VHF DIGITAL LINK IMPLEMENTATION PROVISIONS

ARINC SPECIFICATION 631-3

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Prepared by the Airlines Electronic Engineering Committee

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A description of the changes introduced by each supplement is included on goldenrod paper at the end of this document.

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 Reports 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 Characteristic 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 Purpose of this Document

The intent of this document is to provide general and specific design guidance for the development and installation of the protocols needed to exchange bit-oriented data across an air-ground VHF Digital Link (VDL) in an Open System Interconnection (OSI) environment. Details of the VDL protocols defined herein are specified in the International Civil Aviation Organization (ICAO) VDL Mode-2 (VDLM2) Standards and Recommended Practices (SARPs). VDLM2 is consistent with the concepts of the ICAO Aeronautical Telecommunications Network (ATN).

This document describes the functions to be performed by airborne and ground components of the VDLM2 to successfully transfer messages from VHF ground networks to avionics systems on aircraft and vice versa where the data are encoded in a code and byte independent format. The compatibility of VDLM2 with OSI is established by defining a set of services and protocols that are in accordance with the OSI basic reference model. The compatibility with the ATN protocols is achieved by defining a set of interfaces between the VDLM2 subnetwork protocol specification and the Mobile Subnetwork Dependent Convergence Function (M-SNDCF). The SNDCF is defined in the ICAO ATN SARPs.

COMMENTARY

> VDLM2 as used in this document, refers to the digital communication protocols to be exercised by the VHF transceiver and supporting avionics to exchange messages with any appropriately equipped ground system. The VDLM2 definitions were introduced to enhance the effectiveness of Air Traffic Services (ATS) and Airline Operational Control (AOC) communications.

1.2 Background

Communications across the air-ground VHF link were initiated using the Aircraft Communications Addressing and Reporting System (ACARS). The ACARS air-ground system description was initially included in ARINC Characteristic 597, but was later transferred to ARINC Specification 618, "Air-Ground Character-Oriented Protocol Specification".

ACARS uses a character-oriented protocol that is not suitable for future Communications, Navigation, and Surveillance (CNS) functions necessary for Air Traffic Management (ATM). The bit-oriented, OSI-compliant VDLM2 is designed by ICAO to overcome the limitations of ACARS in order to provide a high-bandwidth, reliable, VHF data link required by CNS/ATM services.

1.3 Relationship of this Document to Other ARINC Standards

This Specification may be referenced by any appropriate equipment Characteristic such as ARINC Characteristics 750 and 758. To obtain VDLM2 communications capability, the VDLM2 functions defined herein should be installed in an ARINC 758 Communications Management Unit (CMU) and ARINC 750 VHF Data Radio to produce a unit capable of exchanging information in a bit-oriented environment.

The VDLM2 function can support both bit-oriented ATN applications and character-oriented ACARS applications. The Transport and Internetworking protocols are defined in ARINC Specification 637.

Session, Presentation and Application layer definitions will be described in ARINC Specification 638, "OSI Upper Layer Specification".

ACARS character-oriented applications are defined in ARINC Specifications 620 and 623.

1.3.1 Characteristic 758

New aircraft will be designed with communications architectures designed to operate within the ATN. The Communications Management Unit (CMU) is described in ARINC Characteristic 758, "Communications Management Unit (CMU) Mark 2".

1.3.2 Characteristic 750

ARINC Characteristic 750, "VHF Data Radio", describes the digital data radio to be used for VHF air-ground communications. This characteristic also includes the CMU to VDR interface description.

1.3.3 Specification 637

ARINC Specification 637, "Aeronautical Telecommunications Network (ATN) Implementation Provisions, Part 1, Protocols and Services", describes the ATN mobile SNDCF, internetworking, dynamic routing, transport, ATN network management, and application interfaces for ACARS and ATN.

1.3.4 Specification 620

ARINC Specification 620, "Data Link Ground System Standard and Interface Specification (DGSS/IS)", describes the ACARS character oriented message formats.

1.3.5 Specification 618

ARINC Specification 618, "Air/Ground Character-Oriented Protocol Specification", defines the character-oriented ACARS messaging protocol and the RF environment.

1.3.6 Specification 638

ARINC Specification 638, "Upper Layer Specifications (End System Communication Specifications)", defines the ATN upper layer protocols.

COMMENTARY

> ARINC Specification 638 is not consistent with the latest ATN SARPs. As such, this specification will be updated or declared obsolete.
> .

1.3.7 Specifications 622 and 623

ARINC Specifications 622 and 623 define the character-oriented ATS application messages.

1.0 INTRODUCTION

1.4 Relationship to Other Standards

Reference is also made to other documents, which were not developed by AEEC (ARINC standards).

1.4.1 Relationship to ICAO Documents

The VDLM2 functions conform to the International Civil Aviation Organization (ICAO) VHF Digital Link (VDL) Standards and Recommended Practices (SARPs). The VDL SARPs define the basic signal-in-space and protocol suite. However, this document provides additional interoperability information needed by the air transport industry.

COMMENTARY

A copy of the final version of the ICAO VDL SARPS and associated Guidance Material may be obtained upon request to the Secretariat of the ICAO Aeronautical Mobile Communications Panel (AMCP) by writing to:

ICAO
Air Navigation Bureau (ANB)
999 University Street
Montreal, Quebec, Canada H3C 5H7

1.4.2 Relationship to RTCA Documents

The RTCA DO-224A, Minimum Aviation System Performance Standard (MASPS) defines the signal and space characteristics of the VDLM2 air/ground data link.

1.5 Relationship to OSI Protocols

The VDLM2 functions are the Physical Layer, Data Link Layer, and the first sub-layer of the Network Layer. The Data Link Layer protocols conform to High-Level Data Link Control (HDLC) as specified by ISO 3309(E) fifth edition 1993-12-15, ISO 4335(E) fifth edition 1993-12-15, ISO 7809(E) fifth edition 1993-12-15 and ISO 8885(E) third edition 1993-12-15. The sub-layer of the Network Layer protocols conform to the X.25 Packet Layer Protocol for Data Terminal Equipment as specified by ISO 8208 1990-03-15.

2.0 INTEROPERABILITY

2.1 Subnetwork Interoperability

VDLM2 is one of a number of air-to-ground subnetworks which may be used to provide communications between the airplane-based application processes and their ground-based peer processes. Interoperability provides the capability for an application process to send or receive data messages over any of the available subnetworks. The application process is not required to select a particular subnetwork or even know which subnetwork is being used for a particular message.

One of the prime reasons for development of VDLM2 is to provide a VHF data link that can coexist with other bit-oriented air-to-ground subnetworks. These other subnetworks might include satellite communication or HF data link. It is essential that each of these subnetworks provide consistent services, as the other subnetworks, such that the network router may choose to establish a path across any available subnet.

2.2 VDLM2/ACARS RF Coexistence

VDLM2 uses differential, 8-level, Phase Shift, Keying (D8PSK), direct, digital modulation. D8PSK is not compatible with the MSK modulation. As such, both ACARS and VDLM2 can not coexist on the same radio frequency within a VHF line-of-sight region. The introduction of VDLM2-capable CMUs and VHF Data Radios (VDR) is intended to minimize any negative impact on the existing avionics units operating under the original ACARS system.

2.3 VDLM2/ACARS Protocol Coexistence

During the transition phase, an aircraft CMU may be both VHF ACARS and VDLM2 capable and switch operational mode based on communication service availability. The transition from VDLM2 to VHF ACARS should be performed automatically as defined in ARINC Specification 618.

The VDLM2 subnetwork can co-exist with other air/ground subnetworks using the original ACARS character-oriented message protocol for as long as the latter is operational. If this occurs, the Network and Transport layer protocol functions defined in ARINC Specification 637 will be responsible for message routing and recovery over these dissimilar data links. Both character-oriented ACARS data link and VDLM2 equipment should satisfy the requirements imposed by their own environments without interference with, or degradation of, the other.

3.0 SYSTEM OVERVIEW

3.1 General Description

This chapter provides the information needed to enable the functional aspects of the equipment to be designed, according to the ICAO VDL SARPs.

3.2 System Architecture

The architecture, message protocols and message formats defined herein for VDLM2 are based on the concepts of the International Organization for Standardization (ISO) Open System Interconnection (OSI) model for telecommunications and data processing services. The OSI model was developed specifically to facilitate data transfer between different end systems without one having precise knowledge of the other's transmission characteristics or the characteristics of all the links that connect them.

The OSI model represents an environment through which messages can be transported as a stream of digital bits. This environment is depicted in Attachment 1 as an accumulation of data processing networks, either public or private, which can be accessed by any user connected to the ATN and employing a compatible application process. All networks and intermediate nodes in the environment are expected to be compatible with the OSI environment.

The OSI model is organized to permit a user's application process to communicate with its counterpart in another end system. The actual communication path, however, descends through the layers from the sender's process and ascends through the layers to the recipient's process. As the user data descends through the layers a header containing protocol control information is attached to the data. The header is a set of instructions intended to be "read" by the peer layer in the recipient's process. No layer is aware of the header used by the other layers. As a received frame ascends through the layers, the headers are read by the peer layer and then removed as the message segment is passed on.

Examples of the application process by which a user may enter the environment are: a person operating a manual keyboard terminal, an aircraft performance sensor with digital output, the sensing of a magnetic strip on an ID card, a digitally encoded time check or any other information transaction which is in digital form.

The term "Open", in Open Systems Interconnect, is used to convey the concept of one end system, or user, communicating with another end system, perhaps having a different design, provided both are compatible with the system architecture of the OSI model.

The OSI model has a structure comprised of a series of seven layers. For each layer functional responsibilities are assigned. The boundaries between these layers are called interfaces. Some layers have been subdivided, producing additional interfaces.

The value of the model is that it provides a uniform nomenclature and an orderly manner in which the responsibility for various network activities can be distributed. The manner in which these activities are executed is known as the protocol. Protocols are used to regulate the interaction across these interfaces. A protocol is defined for each layer (or sublayer). VDLM2 protocols are defined by: (1) standards, such as those developed by ISO, and included in this Specification by reference or (2) defined in this Specification.

The service interface definition describes the way in which each layer, as a functional unit, interacts with the adjacent (upper and lower) layers within a system. The protocol determines how each layer is to communicate with its peer layers. For each layer of the source, a complementary peer layer is normally present at the other end of the communication path. Complementary peer layers may also appear at points along the communication path.

Actually, data are not exchanged directly between peer layers (see Attachment 1), but rather sent down through the lower layers to the physical medium, across the physical medium and then up through the layers at the receiving end. Each layer contributes a portion of the header, which is treated as data by the next lower layer. At the receiving terminal, the appropriate portion of the header, containing the protocol control information, is read and understood by the peer layer, then discarded.

Layer interface protocols are identified in a series of fields in the header inserted at each layer. These headers contain the information necessary for the appropriate receiving layer to process the message. The format and contents of the header fields are described in the associated sections of this Specification pertaining to a particular layer.

3.2.1 Architectural Guidelines

VDLM2 represents a significant architectural extension of the original ACARS air-ground data link. The following set of Architectural Design Guidelines were developed to assure complete compatibility with existing airborne terminals while providing maximum user utility. These Twelve guidelines should be used as a basis for VDLM2 capable CMU design to achieve avionics compatibility with both the aircraft environment and the ground network.

a. Various levels of aircraft equipment must be able to co-exist for extended periods. At any one time in the future, aircraft containing ACARS equipment of various developmental levels may occupy the same airspace. Aircraft equipment replacement should be dictated by business factors, not to avoid incompatibilities with newer VDLM2 system definitions.

b. All equipment designed to operate within the VDLM2 environment should be able to utilize a designated radio frequency within a particular airspace referred to as the appropriate Common Signaling Channel (CSC). The architecture should not limit the number, the type or the administration of VHF frequencies.

c. Frequency management should be a cooperative effort between the ground network and the aircraft. The ground service provider has primary responsibility for aircraft tracking. Ground service providers dynamically assign operational frequencies within a particular airspace to resolve factors beyond the control of the aircraft. If needed, negotiations with the aircraft for frequency use should be initiated by the ground service provider and resolved to a mutual satisfaction. The resulting "system" should be able to freely adjust frequencies to account for volumes, area of responsibility and political jurisdiction.

d. Maximizing message throughput is an important consideration in VDLM2 design.

e. VDLM2 should be able to participate in, and contribute to the establishment and maintenance of a reliable communications path between the aircraft and the ground network.

A CMU should exercise methods of radio station tracking so as to minimize misdirected transmissions as the aircraft transitions, from the reception area of one ground station to another. Similarly, the VDLM2 CMU should be capable of transitioning from one ground network to another. It should be able to maintain continuity for a message, originating either on the ground or in the air, without manual intervention or prompting.

f. VDLM2 should not preclude aircraft-to-aircraft message exchange capability. This feature is not accommodated in this specification.

g. VDLM2 should be “data transparent”; i.e., totally insensitive to the content of messages it carries. Changes in message content and format should have no effect on the implementation or effectiveness of VDLM2 communications.

h. Many computer networks and systems in place today are constrained by prior generations of software and hardware. VDLM2 should not be affected by those constraints. VDL protocol should be independent of data rate.

i. VDLM2 should be able to tolerate less than optimum operating conditions. Degradation should be gradual when operating within adverse operational scenarios, including failure modes. Neither a ground station nor an aircraft should be able to abuse a channel.

j. The architecture should be able to accommodate concurrent message exchanges with multiple ground systems. This allows use of the communications system, not only by multiple airline sources, but also by such entities as air traffic control, weather agencies and others, without the necessity for interlinking within the ground networks.

k. Ground Systems should ensure that the parameters broadcast in GSIFs are current and accurate. If a frequency is shared by multiple DSPs, then the parameters that affect an aircrafts’ ability to communicate with all DSPs, (e.g. MAC layer parameters) should be coordinated apriori by the DSPs. Otherwise, the DSPs should use the default values specified in the VDL SARPs for these parameters.

l. VDLM2 was designed to operate under ATN. Currently this document satisfies that requirement. Other uses of VDL Mode 2 subnetwork have been identified by the industry. Although this document does not specify uses of other network/subnetwork protocols, they are not precluded.

Usage of these non ATN or non-ISO 8208 protocols will be documented in other ARINC specifications. For example, the ACARS Over AVLC (AOA) protocol is defined in ARINC Specification 618.

COMMENTARY

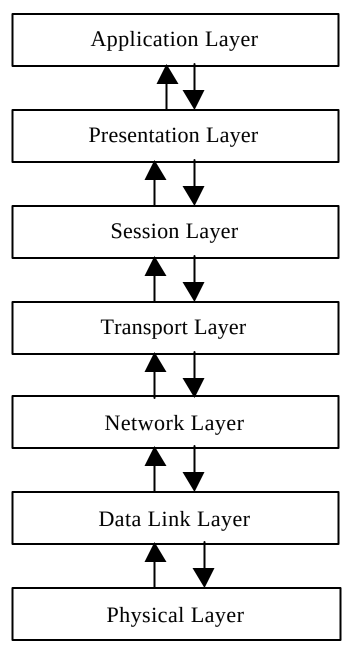
The current version of this Specification ensures only single radio operation having one active link with a ground system. Future supplements will address the multiple radio, multiple link operational requirements.

COMMENTARY

The current version of this specification defines the operation of VDL Mode 2 under the ATN. Provisions for other protocols such as the ACARS Over AVLC (AOA) are not precluded. Details of these protocols can be found in other ARINC specifications.

3.2.2 Layers of the OSI Model

Each communication in the ATN environment represents a series of functions which must be arranged in a logical order to be clearly understood. The OSI model uses the technique of layering to achieve a logical balance between a complicated system structure and complicated protocol. Seven layers are used in the OSI model to provide the functions needed to make the transition from the user's application process to the transmission medium; e.g., the VHF radio. These seven layers are depicted in Figure 3-1.



TRANSMISSION MEDIUM

Figure 3-1
Layers of the OSI Model

3.0 SYSTEM OVERVIEW

3.2.2.1 Layer 1, The Physical Layer

The Physical Layer provides services to activate, maintain and deactivate connections for bit transmission in the Data Link Layers. The following service elements are the responsibility of Layer 1.

Activation of the transmission channel
Establishment of bit synchronization
Physical data transmission by an appropriate
Radio system
Channel status signaling
Fault condition notification
Local network definitions
Service quality parameters

3.2.2.2 Layer 2, The Link Layer

The Link Layer is responsible for transferring information from one network entity to another and for annunciating any errors encountered during transmission.

The Link Layer draws on the service provided by the Physical Layer. This function is transparent to the type of radio media used. The service responsibility of the Link Layer includes the following:

Frame assembly and disassembly
Establish frame synchronization
Rejection of non-standard frame types
Detection and control of frame errors
RF channel selection
Address recognition
Generate and verify the frame check sequence

The Link Layer provides the basic bit transmission service over the RF channel. Data at the Link Layer are transmitted as a bit stream in a series of frames exchanged between the aircraft transceiver and the ground-based radio elements.

3.2.2.3 Layer 3, The Network Layer

It is the responsibility of the Network Layer to ensure that data packets are properly routed between the source airborne end system and the designated recipient ground end system (or vice versa). The Network Layer expects the Link Layer to supply data from correctly received frames; however, it does not assume reliable transmission. Specific responsibilities of the Network Layer include the following:

Data packet assembly and disassembly
Routing
Error resolution
Equipment error resolution
Priority handling

At the Network Layer, messages (data) are broken into packets of a size appropriate for the transmission media. The message is then transmitted as a series of packets. Each packet is transmitted in one frame (INFO or XID_CMD_LE/HO frames). Each frame carries only one packet. A complete message may consist of one or more packets.

The Network Layer has been divided into three Sublayers as shown in Figure 3-2. These are the Subnetwork Access Protocol Sublayer (SNACP, e.g. ISO 8208), the Subnetwork Dependent Convergence Function Sublayer (SNDCF) and the Subnetwork Independent Protocol Sublayer (SCICP, e.g. ES_IS/CLNP/IDRP).

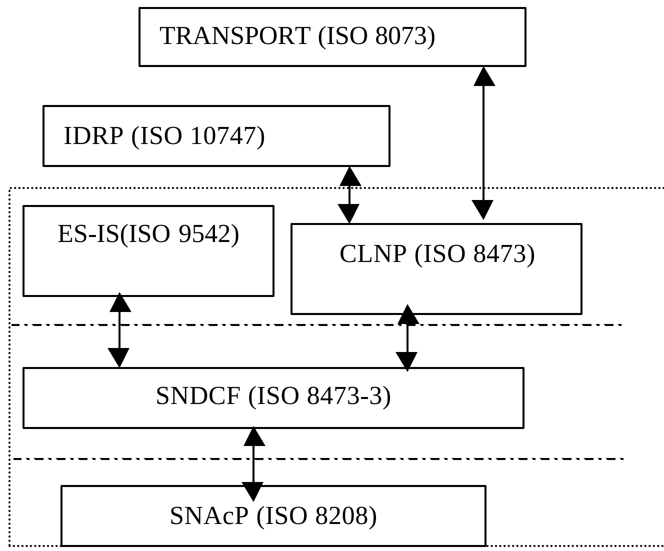


Figure 3-2
The Sub-layers of the Generic ISO Network Layer

The three upper layers (application services) provide direct support of the application process while the lower three layers (network services) support the transmission of information between the end systems. The Transport Layer is the essential link between these services providing end-to-end integrity of the communication.

VDL MODE 2 is constituted of the protocols of layers 1, 2, and the sub-network access sub-layer of layer 3. See Figure 3-3.

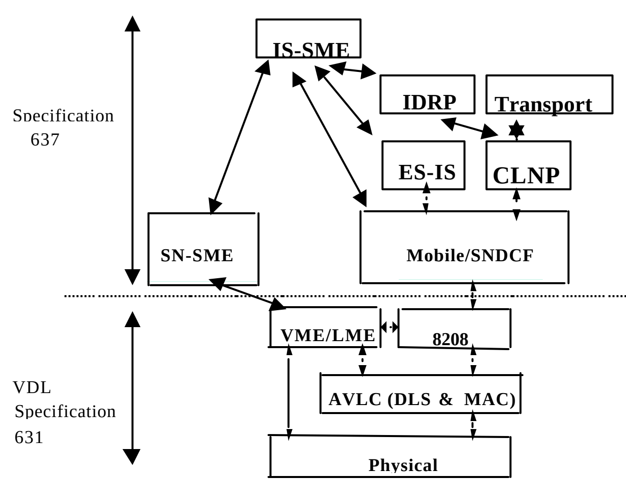


Figure 3-3
Top Level VDL Mode 2 Architectural Diagram

4.0 CONCEPT OF OPERATION

4.0 Introduction

This section provides an overview of some key concepts of VDLM2. Although the fundamentals of VDLM2 are the same regardless of its operational phases, some aspects will likely be different during ACARS to VDL transition. This section specifically covers the ACARS to VDL transition phase.

4.1 Radio Frequency Management

A ground system consists of one or multiple ground stations and one or multiple air-ground routers.

In VDLM2, a tiered structure of operating frequencies and zones is used such that communications are optimized for individual enroute and terminal area requirements.

VDLM2 necessarily operates on multiple frequencies. A common frequency referred to as the Common Signaling Channel or CSC is to be used for initial contact. The CSC provides a ready means for an aircraft user to first enter the system (log on). It also serves as a common or base channel to be used in emergency or light traffic areas, and a fallback (default) channel whenever communication is lost for any reason.

The ground service providers should transmit their Ground Station Information Frames (GSIF's) in the CSC. Data Service Providers should not require an aircraft to autotune in a common service area if the aircraft needs complimentary services from different providers.

The avionics equipment must be capable of operating on the CSC. In fact, it should be able to tune to any discrete frequency within the assigned frequency range. Tuning may be commanded by the aircrew, automatically performed by the CMU based on owner preference table or commanded by the ground systems.

COMMENTARY

It should be noted that aircraft operators may change the owner preference table via data link command.

If an aircraft is using the same radio transceiver to connect to two or more service providers, and one of them commands the aircraft to Autotune, the avionics equipment should be capable of detecting such a case and may refuse the autotune command from the service provider.

Exception Condition

If an aircraft has link connectivity to multiple DSPs over a common frequency, and the airline designated highest priority DSP requests the aircraft to autotune, the aircraft should accept the autotune from that DSP and disconnect all other links that can not be maintained over the autotuned frequency.

In areas where VDL coverage is available during a transition phase the ACARS squitters, as specified in ARINC Specifications 618 and 620, should convey the VDL frequency to the Data Link Manager, which initiates the VDL Mode-2 communication process.

When VDL SVC is available the SN-SME commands the VDL Management Entity (VME) to start the DSP acquisition process on the assigned frequency, via the VDL_STARTUP.req primitive (see Section 10).

The aircraft VME attempts to tune the radio to the assigned frequency. The common signaling channel (CSC) is 136.975 MHz. The source of the frequency may be obtained from an ACARS squitter, or previously known by the CMU from the Owner Preference Table. This is done by sending the PH_PARM.request primitive to the VDR via the ARINC 429W interface. The VME then monitors uplink transmissions (GSIF, or other uplink) to discover the available VHF service providers operating on that frequency.

GSIFs contain all the necessary information for the CMU to establish VDLM2 communications with that ground station. See VDL SARPs Sections 6.5.4.2.1 and Table 6-51.

All data link service providers should make their presence and availability known by transmitting GSIFs on the CSC.

The VDR passes the GSIFs, directly to the VME entity in the CMU via the ARINC 429 interface.

The VME informs the SN-SME of the services and the VDL Specific DTE addresses of the air/ground routers received from the GSIFs.

The VME maintains ground systems connectivity information in a table called the Peer Entity Contact Table (PECT). The PECT contains a list of VDLM2 ground stations and associated parameters such as the Signal Quality Parameter (SQP), supported DSP and the DTE address. The ground station id and the SQP values in the PECT should be updated in every transmission from the ground while the VDLM2 parameters should be updated based on the GSIF.

The VME also receives the PH_SQP.indication primitive from the VDR for every uplink heard. This primitive indicates the signal quality of the ground station.

COMMENTARY

ARINC Characteristic 750 specifies the algorithm for SQP. It gives a range of 0 to 15 (0 being poor lowest signal quality).

It is the responsibility of the SN-SME to choose a service provider with which it wishes to establish a link. The SN-SME should have apriori knowledge of the preferred DSP.

4.1.1 ACARS to VDL Mode 2 Transition

If an airplane is within ACARS coverage the CMU commands the VDR to tune to the VDL frequency provided by the ACARS squitter in order to search for available service providers who are advertising their services via ACARS squitters.

If the avionics is within mode (i.e. both ACARS and VDLM2) capable, the power-up initial mode should be based on owner preference. If the preferred mode is VDLM2, then the avionics tunes to CSC to discover

4.0 CONCEPT OF OPERATION

4.1.1 ACARS to VDL Mode 2 Transition (cont'd)

available VDL DSP(s), and if no VDLM2 service is detected on the CSC, the avionics may fall back to ACARS based on owner preference.

4.1.2 Dedicated VDL Mode 2 Operation

If the aircraft is equipped only for VDLM2 operation, the CMU commands the VDR to tune in the CSC in order to search for available service providers in the area.

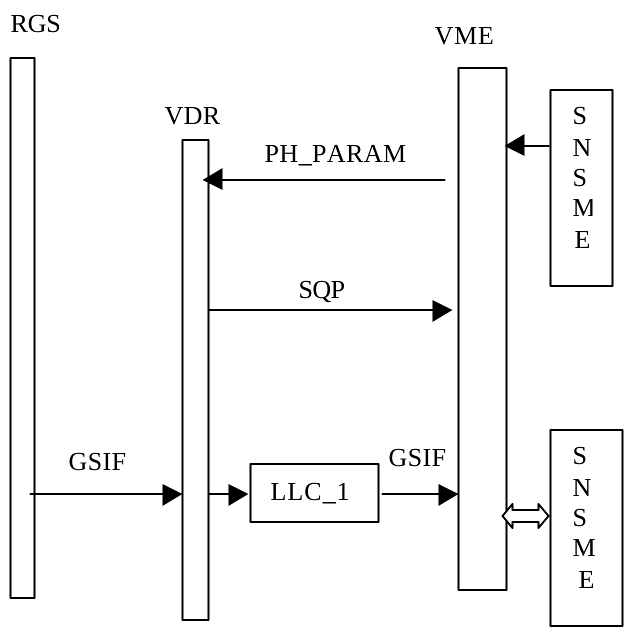


Figure 4-1
Frequency Set and DSP Acquisition

Frequency search and frequency recovery procedures are defined in VDL SARPs Sections 6.5.4.4.1.1 and 6.5.4.4.1.2. The VDL avionics should be configured to tune to the frequencies specified in the search table as per airline preference. In addition, the DSP may uplink VDLM2 service frequencies to the aircraft via GSIF or autotune command. The sequence of exchanges for VDLM2 frequency upload using GSIF is shown in Figure 4-1.

If the avionics can not establish a VDL link to its preferred service provider on the proposed frequency, it may search for alternative DSPs as per airline preference.

COMMENTARY

> If a frequency search table is configured during system initialization, the VDL CSC should be the first VDL frequency in the table.

4.2 VHF and Link Management Entities (VME/LME)

The VME/LME performs the following functions:

a. Frequency Search and Acquisition; this is done with the aid of the Common Signaling Channel or f0 (f0 = VDLM2 frequency received via the ACARS squitter or frequency search table);

b. Link Establishment/Disconnection, Link Parameter Modification and Parameter setting process; this is done via the XID frames;

c. Expedited Subnetwork Establishment process; this is performed with the exchange of the ISO 8208 Call_request and Call_confirm packets via the "XID_CMD/RSP_LE" and "XID_CMD/RSP_HO" frames; and

d. Handoff Connections within the same ground system (same ground system mask); this is done also via the XID frames (XID_CMD/RSP_HO).

A VME should have an LME for each peer LME. Hence, a ground VME should have an LME per aircraft and an aircraft VME should have an LME per ground system. Normally, a LME manages only one link with the peer ground station except during link handoff.

When an aircraft VME makes a connection to a ground station having a system mask that is different from the currently connected ground system, the VME should create a new LME. The new LME should use the link establishment procedures defined in the VDL SARPs 6.5.4.4.4 to create a new link. The old link should be disconnected based on procedures defined in VDL SARPs Section 6.5.4.3.2.

COMMENTARY

> The ground system mask identifies the DSP and possibly the level-1 ATN routing domain. A change in system mask for the ground station typically signifies that the ATN local compression can not be maintained across these ground systems and the ATN routing needs to be reinitiated.

One LME should handle the link handoff within a ground system (as defined by the Ground System Mask parameter).

An LME should establish a link between a local DLE and a remote DLE associated with its peer LME. A ground LME should determine if an aircraft station is associated with its peer aircraft LME by comparing the aircraft address; two aircraft stations with identical aircraft addresses are associated with the same LME. An aircraft LME should determine if a ground station is associated with its peer ground LME by bit-wise logical and the DLS address with that station's ground system mask provided by the peer ground LME. Two ground stations with identical masked DLS addresses should be associated with the same LME in the aircraft. The airborne and the ground LMEs should monitor all transmissions from its peer to maintain a reliable link.

4.2.1 Link Establishment

The aircraft avionics should be able to establish links with one or more Service Providers.

There are two ways to establish a link and subnetwork connection.

4.0 CONCEPT OF OPERATION

a. Explicit Subnetwork Establishment, and

b. Expedited Subnetwork Establishment

COMMENTARY

To improve the RF efficiency, all vendors are encouraged to implement the Expedited Subnetwork Establishment procedures, as defined in the VDL SARPs Section 6.5.4.4.12 and use these procedures whenever possible. The Expedited Subnetwork establishment procedure can only be used if it is supported by both peer entities.

4.2.1.1 Expedited Subnetwork Establishment With One Data Service Provider

Ground station identification. A ground station should send a GSIF by broadcasting a XID_CMD (P=0) with parameters as per the VDL SARPs Table 6-51. See VDL SARPs Section 6.5.4.4.3 and the Protocol Implementation Conformance Statements (PICS) provided in Attachment 2.

When the VDR is tuned to a VLDM2 operating frequency, GSIFs are received via the VDR and processed by the VME entity.

The VME builds a Peer Entity Contact Table (PECT) for all service providers based on the GSIFs and uplink transmissions received on the VDL operating frequency. It informs the SN-SME of the availability of all the service providers and air/ground routers (DSP id & VDL Specific DTE addresses).

Aircraft initiation

COMMENTARY

The aircraft IS-SME should choose the preferred service provider router and should inform the Mobile-SNDCF to establish subnetwork service with the given air/ground router. It should also inform the ES-IS routing process to start the route initiation process. ES-IS process would then generate an "ISH" PDU and forward that to the Mobile SNDCF.

The VDLM2 subnetwork process receives the "ISH" PDU, the source and destination DTE addresses in the call request primitive.

COMMENTARY

The VDL Specific DTE address may not uniquely identify an air/ground router if X.121 addressing is supported by the ground system. In that case, the VDL Specific DTE address specifies a routing domain within a specific organization. The X.121 address is the air/ground router DTE address.

The ISO 8208 subnetwork process should include the SNPDU in the "Fast Select" facility of the packet and forward that packet to the VME for expedited link establishment.

The "called address" field of the Call_request packet should be blank for VDL specific addressing plan. The VDL Specific DTE address should be included in the "called address extension" facility.

COMMENTARY

X.121 addressing is optionally supported by the VDL SARPs. If the ground system indicates support for X.121 addressing, then an aircraft may use X.121 address of the air/ground router in the called address field of the Call Request packet. How the aircraft obtains the X.121 address of the air/ground router for initial call establishment is not within the scope of this document.

The LME should then attempt to establish a link with the desired DSP by sending an XID_CMD_LE (P = 1) frame including the Call_request packet inside the "Expedited Subnetwork Connection" parameter according to the VDL SARPs Section 6.5.4.2.4.6.

The LME determines which ground station it wishes to establish a link with based on the signal quality of all uplink frames and GSIFs received from various ground stations. If multiple DSPs are using the operating frequency, the LME first selects a ground station that has terrestrial connectivity to the air/ground router of the preferred DSP. Therefore, the ground station selection depends on the following criteria, listed in order of priority:

a. Ground station belongs to the preferred DSP;

b. Ground station is connected to the air/ground router (as specified by the VDL Specific DTE Address parameter) selected by the IS-SME; and

c. Any other information available to the avionics including the SQP of all ground stations satisfying (a.) and (b.) above.

The LME should include the mandatory parameters in the XID_CMD frame as per the VDL SARPs Table 6-51. Attachment 2 provides the PICS for connection establishment parameters.

The frame is then delivered to the VDR via the ARINC 429 Interface and transmitted via the RF medium to the ground station.

General ground response. If the ground LME receives the XID_CMD_LE, it should confirm link establishment by sending an XID_RSP_LE frame containing the parameters as described below. See VDL SARPs Table 6-51 and Section 6.5.4.4.3 for additional details.

If the ground system supports X.121 addressing then, the ground network resolves the VDL Specific DTE address to a specific X.121 DTE address of an air/ground router and forwards the Call_request packet to that DTE.

If parameters were acceptable by the ground network, it responds with an XID_RSP_LE. The ground network can optionally send parameter changes with the XID_RSP_LE. The ground response frame should contain the ISO 8208 Call Connected PDU along with the ISH PDU from the air/ground router in the Fast Select facility.

4.0 CONCEPT OF OPERATION

4.2.1.1 Expedited Subnetwork Establishment With One Data Service Provider (cont'd)

If the ground system supports X.121 addressing then, the Call_accept packet received by the aircraft should contain the X.121 DTE address of the air/ground router.

Aircraft should store the X.121 address of the air/ground router and should use it for subsequent connection hand-offs if X.121 addressing is supported by the ground system.

Aircraft LME should decide whether to accept the XID_RSP_LE with the parameters proposed by the ground station.

If the aircraft accepts the parameters, the link and the virtual circuit is considered established and no further processing is required.

Exception Conditions

Rejection by Ground Network. The ground station should respond to the XID_CMD_LE with an XID_RSP_LCR frame if parameters were not acceptable. The XID_RSP_LCR frame should also include the Cause Code of the refusal. The aircraft LME may have to re-try the link connection with down play parameters.

Rejection by the Aircraft. If the aircraft does not accept the parameters, it should send a DISC frame to the ground station. On receipt of the 'DISC' frame, the ground network should consider the link disconnected and should not send any response to the 'DISC' frame.

The LME should update its PECT and forward the subnetwork PDU contained in the XID subnetwork connection parameter to the 8208. The ISO 8208 forwards the data (ISH_PDU) to the SNDCF sublayer.

COMMENTARY

See ARINC Specification 637 for the PDU delivery and routing.

4.2.1.2 Expedited Subnetwork Establishment With Two Data Service Providers

If the IS_SME entity needs to establish another connection, then it should trigger the ES-IS to supply the ISH-PDU to the SNDCF and also request a connection with another router (NET) (See VDL SARPs Section 6.5.4.2.4.6).

The Expedited Connection establishment scenario for the new DSP should be the same as in Section 4.2.1.1.

The VME should create another LME process for the new NET (or DSP or both) to handle the new link (LME # 2).

4.2.1.3 Explicit Subnetwork Establishment With One Data Service Provider

AVLC link establishment with explicit subnetwork connection establishment should follow the same procedure as defined in Section 4.2.1.1 with the following exceptions.

Aircraft Initiated Link Establishment. The ISO 8208 sends a Call_connected packet (triggered by the route initiation process from IS-SME) to the VME for link establishment. The VME should pick a suitable ground station that can support the DSP and the VDL Specific DTE address requested by the ISO 8208 call and should determine that expedited call establishment is not supported by the ground network.

The VME should initiate a link establishment procedure using a LME as discussed in Section 4.2.1.1. Once the link establishment is successful, the VME forwards the call request PDU to the AVLC as if the call was generated directly by the ISO 8208 process. The air/ground router should send a Call_accepted packet to the ISO 8208 completing the connection establishment procedure.

In expedited subnetwork connection establishment, the AVLC link is considered established only when the AVLC, ISO 8208, and mobile SNDCF parameters are all accepted by both peers. In explicit connection establishment, the AVLC link is established when AVLC parameters are accepted by the peers, regardless of the other higher layer parameters.

4.2.1.4 Explicit Subnetwork Establishment With Two Data Service providers

If the IS-SME decides to establish a link with another DSP, the VME should establish another AVLC link with a ground station supporting this desired DSP (assuming a ground station does not support both DSPs). The link and subnetwork connection establishment procedure discussed in Section 4.2.1.3 is repeated for each DSP.

4.3 Handoff Management

It is the responsibility of the aircraft's VME/LME to manage the ground station handoffs within the same ground system (defined by the Ground System Mask Parameter). In this case, a single LME manages the ground station hand-off.

A VDL link handoff should typically be performed as long as the ground stations belong to the same ground system (defined by the Ground System Mask Parameter). See Section B.2 of Appendix B.

If a candidate ground station belongs to a different Air/Ground router, but belongs to the same Ground System (as specified by the VDL Specific DTE Address), the aircraft SN-SME/VME may decide not to perform a link connection hand-off based on local issues.

Connectivity change across administrative and routing domain is managed by the SN-SME because of the route initiation requirement.

COMMENTARY

If the aircraft is able to establish a reliable link with a ground station having coverage at its destination airport, this station should be given preference above all other stations.

When a handoff collision occurs (i.e. when the XID_CMD_HO is transmitted by both the ground and the airborne systems such that reception is nearly

4.0 CONCEPT OF OPERATION

simultaneous) the hand-off command sent by the aircraft should have precedence.

Aircraft handoff. Once the aircraft LME has established a link to a ground station, it should monitor the VHF signal quality on the link and the transmissions of the other ground stations. The aircraft LME should establish a link to a new ground station if any of the following events occur:

a. The VHF signal quality (SQP) on the current link is poor and the signal quality of another ground station is significantly better;

b. Counter N2 is exceeded on any frame sent to the current ground station;

c. Timer TM2 expires for the current link.

If Timer TM2 expires, the aircraft LME should autonomously tune to an alternate frequency (provided in a frequency support list) before initiating the handoff. If no alternate frequency has been provided by the ground system and the aircraft is currently operating on a frequency that is not the CSC, the aircraft should fall back to the CSC. Otherwise, the aircraft should maintain communications on the CSC.

Site selection preference. From among those ground stations with acceptable link quality, the aircraft LME should prefer to handoff to a ground station which indicates (in the GSIF) accessibility to the air-ground router(s) to which the aircraft DTE has subnetwork connections.

If an aircraft has commenced approach to its destination airport and its current link is with a ground station that does not offer service at that airport, it should handoff to a ground station which indicates in its Airport Coverage Indication parameter that it offers service at that airport.

