ARINC

VHF DIGITAL LINK (VDL) MODE 2 IMPLEMENTATION PROVISIONS

ARINC SPECIFICATION 631-6

PUBLISHED: January 10, 2011

AN ARINC DOCUMENT

Prepared by AEEC
Published by
AERONAUTICAL RADIO, INC.
2551 RIVA ROAD, ANNAPOLIS, MARYLAND 21401-7435

DISCLAIMER

THIS DOCUMENT IS BASED ON MATERIAL SUBMITTED BY VARIOUS PARTICIPANTS DURING THE DRAFTING PROCESS. NEITHER AEEC, AMC, FSEMC NOR ARINC HAS MADE ANY DETERMINATION WHETHER THESE MATERIALS COULD BE SUBJECT TO VALID CLAIMS OF PATENT, COPYRIGHT OR OTHER PROPRIETARY RIGHTS BY THIRD PARTIES, AND NO REPRESENTATION OR WARRANTY, EXPRESS OR IMPLIED, IS MADE IN THIS REGARD.

ARINC INDUSTRY ACTIVITIES USES REASONABLE EFFORTS TO DEVELOP AND MAINTAIN THESE DOCUMENTS. HOWEVER, NO CERTIFICATION OR WARRANTY IS MADE AS TO THE TECHNICAL ACCURACY OR SUFFICIENCY OF THE DOCUMENTS, THE ADEQUACY, MERCHANTABILITY, FITNESS FOR INTENDED PURPOSE OR SAFETY OF ANY PRODUCTS, COMPONENTS, OR SYSTEMS DESIGNED, TESTED, RATED, INSTALLED OR OPERATED IN ACCORDANCE WITH ANY ASPECT OF THIS DOCUMENT OR THE ABSENCE OF RISK OR HAZARD ASSOCIATED WITH SUCH PRODUCTS, COMPONENTS, OR SYSTEMS. THE USER OF THIS DOCUMENT ACKNOWLEDGES THAT IT SHALL BE SOLELY RESPONSIBLE FOR ANY LOSS, CLAIM OR DAMAGE THAT IT MAY INCUR IN CONNECTION WITH ITS USE OF OR RELIANCE ON THIS DOCUMENT, AND SHALL HOLD ARINC, AEEC, AMC, FSEMC AND ANY PARTY THAT PARTICIPATED IN THE DRAFTING OF THE DOCUMENT HARMLESS AGAINST ANY CLAIM ARISING FROM ITS USE OF THE STANDARD.

THE USE IN THIS DOCUMENT OF ANY TERM, SUCH AS SHALL OR MUST, IS NOT INTENDED TO AFFECT THE STATUS OF THIS DOCUMENT AS A VOLUNTARY STANDARD OR IN ANY WAY TO MODIFY THE ABOVE DISCLAIMER. NOTHING HEREIN SHALL BE DEEMED TO REQUIRE ANY PROVIDER OF EQUIPMENT TO INCORPORATE ANY ELEMENT OF THIS STANDARD IN ITS PRODUCT. HOWEVER, VENDORS WHICH REPRESENT THAT THEIR PRODUCTS ARE COMPLIANT WITH THIS STANDARD SHALL BE DEEMED ALSO TO HAVE REPRESENTED THAT THEIR PRODUCTS CONTAIN OR CONFORM TO THE FEATURES THAT ARE DESCRIBED AS MUST OR SHALL IN THE STANDARD.

ANY USE OF OR RELIANCE ON THIS DOCUMENT SHALL CONSTITUTE AN ACCEPTANCE THEREOF “AS IS” AND BE SUBJECT TO THIS DISCLAIMER.

ARINC SPECIFICATION 631-6

VHF DIGITAL LINK (VDL) MODE 2 IMPLEMENTATION PROVISIONS

Published: January 10, 2011

Prepared by the AEEC

Specification 631	Adopted by the AEEC Executive Committee	January 31, 1991

Summary of Document Supplements

Supplement	Adoption Date	Published
Specification 631-1	November 3, 1992	January 22, 1993
Specification 631-2	October 31, 1995	December 1, 1995
Specification 631-3	June 26, 2000	October 16, 2000
Specification 631-4	July 11, 2005	August 31, 2005
Specification 631-5	October 9, 2008	December 3, 2008
Specification 631-6	October 6, 2010	January 10, 2011

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

FOREWORD

Aeronautical Radio, Inc., the AEEC, and ARINC Standards

ARINC organizes aviation industry committees and participates in related industry activities that benefit aviation at large by providing technical leadership and guidance. These activities directly support aviation industry goals: promote safety, efficiency, regularity, and cost-effectiveness in aircraft operations.

