



**AERONAUTICAL TELECOMMUNICATIONS
NETWORK (ATN)
IMPLEMENTATION PROVISIONS, PART 1,
PROTOCOLS AND SERVICES**

ARINC SPECIFICATION 637P1-1

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ARINC SPECIFICATION 637P1-1®
AERONAUTICAL TELECOMMUNICATIONS NETWORK (ATN)
IMPLEMENTATION PROVISIONS, PART 1, PROTOCOLS AND SERVICES

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Prepared by the Airlines Electronic Engineering Committee

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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 INTRODUCTION

1.1 Introduction

The intent of this document is to provide general and specific design guidance for the development and installation of Aeronautical Telecommunication Network (ATN) protocols and services needed to transport, route and relay ACARS air-ground data link messages in an open systems interconnection environment. This document describes the necessary internetworking functions to support character oriented application messages (i.e., ACARS) which will be transported over bit oriented sub-networks. The protocols and services defined herein are consistent with those specified in ICAO SARPs and guidance material for the Aeronautical Telecommunication Network (ATN).

1.2 Scope

This document describes the communication functions that should be performed by the aircraft avionics and ground systems to successfully transfer ACARS messages using ATN protocols and services. Messages processed by avionics will be transferred:

- a. from avionics to ground systems
- b. from ground systems to avionics
- c. within the aircraft
- d. between ground systems.

1.3 Background

Communications across the air-ground link have traditionally been accomplished by using the Aircraft Communication Addressing and Reporting System (ACARS). The ACARS VHF air-ground system description was initially included in ARINC Characteristic 597 (obsolete). It was later transferred to ARINC Specification 618 where a similar protocol is adapted to run over Satellite and HF.

The ATN concept emerged from a need to interchange bit-oriented digital data over dissimilar aeronautical data links using, for interoperability purpose, the principles of the International Organization for Standardization (ISO) open systems interconnection (OSI) architecture.

COMMENTARY

The predecessor of ATN, ACARS, was designed to carry character-oriented data. Over time, this was seen as a limitation.

The ATN provides communication facilities for air traffic services (ATS), aeronautical operational control (AOC), aeronautical administrative communications (AAC) and aeronautical passenger communications (APC). The ATN design supports the incorporation of different air-ground subnetworks and different ground-ground subnetworks, resulting in a common data transfer service. Furthermore, the ATN design is such

that user communication services may be introduced in an evolutionary manner.

The ATN air-ground data communication functions described herein are compatible with the OSI Model and were developed as the first step toward a fully OSI compliant protocol “suite”. These protocols may be installed in a Communications Management Unit (CMU) onboard the aircraft, or in any End System (ES) or Intermediate System (IS) onboard the aircraft.

COMMENTARY

The near term goal of airlines choosing to equip with ATN is to eliminate redundant data link avionics as soon as practical. However, a significant inventory of equipment, both in the airplane and on the ground, will continue to operate using only ACARS 618 protocols. This equipment, and the related processes administered by ground service providers and airline host computers needed to enable the equipment to operate, should continue to be supported for the foreseeable future. The architecture proposed and specified herein should be constructed between current data communication methods (ACARS) and the desired goal of communicating in an ATN environment. By providing an OSI-compatible data communications system, current data formats can continue to be supported by the same communication system.

1.4 Relationship to Other Documents

The ATN SARPs and guidance material were developed by the ICAO ATN Panel based on operational requirements defined by the ICAO ADS Panel. These SARPs and guidance material, and the Generic ATN Communication Service (GACS) Application Service Element (ASE) serve as the bases for this document.

Part 2 of this specification will contain the registered X.121 Data Link Service Provider (DSP), Air Ground Router addresses for SATCOM Data 3 and HFRLS. It will also contain the DSP NSAP addresses for the ARINC 620 Gateway Application.

COMMENTARY

ARINC Specification 637 Aeronautical Telecommunications Network (ATN), Part 2, Addressing is being developed. It will contain the registered addresses.

1.5 Overview of OSI Reference Model

The foundation upon which the ATN is specified comes from a document called “International Standards Organization (ISO) 7849” which is titled “Open Systems Interconnection (OSI) Information Processing Systems – Basic Reference Model”.

1.0 INTRODUCTION (cont'd)

This section presents a short introduction to the OSI Reference Model or “seven (7) layer protocol stack” as it is commonly referred to within industry. Figure 1-1 shows the relationships among the layers specified in the OSI Reference Model.

1.5 Overview of OSI Reference Model (cont'd)

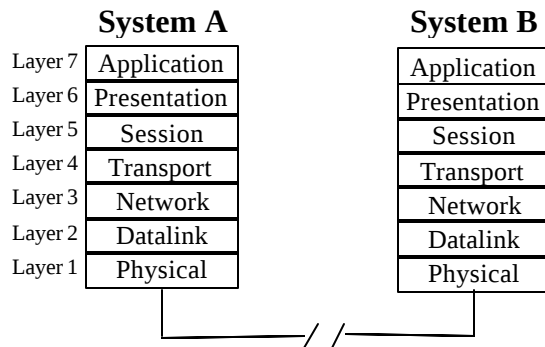


Figure 1-1
OSI Seven (7) Layer Protocol Reference Model

1.5.1 Application Layer (Layer 7)

The application layer is the OSI layer closest to the user. It differs from the other layers in that it does not provide services to any other OSI layer, but rather to application processes lying outside the scope of the OSI model. Examples of such application processes include spreadsheet programs, word-processing programs, banking terminal programs, and so on.

The application layer identifies and establishes the availability of intended communication partners, synchronizes cooperating applications, and establishes agreement on procedures for error recovery and control of data integrity. Also, the application layer determines whether sufficient resources for the intended communication exist.

1.5.2 Presentation Layer (Layer 6)

The Presentation layer ensures that information sent by the application layer of one system is readable by the Application layer of another system. If necessary, the presentation layer translates between multiple data representation formats by using a common data representation format.

The Presentation layer concerns itself not only with the format and representation of actual user data, but also with data structures used by programs. Therefore, in addition to actual data format transformation (if necessary), the Presentation layer negotiates data transfer syntax for the application layer.

1.5.3 Session Layer (Layer 5)

As its name implies, the session layer establishes, manages, and terminates sessions between applications. A Session consists of dialogue between two or more presentation entities (recall that the session layer

provides its services to the presentation layer). The Session layer synchronizes dialogue between presentation layer entities and manages their data exchange. In addition to basic regulation of conversations (sessions), the Session layer offers provisions for data expediton, class of service, and exception reporting of session-layer, presentation-layer, and application-layer problems.

1.5.4 Transport Layer (Layer 4)

The boundary between the Session layer and the transport layer can be thought of as the boundary between application-layer protocols and lower-layer protocols. Whereas the application, presentation, and Session layers are concerned with application issues, the lower four layers are concerned with data transport issues.

The Transport layer attempts to provide a data transport service that shields the upper layers from transport implementation details. Specifically, issues such as how reliable transport over an inter-network is accomplished are the concern of the Transport layer. In providing reliable service, the Transport layer provides mechanisms for the establishment, maintenance, and orderly termination of virtual circuits, transport fault detection and recovery, and information flow control (to prevent one system from overrunning another with data).

1.5.5 Network Layer (Layer 3)

The Network layer is a complex layer that provides connectivity and path selection between two end systems that may be located on geographically diverse subnetworks. A subnetwork, in this instance, is essentially a single network cable (sometimes called a segment).

Because a substantial geographic distance and many subnetworks can separate two end systems desiring communication, the network layer is the domain of routing. Routing protocols select optimal paths through the series of interconnected subnetworks. Traditional Network layer protocols then move information along these paths.

1.5.6 Data Link Layer (Layer 2)

The Data Link layer (formally referred to as the data link layer) provides reliable transit of data across a physical link. In so doing, the link layer is concerned with physical (as opposed to network, or logical) addressing, network topology, line discipline (how end systems use the network link), error notification, ordered delivery of frames, and flow control.

1.5.7 Physical Layer (Layer 1)

The Physical layer defines the electrical, mechanical, procedural, and functional specifications for activating, maintaining, and deactivating the physical link between end systems. Such characteristics as voltage levels, timing of voltage changes, physical data rates, maximum transmission distances, physical connectors, and other, similar, attributes are defined by Physical layer specifications.

1.6 Document Overview

The purpose of Chapter 1 is to describe the purpose of this Specification and to provide background and introductory

1.0 INTRODUCTION (cont'd)

information that will enable a reader to better understand subsequent chapters.

The purpose of Chapter 2 is to introduce the specific ATN communication protocols and architecture, and to illustrate how ARINC Specification 620 messages are transported over the ATN. References are also being made to new application interfaces. Transition from existing ACARS services are introduced.

The purpose of Chapter 3 is to specify how ARINC Specification 620 messages are conveyed over the ATN. Chapter 3 describes how ARINC Specification 620 message attributes (e.g., label/sub-label, priority, subnetwork preference, etc) and ARINC 620 message text are mapped from/to the ATN. ARINC Specification 620 message transport options described are Connectionless Dialog Service (CLDS) and (connection oriented) Dialog Service (DS).

The purpose of Chapter 4 is to identify and extend the ATN naming and addressing plan, and to describe its administration, for all airborne and non-ATC ground names and addresses, including ARINC Specification 620 messaging. Guidance is also given for the assignment of airborne and non ATC ground NSAP and TSAP addresses.

The purpose of Chapter 5 is to describe the initial functions associated with monitoring and management of ATN airborne routers. Chapter 5 describes, but is not limited to the following: data recording, system parameters (configuration), fault management, accounting management and monitoring tools (e.g., ping, trace route).

Appendix A provides a list of Acronyms used in this specification.

The purpose of Appendix B is to provide Fault and Management Guidance material as it becomes available.

The purpose of Appendix C is to describe a generic interface between the ATN routing functions and air/ground data links.

1.7 Regulatory Approval

The equipment should meet all applicable regulatory requirements. This document does not and cannot set forth the specific requirements that an equipment should meet to be assured of approval. Such information should be obtained from the regulatory agencies themselves.

1.8 Protocol Implementation Conformance Statement (PICS)

ATN implementations should consider completing a PICS using the ICAO SARPs APRLs and following general ISO/IEC industry practice.

1.9 Documents Referenced

This specification references the following documents:

ARINC Specification 618, “Air/Ground Character-Oriented Protocol Specification”

ARINC Specification 619, “Airborne Equipment Protocols for File Transfer of Character Data”

ARINC Specification 620, “Data Link Ground System Standard and Interface Specification (DGSS/IS)”

ARINC Specification 622, “Processes for ATS Data Link Applications Over ACARS Air-Ground Network”

ARINC Specification 623, “Character-Oriented Air Traffic Service (ATS) Applications”

ARINC Specification 631, “VHF Digital Link Implementation Provisions”

ARINC Characteristic 741, “Aviation Satellite Communications System”

ARINC Characteristic 750, “VHF Data Radio”

ARINC Characteristic 758, “Communications Management Unit (CMU) Mark 2”

ICAO Amendment 73 to Annex 10 to the Chicago Convention, CORE and SV-1 SARPs, Fall 1998

ICAO DOC 9705-AN/956, “Manual of Technical Provisions for the Aeronautical Telecommunication Network (ATN), Third Edition – 2001

COMMENTARY

Second Edition 1999 corresponds to Amendment 73 to Annex 10, and is the official ICAO publication. Third edition with GACS and CLDS is awaiting state endorsement of Amendment 75 to Annex 10 before 2001 official publication.

ICAO DOC 9739-AN/961, The Comprehensive ATN Manual, First Edition - 1999

ICAO DOC 9694-AN/955, “Manual of Air Traffic Services and Data Link Applications, First Edition – 1998

2.0 AIRBORNE ATN SYSTEM ARCHITECTURE

2.1 Introduction

This chapter introduces specific Aeronautical Telecommunication Network (ATN) protocols and services, and the corresponding avionics architecture resulting from the data communications infrastructure upgrade from ACARS to ATN. It also describes, where necessary, peer components on the ground to give the reader a complete systems overview to better understand the rational of various migration opportunities. An overall system diagram is included as Figure 1-1 of Attachment 1.

