES	End System
FAA	Federal Aviation Administration
FCO	Facilities Notification Contact
FIR	Flight Information Region
FMS	Flight Management System
FPO	Facilities Notification Position
ICAO	International Civil Aviation Organization
ID	Identification
IMI	Imbedded Message Identifier
IS	Intermediate System
ISO	International Organization for Standardization
MFI	Message Format Identifier
MOPS	Minimum Operational Performance Standards

APPENDIX A
ACRONYMS AND GLOSSARY

MU	Management Unit
MTI	Message Text Identifier
OSI	Open Systems Interconnect
RTCA	Requirements and Technical Concepts for Aviation
SATCOM	Satellite Communication System
SARPS	Standards and Recommended Practices (put out by SICASP)
SDL	Specification Description Language
SDU	Service Data Unit
SND CF	Subnetwork Dependent Convergence Function
SICASP	SSR Improvements and Collision Avoidance Systems Panel
SMI	Standard Message Identifier
SSR	Secondary Surveillance Radar
TCEPID	Transport Connection End-Point Identifier
TP4	Transport Protocol Class 4
TSAP	Transport Service Access Point
TWDL	Terminal Weather
VHF	Very High Frequency

APPENDIX B
CRC EXAMPLES

B1.1 Introduction

The following example illustrates the procedure by which Cyclical Redundancy Check (CRC) is to be executed in a communications application defined in this specification.

Table B1.1-1 CRC Process Example

		MSB for CRC		
		↓		
Example: Application Data = ADS072D	Character-oriented IMI	0100	0001	> A
		0100	0100	> D
		0101	0011	> S
	Bit-oriented Data in hex coding	0000	0111	> 07
		0010	1101	> 2D
		↑		
		LSB for CRC		

Input the Application Data to the CRC process:

0100	0001	0100	0100	0101	0011	0000	0111	0010	1101	
↑	A		D		S	0	7	2	D	↑
MSB										LSB

Begin CRC process

First step - Add 2 octets of zeros:

0100	0001	0100	0100	0101	0011	0000	0111	0010	1101	0000	0000	0000	0000
------	------	------	------	------	------	------	------	------	------	------	------	------	------

Second step - Derive G'(X) by performing a 1's complement on first 2 octets:

1011	1110	1011	1011	0101	0011	0000	0111	0010	1101	0000	0000	0000	0000
------	------	------	------	------	------	------	------	------	------	------	------	------	------

Third step – Define F(x) as the Polynomial Divisor:

1	0001	0000	0010	0001
---	------	------	------	------

Notes:

- [1] The bit-oriented data in the example depicted here represents an actual ADS Periodic Contract Request message taken from ADS Characteristic 745. See Section 4.3.2 for further description of the content of the data.
- [2] The example is not consistent with Attachment 6 because the tail number (AN) is not shown. This example was created prior to the addition of the tail number to the bit-oriented message format.

APPENDIX B
CRC EXAMPLES

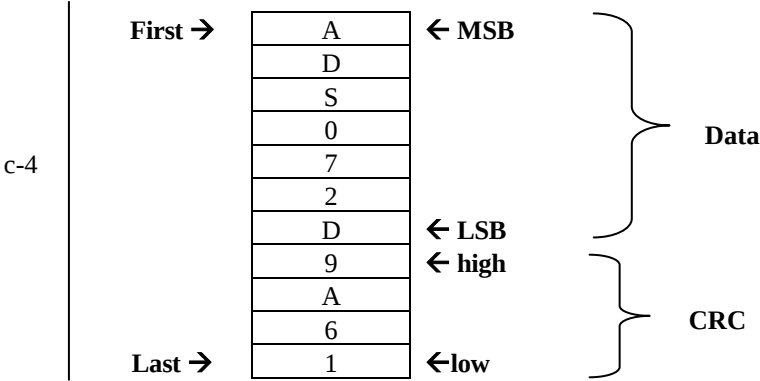
Fourth step - Perform polynomial division of:

$G''(X)$													
$F(X)$													
1011	1110	1011	1011	0101	0011	0000	0111	0010	1101	0000	0000	0000	0000
				1	0001	0000	0010	0001					
				1011	0101	1111	0010	0111	1111	0100	1110	0101	1110
1011	1110	1011	1011	0101	0011	0000	0111	0010	1101	0000	0000	0000	0000
1000	1000	0001	0000	1									
11	0110	1010	1011	110									
10	0010	0000	0100	001									
1	0100	1010	1111	1111									
1	0001	0000	0010	0001									
	101	1010	1101	1110	00								
	100	0100	0000	1000	01								
	1	1110	1101	0110	0111								
	1	0001	0000	0010	0001								
		1111	1101	0100	0110	0							
		1000	1000	0001	0000	1							
		111	0101	0101	0110	10							
		100	0100	0000	1000	01							
		11	0001	0101	1110	110							
		10	0010	0000	0100	001							
		1	0011	0101	1010	1110							
		1	0001	0000	0010	0001							
			10	0101	1000	1111	011						
			10	0010	0000	0100	001						
				111	1000	1011	0101	00					
				100	0100	0000	1000	01					
				11	1100	1011	1101	011					
				10	0010	0000	0100	001					
				1	1110	1011	1001	0100					

(continued next page)

APPENDIX B
CRC EXAMPLES

Order bits for transmission as follows:



APPENDIX B
CRC EXAMPLES

Table B1.1-2 Test Message Example

The following text (in **bold**) would be encoded as shown below. This message can be used to validate CRC software coding in new designs.