ARINC Industry Activities organizes and provides the secretariat for international aviation organizations (AEEC, AMC, FSEMC) which coordinate the work of aviation industry technical professionals and lead the development of technical standards for airborne electronic equipment, aircraft maintenance equipment and practices and flight simulator equipment and used in commercial, military, and business aviation. The AEEC, AMC, and FSEMC develop consensus-based, voluntary standards that are published by ARINC and are known as ARINC Standards. The use of ARINC Standards results in substantial benefits to the aviation industry by allowing avionics interchangeability and commonality and reducing avionics cost by promoting competition.

There are three classes of ARINC Standards:

a) ARINC Characteristics – Define the form, fit, function, and interfaces of avionics and other airline electronic equipment. ARINC Characteristics indicate to prospective manufacturers of airline electronic equipment the considered and coordinated opinion of the airline technical community concerning the requisites of new equipment including standardized physical and electrical characteristics to foster interchangeability and competition.

b) ARINC Specifications – Are principally used to define either the physical packaging or mounting of avionics equipment, data communication standards, or a high-level computer language.

c) ARINC Reports – Provide guidelines or general information found by the airlines to be good practices, often related to avionics maintenance and support.

The release of an ARINC Standard does not obligate any organization or ARINC to purchase equipment so described, nor does it establish or indicate recognition or the existence of an operational requirement for such equipment, nor does it constitute endorsement of any manufacturer's product designed or built to meet the ARINC Standard.

In order to facilitate the continuous product improvement of this ARINC Standard, two items are included in the back of this volume:

An Errata Report solicits any corrections to the text or diagrams in this ARINC Standard.

An ARINC IA Project Initiation/Modification (APIM) form solicits any recommendations for addition of substantive material to this volume which would be the subject of a new Supplement.

TABLE OF CONTENTS

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) and in the ICAO Doc 9776 Manual on VHF Digital Link (VDL) Mode 2 Part II. VDLM2 is consistent with the concepts of the ICAO Aeronautical Telecommunication 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 (MSNDCF). 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 Characteristic 758: Communications Management Unit (CMU) and ARINC Characteristic 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.

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

1.3.1 ARINC 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 ARINC 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 ARINC Specification 618

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

1.3.4 ARINC 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 ARINC Specifications 622 and 623

ARINC Specification 622: *ATS Data Link Applications Over ACARS Air-Ground Network***,** defines the addressing, protocols and contract application that are necessary to support character-oriented ATS messaging.

ARINC Specification 623: *Character-Oriented Air Traffic Service (ATS) Applications*, defines selected character-oriented ATS application messages.

1.3.6 ARINC Specification 637

ARINC Specification 637: *Aeronautical Telecommunications Network (ATN) Implementation Provisions, Part 1, Protocols and Services*, was developed to describe the ATN mobile SNDCF, internetworking, dynamic routing, transport, ATN network management, and application interfaces for ACARS and ATN.
Do not use – ARINC Specification 637 is obsolete and has been reclassified as "historical".

1.3.7 ARINC Specification 638

ARINC Specification 638: *Upper Layer Specification (End System Communication Specification*) attempted to define the ATN upper layer protocols.

ARINC Specification 638 is not consistent with the latest ATN SARPs. Do not use – ARINC Specification 638 has been declared obsolete and reclassified as "historical".

1.4 Relationship to Other Standards

Reference is also made to other industry standards.

1.4.1 Relationship to ICAO Documents

International Civil Aviation Organization (ICAO) Annex 10, Volume III, ***Communication Systems*****,** contains Standards and Recommended Practices (SARPs) and guidance material for various air-ground and ground-ground data communication systems, including the Aeronautical Telecommunication Network (ATN), Very High Frequency (VHF) air-ground Digital Link (VDL), and other services. **Volume III is comprised of:**

- Part I — Digital Data Communication Systems
- Part II — Voice Communication Systems

The specific VDLM2 documents are:

- ICAO Annex 10 (Doc 9705): Aeronautical Telecommunications and Volume III – Communication Systems: Part 1 – Digital Data Communication Systems, Edition 2 published in 2007
- Doc 9776: ICAO Manual on VHF Digital Link (VDL) Mode 2 Part II Edition 1 published in 2001. Doc 9776 contains detailed technical specifications and implementation guidance for VHF Digital Link Mode 2. The VDLM2 SARPs define the basic signal-in-space and protocol suite. Unless otherwise noted, the VDLM2 functions defined herein conform to the functionality defined in Doc 9776: ICAO Manual on VHF Digital Link (VDL) Mode 2 Part II Edition 1.

An ongoing process of amendments is underway to adapt Doc 9776 to the evolving needs of the link. References in this specification to the “VDLM2 SARPs” and the “Manual on VDLM2” should be interpreted to refer to the most recent edition of Doc 9776 and incorporate said amendments, published as new editions, as they apply.

This document identifies certain inconsistencies between provisions stated herein and the prevailing provisions stated in the edition of the VDLM2 SARPs or the edition of the Manual on VDLM2 in effect on the date of publication of this document. Such references are specific to the ICAO VDL Manual Part II Edition 1 and will be so noted. Subsequent editions of Doc 9776 (e.g., Edition 2) may eliminate these noted inconsistencies.