COMMENTARY

Various infrastructure options and product offerings are possible. This document depicts several consensus possibilities which follow a natural migration path from ACARS to ATN. Product configurations other than those shown herein are not precluded as long as they are interoperable.

The ATN was been adopted by the International Civil Aviation Organization (ICAO) as Amendment No. 73 (effective 5 November 1998) to the International Standards and Recommended Practices (SARPs), Aeronautical Telecommunications, Annex 10 to the Convention on International Civil Aviation, Volume III, Part I - Digital Data Communication Systems, Chapter 3 “Aeronautical Telecommunication Network.” For brevity, this specification will refer to the ICAO ATN SARPs as simply the ATN SARPs. ICAO also developed ICAO DOC 9705 “Manual of Technical Provisions for the Aeronautical Telecommunication Network” Second Edition - 1999.

COMMENTARY

The ICAO SARPs specify the ATN as an internet ISO/IEC 8473 (CLNP) as its internetwork protocol. As such, the ATN is a collection of Routers and End Systems interconnected by ground-ground, air-ground, and airborne subnetworks. In this context, the term subnetwork covers almost any bit oriented communications service.

The ATN Routers are responsible for forwarding CLNP packets to their identified destination. Each Router makes its routing decisions autonomously using its own Forwarding Tables, which are built from information provided by router to router routing information exchange protocols. Several such protocols are available for use in the ATN, however, the most important of these is the Inter-Domain Routing Information Exchange Protocol (IDRP) specified in ISO/IEC 10747.

IDRP is responsible for maintaining the ground connectivity between organizations, including Air Traffic Service Organizations (ATSO), Airlines and Service Providers. Its key role is to support the routing of packets to aircraft, enabling the ATN Routers to choose the best route to each aircraft regardless of its geographical location or which air/ground communications service it is using. There is no central point of control in the ATN and

IDRP enables a robust, fast and distributed approach to routing to aircraft with no central point of failure.

IDRP may also be used over the air/ground network, where it permits aircraft to make sensible routing decisions based on connectivity and policy when choosing between alternative service providers and communications services. However, in the development of the ICAO SARPs, it was recognized that many aircraft would only be equipped to use a single service provider and communications service. Such aircraft would have a minimal requirement for IDRP over the air/ground data link and hence the SARPs do not mandate the use of IDRP in such situations. The procedures known as the Optional non-use of IDRP are used over the air/ground data link when IDRP is not implemented by the aircraft. Notwithstanding the above, IDRP is always used in its primary role of supporting ground routing to an aircraft even when the aircraft itself does not implement IDRP.

It should be noted that the optional non-use of the Inter-Domain Routing Protocol (IDRP) by aircraft over the air/ground link is not supported by all International Data Link Service Providers. However, this does not preclude ATN SARPs compliant implementations of “optional non-use of IDRP in the air” bilaterally among Airlines and Service Providers.

The ATN provides end-to-end communications services between ground-ground and air/ground users. Both reliable stream mode and packet oriented (connectionless) communications services are provided. This document is concerned with the use of these services to exchange legacy ACARS messages between ATN equipped aircraft and DSPs or airline host systems, and to provide a framework for future aircraft to airline communications. In the former case, a major objective is to ensure that the airline to DSP interface is the same regardless of whether legacy ACARS or ATN based communications are used over the air/ground media. Refer to Attachment 2 Figure 2-1 diagram depicting the end-to-end protocol architecture.

2.1.1 Data Link System Background

Inter-airline digital data communications began as a ground based airline computer exchange of message switching (MSGSW) data for reservations and other functions. Rather than implement separate ground/ground links to every other airline, it became expedient for airlines to fund international DSP organizations (e.g., ARINC, SITA, etc.) to stage, archive, route and disseminate interline message switching traffic. The rules, communications protocols and message formats for interline data exchange are specified in the International Air Transportation Association (IATA), Interline Communications Manual (ICM) (now called the Systems and Communication Reference (SCR)). A feature of the ICM/SCR protocol is the ADDRESS is expressed as XXXYZZ, where ZZ is the two-character AIRLINE CODE (e.g., AA,

2.0 AIRBORNE ATN SYSTEM ARCHITECTURE (cont'd)

UA, etc.), and XXX & YY is a three & two character OFFICE and DEPARTMENT CODE for airline internal distribution.

2.1.2 Air/Ground Data Exchange

ACARS is a natural extension of the ICM/SCR ground based system, extending interline communications to the air/ground environment, supporting airline-initiated uplink messages to aircraft, and aircraft initiated downlink messages to airline host systems. ACARS uses the same ICM/SCR rules for the ground/ground communications, and the ARINC Specification 618 protocol for air/ground communications. Airlines use the ARINC (XA) or SITA (XS) two-character pseudo airline code and special OFFICE/DEPARTMENT codes to indicate uplink message switching, and the DSPs, in turn, convert the downlink ARINC 618 encapsulated messages to the XXXYYZZ format expected by airline host systems. Further extensions to basic ACARS include the limited ability for aircraft to indicate ATSO addresses in downlink messages, and to receive ATSO uplink responses (i.e., ARINC Specifications 622/623). Figure 2-2 of Attachment 2 depicts the basic ACARS avionics protocol architecture.

COMMENTARY

In Figure 2-2 of Attachment 2, the term “620” is used generically to mean all ACARS character-oriented application data messages (i.e., all messages specified in ARINC Specification 620, ARINC Specification 622 (including the FANS-1/A message set), and ARINC Specification 623). The ACARS Interface performs label/sublabel breakdown in the uplink direction, and subnetwork preferencing in the downlink direction.

SAT Cat B is the emerging next generation satellite systems (e.g., Iridium), and SAT Cat A is the Inmarsat Data 1 and Data 2 service. See Chapters 7, 8, and 9 of ARINC Specification 618 for further detail.

Figure 1-2 of Attachment 2 also introduces VDL Modes 0 and A. These are not ICAO VDL Modes, but instead refer to legacy ACARS communications using a consistent terminology. VDL Mode 0 is no more than an ACARS modem using an analog ARINC 716 radio or an ARINC 750 radio in the analog mode. VDL Mode A is the same except that an ARINC 750 VDR is used providing a digital interface between the Communications Management Unit (CMU) and the VDR. Also, the modem in the VDR is used, rather than the modem in the CMU.

2.1.3 ACARS Evolution

Over the air/ground link, the ACARS ICM/SCR system began with VHF data link Mode 0 using VHF analog radios and 2.4 kbs modems employing binary MSK modulation with CSMA. Inmarsat satellite SATCOM Data-2 (SD2) was added, followed by HF Data Link Service (HF/DLS).

ICAO has now defined the VHF Digital Link, and VDL Modes 1 and 2 have been specified to provide evolutionary development of ACARS providing firstly more efficient data Link access and binary (as opposed to character) oriented communications (VDL Mode 1) and additionally, a higher data rate (VDL Mode 2). VDL Mode 2 uses CSMA data link access, implementing a more efficient version of the original ACARS CSMA. VDL Mode 2 additionally implements the D8PSK modulation scheme with a transmission rate of 31.5 kbs. As bandwidth is now at a premium, VDL Mode 1 is not being seriously considered by the industry and a full transition to VDL Mode 2 is being planned.

The strategic objective is for VDL Mode 2 to provide ATN based communications for both AOC and ATC users. However, at the time of writing, VDL Mode 2 is also planned for use as an ARINC Specification 618 (i.e., ACARS) supporting data link. This is to support an interim solution called ACARS Over AVLC (AOA). Figure 2-3 of Attachment 2 depicts the basic ACARS avionics architecture with the addition of the AOA operations.

2.2 ATN Data Link System

The ATN is an infrastructure upgrade from ACARS. It is designed to be a replacement for all ACARS air/ground communications, and for all ICM/SCR inter-airline digital data communications in the ground/ground environment. It also enables the replacement of all ACARS based legacy 622/623 ATC message exchange. It is further designed to be an infrastructure for ground/ground data link communications among airlines and CAAs. The end-state data link system envisioned by airlines uses a single, common infrastructure (i.e., the ATN) to interconnect three distinct data sources and sinks, namely aircraft applications, ATSO applications and airline host applications. Airlines expect that such an infrastructure will permit the sharing of subnetwork resources for data exchange among airline applications (AOC, AAC & APC) and air traffic control applications (ADS, CM, CPDLC, D-FIS/ATIS, AIDC & AMHS) with priority and preemption used to guarantee safety critical services.

During transition to the ATN, there are likely to be piecemeal implementations of ATN applications (e.g., AOC over ATN without any ATC applications, AOC over ATN with CM/CPDLC only, etc.). Avionics architectural decisions depend on airline strategies, on costs, on availability of avionics hardware and software, and on ground based peer systems with which to communicate. This Specification does not constrain individual airline architectural decisions.

2.2.1 Bilingual Aircraft

It is recognized that there may be an extended transition period while VDL Mode 2 is deployed worldwide. Some aircraft may, therefore have to support both legacy VHF ACARS and AOC communications using VDL Mode 2.

2.0 AIRBORNE ATN SYSTEM ARCHITECTURE (cont'd)

2.2.1 Bilingual Aircraft (cont'd)

During transition, there may be some dual airborne infrastructures (i.e., bilingual aircraft having both ACARS using VDL Mode A and ATN onboard) with the ability to switch (either dynamically or statically) between them. The ACARS portion of such a bilingual architecture will only have VHF services, specifically VDL Mode 0/VDL Mode A in an ARINC Characteristic 750 radio, as both the satellite and HF/RLS data link are not affected by deployment coverage concerns. Such a bilingual architecture may be desired for certain aircraft, until the ATN version of ground based VM2 is sufficiently deployed worldwide. Figure 2-5 of Attachment 2 shows an example of bilingual avionics.

2.2.2 ACARS Over AVLC (AOA)

In an aircraft fitted with a CMU using the digital interface to an ARINC 750 VDR, it is possible to transport ARINC 618/620 format ACARS messages over the air/ground data link using the VDL Mode 2 AVLC. This is known as ACARS over AVLC (AOA). A CMU is used to access the Media Access Control (MAC) layer functions implemented by the VDR and which are only accessible through its digital interface control. Software support is also provided in the CMU to implement the AVLC. This is illustrated in Figure 2-3 of Attachment 2.

Figure 2-5 of Attachment 2 introduces the ATN to the avionics architecture, and depicts the only accepted bilingual architecture (i.e., ATN and ACARS). Such a bilingual architecture permits the use of either legacy VHF ACARS or ATN over VDL Mode 2, but never both simultaneously.

COMMENTARY

When transitioning to ATN, most of the ARINC 631 AOA/VDL Mode 2 software is expected to be reusable, however changes to Specification 618 software is throwaway.

2.2.3 AOC Over ATN Without ICAO ATC Applications

While it is possible for an aircraft to implement air traffic control applications (e.g., ADS, CM, CPDLC and/or D-FIS/ATIS) over the ATN without a corresponding company operations application (e.g., AOC), it is considered unlikely that an aircraft will keep its company operations over ACARS and implement the ATN solely for ATC applications. A likely transition scenario would be to implement the ATN for AOC only, with the upgrade cost justified for improved AOC communications, with the added benefit that CNS/ATM Applications can then be supported at a low marginal cost. Some/all ATC applications would then be added as ATSO ground based services become available and are cost justified.

The ICAO Generic ATN Communication Service (GACS) has been specified for both the transport of legacy ACARS messages and future airline applications. GACS was developed within ICAO, and is expected to be stable before implementations of this

specification are deployed by airlines. AOC use of GACS would use the GACS specified G-Transfer service, and (optionally) the G-Transfer-Confirmed service for guaranteed delivery. Figure 2-4 of Attachment 2 depicts an avionics architecture with the airline company operations (AOC) application over the ATN, without the ACARS VM0/VMA bilingual subnetwork and without any ATC applications.