EXAMPLE CRC TEST MESSAGE.

!"#\$%&'()*+,-./0123456789;<=>?

@ABCDEFGHIJKLMN O P Q R S T U V W X Y Z [\] ^ _

`abcdefghijklmnopqrstuvwxyz{|}~

CHANGING TEST CHARACTER FOLLOWS:

END OF TEST

Count	Hexadecimal Representation	ISO – 5 Representation
000000	45 58 41 4D 50 4C 45 20 43 52 43 20 54 45 53 54	E X A M P L E C R C T E X T
000010	20 4D 45 53 53 41 47 45 2E 0D 0A 20 21 22 23 24	M E S S A G E . ? ? ! “ # \$
000020	25 26 27 28 29 2A 2B 2C 2D 2E 2F 30 31 32 33 34	% & ‘ () * + , - . / 0 1 2 3 4
000030	35 36 37 38 39 3A 3B 3C 3D 3E 3F 0D 0A 40 41 42	5 6 7 8 9 : ; < = > ? ? ? @ A B
000040	43 44 45 46 47 48 49 4A 4B 4C 4D 4E 4F 50 51 52	C D E F G H I J K L M N O P Q R
000050	53 54 55 56 57 58 59 5A 5B 5C 5D 5E 5F 0D 0A 60	S T U V W X Y Z [\] ^ _ ? ? `
000060	61 62 63 64 65 66 67 68 69 6A 6B 6C 6D 6E 6F 70	a b c d e f g h i j k l m n o p
000070	71 72 73 74 75 76 77 78 79 7A 7B 7C 7D 7E 0D 0A	q r s t u v w x y z { } ~ ? ?
000080	43 48 41 4E 47 49 4E 47 20 54 45 53 54 20 43 48	C H A N G I N G T E S T C H
000090	41 52 41 43 54 45 52 20 46 4F 4C 4C 4F 57 53 3A	A R A C T E R F O L L O W S :
0000A0	20 0D 0A 45 4E 44 20 4F 46 20 54 45 53 54 0D 0A	? ? E N D O F T E S T ? ?
	 test character (position 0A0 _h)	

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Notes:

- [1] The **highlighted** character (position 0A0_h) is changed to produce the test results.
- [2] Non-printing characters are represented by two sequential question marks **[? ?]** with a shaded background.
- [3] End of line terminator is 0D0A_h

APPENDIX B
CRC EXAMPLES

Table B1.1-2A Test Message Coding

The values in the character (Char) column in the following table are expressed in hexadecimal.

Char	CRC	Char	CRC	Char	CRC	Char	CRC	Char	CRC
20	4A95	36	A924	4C	11FE	62	86D4	78	F432
21	E2B1	37	0100	4D	B9DA	63	2EF0	79	5C16
22	0AFC	38	781A	4E	5197	64	466F	7A	B45B
23	A2D8	39	D03E	4F	F9B3	65	EE4B	7B	1C7F
24	CA47	3A	3873	50	A3A3	66	0606	7C	74E0
25	6263	3B	9057	51	0B87	67	AE22	7D	DCC4
26	8A2E	3C	F8C8	52	E3CA	68	D738	7E	3489
27	220A	3D	50EC	53	4BEE	69	7F1C		
28	5B10	3E	B8A1	54	2371	6A	9751		
29	F334	3F	1085	55	8B55	6B	3F75		
2A	1B79	40	80A9	56	6318	6C	57EA		
2B	B35D	41	288D	57	CB3C	6D	FFCE		
2C	DBC2	42	C0C0	58	B226	6E	1783		
2D	73E6	43	68E4	59	1A02	6F	BFA7		
2E	9BAB	44	007B	5A	F24F	70	E5B7		
2F	338F	45	A85F	5B	5A6B	71	4D93		
30	1B79	46	4012	5C	32F4	72	A5DE		
31	C1BB	47	E836	5D	9AD0	73	0DFA		
32	29F6	48	912C	5E	729D	74	6565		
33	81D2	49	3908	5F	DAB9	75	CD41		
34	E94D	4A	D145	60	C6BD	76	250C		
35	4169	4B	7961	61	6E99	77	8D28		