Interaction of LMEs. When an aircraft VME transitions from a ground station in one ground-based system (and thus associated with one LME) to a ground station in another ground-based system (and thus associated with a different LME in the aircraft), the new LME should use the new link initiation procedure.

The old link should be disconnected by sending a DISC on expiration of timer TG2.

4.3.1 <u>Handoffs Using Expedited Subnetwork Network Establishment With the Same Ground System</u>

4.3.1.1 <u>Aircraft-Initiated Handoff</u>

The aircraft LME should make the decision to do a handoff based on the factors specified in Section 4.

General ground response. If the ground LME receives the XID_CMD_HO, it should confirm link handoff by sending an XID_RSP_HO frame containing the parameters as per VDL SARPs Table 6-51. See VDL SARPs Section 6.5.4.6.

The LME should attempt to establish a link with the desired DSP/NET by sending an XID_CMD_HO (P = 1) frame including the Call_request packet inside the Expedited Subnetwork Connection parameter according to the VDL SARPs 6.5.4.2.4.6. This frame should include the mandatory parameters as per the VDL SARPs Table 6-51 and also any optional parameters for which the aircraft LME does not wish to use the default value.

Disconnecting old link. The aircraft LME should set TG5 Timer when it receives the XID_RSP_HO and has validated the received parameters. The ground LME should set the Timer after it transmits the XID_RSP_HO. Both stations should continue to receive on the old link until an indication is received confirming successful establishment of the new connection. Then the old link will be "uplink only" until the link' respective TG5 Timer expires, after which each will consider the link disconnected without sending or receiving a DISC.

Exceptional cases. If the ground LME cannot satisfy the XID_CMD_HO, then it should transmit an XID_RSP_LCR instead of an XID_RSP_HO; the current link should not be affected. See VDL SARPs Section 6.5.4.4.6.7.

4.3.1.2 <u>Aircraft-Requested Ground-Initiated Handoff</u>

Section 6.5.4.4.7 of the VDL SARPs should not be implemented by avionics.

4.3.1.3 <u>Ground-Initiated Handoff</u>

If a ground LME implements the ground initiated handoff capability, then it should set the "I" bit in the AVLC Specific Options parameter to 1; otherwise, it should set the "I " bit to 0.

Ground Station action. To command an aircraft, to which a link exists, to establish a new link to a proposed ground station on the same frequency, the ground LME should send via the current ground station an XID_CMD_HO (P=1).

If the ground LME accepts a handoff to other ground stations, the XID_CMD_HO should include the Replacement Ground Station List parameter specifying the Link layer address of those other stations. Any operating parameters in the XID_CMD_HO (either modification or informational) should be valid for the transmitting station and for all ground stations listed in the Replacement Ground Station List parameter, except the Airport Coverage Indication parameter and nearest Airport parameter because they are only valid for the transmitting ground station.

General aircraft response. The aircraft LME should create a new link for the new handoff connection if the parameters are acceptable and inform the IS-SME. The IS-SME then triggers a new call establishment to the subnetwork via the SNDCF.

The LME should then accept the handoff by sending an XID_RSP_HO (F = 1) frame including the Call_request packet inside the Expedited Subnetwork Connection parameter according to the VDL SARPs Section 6.5.4.2.4.6. This frame should include the mandatory parameters as per the VDL SARPs Table 6-51 and also any optional parameters for which the aircraft LME does not wish to use the default value.

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4.3.1.3 Ground Initiated Handoff (cont'd)

General ground response. If the ground LME receives the XID_RSP_HO, and its parameters are acceptable to the Ground LME the new handoff connection is considered successful.

If X.121 addressing is supported by the ground system, then the ground station should forward the Call_request packet to the DTE specified by the X.121 address contained in the Called Address field. The air/ground router DTE should respond back with a Call_connected packet containing the X.121 address of the air/ground router in the called address field. Otherwise, the ground station should resolve the VDL Specific DTE address contained in the Called Address Extension Field and forward the call to the specified air/ground router.

Rejection by aircraft. If the parameters contained in the XID_CMD_HO are not acceptable by the aircraft, then the aircraft LME should response with a XID_RSP_LCR F = 1), the current link should not be affected.

Rejection by ground network. If the parameters proposed by the aircraft in the XID_RSP_HO are not acceptable, then the Ground LME should response with a DISC frame.

Disconnecting the old link. See VDL SARPs Section 6.5.4.4.8.3.

Exceptional cases. See VDL SARPs Section 6.5.4.4.8.4.

4.3.1.4 Ground-Requested Aircraft-Initiated Handoff

Ground action. For the ground LME to request an aircraft to initiate a handoff, it should send an XID_CMD_HO (P = 0) on the current link with parameters as per VDL SARPs Table 6-51. The parameters in the XID (both modification and informational) are valid for all ground stations listed in the Replacement Ground Station List. It should only include operational parameters if it also includes the Replacement Ground Station List parameter. If the Autotune parameter is included, then the Replacement Ground Station List parameter should apply to the new frequency.

General aircraft response. If the aircraft LME receives the XID_CMD_HO, it should commence an aircraft-initiated handoff to a ground station, preferably one listed in the Replacement Ground Station List parameter.

Exceptional cases. If the aircraft LME cannot initiate the handoff, it should send an XID_CMD_LCR (P = 0); the current link should not be affected. If the Autotune parameter is included in the XID_CMD_HO (P = 0), the aircraft LME should retransmit the XID_CMD_HO (P = 1) on the new frequency using the normal retransmission procedures; otherwise, it should only transmit the XID_CMD_HO (P = 1) once per received XID_CMD_HO (P = 0).

4.3.2 Handoffs Using Explicit Connection Establishment With the Same Ground System

This handoff procedure is the same as the procedure described in Section 4.3.1 with the following exceptions.

4.3.2.1 Aircraft-Initiated Handoff

The VME selects a ground station and requests LME to conduct a handoff with that ground station. If the handoff is successful, VME should send a ground station Switch Indication to the SN-SME indicating a handoff has occurred within the same Ground System.

The IS-SME should send a subnetwork request to the SNDCF with the specific DTE address of the specific air/ground router. This is the router with which the aircraft has a subnetwork connection on the existing AVLC link. The SNDCF should forward a call request to the VDLM2 ISO 8208 process with the VDL Specific DTE address of the destination air/ground router. The ISO 8208 process should generate a Call_request packet with the VDL Specific DTE address in the Called Address Extension field and forward that to the ground network via the newly established link. Alternatively, the ISO 8208 process should send the Call_request packet with X.121 address of the air/ground router DTE in the Called Address field if the ground system supports X.121 addressing.

Expected ground response. The air/ground router should accept the call and send a call accepted packet to the aircraft. When the aircraft ISO 8208 process receives this Call Connected packet, the subnetwork connection establishment has occurred and the handoff should be complete.

Any follow-on downlink should be sent over the new Virtual Circuit (VC) and the old VC should be used as receive-only. The old VC should be disconnected when the corresponding link is disconnected after TG5 expires.

If the air/ground router specified by the Called DTE address is not reachable from the ground station, it may redirect the call to a new air/ground router DTE using the "called line address modification notification facility" provided that the ground system supports X.121 addressing. Call redirection using the Called Line Address Modification Notification facility should not be used by the DSPs supporting only the VDL Specific DTE addressing mechanism.

Call rejection by air/ground router. If the ISO 8208 Call Request is not acceptable by the ground network, it should send a clear request packet to the aircraft indicating the clear cause. The aircraft ISO 8208 process should send a clear confirm packet to the ground network. The old VC should remain unaffected. The ISO 8208 process should determine whether to reattempt the call based on the cause code provided by the ground DTE. If it does not reinitiate the call, the underlying new link should be disconnected as it will not be used to carry any user data.

5.0 PHYSICAL LAYER SPECIFICATION

5.1 Introduction

The physical layer protocol and specifications services are defined in the VDL SARPs Section 6.4.

5.2 VDR Design Specifications and Primitives

ARINC Characteristic 750 defines the VHF Data Radio design and primitives.

5.3 Physical Layer Overview

The aircraft and the ground stations should access the physical medium operating in a simplex mode as specified in the VDL SARPs Section 6.4. VDLM2 uses D8PSK modulation scheme running at 10.5 k symbols per second. Each VDLM2 symbol carries 3 bits of information, thereby yielding a raw channel data rate of 31.5 kbits per second.

5.3.1 Functions of the Physical Layer

The functions performed by VDLM2 physical layer are:

a. Transmitter and receiver frequency tuning
b. Data reception of the receiver
c. Data transmission of the transmitter
d. Notification services
e. Mode 2 frames
f. Data Encoding
g. Spectrum Shape
h. Modulation rate
j. Training sequence
k. Header FEC
m. Interleaving
n. Channel busy to idle detection
p. Transceiver interaction

The physical layer of VDLM2 should comply with the ICAO VDL SARPs Sections 6.1.4, 6.3, 6.4.3, and 6.4.4.

The physical layer should implement the system parameters as defined in the VDL SARPS Table 6-5.

6.0 MEDIA ACCESS CONTROL SUB-LAYER SPECIFICATION

6.1 Introduction

The MAC sub-layer uses p-persistent CSMA algorithm to provide equitable RF channel access to all contending transmitters operating within the same radio horizon.

Note: The MAC sub-layer service specification is modeled on the MAC Service Definition (ISO DP 10039).

6.2 Functions of the MAC Sub-Layer

Key functions of the MAC sub-layer are:

a. Channel Access

b. Channel status monitoring

VDLM2 should comply with the MAC functions defined in VDL SARPs Section 6.5.2.

The MAC system parameters should be implemented as defined in the VDL SARPS Table 6-6.

6.3 Procedures of the MAC Sub-Layer

The MAC sub-layer should perform the following procedures:

a. Channel sensing: As per VDL SARPs Section 6.5.2.4.1

b. Access attempt: As per VDL SARPs Section 6.5.2.4.2

6.4 MAC Parameters

The MAC layer parameters are TM1, TM2, p, and M1. The TM1 is not negotiable while TM2, p, and M1 can be updated by the ground system using uplink XID frames.

COMMENTARY

It is desirable that the default values are used for these parameters. As ground systems will not know the value of TM1 being used in the aircraft, it is possible that uncoordinated selection of the MAC parameters may reduce the efficiency of the RF environment.

6.5 Multiple Link Operation

If an aircraft establishes multiple links to different ground systems using the same radio, then the aircraft should either use the default MAC parameters or MAC parameters mutually agreed by all DSPs operating on that frequency. The DSPs should only advertise MAC parameters in the GSIF if those have been coordinated apriori among all DSPs. If MAC parameters are not co-ordinated among the DSPs offering service on the same frequency, all DSPs should use the default MAC parameters specified in the SARPs. Any unique MAC parameter modification request by a specific DSP may be rejected (using XID_RSP_LCR) by the aircraft if unilateral modification of the MAC parameter of the radio affects all data links.

7.0 DATA LINK LAYER SPECIFICATION

7.1 Introduction

The DLS should support bit-oriented simplex air-ground communications using the aviation VHF link control (AVLC) protocol specified in the VDL SARPS Section 6.5.3.

AVLC is a variation of the international standard High-level Data Link Control (HDLC) protocol as specified in the ISO documents ISO 3309, ISO 4335, ISO 7776, ISO 7809 Options 1, 3, 7, 8, 12, and ISO 8885.

7.2 Data Link Layer Partitioning

VDLM2 link layer functionality is to be implemented in two distinct Line Replacement Units (LRUs) in the aircraft. Basic frame structure, addition and deletion of flags, bit stuffing and removal, and address filtering functions are to be supported by the ARINC 750 VDR. The remaining Data Link Service (DLS) functions are to be provided by the ARINC 758 CMU.

See Attachment 10 of ARINC Characteristic 750-2 for the VDLM2 Simple Interface Protocol that defines the data transfer rules between the CMU and the VDR.

7.3 Transmit Queue Management

The Transmit Queue Management function should be located in the CMU.

Except as noted below, the Transmit Queue Management recommendations specified in the VDL SARPs should not be supported for VDLM2.

7.3.1 Transmit Queue Management

When the DLS sub-layer has frames to transmit, it should wait for the MAC sub-layer to authorize transmission. Two transmit queues should be maintained, one for supervisory and unnumbered (XID, FRMR, TEST, DISC, DM, RR, SREJ) frames and the other for information (INFO and UI).

7.3.2 Procedures for Transmission

Supervisory frames have higher priority than the information frames, therefore supervisory and unnumbered frames should be transmitted in preference to information frames.

a. A station receiving a FRMR, DISC, or DM frame should delete all outstanding traffic for the transmitting DLE as it would not be accepted if transmitted.

b. All unicast frames in the transmit queue should be deleted after the radio supporting this transmit queue is retuned as the intended station cannot receive the transmission.

SREJ frame: See VDL SARPs Section 6.5.3.11.2 for the SREJ procedures.

FRMR frame: See VDL SARPs Section 6.5.3.11.3 for the FRMR procedures.

UA frame: See VDL SARPs Section 6.5.3.11.4 for the UA procedures.

UI frames: If UI frames are received, they should be discarded.

TEST frame: See VDL SARPs Section 6.5.3.11.6 for the TEST procedures.

A station that is isolated from the normal frame processing should use The TEST command/response to perform a loopback test.

7.4 Addressing

7.4.1 Allocation of a Remote Ground Station Address

The DLS address should be 27 bits, divided into a 3-bit type field and a 24-bit specific address field. See VDL SARPs Section 6.5.3.3.3.3.

The address type field is described in the VDL SARPs Table 6-7.

The table in Appendix F provides for blocks of consecutive addresses available to Data link Service Providers (DSPs) and other organizations for assignment to VDL ground stations. TBD will administer these blocks of addresses to these organizations, who will, in turn, assign the individual ground station addresses.

COMMENTARY

> During the preparation of this standard ICAO and IATA were in discussions to determine which organization would administer the blocks of remote ground station addresses. A reference to the administrator will be added to a future Supplement when it becomes known.

7.4.2 Allocation of Aircraft Addresses

The aircraft specific address field should be the ICAO 24-bit Aircraft Address. See VDL SARPs Section 6.5.3.3.3.5.

7.5 Ground Station Information Frames

The Ground Station Information Frames (GSIF) should be used by the service providers to announce the availability of VDLM2 service at a given geographic region. The GSIFs should explicitly define the operational capability of the service provider and the desired parameters necessary for the aircraft to establish communications with the ground system. GSIFs should be transmitted by the DSPs on every operational VDLM2 frequency using procedures defined in VDL SARPs Section 6.5.4.4.3.

7.5.1 GSIF Parameters

The following parameters should be included with every GSIF (see VDL SARPs Table 6-51a and Section 6.5.4.2 for definition):

Public parameter set ID
Public procedure classes
HDLC options
Private parameter set ID
AVLC specific options
System Mask

7.0 DATA LINK LAYER SPECIFICATION

7.5.1 GSIF Parameters (cont'd)

ATN Router NET/s
Airport coverage
Ground Station location

The following parameters are optional for GSIF:

N1 (for both uplink and downlink)
K (for both uplink and downlink)
T1 – downlink
N2
T2
T4
MAC persistence, p
M1
TM2
TG5
$T3_{min}$
TG3
TG4
Frequency support

COMMENTARY

It is recommended that all peer entities use the default value specified in the VDL SARPs during initial implementation. The aircraft should allow dynamic modification and negotiation of these parameters as defined in the SARPs to ensure system optimization as more knowledge is gained regarding the operational behavior of the system.

A DSP should include the Frequency Support List parameter in the GSIF if the DSP offers multiple frequency operation in a given region. The Frequency Support List parameter should be duplicated for each additional frequency supported. The parameter may contain more than one ground station address that is operating on that frequency. If more than one ground station address is listed in the Frequency Support List parameter, then these ground stations should be located within the VHF line of sight of any aircraft at an altitude of 20,000 feet or above.

If a DSP intends to modify the TG3, TG4, or TG5, it should broadcast the updated value in the GSIF. TG3, TG4, and TG5 timers should be included in the GSIF even if modification of only one timer is desired. This permits the aircraft to validate the new value to ensure consistency with other timers.

7.6 Timers

7.6.1 Timer T1

This Section is included to clarify the SARPs specifications for calculating the value of Timer T1. Timer T1 is the time that the DLE waits for an acknowledgment before retransmitting a frame (only some frames are retransmitted). See SARPs. The value of Timer T1 should be calculated by the following formula:

$$\text{Timer T1} = \text{T1min} + 2\text{T1int} + 2\text{TD}_{99} + \min(U(x), \text{T1max})$$

Where:
T1min and T1max are parameters set by the ground system, as defined in the SARPS.

T1int is the propagation delay between the VDL mode components in the CMU and VDR. This term was added to the equation in the SARPS because the SARPS do not take the CMU-VDR interface into consideration. If T1min is set to a small value and the channel loading is very light it is possible to calculate a T1 value that is smaller than the propagation delays between the CMU and VDR. T1int includes the estimated ARINC 429 access delay, file transfer time and ARINC 429 receive processing delay. T1int is set to 0.5 second.

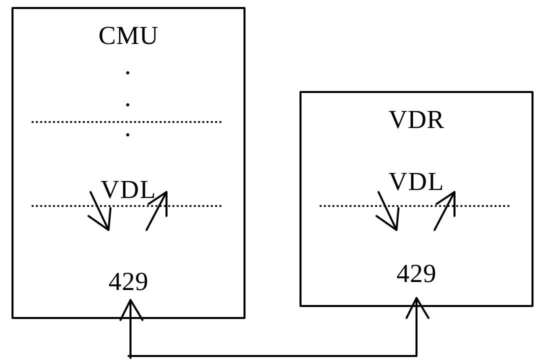


Figure 7-1: CMU-VDR Transfer Delay

TD_{99} is the running estimate of the 99^{th} percentile transmission delay. Transmission delay is defined to be the time that the frame is sent to the MAC sub-layer until the time that the transmission of that frame is completed. Even though the CMU-VDR interface provides actual values for transmission delay for each frame, the SARPS indicate that the value of TD_{99} should be calculated by the following formula:

$$TD_{99} = (TM1 * M1)/(1 - u)$$

Where:

TM1 and M1 are parameters set by the ground system, as defined in the SARPs.

The percent of time that the channel is busy is represented by u. Channel sensing should be performed as defined in the SARPS and that data should be used to calculate u. The range of values for u is 0 to 1 with 1 corresponding to a channel that is 100 per cent occupied.

U(x) is a uniform random number generated between 0 and x. The value of x should be calculated by the following formula:

$$x = \text{T1mult} * TD_{99} * \text{T1exp}^{\text{retrans}}$$

Where:

T1mult and T1exp are parameters set by the ground system, as defined in the SARPS.

Retrans is the largest retransmission count of all of the outstanding frames (not to exceed the value of N2).

There should be only one instance of the T1 Timer per DLS. Timer T1 should start when a retransmitable frame

7.0 DATA LINK LAYER SPECIFICATION

(INFO, RR (P = 1), SREJ (P = 1) or FRMR frame) is "queued for transmission" except when the T1 timer is already running.

For the avionics, queued for transmission is defined to be when the frame enters the transmit queue maintained by the CMU. It is recommended that the CMU implement the recommendations in SARPs Section 6.5.3.11.1.

COMMENTARY

At this time there does not appear to be a need to provide additional guidance for the ground definition of T1 except to caution the ground system implementers that a value that is too small will cause unnecessary transmission and waste RF.

7.6.2 Timer T3

Timer T3 should be calculated the same way as timer T1 except that T1 timer components should be substituted by the corresponding T3 timer components viz. $T3_{min}$, $T3_{max}$, $T3_{multi}$, and $T3_{exp}$. The timer component $T1_{int}$ should also be applicable to timer T3.

7.6.3 Other Timers

COMMENTARY

VDLM2 permits the DSP to dynamically change most of the link and MAC layer timers (T1, T2, T3, T4, TM2, TG3, TG4, and TG5). Although default values are recommended for initial operation, DSPs should adjust these timers to optimize system performance under varied RF conditions as more operational experience is gained.

7.7 System Mask Parameter

The first (i.e., Most Significant address prefix) number of bits (4 or 10) is used to extract the service provider identifier from the ground station address. The remaining bits (20 or 14) are defined by a service provider to identify their ground system.

7.8 HDLC Public Parameter Set ID

The HDLC Public Parameter Set ID should be 0x01.

COMMENTARY

At the writing of this document the value was in contradiction with the HDLC Public Parameter Set ID value contained in VDL SARPs Table 6-11. The SARPs are expected to be corrected in this regard.

7.9 AVLC Specific Option

If the ground station sets bit 6 of the AVLC specific options parameter to 1 in its GSIF, it indicates that the ground station supports both ISO 8208 protocol and non-ISO 8208 protocol over the VDL link. Currently, non-ISO protocol should be interpreted to be AOA. Upon receiving a GSIF with bit 6 of the AVLC specific options parameter set to 1, if the aircraft responds (via an XID frame) with bit 6 of the AVLC specific options parameter also set to 1, then non-ISO 8208 service is available on the established link. If the aircraft responds with bit 6 of the AVLC specific options parameter set to 0, then ISO 8208 service is available on the established link.

COMMENTARY

During initial deployment, even when the ground station sets bit 6 of the AVLC specific options parameter bit to 1, it may not support ISO 8208 and may only support non-ISO 8208 due to a phased deployment approach. In this case, if the VDL Specific DTE Address (VSDA) contained in the ground station's GSIF is "00 00 00 00 00 00", then that ground station supports non-8208 service only. If the VSDA contained in the ground station's GSIF is non-zero, then that ground station supports both ISO 8208 and non-ISO 8208 service.

If the ground station sets bit 6 of the AVLC specific options parameter to 0 in its GSIF, it indicates that the ground station does not support non-ISO 8208 protocol over the VDL link. If the aircraft responds (via an XID frame) with bit 6 of the AVLC specific options parameter also set to 0, then AOA service is not available over the established link. In this case, if the aircraft responds (via an XID frame) with bit 6 of the AVLC specific options parameter set to 1, then the ground station may reject the aircraft-initiated link establishment or aircraft-initiated hand-off.

COMMENTARY

Currently, a VDL link does not support both ISO 8208 and non-ISO 8208 services simultaneously.

7.10 VDL Parameter Length

The length of VDLM2 parameters should be as specified in the following table.

Parameter Name	PID	Range of Values	Recommended Length
N1 downlink	5	1144-16504	2 octets
N1 Uplink	6	1144-16504	2 octets
N2	10	1-15	1 octet
T2	11	25-10000 (ms)	2 octets
All Other Parameters		As specified in the SARPs	As Specified in the SARPs

7.11 Embedded Acknowledgment

Airborne and ground-based VDL stations should make use of the embedded acknowledgement whenever possible in order to conserve RF bandwidth. The embedded acknowledgment should be done by encoding the Link Control Field of the INFO command and response frames as specified in ISO 4335.

7.12 PICS

See Attachment-2 for DLS PICS.

8.0 SUBNETWORK LAYER SPECIFICATION

8.1 Introduction

The subnetwork layer protocol used across the VHF air-ground subnetwork is referred to formally as a Subnetwork Access Protocol (SNAcP) and should conform to ISO 8208, except as noted below. See VDL SARPs Section 6.6.

COMMENTARY

> The subnetwork layer provisions defined herein are not applicable for the ACARS over AVLC (AOA) implementation.

8.2 Connection Establishment

Only the aircraft should generate the VDLM2 Call Request to initiate the connection establishment procedure.

8.2.1 Explicit Connection Establishment

The explicit subnetwork connection establishment is the default mode as specified in the VDLM2 SARPs. It is mandatory for both aircraft and ground systems.

There will likely be cases where XID_RSP_LE/HO, containing the call confirm packet is not received by the aircraft. (e.g., collision over the RF).

In such cases, the ground system and Air Ground Radio (GS + AGR) will consider the link and subnet connection established with the aircraft, while the latter will not have any line nor subnet connection established.

This asymmetrical situation may cause the ground system to send info packets/frames to an aircraft that is not logged on to the ground system.

This situation may happen in an ATN environment where "Roles Reversal" is used (i.e., the AGR sends the open PDU), therefore creating unwanted overhead on RF and within the ground system (GS + AGR).

8.2.2 Expedited Connection Establishment

Both the aircraft and ground LMEs should support expedited subnetwork as described in VDL SARPs Section 6.5.4.4.12. The initiating DTE should issue CALL REQUESTs for those logical channels that were not initiated by the XID_exchange.

8.3 Fast Select

The fast select facility should be used to carry the VDL mobile SNDCF Call User Data including the intermediate system hello (ISH) PDU. Up to 128 octets of user data can be included in the Fast Select facility.

The maximum size of the Expedited Subnetwork Connection parameter is 255 octets. Hence, the Call request/confirm PDU with the Fast Select facility should not exceed 255 octets.

COMMENTARY

> This reduces the number of transmissions required to setup the various layers. Refer to the Aeronautical Telecommunication Network (ATN) SARPs (ICAO Doc 9705), Chapter 11.

The Fast Select facility should not be used for link hand-off within the same air/ground router (as identified by its VSDA) because peer to peer router context did not change.

8.4 Call Maintenance

All virtual connections between aircraft and the ground systems should be maintained through ground station handoffs. A new Virtual Circuit (VC) should be established (explicit or expedited) with the link handoff. All downlinks should be transmitted on the newly established VC. The old VC should be terminated along with the link termination due to the expiration of the TG5 timer.

8.4.1 Call Redirection for X.121 Based Networks

If the ground network supports X.121 addressing, then the aircraft should generate the new Call Request for Handoff with the X.121 address of the specific air/ground router in the Called Address field. If the addressed air/ground router is not reachable from the ground station, the ground system should redirect the call to a different air/ground router DTE and inform the aircraft about the call redirection using the Called Line Address Modification Notification (CLAM) facility as specified in the VDL SARPs Section 6.6.6.3.3. On receipt of the CLAM facility, the aircraft should initiate route discovery and initiation procedures by sending the ISH PDU.

COMMENTARY

> This is necessary because the physical air/ground router entity may have changed and the new router may not be able to access the routing databases of the old air/ground router.

Call redirection should only be used in case of ground network failures as it introduces additional overhead to the RF due to route initiation.

8.5 Call Switching Within Same Routing Domain

There should be one LME per ground system.

A Call_request packet should be initiated to the same air/ground router (as defined by its VSDA). The SNDCF should maintain the Local Reference (LREF) tables across the new and the old VCs as they connect the same Data Terminal Equipment (DTE) address pairs.

The old VC should be torn down when the corresponding link is removed due to TG5 expiration.

8.6 Call Clearing

An aircraft DTE or ground DTE should send a CLEAR REQUEST, RESET REQUEST, or RESTART REQUEST packet only for recovery from a DTE failure. When an aircraft DTE or ground DTE receives a packet with a bad sequence number, it should transmit a REJECT, as specified in ISO 8208, Section 13.4.

8.0 SUBNETWORK LAYER SPECIFICATION

8.7 Priority (QOS)

Priority is not supported by VDLM2 at this time.

8.8 DTE Addressing

VDL SARPs supports two addressing options at the subnetwork layer. The default addressing is called VSDA and should be supported by all VDL entities. Optionally, VDL SARPs supports X.121 addressing. The VSDA consists of six octets. The first three octets of VSDA should be the same as the ATN Administration Domain Identifier (ADM) field as defined in the ATN SARPs. The second three octets of VSDA should be assigned by the DSP. The DSP may use these three octets to uniquely address an air/ground router or may use them as a routing area identifier (same as the ATN ARS field specified in the ATN SARPs). If the VSDA assigned by the DSP does not uniquely identify a specific air/ground router, then the ground system should support X.121 addressing option. The following paragraphs describe the DTE addressing algorithm:

> IF AVLC_Specific_Option indicates ground support of X.121 address THEN
>
> ATN Router NET parameter should be as defined in the ICAO Doc 9705 (ATN SARPs)
>
> If AVLC_Specific_Option indicates ground support of X.121 address, then NET parameter may also be configured as uniquely identifying each air-ground router.
>
> ELSE /* ground does not support X.121 address */NET Parameter identifies an air-ground router

8.9 PICS

VDLM2 subnetwork PICS are provided in Attachment 3.

9.0 LINK MANAGEMENT ENTITY (LME) SPECIFICATION

9.1 Introduction

The Link management function used for VHF air-ground link is referred to formally as LME/VME. It should conform to VDL SARPS Section 6.5.4.

For multiple radios the CMU tunes each radio to the frequency of each DSP. This frequency may be the CSC or any frequency provided by the ACARS squitter. Data link operation using multiple radios is out of scope for this version of this specification.

9.2 Initial Frequency Acquisition

VDL SARPs Section 6.5.4.4.1 on Frequency Search should be implemented.

The CMU should tune the radio to a frequency as defined below:

a. Common Signaling Channel (CSC)

b. A frequency which is supplied by the ACARS squitter

c. A frequency obtained from the Owner Preference Table.

For each DSP that announces its services via GSIFs the VME should build a Peer Entity Contact Table (PECT). Relevant PECT entries should be updated on each subsequent GSIF or uplink received from any DSP.

9.3 Link Establishment

For the Expedited Link Establishment see Section 4.2.1.

9.4 Link Maintenance

See Section 4.2.1 for more details on the Link maintenance.

9.4.1 Hand-Off

The aircraft should have only one VDLM2 link with a ground system at any time, except for the duration of the TG5 timer (i.e., during handoff within the same ground system).

When the aircraft transitions from an existing ground station to the new ground station and both ground stations belong to the same ground systems (Identified by the same VDL_SysID) the aircraft should send XID_CMD_HO to the new ground station. XID_CMD_LE should not be sent by the aircraft in this case.

When the aircraft transitions from an existing ground station to the new ground station and the two ground stations belong to two different ground systems (Identified by two different VDL_SysID's) the aircraft should send an XID_CMD_LE to the new ground station (XID_CMD_HO should not be sent by the aircraft in this case).

There is no coupling between the Link layer level handoff and IS-SME level Handoff Event. This means ISH PDU and Call Request/Call Confirm packet can be sent in an XID_CMD_HO/XID_RSP_HO to perform route initiations (IS-SME route initiation (as defined in the ATN ICS SARPs) is performed as a result of IS-SME receiving a Join Event from the subnetwork (i.e., SN-SME)) when expedited subnetwork connection establishment is supported with VDL link handoff.

From the definitions stated above, an aircraft crossing, within a same Ground System, two Ground Stations connected to different VSDA (whether ground system supports X.121 addressing or not) should send a handoff (XID_CMD_HO) to the new ground station. In this case, a ISH PDU should be included into the call request in order to ensure proper route initiation and exchange of configuration information.

See Section 4.2.1 for additional details on link handoff.

9.4.1.1 New Call Per Hand-Off

Every time a handoff is to be implemented the Call_request packet should be generated from the aircraft to the GS and the ground should respond with a Call_confirm packet.

For expedited, ground initiated handoffs, the XID_CMD_HO from the ground station should not contain the Call Request PDU. It should be included in the downlink XID_RSP_HO from the aircraft.

9.5 Ground Station Selection

Selection of the ground station should be based on the uplink Signal Quality Parameter reported by the VDR. Any other information (such as aircraft position, preferred DSP, etc) can be incorporated in the GS selection algorithm to satisfy customer preferences and to improve the integrity of the algorithm.

9.6 Parameter Negotiation

All entities operating in VDLM2 should support all parameter ranges specified in the VDLM2 SARPs Table 6-51. It is recommended that both avionics and ground stations use the default values specified in the SARPs Tables 6-10, 6-26, and 6-50.

9.7 ATN Router NET Parameter

The ATN Router NET parameter should contain one or more VSDAs reachable from the ground station broadcasting the GSIF. See Section 8.8 for a description of this parameter.

Each ground station should periodically broadcast the VSDAs of all air/ground routers reachable through it. The VSDAs should be included in the ATN Router NET Parameter of the GSIF. The ground system should ensure that only current and up to date information is contained in the GSIF.

If a Ground System advertises multiple VDL Specific DTE Addresses (VSDAs) in the GSIF, then the GSIF should contain:

a. Exactly the same VSDA from Ground Station to Ground Station within that Ground System as identified by its VDL_SysID (e.g.: Ground Station #1 advertises VSDA #1 and VSDA #2 while Ground Station #2 also advertises VSDA #1 and VSDA #2);

9.0 LINK MANAGEMENT ENTITY (LME) SPECIFICATION

b. Mutually exclusive VSDAs from Ground Station to Ground Station within that Ground System as identified by its VDL_SysID (e.g.: Ground Station #1 advertises VSDA #1 and VSDA #2 while Ground Station #2 advertises VSDA #3 and VSDA #4);

c. A combination of exclusive and shared VSDAs from Ground Station to Ground Station within that Ground System as identified by its VDL_SysID (e.g.: Ground Station #1 advertises VSDA #1 and VSDA #2 while Ground Station #2 advertises VSDA #1, VSDA #2 and VSDA #3).

The VDL ground stations allow the aircraft to establish connections to terrestrial air-ground routers that are parts of a wider ATN network of routers and systems. The aircraft relies on the router to which it establishes a connection to provide Aeronautical Internet services and move its traffic to the intended destination systems. Service providers, states and users are responsible for ensuring that the proper routing and quality of service is provided for the delivery of the data.

COMMENTARY

The aircraft will need to consider it's routing requirements, connectivity needs and the identity of the ground system to which the ground stations belong to manage its air-ground links and connections appropriately.

9.8 Frequency Management/Auto-Tune

All VDLM2 systems should support the CSC as specified in the VDL SARPs Section 6.1.2.3.

If a frequency support list is provided in an uplink XID (GSIF or other XIDs), the aircraft should attempt all the available frequencies to establish and maintain communications with peer ground systems using procedures defined in the VDL SARPs.

A ground system may command an aircraft to switch to an alternate frequency by sending a "ground requested, air-initiated handoff" command as per VDL SARPs Section 6.5.4.4.9. This uplink should contain the autotune and the replacement ground station list parameters. If the aircraft can not support the autotune, it should send an XID_CMD_LCR (P = 0) as per VDL SARPs Section 6.5.4.4.4.3. The current link on the current frequency should remain unaffected.

When a DSP requests an autotune, the parameters and the set of VSDA's reachable through the original ground station should be maintained for each station in the replacement ground station list associated with the autotune.

COMMENTARY

During frequency search operations, the airborne VME may wait until expiration of TG1 before selecting a Provider/Ground Station to connect to, or select it more quickly if GSIFs from a suitable provider (based on airline preferences) are received before expiration TG1. Other options are also allowed by the SARPs. Designers should bear in mind that waiting for expiration of TG1 before selecting a provider may lead to an extensive period of NO-COMM.

Upon frequency change following autotune command, in order to ensure service continuity, it is recommended that the airborne VME/LME does not wait for collection of valid uplink on the new frequency, but anticipates and selects a Ground Station using the "Ground Station Replacement list" of the autotune command.

9.9 PECT Maintenance

The VME/LME should update the Peer Entity Contact Table (PECT) based on each uplink received. The PECT should contain a list of ground stations that are available from the aircraft. The PECT should also contain the DSP ID, NET, SQP, and other GS specific VDLM2 parameters. The GS entry from PECT should be removed when a GS becomes unavailable after timer TG2 expires.

10.0 EXTERNAL INTERFACES

10.1 Introduction

10.2 VDLM2 to System Management Interface

The VDLM2 to ATN System Management Interface defines the subnetwork connectivity information to be exchanged between the VDL Management Entity (VME) and the Subnetwork System Management Entity (SN-SME).

The SN-SME is responsible for making the selection of the ground systems used for VDLM2 connectivity and for generating the corresponding ATN Join, Hand-off and Leave Events expected by the ATN Intermediate System – System Management Entity (IS-SME).

The VDLM2 to ATN interface consists of the following:

10.2.1 Service Available Indication

A Service Available Indication should be generated by the VME and forwarded to the SN-SME whenever availability of a new ground system is detected upon receipt of a GSIF. The new ground system may be denoted by a new DSP ID, determined using a ground system mask parameter, or a new VDL Specific DTE Address parameter. The VME should forward the Service Available Indication to the SN-SME function.

The Service Available Indication event should convey the DSP ID and the list of newly reachable VDL specific DTE Addresses.

COMMENTARY

> The processing by the SN-SME of the Service Available Indication may result in one or more ATN Join events being generated and forwarded to the IS-SME function.
>
> The SN-SME updates the routing entry and may use the Service Available Indication in determining which ground system should be used for future VDLM2 connection.

10.2.2 Service Unavailable Indication

The Service Unavailable Indication should be sent from the VME to the ATN entity (SN-SME) whenever one or more VSDAs or ground systems are no longer reachable. A VDL specific Address is no longer reachable when all ground stations within a ground system providing connectivity to that VSDA are removed from the PECT. The Service Unavailable Indication should convey the DSP ID and the VDL Specific DTE Address parameter(s).

COMMENTARY

> The processing by the SN-SME of the Service Unavailable Indication may result in one or more ATN Leave events being generated by the SN-SME and forwarded to the IS-SME function. The S-SME removes the routing entry (entries) associated with that DSP ID and VDL Specific DTE Address.

10.2.3 Ground Station Switch Indication

VDLM2 is unique whereby the point-to-point link and virtual connection between the aircraft and the ground system is maintained in a mobile, line-of-sight environment. As the aircraft moves from the RF coverage region of one ground station to another, the logical connections are handed off dynamically across ground stations while maintaining the upper layer protocol relationships.

To initiate the handoff, a ground Station Switch Indication should be sent from the VME to the ATN entity (SN-SME). The Ground Station Switch Indication should contain the DSP ID and the VSDA of the peer ground system that is being handed off.

COMMENTARY

> The processing by the SN-SME of the Ground Station Switch Indication may result in one or more ATN Hand-off and/or Leave followed by Join events being generated and forwarded to the IS-SME function. On receipt of the handoff event, the ATN entity (IS-SME) generates a call request for the DTE address of the air-ground router which was identified by the DSP ID and the VSDA parameters provided by the VME in the handoff event.
>
> The ATN entity (IS-SME) should not initiate the routing exchange process for an ATN handoff as the routing relationship with the peer router does not change as a result of an ATN handoff.

The subnetwork (ISO 8208) function of the VDLM2 receives the resulting call request from the MSNDCF via the standard interface specified in Section 10.3. The VDLM2 subnetwork function should create a Call Request PDU for handoff containing either the VSDA or the X.121 address of the destination DTE address. The VSDA should be contained in the Called Address Extension facility. On the other hand the X.121 DTE address should be placed in the "Called Address" field.

10.2.4 Ground Station Switch Reject

The ground station switch reject primitive should be sent from the SN-SME to the VME to reject the handoff if the handoff can not be supported by the upper layers due to policy or some other local reasons. The reject primitive should include the DSP ID and the VSDA of the ground router that is being rejected.