This specification provides additional interoperability information needed by the air transport industry.

COMMENTARY

A copy of the final version of the VDLM2 SARPS and the Manual on VDLM2 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

RTCA DO-224B: Minimum Aviation System Performance Standards (MASPS) defines the Signal-In-Space characteristics of the VDLM2 air/ground data link.

RTCA DO-281A: Minimum Operational Performance Standards for Aircraft VDL Mode 2 Physical, Link, and Network Layer.

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. 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 VDLM2 SARPs and the Manual on VDLM2.

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 was developed to assure complete compatibility with existing airborne terminals while providing maximum user utility. These 14 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.

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

- 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.
- VDLM2 should not preclude aircraft-to-aircraft message exchange capability. This feature is not accommodated in this specification.
- 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.
- 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.
- 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.
- 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.
- Ground Systems should ensure that the parameters broadcast in Ground Station Information Frames (GSIFs) are current and accurate. If a frequency is shared by multiple DSPs, then the parameters that affect an aircraft's ability to communicate with all DSPs, (e.g. Media Access Control (MAC) layer parameters) should be coordinated apriori by the DSPs. Otherwise, the DSPs should use the default values specified in the Manual on VDLM2 for these parameters.
- 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 Aviation VHF Link Control (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.

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.

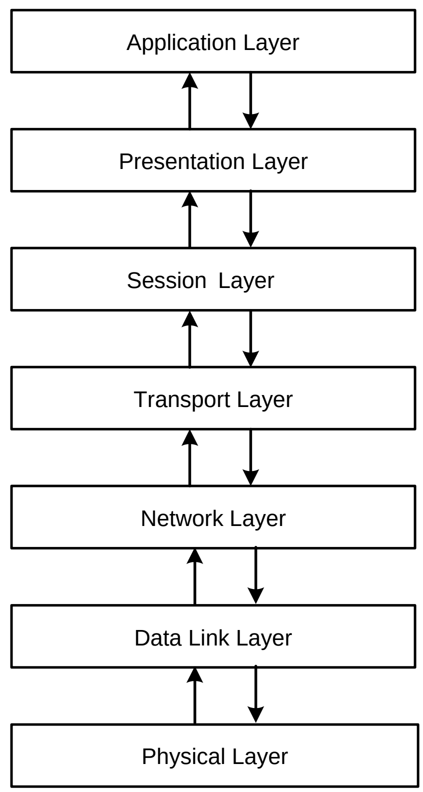


Figure 3-1 – Transmission Medium Layers of the OSI Model

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 (SNAcP) Sublayer (e.g. ISO 8208), the Subnetwork Dependent Convergence Function (SNDCF) Sublayer and the Subnetwork Independent Convergence Protocol (SNICP) Sublayer (e.g. ES_IS/CLNP/IDRP).