APPENDIX C
AFN EXAMPLE

C1.1 AFN Transactions Diagram

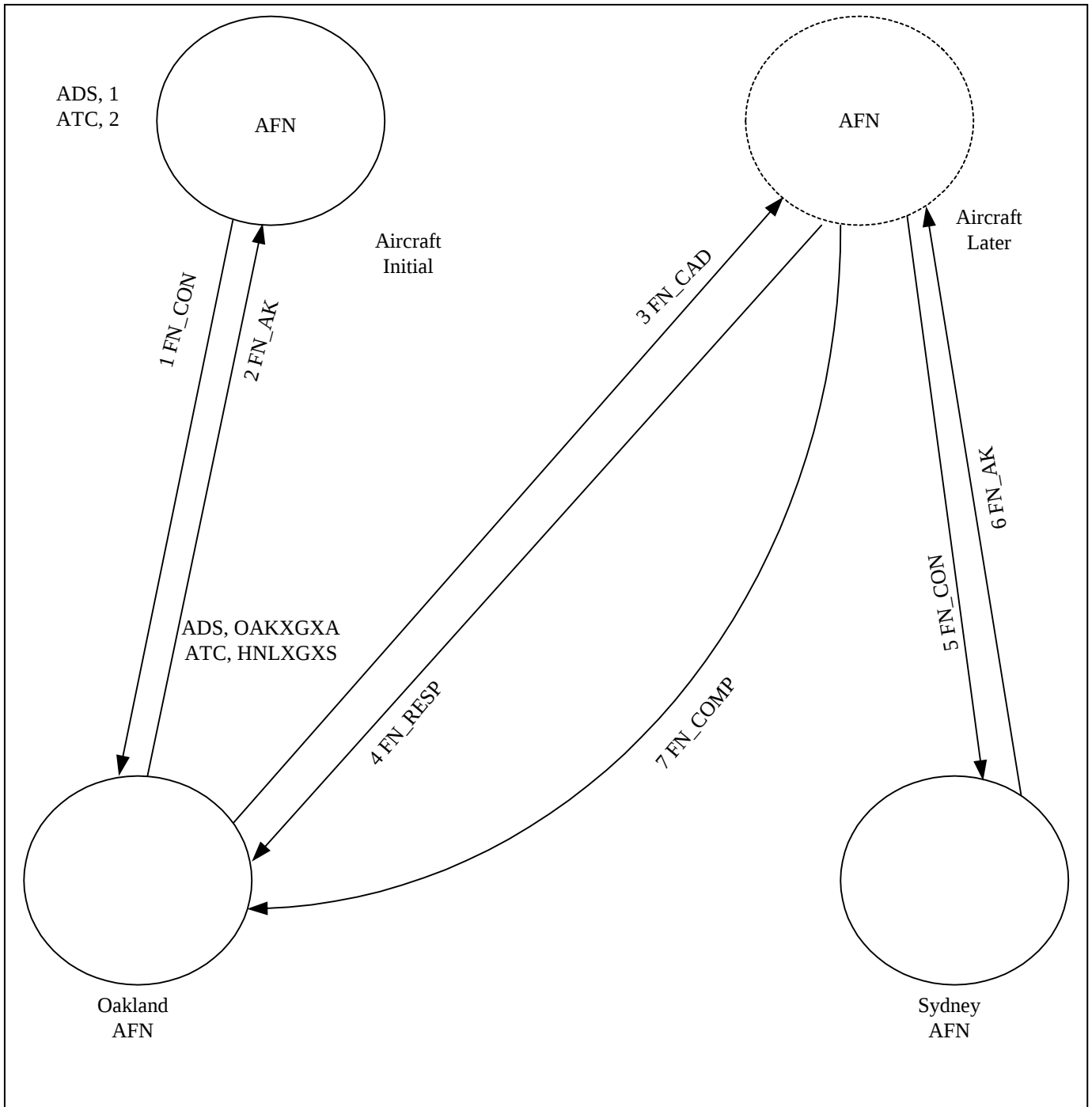


Figure C1-1 Example of AFN Transactions

APPENDIX C
AFN EXAMPLE

C1.2 AFN Example

The following example illustrates the procedure for first establishing an AFN relationship, then establishing an ADS connection. The AFN transaction passes the necessary data between the aircraft and the ATS facility to enable an ADS connection to be formed.

An aircraft is starting at Oakland, California and passes through the Sydney ATC region. This aircraft is equipped with the ADS and AFN application processes. The procedures dictate that this aircraft must perform the notification procedure at Oakland and at Sydney. The aircraft closes its flight plan when it lands at Sydney. The following takes place:

0. At initialization time, the ADSF registers its name and version number in the local directory table (this is an on-board table).
1. The flight crew enters "KZAK" on the CDU, and selects "notify".
2. The avionics AFN application reads the local directory table to find all of the application names and version numbers for which it is responsible.
3. The avionics AFN sends a FN_CON message to the Oakland AFN. (The message to Oakland contains the aircraft application names and version numbers, application interface and version number, aircraft position and the active flag.)
4. The Oakland AFN sends a FN_AK message to the aircraft. (The message to the aircraft contains the 7-character ATS facility address, and the matching ground application names along with their optional addresses.) The Oakland Center becomes the active facility.
5. The aircraft takes off. Twenty minutes into flight, the ground ADS application sends an AP-nPCreq (application normal Periodic Contract request) to the avionics ADSF.
6. The ADS contract is in effect. The avionics ADSF sends Basic Reports as specified to the ground.
7. The Oakland AFN is stimulated by ground procedures when the aircraft approaches the FIR boundary.
8. The Oakland AFN sends a FN_CAD message to the avionics AFN, passing the active flag.
9. The avionics AFN sends a FN_RESP message to the Oakland AFN.
10. The avionics AFN sends a FN_CON message (with the active flag set) to the Sydney AFN, using the address given to it by Oakland in the FN_CAD message.
11. The Sydney AFN sends a FN_AK message to the avionics AFN. Sydney becomes the active facility.
12. The avionics AFN sends a FN_COMP message to the Oakland AFN, and this terminates the Request for Notification procedure.
13. The Sydney ADS application sends an AP-nPCreq (application normal Periodic Contract request) to the avionics ADSF.
14. Ground procedures take place between Oakland and Sydney to arbitrate the sequence of application association establishment and release. The ground facilities are responsible for this transfer independently of the aircraft.
15. The Oakland ADS application sends an AP-CACTCreq (application Cancel All Contracts and Terminate Connection request) to the avionics ADSF.
16. The avionics ADSF clears the connection table for Oakland. (The ADS connection table with Sydney is still in effect.)
17. The aircraft lands at Sydney. Ground procedures stimulate the Sydney ADS application to send an AP-CACTCreq to the avionics ADSF. The avionics ADSF clears the connection table for Sydney.

APPENDIX D
LABEL, SUBLABEL, MFI AND IMI INFORMATION

The MU does not use Sublabels or MFIs for messages it processes. These apply only to peripherals.

Table D-1 ATS Uplinks To An MU (As End System)

Uplink Message Definition	Label	SMI	IMI ("x" is Version #.)	Notes
Oceanic Clearance	A1	CLX	OCx	
Unassigned	A2	--	--	
Departure Clearance Response	A3	CLD	DCx	
Flight Systems Message	A4	FSM	FSx	
Unassigned	A5		---	
Request ADS Reports	A6	RAR	ADx	
Free Text	A7	FTU	FTx	
Deliver Departure Slot	A8	DDS	---	
ATIS Report	A9	DAI	TIx	
ATS Facility Notification (AFN)	A0	AFU	AFx	
ATCComm	AA	ATC	ATx	
TWIP Report	AB	TWI	TWx	
Pushback Clearance	AC	PBC	PCx	
Expected Taxi Clearance	AD	ETC	ETx	
Unassigned	AE	--	--	
CPC Command/Response	AF	CPR	CPx	

Table D-2 ATS Downlinks From An MU (As End System)

Downlink Message Definition	Label	SMI	IMI ("x" is Version #.)	Notes
Request Oceanic Clearance	B1	RCL	OCx	
Oceanic Clearance Readback	B2	CLA	OCx	
Request Departure Clearance	B3	RCD	DCx	
Departure Clearance Readback	B4	CDA	DCx	
Reserved	B5	---	---	
Provide ADS Report	B6	PAR	ADx	
Free Text	B7	FTD	FTx	
Request Departure Slot	B8	RDS	---	
Request ATIS Report	B9	RAI	TIx	
ATS Facility Notification	B0	AFD	AFx	
ATCComm	BA	ATC	ATx	
Request TWIP Report	BB	TWR	TWx	
Pushback Clearance Request	BC	PBR	PCx	
Expected Taxi Clearance Request	BD	ETR	ETx	
CPC Aircraft Log-On /Off Request	BE	CPL	CLx	
CPC WILCO/UNABLE Response	BF	CWR	CPx	

APPENDIX D
LABEL, SUBLABEL, MFI AND IMI INFORMATION

This list of SMIs and Sublabels is used when the message is generated by a peripheral (in the case of a downlink), or directed to (in the case of an uplink) a peripheral using the label 'H1'. When two units are installed (dual installation), an uplink may be delivered to the unit selected as active (designated).

Table D-3 ACARS Peripherals: Sub-Label Assignments

Description	Sublabel	SMI	Notes
ADS Unit (ADSU), Left	A1	AUL	
ADS Unit (ADSU), Right	A2	AUR	
ADS Unit (ADSU), Selected	AD	AUD	
All Cabin Terminals	T0	TT0	3
Cabin Terminal 1 through 4 respectively	T1-T4	TT1-TT4	3
User Defined Cabin Terminal 5 through 8 respectively	T5-T8	TT5-TT8	3
Centralized Fault Display Unit (CFDIU)	CF	CFD	1
Digital Flight Data Acquisition Unit (DFDAU)	DF	DFD	2
Flight Management Computer (FMC), Left (1)	M1	FML	
Flight Management Computer (FMC), Right (2)	M2	FMR	
Flight Management Computer (FMC), Center (3)	M3	FM3	
Flight Management Computer (FMC), Selected	MD	FMD	
Optional Auxiliary Terminal (OAT)	None	OAT	
Satellite Data Unit (SDU), Left	S1	SDL	
Satellite Data Unit (SDU), Right	S2	SDR	
Satellite Data Unit (SDU), Selected	SD	SDD	

NOTES:

[1] This unit is also known as the Central Maintenance Computer (CMC).