10.2.5 VDL Service Startup Request

During the transition phase of the VHF service an aircraft may be equipped to operate on either ACARS or the VDL mode. The VDL Service Startup Request primitive should be sent by the SN-SME to the VME to initialize the VDL service and to transfer the control of the VDR to VDL function. The Service Startup Request primitive may optionally contain a default VDL frequency that should be used by the VDL function to initially detect a preferred DSP.

10.0 EXTERNAL INTERFACES

10.2.6 VDL Service Shutdown Request

The VDL Service Shutdown Request should be sent from the SN-SME to the VME to shutdown the VDL functions. On receipt of this primitive, the VME should ensure that all VDL functionality has been deactivated and control of the VDR should be transferred back to the SN-SME.

COMMENTARY

> This capability enables an aircraft to switch operational VHF mode to ACARS during the transition phase whenever the VDL ground coverage is not available.

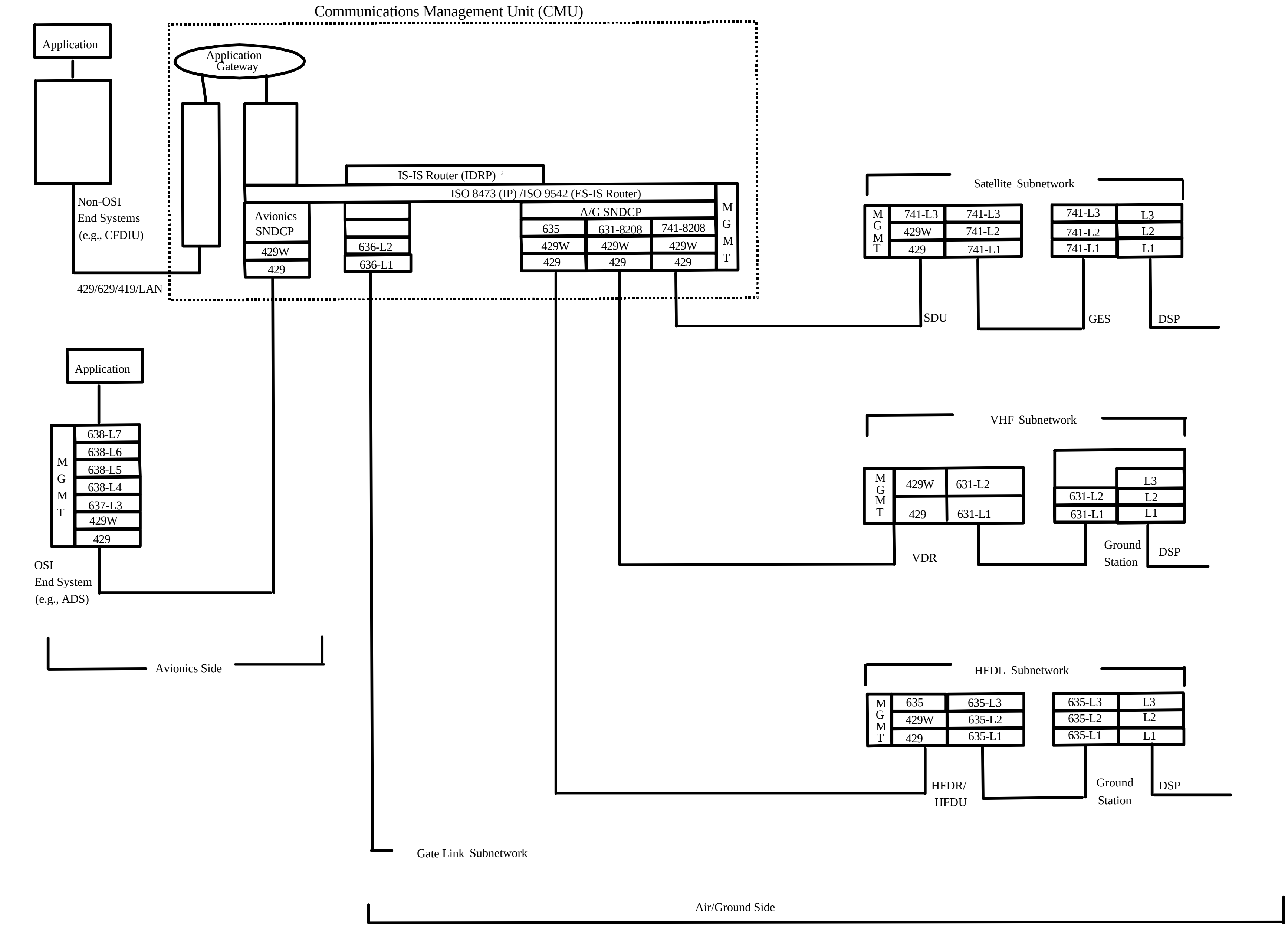
10.3 SNAcP to SNDCF Interface

The interface between the subnetwork access protocol (VDLM2 8208) and the mobile SNDCF should comply with the ATN SARPs and the ISO 8473-3 specifications.

10.4 VDLM2 CMU to VDR Interface

The CMU to VDR interface is defined in ARINC Characteristic 750-3, Attachment 10.

ATTACHMENT 1
GENERIC OSI NETWORK ARCHITECTURE



NOTES:

1. This figure also appears in other ARINC standards. Due to non-synchronous update of ARINC standards, differences in this figure between standards may arise. In all cases, the figure with the most recent date (see lower left hand corner) should have precedence.
2. Early air-ground links are not likely to support IDRP. IDRP is optional for air-ground links.

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ATTACHMENT 2
DATA LINK LAYER PICS

The following Protocol Implementation Conformance Statements (PICS) have been selected for the implementation of VDL Mode 2.

In the tables that follow, capability definitions and support alternatives are consistent with VDL SARPs definitions. The use of terms such as “shall” and “mandatory” are used herein for consistency with the VDL SARPs and only imply the provisions are necessary to achieve interoperability.

Convention:
The PICSs provided in this document use the following convention and symbols:

M	Mandatory - the capability is to be supported
O	Optional - The capability may optionally be supported
X	Prohibited/precluded i.e. the capability is not to be supported.
R	Recommended, but not required.
NR	Not Recommended
^	Negation
N/A	Not Applicable
*	This represents a deviation from the VDL SARPs
:	Conditional requirement

Notes that are specific to each table are included immediately following the table.

Scope:
The PICS defined herein cover the following VDL protocols: MAC, VME, LME, and DLS. The PICS for the subnetwork protocol (ISO 8208) are contained in Attachment 3.

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-1 General Capabilities

Item	Capabilities	VDL SARPS Reference	Ground Station Support	Aircraft Support
DLS-conn	Does the DLS sublayer support connection-oriented data link services?	6.5.1.2.1	M	M
DLS-cnls	Does the DLS sublayer support unacknowledged connectionless broadcast services?	6.5.1.2.2	X	X
MAC-csma	Does the MAC sublayer support non-adaptive p-persistent CSMA?	6.5.2.2.1	M	M
MAC-cong	Does the MAC sublayer support congestion management?	6.5.2.2.2	M	M
DLS-seq	Does the DLS sublayer support frame sequencing?	6.5.3.2.1	M	M
DLS-fcs	Does the DLS sublayer support error detection?	6.5.3.2.2	M	M
DLS-addr1	Does the DLS sublayer support individual station address?	6.5.3.2.3	M	M
DLS-addr2	Does the DLS sublayer support broadcast address?	6.5.3.2.4	O	O
DLS-data1	Does the DLS sublayer support data transfer using INFO and XID frames?	6.5.3.2.5	M	M
DLS-data2	Does the DLS sublayer support data transfer using UI frames?	6.5.3.11.5	X	X
DLS-collis	Does the DLS sublayer support unnumbered command frame collision resolution?	6.5.3.8	M	M

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-1-2 Cooperative Channel Utilization

Item	Capabilities	VDL SARPS Reference	Ground Station Support	Aircraft Support
CO-MACpers	The aircraft shall use the MAC persistence parameter as suggested by the ground station in the XID_CMD_LPM.	6.5.4.2.6.4, Table 6-34	N/A	M
CO-n1-dn	The aircraft shall use the N1-downlink parameter for downlink frames as suggested by the ground station in the GSIF.	6.5.3.4.5	N/A	M
CO-n1-up	The aircraft shall use the N1-uplink parameter to process uplink frames as suggested by the ground station in the GSIF.	6.5.3.4.5	N/A	M
CO-n2	The aircraft shall use the N2 parameter to control the number of frame retransmission as suggested by the ground station in the GSIF.	6.5.3.4.6	N/A	M
CO-t2	The aircraft shall use t2 parameter to control the retransmissions of frames as suggested by the ground station in the GSIF.	6.5.3.4.2	N/A	M
CO-k-dn	The aircraft shall use the k-downlink parameter to flow control the transmissions of downlink frames as suggested by the ground station in the GSIF.	6.5.3.4.7	N/A	M
CO-k-up	The aircraft shall use the k-uplink parameter to flow control the receptions of uplink frames as suggested by the ground station in the GSIF.	6.5.3.4.7	N/A	M
CO-m1	The aircraft shall use the M1 parameter for channel access as suggested by the ground station in the XID_CMD_LPM.	6.5.4.2.6.5	N/A	M
CO-tm2	The aircraft shall use the TM2 timer as suggested by the ground station in the XID_CMD_LPM.	6.5.4.2.6.6	N/A	M
CO-tg5	The aircraft shall use the TG5 timer as suggested by the ground station in the XID_CMD_LPM.	6.5.4.2.6.7	N/A	M
CO-t4	The aircraft shall use the T4 timer as suggested by the ground station in the XID_CMD_LPM.	6.5.4.2.6.3	N/A	M
CO-repl	The aircraft shall use the ground station addresses in the Replacement Ground Station list for handoffs, in the order of preference suggested by the ground station in the uplinked XID_RSP_LE, XID_CMD_HO, and XID_RSP_HO.	6.5.4.2.6.2	N/A	O
CO-addrfilter	The aircraft shall use Ground Station Address Filter parameter as suggested by the ground station in the XID_CMD_HO (P=0) – ground requested broadcast.	6.5.4.2.6.9	N/A	M
CO-brdconn	The aircraft shall use Broadcast Connection parameter as suggested by the ground station in the XID_CMD_HO (P=0) – ground requested broadcast.	6.5.4.2.6.10	N/A	O
CO-t3min	The aircraft shall use the t3min parameter as suggested by the ground station in the XID_CMD_HO (P=0), XID_RSP_LE, and XID_RSP_HO.	6.5.4.2.6.8	N/A	M
CO-tune	The aircraft shall use the frequency and modulation scheme as suggested by the ground station in the uplinked XID_RSP_LE, XID_RSP_HO, and XID_CMD_HO.	6.5.4.2.6.1	N/A	O

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-1-3 Link Establishment and Handoff

Item	Capabilities	VDL SARPS Reference	Ground Station Support	Aircraft Support
HO-ai	Does the VDL station support aircraft-initiated handoff?	6.5.4.4.6	M	M
HO-argi	Does the VDL station support aircraft-requested ground-initiated handoff?	6.5.4.4.7	X	X
HO-gi	Does the VDL station support ground-initiated handoff?	6.5.4.4.8	O,R	M
HO-grai	Does the VDL station support ground-requested aircraft-initiated handoff?	6.5.4.4.9	O,R	O,R
HO-tune	Does the VDL station support ground-commanded autotune?	6.5.4.4.11	O,R	O,R
LE-exped1	Does the VDL station support expedited subnetwork connection establishment?	6.5.4.2.4.2, 6.5.4.4.12, 6.6.6.3.2.2, 6.6.6.3.3.2	O,R	O,R
LE-explicit	Does the VDL station support explicit subnetwork connection establishment?	6.6.6.3.2.1, 6.6.6.3.3.1	M	M
LE-exped2	If the GSIF indicates that a ground station does not support expedited subnetwork connection establishment, the aircraft should not initiate link establishment with this ground station using expedited subnetwork connection establishment.	6.5.4.4.12	N/A	M
HO-grb	Does the VDL station support ground-requested broadcast handoffs?	6.5.4.4.10	O	O
HO-bl	Does the VDL station support broadcast link handoff?	6.5.4.4.10	O	O
HO-bs	Does the VDL station support broadcast subnetwork handoff?	6.5.4.4.10	O	O
DTE-x.121	Does the ground station support ground network DTE X.121 address received in the Called Address field of an aircraft initiated CALL REQUEST packet?	Table 6-21	O	N/A
LPM	Does the VDL station support link parameter modification?	6.5.4.4.5	O	M
HO-tg5	Link overlap timer.	6.5.4.3.5, 6.5.4.4.6.6, 6.5.4.4.8.3	M	M
	Does the VDL station support GSIF frames	6.5.4.4.3		
GSIF.s	Transmit		M	N/A
GSIF.r	Receive and process		N/A	M

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-1-4 AVLC Frames

The VDL protocol entity should be able to send and receive the following frames.

Item	Frame	VDL SARPS Reference	Ground Station Support	Aircraft Support
	INFO (Information)			
INFO-cmd	Sent and received as command?	6.5.3.7.2	M	M
INFO-rsp	Sent and received as response?	6.5.3.11.2	M	M
	RR (Receive Ready)			
RR-cmd	Sent and received as command?	6.5.3.7.2	M	M
RR-rsp	Sent and received as response?		M	M
	XID (Exchange Identity)			
XID-cmd	Sent and received as command?	6.5.3.9	M	M
XID-rsp	Sent and received as response?		M	M
	TEST	6.5.3.11.6		
TEST-cmd	Sent and received as command?		O	O
TEST-rsp	Sent and received as response?		O,R	O,R
	SREJ (Selective Reject)			
SREJ-cmd	Sent and received as command?	6.5.3.4.4	M	M
SREJ-rsp	Sent and received as response?	6.5.3.11.2	M	M
	FRMR (Frame Reject)	6.5.3.4.4,		
FRMR-cmd	Sent and received as command?	6.5.3.11.3	M	M
	UI (Unnumbered INFO)			
UI-cmd	Sent and received as command?	6.5.3.11.5	X	X
	UA (Unnumbered Acknowledge)			
UA-rsp	Sent and received as response?	6.5.3.11.4	M	M
	DISC (Disconnect)			
DISC-cmd	Sent and received as command (P=0)?	6.5.3.6.2.1	M	M
	DM (Disconnected mode)			
DM-rsp	Sent and received as response (F=0)?	6.5.3.6.2.2	M	M

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-2 Parameters

Tables 2-2-1 through 2-2-12 define the provisions for the sending station to include certain parameters in an XID frame. It also defines the requirements on the receiving station to process these parameters when they are included in the received XID frame. Therefore, for each parameter, there is a provision for inclusion by the sender and a provision for processing by the receiver.

Table 2-2-1 Uplink GSIF (P = 0)

This frame is sent by each ground station to all aircraft. The parameters that can be included in the GSIF frame are listed in VDL SARPs Table 6 -51a.

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
Public Parameters [1]				
GSIF.puid	Public parameter set ID	6.5.4.2.2	M	M
GSIF.class	Procedure classes [2]	Table 6-51a	M	M
GSIF.hdlc	HDLC options	6.5.4.2.2.1, Table 6-11	M	M
GSIF.n1dn	N1- downlink (max number of bits in a frame)	6.5.3.4.5	O	M
GSIF.n1up	N1- uplink	6.5.3.4.5	O	M
GSIF.kdn	K - downlink (window size)	6.5.3.4.7	O	M
GSIF.kup	k- uplink	6.5.3.4.7	O	M
GSIF.t1	Timer T1- downlink (retransmission timer)	6.5.3.4.1	O	M
GSIF.n2	Counter N2 (max number of retransmissions)	6.5.3.4.6	O	M
GSIF.t2	Timer T2 (max delay before sending ACK)	6.5.3.4.2	O	M
Private Parameters				
GSIF.prid	Private parameter set ID	6.5.4.2.3, Table 6-14	M	M
GSIF.avlc	AVLC specific options	6.5.4.2.4.5, Tables 6-20, 6-21	M	M
GSIF.t4	Timer T4 (max delay between transmissions; also, max delay between receptions)	6.5.3.4.4, Table 6-33	O	M
GSIF.persist	MAC persistence	6.5.2.3.3, Table 6-34	O	M
GSIF.m1	Counter M1 (max number of access attempts)	6.5.2.3.4, Table 6-35	O	M
GSIF.tm2	Timer TM2 (max time MAC waits after receiving RTS)	6.5.2.3.2, Table 6-36	O	M
GSIF.tg5	Timer TG5 (max time for link overlap)	6.5.4.3.5, Table 6-37	O	M
GSIF.t3min	Timer T3min (T3: max time to wait for XID_RSP_LE)	6.5.4.3.3, 6.5.4.2.4.8	O	M
GSIF.freq	Frequency support	6.5.4.2.7.1, Table 6-42	O	M
GSIF.cover	Airport coverage	6.5.4.2.7.2, Table 6-43	M [3]	M
GSIF.near	Nearest airport ID	6.5.4.2.7.3, Table 6-44	M [3]	M
GSIF.net	ATN router NETs	6.5.4.2.7.4, Table 6-45	M	M
GSIF.mask	System mask	6.5.4.2.7.5, Table 6-46	M	M
GSIF.tg3	TG3 (max time between ground station transmissions)	6.5.4.2.7.6, Table 6-47	O,NR	O
GSIF.tg4	TG4 (max time between GSIF transmissions)	6.5.4.2.7.7, Table 6-48	O,NR	O
GSIF.loc	Ground station location	6.5.4.2.7.8, Table 6-49	M	O,R

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Notes:

[1] Encoding of XID public parameters are defined in ISO 8885:1993.

[2] Encoding of procedure class is defined in ISO 8885:1993. The parameter value for AVLC should be "ABM".

[3] It is mandatory to include either the Airport Coverage parameter or the Nearest Airport parameter, but not both.

[4] If the parameter is marked O and it is not included, its default value (as defined in VDL SARPs) is assumed.

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-2-2 Air-Initiated Link Establishment (Command)

Downlink XID_CMD_LE (P=1)

This command is sent by the aircraft to the proposed ground station.

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
Public Parameters				
CMD_LE.puid	Public parameter set ID	6.5.4.2.2	M	M
CMD_LE.clss	Procedure classes	Table 6-51a	M	M
CMD_LE.hdlc	HDLC options	6.5.4.2.2.1, Table 6-11	M	M
Private Parameters				
CMD_LE.prid	Private parameter set ID	6.5.4.2.3, Table 6-14	M	M
CMD_LE.mgt	Connection management	6.5.4.2.4.2, Tables 6-15, 6-16	M	M
CMD_LE.sqp	SQP	6.5.4.2.4.3, Table 6-18	O	O
CMD_LE.seq	XID sequencing	6.5.4.2.4.4, Table 6-19	M	M
CMD_LE.avlc	AVLC specific options	6.5.4.2.4.5, Tables 6-20, 6-21	M	M
CMD_LE.exp	Expedited SN connection	6.5.4.2.4.6, Table 6-22	O	O
CMD_LE.mod	Modulation support	6.5.4.2.5.1, Table 6-25	M	M
CMD_LE.gs	Alternate ground stations	6.5.4.2.5.1.2, Table 6-27	O	O
CMD_LE.dest	Destination airport	6.5.4.2.5.3, Table 6-28	O	O
CMD_LE.loc	Aircraft location	6.5.4.2.5.4, Tables 6-29, 6-30	O,R	O,R

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-2-3 Air-Initiated Link Establishment (Response)

Uplink XID_RSP_LE (F=1)

This response is sent by the new ground station to the aircraft.

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
Public Parameters				
RSP_LE.puid	Public parameter set ID	6.5.4.2.2	M	M
RSP_LE.clss	Procedure classes	Table 6-51a	M	M
RSP_LE.hdlc	HDLC options	6.5.4.2.2.1, Table 6-11	M	M
RSP_LE.n1dn	N1- downlink	6.5.3.4.5	O	M
RSP_LE.n1up	N1 - uplink	6.5.3.4.5	O	M
RSP_LE.kdn	K - downlink	6.5.3.4.7	O	M
RSP_LE.kup	K - uplink	6.5.3.4.7	O	M
RSP_LE.t1dn	Timer T1 – downlink [1]	6.5.3.4.1	O	M
RSP_LE.n2	Counter N2	6.5.3.4.6	O	M
RSP_LE.t2	Timer T2	6.5.3.4.2	O	M
Private Parameters				
RSP_LE.prid	Private parameter set ID	6.5.4.2.3, Table 6-14	M	M
RSP_LE.mgt	Connection management	6.5.4.2.4.2, Tables 6-15, 6-16	M	M
RSP_LE.sqp	SQP	6.5.4.2.4.3, Table 6-18	O	O
RSP_LE.seq	XID sequencing	6.5.4.2.4.4, Table 6-19	M	M
RSP_LE.avlc	AVLC specific options	6.5.4.2.4.5, Tables 6-20, 6-21	M	M
RSP_LE.exp	Expedited SN connection	6.5.4.2.4.6, Table 6-22	O	O,R
RSP_LE.tune	Autotune frequency	6.5.4.2.6.1, Table 6-31	O	M [2]
RSP_LE.gs	Replacement ground station	6.5.4.2.6.2, Table 6-32	O	O
RSP_LE.t4	Timer T4	6.5.3.4.4, Table 6-33	O	M
RSP_LE.pers	MAC persistence	6.5.2.3.3, Table 6-34	O	M
RSP_LE.m1	Counter M1	6.5.2.3.4, Table 6-35	O	M
RSP_LE.tm2	Timer TM2	6.5.2.3.2, Table 6-36	O	M
RSP_LE.tg5	Timer TG5	6.5.4.3.5, Table 6-37	O	M
RSP_LE.t3min	Timer T3min	6.5.4.3.3, 6.5.4.2.4.8	O	M
RSP_LE.freq	Frequency support	6.5.4.2.7.1, Table 6-42	O	O
RSP_LE.cover	Airport coverage	6.5.4.2.7.2, Table 6-43	O [3]	O
RSP_LE.near	Nearest airport ID	6.5.4.2.7.3, Table 6-44	O [3]	O
RSP_LE.net	ATN router NETs	6.5.4.2.7.4, Table 6-45	M	M
RSP_LE.mask	System mask	6.5.4.2.7.5, Table 6-46	M	M
RSP_LE.tg3	TG3	6.5.4.2.7.6, Table 6-47	O,NR	O
RSP_LE.tg4	TG4	6.5.4.2.7.7, Table 6-48	O,NR	O
RSP_LE.loc	Ground station location	6.5.4.2.7.8, Table 6-49	O,R	O,R

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Notes:

[1] Service providers should be aware that systems architectures may result in a round trip AVLC "ACK" latency that can exceed the default T1 minimum calculation.

[2] Aircraft is required to process the autotune parameter, but is not required to support the autotune capability.

[3] It is optional to include either the Airport Coverage Indication parameter or the Nearest Airport Identifier parameter, or neither, but not both.

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-2-4 Link Parameter Modification (Command)

Uplink XID_CMD_LPM (P=1)

This command is sent by the current ground station to the aircraft.

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
Private Parameters				
CMD-LPM.prid	Private parameter set ID	6.5.4.2.3, Table 6-14	M	M
CMD-LPM.sqp	SQP	6.5.4.2.4.3, Table 6-18	O	O
CMD-LPM.seq	XID sequencing	6.5.4.2.4.4, Table 6-19	M	M
CMD-LPM.t4	Timer T4	6.5.3.4.4, Table 6-33	O	M
CMD-LPM.pers	MAC persistence	6.5.2.3.3, Table 6-34	O	M
CMD-LPM.m1	Counter M1	6.5.2.3.4, Table 6-35	O	M
CMD-LPM.tm2	Timer TM2	6.5.2.3.2, Table 6-36	O	M
CMD-LPM.tg5	Timer TG5	6.5.4.3.5, Table 6-37	O	M

Table 2-2-5 Link Parameter Modification (Response)

Downlink XID_RSP_LPM (F=1)

This response is sent by the aircraft to the current ground station.

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
Private Parameters				
RSP_LPM.prid	Private parameter set ID	6.5.4.2.3, Table 6-14	M	M
RSP_LPM.sqp	SQP	6.5.4.2.4.3, Table 6-18	O	O
RSP_LPM.seq	XID sequencing	6.5.4.2.4.4, Table 6-19	M	M

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-2-6 Ground-Initiated Handoff (Command)

Uplink XID_CMD_HO (P=1)

This command is sent by the proposed ground station to the aircraft when the handoff is ground initiated.

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
Public Parameters				
GCMD_HO.puid	Public parameter set ID	6.5.4.2.2	M*	M
GCMD_HO.clss	Procedure classes	Table 6-51a	M*	M
GCMD_HO.hdlc	HDLC options	6.5.4.2.2.1, Table 6-11	M*	M
GCMD_HO.n1dn	N1-downlink	6.5.3.4.5	O	M
GCMD_HO.n1up	N1-uplink	6.5.3.4.5	O	M
GCMD_HO.kdn	k-downlink	6.5.3.4.7	O	M
GCMD_HO.kup	k-uplink	6.5.3.4.7	O	M
GCMD_HO.t1dn	Timer T1 –downlink [1]	6.5.3.4.1	O	M
GCMD_HO.n2	Counter N2	6.5.3.4.6	O	M
GCMD_HO.t2	Timer T2	6.5.3.4.2	O	M
Private Parameters				
GCMD_HO.prid	Private parameter set ID	6.5.4.2.3, Table 6-14	M	M
GCMD_HO.mgt	Connection management	6.5.4.2.4.2, Tables 6-15, 6-16	M	M
GCMD_HO.sqp	SQP	6.5.4.2.4.3, Table 6-18	O	O
GCMD_HO.seq	XID sequencing	6.5.4.2.4.4, Table 6-19	M	M
GCMD_HO.avlc	AVLC specific options	6.5.4.2.4.5, Tables 6-20, 6-21	O	M
GCMD_HO.exp	Expedited SN connection	6.5.4.2.4.6, Table 6-22	X	X
GCMD_HO.gs	Replacement ground station	6.5.4.2.6.2, Table 6-32	O	O
GCMD_HO.t4	Timer T4	6.5.3.4.4, Table 6-33	O	M
GCMD_HO.pers	MAC persistence	6.5.2.3.3, Table 6-34	O	M
GCMD_HO.m1	Counter M1	6.5.2.3.4, Table 6-35	O	M
GCMD_HO.tm2	Timer TM2	6.5.2.3.2, Table 6-36	O	M
GCMD_HO.tg5	Timer TG5	6.5.4.3.5, Table 6-37	O	M
GCMD_HO.t3min	Timer T3min	6.5.4.3.3, 6.5.4.2.4.8	O	M
GCMD_HO.freq	Frequency support	6.5.4.2.7.1, Table 6-42	O	O
GCMD_HO.cover	Airport coverage	6.5.4.2.7.2, Table 6-43	O [2]	O
GCMD_HO.near	Nearest airport ID	6.5.4.2.7.3, Table 6-44	O [2]	O
GCMD_HO.net	ATN router NETs	6.5.4.2.7.4, Table 6-45	M	M
GCMD_HO.mask	System mask	6.5.4.2.7.5, Table 6-46	M*	M
GCMD_HO.tg3	TG3	6.5.4.2.7.6, Table 6-47	O,NR	O
GCMD_HO.tg4	TG4	6.5.4.2.7.7, Table 6-48	O,NR	O
GCMD_HO.loc	Ground station location	6.5.4.2.7.8, Table 6-49	O,R	O,R

Notes:

[1] Service providers should be aware that systems architectures may result in a round trip AVLC "ACK" latency that can exceed the default T1 minimum calculation.

[2] It is optional to include either the Airport Coverage Indication parameter or the Nearest Airport Identifier parameter, or neither, but not both.

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-2-7 Ground Initiated Handoff (Response)

Downlink XID_RSP_HO (F=1)

This response is sent by the aircraft to the new ground station when the handoff is ground initiated.

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
Public Parameters				
GRSP_HO.puid	Public parameter set ID	6.5.4.2.2	M	M*
GRSP_HO.clss	Procedure classes	Table 6-51a	M	M*
GRSP_HO.hdlc	HDLC options	6.5.4.2.2.1, Table 6-11	M	M*
Private Parameters				
GRSP_HO.prid	Private parameter set ID	6.5.4.2.3, Table 6-14	M	M
GRSP_HO.mgt	Connection management	6.5.4.2.4.2, Tables 6-15, 6-16	M	M
GRSP_HO.sqp	SQP	6.5.4.2.4.3, Table 6-18	O	O
GRSP_HO.seq	XID sequencing	6.5.4.2.4.4, Table 6-19	M	M
GRSP_HO.avlc	AVLC specific options	6.5.4.2.4.5, Tables 6-20, 6-21	M	O
GRSP_HO.exp	Expedited SN connection	6.5.4.2.4.6, Table 6-22	O, R	O, R
GRSP_HO.dest	Destination airport	6.5.4.2.5.3, Table 6-28	O	O
GRSP_HO.loc	Aircraft location	6.5.4.2.5.4, Tables 6-29, 6-30	O	O

Table 2-2-8 Air-Initiated Handoff (Command)

Downlink XID_CMD_HO (P=1)

This command is sent by the aircraft to the proposed ground station when the handoff is aircraft initiated.

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
Public Parameters				
ACMD_HO.puid	Public parameter set ID	6.5.4.2.2	M	M*
ACMD_HO.clss	Procedure classes	Table 6-51a	M	M*
ACMD_HO.hdlc	HDLC options	6.5.4.2.2.1, Table 6-11	M	M*
Private Parameters				
ACMD_HO.prid	Private parameter set ID	6.5.4.2.3, Table 6-14	M	M
ACMD_HO.mgt	Connection management	6.5.4.2.4.2, Tables 6-15, 6-16	M	M
ACMD_HO.sqp	SQP	6.5.4.2.4.3, Table 6-18	O	O
ACMD_HO.seq	XID sequencing	6.5.4.2.4.4, Table 6-19	M	M
ACMD_HO.avlc	AVLC specific options	6.5.4.2.4.5, Tables 6-20, 6-21	M	O
ACMD_HO.exp	Expedited SN connection	6.5.4.2.4.6, Table 6-22	O,R	O,R
ACMD_HO.gs	Alternate ground stations	6.5.4.2.5.2, Table 6-27	O	O
ACMD_HO.dest	Destination airport	6.5.4.2.5.3, Table 6-28	O	O
ACMD_HO.loc	Aircraft location	6.5.4.2.5.4, Tables 6-29, 6-30	O	O

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-2-9 Air-Initiated Handoff (Response)

Uplink XID_RSP_HO (F=1)

This response is sent by the new ground station to the aircraft when the handoff is aircraft initiated.

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
Public Parameters				
ARSP_HO.puid	Public parameter set ID	6.5.4.2.2	M*	M
ARSP_HO.clss	Procedure classes	Table 6-51a	M*	M
ARSP_HO.hdlc	HDLC options	6.5.4.2.2.1, Table 6-11	M*	M
ARSP_HO.n1dn	N1-downlink	6.5.3.4.5	O	M
ARSP_HO.n1up	N1-uplink	6.5.3.4.5	O	M
ARSP_HO.kdn	k-downlink	6.5.3.4.7	O	M
ARSP_HO.kup	k-uplink	6.5.3.4.7	O	M
ARSP_HO.t1dn	Timer T1 – downlink [1]	6.5.3.4.1	O	M
ARSP_HO.n2	Counter N2	6.5.3.4.6	O	M
ARSP_HO.t2	Timer T2	6.5.3.4.2	O	M
Private Parameters				
ARSP_HO.prid	Private parameter set ID	6.5.4.2.3, Table 6-14	M	M
ARSP_HO.mgt	Connection management	6.5.4.2.4.2, Tables 6-15, 6-16	M	M
ARSP_HO.sqp	SQP	6.5.4.2.4.3, Table 6-18	O	O
ARSP_HO.seq	XID sequencing	6.5.4.2.4.4, Table 6-19	M	M
ARSP_HO.avlc	AVLC specific options	6.5.4.2.4.5, Tables 6-20, 6-21	O	O
ARSP_HO.exp	Expedited SN connection	6.5.4.2.4.6, Table 6-22	O, R	O, R
ARSP_HO.tune	Autotune frequency	6.5.4.2.6.1, Table 6-31	O	M
ARSP_HO.gs	Replacement ground station	6.5.4.2.6.2, Table 6-32	O	O
ARSP_HO.t4	Timer T4	6.5.3.4.4, Table 6-33	O	M
ARSP_HO.pers	MAC persistence	6.5.2.3.3, Table 6-34	O	M
ARSP_HO.m1	Counter M1	6.5.2.3.4, Table 6-35	O	M
ARSP_HO.tm2	Timer TM2	6.5.2.3.2, Table 6-36	O	M
ARSP_HO.tg5	Timer TG5	6.5.4.3.5, Table 6-37	O	M
ARSP_HO.t3min	Timer T3min	6.5.4.3.3, 6.5.4.2.4.8	O	M
ARSP_HO.freq	Frequency support	6.5.4.2.7.1, Table 6-42	O	O
ARSP_HO.cover	Airport coverage (list of airport identifiers)	6.5.4.2.7.2, Table 6-43	O [2]	O
ARSP_HO.near	Nearest airport ID	6.5.4.2.7.3, Table 6-44	O [2]	O
ARSP_HO.net	ATN router NETs	6.5.4.2.7.4, Table 6-45	M	M
ARSP_HO.mask	System mask	6.5.4.2.7.5, Table 6-46	M	M
ARSP_HO.tg3	TG3	6.5.4.2.7.6, Table 6-47	O, NR	O
ARSP_HO.tg4	TG4	6.5.4.2.7.7, Table 6-48	O, NR	O
ARSP_HO.loc	Ground station location	6.5.4.2.7.8, Table 6-49	O, R	O, R

Notes:

[1] Service providers should be aware that systems architectures may result in a round trip AVLC "ACK" latency that can exceed the default T1 minimum calculation.

[2] It is optional to include either the Airport Coverage Indication parameter or the Nearest Airport Identifier parameter, or neither, but not both.

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-2-10 Ground-Requested-Air-Initiated Handoff (Command)

Uplink XID_CMD_HO (P=0)

This command is sent by the current ground station to the aircraft when the handoff is requested by the ground station (and then initiated by the aircraft).

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
Public Parameters				
GrCMD_HO.puid	Public parameter set ID	6.5.4.2.2	M*	M
GrCMD_HO.clss	Procedure classes	Table 6-51a	M*	M
GrCMD_HO.hdlc	HDLC options	6.5.4.2.2.1, Table 6-11	M*	M
GrCMD_HO.n1dn	N1-downlink	6.5.3.4.5	O	M
GrCMD_HO.n1up	N1-uplink	6.5.3.4.5	O	M
GrCMD_HO.kdn	k-downlink	6.5.3.4.7	O	M
GrCMD_HO.kup	k-uplink	6.5.3.4.7	O	M
GrCMD_HO.t1dn	Timer T1 –downlink [1]	6.5.3.4.1	O	M
GrCMD_HO.n2	Counter N2	6.5.3.4.6	O	M
GrCMD_HO.t2	Timer T2	6.5.3.4.2	O	M
Private Parameters				
GrCMD_HO.prid	Private parameter set ID	6.5.4.2.3, Table 6-14	M	M
GrCMD_HO.mgt	Connection management	6.5.4.2.4.2, Tables 6-15, 6-16	M	M
GrCMD_HO.seq	XID sequencing	6.5.4.2.4.4, Table 6-19	M	M
GrCMD_HO.avlc	AVLC specific options	6.5.4.2.4.5, Tables 6-20, 6-21	O	M
GrCMD_HO.tune	Autotune frequency	6.5.4.2.6.1, Table 6-31	O	M
GrCMD_HO.gs	Replacement ground station	6.5.4.2.6.2, Table 6-32	O	M
GrCMD_HO.t4	Timer T4	6.5.3.4.4, Table 6-33	O	M
GrCMD_HO.pers	MAC persistence	6.5.2.3.3, Table 6-34	O	M
GrCMD_HO.m1	Counter M1	6.5.2.3.4, Table 6-35	O	M
GrCMD_HO.tm2	Timer TM2	6.5.2.3.2, Table 6-36	O	M
GrCMD_HO.tg5	Timer TG5	6.5.4.3.5, Table 6-37	O	M
GrCMD_HO.t3min	Timer T3min	6.5.4.3.3, 6.5.4.2.4.8	O	M
GrCMD_HO.freq	Frequency support	6.5.4.2.7.1, Table 6-42	O	O
GrCMD_HO.net	ATN router NETs	6.5.4.2.7.4, Table 6-45	M*	M
GrCMD_HO.mask	System mask	6.5.4.2.7.5, Table 6-46	M*	M
GrCMD_HO.tg3	TG3	6.5.4.2.7.6, Table 6-47	O,NR	O
GrCMD_HO.tg4	TG4	6.5.4.2.7.7, Table 6-48	O,NR	O
GrCMD_HO.loc	Ground station location	6.5.4.2.7.8, Table 6-49	O,R	O,R

Note:

[1] Service providers should be aware that systems architectures may result in a round trip AVLC "ACK" latency that can exceed the default T1 minimum calculation.

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-2-11 Broadcast Ground-Requested Air-Initiated Handoff (Command)

Uplink XID_CMD_HO (P=0)

This command is broadcast by the new ground station to all aircraft to request handoff.