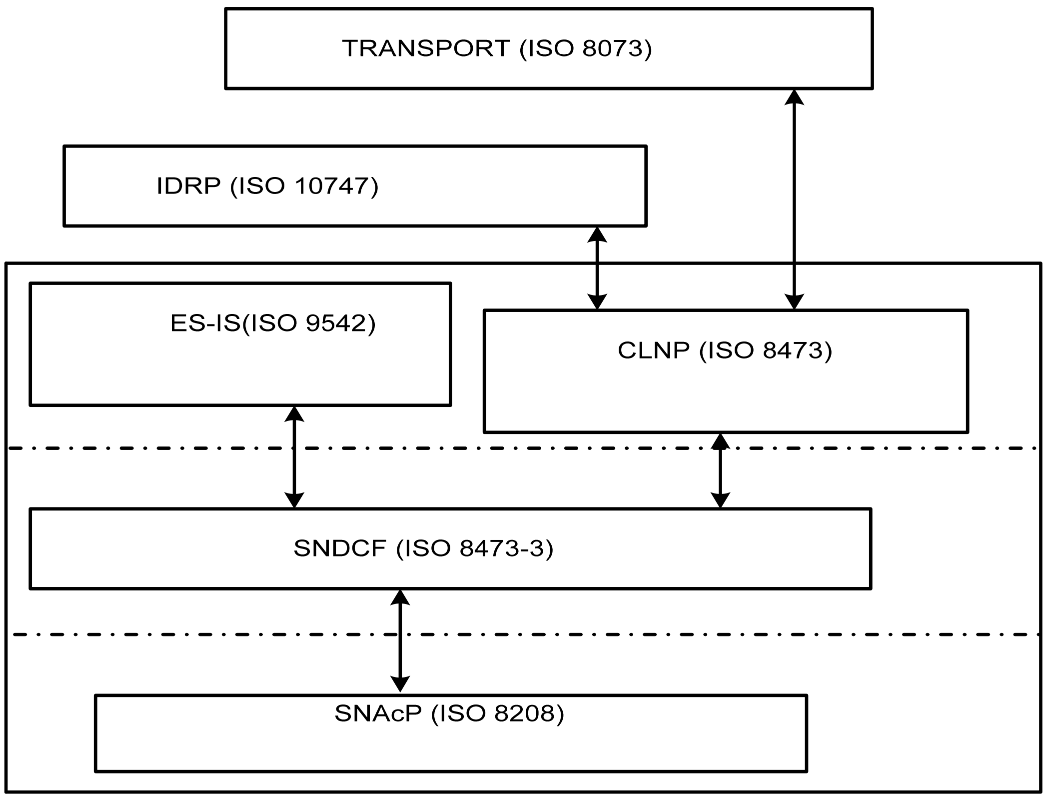


Figure 3-2 – The Sub-layers of the Generic ISO Network Layer

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.

3.0 SYSTEM OVERVIEW

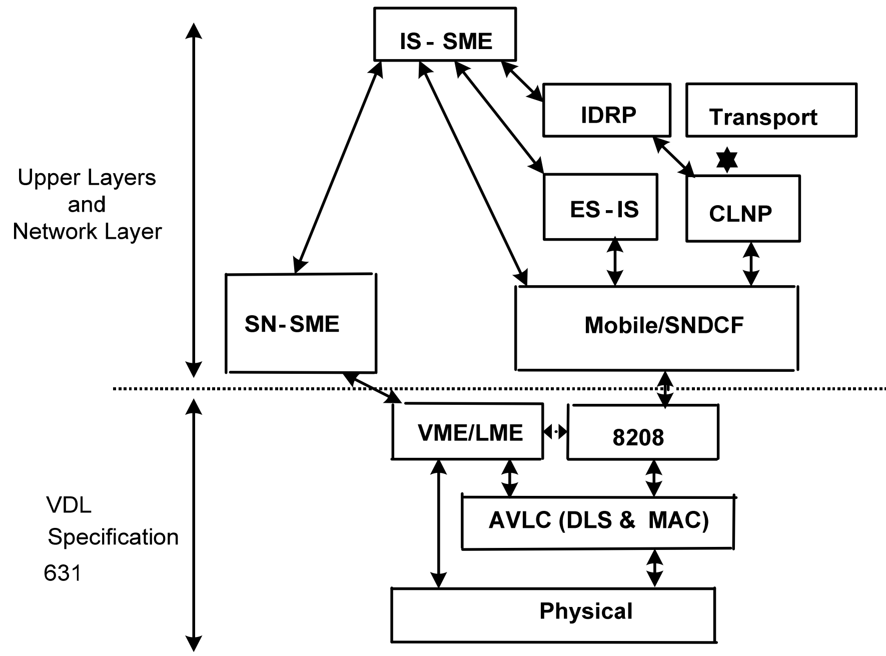


Figure 3-3 – Top Level VDL Mode 2 Architectural Diagram

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. Individual frequencies may be either shared by service providers, or else dedicated to individual providers, depending on local allocations.

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 (GSIFs) in the CSC. 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 the 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.

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 service is available the Subnetwork-System Management Entity (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 PARAM.request primitive to the VDR via the ARINC 429 Williamsburg 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 the Manual on VDLM 2 Sections 5.4.2.1 and Table 5-46.

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 Data Terminal Equipment (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 identifier 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 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 the 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.

Some regions may implement one or more frequencies dedicated exclusively for use on the ground. The service provider advertises these frequencies by means of a Frequency Support List (FSL) transmitted in a GSIF with the “gnd”-bit set to 1. An aircraft on the ground receiving an FSL with the “gnd”-bit set, either after start-up or after landing, should transfer to a dedicated ground frequency from the FSL. On becoming airborne the aircraft should transfer back to a frequency designated for airborne use, all in accordance with the detailed provisions of Section 9.8.2 of this document.

COMMENTARY

> This mechanism provides a means to transfer a large number of aircraft to and from a dedicated ground frequency without the channel overhead that would arise from issuing autotune commands to individual aircraft.

The service provider may transfer an aircraft to an alternate frequency at any time by issuing an Autotune Command. This may be carried in an uplink Exchange Identification (XID) response to either a link establishment or an air-initiated handoff, or alternatively requested by the ground by means of a ground requested, air-initiated handoff. Detailed technical provisions relating to Autotune are provided in Section 9.8.1 of this document.

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. This may arise in a common service area if the aircraft needs complimentary services from different providers, or if the autotune command is sent by a DSP designated a lower priority by the airline. On the other hand, 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 cannot be maintained over the autotuned frequency.

While operating on the CSC, or another frequency for airborne use, the aircraft could find itself unable to establish or maintain a connection due to temporary disruption or congestion on the channel (e.g. if timer TM2 expires). Under these conditions, the aircraft should perform the frequency recovery procedure, in accordance with the Manual on VDLM2 Section 5.4.4.1.2 and either return to the CSC or else select an alternative frequency from those contained in an FSL uplinked by the ground with the “gnd”-bit set to 0.