[2] This unit is also known as the Aircraft Condition Monitoring System (ACMS).

[3] No Header in message.

APPENDIX D
LABEL SUBLABEL, MFI AND IMI INFORMATION

Messages to a peripheral are delivered with the Label H1. Table D-4 illustrates example coding of SMI, MFI, and IMIs for uplink messages to various peripherals. These assignments reflect the information in Table D-2. See Table D-3 for sublabels.

Table D-4 Examples of ATS Uplinks To A Peripheral

Uplink Message Definition	Destination	SMI [1]	MFI	IMI (‘x’ is version #.)	Notes
Oceanic Clearance	ADSU	AUD	A1	Ocx	2
Unassigned			A2	--	
Departure Clearance Response			A3	DCx	
Flight Systems Message	OAT		A4	FSx	
Unassigned			A5	---	
Request ADS Reports	FMC	FMD	A6	ADx	3
Free Text			A7	FTx	
Deliver Departure Slot			A8	---	
ATIS Report			A9	TIx	
ATS Facility Notification			A0	AFx	
ATCComm			AA	ATx	
TWIP Report			AB	TWx	
Pushback Clearance			AC	PCx	
Expected Taxi Clearance			AD	ETx	
Unassigned			AE	--	
CPC Command/Response			AF	CPx	

NOTES:

- [1] The assignment of the SMI is associated with the identity of the destination LRU. See Table D-3 Sublabel assignments are listed in Table D-3.
- [2] Uplinks to the left ADSU use the SMI of ‘AUL’; uplinks to the right ADSU use SMI of ‘AUR’.
- [3] Uplinks to the left FMC use the SMI of ‘FML’; uplinks to the right FMC use SMI of ‘FMR’. See Table D-3.

APPENDIX D
LABEL, SUBLABEL, MFI AND IMI INFORMATION

Table D-5 Examples of ATS Downlinks From a Peripheral

Downlink Message Definition	Source	SMI [1]	MFI	IMI ("x" is Version #.)	Notes
Request Oceanic Clearance	ADSU	AUR	B1	Ocx	2
Oceanic Clearance Readback			B2	OCx	
Request Departure Clearance			B3	DCx	
Departure Clearance Readback	OAT		B4	DCx	
Reserved			B5		
Provide ADS Report	FMC	FMR	B6	ADx	3
Free Text			B7	FTx	
Request Departure Slot			B8	--	
Request ATIS Report			B9	TIx	
ATS Facility Notification			B0	AFx	
ATCComm			BA	ATx	
Request TWIP Report			BB	TWx	
Pushback Clearance Request			BC	PCx	
Expected Taxi Clearance Request			BD	ETx	
CPC Aircraft Log-on/Log-off Req.			BE	CLx	
CPC WILCO/UNABLE Response			BF	CPx	

Note:

- [1] The assignment of the SMI is associated with the identity of the Source LRU. See Table D-3.
- [2] Downlinks from the right ADSU use the SMI of 'AUR'. See Table D-3.
- [3] Downlinks from the right FMC use the SMI of 'FMR'. See Table D-3.

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TO
ARINC SPECIFICATION 622
PROCESSES FOR ATS DATA LINK APPLICATIONS OVER ACARS AIR-GROUND NETWORK

Published: November 30, 1993

Prepared by the Airlines Electronic Engineering Committee
Adopted by the Airlines Electronic Engineering Committee: October 19, 1993

A. PURPOSE OF THIS DOCUMENT

This Supplement adds new character-oriented definitions of:

ATIS Request for Version 2,
ATIS Uplink for Version 2,
Request for Oceanic Clearance,
Oceanic Clearance,
Acknowledge Oceanic Clearance,
Request for Departure Clearance,
Departure Clearance, and
Acknowledge Departure Clearance.

B. ORGANIZATION OF THIS DOCUMENT

The first part of this document contains a list of the changes proposed for introduction into the Specification by this Supplement.

**C. CHANGES TO ARINC SPECIFICATION 622
INTRODUCED BY THIS SUPPLEMENT**

This section presents a complete tabulation of the changes and additions to the Specification to be introduced by this Supplement. Each change or addition is defined by the section number and the title that will be employed when the Supplement is eventually incorporated. In each case a brief description of the change or addition is included.

1.1 Introduction

Text revised to clarify the distinction between processes and applications. Add commentary to alert readers that the ATS character-oriented applications defined in Chapter 4 and the references to bit-oriented ATS applications in Chapter 2 will be moved to AIRNC Specification 623 by Supplement 1.

1.4 Organization of this Document

Revised to identify ATC Facilities Notification as a standalone chapter (Chapter 3). Character applications were moved to Chapter 4.

2.3.1.2 ACARS Bit-to-Character Conversion

Four spaces if CRC is not calculated.