GACS enables several possible modes of operation supporting:

- a. Exchanging AOC messages using ATN to/from DSP and legacy interline communications DSP to/from airline
- b. Exchanging AOC messages using ATN to/from airline host
- c. ARINC 622/623 message exchange with ATSO via DSP

AOC (e.g., ACARS) labels and sub-labels defined in ARINC Specification 620, Appendix C, Tables C-2 and C-2A show which Mode(s) of operation are possible.

2.2.3.1 AOC Over ATN To/From DSP

This operational mode assumes that an airline host system does not change (i.e., uplinks originate as MSGSW ICM/SCR traffic from an airline host and are sent to a DSP for ATN conversion. Similarly, ATN downlinks are converted by the DSP to MSGSW ICM/SCR traffic for airline legacy host processors). All downlink traffic is sent to a specific DSP ATN end-system.

If an aircraft is capable of using air/ground communications services from more than one DSP, then it should be noted that the DSP is selected when the message is passed to GACS and not by the ATN.

In this operational mode, GACS would use the connectionless dialog service. This provides for ACARS messaging and is the most efficient approach for the DSP. For those ACARS messages that expect it, GACS provides a delivery confirmation (that is a confirmation of delivery to the DSP).

2.2.3.2 AOC Over ATN To/From An Airline Host

This operational mode assumes that the airline host is an ATN end-system and receives the message directly from the ATN (i.e., GACS logic exists within an airline host complex, and uplink and downlink traffic is transmitted end-to-end between aircraft ATN end system and airline host ATN end system). For this operational mode, GACS may use either the ATN connection oriented dialogue service or the ATN connectionless dialogue service. The choice depends upon the actual communications requirements and airline policy.

However, this operational mode may still require the use of ATN communications with a DSP using GACS and the connectionless dialog service. This is to support any legacy ARINC 622/623 ATC messaging requirements. Figure 1-1 of Attachment 1 shows the

2.0 AIRBORNE ATN SYSTEM ARCHITECTURE (cont'd)

existing and envisioned data link system. An ATN aircraft may communicate directly end-to-end with its legacy host system using only a DSP network of ATN routers. This capability permits unencumbered transition to bit oriented AOC applications.

COMMENTARY

Note that, whereas there are few message size limitations between an airline host system and its aircraft peer, implementations should be aware of inherent size limitations in peripherals.

2.2.3.3 Bilingual (ACARS and ATN)

Refer to Figure 2-5 of Attachment 2 for a depiction of a bilingual architecture.

2.2.3.4 Legacy ARINC 622/623 ATC Messaging

Regardless of whether airline company operations (AOC) application messages go to a DSP gateway end system or direct to an airline host, any existing legacy ARINC 622/623 ATC messages should go only to a DSP.

COMMENTARY

ATC services will ultimately transition from the ARINC 622/623 character message set and FANS-1/A applications to the CPDLC application defined by ICAO. It is not clear how long legacy ARINC 622/623 ATC services will be supported by ATSOs after the introduction of the ICAO ATS messages (CPDLC, ADS, CM, and/or D-FIS/ATIS). A lengthy transition period is expected. This will necessitate continued reliance on the ACARS based ATC applications for many years to come.

The DSP will need readily differentiate ARINC 622/623 (ATS) from other ARINC 620 and process them accordingly. This will be accomplished using their GACS "Message Type." The DSP may thus readily recognize them and process them accordingly.

COMMENTARY

Until the ARINC 619 Traffic Type flag is implemented, all FMC downlink traffic for B-747-400 and B-777 fleet types equipped with FANS-1 need to be routed through a DSP. This is because of restrictions imposed by FANS-1 certification. The current procedure does not support the examination (e.g., of the MFI) of FMC generated downlinks by CMUs.

2.2.4 ICAO ATC Applications Using The ATN

The final level of transition will likely occur in stages as selected ICAO ATC applications (or pieces of applications) are added to avionics platforms. Candidate applications include automatic dependence surveillance (ADS), context management (CM), controller-pilot data link communication (CPDLC) and flight information services/automatic terminal information service (FIS/ATIS). Additionally, the GACS application service element provides a common mechanism to introduce bit-oriented applications,

which can interface to any/all ATN based services. Figure 2-6 of Attachment 2 depicts this transition phase.

COMMENTARY

It should be noted that no change to the AOC components (either through a DSP gateway or direct to an airline host) is necessary when ATC or other bit oriented applications are introduced.

Table 2.2.4 is a high level breakdown of the data link system components.

Table 2.2.4 - Comparison of Data link System Components

	<u>ACARS</u>	<u>ATN</u>
<u>Applications:</u>	AOC ARINC 620, MSGSW Limited ATC ARINC 622/623	AOC ARINC 620, AMHS AAC & APC ICAO ADS, CM, CPDLC FIS/ATIS
<u>Infrastructure:</u>	Airborne ACARS 619, A/G ACARS 618, and G/G ICM/SCR	Airborne ATN, A/G ATN, and G/G ATN
<u>Subnetworks:</u>	VM0 (VMA) & VM2 (AOA), SD2, HF/DLS, and Gatelink	VM2 & VM3 & VM4, SD3 & X-GEN SATCOMs HF/RLS, and Gatelink

2.3 Subnetwork Management

Avionics software management of air/ground subnetworks (such as AMSS, VDL Mode 2, etc.) is implementation specific and is outside the scope of this specification. In order to illustrate the interaction of various subnetwork functions in an airborne router, this section defines a subnetwork management model. See Appendix B for more details.

3.0 ARINC 620 MESSAGES DELIVERED OVER ATN SERVICES**3.1 Introduction**

The protocol architecture used to transfer ARINC Specification 620 messages over ATN is described in Chapter 2 of this specification.

This chapter defines the details of the communications services that are called out in Chapter 2. These services are predicated on the ICAO Generic ATN Communications Service (GACS).

COMMENTARY

GACS is a framework for the transport of “messages” between two ATN users and has been designed to be simple to implement and avoids having to prepare an ATN “ASE” for each new use to which the ATN may be put. It also avoids the need to define the messages using ASN.1 (and hence having to implement the encoding of those messages using the ASN.1 Packed Encoding Rules (PER)). GACS messages may use any appropriate encoding e.g. International Alphabet No. 5 (IA5). Different message formats (and encodings) may be exchanged between the same service users, with each such message format identified by its message type.

An important feature of GACS is that messages may be exchanged using either the connectionless or connection mode communication services offered by the ATN. The choice of service may be dynamic or may be limited, by prior agreement, to either connectionless or connection mode communications.

The ATN connection mode communications services are accessed through the Dialogue Service (DS) defined in the ICAO ATN SARPs. These provide stream mode reliable communications suitable for large messages, regular message exchanges, and/or when there is a need for the service provider to provide recovery from communications errors.

The ATN connectionless communications service is accessed through the Connectionless Dialogue Service (CLDS) defined in the ICAO ATN SARPs. This provides a low overhead communications service for messages up to 64kB. Message delivery can be unacknowledged or acknowledged by the delivering GACS provider.

3.2 Message Encapsulation

As described in Chapter 2, either the Dialogue Service (DS) or the Connectionless Dialogue Service (CLDS) is used to provide ATN service for AOC messages. The DSP should support the CLDS, and hence the GACS, using the connectionless ATN communications service.

When an AOC message is transmitted over the ATN air/ground subnetwork, it is encapsulated within protocol headers as shown in Figure 3-1.

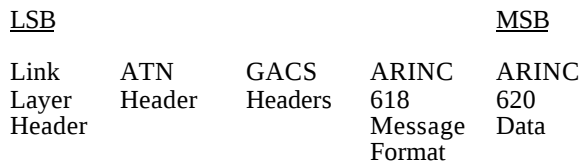


Figure 3-1 AOC Message Encapsulation
(Transmission Over ATN Air-Ground Subnetworks)

The purpose of the ARINC 618 message format is to facilitate the routing and forwarding of AOC messages, up to 3538 characters (i.e., 16 blocks of 220-character user data plus ARINC 618 control characters) over the end-to-end path. The ARINC 618 message formatting is performed by a function called ARINC 620 Convergence Function (620CF). With the exception of the BCS, the ARINC 618 formatted message is encoded using the ISO-5 character set specified in ARINC Specification 618.

Not all fields of the ARINC 618 ACARS message formats are used by this Specification. Table 3-1 identifies whether the ARINC 618 fields are used (or not used) by this Specification. The used fields must contain valid values to enable the correct processing of the message according to the provisions defined herein. The non-used fields are encoded as ISO-5 characters, but their values are not semantically meaningful and do not affect the processing of the message according to the protocols defined herein.

TABLE 3-1 ACARS 618 Fields Used by ATN

<u>Field of ARINC 618 Message</u>	<u>Included in ATN Message</u>
SOH	No
Mode	No
Address	Yes (Note 1)
Technical	No
Acknowledgement	
Label	Yes
UBI/DBI	No
STX	No
MSN	Yes (Note 2)
Flight Identifier	Yes (Note 3)
Free Text	Yes (Note 4)
ETB or ETX	No
BCS	No
BCS Suffix	No

Notes:

- [1] This is the ACARS aircraft address for both uplink and downlink. For downlink it is the aircraft registration number (a.k.a. tail number); for uplink it can either be registration number or flight ID.
- [2] The MSN field exists only for downlink. It is retained for ACARS-related processing purposes. The GACS Message Identifier/Reference Number is a different

3.0 ARINC 620 MESSAGES DELIVERED OVER ATN SERVICES (cont'd)

value and is used, as defined in ICAO DOC 9705 Third Edition, for GACS Acknowledgment purposes for both uplink and downlink.

- [3] Flight ID is for downlink only.
- [4] Free Text may start with supplementary Address(es) and/or Sublabel.

COMMENTARY

To date, ACARS messages have been formatted according to ARINC Specification 618 and ACARS data has been formatted according to ARINC Specification 620. For the remainder of this specification, the term “ARINC 620 Messages” will be used to refer to these ACARS messages and data. In order to minimize the impact on existing implementations, the ARINC 618 message format and ARINC 620 data formats have been retained and GACS will be used to transfer them over the ATN.

The GACS header is defined in ICAO DOC 9705, Third edition - 2001.

COMMENTARY

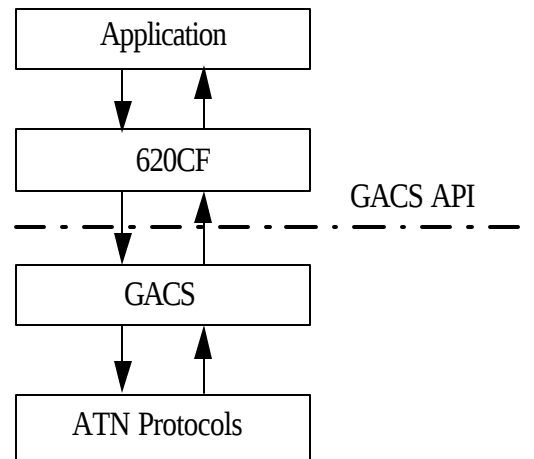
The GACS header is defined using ASN.1 and encoded using the ASN.1 Packed Encoding Rules (PER). The ATN headers include all applicable ATN protocol headers such as (from top of stack) ACSE, Presentation, Session, Transport, CLNP, and ISO 8208 (if applicable). These protocol headers are described in ICAO ATN SARPs. The Link layer header depends on the type of ATN air-ground subnetwork. For VDL Mode 2, for example, the Link layer header is the AVLK protocol header. The Link layer header is defined in the applicable SARPs of the relevant ICAO subnetwork.

3.3 Functional Components

The 620CF is defined by this specification to provide the interface between existing ARINC 620 applications (including those applications implemented in subsystems other than the CMU) and GACS. The 620CF provides interfaces to local applications and to ACARS end system applications according to ARINC Specification 619.