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
Public Parameters				
BgrCMD_HO.puid	Public parameter set ID	6.5.4.2.2	M	M
BgrCMD_HO.clss	Procedure classes	Table 6-51a	M	M
BgrCMD_HO.hdlc	HDLC options	6.5.4.2.2.1, Table 6-11	M	M
BgrCMD_HO.n1dn	N1-downlink	6.5.3.4.5	O	M
BgrCMD_HO.n1up	N1-uplink	6.5.3.4.5	O	M
BgrCMD_HO.kdn	k-downlink	6.5.3.4.7	O	M
BgrCMD_HO.kup	k-uplink	6.5.3.4.7	O	M
BgrCMD_HO.t1dn	Timer T1 – downlink [1]	6.5.3.4.1	O	M
BgrCMD_HO.n2	Counter N2	6.5.3.4.6	O	M
BgrCMD_HO.t2	Timer T2	6.5.3.4.2	O	M
Private Parameters				
BgrCMD_HO.prid	Private parameter set ID	6.5.4.2.3, Table 6-14	M	M
BgrCMD_HO.mgt	Connection management	6.5.4.2.4.2, Tables 6-15, 6-16	M	M
BgrCMD_HO.seq	XID sequencing	6.5.4.2.4.4, Table 6-19	M	M
BgrCMD_HO.avlc	AVLC specific options	6.5.4.2.4.5, Tables 6-20, 6-21	O	M
BgrCMD_HO.t4	Timer T4	6.5.3.4.4, Table 6-33	O	M
BgrCMD_HO.pers	MAC persistence	6.5.2.3.3, Table 6-34	O	M
BgrCMD_HO.m1	Counter M1	6.5.2.3.4, Table 6-35	O	M
BgrCMD_HO.tm2	Timer TM2	6.5.2.3.2, Table 6-36	O	M
BgrCMD_HO.tg5	Timer TG5	6.5.4.3.5, Table 6-37	O	M
BgrCMD_HO.t3min	Timer T3min	6.5.4.3.3, 6.5.4.2.4.8	O	M
BgrCMD_HO.filter	Address filter parameter	6.5.4.2.6.9, Table 6-39	M	M
BgrCMD_HO.conn	Broadcast connection parameter	6.5.4.2.6.10, Table 6-40, 6-41	HO_grb:M	HO_grb:M
BgrCMD_HO.freq	Frequency support	6.5.4.2.7.1, Table 6-42	O	O
BgrCMD_HO.cover	Airport coverage	6.5.4.2.7.2, Table 6-43	O [2]	O
BgrCMD_HO.near	Nearest airport ID	6.5.4.2.7.3, Table 6-44	O [2]	O
BgrCMD_HO.net	ATN router NETs	6.5.4.2.7.4, Table 6-45	M	M
BgrCMD_HO.mask	System mask	6.5.4.2.7.5, Table 6-46	M*	M
BgrCMD_HO.tg3	TG3	6.5.4.2.7.6, Table 6-47	O, NR	O
BgrCMD_HO.tg4	TG4	6.5.4.2.7.7, Table 6-48	O, NR	O
BgrCMD_HO.loc	Ground station location	6.5.4.2.7.8, Table 6-49	O, R	O, R

Notes:

[1] Service providers should be aware that systems architectures may result in a round trip AVLC "ACK" latency that can exceed the default T1 minimum calculation.

[2] It is optional to include either the Airport Coverage Indication parameter or the Nearest Airport Identifier parameter, or neither, but not both.

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-2-12 Link Connection Rejection (Command/Response)

Uplink or Downlink XID_CMD_LCR/ XID_RSP_LCR

This command/response is sent by any station (airborne or ground-based).

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
Private Parameters				
LCR.prid	Private parameter set ID	6.5.4.2.3, Table 6-14	M	M
LCR.mgt	Connection management	6.5.4.2.4.2, Tables 6-15, 6-16	M	M
LCR.seq	XID sequencing	6.5.4.2.4.4, Table 6-19	M	M
LCR.cause	LCR cause	6.5.4.2.4.7, Table 6-23	M	M

Table 2.3-1 MAC Parameters - Timers and Counters

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
	Inter-access delay			
TM1.min	Minimum = 0.5 ms	6.5.2.3.1, Table 6-6	M	M
TM1.max	Maximum = 12.5 ms		M	M
TM1.default	Mode 2 default = 4.5		M	M
	Channel busy			
TM2.min	Minimum = 6 s	6.5.2.3.2, Table 6-6	M	M
TM2.max	Maximum = 120 s		M	M
TM2.default	Mode 2 default = 60		M	M
	Persistence			
P.min	Minimum = 1/256	6.5.2.3.3, Table 6-6	M	M
P.max	Maximum = 1		M	M
P.default	Mode 2 default = 13/256		M	M
	Maximum number of access attempts.			
M1.min	Lowest value = 1	6.5.2.3.4, Table 6-6	M	M
M1.max	Highest value = 65535		M	M
M1.default	Mode 2 default = 66		M	M

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-3-2 DLS Parameters - Timers and Counters

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
	Delay before retransmission – T1min parameter	6.5.3.4.1, Table 6-10		
T1min.low	Lowest = 0 s		M	M
T1min.high	Highest = 20 s		M	M
T1min.default	Mode 2 default = 1 s		M	M
	Delay before retransmission – T1max parameter	6.5.3.4.1, Table 6-10		
T1max.low	Lowest = 1 s		M	M
T1max.high	Highest = 20 s		M	M
T1max.default	Mode 2 default = 15 s		M	M
	Delay before retransmission – T1 Multiplier parameter	6.5.3.4.1, Table 6-10		
T1mult.min	Minimum = 1		M	M
T1mult.max	Maximum = 2.5		M	M
T1mult.default	Mode 2 default = 1.45		M	M
	Delay before retransmission – T1 exponent parameter	6.5.3.4.1, Table 6-10		
	Minimum = 1			
T1exp.min	Maximum = 2.5		M	M
T1exp.max	Mode 2 default = 1.7		M	M
T1exp.default			M	M
	Delay before ACK	6.5.3.4.2, Table 6-10		
T2.min	Minimum = 25 ms		M	M
T2.max	Maximum = 10 s		M	M
T2.default	Mode 2 default = 500 ms		M	M
	Link Initialization Time – T3min parameter	6.5.3.4.3, Table 6-10		
T3min.low	Lowest = 5 s		M	M
T3min.high	Highest = 25 s		M	M
T3min.default	Mode 2 default = 6 s		M	M
	Link Initialization Time – T3max parameter	6.5.3.4.3, Table 6-10		
T3max.low	Lowest = 1 s		M	M
T3max.high	Highest = 20 s		M	M
T3max.default	Mode 2 default = 15 s		M	M
	Link Initialization Time – T3 multiplier parameter	6.5.3.4.3, Table 6-10		
T3mult.min	Minimum = 1		M	M
T3mult.max	Maximum = 2.5		M	M
T3mult.default	Mode 2 default = 1.45		M	M
	Link Initialization Time – T3 exponent parameter	6.5.3.4.3, Table 6-10		
T3exp.min	Minimum = 1		M	M
T3exp.max	Maximum = 2.5		M	M
T3exp.default	Mode 2 default = 1.7		M	M
	Max delay between transmissions	6.5.3.4.4, Table 6-10		
	Aircraft			
aT4.min	Minimum = 1 min		M	M
aT4.max	Maximum = 1440 min		M	M
aT4.default	Mode 2 default = 20 min		M	M
	Max delay between transmissions	6.5.3.4.4, Table 6-10		
	Ground			
gT4.min	Minimum = 3 min		M	M
gT4.max	Maximum = 1442 min		M	M
gT4.default	Mode 2 default = 22 min		M	M
	Maximum number of bits in any frame	6.5.3.4.5, Table 6-10		
N1.low	Lowest = 1144 bits		M	M
N1.high	Highest = 16504 bits		M	M
N1.default	Mode 2 default = 8312 bits		M	M
	Maximum number of transmissions	6.5.3.4.6, Table 6-10		
N2.low	Lowest = 1		M	M
N2.high	Highest = 15		M	M
N2.default	Mode 2 default = 6		M	M
	Window Size	6.5.3.4.7, Table 6-10		
K.min	Minimum = 1 frame		M	M
K.max	Maximum = 7 frames		M	M
K.default	Mode 2 default = 4 frames		M	M

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-3-3 VME Parameters – Timers and Counters

Item	Parameters	VDL SARPS Reference	Ground Station Support	Aircraft Support
	Minimum frequency dwell time	6.5.4.3.1, Table 6-50		
TG1.low	Lowest = 20 s		M	M
TG1.high	Highest = 600 s		M	M
TG1.default	Mode 2 default = 240 s		M	M
	Maximum idle activity time - aircraft	6.5.4.3.2, Table 6-50		
aTG2.low	Lowest = 120 s		M	M
aTG2.high	Highest = 360 s		M	M
aTG2.default	Mode 2 default = 240 s		M	M
	Maximum idle activity time – ground station	6.5.4.3.2, Table 6-50		
gTG2.low	Lowest = 10 min		M	M
gTG2.high	Highest = 4320 min		M	M
gTG2.default	Mode 2 default = 60 min		M	M
	Maximum time between ground transmissions	6.5.4.3.3, Table 6-50		
TG3.low	Lowest = 100 s		M	M
TG3.high	Highest = 120 s		M	M
TG3.default	Mode 2 default = Uniformed between 100-120 s		M	M
	Maximum time between GSIFs	6.5.4.3.4, Table 6-50		
TG4.min	Lowest = 100s		M	M
TG4.max	Highest = N/A		M	M
TG4.default	Mode 2 default = N/A		M	M
	Maximum link overlap time – Initiating	6.5.4.3.5, Table 6-50		
iTG5.low	Lowest = 0 s		M	M
iTG5.high	Highest = 255 s		M	M
iTG5.default	Mode 2 default = 20 s		M	M
	Maximum link overlap time - Responding	6.5.4.3.5, Table 6-50		
rTG5.low	Lowest = 0 s		M	M
rTG5.high	Highest = 255 s		M	M
rTG5.default	Mode 2 default = 60 s		M	M

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-3-4 Transmit Queue Management

Item	Capabilities	VDL SARPS Reference	Ground Station Support	Aircraft Support
TqM1	Maintain 2 queues: one for supervisory and unnumbered frames, one for information.	6.5.3.11.1	M	M
TqM2	At most one RR, SREJ, DM, FRMR, or retransmitted INFO shall be queued in response to a transmission.	6.5.3.11.1.1	M	M
TqM3	If any INFO frame is received from a peer DLE, the DLS sublayer shall update the N(r) of all numbered frames addressed to that DLE in the transmit queue.	6.5.3.11.1.3	O,R	O,R
TqM4	To eliminate unnecessary retransmissions, if any numbered frame is received from a peer DLE, all frames in the transmit queue that it acknowledges should be deleted.	6.5.3.11.1.4	O,R	O,R
TqM5	Supervisory frames have higher priority than the information frames, and so supervisory and unnumbered (XID, FRMR, TEST, DISC, DM) frames shall be transmitted in preference to information frames.	6.5.3.11.1.5	O,R	O,R
TqM6	On transmission of an INFO frame, the DLE should piggyback any queued RR so as to avoid transmitting the RR as a separate frame.	6.5.3.11.1.6	O,R	O,R
TqM7	A station receiving a FRMR, DISC, or DM frame should delete all outstanding traffic for the transmitting DLE as it would not be accepted if transmitted.	6.5.3.11.1.7	M	M
TqM8	All unicast frames in the transmit queue should be deleted after the radio supporting this transmit queue is retuned as the intended station cannot receive the transmission.	6.5.3.11.1.7	M	M

Note: This transmit queue refers to the link layer queue in the CMU, not the MAC queue in the VDR.

Table 2.3-5 Frequency Management

Item	Capabilities	VDL SARPS Reference	Ground Station Support	Aircraft Support
	Does the aircraft initiate frequency search procedure	6.5.4.4.1.1		
FM-search1	Upon system initialization?		N/A	O
FM-search2	After link disconnection and it no longer detects uplink VDL frames in current frequency?		N/A	O
	Does the aircraft initiate frequency search on	6.5.4.4.1.1		
FM-search3	The VDL frequency provided on ACARS squitter?		N/A	O
FM-search4	The VDL Mode 2 CSC?		N/A	O,R
FM-search5	The predefined frequency table?		N/A	O
FM-search6	Does the aircraft initiate frequency recovery procedure when it no longer detects uplink VDL frames in current frequency?	6.5.4.4.1.2	N/A	M

ATTACHMENT 2 (cont'd)
DATA LINK LAYER PICS

Table 2-3-6 ISO 4335 Conformance

Item	Field	VDL SARPS reference	Ground Station Support	Aircraft Support
FRM-NStx	Frame send sequence number sent	6.5.3.2.1	M	M
FRM-NSRx	Frame Send Sequence Number checked	6.5.3.2.1	M	M
FRM-NRtx	Frame receive sequence number sent	6.5.3.2.1	M	M
FRM-NRrx	Frame receive Sequence Number checked	6.5.3.2.1	M	M
FRM-CRCtx	Frame CRC Generated	6.5.3.2.2	M	M
FRM-CRCrx	Frame CRC checked	6.5.3.2.2	M	M
FRM-pf	Final bit send in response to poll	6.5.3.7.1	M	M
FRM-infofinal	Only RR or SREJ with F=1 sent in response to Info P=1	6.5.3.7.2	M	M
FRM-infopoll	INFO sent with P=1 when window closed	6.5.3.7.3	M	M
FRM-infopollT4	INFO sent with P=1 when T4 expires	6.5.3.7.3	M	M
FRM-infopollmin	INFO sent with P=1 at other times	6.5.3.7.3	O, NR	O, NR
FRM-pollunnum	P set in UI or DISC frames	6.5.3.7.4	X	X
FRM-Addfilt	Frames sent to other stations ignored	6.5.3.2.3	M	M
FRM-bcrx	Broadcast frames processed	6.5.3.2.4	M	M
FRM-aggnd	Air-ground bit set to one when aircraft on ground	6.5.3.3.3.1	N/A	O
FRM-agair	Air-ground bit set to zero when aircraft airborne	6.5.3.3.3.1	N/A	M
FRM-agrgs	Air-ground bit set to one for ground stations	6.5.3.3.3.1	M	N/A
FRM-addlen	Frame addresses 8 bytes, consisting of 4 bytes each for source and destination	6.5.3.3.2,6.5.3.3.3	M	M
FRM-cr	Command-response status bit used to distinguish command and response frames	6.5.3.3.3.2	M	M
FRM-addtype	Address type set appropriately	6.5.3.3.3.4, table 6-7	M	M
FRM-bcaddr	Broadcast address used for GSIF	6.5.3.3.4	M	X
FRM-bcaddrx	Broadcast address used for any frame except GSIF	6.5.3.3.4	X	X

ATTACHMENT 3
SUBNETWORK LAYER PICS

3.1 Subnetwork Layer PICS

The tables in this attachment list the Subnetwork Layer Protocol Implementation Conformance Statements (PICS).

Convention

The PICSs provided in this attachment use conventions and symbols that are consistent with the reference document, the ATN VDL SARPs. They are:

M	Mandatory – the capability is to be supported
O	Optional – the capability may optionally be supported
X	Prohibited/precluded (i.e., the capability is not to be supported)
N/A	Not applicable
NR	Not recommended

Scope

The PICS defined herein represent ISO 8208 protocol provisions for VDL Mode 2 subnetwork. They are not applicable to other ATN air-ground subnetworks.

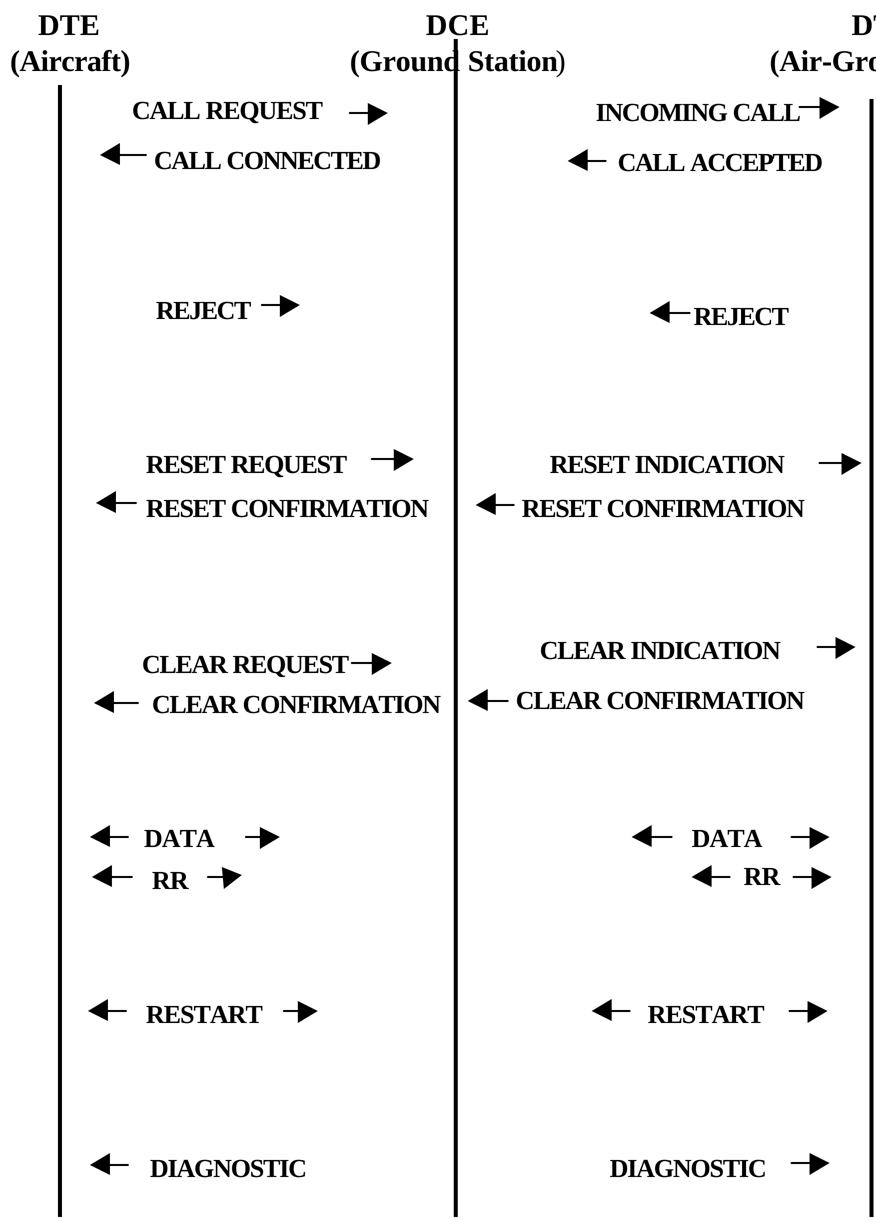
Airborne DTEs and ground-based DCEs (i.e., VDL ground stations) that operate on the VDL Mode 2 subnetwork should comply with these PICS to ensure interoperability.

Although these PICS do not specifically reference ground-based DTEs (i.e., air-ground Boundary Intermediate Systems), these DTEs should support the provisions in these PICS in order to achieve interoperability across the air-ground X.25 communication path.

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

ISO 8208 Packets Used in VDL Mode 2 Subnetwork

In the VDL Mode 2 environment, the following ISO 8208 packets are used:



Note 1: In VDL SARPs, only airborne DTE can issue call request.

Note 2: Ground station (DCE) may not send REJECT packets to either airborne or ground-based DTEs.

Note 3: DCE can also generate reset, in which case RESET INDICATION is sent to both airborne and ground-based DTEs.

Note 4: Clear Request can also be issued by ground DTE. DCE can also initiate call clearing, in which case CLEAR INDICATION is sent to both airborne and ground-based DTEs.

Note 5: VDL SARPs allows RESTART to be used only for error recovery after both RESET and REJECT have been tried unsuccessfully.

Note 6: Only ground stations (DCE) are allowed to send DIAGNOSTIC packets (per ISO 8208)

Figure 3-1

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-1 General DTE Characteristics

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
Vs	Virtual Call	3.4, 3.7	M	M
Vp	Permanent Virtual Circuit	3.4, 3.7	X	X
Ec/8	DTE/DCE (1988) environment	3.3.2	M	M
Ec/4	DTE/DCE (1984) environment	3.3.2	X	X
Ec/0	DTE/DCE (1980) environment	3.3.2	X	X
Et/t	DTE/DTE in fixed role as DTE	3.3.2	X	X
Et/d	DTE/DTE with dynamic role selection	4.5	X	X
M8	Packet sequence numbering modulo 8	13.2, 12.1.1	M	M
M128	Packet sequence numbering modulo 128 (extended)	13.2, 12.1.1	X	X
RNa	Is the Reference Number optional user facility supported (DTE/DTE only) ?	13.29	X	X

Table 3-2 Link Layer Interactions

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
L1a	Restarting of the packet layer initiated (in the DTE) on completion of link layer initialization	3.10	X	X
L1b	Restarting of the packet layer initiated (in the DTE) on recovery from failure of the link layer [1]	10	X	X
L2	Can packets consisting of a non-integral number of octets be received from the link layer? [2]	12.1	X	X

Notes:

[1] Although sending RESTART packets is allowed in VDL SARPs for limited error recovery, this document limits the use of RESTART packets, since sending RESTART packets (even for error recovery) on one VDL link clears all connections on that link.

[2] AVLC allows frames to be aligned on bit-boundary. However, VDL SARPs specifies packet sizes as integral numbers of octets. Per ISO 3309, all fields in an HDLC frame are octet aligned except for the information field which may contain any arbitrary number of bits. If the packet layer sends octet-aligned packets, AVLC INFO frames will be octet-aligned.

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-3 General Packet Formatting

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
P2	Do all (DTE) transmitted packets consist of an integral number of octets?	12.1	M	M
P3a	Do all (DTE) transmitted packets contain General Format Identifier?	12.1.1	M	M
P3b	Do all (DTE) transmitted packets contain Logical Channel Identifier?	12.1.2	M	M
P3c	Do all (DTE) transmitted packets contain Packet Type Identifier?	12.1.3	M	M
P4	Are all (DTE) received packets that do not contain valid GFI, LCI and PTI fields treated as erroneous?	12.1.1 Table 3, 12.1.3, 12.1.2, Table 6, Table 31-36	M	M

Table 3-4 Packet Layer Functions Independent of Logical Channels

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
Z1i	DTE restarts the packet layer as initiator	12.6.1	O	O
Z1r	DTE restarts the packet layer as responder	12.6.1	O	O
Z2r	DTE receives DIAGNOSTIC packet	11.1, 12.7	M	M
Z2s	DTE sends DIAGNOSTIC packet	12.7, Table 24	N/A	X
Z3	Discard received erroneous packets not assignable to a logical channel and not covered by item Z2s	11.1, Tables 31-32	M	M
Z4I	DTE initiating On-line Facility Registration	13.1, 12.9.1	X	X

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-5 Call Setup

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
S1a	Outgoing Virtual Calls support Fast Select, no restriction on response	5.2.4, 13.16	M [1]	M
S1b	Outgoing Virtual Calls support Fast Select with restricted response	13.16	X	X
S1c	Outgoing Virtual Calls support non-Fast-Select?	5.2.4	X [3]	X [3]
S1d	Outgoing Virtual Calls have ground system's ADM/ARS in Called Address Extension facility of a CALL REQUEST packet [2]	13.28.2.2, 14.2	M [1]	M
S1e	Outgoing Virtual Calls have X.121 address of ground DTE in Called Address field of a CALL REQUEST packet		O	O
SP1b	DTE sends CALL REQUEST, basic format	12.2.3.1	N/A	M
SP1e	DTE sends CALL REQUEST, extended format	12.2.3.1, 12.2.3.2	N/A	M
SP2b	DTE receives CALL CONNECTED, basic format	12.2.4.1	N/A	M
SP2e	DTE receives CALL CONNECTED, extended format	12.2.4.1, 12.2.4.2	N/A	M
S2a	Incoming Virtual Calls support Fast Select with acceptance possible	5.2.3, 13.17	M [1]	X
S2b	Incoming Virtual Calls support Fast Select, no restriction on response, always cleared	13.17	X	X
S2c	Incoming Virtual Calls support non-Fast-Select with acceptance possible	5.2.3	X	X
S2d	Incoming Virtual Calls support non-Fast-Select, always cleared	5.2.3	X	X
SP3b	DTE receives INCOMING CALL, basic format	12.2.3.1	N/A	X
SP3e	DTE receives INCOMING CALL, extended format	12.2.3.1, 12.2.3.2	N/A	X
SP4b	DTE sends CALL ACCEPTED, basic format	12.2.4.1	N/A	M
SP4e	DTE sends CALL ACCEPTED, extended format	12.2.4.1, 12.2.4.2	N/A	M
DN1	D-bit negotiation is supported for outgoing Virtual Calls	6.3	X	X
DN2	D-bit negotiation is supported for incoming Virtual Calls	6.3	X	X

Notes:

[1] The ground DCE does not initiate virtual calls, however, it should support and forward these calls. Where the provision is marked "M", the ground DCE should not drop the packets due to the presence of the parameter referenced in the provision.

[2] This is a VDL SARPs requirement. When the Called Address Extension Facility is used the Called Address field should have an address length of 0 to indicate that this field is not used.

[3] For ISO 8208 supporting ATN only.

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-6 Call Clearing

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
C1	Call clearing is supported to respond to an indication of clearing	5.5.2	M	M
C2a	Call clearing is supported to abort an outgoing Virtual Call attempt	5.4, 5.5.1, 5.5.3	M	M
C2b	Call clearing is supported to reject an incoming Virtual Call	5.3, 5.5.1, 5.5.3	M	M
C2c	Call clearing is supported to clear an established Virtual Call	5.5.1, 5.5.3	M	M
CP1b	DTE receives CLEAR INDICATION, basic format	12.2.5.1	M	M
CP1e	DTE receives CLEAR INDICATION, extended format	12.2.5.1, 12.2.5.2	O	O
CP2b	DTE sends CLEAR CONFIRMATION, basic format	12.2.6.1	M	M
CP2e	DTE sends CLEAR CONFIRMATION, extended format [1]	12.2.6.1, 12.2.6.2	X	X
CP3b	DTE sends CLEAR REQUEST, basic format	12.2.5.1	M	M
CP3e	DTE sends CLEAR REQUEST, extended format [2]	12.2.5.1, 12.2.5.2	O	O
CP4b	DTE receives CLEAR CONFIRMATION, basic format	12.2.6.1	M	M
CP4e	DTE receives CLEAR CONFIRMATION, extended format [1]	12.2.6.1, 12.2.6.2	X	X

Notes:

[1] The extended format is used for CLEAR CONFIRMATION packets issued by a DCE only in conjunction with the Charging Information facility (see ISO 8208 Section 13.22).

[2] The extended format is used only when the DTE uses the Address fields, the Facility field, and/or the Clear User Data field.

Table 3-7 Resetting of Logical Channels

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
RSi	Resetting is supported when DTE is an initiator	12.5.1, 12.5.2	M	M
RSr	Resetting is supported when DTE is a responder	12.5.1, 12.5.2	M	M

Table 3-8 Interrupt Transfer

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
Is	Sending interrupts	6.8, 12.3	X	X
Ir	Receiving interrupts	6.8, 12.3	X	X

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-9 Sending Data

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
DS1	Sending of DATA packets is supported	6, 6.1, 6.2, 7.1, 12.3	M	M
DS2	Send-window rotation on receiving updated P(R) values	7.1, 7.1.2, 7.1.3	M	M
DS3a	Response to flow control by received RR packets	7.1.5, 7.1.6, 12.4.1, 12.4.2	M	M
DS3b	Response to flow control by received RNR packets	7.1.6, 12.4.2	X	X
DS4a	Sending M=0 in DATA packets	6.4, 6.5, 6.7	M	M
DS4b	Sending M=1 in DATA packets	6.4, 6.5, 6.7	M	M
DS5a	Sending Q=0 in DATA packets	6.6	M	M
DS5b	Sending Q=1 in DATA packets	6.6	X	X

Table 3-10 Receiving Data

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
DR1	Receiving DATA packets	6, 6.1, 6.2, 7.1.1, 7.1.2, 7.1.3, 12.3.1	M	M
DR2	Receive-window rotation by sending updated P(R) values	7.1.2, 7.1.3	M	M
DR3a	Flow control by sending RR packets	7.1.5, 7.1.6, 12.4.1, 12.4.2	M	M
DR3b	Flow control by sending RNR packets	7.1.6, 12.4.2	X	X
DR4a	Receiving M=0 in DATA packets	6.4, 6.5, 6.7	M	M
DR4b	Receiving M=1 in DATA packets	6.4, 6.5, 6.7	M	M
DR5a	Receiving Q=0 in DATA packets	6.6	M	M
DR5b	Receiving Q=1 in DATA packets	6.6	X	X
DR6	Requesting packet retransmission by sending REJECT packets	13.4.1, 12.8	M	M

Table 3-11 Delivery Confirmation (D-bit)

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
DC	Support of Delivery Confirmation	6.3, 6.5, 6.7, 7.1.4	X	X

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-12 Values of Cause and Diagnostic Code Fields

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
Y3a	In CLEAR REQUEST packets sent (by DTE), when Cause equals 0, Diagnostic Codes equal specific codes	12.2.3.1.1, 12.2.3.1.2, Tables 24 -25	M	M
Y3b	In CLEAR REQUEST packets sent (by DTE), when Cause equals 0, Diagnostic Codes equal generic codes (including 0)	12.2.3.1.1, 12.2.3.1.2, Tables 24 -25	M	M
Y3c	In CLEAR REQUEST packets sent (by DTE), when Cause equals 0, Diagnostic Codes equal 0, always	12.2.3.1.1, 12.2.3.1.2, Tables 24 -25	X	X
Y3d	In CLEAR REQUEST packets sent (by DTE), when Cause equals 128, Diagnostic Codes equal private diagnostic codes [1]	12.2.3.1.1, 12.2.3.1.2, Tables 24 -25	M	M
Y3e	In CLEAR REQUEST packets sent (by DTE) Causes and Diagnostic Codes other than in items Y3a and Y3b	12.2.3.1.1, 12.2.3.1.2, Tables 24 -25	X	X
Y4a	In CLEAR INDICATION packets received (by DTE), Cause equals 0 or 128, any diagnostic code value	12.2.3.1.1, Table 7, 12.2.3.1.2	M	M
Y4b	In CLEAR INDICATION packets received (by DTE), Cause is not equal to 0 or 128, any diagnostic code value	12.2.3.1.1, Table 7, 12.2.3.1.2	M	M
Y5a	In RESET REQUEST packets sent (by DTE), when Cause equals 0, Diagnostic Codes equal specific diagnostic codes	12.5.1.1, 12.5.1.2, Tables 24 -25	M	M
Y5b	In RESET REQUEST packets sent (by DTE), when Cause equals 0, Diagnostic Codes equal generic diagnostic codes (including 0)	12.5.1.1, 12.5.1.2, Tables 24 -25	M	M
Y5c	In RESET REQUEST packets sent (by DTE), when Cause equals 0, Diagnostic Codes equal 0, always	12.5.1.1, 12.5.1.2, Tables 24 -25	X	X
Y5d	In RESET REQUEST packets sent (by DTE), when Cause equals 128, Diagnostic Codes equal private diagnostic codes	12.5.1.1, 12.5.1.2, Tables 24 -25	X	X
Y5e	In RESET REQUEST packets sent (by DTE) Causes and Diagnostic Codes other than in items Y5a and Y5b	12.5.1.1, 12.5.1.2, Tables 24 -25	X	X
Y6a	In RESET INDICATION packets received (by DTE), Cause equals 0 or 128, any diagnostic code value	12.5.1.1, Table 8, 12.5.1.2	M	M
Y6b	In RESET INDICATION packets received (by DTE), Cause is not equal to 0 or 128, any diagnostic code value	12.5.1.1, Table 8, 12.5.1.2	M	M

Note:

[1] Various ATN diagnostic codes are defined in the ICAO SARPs (Section 5.7.6.2.4, Table 5.7-3) for mobile SNDCF Clear Request packets (Cause equals 128).

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-13 Facilities Sent in Outgoing CALL REQUEST Packets (DTE To DCE)

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
FS1pi	Flow Control Parameter Negotiation, packet size	13.12, 15.2.2.1.1	M	M
FS1wi	Flow Control Parameter Negotiation, window size	13.12, 15.2.2.1.2	M	M
FS2ib	Throughput Class Negotiation (basic)	13.13, 15.2.2.2.1	X	X
FS2ie	Throughput Class Negotiation (extended)	13.13, 15.2.2.2.2	X	X
FS3b	Closed User Group Selection, basic format	13.14.6, 15.2.2.3.1	X	X
FS3e	Closed User Group Selection, extended format	13.14.6, 15.2.2.3.2	X	X
FS4b	Closed User Group With Outgoing Access Selection, basic format	13.4.7, 15.2.2.4.1	X	X
FS4e	Closed User Group With Outgoing Access Selection, extended format	13.4.7, 15.2.2.4.2	X	X
FS5	Bilateral Closed User Group Selection	13.15, 15.2.2.5	X	X
FS6a	Fast Select	13.16, 15.2.2.6	M	M
FS6b	Reverse Charging	13.18, 15.2.2.6	X	X
FS7i	Network User Identification	13.21, 13.21.3, 15.2.2.7	X	X
FS8i	Charging Information, requesting service	13.22, 15.2.2.8.1	X	X
FS9b	ROA Selection, basic format	13.23, 13.23.2, 15.2.2.9.1	X	X
FS9e	ROA Selection, extended format	13.23, 13.23.2, 15.2.2.9.2	X	X
FS12	Transit Delay Selection and Indication	13.27, 15.2.2.13	X	X
FS99i	Local non-X.25 facilities, following Facility Marker	15.1, Table 18	X	X
FS98i	Remote non-X.25 facilities, following Facility Marker	15.1, Table 18	X	X
FS20i	Facility Marker, ITU-T-specified DTE facilities	15.1	M	M
FS21i	Calling Address Extension	14.1, 15.3.2.1	X	X
FS22i	Called Address Extension	13.28.2.2,14.2, 15.3.2.2	M	M
FS23ib	Minimum Throughput Class Negotiation (basic)	14.3, 15.3.2.3.1, Table 20a	X	X
FS23ie	Minimum Throughput Class Negotiation (extended)	14.3, 15.3.2.2, Table 20b	X	X
FS24i	End-to-End Transit Delay Negotiation	14.4, 15.3.2.4	X	X
FS25i	Expedited Data Negotiation	14.7, 15.3.2.7	X	X
FS26i	Priority	14.5, 15.3.2.5	X	X
FS27i	Protection	14.6, 15.3.2.6	X	X

Note [1] VDL SARPs only allows airborne DTE to send CALL REQUEST packets.

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-14 Facilities Sent in Outgoing CALL ACCEPTED Packets (DTE To DCE)

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
FS1pr	Flow Control Parameter Negotiation, packet size	13.12, 15.2.2.1.1, Table 13	M	M
FS1wr	Flow Control Parameter Negotiation, window size	13.12, 15.2.2.1.2, Table 13	M	M
FS2rb	Throughput Class Negotiation (basic)	13.13, 15.2.2.2.1, Table 20a	X	X
FS2re	Throughput Class Negotiation (extended)	13.13, 15.2.2.2.2, Table 20b	X	X
FS7r	Network User Identification	13.21, 13.21.3, 15.2.2.7	X	X
FS8r	Charging Information, requesting service	13.22, 15.2.2.8.1	X	X
FS10r	Called Line Address Modified Notification	13.26, 15.2.2.12	X	X
FS20r	Facility Marker, ITU-T-specified DTE facilities	15.1	M	M
FS22r	Called Address Extension	14.2, 15.3.2.2	X	X
FS24r	End-to-End Transit Delay Negotiation	14.4, 15.3.2.4	X	X
FS25r	Expedited Data Negotiation	14.7, 15.3.2.7	X	X
FS26r	Priority	14.5, 15.3.2.5	X	X
FS27r	Protection	14.6, 15.3.2.6	X	X
FS98r	Remote non-X.25 facilities, following Facility Marker	15.1, Table 18	X	X
FS99r	Local non-X.25 facilities, following Facility Marker	15.1, Table 18	X	X

Note [1] Airborne DTEs always initiate call requests, thus never send CALL ACCEPTED packets. Ground-based DTEs never initiate call requests, thus are always in the acceptance role (i.e., sending CALL ACCEPTED packets).

Table 3-15 Facilities Sent in CLEAR REQUEST Packets (DTE to DCE)

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
FS10d	Called Line Address Modified Notification	13.26, 15.2.2.12	O	O
FS13	Call Deflection Selection	13.25.2.2, 15.2.2.10	X	X
FS20d	Facility Marker, ITU-T-specified DTE facilities	15.1	X	X
FS22d	Called Address Extension	14.2, 15.3.2.2	X	X
FS98d	Remote non-X.25 facilities, following Facility Marker	15.1, Table 18	X	X
FS99d	Local non-X.25 facilities, following Facility Marker	15.1, Table 18	X	X

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-16 Facilities Received in INCOMING CALL Packets (DCE To DTE)

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
FR1pi	Flow Control Parameter Negotiation, packet size	13.12, 15.2.2.1.1	M	X
FR1wi	Flow Control Parameter Negotiation, window size	13.12, 15.2.2.1.2	M	X
FR2ib	Throughput Class Negotiation (basic)	13.13, 15.2.2.2.1, Table 20a	X	X
FR2ie	Throughput Class Negotiation (extended)	13.13, 15.2.2.2.2, Table 20b	X	X
FR3b	Closed User Group Selection, basic format	13.14.6, 15.2.2.3.1	X	X
FR3e	Closed User Group Selection, extended format	13.14.6, 15.2.2.3.2	X	X
FR4b	Closed User Group With Outgoing Access Selection, basic format	13.4.7, 15.2.2.4.1	X	X
FR4e	Closed User Group With Outgoing Access Selection, extended format	13.4.7, 15.2.2.4.2	X	X
FR5	Bilateral Closed User Group Selection	13.15, 15.2.2.5	X	X
FR6a	Fast Select	13.16, 13.17, 15.2.2.6	M	X
FR6b	Reverse Charging	13.18, 13.19, 15.2.2.6	X	X
FR11	Call Redirection or Call Deflection Notification	13.25.3, 15.2.2.11	X	X
FR12i	Transit Delay Selection and Indication	13.27, 15.2.2.13	X	X
FR20i	Facility Marker, ITU-T-specified DTE facilities	15.1	M	X
FR21	Calling Address Extension	14.1, 15.3.2.1	X	X
FR22i	Called Address Extension	14.2, 15.3.2.2	X	X
FR23b	Minimum Throughput Class Negotiation (basic)	14.3, 15.3.2.3.1, Table 20a	X	X
FR23e	Minimum Throughput Class Negotiation (extended)	14.3, 15.3.2.3.1, Table 20b	X	X
FR24i	End-to-End Transit Delay Negotiation	14.4, 15.3.2.4	X	X
FR25i	Expedited Data Negotiation	14.7, 15.3.2.7	X	X
FR26i	Priority	14.5, 15.3.2.5	X	X
FR27i	Protection	14.6, 15.3.2.6	X	X
FR99i	Local non-X.25 facilities, following Facility Marker	15.1, Table 18	X	X

Note [1] Since the airborne DTE always initiates the call request, it never receives INCOMING CALL packets.

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-17 Facilities Received in Incoming CALL CONNECTED Packets (DCE To DTE)

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
FR1pr	Flow Control Parameter Negotiation, packet size	13.12, 15.2.2.1.1, Table 14	M	M
FR1wr	Flow Control Parameter Negotiation, window size	13.12, 15.2.2.1.2, Table 14	M	M
FR2rb	Throughput Class Negotiation (basic)	13.13, 15.2.2.2.1, Table 20a	X	X
FR2re	Throughput Class Negotiation (extended)	13.13, 15.2.2.2.2, Table 20b	X	X
FR10r	Called Line Address Modified Notification [1]	13.26, 15.2.2.12	M	M
FR12r	Transit Delay Selection And Indication	13.27, 15.2.2.13	X	X
FR20r	Facility Marker, ITU-T-specified DTE facilities	15.1	M	M
FR22r	Called Address Extension [2]	14.2, 15.3.2.2	X	X
FR24r	End-to-End Transit Delay Negotiation	14.4, 15.3.2.4	X	X
FR25r	Expedited Data Negotiation	14.7, 15.3.2.7	X	X
FR26r	Priority	14.5, 15.3.2.5	X	X
FR27r	Protection	14.6, 15.3.2.6	X	X
FR99r	Local non-X.25 facilities, following Facility Marker	15.1, Table 18	X	X

Notes:

[1] For those DSPs supporting X.121 addressing

[2] Since the ground-based DTE never initiates the call request, it never receives CALL CONNECTED packets.