**2.4.2 ATCComm Provisions within the ACARS
Convergence Function - Application Interface**

Replace old text with definition of the processes necessary to support two way data link. Add reference to new IMI.

2.4.2.1 ATCComm Uplink Message

New Section added.

2.4.2.2 ATCComm Downlink Message

New Section added.

**2.4.3 CMA Provisions within the ACARS Convergence
Function - Application Interface**

New Section added.

3.0 ATC Facilities Notification Process

New chapter heading. Subsections renumbered.

3.1 Introduction

New Section added.

4.3.1.1 Version 1

New Section added.

4.3.1.2 Version 2

New Section added.

4.3.2 Avionics Indicator

New Section number; formerly Section 3.3.4. Add reference to use of ATIS for enroute service.

4.3.3 Airport ID

New Section number; formerly Section 3.3.2.

4.3.4 Arrival/Departure Indicator

New Section number; formerly Section 3.3.3

4.3.5 Cyclical Redundancy Check (CRC)

Add new Section - applicable to Version 2.

**4.4 Deliver Automatic Terminal Information Service
(ATIS) Uplink**

New section and subsections added to describe uplink separate from the request (defined in Section 3.3).

4.4.1 Version Number

Expand definition to include dual use of the field.

4.4.1 Version 1

New Section added.

4.4.1 Version 2

New Section added.

4.4.5 Cyclical Redundancy Check (CRC)

Add new Section - applicable to Version 2.

4.5 Request Oceanic Clearance Downlink

New Section and subsections added.

4.5.1 ATC Address

4.5.2 Message Text

4.5.2.1 Imbedded Message Identifier

4.5.2.2 Avionics Indicator

4.5.2.3 Application Text

4.5.2.4 Cyclical Redundancy Check (CRC)

4.6 Oceanic Clearance Uplink

New Section and subsections added.

4.6.1 ATC Address

New Section added.

4.6.2 Message Text

New Section added.

4.6.2.1 Imbedded Message Identifier

New Section added.

4.6.2.2 Application Text

New Section added.

4.6.2.3 Cyclical Redundancy Check (CRC)

New Section added.

4.7 Acknowledge Oceanic Clearance Downlink

New Section added.

4.7.1 ATC Address

New Section added.

4.7.2 Message Text

New Section added.

4.7.2.1 Imbedded Message Identifier

New Section added.

4.7.2.2 Application Text

New Section added.

4.7.2.3 Cyclical Redundancy Check (CRC)

New Section added.

4.8 Request Departure Clearance

New Section added.

4.8.1 ATC Address

New Section added.

4.8.2 Message Text

New Section added.

4.8.2.1 Imbedded Message Identifier

New Section added.

4.8.2.2 Avionics Indicator

New Section added.

4.8.2.3 Application Text

New Section added.

4.8.2.4 Cyclical Redundancy Check (CRC)

New Section added.

4.9 Acknowledge Departure Clearance Request Uplink

New Section added.

4.9.1 ATC Address

New Section added.

4.9.2 Message Text

New Section added.

4.9.2.1 Imbedded Message Identifier

New Section added.

4.9.2.2 Application Text

New Section added.

4.9.2.3 Cyclical Redundancy Check (CRC)

New Section added.

4.10 Departure Clearance Uplink

New Section added.

4.10.1 ATC Address

New Section added.

4.10.2 Message Text

New Section added.

4.10.2.1 Imbedded Message Identifier

New Section added.

4.10.2.2 Application Text

New Section added.

4.10.2.3 Cyclical Redundancy Check (CRC)

New Section added.

4.11 Acknowledge Departure Clearance Downlink

New Section added.

4.11.1 ATC Address

New Section added.

4.11.2 Message Text

New Section added.

4.11.2.1 Imbedded Message Identifier

New Section added.

4.11.2.2 Application Text

New Section added.

4.11.2.3 Cyclical Redundancy Check (CRC)

ATTACHMENT 2 - ACF IMI Table

Add IMI for ATCComm.

ATTACHMENT 3 - AIR TRAFFIC SERVICES TABLES

Add Notes to Table 3-1.

ATTACHMENT 4 - AFN PROCEDURE

Renumbered. Formerly Attachment 5.

ATTACHMENT 5 - REQUEST ATIS DOWNLINK FORMATS

Renumbered. Formerly Attachment 4. New table added.

ATTACHMENT 6 - REQUEST ATIS DOWNLINK/DELIVER ATIS UPLINK FORMATS

Renumbered. Formerly Attachment 4. New table added.

ATTACHMENT 7 - REQUEST OCEANIC CLEARANCE DOWNLINK FORMAT

New Attachment added.

ATTACHMENT 8 - OCEANIC CLEARANCE UPLINK FORMAT

New Attachment added.

ATTACHMENT 9 - ACKNOWLEDGE OCEANIC CLEARANCE DOWNLINK FORMAT

New Attachment added.

ATTACHMENT 10 - REQUEST DEPARTURE CLEARANCE DOWNLINK FORMAT

New Attachment added.