The following interfaces are described here:

- a. Interfaces between the 620CF and the applications
- b. Interfaces between GACS and its users (e.g, the 620CF)

**3.3.1 The 620CF**

In order to facilitate the forwarding of ACARS messages based on parameters such as Label/Sublabel, aircraft registration number or flight ID, etc. This defines a technique for exchanging ACARS character-oriented data messages, as defined in ARINC Specification 620, over the ATN.

The 620CF is an abstract function that inserts the ARINC 620 data into an ARINC 618 message to be sent over the ATN.

COMMENTARY

While 620CF is an abstract function used in this specification to illustrate this provision, the implementation is not restricted to a dedicated function called 620CF.

For inbound messages, the 620CF extracts the ARINC 620 data from an ARINC 618 formatted message received over the ATN. For an uplink message, this may require the transmission of the message to an ACARS end system according to ARINC Specification 619, if so indicated by the Label/Sublabel in the received message header.

For airborne GACS an inbound message is an uplink; for the ground based GACS, it's a downlink. GACS distributes inbound messages to an appropriate user according to the received message type. All messages of Message Types 1, 2, or 3 are passed to the 620CF.

This specification does not define how 620CF interfaces to local AOC applications, since this is considered a local implementation issue. See Section 3.7 for interface with avionics ACARS End Systems.

ARINC 620 application data should be in ARINC 618 message format before the message is passed to GACS.

3.3.2 GACS

A description of GACS service, protocol, and user interface may be found in ICAO DOC 9705 Third Edition 2001.

3.0 ARINC 620 MESSAGES DELIVERED OVER ATN SERVICES (cont'd)**3.3.2 GACS (cont'd)****COMMENTARY**

The ICAO Doc 9705 permits GACS to be implemented as an Application Entity (AE) in its own right, or as an Application Service Object (ASO). In the former case, it is a complete application providing messaging services for local users, while in the latter case it is part of another application.

Conformance to this Specification uses GACS as an Application Entity (AE), not as an Application Service Object (ASO).

The 620CF should format an application message according to ARINC Specification 618 and forward the message by invoking the G-TRANSFER or G-TRANSFER-CONFIRMED service as appropriate, passing the ARINC 620 Message as the User Data parameter of G-TRANSFER or G-TRANSFER-CONFIRMED service. The remaining parameters should be set as specified by GACS.

COMMENTARY

The parameter Message Type (in G-TRANSFER and G-TRANSFER-CONFIRMED) is provided by the GACS user and can be used to distinguish between multiple users served by the destination GACS AE. It also provides a means of identifying the encoding and syntax for the message itself. This specification uses the Message Type to identify ARINC 618/620 encoded messages and to distinguish standard AOC messages from the ATC messages defined in ARINC Specification 623, and FANS 1/A messages encoded according to ARINC Specification 622. A DSP may then readily direct each such message to the airline or ATC authority as appropriate. The Message Type should be expressed as an integer and the permissible values for this field are defined below in Table 3-2.

Table 3-2 GACS Message Types Values

<u>Message Type</u>	<u>Semantic</u>
0	Reserved
1	ARINC 620 messages that are not ARINC 622 messages and not ARINC 623 messages
2	ARINC 622 (i.e. FANS 1/A messages that are not ARINC 623 messages)
3	ARINC 623 messages
4 through 10	Reserved for future standardization
11 through 20	Available for use by Airline Applications
21 through 255	Reserved

As shown in Table 3-2, the 620CF uses message types 1, 2, and 3 only, and other message types are used by other GACS users. Therefore, when GACS receives message types 1, 2, or 3 it forwards these messages to the 620CF which then passes the messages to the appropriate application.

3.4 Encoding Rules

The GACS protocol header should be encoded using ASN.1 Packed Encoding Rules (PER) specified in ISO/IEC 8825-2 using the basic unaligned variant as specified in the GACS requirements.

COMMENTARY

The ARINC 618 formatted message that follows the GACS header is encoded per ARINC specification 618 and is not ASN.1 PER encoded. The use of Message Type 1, 2, or 3 indicates that this encoding rule is followed.

3.5 GACS Inbound Messages

GACS distributes inbound messages to an appropriate user according to the received message type. All messages of Message Type values 1, 2, and 3 are passed to the 620CF.

The handling of inbound messages using a private airline message type is outside of the scope of this specification.

3.6 Delivery Confirmation**COMMENTARY**

GACS message transfer services are either confirmed or unconfirmed. When the G-TRANSFER-CONFIRMED service is selected, the delivery of a message to the GACS user is confirmed by the delivering GACS entity returning an acknowledgement. It should be noted that this is not a true end-to-end acknowledgement as it is the delivering agent that returns the confirmation and not the receiving user. This mechanism is also independent of whether the CLDS or the DS is used for message transport.

Since the GACS Message Identifier is used for delivery confirmation and for detection of duplicate messages, GACS' users should ensure that the Message Identifiers are unique per GACS application entity. When there are multiple user peer GACS application entities, implementations should ensure that the Message Identifiers are unique among these users. When the GACS user retransmits a message, it should use the same message identifier value.

The GACS Message Identifier should be incremented from one message to the next (i.e. optional for G-TRANSFER request and mandatory for G-TRANSFER_CONFIRMED request), starting from the lower bound of the range for the Message Identifier. Except when the value of the Message Identifier wraps around, the use of an already used value causes the message to be

3.0 ARINC 620 MESSAGES DELIVERED OVER ATN SERVICES (cont'd)

treated by the receiving GACS as a duplicate message.

GACS should go back as far as 7 message identifiers to detect duplicate messages.

When GACS detects a duplicate message, based on the Message Identifier, it confirms the successful reception of this message and it does not forward this message to the user.

When AOC messages are delivered using GACS they are confirmed by the GACS delivery confirmation service if this service is selected.

Furthermore, if the messages are sent using the GACS error recovery service (i.e., using Dialog Service), the ATN TP4 transport service provides acknowledgement and sequencing for all Transport Protocol Data Units (TPDUs). TP4 message acknowledgement, however, is transparent to applications.

If the messages are sent over CLDS, GACS is the only entity that provides delivery confirmation.

3.7 Support of ACARS End System Using ARINC 619 Interfaces

GACS delivery confirmation can be utilized to provide backward compatibility for ARINC 619 ground acknowledgment. The G-TRANSFER-CONFIRMED service should be used for the downlink of ARINC 619 originated messages that expect ground acknowledgment.

When a GACS delivery confirmation is received for a message originating from an ACARS end system, an ARINC 619 ground acknowledgment message should be sent by the 620CF to this ACARS end system.

FANS-1 Certification does not call for examination of the contents (e.g., the MFI) of FMC-generated downlinks by CMU's. Therefore, until the ARINC 619 Traffic Type flag is implemented, all FMC downlink traffic for B747-400 and B777 fleet types with FANS-1 should be routed through a DSP.

COMMENTARY

Modifications to ARINC 619 ACARS End Systems are not needed to use the ATN services defined in this specification. Based on GACS message type, label and sublabel, the 620CF forwards uplink messages to the appropriate ARINC 619 ACARS End System.

3.8 Message Retransmission

If GACS delivery confirmation is selected, when an AOC message is sent and a corresponding GACS delivery confirmation is not returned, the sending application may re-send the message if appropriate.

When reliable transfer is expected, the 620CF may start an optional timer T when a message is passed to GACS with G-TRANSFER-CONFIRMED service. If the timer expires before receiving the confirm, the application sends the message again. A message may

be retransmitted a total of n times before delivery failure is reported.

Note that this procedure may result in duplicate message delivery. The receiving application (or 620CF) should be prepared to receive duplicate messages gracefully (i.e. do not hang up or crash). The GACS message identifier can be used to detect possible duplicate messages.

3.9 Subnetwork Selection

GACS users (e.g., the 620CF) indicate subnetwork selection by means of the security label as specified in the ICAO ATN SARPs. This security label is passed to GACS in the Class of Communication parameter of the G-TRANSFER or G-TRANSFER-CONFIRMED.

If the 620CF receives a downlink message from an ARINC 619 ACARS end system and subnetwork selection is not indicated by the end system, the 620CF passes a "no preference" selection to GACS.

3.10 ARINC 620 Messages Priority

All ARINC 620 Messages sent using the ATN services use the priority as specified in ARINC Specification 620, Appendix C, Tables C-2 and C-2A.

The priority defined in ARINC Specification 620, Appendix C, Tables C-2 and C-2A override the ARINC 619 priority in downlink messages from ARINC 619 ACARS end systems.

4.0 NAMING AND ADDRESSING FOR ARINC 620 MESSAGING

4.1 Introduction

This chapter identifies and extends the ATN Naming and Addressing Plan, and describes how the plan is to be administered for ARINC 620 messages. Guidance is given for the assignment of airborne NSAP and TSAP Addresses.

4.2 Airborne Naming and Addressing

COMMENTARY

The address assigned to each ATSC and AINSC Application is a Presentation (or PSAP) Address. According to ISO/IEC 7498-3, a Presentation Address comprises a globally unique Network Service Access Point (NSAP) address, plus a local Transport Selector, Session selector and Presentation selector. The Session and Presentation selectors are not used in the ATN, and are null. A local or global Directory Service is used to relate ATSC and AINSC Application Names to Addresses. For Aircraft, the Context Management (CM) Application may be used as the source of a local directory to relate the names of ground based ATSC applications to their Presentation Addresses. For aircraft AINSC applications, relationships are known a priori (aircraft to/from airline hosts), or are registered in Specification 637, Part 2 (aircraft to DSPs), or are discovered (DSP to aircraft). "AOC" is the Name for the ARINC 620 Messaging/GACS Application.

COMMENTARY

Aircraft to/from airline host implementations of "AOC" may configure two instances of GACS in the airborne platform, one for exchange of some ARINC 620 messages with DSPs, and one for exchange of most ARINC 620 messages with their host systems.

The ATN SARPs specify airborne implementations to define:

- a. A unique Network Entity Title (NET) for each airborne system implementing CLNP.
- b. A unique Routing Domain Identifier (RDI) for each Aircraft.
- c. A unique Transport Address for each support application on an aircraft (with null session and presentation selectors, this equates to the application's Presentation Address).
- d. A unique Application Entity Title for each supported application on an aircraft that uses the ATN Dialog Service.

This specification provides guidelines for the assignment of each of the above to airborne systems. NETs, RDIs and Transport Addresses all derive from, or include, an NSAP Address. Formally, an NSAP Address is a unique identifier that can be used

to locate a given Network Address User and is thus fundamental to routing in the ATN. However, NETs are also allocated from the same address space as NSAP Addresses and are also used to locate the Network Entity. An NET identifies each Network Entity, and is used as the destination of a CLNP packet sent to a network entity (e.g. for a ping-type diagnostic).

A RDI is also defined to be a NET, but it is used only as an identifier (e.g. in IDRP route trace information) and never as the destination of a packet.

The Transport Address comprises an NSAP Address and a TSAP Selector. The NSAP Address component is formally that of the transport entity implementing TP4 and/or CLTP, and the TSAP Selector is a local identifier used to address different applications (they are directly analogous to IP Addresses and Port Numbers in TCP/IP). Transport Address are, for example, used as the destination address for a transport connection request.

Application Entity Titles can be either OSI Object Identifiers allocated using a containment hierarchy defined in the ATN SARPs, or more user friendly directory names. In either case, they serve to uniquely identify (e.g.) a CPDLC application on board a given aircraft, and are used to find the application's Transport Address using a Directory Service or Context Management.

4.3 Airborne NSAP Address Assignment

4.3.1 Background

NSAP Addresses are used by CLNP to identify network service users; they are used both to identify the sender and the destination of each packet. As far as CLNP is concerned, they are no more than variable length octet strings and a router assumes only a very limited syntax for an NSAP Address or none at all.

Figure 4-1 illustrates the format of the NSAP Address specified by the ATN SARPs. This imposes a syntax on NSAP Addresses for the purposes of devolved allocation only – it is largely invisible to routers. The ATN SARPs also specify that all ATN NSAP Addresses are fixed length.