Table 3-18 Facilities Received in CLEAR INDICATION Packets (DCE to DTE)

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
FR8ad	Charging Information, monetary unit	13.22, 15.2.2.8.2	X	X
FR8bd	Charging Information, segment count	13.22, 15.2.2.8.3	X	X
FR8cd	Charging Information, call duration	13.22, 15.2.2.8.4	X	X
FR10d	Called Line Address Modified Notification	13.26, 15.2.2.12	O	O
FR99d	Local non-X.25 facilities, following Facility Marker	15.1, Table 18	X	X
FR20d	Facility Marker, ITUT-specified DTE facilities	15.1	X	X
FS22d	Called Address Extension [1]	14.2, 15.3.2.2	M	M

Note: [1] For those DSPs supporting X.121 addressing

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-19 Facilities Received in CLEAR CONFIRMATION Packets (DTE to DCE)

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
FR8af	Charging Information, monetary unit	13.22, 15.2.2.8.2	X	X
FR8bf	Charging Information, segment count	13.22, 15.2.2.8.3	X	X
FR8cf	Charging Information, call duration	13.22, 15.2.2.8.4	X	X

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-20 Values for Flow Control Parameters and Throughput Class, Virtual Call Service

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
V1s	What values are supported for default packet sizes, sending (octets)?	16.2.2.5	1024	1024
V1r	What values are supported for default packet sizes, receiving (octets)?	16.2.2.5	1024	1024
V2s	What values are supported for default window sizes, sending?	16.2.2.6	7	7
V2r	What values are supported for default window sizes, receiving?	16.2.2.6	7	7
V2ack	What values are supported for default acknowledgment window size?	N/A	4	4
V3s	What values are supported for default throughput classes, sending (bps)?	16.2.2.7, Table 20a, Table 20b	N/A	N/A
V3r	What values are supported for default throughput classes, receiving (bps)?	16.2.2.7, Table 20a. Table 20b	N/A	N/A
V5	Can different default packet sizes be set for sending and receiving?	13.9	M	M
V7	Can different window sizes be set for sending and receiving?	13.10	M	M
V8	Can different default throughput classes be set for sending and receiving?	13.11	N/A	N/A
V9s	What values are supported in flow control parameter negotiation for packet sizes, sending (octets)?	15.2.2.1.1	128/256/ 512/1024 /2048	128/256/ 512/1024 /2048
V9r	What values are supported in flow control parameter negotiation for packet sizes, receiving (octets)?	15.2.2.1.1	128/256/ 512/1024 /2048	128/256/ 512/1024 /2048
V10s	What values are supported in flow control parameter negotiation for window sizes, sending (octets)?	15.2.2.1.2	1-7	1-7
V10r	What values are supported in flow control parameter negotiation for window sizes, receiving (octets)?	15.2.2.1.2	1-7	1-7
V11s	What values are supported in flow control parameter negotiation for throughput class, sending (bps)?	15.2.2.2, Table 20a, Table 20b	N/A	N/A
V11r	What values are supported in flow control parameter negotiation for throughput class, receiving (bps)?	15.2.2.2, Table 20a, Table 20b	N/A	N/A

Note [1] V1s, V1r, V9s, V9r. The term "packet size" refers to the maximum length of the User Data Field in a DATA packet.

ATTACHMENT 3 (cont'd)
SUBNETWORK LAYER PICS

Table 3-21 Timers, Retransmission Counts and Logical Channel Ranges

Item	**Function** [1]	**ISO/IEC 8208 Reference**	**Ground DCE Support**	**Air DTE Support**
T20	Restart Request Response Timer	18, Table 26	M	M
T21	Call Request Response Timer	18, Table 26	M	M
T22	Reset Request Response Timer	18, Table 26	M	M
T23	Clear Request Response Timer	18, Table 26	M	M
T24	Window Status Transmission Timer	18, Table 26	O	O
T25	Window Rotation Timer	18, Table 26	O	O
T26	Interrupt Response Timer	18, Table 26	X	X
T27	Reject Response Timer	18, Table 26	M	M
T28	Registration Request Response Timer	18, Table 26	X	X
LC8	Maximum number of active SVCs (Switched Virtual Circuits)	3.7	Local Choice for DTE/ DCE	8 (per air-ground subnetwork. [2]

Notes:

[1] All timers use VDL SARPs default, minimum, and maximum values where applicable.

[2] For VDL Mode 2 subnetwork, provision is made for 4 air-ground routers (2 DSPs, 1 AOC, 1 spare) and 2 virtual circuits per air-ground router.

APPENDIX A
TERMS AND ACRONYMS

A1.1 Terms

Network Entity Title (NET)	The name of a network entity located within an ES or IS. Also an address that may be used to find the Network Entity.
Routing Domain	A set of end systems and intermediate systems which operate the same routing protocols and procedures and which are wholly contained within a single administrative domain.
Routing Domain Confederation	Formed by private arrangement between its members without any need for global coordination. An ATN backbone for example.
Transit Routing Domain	A domain whose policies permit its BIS to provide relaying for PDUs whose source is located in either the local routing domain or in a different routing domain.
Ground System	Consists of one or multiple ground stations and one or multiple air-ground routers.

A1.2 Acronyms

A/G	Air/Ground
AAC	Airline Administrative Communications
ABM	Asynchronous Balanced Mode
ACA	Address Compression Algorithm
ACARS	Aircraft Communications Addressing and Reporting System
ACARS-CF	ACARS Convergence Function
ADCE	Airborne Data Circuit-Terminating Equipment
ADLP	Airborne Data Link Processor
AEEC	Airlines Electronic Engineering Committee
AFN	ATS facilities notification
AGR	Air Ground Radio
AMCP	Aeronautical Mobile Communications Panel
AM-MSK	Amplitude Modulated Minimum Shift Keying
ANI	Airborne Network Interface
AOC	Airline Operational Control
APC	Airline Passenger Communications
ARINC	Aeronautical Radio Inc
ARQ	Automatic Repeat Request
ATC	Air Traffic Control
ATN	Aeronautical Telecommunication Network
ATNP	ATN Panel
ATNSI	ATN Systems Inc.
ATS	Air Traffic Service
ATSC	Air Traffic Service Communication
AVLC	Aviation VHF Link Control
BAC	Balanced operation Asynchronous balanced mode Class
BIS	Boundary Intermediate System
C/R	Command/Response
CAA	Civil Aviation Authority
CF	Control Function
CLAM	Called Line Address Modification Notification
CLNP	Connectionless Network Protocol
CLNS	ConnectionLess Network Service
CLTP	ConnectionLess Transport Protocol
CM	Context Management
CMA	Context Management Application
CMU	Communications Management Unit
CNS	Communications, Navigation and Surveillance
COTP	Connection Oriented Transport Protocol
COTS	Commercial Off-the-shelf
CPDLC	(1) Controller-Pilot Datalink Communications
CSC	Common Signaling Channel
CSMA	Carrier Sense Multiple Access

APPENDIX A (cont'd)
TERMS AND ACRONYMS

CU	Control Unit
D8PSK	Differentially encoded 8-Phase Shift Keying
DISC	Disconnect
DL	Data Link
DLE	Data Link Entity
DLPI	Data Link Provider Interface
DLS	Data Link Service
DLSAP	Data Link Service Access Point
DLSDU	Data Link Service Data Unit
DSB-AM	Double Side Band – Amplitude Modulation
DSP	Data Link Service Provider
DT NPDU	Data NPDU
DTE	Data Terminal Equipment
DM	Disconnected Mode
DSP	Data Service Provider
ER NPDU	Error NPDU
ERD	End Routing Domain
ES	End System
ESH	End System Hello
ES-IS	End System to Intermediate System
FANS	Future Air Navigation Systems
FEC	forward error correction
FFAS	Free Flight Airspace
FIB	Forwarding Information Base
FM	Frequency Modulation
FMC	Flight Management Computer
FMS	flight management system
FP	Frame Processor
FRMR	Frame Reject
GDCE	ground DCE
GDLP	Ground Data Link Processor
GES	Ground Earth Station
GNI	Ground Network Interface
GS	Ground Station
GSIF	Ground Station Information Frames
GTU	Ground transceiver unit
HF	High Frequency
HDLC	High-level Data Link Control
HO	Hand Off
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ID	Identification
IDRP	Inter Domain Routing Protocol
INFO	Information
IP	Internet Protocol
IS	Intermediate System
ISH	Intermediate System Hello
ISO	International Standards Organization
ISPs	International Standardised Profiles
IS-SME	Intermediate System – System Management Entity
ITU	International Telecommunications Union
LACK	Logical Acknowledgement
LAPB	Link Access Procedure – Balanced
LIDU	Link Interface Data Unit
LLC	Logical Link Control
LLC-1	Logical Link Control Type 1
LME	Link Management Entity
LREF	Local Reference (table or compression, depending on usage)
LRU	Line Replacement Unit
MAC	Media Access Control
MIB	Management Information Base
MO	Managed Object

APPENDIX A (cont'd)
TERMS AND ACRONYMS

MOPS	Minimum Operational Performance Standards
MSNDCF	Mobile Sub-Network Dependent Convergence facility
MU	Management Unit
NET	Network Entity Titles
NMA	Network Management Agent
NPDU	Network Protocol Data Unit
NPI	Network Provider Interface
NS	Network Service
NSAP	Network Service Access Point
NSDU	Network Service Data Unit
OOOI	Off, Out, On and In times
OSI	Open Systems Interconnection
P/F	Poll/Final
PDC	Pre-departure Clearance
PDU	Protocol Data Units
PECT	Peer Entity Contact Table
PER	Packed Encoding Rules
PICS	Protocol Implementation Conformance Statement
PLP	Packet Layer Protocol
PPP	Point to Point Protocol
QOS	Quality of Service
RD	Routing Domain
RGS	Remote Ground Stations
RIB	Routing Information Base
RIF	Routing Initiation Function
RR	Receive Ready
SAP	Service Access Point
SARPs	Standards and Recommended Practices
SITA	Societe International de Telecommunications Aeronautiques
SLM	Standard Length Message
SME	System Management Entity
SMI	Standard Message Identifier
SMT	Standard Message Text
SN	SubNetwork
SNAcP	Subnetwork Access Protocol
SNDCF	Subnetwork Dependent Convergence Functions
SNICP	Subnetwork Independent Convergence Protocol
SNPA	Subnetwork Point of Attachment
SN-SME	Sub-Network-System Management Entity
SQP	Signal Quality Parameter
SREJ	Selective Reject
TP4	Transport Protocol class 4
TPDUs	Transport Protocol Data Units
TPI	Transport Provider Interface
TRD	Transit Routing Domain
TSAP	Transport Service Access Point
TSDU	Transport Service Data Unit
UA	Unnumbered Acknowledgement
VC	Virtual Circuit
VDL	VHF Digital Link
VDLM2	VDL Mode 2
VDR	VHF Data Radio
VME	VDL Management Entity
VMF	VDL Management Function
VHF	Very High Frequency
VSDA	VDL Specific DTE Address
XID	Exchange Identification
WAN	Wide Area Network

APPENDIX B
DEFINITION OF VDL ADDRESSES, GROUND SYSTEM, SYSTEM MASK AND USE OF THESE PARAMETERS FOR VDL LINK HANDOFF

B.1 Use of ATN Router NET Parameter <ADM ,ARS> (i.e., the VDL specific DTE address as defined in the VDL SARPs).

IF AVLC_Specific_Option indicates ground support of X.121 address THEN
ATN Router NET parameter will be as defined in the ICAO Doc 9705 (ATN SARPs)

If AVLC_Specific_Option indicates ground support of X.121 address, then NET parameter may also be configured as uniquely identifying each air-ground router.

ELSE /* ground does not support X.121 address */
NET Parameter identifies an air-ground router

In either of the above two cases, the field ADM is as defined in the ATN SARPs.

B.2 Definition of the term (VDL-2) “ground system”:

A ground system is uniquely identified by a VDL_SysID.

where

VDL_SysID = BitwiseAND (System_Mask, Ground_Station_Address)

A ground system consists of one or multiple ground stations and one or multiple air-ground routers.

B.3 Definition of System_Mask:

The first (i.e., Most Significant) address prefix number of bits (4 or 10) are used to extract the service provider identifier from the ground station address.

The remaining bits (20 or 14) are defined by a service provider to identify their ground system.

B.4 Handoff Rules

Aircraft should send XID_CMD_HO and XID_CMD_LE as follows:

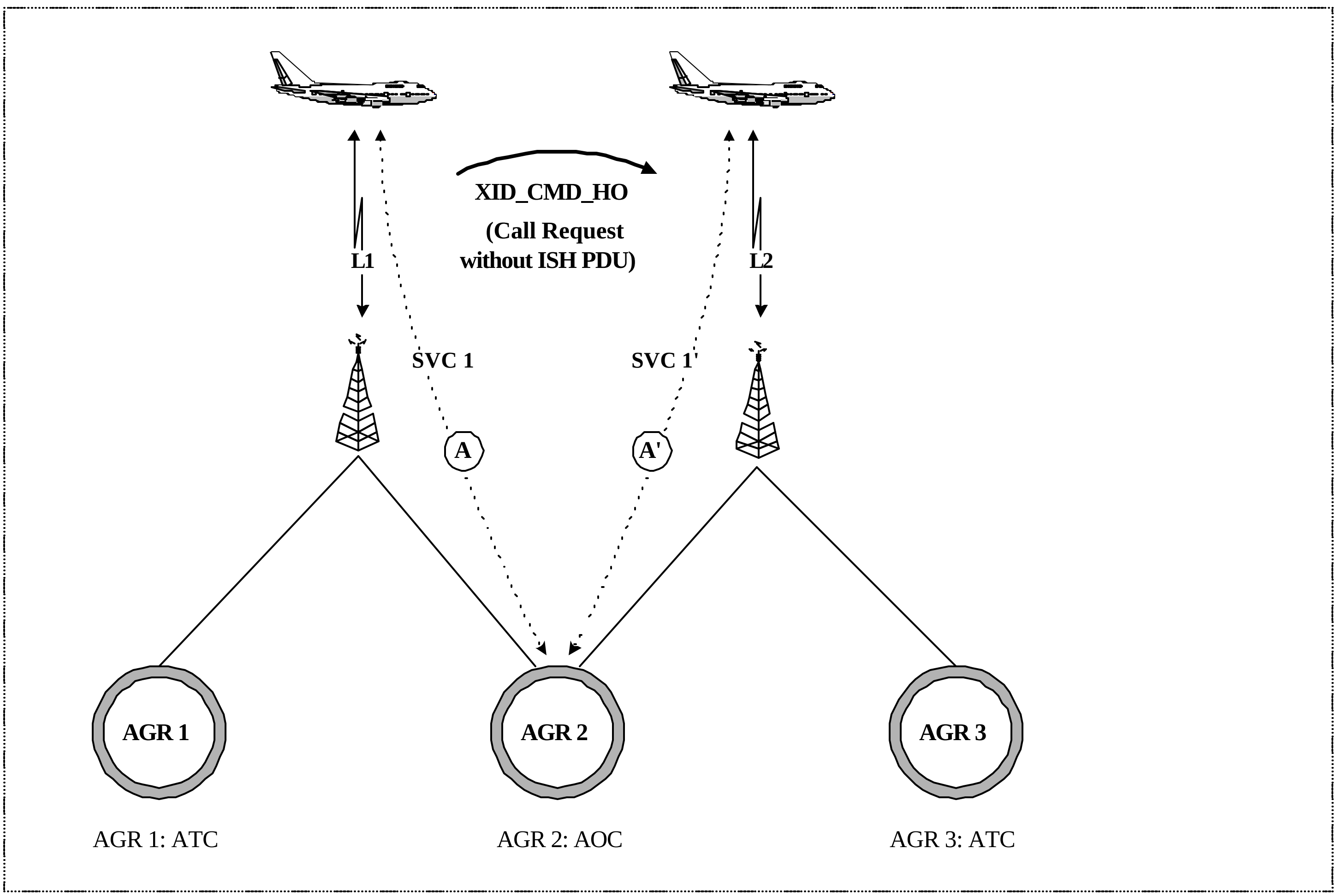
When the aircraft transitions from an existing ground station to the new ground station and both ground stations belong to the same ground system (Identified by the same VDL_SysID) it should send XID_CMD_HO to the new ground station.(XID_CMD_LE should not be sent by the aircraft in this case. This results in the aircraft having only one VDL-2 link with a ground system at any time, except in the duration of the TG5 timer (i.e., during handoff within the same ground system).

When the aircraft transitions from an existing ground station to the new ground station and the two ground stations belong to two different ground systems (Identified by two different VDL_SysID’s.) it should send XID_CMD_LE to the new ground station. (XID_CID_HO should not be sent by the aircraft in this case.)

There is no coupling between Link layer level handoff and IS-SME level Handoff Event. This means ISH PDU and Call Request/Call Confirm packet can be sent in an XID_CMD_HO/XID_RSP_HO to perform route initiation (IS-SME route initiation (as defined in the ATN ICS SARPs) is performed as a result of IS-SME receiving a Join Event from the subnetwork (i.e., SN-SME), when expedited subnetwork connection establishment is supported with VDL link handoff.

From the definitions stated above, an aircraft crossing, within a same Ground System, two Ground Stations connected to different ADM/ARS (whatever ground supports X.121 addressing or not) will send an handoff (XID_CMD_HO) to the new ground station. In this case, a ISH PDU should be included into the call request in order to ensure proper route initiation and exchange of configuration information. Refer to Figure 2 and Figure 3.

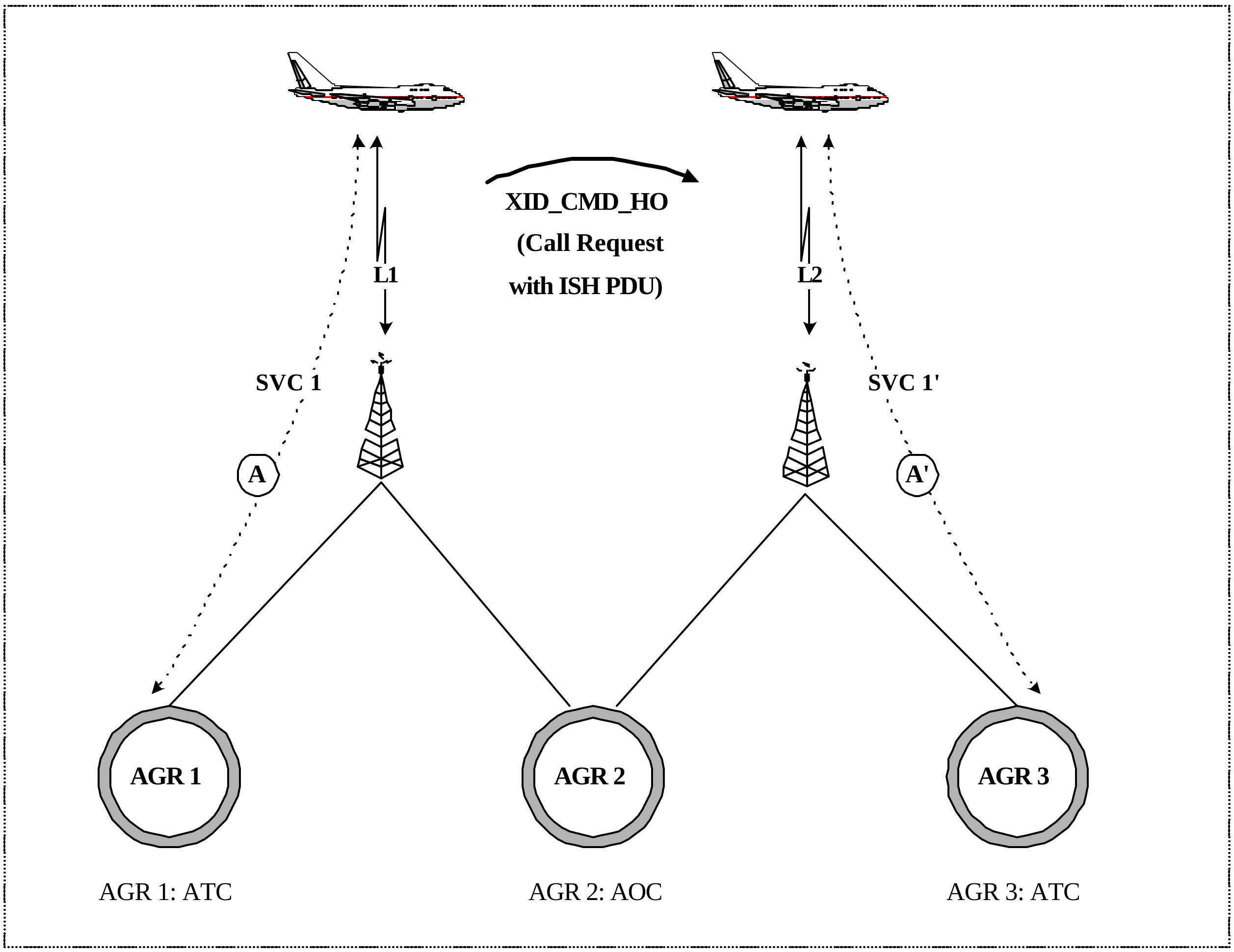
APPENDIX B (cont'd)
DEFINITION OF VDL ADDRESSES, GROUND SYSTEM, SYSTEM MASK AND USE OF THESE PARAMETERS FOR VDL LINK HANDOFF



Ground System
(unique VDL_SysID)

Figure B-1: Handoff event sent without ISH PDU

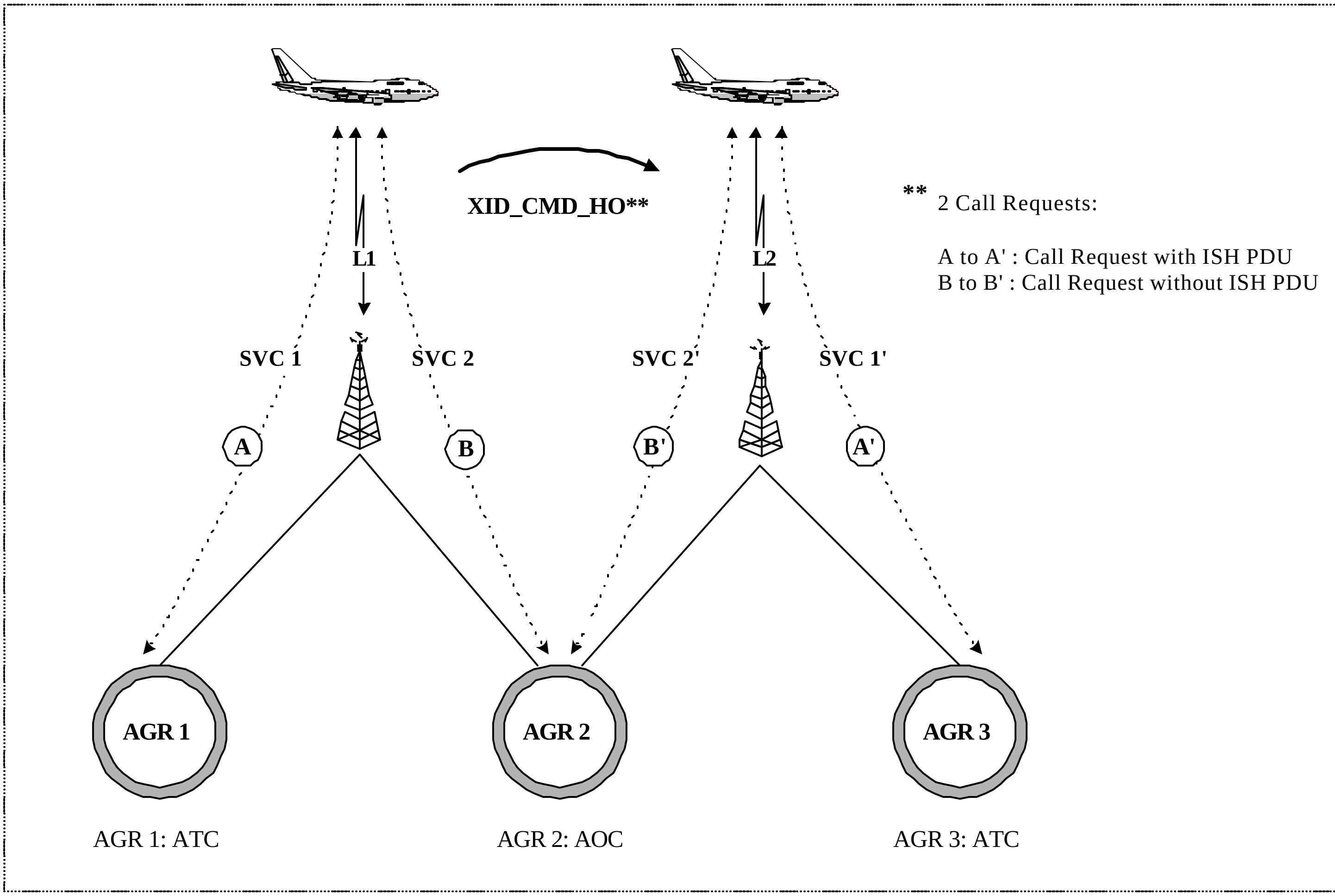
APPENDIX B (cont'd)
DEFINITION OF VDL ADDRESSES, GROUND SYSTEM, SYSTEM MASK AND USE OF THESE PARAMETERS FOR VDL LINK HANDOFF



Ground System
(unique VDL_SysID)

Figure B-2: Handoff event sent with ISH PDU (first example)

APPENDIX B (cont'd)
DEFINITION OF VDL ADDRESSES, GROUND SYSTEM, SYSTEM MASK AND USE OF THESE PARAMETERS FOR VDL LINK HANDOFF



Ground System
(unique VDL_SysID)

Figure B-3: Handoff event sent with ISH PDU (second example)

APPENDIX B (cont'd)
DEFINITION OF VDL ADDRESSES, GROUND SYSTEM, SYSTEM MASK AND USE OF THESE PARAMETERS FOR VDL LINK HANDOFF

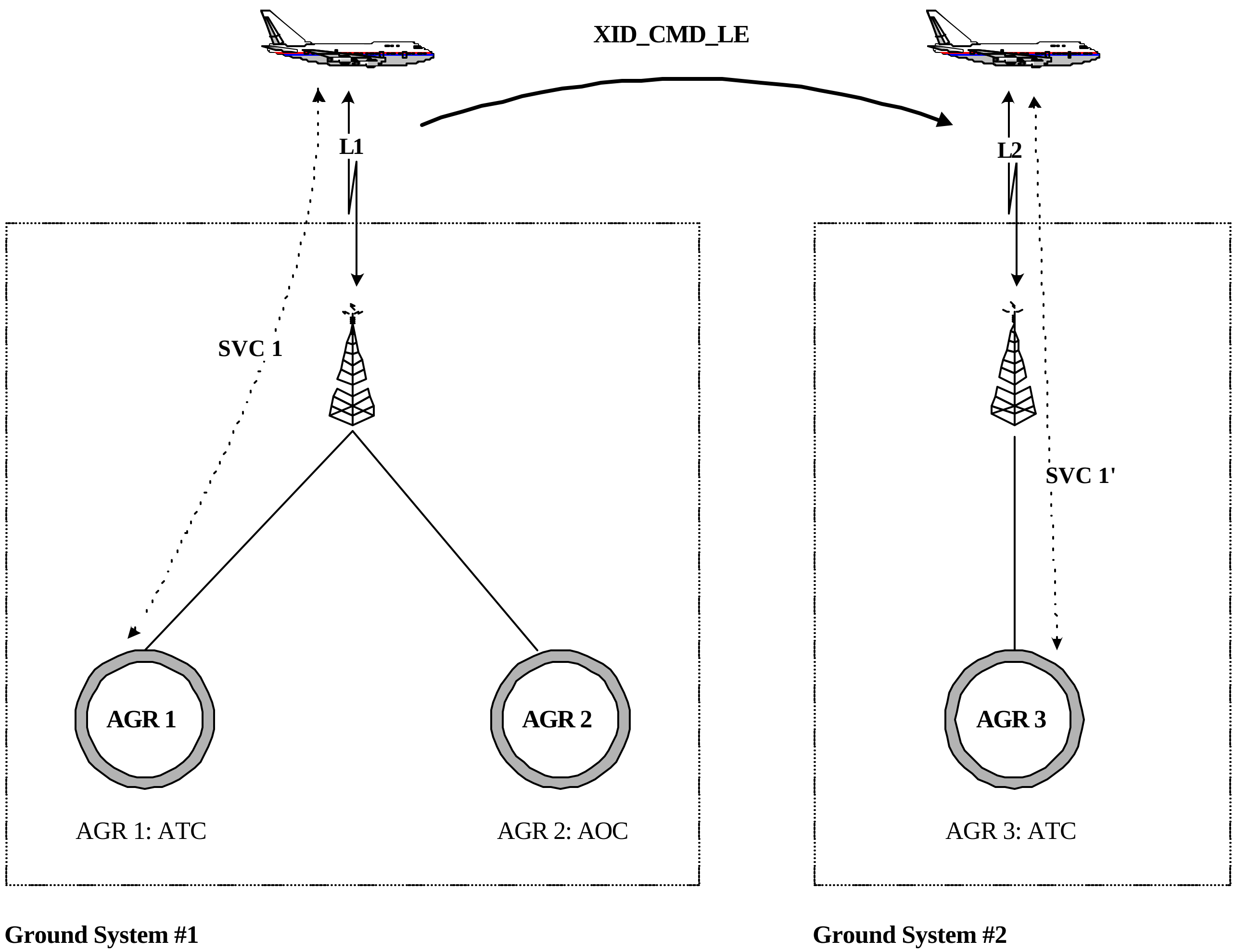
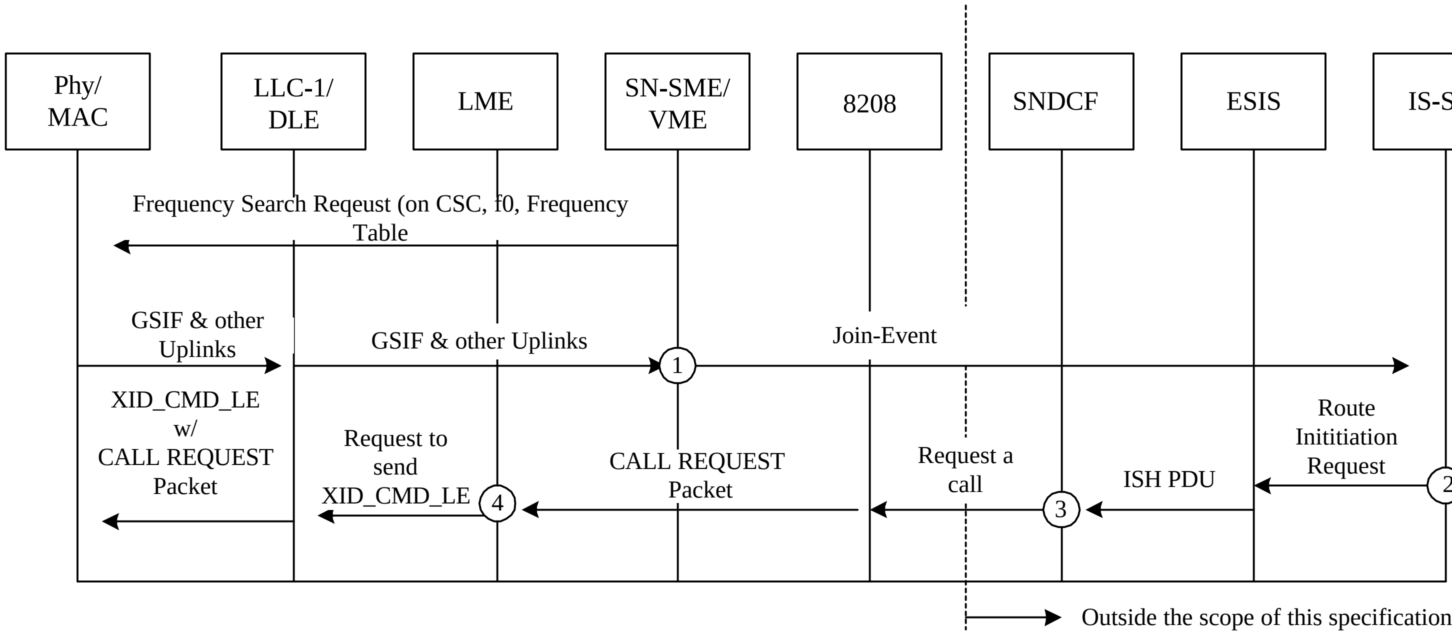


Figure B-4: Leave Event – Crossing Ground Systems

AVLC Link and Subnetwork Connection Establishment
(Expedited Subnetwork Connection) - Part I



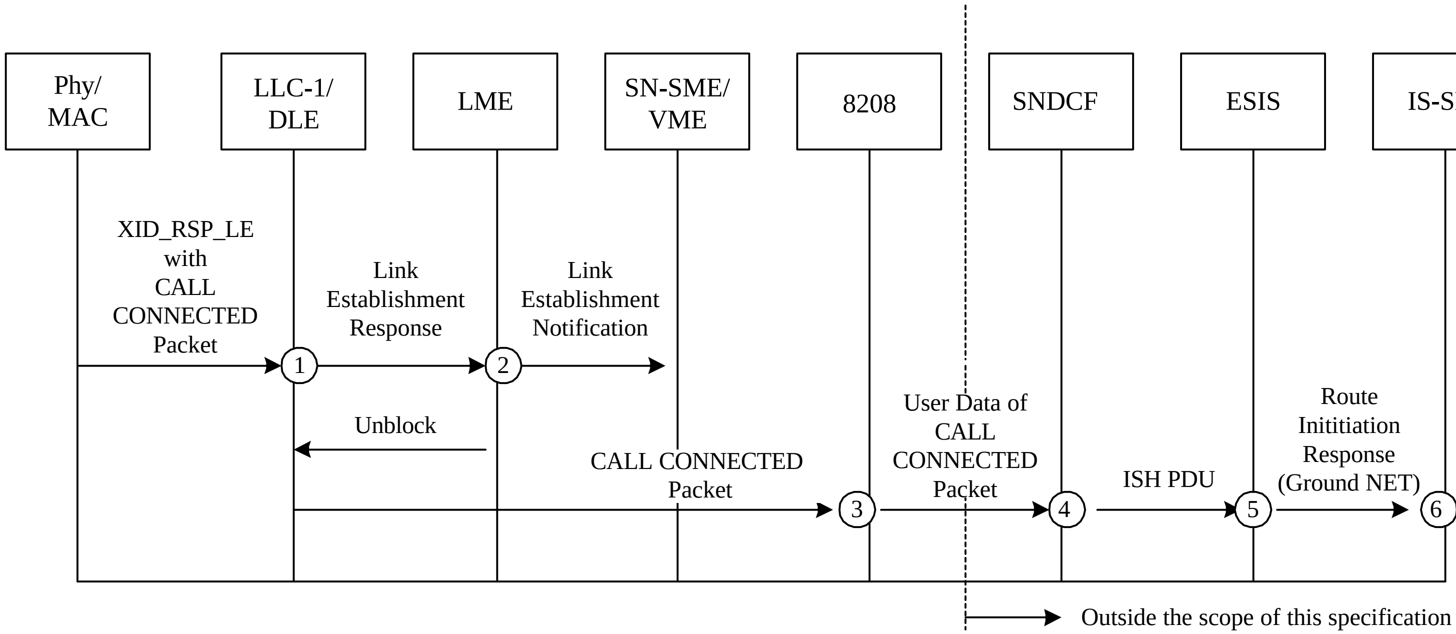
[1] Creates a join-event based on local policy. It consists of 1) DSP ID, 2) VDL Specific DTE adddress of the air/ground router(s), and 3) Other parameters.

[2] Based on join-event parameters and airline's policy, selects the ground router to connect with. Sends a route initiation request to ESIS with DTE address of ground router and ground station ID. ESIS then creates an ISH PDU to be sent to this router.

[3] Creates mobile SNDCF header with compression options. Sends a call request command to 8208 with user's data consisting of ISH PDU and mobile SNDCF header, specifying the ground DTE address.

[4] LME requests DLE to send an expedited XID_CMD_LE with the embedded 8208 CALL REQUEST packet (user's data 's = ISH PDU and SNDCF header). Starts T3 (XID_CMD_LE retransmission timer)

AVLC Link and Subnetwork Connection Establishment
(Expedited Subnetwork Connection) - Part II



[1] Receives the XID_RSP_LE frame from MAC. Validates the syntax/semantics of this frame. Forwards AVLC parameters in the XID_RSP_LE to LME. If LME accepts the parameters in the XID_RSP_LE, extracts the data part of XID_CMD_LE (which is a 8208 CALL CONNECTED packet) and sends it to 8208.

[2] If link parameters are acceptable marks the link as established. Unblocks DLE so that it is ready for data transfer, and notifies SN-SME/ VME that the link is now established. If link parameters are not acceptable, commands LLC-1/MAC to send XID_RSP_LCR, and notifies SN-SME/ VME of the link establishment failure.