ATTACHMENT 11 - ACKNOWLEDGE DEPARTURE CLEARANCE REQUEST UPLINK FORMAT

New Attachment added.

ATTACHMENT 12 - DELIVER DEPARTURE CLEARANCE UPLINK FORMAT

New Attachment added.

ATTACHMENT 13 - ACKNOWLEDGE DEPARTURE CLEARANCE DOWNLINK FORMAT

New Attachment added.

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TO
ARINC SPECIFICATION 622
PROCESSES FOR ATS DATA LINK APPLICATIONS OVER ACARS AIR-GROUND NETWORK

Published: December 20, 1994

Prepared by the Airlines Electronic Engineering Committee
Adopted by the Airlines Electronic Engineering Committee: October 19, 1994

A. PURPOSE OF THIS DOCUMENT

This Supplement removes character-oriented definitions which will appear in ARINC Specification 623. The remaining material will address the processes necessary to support Air Traffic Service (ATS) applications.

The character-oriented application definitions that were removed are:

ATIS - Request and Uplink

Oceanic Clearance - Request, Uplink and Acknowledge Uplink

Departure Clearance - Request, Acknowledge Request, Uplink, and Acknowledge Uplink.

B. ORGANIZATION OF THIS DOCUMENT

Changes introduced by Supplement 2 are too extensive to make the integration of replacement pages from a separate supplement into Specification 622-1 practical for our readers.

The changes introduced by Supplement 2 have been identified using change bars and are labelled c-2.

C. CHANGES TO ARINC SPECIFICATION 622 INTRODUCED BY THIS DRAFT SUPPLEMENT

This section presents a complete tabulation of the changes and additions to the Specification to be introduced by this Supplement. Each change or addition is defined by the section number and the title that will be employed when the Supplement is eventually incorporated. In each case a brief description of the change or addition is included.

1.1 Introduction

This section was rewritten in its entirety to reflect the increased emphasis on processes.

1.2 Purpose of this Document

This section was revised to note that uniform message formats are needed for worldwide operation. Also, the ACF process is intended for ATS applications, but AOC applications are not precluded from using this process.

1.3 Organization of this Document

This section was revised to reflect the transfer of application information to Project Paper 623.

1.4 Data Link Network Components

The definitions of uplink and downlink are added.

1.5.1 References for ATS Applications

The reference to Appendix D which listed the preliminary message format of Two Way Data Link messages was deleted.

2.0 ACARS Compatible System

Chapter 2 was revised extensively to accommodate deletion of references to character-oriented message formats and to clarify the functionality of the ACARS Compatible system. These changes include an entirely new set of Section titles

and substantial restructuring of the text. Some text was moved to Chapter 4 for improved readability. Further, text revisions were made and new text was added.

3.0 ATS Facilities Notification

Chapter 3 was revised extensively. The numbering of all sections was affected by the deletion of Section 3.1, Introduction. Some new Section titles were added. These changes include an entirely new set of Section titles and substantial restructuring of the text. Further, text revisions were made and new text was added.

4.0 Support for Bit-Oriented Applications

Chapter 4 is a new chapter created to accommodate the transfer of character-oriented application definitions to ARINC Specification 623. It was written to incorporate enhanced understanding that resulted from implementation of bit-oriented ATS applications. Some material was moved to Chapter 4 from Chapter 2. Further, text revisions were made and new text was added.

5.0 Support for Character-Oriented Applications

Formerly Chapter 4, this chapter has been reduced significantly in size as its contents were transferred to ARINC Specification 623. Since several sections were removed, the section numbers have been revised. Minor editorial changes have been made to improve readability.

An illustrative diagram was added to highlight the relationship of the functions defined in Specifications 620, 622 and 623.

ATTACHMENT 1

ACARS Compatible System diagram, Figure 1-1, was deleted. Figure 1-2 was renumbered as Figure 1-1 and revised to expand transport layer interactions.

ATTACHMENT 2

ACF IMI Table - Added references to RTCA. Added ATCComm IMIs.

ATTACHMENT 3

The Length and Format definition of ctr_addr were changed and the format of the time was changed in Table 3-1. In Table 3-2 the format and notes (2 and 4) were modified.

ATTACHMENT 5

SDL Representation of ATS Facilities Notification was added.

ATTACHMENT 6

Encapsulation figure of Bit-oriented ATS Messages was added.

ATTACHMENT 7

Encapsulation figure of Character-oriented ATS Messages was added.

APPENDIX D

Appendix D was deleted by Supplement 1, but this fact was not noted in the supplement description of changes. New material, a listing of MFIs and IMIs, has been added as the new Appendix D.

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TO
ARINC SPECIFICATION 622

ATS DATA LINK APPLICATIONS OVER ACARS AIR-GROUND NETWORK

Published: October 15, 1998

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: October 8, 1998

A. PURPOSE OF THIS DOCUMENT

This Supplement adds an encouragement to CAAs to utilize the provisions of ARINC Specification 622 when implementing ATS applications. The other substantive change is to introduce new character-oriented ATS applications:

Terminal Weather Information for Pilots (TWIP)
Digital Delivery of Taxi Clearance (DDTC)
Controller to Pilot Communications (CPC)

This Supplement also introduces editorial corrections and clarifications.