The ATN SARPs format is, as illustrated, derived from two sources: the IS-IS routing protocol specification (ISO/IEC 10589) and the ISO network addressing standard (ISO/IEC 8348). IS-IS requires that all NSAP addresses are composed of an Area Address prefix, a System Identifier and an NSAP Selector (NSEL), and this is the most that a router knows about the NSAP Address structure. An Area Address is common to all systems within a "Routing Area" (a collection of linked End Systems and Routers). Within a Routing Area, routing is done on the "System ID", while inter-area routing is performed on Area Address prefixes (and prefixes of Area Addresses). The NSEL is used to permit address

4.0 NAMING AND ADDRESSING FOR ARINC 620 MESSAGING (cont'd)

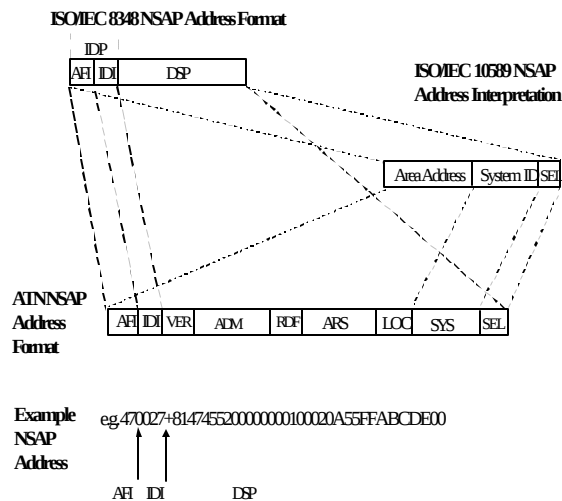


Figure 4-1 ATN NSAP Address Format

fan-out to multiple network service users in the same system.

The ISO network addressing standard is primarily concerned with address management and divides the global NSAP addressing domain into a number of sub-domains each distinguished by a different Initial Domain Part (IDP). ICAO has registered for and obtained a unique IDP, and all ATN NSAP Addresses start with this value (470027 decimal).

The ATN SARPs then go on to subdivide the ATN Area Addresses into five separate fields for the purpose of devolved address administration. These are:

- a. The one octet **VER** field which subdivides the ICAO addressing subdomain into IATA and ICAO registered fixed and mobile systems, making four sub-domains in all.
- b. The three octet **ADM** field is used to devolve further administration to ICAO states and regions, and to IATA registered organizations. Therefore each state, region or IATA registered organization will be allocated a seven-octet NSAP Address prefix from which they can allocate unique NSAP Addresses.
- c. The one octet **RDF** field is a constant and serves only to permit future extension.
- d. The three-octet **ARS** field permits the further sub-allocation of NSAP Addresses to Routing Domains. For aircraft, this field is the ICAO 24-bit Aircraft Address. Hence, in the ATN, all systems in the same Routing Domain have a common eleven-octet NSAP Address prefix. The ATN SARPs also define this to be the RDI for the Routing Domain.

- e. The **LOC** field is used to identify each Routing Area within a Routing Domain.

The IDP, VER, ADM, RDF and ARS fields together comprise an eleven octet NSAP Address Prefix that is common to and uniquely identifies all network service users in a given aircraft. This eleven octet NSAP Address Prefix should be used as the Routing Domain Identifier (RDI) for the aircraft's Routing Domain.

4.3.2 Guidelines for Airborne NSAP Address Field Value Assignment

Airborne NSAP Address assignment is summarised in the following table:

Value assigned, or assignment rules			
NSAP Field	IATA Registered Airlines	General Aviation	Address Field Size
AFI/IDP	470027 decimal	470027 decimal	3 Octets
VER	C1 hexadecimal	01 hexadecimal	1 Octet
ADM	Assigned by IATA	ICAO State identifier (see ATN SARPs)	3 Octets
RDF	00 hexadecimal	00 hexadecimal	1 Octet
ARS	24-bit ICAO Aircraft Identifier	24-bit ICAO Aircraft Identifier	3 Octets
LOC	See below	See below	2 Octets
SYS	See below	See below	6 Octets
NSEL	See below	See below	1 Octet

ADM Field Assignment (3 Octet Field)

Airlines should obtained a unique ADM value from the IATA registration authority, while General Aviation aircraft should used the ICAO assigned ADM field for their country of registration.

LOC Field Assignment (2 Octet Field)

Aircraft Routing Domains should contain a single Routing Area identified by a LOC field.

4.0 NAMING AND ADDRESSING FOR ARINC 620 MESSAGING (cont'd)**4.3.2 Guidelines for Airborne NSAP Address Field Value Assignment (cont'd)****COMMENTARY**

In the absence of local requirements, a value of zero is suggested for the LOC field. Other values are reserved for future expansion.

SYS Field Assignment (6 Octet Field)

This specification does not constrain the assignment of SYS Fields which may be any appropriate scheme (e.g. a 48-bit MAC Address assigned to a CMU interface may be used). However, in the absence of any local preference, the following scheme is offered.

COMMENTARY

In the absence of local requirements, the system containing the Airborne ATN Router (e.g. CMU, ATSU) should be allocated a System Identifier of 000000000001 hexadecimal (this is a six octet field).

If packets are to be routed to the FMS (i.e. the FMS implements TP4) then the FMS should be given a System Identifier of 000000000002 hexadecimal.

Packets may also be routed to other systems. Local assignments of System Identifiers, should be of the form 01xxxxxxxx hexadecimal (where “xxxxxxxx” represents locally assigned values of the remaining 5 octets of this 6 octet field). Airlines are responsible for ensuring that each system on board an aircraft is allocated a unique System Identifier.

NSEL Assignment

The ATN SARPs require that the NSEL field is set to 00 to identify the Network Entity. Alternatively, the value FE hexadecimal is used conventionally to identify the Network Entity for Airborne Routers implementing the procedures for optional non-use of IDRP.

COMMENTARY

For example, using the above scheme for SYS field assignment, the NET for a CMU/ATSU comprises the aircraft's unique eleven octet NSAP Address Prefix followed by 6 octets of the System Identifier and 1 octet of the NSEL as follows:

- a. 000 000 000 000 000 100 hexadecimal for a CMU/ATSU supporting IDRP
- b. 000 000 000 000 000 1FE hexadecimal for a CMU/ATSU not supporting IDRP

- c. An NSEL value of 01 hexadecimal should be used to identify the NSAP supporting TP4 and CLTP.

COMMENTARY

For example, and again using the above scheme for the 6 octet SYS field assignment followed by the 1 octet NSEL, the NSAP Address for an airborne application hosted on a CMU/ATSU comprises the aircraft's unique eleven octet NSAP Address Prefix followed by:

000 000 000 000 000 101 hexadecimal

Other NSEL values may be locally assigned to identify NSAPs supporting other transport protocols. As a local matter, other NSEL values may be used for the CLTP/TP4 service provided that they do not conflict with ICAO assignments. Implementations should not use a separate NSEL value for CLTP and TP4 as this complicates the dynamic choice of DS and CLDS services by GACS.

4.4 Airborne TSAP Selector Assignment

The ATN TSAP Selector is a single value field and takes the value of an unsigned 16 bit number. If the number has 8 leading zero bits then the field is encoded as 8 bits. Otherwise it is encoded as 16 bits.

COMMENTARY

In the absence of local requirements, the following TSAP Selector values contained in Table 4-2 are defined for the identified AOC and ATC Applications:

Table 4-2 TSAP Selector Values

<u>Application</u>	<u>TSAP Selector (decimal)</u>
ARINC 620CF GACS based services	01
ADS	02
CPDLC	03
FIS	04
Context Management	05

Note that the same TSAP Selector is used for both CLTP and COTP variants of ACARS messaging.

TSAP selector values up to 127 (decimal) are reserved for future assignment.

TSAP Selectors of 128 (decimal) are available for private use by applications not subject to standardization. Airlines may choose to use a

4.0 NAMING AND ADDRESSING FOR ARINC 620 MESSAGING (cont'd)

different TSAP Selector value (> 127) for their GACS based applications when communicating with their own Ground Systems.

4.5 Application Names

Application Entity Titles for ATSC Airborne Applications are wholly defined by the ATN SARPs, and include the ICAO 24-bit Aircraft Address in order to ensure uniqueness on a per aircraft basis.

“AOC” is the name for ARINC 620 Messaging/GACS Applications.

5.0 AIRBORNE ATN SYSTEMS MANAGEMENT

5.1 Introduction

The purpose of this Chapter is to describe the initial functions associated with monitoring and management of ATN airborne routers.

This Chapter describes, but is not limited to the following: data recording, system parameters (configuration), fault management, accounting management and monitoring tools (e.g., ping, trace route).

COMMENTARY

Work on ATN System Management SARPs and guidance material is evolving, and will be used to develop material for this Chapter at a later date. Appendix A provides guidance material on fault and performance management.

ATTACHMENT 1
SYSTEM DIAGRAMS

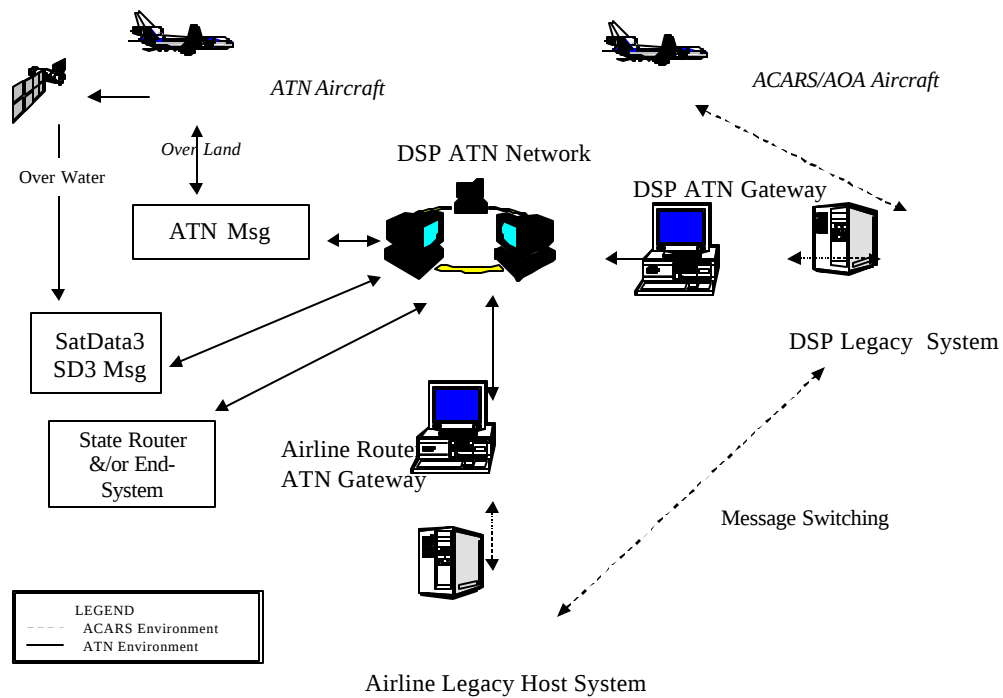
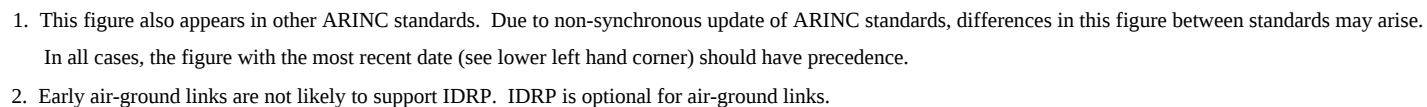