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 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 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.

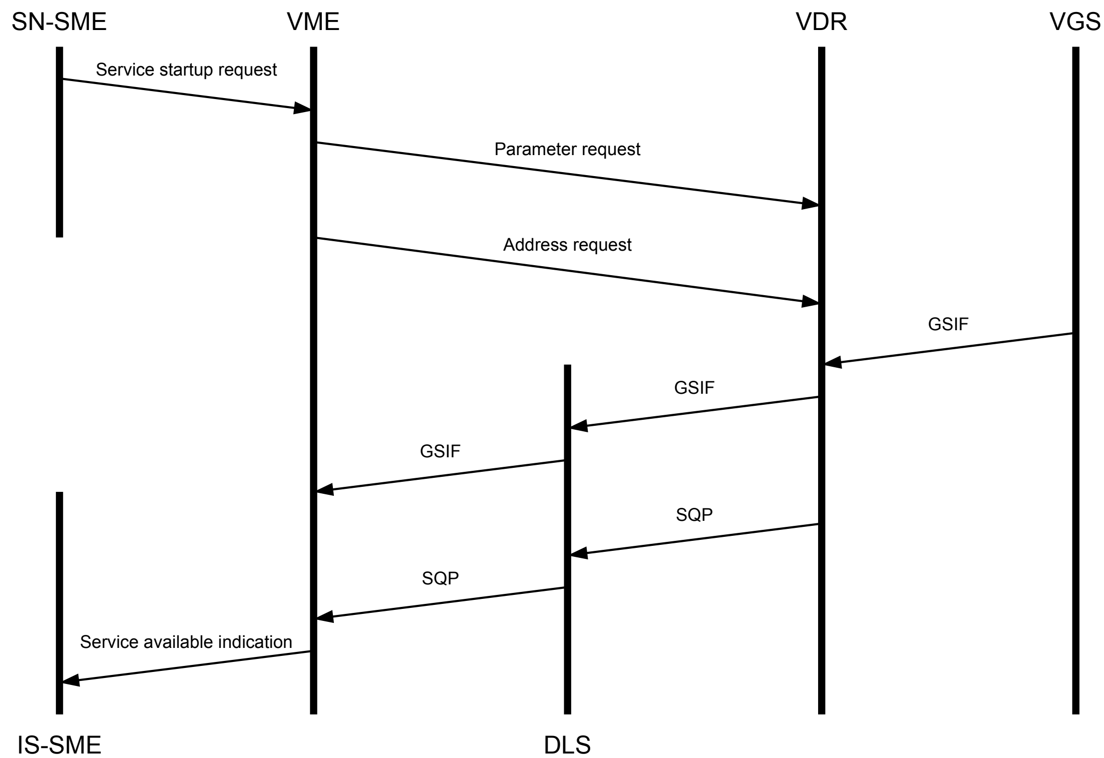


Figure 4-1 – Frequency Set and DSP Acquisition

Frequency search and frequency recovery procedures are defined in Manual on VDLM2 Sections 5.4.4.1.1 and 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:

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

- 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
- 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 Manual on VDLM2 Section 5.4.4.4 to create a new link. The old link should be disconnected based on procedures defined in the Manual on VDLM2 Section 5.4.4.6.4.

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:

- Explicit subnetwork establishment.
- Expedited subnetwork establishment.

COMMENTARY

> To improve the RF efficiency, all vendors are encouraged to implement the Expedited Subnetwork Establishment procedures, as defined in the Manual on VDLM2 Section 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 Manual on VDLM2 Table 5-46a. See the Manual on VDLM2 Section 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.

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 Manual on VDLM2 Section 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:

- Ground station belongs to the preferred DSP.
- Ground station is connected to the air-ground router (as specified by the VDL Specific DTE Address parameter) selected by the IS-SME.
- Any other information available to the avionics including the SQP of all ground stations satisfying the above criteria.

The LME should include the mandatory parameters in the XID_CMD frame as per the Manual on VDLM2 Table 5-46a. 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 the Manual on VDLM2 Table 5-46a and Section 5.4.4.4.2 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.

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.

General Ground-Aircraft Exchange Behavior. The 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 is considered established.

The LME should update its PECT and forward the subnetwork PDU contained in the XID subnetwork connection parameter to the 8208 sublayer. The ISO 8208 sublayer forwards the data (ISH_PDU) to the SNDCF sublayer. The virtual circuit is now considered completely established.

If the XID_RSP_LE received by the aircraft LME includes the Autotune parameter, the aircraft should perform the actions specified in Section 9.8.1.

Prior to sending an XID_CMD_LE, the aircraft should silently disconnect any existing AVLC link it has with the same DSP. When a DSP receives a request to establish a new link by means of an XID_CMD_LE, it should silently disconnect any existing link with the aircraft through any VGS, before responding to the request.