B. ORGANIZATION OF THIS DOCUMENT

The first part of this document, printed on buff-colored paper, is the Supplement itself. It contains descriptions of the changes introduced into the Specification and, where appropriate, extracts from the original text for comparison purposes. The second part consists of replacement white pages for the Specification, modified as required by the Supplement. The modified and added material on each replacement page is identified in the margin by a "c-3" indicator.

C. CHANGES TO ARINC SPECIFICATION 622 INTRODUCED BY THIS DRAFT SUPPLEMENT

This section, listed directly below, presents a complete tabulation of the changes and additions to the Specification to be introduced by this Supplement. Each change or addition is defined by the section number and the title that will be employed when the Supplement is eventually incorporated. In each case a brief description of the change or addition is included.

General

In view of the introduction of ACARS-capable CMUs, the generic designator[C]MU is used.

1.1 Introduction

Commentary added.

1.4 Data Link Network Components

Editorial change to clarify the media options available to the ACARS MU.

1.5.1 References for ATS Applications

The list of referenced documents was expanded to include ICAO SARPs. The text was reorganized to separate ADS application references from CPDLC references.

2.1.2 The End-to-End Communication Process

The text of the last two paragraphs was expanded to clarify the usage of the term "Application Data" and to clarify the hex encoding and decoding process.

2.2.2.2 Application Text Field

Commentary added.

2.2.3 ACARS Compatible Process CRC

Editorial change to clarify the relationship of the Application Data to the Application Text.

2.2.4 ACARS Bit-to-HEX (ISO-5) Conversion

Editorial change. Added a reference to Attachments 6 and 7 to clarify the relationship of the Application Data to the Application Text. Corrected typographical error in the coding of the application data, when padded, in commentary.

3.5.1 Labels/MFIs

Editorial change. Commentary added.

3.5.3 AFN Message Header

A reference to ARINC Specification 429, Part 1, was added to obtain the coding of the ICAO 24-bit Aircraft Address.

3.5.4 AFN Contact Message

The example of an uplink AFN Contact message was modified to show two characters for the Version number field length to be consistent with the field length specified in Specification 623. Previously only one character was shown.

4.4.2.1 ATCComm Connection Establishment Uplink

Commentary added.

5.1 Introduction

Text was added to encourage CAAs to implement the provisions IMI and CRC of Chapter 5 when installing character-oriented ATS applications.

5.7 Terminal Weather Information for Pilots (TWIP)

New section and subsections were added.

5.8 Reserved

Placeholder for new section added..

5.9 Digital Delivery of Taxi Clearance (DDTC)

New section and subsections were added.

5.10 Controller to Pilot Communications (CPC)

New section and subsections were added.

ATTACHMENT 3 – AIR TRAFFIC SERVICES TABLES

The length of the Version Number field was changed from "Variable" to a fixed length of '2'.

ATTACHMENT 6 – BIT-ORIENTED ATS MESSAGES

Note added. The list of bit-oriented applications was expanded to include ICAO SARPs.

ATTACHMENT 7 – CHARACTER-ORIENTED ATS
MESSAGES

Notes added.

APPENDIX B – CRC EXAMPLE

Notes added.

APPENDIX D

These tables were revised to consolidate the information presented. This reorganization resulted in the elimination of Tables D-6 through D-11.

Entries for the TWIP, DDTC and CPC messages were added to the appropriate tables.

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TO

ARINC SPECIFICATION 622

ATS DATA LINK APPLICATIONS OVER ACARS AIR-GROUND NETWORK

Published: October 12, 2001

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: July 18, 2001

A. PURPOSE OF THIS DOCUMENT

This Supplement introduces typographical corrections and adds a clarifying commentary.

B. ORGANIZATION OF THIS DOCUMENT

The first part of this document, printed on goldenrod-colored paper, is the Supplement itself. It contains descriptions of the changes introduced into the Specification and, where appropriate, extracts from the original text for comparison purposes. The second part consists of replacement white pages for the Specification, modified as required by the Supplement.

**C. CHANGES TO ARINC SPECIFICATION 622
INTRODUCED BY THIS DRAFT SUPPLEMENT**

This section, listed directly below, presents a complete tabulation of the changes and additions to the Specification to be introduced by this Supplement. Each change or addition is defined by the section number and the title that will be employed when the Supplement is eventually incorporated into the existing Specification. In each case a brief description of the change or addition is included.

2.2.4 ACARS Bit-to-HEX (ISO-5) Conversion

Typographical errors corrected in table.

A commentary was added after the fourth paragraph to assist the reader in comprehending the section.

APPENDIX B

Clarifications were added to Table B1.1-1.

New Tables B1.1-2 and B1.1-2A were added to provide better insight into the operation of the CRC and to provide a mechanism for testing new CRC software.