Figure 1 Existing and Envisioned Data Link System



ATTACHMENT 2 (cont'd)
PROTOCOL ARCHITECTURE DIAGRAMS

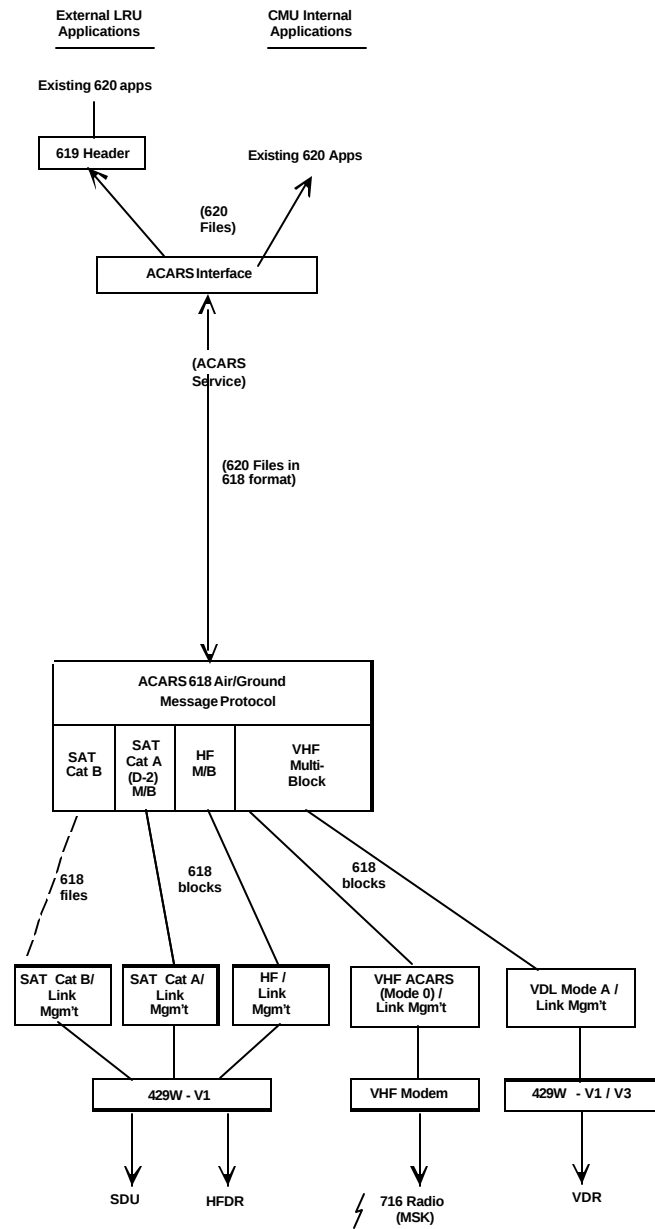


Figure 2-2 Basic ACARS Avionics Architecture

ATTACHMENT 2 (cont'd)
PROTOCOL ARCHITECTURE DIAGRAMS

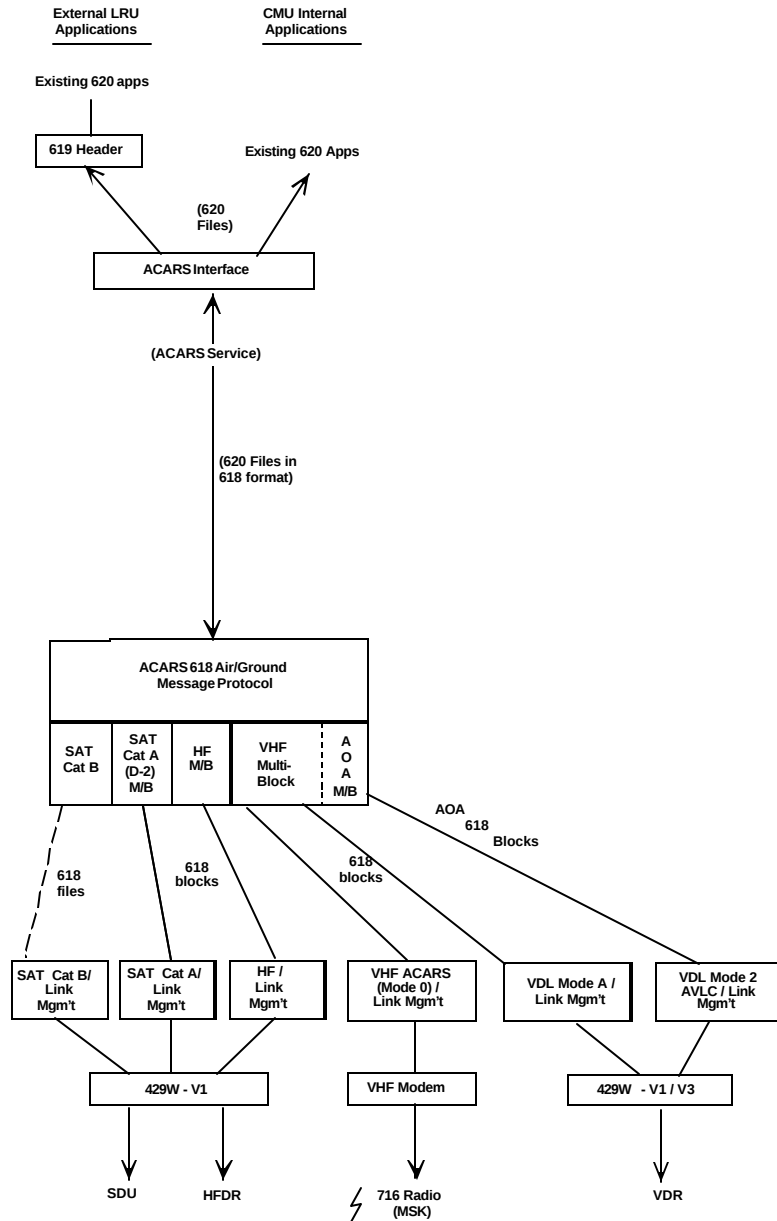


Figure 2-3 Basic ACARS with AOA Subnetwork

ATTACHMENT 2 (cont'd)
PROTOCOL ARCHITECTURE DIAGRAMS

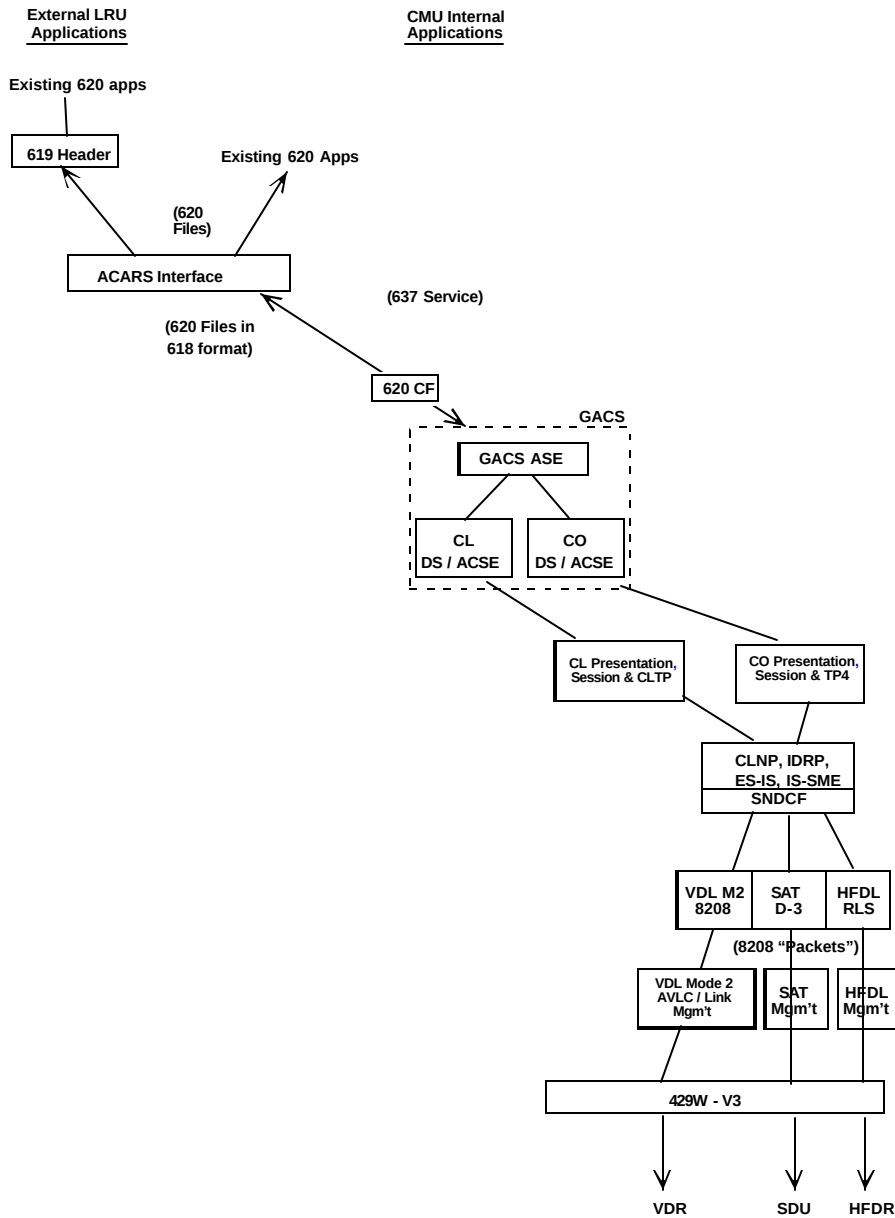


Figure 2-4 ATN Architecture for AOC

ATTACHMENT 2 (cont'd)
PROTOCOL ARCHITECTURE DIAGRAMS

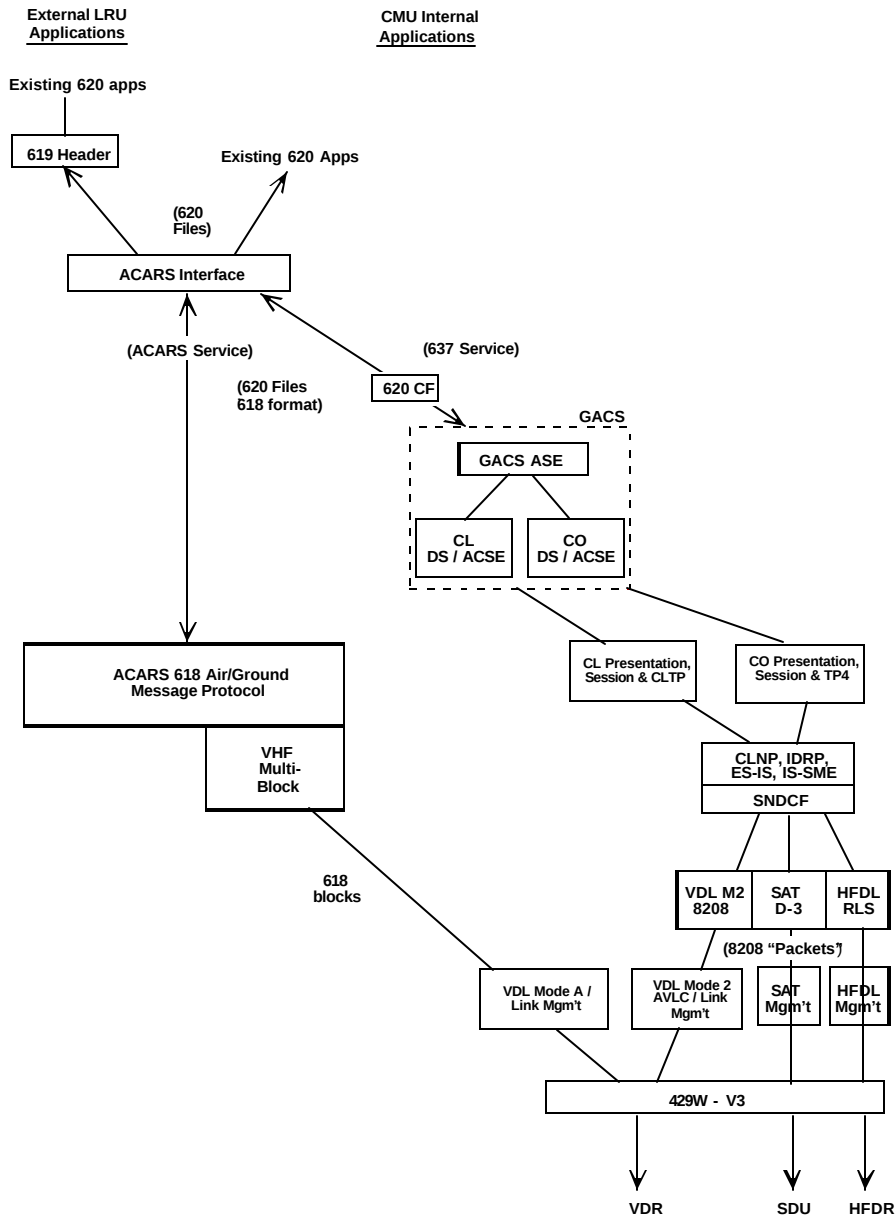


Figure 2-5 Bilingual Architecture for ATN and ACARS

ATTACHMENT 2 (cont'd)
PROTOCOL ARCHITECTURE DIAGRAMS

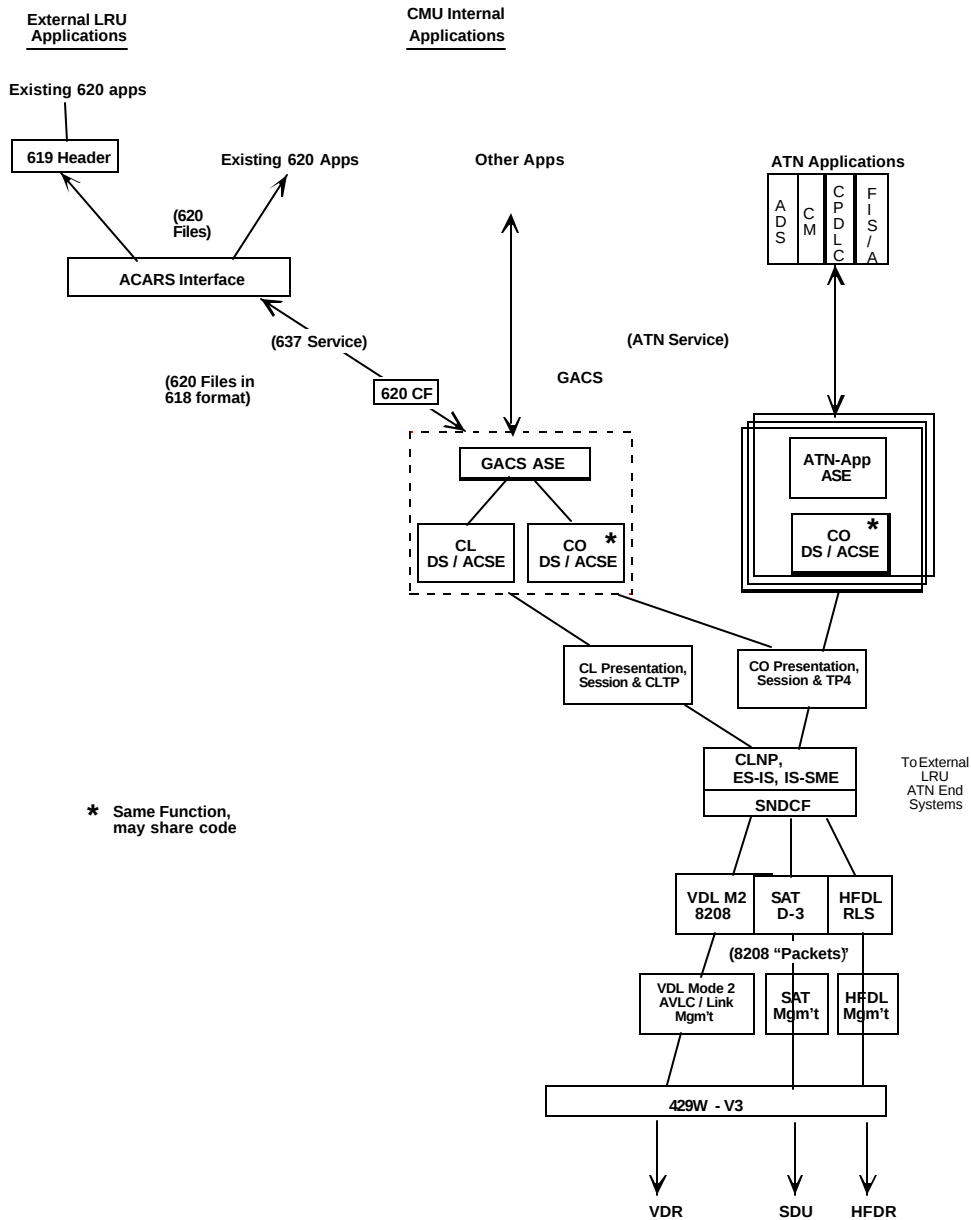


Figure 2-6 ATN Architecture for AOC and ATC

APPENDIX A
LIST OF ACRONYMS

AAC	Aeronautical Administrative Communications
ACARS	Aircraft Communication Addressing and Reporting System
ADS	Automatic Dependence Surveillance
AE	Application Entity
AOA	ACARS over AVLC
AOC	Aeronautical Operational Control
APC	Aeronautical Passenger Communications
ASE	Application Service Element
ASO	Application Service Object
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
ATSO	Air Traffic Service Organization
CLDS	Connectionless Dialog Service
CM	Context Management
CMU	Communications Management Unit
CPDLC	Controller-Pilot Data Link Communication
DGSS/IS	Data Link Ground System Standard and Interface Specification
DS	Dialog Service
DSP	Data Link Service Provider
ES	End System
FIS/ATIS	Flight Information Services/Automatic Terminal Service
GACS	Generic ATN Communication Service
IATA	International Air Transportation Association
ICAO	International Civil Aviation Organization
ICM	Interline Communications Manual
IDP	Initial Domain Part
IDRP	Inter-Domain Routing Protocol
ISO	International Standards Organization
MAC	Media Access
MSGSW	Message Switching
NET	Network Entity
PER	Packed Encoding Rules
RDI	Routing Domain Identifier
SARPs	Standards and Recommended Practices
SCR	Systems and Communication Reference
SN-SME	Subnetwork Management Entity
TPDUS	Transport Protocol Data Units

APPENDIX B
FAULT AND PERFORMANCE MANAGEMENT GUIDANCE

B.1 Overview

The purpose of Appendix A is to describe the initial functions associated with monitoring and management of ATN airborne routers.

This Appendix describes, but is not limited to the following: fault and performance management.

B.2 Fault Management

B.2.1 Transport Layer

1. The Transport Provider should record in an event log when a Transport Connection fails to be established.
2. The Transport Provider should record in an event log when a Transport Connection is lost.
3. The Transport Layer should record in an event log when the end-to-end transit delay as measured by the transport provider and derived from the round trip delay, falls below a specified threshold (typically application specific - e.g. based on ATSC Class).
4. The Transport Layer should record in an event log when the number of TPDUs discarded due to checksum validation failure exceeds a Network Manager specified threshold during a given reporting period.
5. Transport layer implementations should support the measurement of round trip delay on a per transport connection basis, and hence to estimate the end-to-end transit delay. An unacceptably long transit delay is to be reported to the flight crew as this may necessitate a change in operational procedures. The threshold value should be configurable on a per user (i.e. application) basis.

COMMENTARY

The above requirement is crucial to any safety case for operational ATN use in support of ATC, as it will be the trigger for fallback to voice operations following a partial or total loss of datalink.

B.2.2 CLNP

1. The connectionless network service provider should record in an event log when the number of CLNP PDUs discarded for Header Checksum verification, lifetime expiry or routing problems exceeds a specified threshold. Such thresholds will need to be specified by discard reason.
2. The connectionless network service provider should support Echo Response.
3. CLNP Header checksums should be implemented, in order to detect subnetwork problems at source.

4. A CLNP Error Report should be requested for all uplink Data PDUs.

B.2.3. IS-SME

1. The IS-SME should record in an event log, each failure to complete the Route Initiation procedures.

B.2.4 IDRP

1. IDRP should record in an event log loss of an adjacency.

B.2.5 Subnetworks

1. Subnetworks should record in an event log counts of packets sent and received, and of error counts where applicable.
2. Subnetworks should record in an event log when error counts that exceed a specified threshold during a set reporting period.