COMMENTARY

> Existing links may be in place at the aircraft and/or at the DSP, for example, if the aircraft performs a link establishment following a failed Autotune command in accordance with Section 9.8.1.

Throughout this document, the term 'silently disconnect' refers to the disconnection of an existing link without sending of a DISC. Typically, this is performed when the peer entity can be assumed to have also disconnected the link by procedural means, such as expiration of a timer.

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.

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 (Network Entity Title (NET)) (See the Manual on VDLM2 Section 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. Generally the LME should attempt to handoff to all ground stations of the preferred DSP in the active PECT before disconnecting from the preferred DSP/ground-based system.

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. However, it should be noted that the aircraft can begin its descent near the RF boundary of the destination airport and care should be taken to prevent the hand-off from occurring too early and the aircraft flying “under” the coverage of the destination airport.

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 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 handoff to a new ground station belonging to the same DSP or ground system, when available, if any of the following events occur:

- The VHF signal quality (SQP) on the current link is poor and the signal quality of another ground station is significantly better.
- Counter N2 is exceeded on any frame sent to the current ground station.
- Timer TM2 expires for the current link.
- The flow control window on a subnetwork SVC carried on the link remains closed for greater than 1 minute (see Section 8.10).
- Timer TG2 expires for the current ground station.

If the handoff is initiated as a result of counter N2 being exceeded, closure of the SVC flow control window, or expiration of Timer TG2, then the old VGS should be removed from the PECT.

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.

If the old link is not desired (as defined by the user preference) then once the new link is established, the old link should be disconnected by sending a DISC. At the latest, the DISC should be issued on expiration of timer TG2 (i.e., when the “old provider” ground station entry is removed from the PECT).

COMMENTARY

When VDL handoff takes place between VGSs connected to different ATN air-ground routers, a potential exists for ambiguity in ATN Routes over the air-ground link during the link overlap period. Avionic vendors and service providers should be aware of this issue, and take steps to minimize its impact.

The issue arises due to the establishment of a new IDRP route following handoff to a VGS connected to a different air-ground router, while the original IDRP route is retained until expiry of TG5. It is desirable that PDUs should be transferred via the new IDRP Route, since the Route via the old VGS may be compromised. However, both Routes may have equal merit and the IDRP protocol, as currently specified by ATN standards, cannot be expected to select the most appropriate route.

In the aircraft, it is recommended that in these circumstances, there should be a local preference for sending downlinks via the new SVC to the newly-established air-ground router.

If the aircraft intends to maintain links with multiple providers, additional action may be required to ensure that uplinks are transferred via the desired provider.

On the ground, other measures may be applied to minimize the impact of routing ambiguity. Close alignment of default values of TG5 on the air and ground may be desirable, to avoid maintenance of an IDRP route that is incapable of reaching the aircraft after expiry of TG5 in the air. Additional system management action may be necessary by the service provider to transfer uplinks via the most appropriate IDRP route prior to TG5 expiry.

In order to avoid additional hazards associated with multi-frequency handoffs, Section 9.8.1 of this document specifies that the ground should only request an autotune via a VGS connected via the same air-ground router.

4.3.1 Handoffs Using Expedited Subnetwork Network Establishment with the Same Ground System

4.3.1.1 Aircraft-Initiated Handoff (Expedited)

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 Manual on VDLM2 Table 5-46b. See also the Manual on VDLM2 Section 5.4.4.6.

The aircraft 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 Manual on VDL M2 Section 5.4.2.4.6. This frame should include the mandatory parameters as per the Manual on VDLM2 Table 6-51 and also any optional parameters for which the aircraft LME does not wish to use the default value.

If the XID_RSP_HO received by the aircraft LME includes the Autotune parameter, the aircraft should perform the actions specified in Section 9.8.1.

The aircraft LME should set Timer TG5 when it receives the XID_RSP_HO and has validated the received parameters. The ground LME should set TG5 after it transmits the XID_RSP_HO. In the event that a further handoff is performed while a

TG5 timer is still running, the TG5 timer should be considered to have expired, and the previous link silently disconnected, prior to restarting TG5.

Disconnecting Old Link (Autotune Parameter Not Used). Both stations should preferentially use the new link once it has been created, and should retain the old link until TG5 expiration, after which each will consider the link disconnected without sending or receiving a DISC.

Disconnecting Old Link (Autotune Parameter Used). Both stations should disconnect the old link after TG5 expiration, after which each will consider the link disconnected without sending or receiving a DISC.

COMMENTARY

Following a transfer of an Autotune Parameter, the aircraft will generally attempt to create a new link on a different frequency, and thus it will no longer be possible to transfer messages on the old link. Under such circumstances, disconnection of the old link following TG5 expiration is intended to provide commonality of procedure over all handoff scenarios, thus easing implementation and integration with other entities such as the ATN.

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 the Manual on VDL M2I Section 5.4.4.6.7.