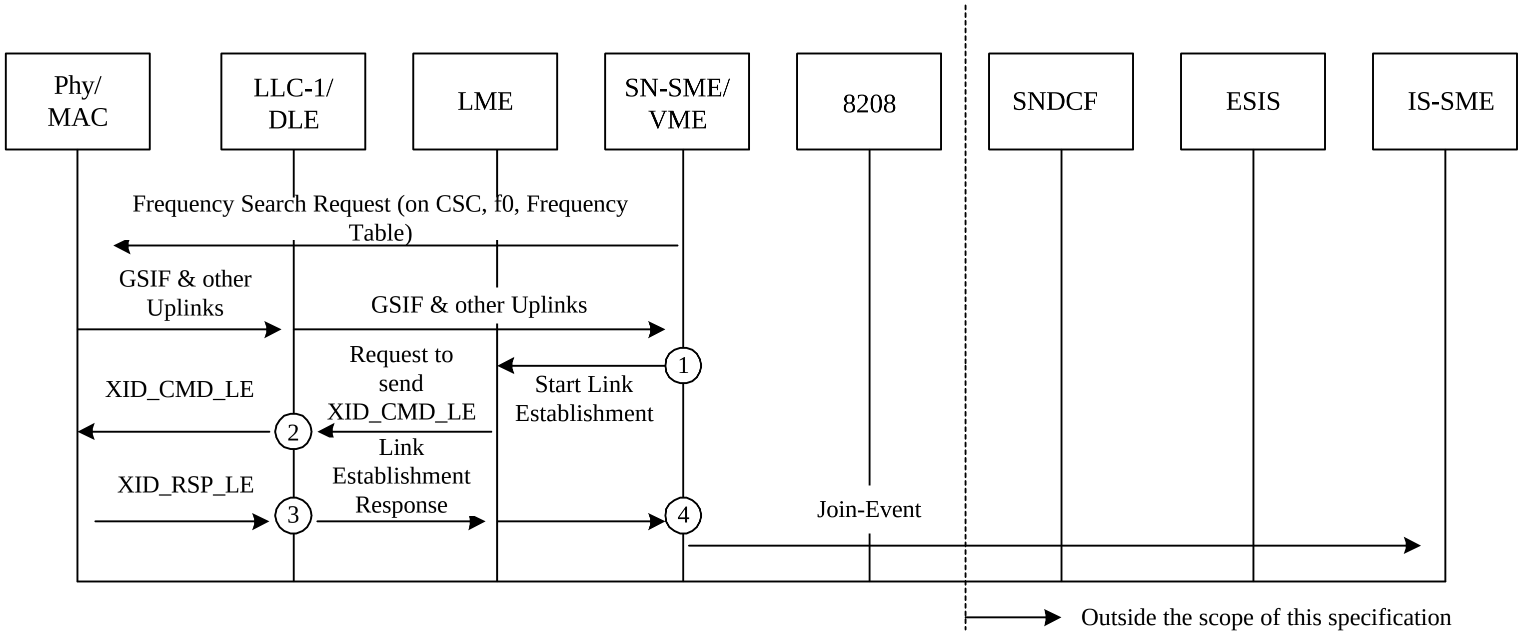
[3] Extracts the user's data part of the CALL CONNECTED packet (which is the SNDCF header and ISH PDU) and sends it to SNDCF.

[4] Extracts the users's data part of the SNDCF header (which is the ISH PDU) and sends it to ESIS.

[5] Extracts the air/ground router NSAP address from ISH PDU and forwards it to IS-SME.

[6] Matches the received NET against the list of configured adjacent NETs. If matched, commands IDRP to start IDRP connection.

AVLC Link and Subnetwork Connection Establishment
(Explicit Subnetwork Connection) - Part I



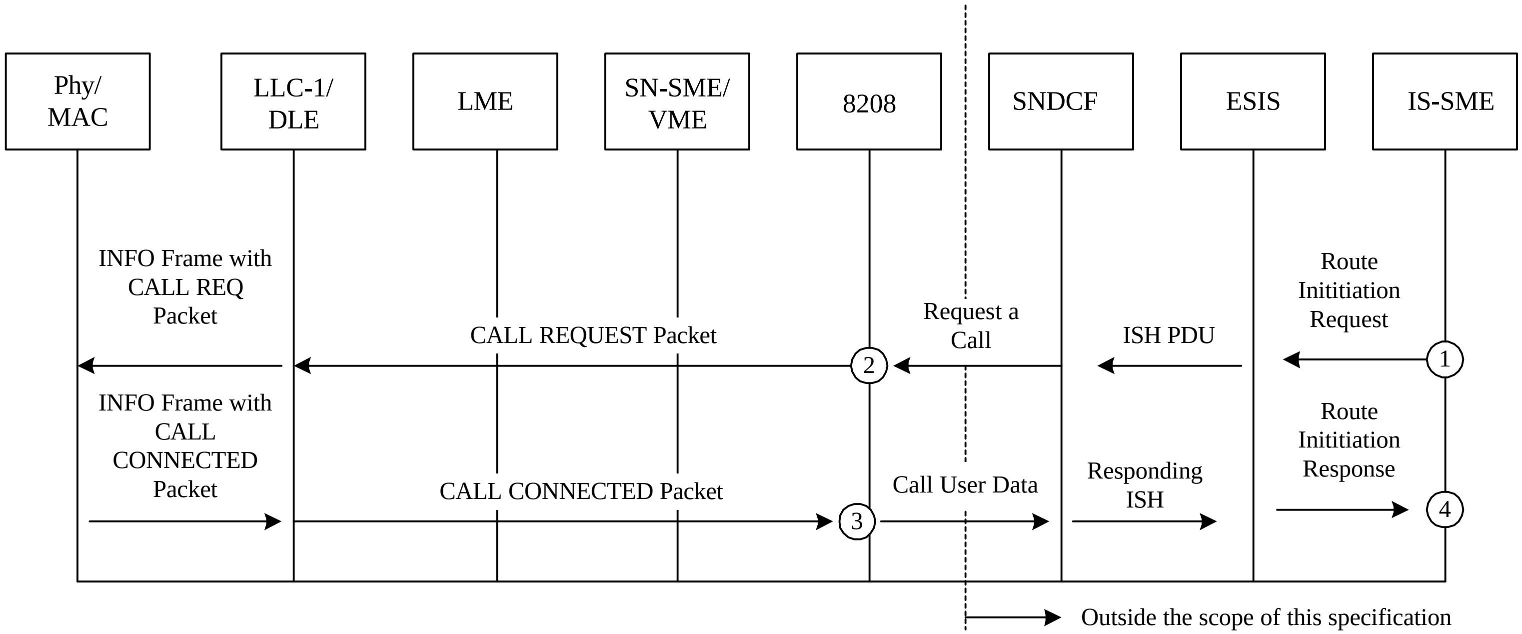
[1] SN-SME requests for a VDL link to be established to a specific DSP.

[2] XID_CMD_LE is sent without the CALL REQUEST packet.

[3] XID_RSP_LE is received without the CALL CONNECTED packet.

[4] If LME accepts the AVLC parameters in the XID_RSP_LE, it will send a link-up notification to IS-SME; otherwise, it will send an XID_CMD-LCR to the responding ground station.

AVLC Link and Subnetwork Connection Establishment
(Explicit Subnetwork Connection) - Part II



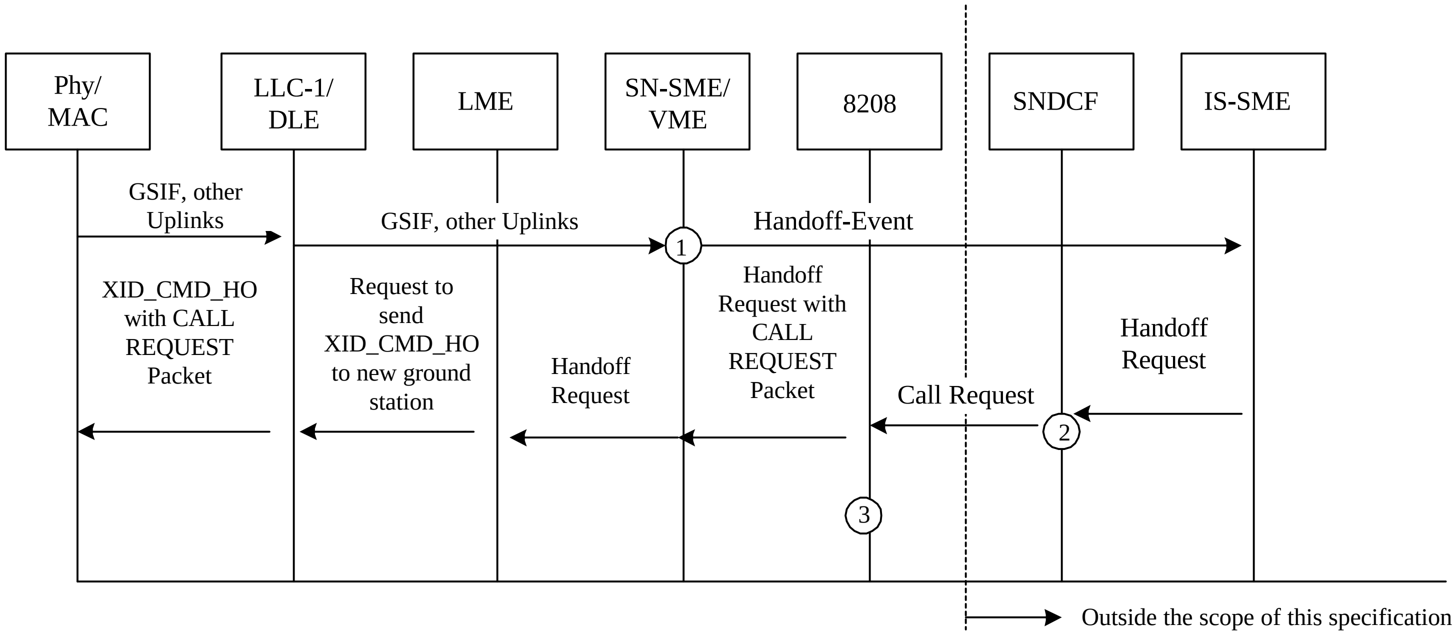
[1] Upon receiving the link-up notification, IS-SME starts the route initiation sequence.

[2] The CALL REQUEST packet is sent with the fast select facility where the call user data consists of mobile SNDCF header and ISH PDU.

[3] The CALL CONNECTED packet is received with the call user data consisting of the mobile SNDCF header and responding ISH PDU.

[4] Upon receiving the route initiation response, IS-SME requests IDRP to start the BIS-BIS connection.

Aircraft-Initiated Handoff - Same Air-Ground Router
(Expedited Subnetwork Connection) - Part I



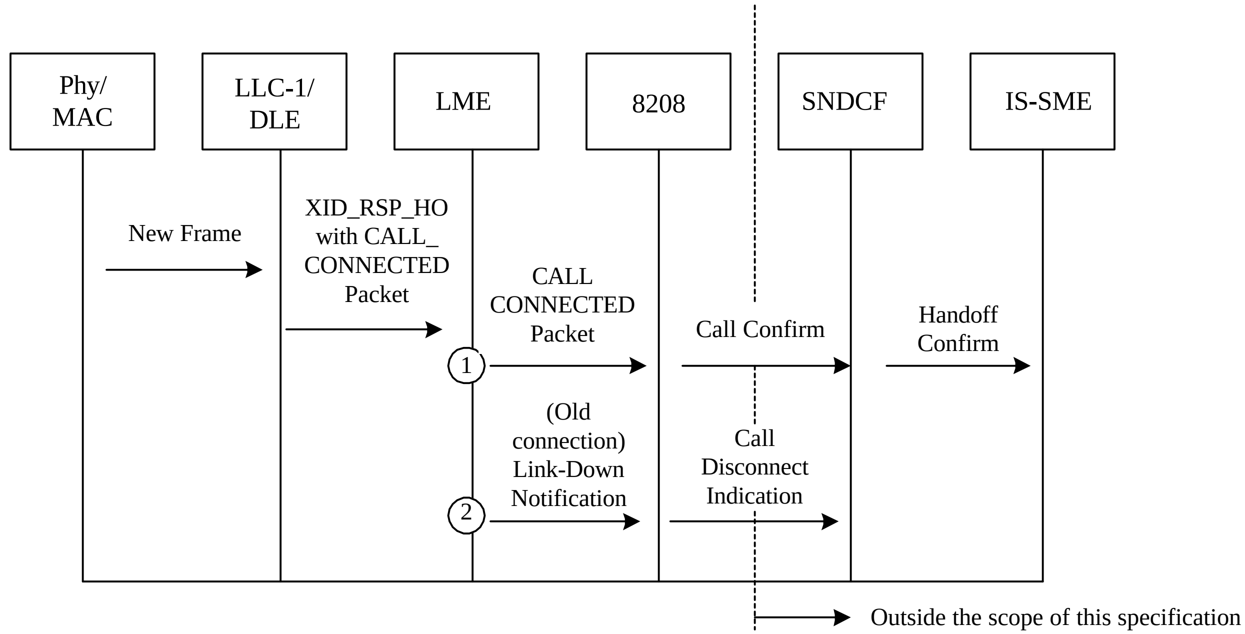
Note: The MSC for ground-requested aircraft-initiated handoff is similar to aircraft-initiaited handoff, except that the XID_CMD_HO (P=0) is the trigger that causes SN-SME/VME to send the handoff-event to SNDCF (same ADM/ ARS).

[1] The LME determines that the aircraft needs to initiate a handoff, based on conditions listed in VDL Mode 2 SARPs Section 6.5.4.4.6.1. It selects a new ground station that connects to the same air-ground router (based on ADM and ARS fields), and sends a handoff-event to IS-SME with the selected ground station.

[2] If the ground station supports the Ground Network DTE Address (VDL SARPs Table 6-21) option, the mobile SNDCF sends a Call Request to 8208, passing the ground DTE X.121 address to be used for the Called Address in the CALL REQUEST packet. (During previous SVC establishment, when the SNDCF received the Call Confirm, it extracted the ground DTE X.121 address from the Called Line Address Modified Notification Facility field and saved this address in its memory). The SNDCF header has the M/I bit set (to 1) to indicate that the LREF compression table for the old SVC is to be reused for the new SVC. Also note that SNDCF must select an SNCR (subnetwork connection reference) number that is different from the SNCR of the old SVC that is going to be cleared (upon TG5 expiry) as a result of the handoff.

[3] The 8208 builds a CALL REQUEST packet with the X.121 address in the Called Address field. The Called Address Extension facility is not used. If X.121 addressing is not supported by the ground system, then the VDL Specific DTE address is not used in the address extension field of the CALL REQUEST packet.

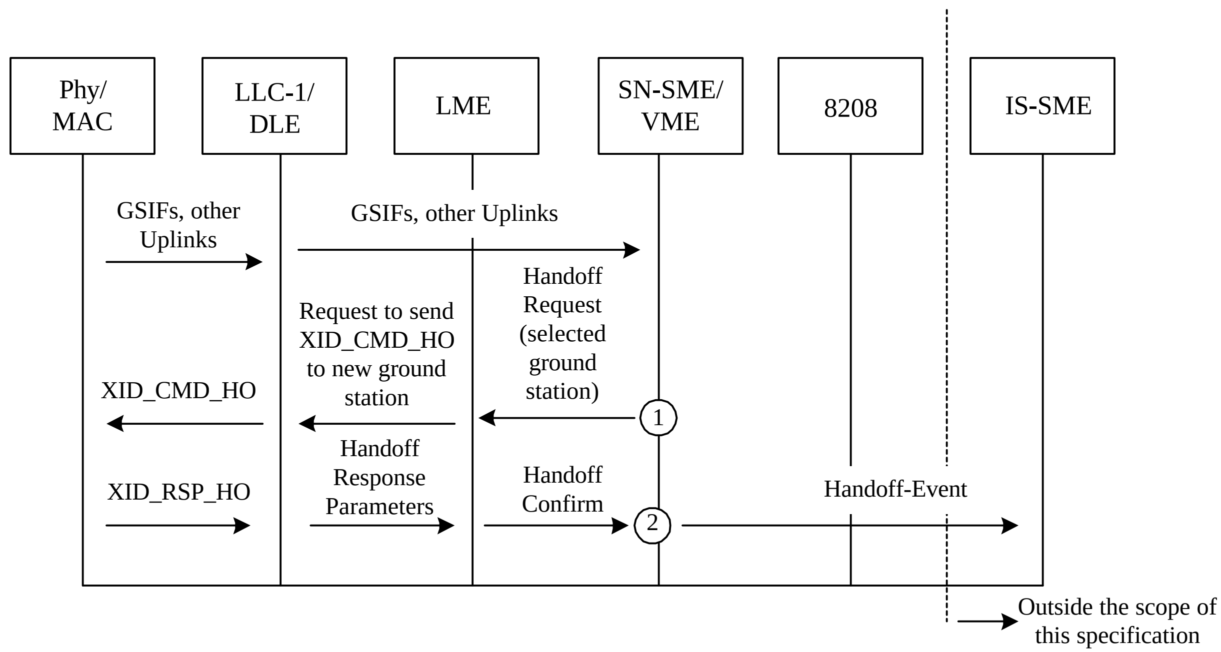
Aircraft-Initiated Handoff - Same Air-Ground Router
(Expedited Subnetwork Connection) - Part II



[1] If LME accepts the parameters in the XID_RSP_HO, it forwards the CALL_CONNECTED packet to 8208 and starts timer TG5. 8208 extracts the user data field and sends it to the mobile SNDCF. If LME does not accept the parameters in the XID_RSP_HO, it sends an XID_CMD_LR frame back to the new ground station.

[2] When timer TG5 expires, the mechanism to de-establish the old virtual circuit and clean up associated resources is implementation dependent. One possible way to implement this mechanism is having the LME send a link-down event to 8208 with a link ID. 8208 clears the virtual circuit associated with this link, and sends a disconnect indication to SNDCF for this virtual circuit.

Aircraft-Initiated Handoff - Same Air-Ground Router
(Explicited Subnetwork Connection) - Part I



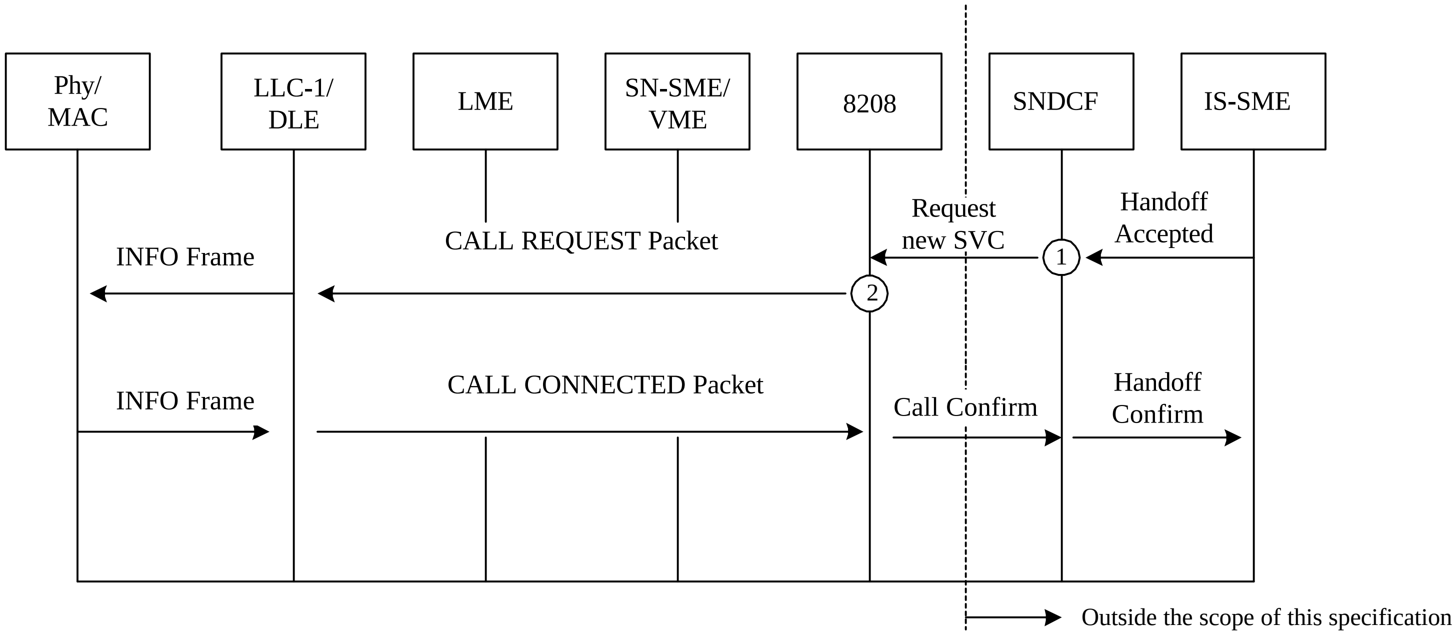
Note: The MSC for ground-requested aircraft-initiated handoff is similar to aircraft-initiated handoff, except that the XID_CMD_HO (P=0) is the trigger that causes SN-SME/VME to send the handoff request to LME.

[1] The SN-SME/VME determines that the aircraft needs to initiate a handoff, based on conditions listed in VDL Mode 2 SARPs Section

6.5.4.4.6.1. It selects a new ground station that connects to the same air-ground router (based on ADM and ARS fields), and requests LME to initiate a handoff with the selected ground station.

[2] Upon receiving the handoff confirm from LME, SN-SME/VME sends a handoff event to SNDCF.

Aircraft-Initiated Handoff - Same Air-Ground Router
(Explict Subnetwork Connection) - Part II



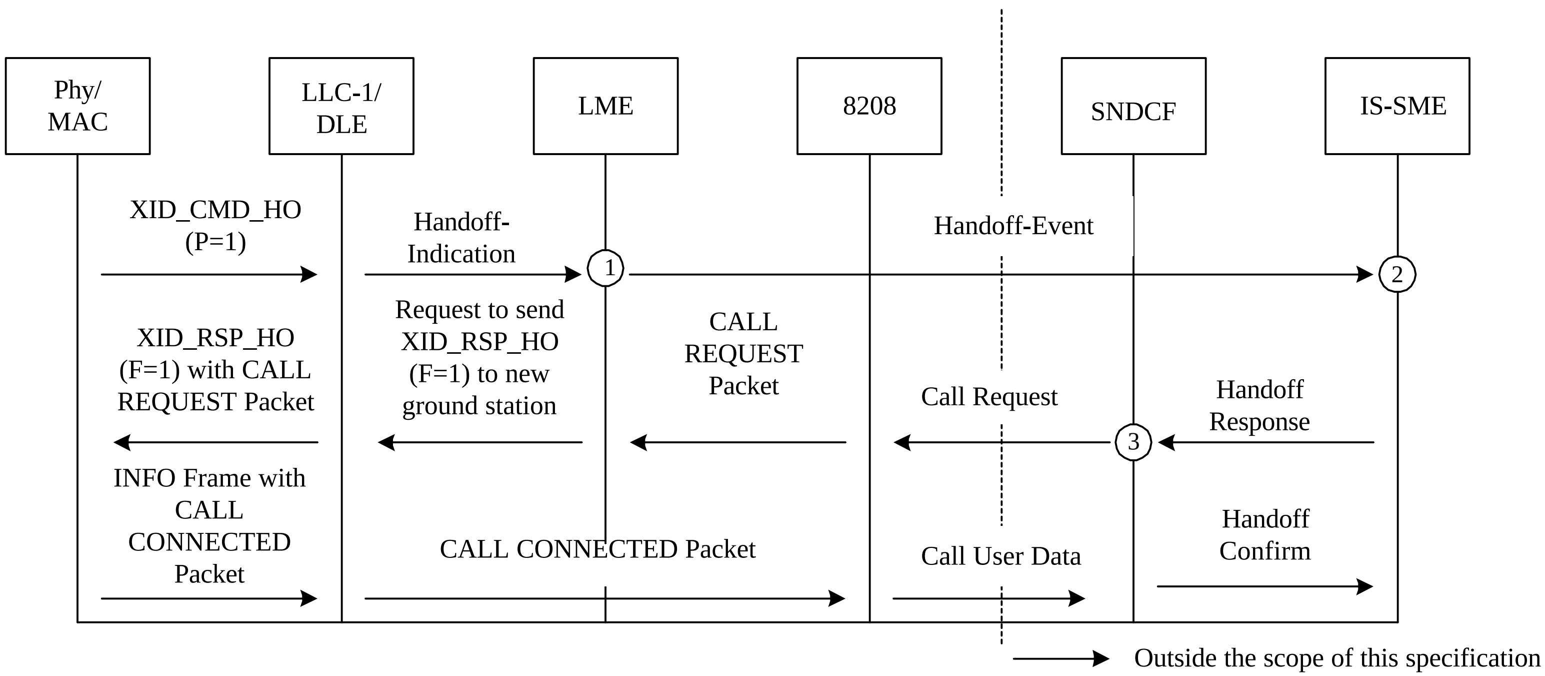
[1] Upon receiving the handoff event from SN-SME/VME, the SNDCF sends a call request to 8208 with fast select facility.

If the ground system supports the Ground Network DTE Address (VDL SARPs Table 6-21) option, the mobile SNDCF passes the ground DTE X.121 address to be used for Called Address in the CALL REQUEST packet. (During previous SVC establishment, when the SNDCF received the Call Confirm, it extracted the ground DTE X.121 address from the Called Line Address Modified Notification Facility field and saved this address in its memory. The SNDCF header has the M/I bit set (to 1) to indicate that the LREF compression table for the old SVC is to be reused for the new SVC.

[2] The SNDCF must select an SNCR (subnetwork connection reference) number that is different from the SNCR of the old SVC that is going to be cleared (upon TG5 expiry) as a result of the handoff.

The 8208 builds a CALL REQUEST packet with the X.121 address in the Called Address field. The Called Address Extension facility is not used if the ground system supports X.121 addressing. Otherwise, the call request contains the VDL Specific DTE address in the address extension field.

Ground-Initiated Handoff - Explict on Uplink, Expedited on Downlink



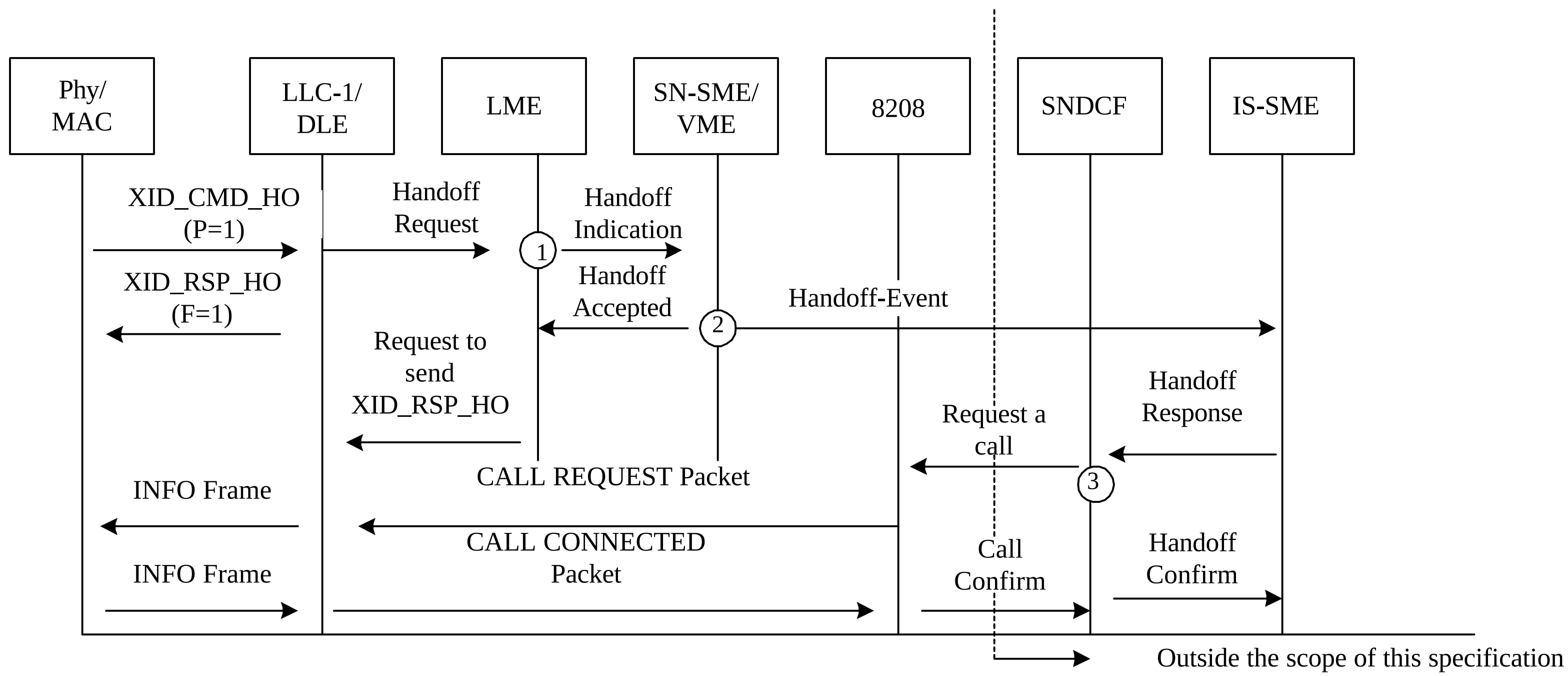
The MSC for aircraft-requested ground-initiated handoff (expedited) is similar to ground-initiated handoff, except that the airborne SN-SME-VME sends the XID_CMD_HO (P=0) to the existing ground station to trigger the XID_CMD_HO (P=1) initiated by the new ground station.

[1] If the LME does not accept the parameters in the XID_CMD_HO, it will send back (to the ground LME) the XID_RSP_LCR. If it accepts the XID_CMD_HO, it sends a handoff event to IS-SME. The ground-initiated XID_CMD_HO does not include the CALL REQUEST packet. The handoff event includes the VDL Specific DTE Address of the air/ground router.

[2] If IS-SME accepts the handoff, it sends a Handoff Response to SNDCF, passing the air/ground router's address.

[3] SNDCF sends a Call Request to 8208 with the M/I bit set (to 1). In order to connect to the exact same router, SNDCF needs to pass the ground X.121 address in the CALL REQUEST packet, in the Called Address field. Such use of the X.121 address is possible only if the ground station supports the Ground Network DTE Address option (VDL SARPs Table 6-21.

Ground-Initiated Handoff - Explicit Subnetwork Connection
(When Aircraft or Ground Station Do Not Support Expedited Option)



Note: The MSC for aircraft-requested ground-initiated handoff (explicit) is similar to ground-initiated handoff, except that the airborne SN-SME/VME sends the XID_CMD_HO (P=0) to the existing ground station to trigger the XID_CMD_HO (P=1) initiated by the new ground station.

[1] If the LME does not accept the parameters in the XID_CMD_HO, it will send back (to the ground LME) an XID_RSP_LCR; otherwise it will forward the handoff indication to SN-SME/VME.

[2] If the ground station ID is the same, SN-SME/VME commands LME to accept the handoff and send a handoff event to IS-SME.

[3] The SNDCF header has the M/I bit set (to 1) to indicate that the LREF compression table for the old SVC is to be reused for the new SVC. Implementation should provide sufficient time to allow the XID_RSP_HO frame to arrive before the INFO frame that carries the CALL REQUEST packet.

APPENDIX D
VSDA CONFIGURATION ISSUE

D.1 Introduction

The purpose of this Appendix is to address the scenario in which an aircraft flies between Ground Stations in the territory of different ATS providers. In such a situation, how can an aircraft select, establish and handoff link connections to Ground Stations having a varied ground topology (Ground Stations possibly connected to different ATC routers in adjacent territories) while ensuring continuing AOC and ATC services to the users.

In this Appendix, three scenarios are presented. The first scenario addresses the problem; the second scenario presents a solution to that problem; the third scenario presents an alternate solution to the same problem. Finally, the last section of this Appendix presents some requirements summarizing the propositions raised.

Before depicting the three scenarios, here are some assumptions that apply throughout this Appendix:

Assumptions:

1. All VSDAs announced by a GS belong to the same Ground System (as identified by the Ground System mask);

2. A Ground System mask may not identify a specific air/ground router (particularly when multiple routers are connected to a Ground Station);

3. An ATN router (identified by its VSDA) may be connected to multiple Ground Stations. These Ground Stations may or may not be part of the same VDL Ground System (identified by the system mask).

4. An ATN router (identified by its VSDA) may be connected to more than one VDL Ground System (identified by the system mask).

APPENDIX D (cont'd)
VSDA CONFIGURATION ISSUE

D.2 Scenario 1 – Identification of the problem

A set of Ground Stations connected to AOC router and ATC router 1. A different set of Ground Stations connected to the same AOC router and ATC router 2. All Ground Stations belong to the same Ground System.

This scenario can bee seen as the ATC Router 1 being in UK, the ATC Router 2 being in France and the AOC router being the one of a given service provider.

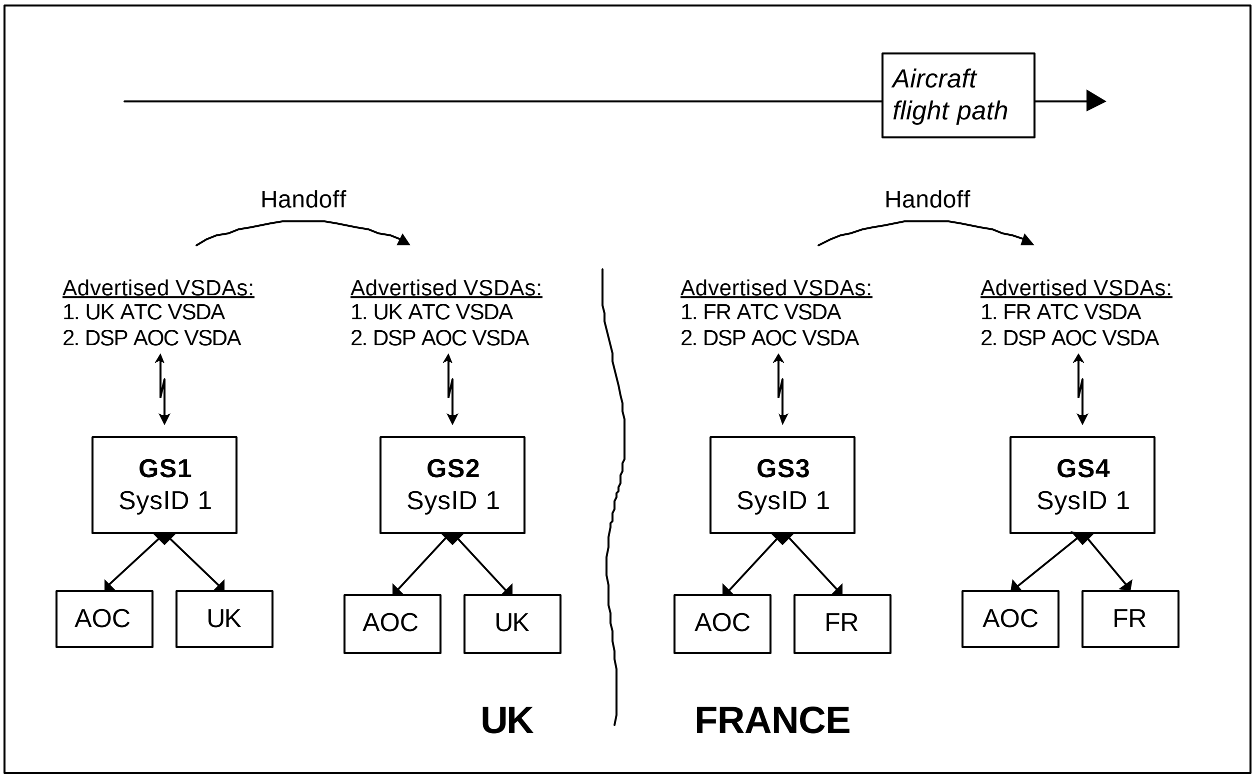


Figure D1: Scenario 1 - Identification of the problem

Let's assume that the aircraft is initially connected with GS1 based on signal quality (it did not hear any uplinks from GS2 through GS4). Also, both AOC and ATC services are required by the application. The GSIF from the Ground Stations will contain the VSDAs of all air/ground routers the GS is connected to. Therefore, GSIF from GS1 will contain the VSDA of AOC and the UK routers. By definition of VSDA, first 3 octets will identify the administrative domain of the router. Therefore, the aircraft would be able to identify one router as the AOC pertaining to a given DSP and the other one as being the ATC router of UK.

(Hopefully there will be code to do that in the aircraft. It might be in SN-SME or IS-SME but it is NOT in VDLM2 software. It is the upper layer's responsibility to pick the desired router. The decision logic is out of scope for this paper. Therefore, it is assumed that functionality will be provided for the remaining discussion.)

The aircraft decides to establish subnetwork connectivity with both AOC and UK routers. As the aircraft flies into the coverage region of GS2, it will recognize that same services are provided by GS2. As such, the aircraft would be able to handoff from GS1 to GS2 (eventually GS1 fades away) without any loss in service.

APPENDIX D (cont'd)
VSDA CONFIGURATION ISSUE

As the aircraft flies further to the right, it comes into the coverage region of GS3 which announces the same AOC router and the French ATC router. At this point, the VDLM2 function will send a "Service Available" indication to SN-SME regarding the new French ATC router. It is possible that the upper layers (and application) may decide to request a connection with the French Router while it is still connected with the UK router and the AOC router via GS2. However, the VDLM2 function will not be able to connect to the French ATC router while maintaining the UK ATC router connection.

LIMITATION: As all Ground Stations belong to the same Ground System (specified by System ID), the aircraft will not be able to connect to the French ATC router as it belongs to GS3 and the aircraft has the active link with GS2. This is due to the fact that <u>only one VDL link to an aircraft is supported within a given Ground System</u>.

To continue with the scenario, when the SQP of GS3 becomes greater than GS2, the VDLM2 function will send a handoff request for the AOC router (because same AOC router is supported by GS3 and GS3 has the same system mask). When the link is handed off from GS2 to GS3, the subnetwork connection for AOC router can be switched over to GS3. However, a subnetwork connection for UK router can not be established as it is not supported by GS3. The old link with GS2 will be disconnected after TG5 expires (20 seconds) which will also terminate the service for the UK router.

The VDLM2 function will send a "service unavailable" indication to SN-SME when the aircraft flies out of the coverage region of GS2.

***ISSUE*:** Because GS2 and GS3 belong to the same Ground System, a data link handoff will be executed for transition between GS2 and GS3. However, the VDLM2 function will not be able to establish a connection (SVC) to the French ATC router while maintaining the UK ATC router connection. The new connection via the French ATC router will only be possible after the old link be terminated (after TG5) and therefore the aircraft will loose its connection with the UK ATC router before it gets a new connection via the French ATC router.

Such a configuration is not desirable since a make-before-break for the ATC router connections cannot be performed in this case. Scenario 2 and 3 present two solutions to that issue.

Action Item: Avionics vendors to provide a detailed scenario of what would happen if the aircraft encounter a ground configuration like the one depicted in scenario 1.

APPENDIX D (cont'd)
VSDA CONFIGURATION ISSUE

D3. Scenario 2 – First Solution

This scenario, as the previous one, is depicted using an example involving the following countries: UK, France. This scenario can obviously be extended to different parts of the world.