3. Mobile Subnetworks should record in an event log each failure to join a mobile subnetwork.
4. The Deflate compression algorithm should be used on all air/ground datalinks in order to support early detection of Ground Station problems.

B.3 Performance Management

1. Airborne systems should keep local event logs for the recording of designated systems management events. Some mechanism should also be provided to transfer these logs to an offline processor.
2. Airborne Systems should log each successful and each unsuccessful attempt to establish a connection over a connection mode subnetwork.
3. Airborne Systems should log the number of successful and unsuccessful attempts to send a packet over a connectionless subnetwork.
4. Airborne Systems should log the number of packets sent and received over each subnetwork or subnetwork connection, and to count the volume of data sent and received, analysed by priority and ATSC Class.
5. Airborne Systems should log the time of uncommanded loss of a subnetwork connection.
6. Airborne Systems should keep a count of the number of packets received with a CLNP header checksum failure.
7. Airborne Systems should keep a count of the number of packets received with a Deflate checksum failure.
8. On each connection mode subnetwork, an ATN system is required to log the time at which each connect request is sent and the time at which the connection is successfully established.

APPENDIX B (cont'd)
FAULT AND PERFORMANCE MANAGEMENT GUIDANCE

- | | |
|---|--|
| <p>9. Airborne Systems should monitor average queue length analyzed by priority during each sampling period, and to generate a notification when the average queue length exceeds a set threshold (high watermark) or drops below another set threshold (low watermark).</p> <p>10. The user application is required to record, in a local log, each successful attempt to establish an end-to-end connection.</p> <p>11. The user application is required to record, in a local log, each unsuccessful attempt to establish an end-to-end connection.</p> <p>12. The transport layer is required to record, in a local log, the number and size of user messages sent on each transport connection.</p> <p>13. The transport layer is required to record, in a local log, the number and size of user messages received on each transport connection.</p> <p>14. The transport layer is required to record, in a local log, each connect request, and the time at which the connect request was issued.</p> <p>15. The transport layer is required to record, in a local log, the time of each successful connection establishment.</p> <p>16. The transport layer is required to record, in a local log, each uncommanded transport connection loss.</p> <p>17. The transport layer is required to record the measured round trip delay between transmission of a TPDU and its acknowledgement together with an indication of whether the TPDU marks the end of a TSDU.</p> <p>18. When authentication is implemented, authentication failures shall be logged.</p> <p>19. The Dialogue Service is required to record, in a local log, each connect request, and the time at which the connect request was issued.</p> <p>20. The Dialogue Service is required to record, in a local log, the time of each successful connection establishment.</p> <p>21. The number, average and maximum size of CLNP packets sent and received during a reporting period should be logged. These are to be analyzed by ATSC Class and priority, and by each datalink.</p> <p>22. ATN Routers should keep counts of packets forwarded and data volumes, analyzed by priority and ATSC Class.</p> <p>23. ATN Routers should log packet discards by discard reason.</p> | <p>24. When the number of packet discards due to congestion exceeds a defined threshold, then a notification shall be sent to a network manager.</p> <p>25. System specific parameters that affect forwarding performance should be logged.</p> <p>26. Changes to the number of entries in a Router's FIB should be logged.</p> <p>27. ATN Routers should log each route received and each route advertised to another router, recording the time received/advertised.</p> <p>28. ATN Routers should maintain synchronized clocks for event logging purposes.</p> <p>29. An Air/Ground Router should log the establishment and termination of adjacencies with Airborne Routers.</p> <p>30. An Air/Ground Router should log the establishment and termination of subnetwork connections with Airborne Routers.</p> |
|---|--|

APPENDIX C

GENERIC DATA LINK INTERFACE

C.1 Overview

The purpose of this Appendix is to describe a generic interface between the ATN routing functions and air/ground data links. It is provided as guidance to implementers and there are no conformance requirements associated with this appendix.