4.3.1.2 Aircraft-Requested Ground-Initiated Handoff

Section 5.4.4.7 of the ICAO Manual on VDL Mode 2 Part II Edition 2 should not be implemented by avionics.

COMMENTARY

This hand-off would only be requested if the aircraft is in the range of only one ground station, has a link with that ground station, and determines that the quality of service from that ground station is no longer acceptable (i.e. low SQP, N2 on downlink, etc.). In this case the aircraft would only have the current ground station in the PECT and would not have a candidate ground station for hand-off.

However, the VDLM2 SARPs constrain the “Aircraft-Requested Ground-Initiated Handoff” to the current frequency.

In this case there are no other candidate “proposed” ground stations on that frequency and therefore the “Aircraft-Requested Ground-Initiated Handoff” would serve no purpose.

4.3.1.3 Reserved

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 the Manual on VDLM2 Table 5-46c. 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. The Replacement Ground Station List parameter **applies** to the new frequency.

General Aircraft Response. If the aircraft LME receives the XID_CMD_HO **(P=0)**, it should perform the actions specified in Section 9.8.1.

Contrary to Section 5.4.4.9.3 of the ICAO Manual on VDL Mode 2 Part II Edition 1, normal retransmission logic should always be used for the XID_CMD_HO (P=1).

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.

COMMENTARY

Section 9.6 of this document indicates that avionics should not reject an XID frame if a Mandatory parameter is not present. The action of the avionics in the event of receiving a Ground-Requested Air-Initiated Handoff without an Autotune parameter is outside the scope of the current specification. The avionics may attempt to perform a handoff to a station from the Replacement Ground Station List as specified in ARINC Specification 631-5. Other actions are not excluded.

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 (Explicit)

The aircraft LME should make the decision to handoff based on the factors specified in Section 4.3.

When the avionics wants to perform an aircraft initiated handoff with explicit subnetwork connection establishment then the LME should attempt to establish a link with the desired DSP by sending an XID_CMD_HO (P=1) frame that does not contain a Call Request packet.

This frame should include the mandatory parameters as per the Manual on VDLM2 Table 5-46c and also any optional parameters for which the aircraft LME does not wish to use the default value.

General Ground Response. If the ground LME receives the XID_CMD_HO, it should confirm the link handoff by sending an XID_RSP_HO frame containing the parameters as per Manual on VDLM2 Table 5-46b. See also the Manual on VDLM2 Section 5.4.4.6.5. The aircraft should make the handoff as defined in Section 4.3 and as specified in Section 10.2.3.

When the avionics receives the XID_RSP_HO frame then the aircraft ISO 8208 process sends a Call _Request packet in an INFO frame via the new ground station to the air-ground router that the airborne router chooses to establish a virtual circuit with.

The air-ground router should accept the call and send a call accepted packet to the aircraft. When the aircraft VDLM2 8208 process receives this Call Connected packet, the subnetwork connection establishment has occurred and the handoff should be complete.

Both the old Virtual Circuit (VC) and the new VC are active until the old VC is terminated. If the old VC is still active when the old link is disconnected, then the old VC is terminated.

The air-ground router can use the “Called Line Address Modification Notification” (CLAMN) facility to notify the aircraft DTE of called address modification. There are many reasons why a called address may need to be modified as can be seen from the numerous reason codes defined in ISO 8208. One use for the CLAMN facility is to notify the aircraft DTE of redirection of the call to a new air-ground router DTE, if the ground system supports X.121 addressing. The receipt of a CLAMN should not infer call redirection. Call redirection should not be used by the DSPs that support only the VDL Specific DTE addressing mechanism.

Call Rejection by Air-ground Router. If the VDLM2 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 VDLM2 8208 process should send a clear confirm packet to the ground network. The old VC should remain unaffected. The VDLM2 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.

Disconnecting Old Link. Same as in Section 4.3.1.1.

Exceptional Cases. Same as in Section 4.3.1.1.

4.3.2.2 Ground-Initiated Handoff

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 proposed 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 mobile SNDCF (MSNDCF).

The LME should then accept the handoff by sending an XID_RSP_HO (F=1). This frame should include the mandatory parameters as per the Manual on VDLM2 Table 5-46b and also any optional parameters for which the aircraft LME does not wish to use the default value.

After the aircraft LME accepts the XID_CMD_HO (P=1) and sends the response XID_RSP_HO (F=1) frame, the aircraft should initiate explicit subnetwork connection as described in Section 4.3.2.1. The explicit subnetwork connection procedure described in Section 4.3.2.1 should be followed.

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. The ground should follow the explicit subnetwork connection procedure described in Section 4.3.2.1.

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 the Manual on VDLM 2 Section 5.4.4.8.3.

Exceptional Cases. See the Manual on VDLM2 Section 5.4.4.8.4.

4.4 Provisions for Test DSP

4.4.1 Aircraft Considerations

The aircraft should consider ground stations having addresses within the Test DSP system mask as a provider of testing services. This means that the aircraft should NOT regard them as a network path for delivery of operational data.