An aircraft flying from UK to France needs to maintain at all times (and especially when crossing the UK-France border) an ATC connection with the appropriate ATC router (depending over which country the aircraft is flying). As a general concept, it is assumed that an aircraft wants to be linked to the ATC router pertaining to the country over which it is flying. The aircraft has to connect to the French ATC router before it leaves the UK ATC router and vice-versa. In order to achieve such a requirement, the following ground topology may be set (solution #1):

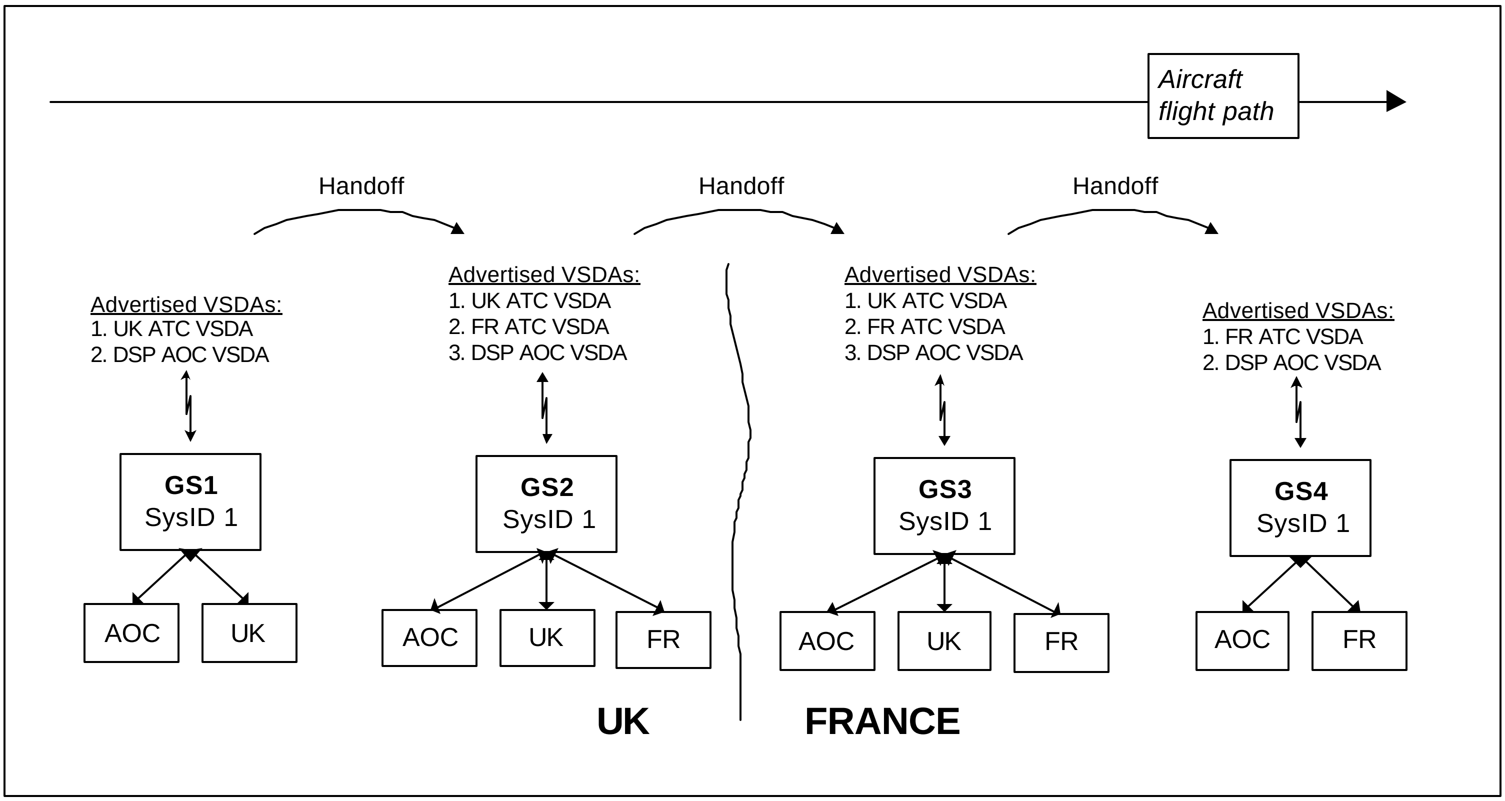


Figure D2: Scenario 2 – First Solution

As shown in the figure above, a Ground Station in UK but close to the France/UK border has connectivity to the AOC router and to the French ATC router <u>and</u> to the UK ATC router (and advertise such connections). The same principle applies for a router in France but close to the UK/France border. A router in central France or in central UK (i.e.: not close to a border) would only be connected to the AOC router and to the ATC router of its respective ATS authority.

APPENDIX D (cont'd)
VSDA CONFIGURATION ISSUE

With such a ground topology, an aircraft flying from UK to France will be able to connect to the French ATC router before it leaves the UK and before it looses its connectivity with the UK ATC router. Figures D3 depicts, through steps 1 to 5, the router connectivity that will be maintained by an aircraft flying from UK to France while maintaining at all times a connection with the AOC router and a connection to the ATC router of the country over which it is flying.

Rationale

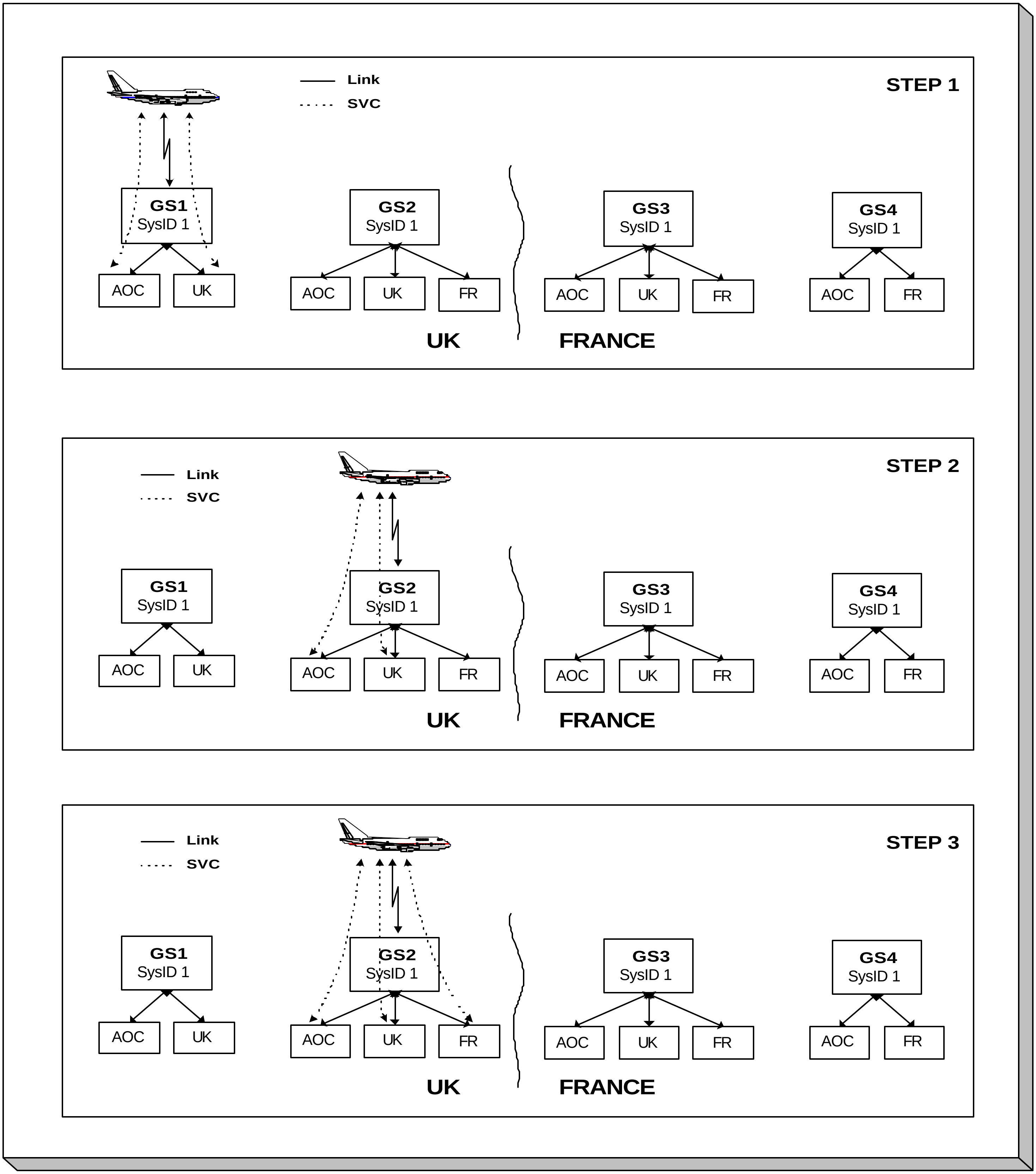
It has to be brought up that having proper Ground Station - Router connectivity ensuring a continuing ATC service to the aircraft (especially when the aircraft is crossing a state border - see Figure D2) will be a service provider responsibility. Along with their Ground Stations deployment, the service providers will have to work on a 'best effort' basis to ensure continuing ATC service such as described in the example above.

That being said, the configuration presented throughout this example is pretty straightforward in the sense that only two countries are involved and then only one state border needs to be taken into account. For sure, the service providers will have to cope with more complex configurations. Let's think for example of one small country (country A) having its own ATS authority amid four other countries (countries B, C, D and E) each also having their own ATS authority. It is very likely that a Ground Station in country A will have to advertise its own ATC router VSDA in addition to the ATC router VSDA of each surrounding ATS authority. Some Ground Station of countries B, C, D and E may also have in this case to advertise more than two ATC router VSDAs to ensure continuing ATC service in the region.

Now if we push such a ground topology complexity to its limit, we can tell that a given Ground Station might have to advertise up to N different VSDAs. However, it is noteworthy that a maximum number of VSDAs may be advertised in a GSIF.

The maximum number of VSDAs that can be advertised in a GSIF will have to be clearly determined and this limitation will have to be taken into account when building an efficient ground topology.

APPENDIX D (cont'd)
VSDA CONFIGURATION ISSUE



FigureD3 – Part 1: Scenario 2, Step-by-Step

APPENDIX D (cont'd)
VSDA CONFIGURATION ISSUE

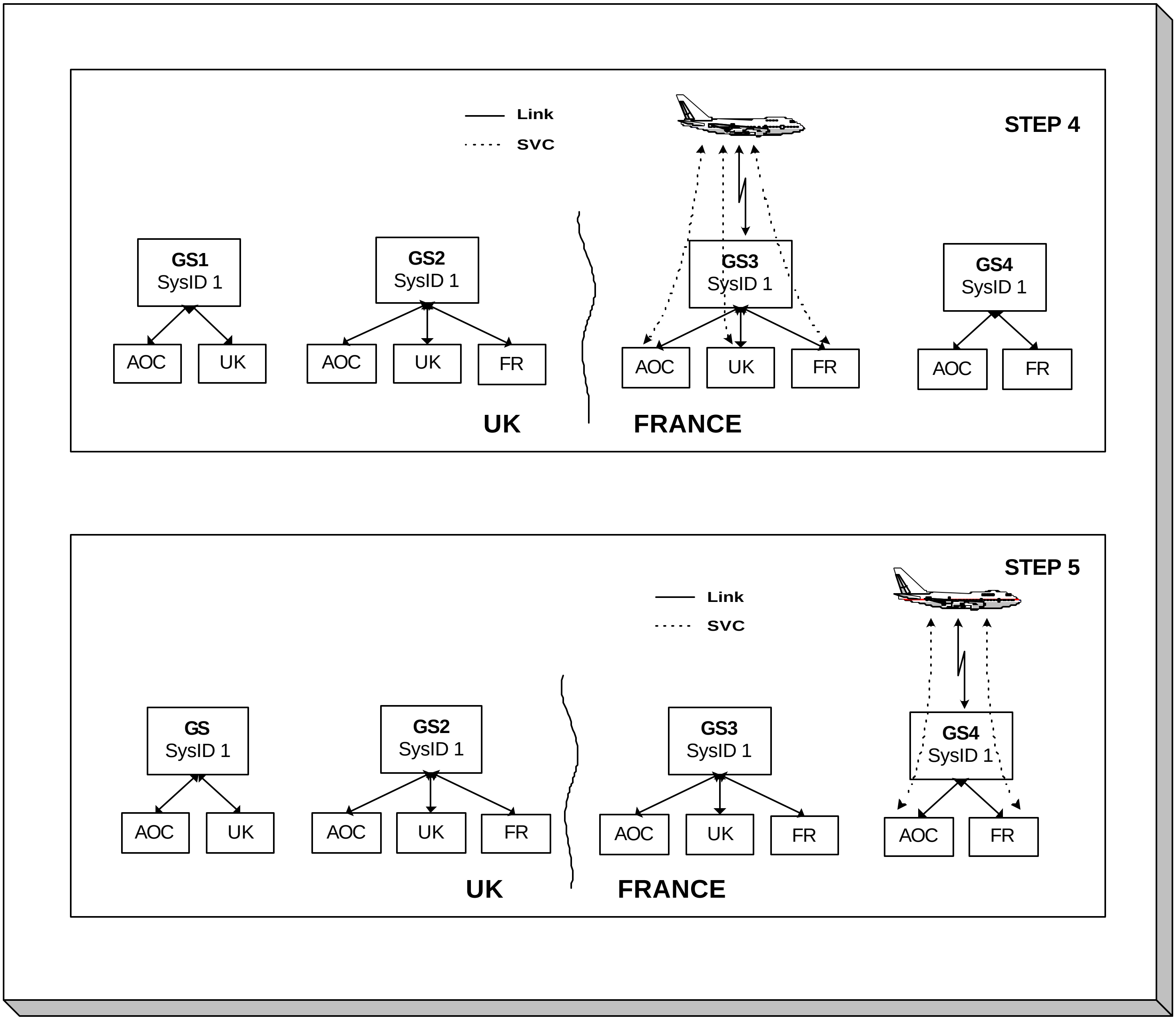


Figure D3 – Part 2: Scenario 2, Step-by-Step

APPENDIX D (cont'd)
VSDA CONFIGURATION ISSUE

D4. Scenario 3 – Second Solution

This scenario, as the previous ones, is depicted using an example involving the following countries: UK, France. This scenario can obviously be extended to different parts of the world.

The third scenario presents an alternate solution for a service provider to ensure continuing ATC service through different states having different ATS authorities. While ensuring proper services, this solution will allow a service provider to not ensure a physical connectivity between a Ground Station at the border of a state and the ATC routers of each adjacent state ATS authority (see scenario 2). However, contrary to the previous scenario, the Ground Stations in the different states (e.g.: UK and France) have been configured to be part of different Ground Systems as shown in Figure D4.

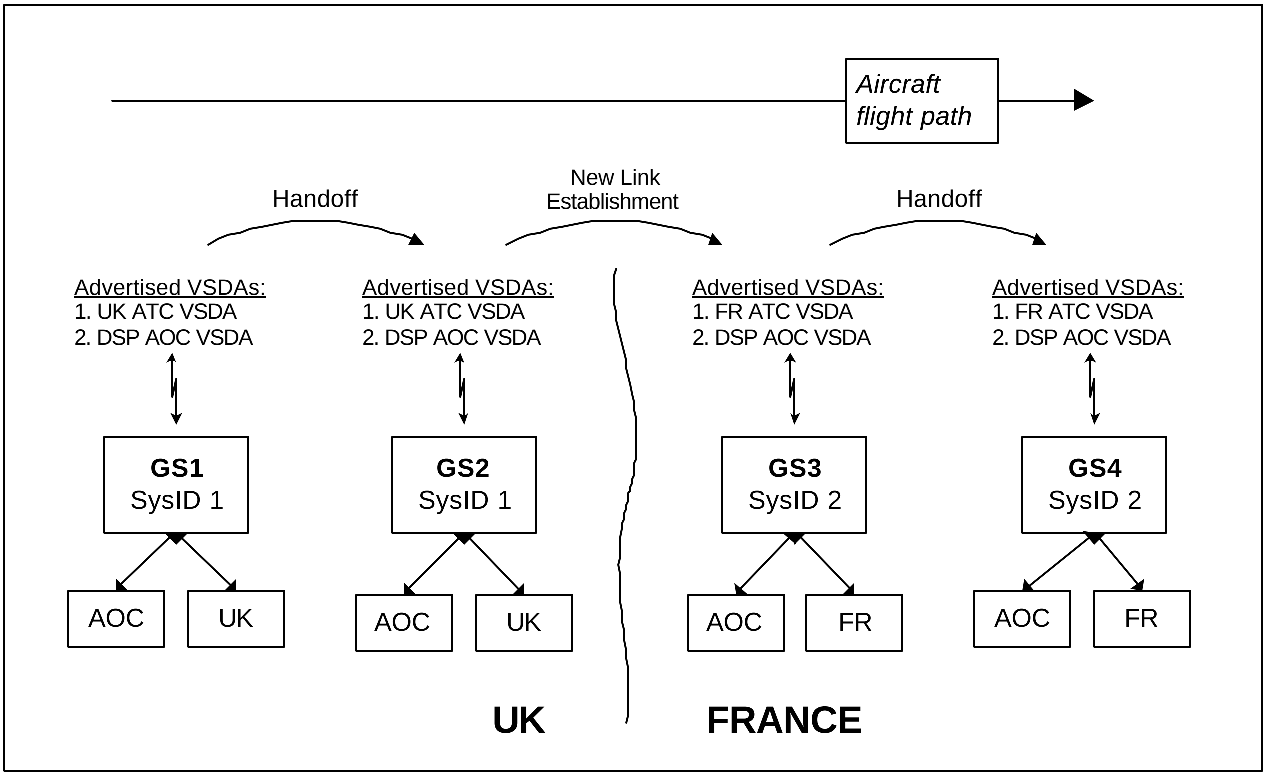


Figure D4: Scenario 3 – Second Solution

With this scenario, an aircraft flying from UK to France will be able to establish a new link with GS3 while maintaining for a certain period of time (not limited by TG5) its previous link with GS2. This can be accomplished since GS2 and GS3 are part of different Ground Systems. This scenario will then permit a make-before-break for the ATC router connections.

With such a ground topology, an aircraft flying from UK to France will be able to connect to both the French ATC router and the UK ATC router while crossing the France-UK border. Figures D5 depicts, through steps 1 to 5, the router connectivity that will be maintained by an aircraft flying from UK to France in that case.

APPENDIX D (cont'd)
VSDA CONFIGURATION ISSUE

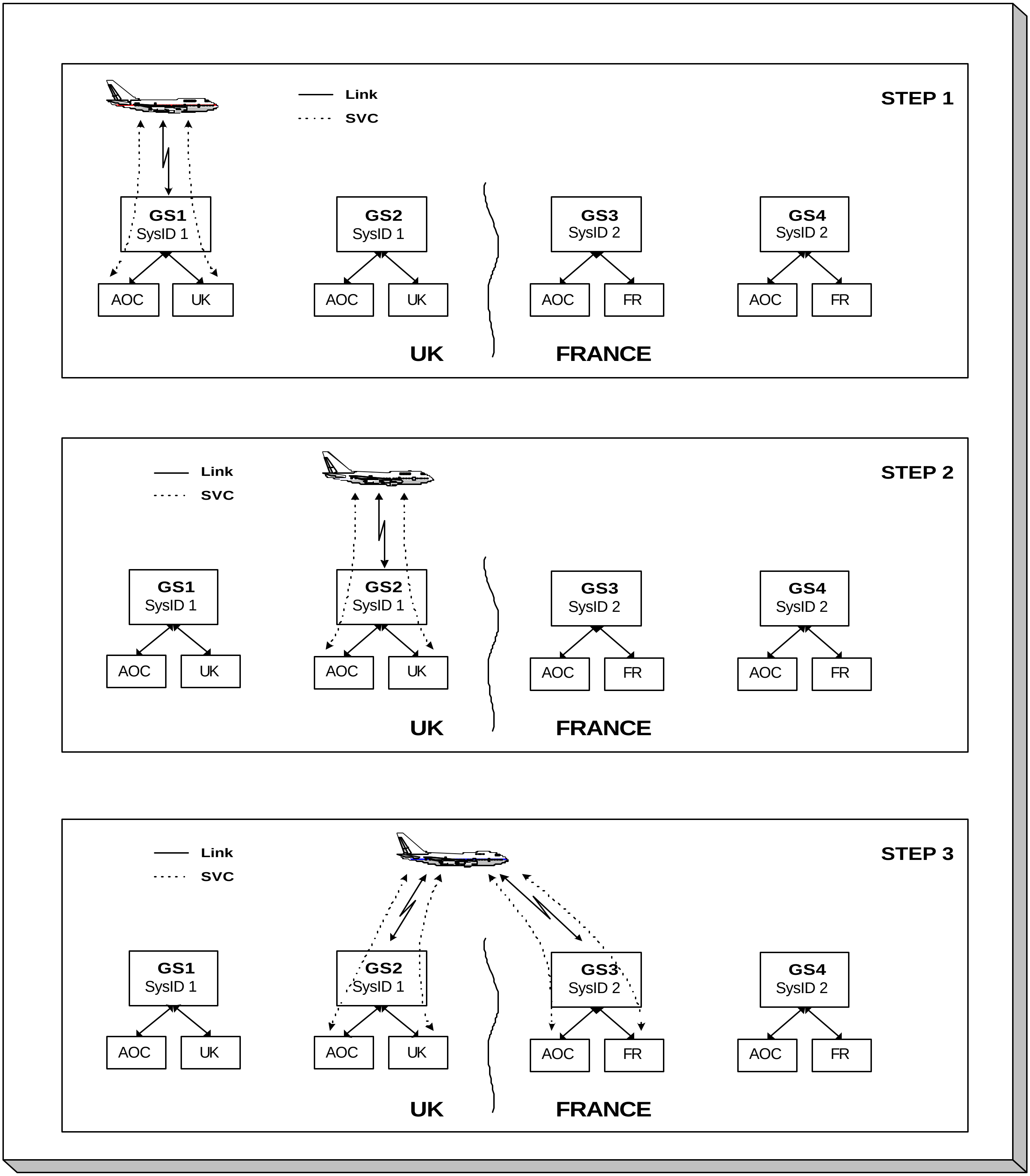


Figure D5 – Part 1: Scenario 3, Step-by-Step

APPENDIX D (cont'd)
VSDA CONFIGURATION ISSUE

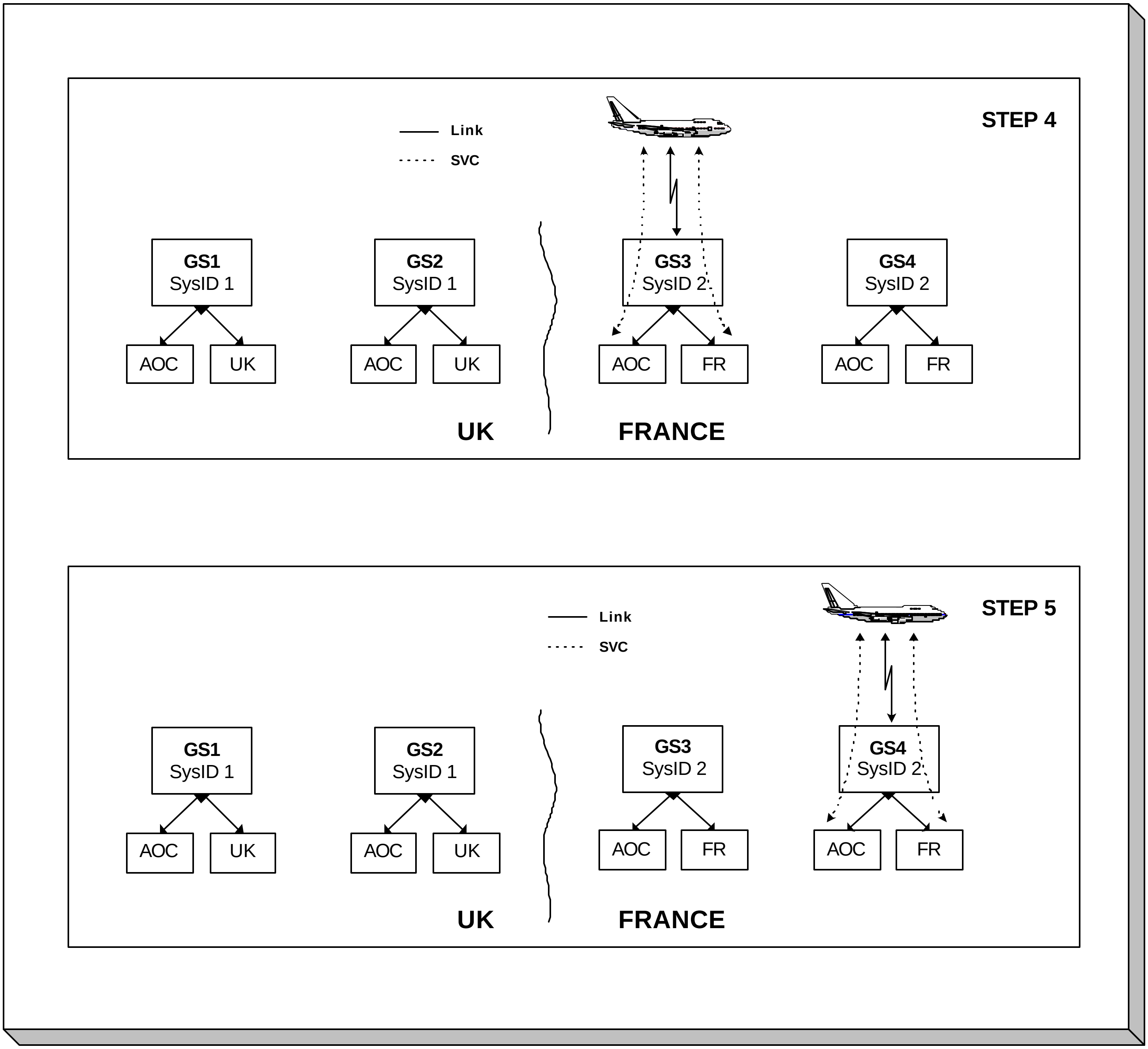


Figure D5 – Part 2: Scenario 3, Step-by-Step

APPENDIX E
STATE MACHINES

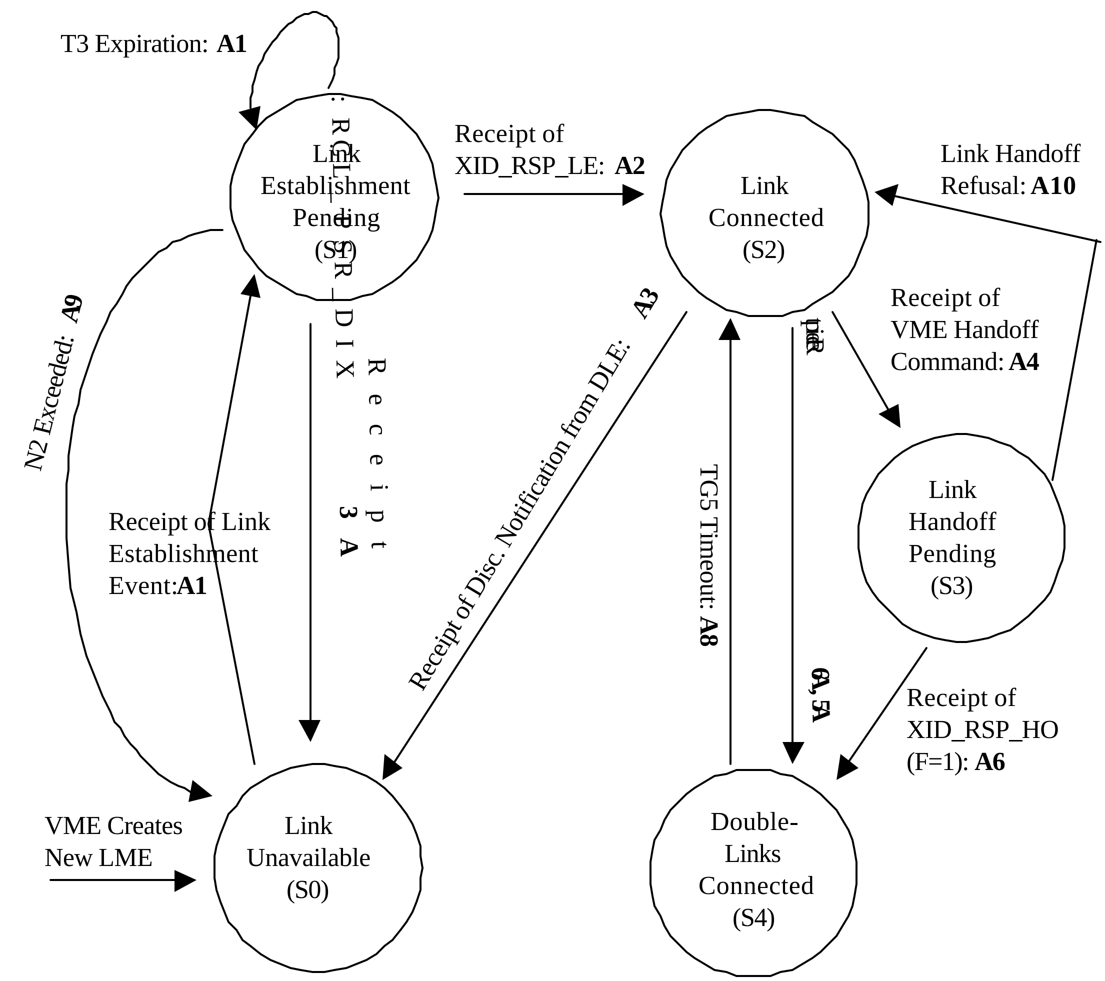


Figure E-1 LME State Diagram

Note: Starting with state S0, upon an event, the LME takes an action and transitions to a new state. The actions A1 through A9 are described below:

A1: Send XID_CMD_LE (P=1) to the ground station proposed by VME. Increment N2.
A2: Mark current ground station, set up link_id for this link connection. Create DLE.
A3: Notify VME and wait for command from VME to establish connection with a new ground station.
A4: Send XID_CMD_HO (P=1).
A5: Send XID_RSP_HO (F=1).
A6: Mark current link as “old”; mark new link as “current”; start timer TG5 on the old link.
A7: Mark old link as terminated; notify VME of old link termination.
A8: Maintain single link connection.
A9: Notify VME of failure in link establishment to this ground station.
A10: Notify VME of a handoff refusal.

APPENDIX E (cont'd)
STATE MACHINES

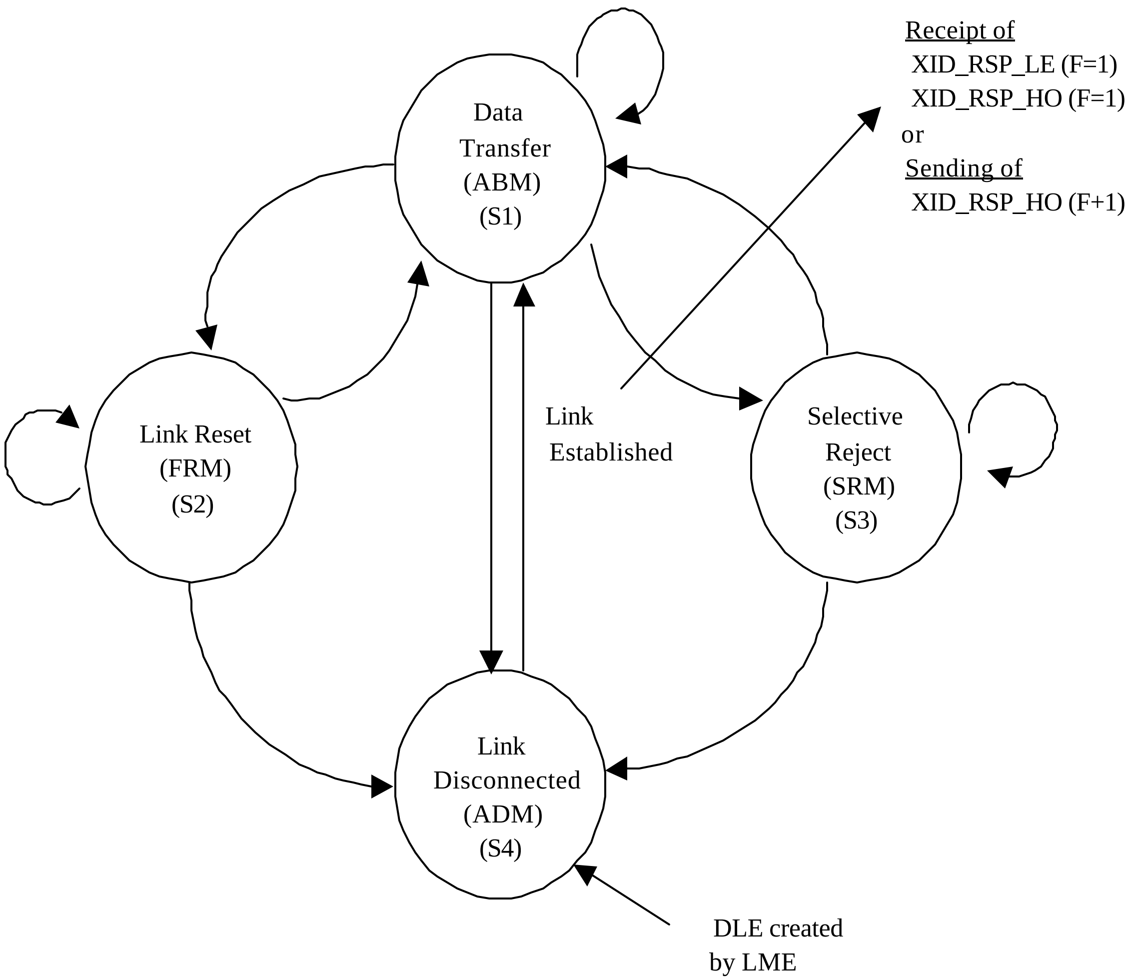


Figure E-2 DLE Top Level State Diagram

Note: The state diagrams illustrate VDL Mode-2 process. They do not constrain implementation.