VDL Mode 2 is used as an example subnetwork. However, this is not intended to constrain the application of this chapter to VDL Mode 2.

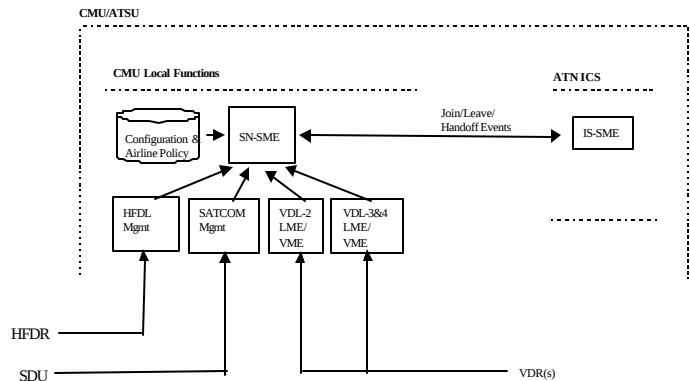


Figure C-2. Airborne SN-SME Model

C.2 Subnetwork Interface Architecture

A generic subnetwork interface architecture is illustrated in Figure C-1 below. This shows the lower layer ATN functions, the separate control and data interfaces expected from the subnetwork, and a generic view of subnetwork architecture.

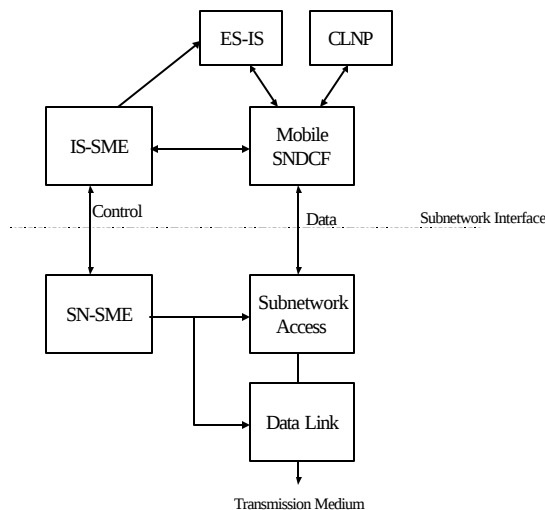


Figure C-1 Subnetwork Interface Architecture

There are two ATN functions that require access to subnetwork services. These are the IS-SME and the Mobile SNDCF. Respectively, they require an interface to the subnetwork's control functions and its data transport functions.

The IS-SME is concerned with subnetwork management and manages the establishment of data links, their later termination and, for VDL Mode 2, the ATN procedures associated with Handoff between Ground Stations attached to the same ATN Router.

The Mobile SNDCF is concerned with establishing and maintaining subnetwork connections and the transfer of data over those connections. It is also responsible for data compression.

The control interface is used to receive event notifications from the subnetwork, which are then processed by the IS-SME. These events are:

- a. **The Join Event:** this is used to notify the IS-SME of the availability of one or more ATN Routers.
- b. **The Leave Event:** this is used to notify the IS-SME that one or more ATN Routers are no longer reachable.
- c. **The Handoff Event:** this is used to notify the IS-SME that an existing communications path has to be re-established (via a different Ground Station) in order to maintain communication with a given ATN Router.

It should be noted that the Leave Event may be alternatively realised by the data interface by issuing a Call Clear on all subnetwork connections associated with the data link.

The data interface is used to establish and terminate subnetwork connections and to send and receive data over such connections. The current generation of ICAO air/ground data links all provide an ISO 8208 data communications service and hence this interface provides an ISO 8208 communications service.

The actual components of a subnetwork will vary between subnetwork types. However, it may be expected that with some variations, the three components identified above will be present in one form or another.

The Subnetwork Management Entity (SN-SME) comprises all subnetwork dependent management functions and is the source of the Join, Leave and Handoff events. Each airborne intermediate system has one SN-SME to manage all air-ground subnetworks and to interface to the IS-SME on behalf

APPENDIX C (cont'd)

GENERIC DATA LINK INTERFACE

C.2 Subnetwork Interface Architecture (cont'd)

of these subnetworks. A generic model of the airborne SN-SME is shown in Figure C-2.

In VDL Mode 2, for example, the VME and LME do not send Join, Leave and Handoff events to the IS-SME, but instead provide connectivity information to the SN-SME and it is the SN-SME's function to:

- a. Generate a Join Event on Link Establishment.
- b. Analyze VDL Link Handoffs to determine if these are ATN Handoffs Events (same VDL specific address reachable), ATN Join Events (new VDL specific address reachable), or ATN Leave Events (VDL specific address no longer reachable)
- c. Generate a Leave Event when the connectivity with one or more ATN routers can no longer be maintained.

In order to select the DSP for air-ground connectivity the SN-SME looks up the database that contains airline's policy and avionics configuration.

The Subnetwork Access function comprises the functions necessary to access the network including the implementation of subnetwork connections. For example, in VDL Mode 2, the Subnetwork Access function is the implementation of the modified form of ISO 8208 specified for air/ground communications.

The Data Link function comprises the functions needed to establish and maintain a data link with one or more Ground Stations. For example, in VDL Mode 2, it implements the AVLC.

C.3 Control Interface

C.3.1 The Join Event

The Join Event is typically implemented as a function call from the SN-SME to the IS-SME. Parameters passed on this event include, but are not limited to, the following:

- a. Data Link Reference
- b. List of the Subnetwork Addresses of one or more ATN Routers for which a communications path is now available.
- c. The subnetwork type. (This is required if a single SN-SME entity is used to manage all the subnetworks)

(Implementation may choose to send multiple Join Events for multiple ATN routers, with one router's address in each event)

The purpose of the Join Event is to indicate to the IS-SME the potential availability of one or more ATN Routers. Both IS-SME and SN-SME may need to

look up local policy to make a decision on a Join Event. The functional decomposition between the IS-SME and SN-SME with regard to policy look-up is implementation specific. For example, the SN-SME may base on local policy to select a preferred service provider (hence their ground station and router). In VDL Mode 2, it is likely that the ATN router's subnetwork addresses that the VME receives on GSIFs are routing domain identifiers rather than actual ATN router's subnetwork addresses. In this case, the SN-SME may be able to make the selection more appropriately than the IS-SME.

The IS-SME instructs the Mobile SNDCEF to establish the required subnetwork connections through the Data Interface.

A data link reference is needed because more than one data link may be accessible through the Data Interface at any one time. For example, in VDL Mode 2, it is possible for an aircraft to be in contact with more than one DSP simultaneously. Also, during Handoffs, two data links to the same DSP may be available. It is therefore important that any response to a Join Event also references the data link on which the ATN Routers are available.

C.3.2 The Handoff Event

The Handoff Event is typically implemented as a function call from the SN-SME to the IS-SME, with Parameters passed on this event may include, but are not limited to, the following:

- a. Old Data Link Reference
- b. New Data Link Reference
- c. List of the Subnetwork Addresses of ATN Routers affected by the Handoff.
- d. The subnetwork type. (This is required if the aircraft simultaneously supports communication over VDL Mode 2 and 3 and a single SN-SME is used to manage all the subnetworks).

The purpose of the Handoff Event is to inform the IS-SME that any subnetwork connections with the ATN Routers (identified by the Subnetwork Address) that were made using the "Old Data Link Reference" must now be re-established using the "New Data Link Reference".

On receipt of a Handoff Event, the IS-SME checks to see if any such subnetwork connections exist and, if they do, it instructs the Mobile SNDCEF to establish a new subnetwork connection with each affected Router using the "New Data Link Reference". Following the ATN SARPs, the same subnetwork connection group is signaled and hence the data compression context carried forward.

Note that in the case of VDL Mode 2, the Subnetwork Address signaled on the Handoff will be the VDL Specific Address, as this is the address received on the GSIF. However, if X.121 addressing is supported by the subnetwork, then the X.121

APPENDIX C (cont'd)
GENERIC DATA LINK INTERFACE

address returned on the first subnetwork connection establishment will have to be used as the called address for all subnetwork connections established as a result of a Handoff Event. It is the IS-SME's responsibility to correlate returned subnetwork addresses (e.g. VDL X.121 addresses) with the Subnetwork Addresses signaled on Join and Handoff events (e.g. VDL Specific Addresses).

C.3.3 The Leave Event

The Leave Event is typically implemented as a function call from the SN-SME to the IS-SME. It will have three parameters, the subnetwork addresses of the ATN Routers that are no longer reachable, the Data Link reference of the data link that was used for communicating with the ATN Routers, and the subnetwork type. (This last parameter is required if a single SN-SME is used to manage all the subnetworks). The data link reference is the same reference that was given on the Join or Handoff Event and allows the IS-SME to correlate the Leave Event with the affected subnetwork connections.

In response to a Leave Event, an IS-SME should also identify any BIS-BIS adjacencies supported by those subnetwork connections and which are not supported by any other subnetwork connection. These must also be terminated.

Note that the Leave Event is not guaranteed as it can be implicit on the clearing (by the subnetwork) of all subnetwork connections associated with the ATN Router.

C.4 The Data Interface

It is not the intention of this Appendix to describe a generic ISO 8208 interface as many examples already exist in text books and implementations. However, the Data Interface does diverge in one important respect from a standard ISO 8208 interface and that is in the use of the Data Link reference.

The interface function that implements an ISO 8208 Call Request must include the data link reference as an additional parameter. Thus when the Mobile SNDCF calls this function it will include the data link reference given to it on a Join or Handoff Event and this will tell the Subnetwork Access function which data link (out of those currently available) it must use to fulfil the Call Request.

Note that it may be concluded from this that the Data Link reference is an identifier of which the semantics are local to the subnetwork. It may thus be anything from a table index to a memory address – the IS-SME does no more than compare such references for equality and to use them on Call Requests.

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SUPPLEMENT 1
TO
ARINC SPECIFICATION 637P1
AERONAUTICAL TELECOMMUNICATIONS NETWORK (ATN)
IMPLEMENTATION PROVISIONS, PART 1
PROTOCOLS AND SERVICES

Published: June 20, 2000

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Adopted by the Airlines Electronic Engineering Committee: April 18, 2000

A. THE PURPOSE OF THIS SUPPLEMENT

This Supplement introduces changes and additions to ARINC Specification 637 to provide general and specific design guidance for the development and installation of Aeronautical Telecommunication Network (ATN) protocols and services needed to transport, route and relay digital (bit-oriented) air-ground data link messages in an open systems interconnection environment. This document also describes the necessary internetworking functions to support legacy character-oriented application messages (i.e. ACARS) which will be transported over bit-oriented sub-networks.

The protocols and services defined herein are consistent with those specified in ICAO SARPs and guidance material for the (ATN). This document relies heavily upon the ICAO SARPs for the definition of the functionality of the Network and Transport protocols. The functions described herein supply important definition of processes deemed to be “local issues” by the SARPs but wherein uniformity is essential to worldwide interoperability.

B. ORGANIZATION OF THIS DOCUMENT

This document is a replacement of Specification 637 in its entirety. Since this Supplement represents all new material, the typical change bars (c-1) and labeling along the margins have been omitted.

C. CHANGES TO SPECIFICATION 637
INTRODUCED BY THIS SUPPLEMENT

Supplement 1 makes two fundamental structural changes. Specification 637 defined only the Network Layer functions of the Aeronautical Telecommunications Network (ATN). Supplement 1 introduces both Network and Transport Layer definitions. Supplement 1 also anticipates the development of a second part, resulting in the new designation of Part 1 for the definition of protocol provisions. Part 2 will be used to document Network layer addresses.

This Supplement discusses the history and evolution of the Data Link System, and provides an overview of OSI reference model. The new material reviews the message encapsulation and functional components necessary, then defines the support for the ACARS End System, the method for subnetwork selection, and message retransmission.

Supplement 1 identifies the airborne naming and addressing of ARINC 620 messaging to include airborne NSAP Address Assignments, Airborne TSAP Selector Assignment, and Application Names.