APPENDIX E (cont'd)
STATE MACHINES

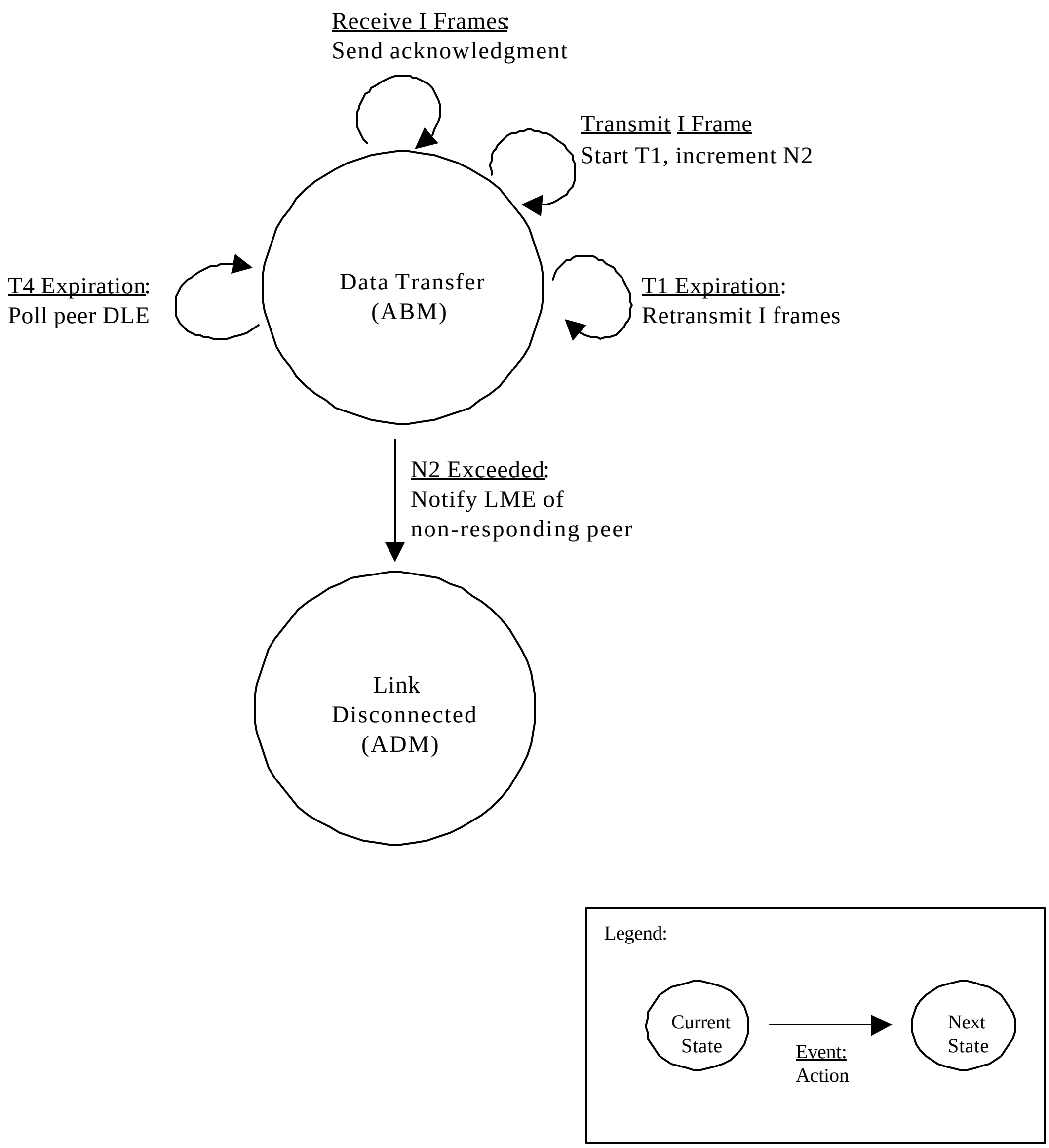


Figure E-3 DLE Data Transfer (ABM) State Diagram

APPENDIX E (cont'd)
STATE MACHINES

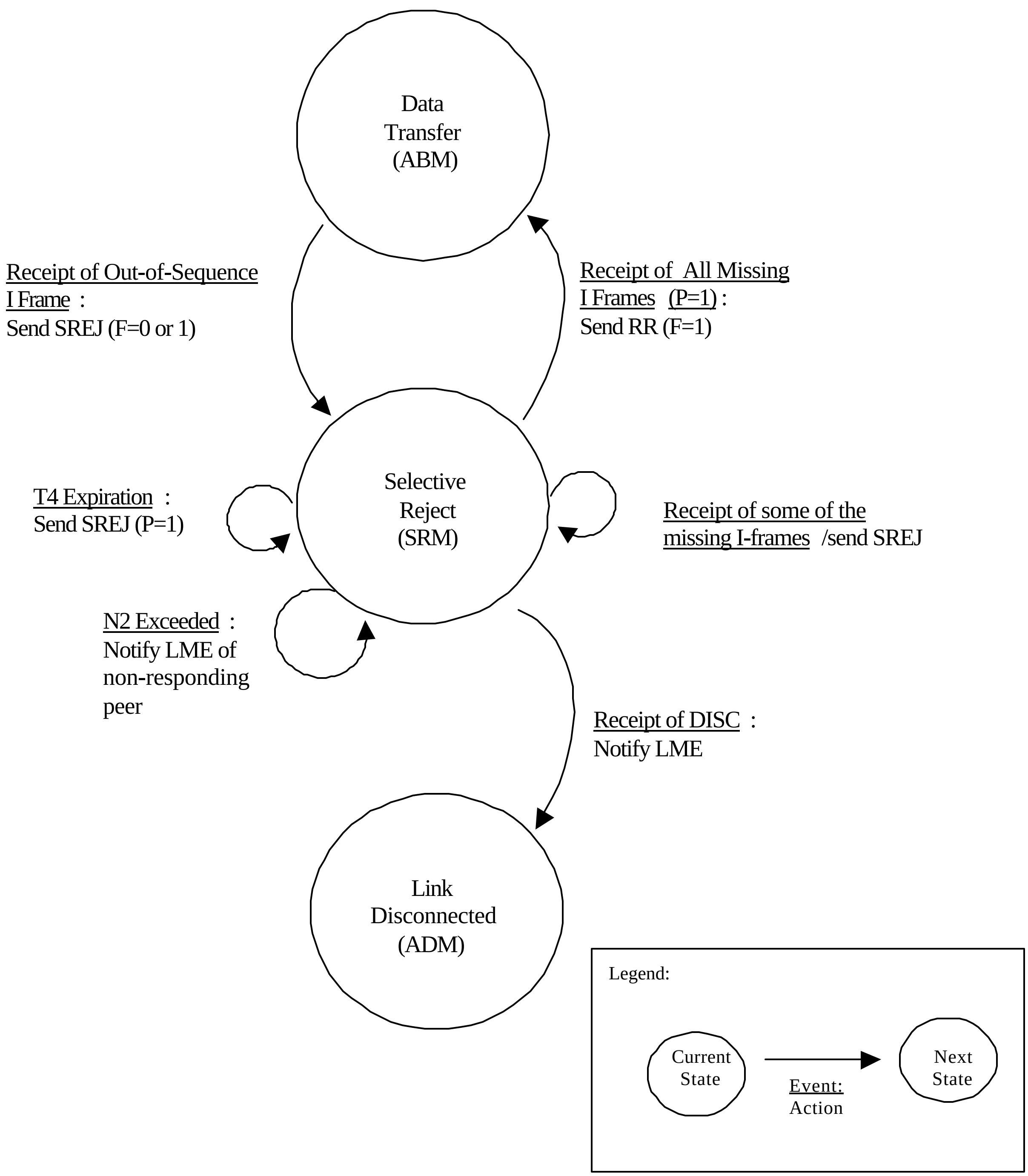
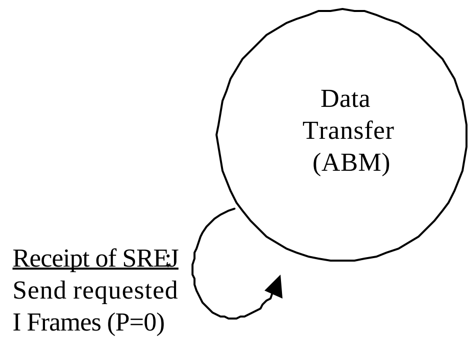


Figure E-4 DLE Selective Reject (SRM) State Diagram
(Sending SREJ)



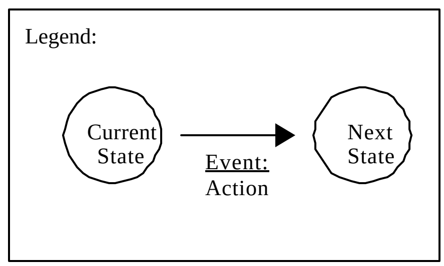


Figure E-5 DLE Selective Reject (SRM) State Diagram (Receiving SREJ)

APPENDIX E (cont'd)
STATE MACHINES

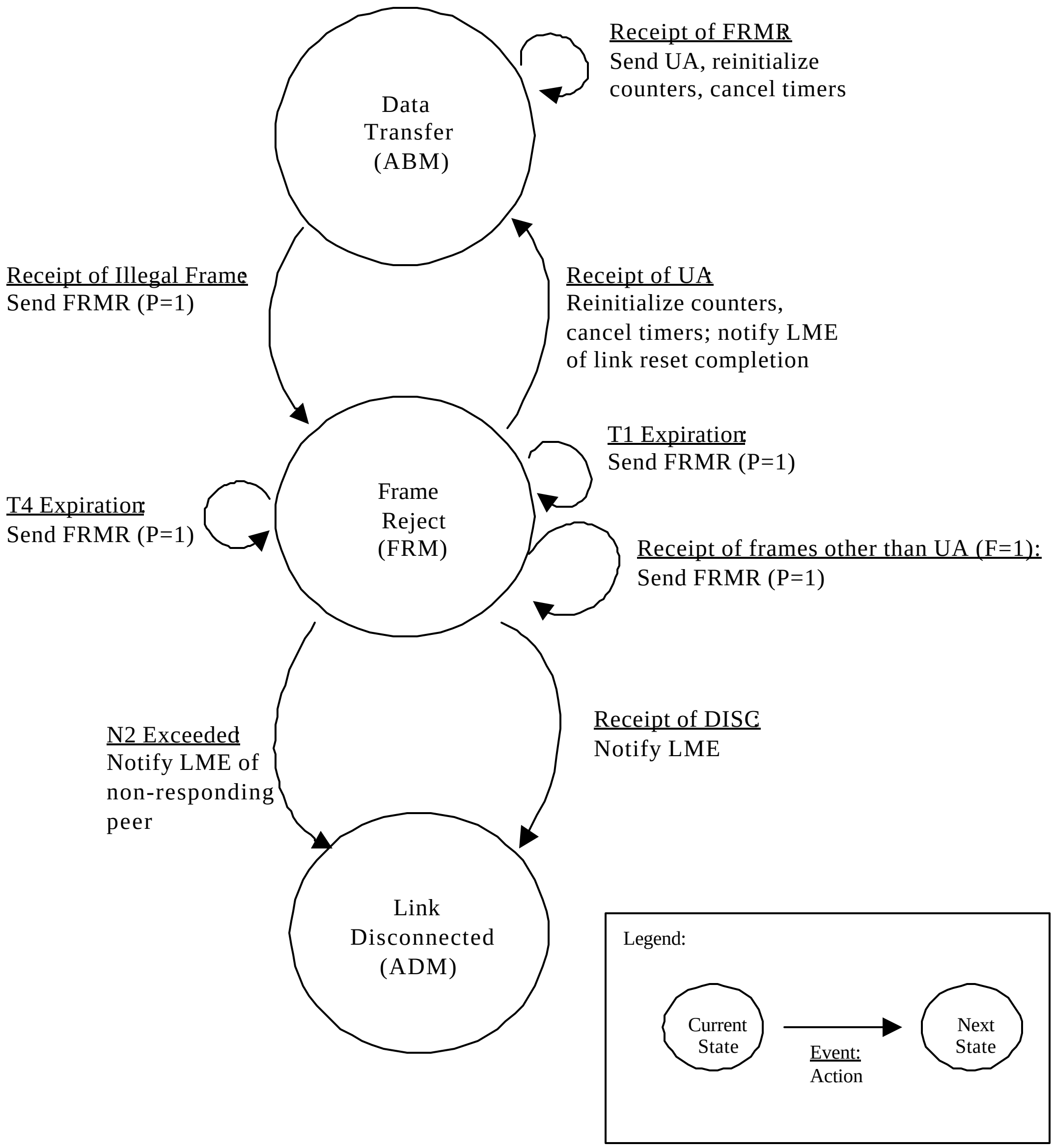
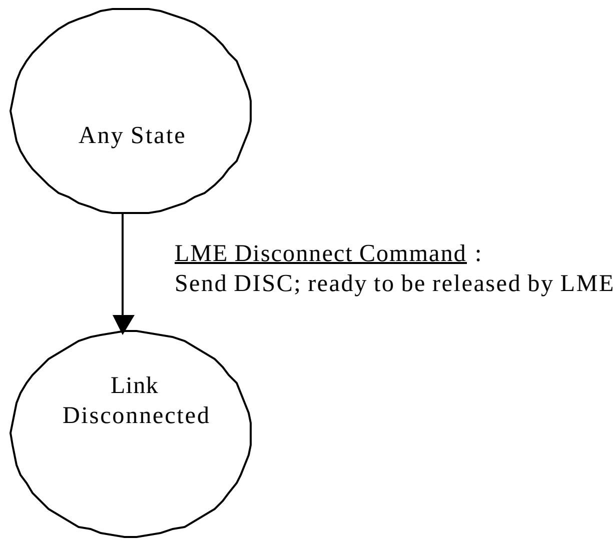


Figure E-6 DLE Frame Reject (FRM) State Diagram

Note: The Frame Reject is a frame as specified in the SARPs which is not compliant with any of the ISO or CCITT standards, a FRM is a Response Frame.

APPENDIX E (cont'd)
STATE MACHINES



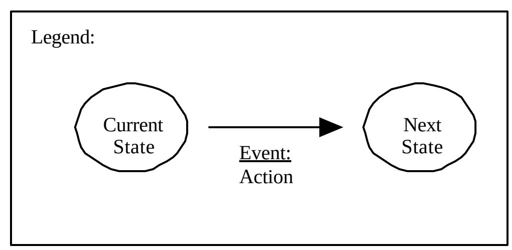


Figure E-7 DLE Termination

APPENDIX F
ALLOCATION OF GROUND STATION ADDRESSES

The following table provides for blocks of consecutive addresses available to Data link Service Providers (DSPs) and other organizations for assignment to VDL ground stations. Each block is defined by a fixed pattern of the first 4 or 10 bits of the 24-bit address. Thus, blocks of different sizes (1048576 and 16384 consecutive addresses respectively) are made available. If the first four bits of the 24-bit address are 1111, then the DSP is identified by the first 10 bits of the 24-bit address. Otherwise, the DSP is identified by the first four bits of the 24-bit address.

Ground station addresses will be assigned to ground stations with the following principles:

a) at any one time a ground station may have multiple addresses depending on the number of VHF radios in use. No address will be assigned to more than one VHF radio (i.e. each address will be unique).
b) the address will serve only a technical role for addressing and identification of data link service entities; i.e., the address will not be used to convey any specific application information;
c) the addresses composed of 24 ZEROs and 24 ONEs are reserved. They will not be assigned to ground station VHF radios.

Organization	Prefix
	0000 — — — — —
	0001 — — — — —
	0010 — — — — —
	0011 — — — — —
	0100 — — — — —
	0101 — — — — —
	0110 — — — — —
	0111 — — — — —
	1000 — — — — —
	1001 — — — — —
	1010 — — — — —
	1011 — — — — —
	1100 — — — — —
	1101 — — — — —
	1110 — — — — —
	1111 0000 00– — — —
	1111 0000 01– — — —
	1111 0000 10– — — —
	1111 0000 11– — — —
	1111 0001 00– — — —
	1111 0001 01– — — —
	1111 0001 10– — — —
	1111 0001 11– — — —
	1111 0010 00– — — —
	1111 0010 01– — — —
	1111 0010 10– — — —
	1111 0010 11– — — —
	1111 0011 00– — — —
	1111 0011 01– — — —
	1111 0011 10– — — —
	1111 0011 11– — — —
	1111 0100 00– — — —
	1111 0100 01– — — —

APPENDIX F (cont'd)
ALLOCATION OF GROUND STATION ADDRESSES

	1111 0100 10– — — —
	1111 0100 11– — — —
	1111 0101 00– — — —
	1111 0101 01– — — —
	1111 0101 10– — — —
	1111 0101 11– — — —
	1111 0110 00– — — —
	1111 0110 01– — — —
	1111 0110 10– — — —
	1111 0110 11– — — —
	1111 0111 00– — — —
	1111 0111 01– — — —
	1111 0111 10– — — —
	1111 0111 11– — — —
	1111 1000 00– — — —
	1111 1000 01– — — —
	1111 1000 10– — — —
	1111 1000 11– — — —
	1111 1001 00– — — —
	1111 1001 01– — — —
	1111 1001 10– — — —
	1111 1001 11– — — —
	1111 1010 00– — — —
	1111 1010 01– — — —
	1111 1010 10– — — —
	1111 1010 11– — — —
	1111 1011 00– — — —
	1111 1011 01– — — —
	1111 1011 10– — — —
	1111 1011 11– — — —
	1111 1100 00– — — —
	1111 1100 01– — — —
	1111 1100 10– — — —
	1111 1100 11– — — —
	1111 1101 00– — — —
	1111 1101 01– — — —
	1111 1101 10– — — —
	1111 1101 11– — — —
	1111 1110 00– — — —
	1111 1110 01– — — —
	1111 1110 10– — — —
	1111 1110 11– — — —
	1111 1111 00– — — —
	1111 1111 01– — — —
	1111 1111 10– — — —
Reserved for future growth	1111 1111 11– — — —

SUPPLEMENT 1 TO ARINC SPECIFICATION 631-1© AVIATION VHF PACKET COMMUNICATIONS (AVPAC) FUNCTIONAL DESCRIPTION

Published: January 22, 1993

Adopted by the Airlines Electronic Engineering Committee: November 3, 1992

A. PURPOSE OF THIS DOCUMENT

This Supplement introduces a major rework of ARINC Specification 631 to reflect an evolving AVPAC system. The normal practice of publishing a separate supplement to update an existing document has not been followed. A detailed overview of the changes is provided in Section C below. A general overview of the changes made is as follows:

In Chapter 1 “Introduction” the commentary (referring to Mark 3 MUs) was removed and ARINC Characteristic 750 was referenced. Descriptions of the conventions used in the document and the state tables were added.

In Chapter 2 “Interoperability” the commentary was updated.

In Chapter 3 “System Overview” the functional organization and RF management sections were updated and the Signal in Space section was removed.

In Chapter 4 “Interfaces and Protocols for Layer 1 - The Physical Layer” the primitives were rewritten to be consistent with new RTS/CTS operation and the modulation scheme information was removed. The OQAM modulation scheme is now documented in ARINC Project Paper 750, “VHF Data Radio and the MSK scheme is now documented in ARINC Project Paper 618, “Air Ground Character Oriented Protocol Specification”.

In Chapter 5 “Services and Protocol of Layer 2 - The Link Layer” the MAC Layer was changed to a nonadaptive P-persistent CSMA. Also, in the Data Link Layer - ISO 8802, which is a LAN Standard for Logical Link Control, is no longer referenced. Instead ISO 8886, which is a Data Link Service, is referenced. As a result, LLC has been globally replaced with DLS. In general all text that can be referenced in ISO standards has been removed and appropriately referenced. Only extensions or deviations from the ISO standards has been noted. A connectionless mode unacknowledged broadcast service was added at the link layer. Both UI’s and DISC’s are no longer acknowledged. (The P/F bit is now set to 0). The XID bit encodings changed to incorporate ISO 8885 parameters wherever possible. Negotiation of XID’s is now per ISO 8885 which specifies a single transaction; therefore, the NFN bit was deleted. When busy, a station will no longer send out RNR’s, instead it should acknowledge outstanding frames and disconnect. New primitives were added to the link layer to accommodate the new link Management Entity in Chapter 5.5.

In Chapter 6 “Services and Protocol of Layer 3 - The Network Layer” Subnetwork was changed to Network in the title. The DTE addresses were revised. ISO documents were referenced rather than repeated. The profile was added and the use of acknowledgement packets and acknowledgement timers were defined.

In general most of the Attachments have been updated or removed and replaced with new information. The acronym list and references were also edited.

B. ORGANIZATION OF THIS DOCUMENT

Due to the extensive nature of the changes incorporated into this Supplement, ARINC Specification 631 has been reproduced in its entirety. The modified and added material on each page is identified by a c-1 symbol in the margins.

Copies of ARINC Specification 631 adopted by the AEEC November 6, 1990 and published December 20, 1991, should be considered obsolete.

C. CHANGES TO ARINC SPECIFICATION 631 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete tabulation of the changes and additions to the Characteristic 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 Purpose of this Document

A minor editorial change was made in the first paragraph.

1.2 Background

The last sentence of the second paragraph and the commentary were deleted.

1.3 Relationship of this Document to ARINC Characteristics

References to ARINC Characteristic 748, “Communications Management Unit (CMU)” and ARINC Characteristic 750 “VHF Data Radio” have been added. “Chapter TBD” was changed to “Section 2”. The second paragraph was deleted and references to ARINC project Papers 637 and 638 were added.

1.3.1 Characteristic 748

The last sentence was deleted and an editorial change was made.

1.3.2 Characteristic 724B

An editorial change was made.

1.3.5 Characteristic 750

A new section was added which refers to the development of the Data Radio.

1.4 Relationship to Other OSI Protocols

Reference to the Subnetwork Layer has been removed from the AVPAC functions. References were added for the High-Level Data Link Control (HDLC) as specified in ISO 3309(E) version 3 10/84, ISO 4335(E) version 3 8/87, ISO 7809(E) version 1 2/84 and ISO 8885(E) second edition 6/91 except as noted in Sections 4 and 5 of this Specification. The second paragraph and both commentaries were deleted.

1.5 Conventions Used in This Document

This is a new section.

1.5.1 State Tables

This is a new section.

2.1 Subnetwork Interoperability

The third paragraph was deleted.

2.2 AVPAC/ACARS RF Coexistence

The first sentence of the commentary was deleted.

3.2 System Architecture

An editorial change was made in the eighth paragraph. The last paragraph, referencing the International Standards Organization (ISO) 8208, was deleted.

3.2.2.3 Layer 3, The Network Layer

The third sentence of the first paragraph was deleted. Flow control, Duplicate control and Sequencing were deleted from the list of Network Layer responsibilities.

3.2.3 AVPAC Functional Organization

A reference to Appendix B was added to the second paragraph. The reference to Attachment 1 was deleted from the third paragraph. The first sentence of the fourth paragraph was moved to the end of the third paragraph. The second sentence of the fourth paragraph was deleted.

3.3 Radio Frequency Management

The second paragraph and commentary were deleted. The last sentence of the fourth paragraph was deleted. The fifth paragraph and commentary were deleted. The last paragraph was deleted.

3.5 Signal in Space

This entire section was deleted.

4.1 Introduction

Editorial changes were made to the first paragraph. The remainder of the section was deleted. A new paragraph was added to refer to ARINC Specification 618 and ARINC Characteristic 750 for defined AVPAC modulation techniques.

4.2 Physical Layer Service Definition

An editorial change was made in the first paragraph. Commentary was added after the first paragraph. The third paragraph was deleted. The last sentence of the fifth paragraph was deleted.

4.2.1 Functions

In the first sentence, the words "Physical Layer of the modem" was changed to "Physical Layer". The second paragraph and commentary were deleted.

4.2.1.1 Transceiver Control

The second paragraph and commentary were deleted. A new paragraph was added to indicate that AVPAC will not support voice/data mode as defined in ACARS, but instead will execute a DISC upon switching from data to voice and the link re-established once the radio is returned to data mode.

4.2.1.2 Data Reception

Editorial changes were made to the section header and text.

4.2.1.3 Data Transmission

Editorial changes were made to the section header and text.

4.2.1.4 Notification Services

"Transceiver" was changed to "modem" and references to "MU" were deleted in the first paragraph. The second paragraph and the commentary were deleted and rewritten to indicate how the signal quality analysis can be performed on the demodulator evaluation process.

4.2.2 Service Primitives

The first paragraph was changed to indicate that all primitive parameters are mandatory for the correct operation of the protocol state machine. References to a Table and an Attachment were changed in both paragraphs.

4.2.2.1 Physical Layer Data Request

Transfer was changed to transmission editorial changes were made for clarity. The phrase "(contains Data Link PDU, in general)" was deleted from the parameters.

4.2.2.2 Physical Layer Data Indication

Editorial changes were made for clarity. The phrases "(contains Data Link PDU, in general)" and "PhS signal quality parameter (O)" were deleted from the parameters.

4.2.2.4 Physical Layer Prekey Request

A new sentence was added to indicate that this primitive is used only for the AM MSK data rate/modulation scheme defined in Attachment 5. "Pre-key length (M)" was changed to "AM MSK Pre-key length (M)".

4.2.2.5 Physical Layer Chansense Indication

"This primitive" was changed to "Ph_CHANNELSENSE.indication" in the first sentence. A reference was made to ARINC Characteristic 750 and the commentary was deleted.

4.2.2.6 Physical Layer Data Rate Request

A change was made to indicate that the receipt of the Ph_DATARATE.request by the Ph_Provider causes the local Ph_Provider to set the physical data rate and modulation for the requested speed. A reference to Attachment 5 was added. The commentary was deleted.

4.2.2.7 Physical Layer Signal Quality Indication

This is a new section that describes the Ph_SQP.indication primitive for the signal quality service.

4.3 Protocol State Machine

This section was formerly section 4.3.4 and now only refers to the physical layer Event and State Transition tables in Attachment 2. The former section 4.3 "Protocol Specification" was deleted.

4.3.1 Modem Characteristics

This section was deleted.

4.3.1.1 Data Transmission

This section was deleted; references are now made to ARINC Specification 618 and ARINC Characteristic 750 in Section 4.1 instead.

4.3.1.2 Analog Signal Transmission

This section was deleted; references are now made to ARINC Specification 618 and ARINC Characteristic 750 in Section 4.1 instead.

4.3.1.3 RF Frequency

This section was deleted; references are now made to ARINC Specification 618 and ARINC Characteristic 750 in Section 4.1 instead.

4.3.1.4 Data Rate

This section was deleted; references are now made to ARINC Specification 618 and ARINC Characteristic 750 in Section 4.1 instead.

4.3.1.5 Pre-Key

This section was deleted; references are now made to ARINC Specification 618 and ARINC Characteristic 750 in Section 4.1 instead.

4.3.1.6 Modulator Specifications

This section was deleted; references are now made to ARINC Specification 618 and ARINC Characteristic 750 in Section 4.1 instead.

4.3.1.7 Demodulator Specifications

This section was deleted; references are now made to ARINC Specification 618 and ARINC Characteristic 750 in Section 4.1 instead.

4.3.2 Transceiver Interface

This section was deleted.

4.3.2.1 Radio Transmitter Keying

This section was deleted; references are now made to ARINC Specification 618 and ARINC Characteristic 750 in Section 4.1 instead.

4.3.2.2 Radio Transmitter Tuning

This section was deleted; references are now made to ARINC Specification 618 and ARINC Characteristic 750 in Section 4.1 instead.

4.3.2.3 Transceiver Characteristics

This section was deleted; references are now made to ARINC Specification 618 and ARINC Characteristic 750 in Section 4.1 instead.

4.3.3 Synchronization and Ambiguity Resolution

This section was deleted; references are now made to ARINC Specification 618 and ARINC Characteristic 750 in Section 4.1 instead.

4.3.3.1 Bit Ambiguity Resolution

This section was deleted; references are now made to ARINC Specification 618 and ARINC Characteristic 750 in Section 4.1 instead.

4.3.4 Protocol State Machine

This section is now Section 4.3.

4.3.4.1 Conventions

This section was deleted and rewritten in Section 1.5 "Conventions Used in This Document".

4.3.4.2 State Definitions and Event Tables

This section was deleted and rewritten in Section 1.5.1 "State Tables".

5.1.1 Model

This section has been rewritten to indicate that the Link Layer is divided into three sublayers: the Media Access Control (MAC) sublayer, the Data Link Service (DLS) sublayer and the Link Management Entity (LME). "Logical Link Control (LLC)" was changed to "Data Link Service (DLS)" and LME was added.

5.1.2 General Operation

References to ISO 8208 were changed to ISO 8886 and references to LLC were change to DLS.

5.2 AVLC Media Access Control Sublayer

Most of section 5.2 and the subsections were extensively revised. In general, VT-csma was replaced with p-persistent csma, the frame queue was removed from the MAC and an RTS/CTS scheme was specified for acquisition of the media.

5.3 AVLC Data Link Service Definition and
5.4 AVLC Data Link Service Protocol Specification

Most of Sections 5.3 and 5.4 and the subsections were extensively revised. The Link layer was edited to keep the queue of frames until time for transmission. Handoff primitives were added. The address format and definition was updated (it now has a variable field size, definitions for broadcast addresses were added, and ground station address space was partitioned between ICAO and AEEC). The XID frame was revised extensively to contain login and handoff parameters and use standard ISO parameters where possible. There is no negotiation at login so the NFN bit was deleted. Timer parameters were modified, and very low rate keep-alive messages were added explicitly (they were there implicitly before). References to ISO documents were added and text from ISO documents was removed. Operation on queued frames was defined. The autotune function was fixed. Some protocol modifications were made based on simulations that showed improved performance. Explanatory text was added/updated.

5.5 Link Management Entity

All of section 5.5 and the subsections are new.

6.1.1 Model

Minor editorial changes were made.

6.1.2 General Operation

Editorial changes were made.

6.2.1 Functions

The first sentence was deleted and “Network Layer” was changed to “SNAcP”.

6.2.1.1 Subnetwork Connection Management

This section was formerly Section 6.2.1.2. The former Section 6.2.1.1 Equipment Address Management was deleted.

6.2.1.2 Packet Fragmentation and Reassembly

This section was formerly Section 6.2.1.3. Fragmentation was added to the header and “disassembly” was changed to “fragmenting” in the text.

6.2.1.3 Subnetwork Connection Quality of Service Management

This section was formerly Section 6.2.1.4. Minor editorial changes were made.

6.2.1.4 Error Recovery

This section was formerly Section 6.2.1.6. DIAGNOSTIC packet type was deleted. The last sentence of the first paragraph and the entire second paragraph has been deleted. New text was added to indicate that RESET or RESTART should not be used to recover from an error which can be handled by REJECT.

6.2.1.5 Connection Flow Control

This section was formerly Section 6.2.1.7. Editorial changes were made. The former Section 6.2.1.5 Subnetwork Connection Selection and Management was deleted.

6.2.1.8 Priority Handling

This section was deleted.

6.2.2.2 Data Transfer Phase

The last paragraph on expedited data was deleted.

6.2.2.4 Service Primitive Specification

This section was rewritten in its entirety. Section 6.2.2.4.1 Subnetwork Connect Primitives is a new section. All remaining Subsections of 6.2.2.4 were deleted.

6.2.4 Addressing Issues

The first sentence was replaced to indicate that the Fast Select field of the Call Setup packets should carry IS-Hello PDUs. “NSAP” was changed to “NET” in the second sentence.

6.3 Subnetwork Protocol Specification

Editorial changes were made to indicate that the intent of this section is to clarify the appropriate ISO standards as used in AVPAC rather than to fully specify the subnetwork protocol.

6.3.1 SNPDU Format

New text was added to indicate that the SNPDU format is specified in ISO 8208 except as qualified in the following subsections. The former Subsections 6.3.1.1 General Packet Structure, 6.3.1.1.2 Logical Channel Identifier, 6.3.1.1.3 Packet Type Identifier, 6.3.1.1.4 Address Length Indicators, 6.3.1.1.6 Facilities Length Indicator, 6.3.1.1.7 Facility Field, 6.3.1.1.9 Cause Fields, 6.3.1.1.10 Diagnostic Code, 6.3.1.1.11 Packet Send Sequence Number, 6.3.1.1.12 Packet Receive Sequence Number and 6.3.1.1.13 More Data Mark were deleted.

6.3.1.1 General Format Identifier

This was formerly Section 6.3.1.1.1. It was rewritten to indicate that modulo 128 sequencing is the only defined sequencing in AVPAC. The former Section 6.3.1.1 General Packet Structure was deleted.

6.3.1.2 Calling and Called DTE Addresses

This was formerly Section 6.3.1.1.5. An editorial addition was made to the first paragraph. The remainder of the section was replaced with new addressing information that accommodates Service Provider and CAA routers.

6.3.1.3 Call User Data Field

This was formerly Section 6.3.1.1.8. This section was edited to indicate that the Fast Select Facility should be used to carry the ISH PDU. Commentary was added.

6.3.2 Types of SNPDUs

This was formerly Section 6.3.1.2. This section was completely rewritten to show the DTE-to-DXE and DXE-to-DTE SNPDUs that an AVPAC DTE should support as specified in ISO 8208 and clarified in this section. The former subsections 6.3.1.2.3 Clear Request and Clear Indication, 6.3.1.2.4 Clear Confirmation, 6.3.1.2.5 Data, 6.3.1.2.6 Interrupt, 6.3.1.2.7 Interrupt Confirmation 6.3.1.2.9 Receive Not Ready, 6.3.1.2.10 Reset Request and Reset Indication, 6.3.1.2.11 Reset confirmation, 6.3.1.2.12 Restart Request and Restart Indication, 6.3.1.2.13 Restart Confirmation, 6.3.1.2.14 Reject, 6.3.1.2.15 Diagnostic, 6.3.1.2.16 Registration Request and 6.3.1.2.17 Registration Confirmation were deleted. In addition, the former section 6.3.2 Protocol State Machine and subsections 6.3.2.1 Phases of Operation, 6.3.2.1.1 Connection Establishment Phase, 6.3.2.1.2 Data Transfer Phase, 6.3.2.1.3 Disconnection Phase and 6.3.2.2 Optional User Facilities and Subnetwork Parameters were deleted.

6.3.2.1 Call Request, Incoming Call, Call Accepted, and Call Connected

This new section consists of former Sections 6.3.1.2.1 and 6.3.1.2.2 which were combined and rewritten.

6.3.2.2 Clear PDUs, Reset PDUs, and Restart PDUs

This is a new section.

6.3.2.3 Receive Ready

This was formerly Section 6.3.1.2.8 and has been completely rewritten.

6.3.3 Facilities and Procedures

This is a new section.

6.3.3.1 Effects of Layers 1 and 2 on the Packet Layer

This is a new section.

6.3.3.2 Acknowledgment Window

This is a new section.

6.3.3.3 Nonreceipt of Window-Rotation Information

This is a new section.

6.3.3.4 Receipt of Erroneous DATA Packets

This is a new section.

6.3.4 Parameter

This is a new section.

6.3.4.1 T25 - Window Rotation Timer

This is a new section.

6.3.4.2 R25 - Window Rotation Timer

This is a new section.

6.3.4.3 P- Packet Size

This is a new section.

6.3.4.4 W - Window Size

This is a new section.

ATTACHMENT 1, INTERFACE DIAGRAM

This diagram has been updated.

ATTACHMENT 2, PHYSICAL SERVICE TABLES

These tables were previously in Attachment 3 “SERVICE TABLES” and they have been updated. The former Table A3-1 “Service Primitive List” was deleted. The former Attachment 2 “MESSAGE CONSTRUCTION PROGRAM” was deleted.

ATTACHMENT 3, MEDIA ACCESS CONTROL (MAC) TABLES

These tables were previously in Attachment 4 “MAC TABLES” and they have been updated.

ATTACHMENT 4, DATA LINK SERVICE (DLS) TABLES

In general, Attachment 4 was edited to reflect the deletion of the NFN bit and to be integrated with the LME. These tables were previously in Attachment 6 “LLC TABLES”. The LLC Connection Set-Up and Hand-Off Input Events Table and the LLC Transition Elements Table were deleted. The other Tables were edited and LLC was changed to DLS in the title. New Tables were added on Data Link Timer Actions and AVPAC DLS Connection Set-up and Hand-off Input Events.

ATTACHMENT 5, DATA RATE PARAMETER ENCODING TABLE

This table was previously in Attachment 8 “DATA TABLES” as Table A8-2 and has been updated to include 4-OQAM and 16-OQAM. The former Attachment 5 “CONTROL FIELD BITS CHART” has been deleted.

ATTACHMENT 6, LINK MANAGEMENT ENTITY (LME) SERVICE TABLES

These are new tables to accommodate the new Link Management Entity functions in Section 5.5. A new LME Primitive Flow Diagram was added. The former Attachment 6 “LLC TABLES” is now in Attachment 4 “DATA LINK SERVICE (DLS) TABLES”.

ATTACHMENT 7, LINK LAYER HEADER BASIC FORMAT

This is a new Attachment and provides new information on the Link Layer Header Basic Format and link layer address format. A Link Layer Header Sample is included in Appendix 1. The former Attachment 7 “INTERMEDIATE SYSTEM was deleted.

ATTACHMENT 8, DATA TABLES

Attachment 8 was deleted. Table A8-2 was updated and moved to Attachment 5 “DATA RATE PARAMETER ENCODING TABLE”.

ATTACHMENT 9, SUBNETWORK LAYER TIMER PARAMETERS

Attachment 9 was deleted.

APPENDIX A, LINK LAYER HEADER SAMPLE

This table is new and complements the Link Layer Basic Format in Attachment 7. The former APPENDIX A “LINK LAYER HEADER” was deleted.

APPENDIX B, PRIMITIVE FLOW DIAGRAM

This is a new diagram. The former APPENDIX B “SUBNETWORK LAYER PACKET STRUCTURES” was deleted.

APPENDIX C, ACRONYM LIST

This APPENDIX has been updated.

APPENDIX D, REFERENCES

This APPENDIX has been updated.

SUPPLEMENT 2

TO

ARINC SPECIFICATION 631-2©

AVIATION VHF PACKET COMMUNICATIONS (AVPAC)

FUNCTIONAL DESCRIPTION

Published: December 1, 1995

Adopted by the Airlines Electronic Engineering Committee: October 31, 1995

A. PURPOSE OF THIS DOCUMENT

This Supplement introduces a major rework of ARINC Specification 631 to reflect an evolving AVPAC system. The normal practice of publishing a separate Supplement to update an existing document has not been followed. A detailed overview of the changes is provided in Section C below. A general overview of the changes made is as follows:

Chapters 4, 5, and 6 were deleted in favor of a single citation to the ICAO VDL SARPs.

B. ORGANIZATION OF THIS DOCUMENT

Due to the extensive nature of the changes incorporated into this Supplement, ARINC Specification 631 has been reproduced in its entirety. The modified and added material on each page is identified by a c-2 symbol in the margins. Copies of ARINC Specification 631-1 adopted by the AEEC November 3, 1992 and published January 22, 1993, should be considered obsolete.

C. CHANGES TO ARINC SPECIFICATION 631 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete tabulation of the changes and additions to Specification 631 introduced by Supplement 2. Each change or addition is defined by the section number and the title currently employed in Specification 631. In each case a brief description of the change or addition is included.

1.2 Background

Editorial changes were made.

1.3 Relationship of this Document to ARINC Characteristics

Editorial changes were made. ARINC Characteristic 748 was changed to ARINC Characteristic 758.

1.3.1 ARINC Characteristic 758

ARINC Characteristic 748 was changed to ARINC Characteristic 758 and commentary was added.

1.5 Relationship to ICAO Documents

This Section was added, since ICAO documents are being cited.

3.1 General Description

Reference changed to cite ICAO VDL SARPs.

3.2 System Architecture

Editorial change was made.

3.2.3. AVPAC Functional Organization

Reference to ICAO Guidance Material for the VDL SARPs (MSC) was added.

3.5 Protocols

This new section cites the appropriate ICAO documents.

3.6 Allocation of Ground Station Addresses

New section was added.

4.0 INTERFACES AND PROTOCOLS FOR LAYER 1 - THE PHYSICAL LAYER

This Chapter had been deleted in its entirety.

5.0 INTERFACES AND PROTOCOLS FOR LAYER 2 - THE LINK LAYER

This Chapter had been deleted in its entirety.

6.0 INTERFACES AND PROTOCOLS FOR LAYER 3 - THE NETWORK LAYER

This Chapter had been deleted in its entirety.

ATTACHMENT 1 - INTERFACE DIAGRAM

The interface diagram has been updated to include the HF Data Link Subnetwork.

ATTACHMENT 2 - PHYSICAL SERVICE TABLES

This attachment has been deleted.

ATTACHMENT 3 - MEDIA ACCESS CONTROL (MAC) TABLES

This attachment has been deleted.

ATTACHMENT 4 - DATA LINK SERVICE (DLS) TABLES

This attachment has been deleted.

ATTACHMENT 5 - DATA RATE PARAMETER ENCODING TABLE

This attachment has been deleted.

ATTACHMENT 6 - LINK MANAGEMENT ENTITY (LME) SERVICE TABLES

These attachment has been deleted.

ATTACHMENT 7 - LINK LAYER HEADER - BASIS FORMAT

This attachment has been deleted.

APPENDIX A - ALLOCATION OF IATA-ADMINISTERED GROUND STATION ADDRESSES

Table A7-3 has been renumbered A-1 Allocation of IATA-Administered Ground Station Addresses. Table A7-4 has been renumbered A-2 Defined Service Providers and has been revised.

APPENDIX B - ACRONYM LIST

This APPENDIX has been updated. It was formerly APPENDIX C. The previous APPENDIX B - PRIMITIVE FLOW DIAGRAM has been deleted.

APPENDIX C - REFERENCES

This APPENDIX has been updated. It was formerly APPENDIX D.

SUPPLEMENT 3

TO

ARINC SPECIFICATION 631-3©

VHF DIGITAL LINK

IMPLEMENTATION PROVISIONS

Published: October 16, 2000

Adopted by the Airlines Electronic Engineering Committee: June 26, 2000

A. PURPOSE OF THIS DOCUMENT

This Supplement provides the VDL Mode 2 protocol definitions and introduces the ACARS over AVLC (AOA) air/ground protocol definition. Details of the VDL protocols defined herein are specified in the International Civil Aviation Organization (ICAO) VDL Mode 2 (VDLM2) Standards and Recommended Practices (SARPs).

B. ORGANIZATION OF THIS DOCUMENT

This document is a replacement of Specification 631 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 ARINC SPECIFICATION 631 INTRODUCED BY THIS SUPPLEMENT

This document title has been changed from “Aviation VHF Packet Communication (AVPAC) Functional Description” to “VHF Digital Link Implementation Provisions”. This document provides a system overview and architectural guidelines for VDL Mode 2 which is constituted of the protocols of the Physical Layer, Link Layer, and the sub-network access sub-layer of the Network Layer. A concept of operations is provided to include radio frequency management, ACARS to VDL Mode 2 transition, and dedicated VDL Mode 2 operation. VHF and Link Management Entities (VME/LME) and Handoff Management provisions are included as are the Data Link Layer and Subnetwork Layer Protocol Implementation Conformance Statements (PICS). Appendices include Link Handoff event examples and Message Sequence Charts, as well as LME and Data Link Entity (DLE) State Machines.