COMMENTARY

The unintentional delivery of operational data over a Test DSP ground system could result in permanent data loss especially if such data is ACKed by those ground stations.

The aircraft should be placed into an alternate mode of operation, i.e. a Test Mode, before it would respond to GSIFs being broadcast by the Test Equipment (TE).

COMMENTARY

The means by which the aircraft is transitioned into Test Mode is a determination made by the avionics vendor. One option may be via a manual selection of the Test DSP from the DSP preference table menu on the aircraft's MCDU. Following the completion of testing the aircraft may be returned to its normal operating mode via the same means.

While in this Test Mode of operation, the ability to verify the aircraft's transitioning between VDLM2 and ACARS and vice versa, via labels (:;) (:}) and Squitter would be useful. The avionics support for such testing while in Test Mode is suggested.

4.4.2 Ground Station Considerations

The TE should use a VDLM2 ground station address which resides within the Test DSP address allocation range.

The emission of GSIFs by the TE should have the System Mask XID parameter set accordingly so as to indicate that the ground station resides within the Test DSP.

COMMENTARY

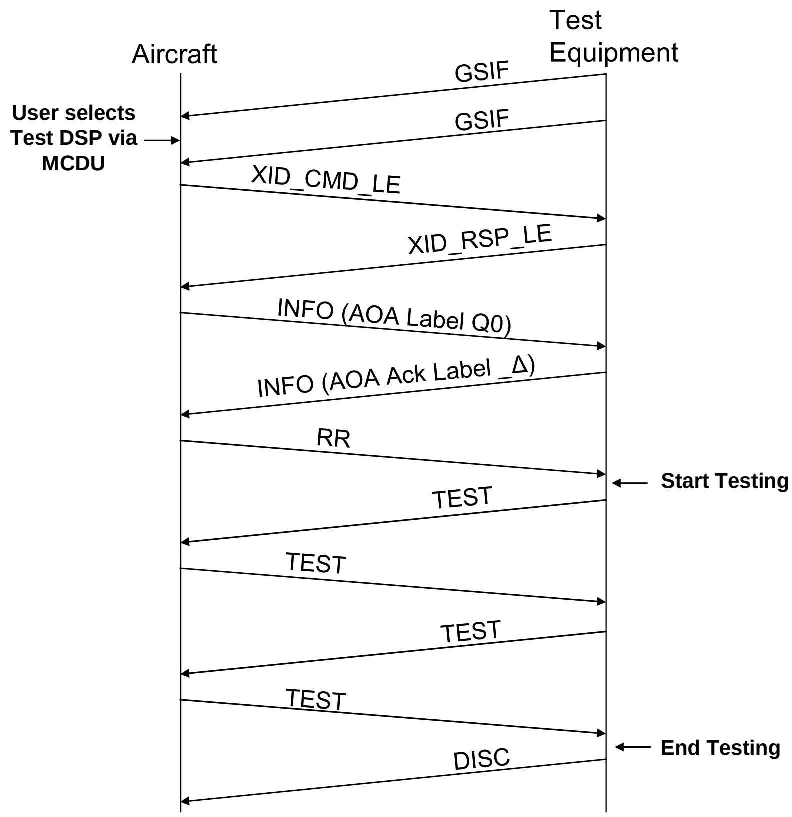
The table of Appendix F specifies this Test DSP system mask value.

The TE should only accept data link connections from the aircraft under test.

COMMENTARY

This is to guard against the situation where aircraft other than the one under test may hear GSIFs emitted by the test equipment and attempt link establishment.

4.4.3 Typical Message Exchanges



Station Identification

The TE should announce its presence by commencing GSIF emission.

COMMENTARY

The aircraft should be placed into the operating mode, i.e., Test Mode, which allows connection to Test Equipment.

Link Establishment

The aircraft should attempt to establish a link with the TE by the emission of a XID_CMD_LE.

COMMENTARY

If the aircraft includes within the XID_CMD_LE the optional SQP (which would contain the SQP value of the last received GSIF) this could give test equipment an indication of how well the aircraft is receiving it.

The TE should accept or reject the link in accordance with the link establishment procedures of Section 4.2.1.

AOA Link Test

If the aircraft issues a Link Test message (label <Q0>) the test equipment should respond with the General Response message (Label <_DEL>).

COMMENTARY

The <_DEL> response is necessary so that the link test dialogue commenced by the aircraft may be closed.

Test Frame Exchange

The TE may issue a TEST frame to the aircraft as a means of performing a type of loopback testing. Every TEST frame received by the aircraft should induce the emission of a TEST frame identical in content to that received.

COMMENTARY

Note also that it is not necessary for a link between the test equipment and aircraft to exist prior to commencing TEST frame exchange.

Link Termination

The TE terminates its link with the aircraft by the emission of a DISC frame.

COMMENTARY

Following the completion of testing the aircraft should be returned to its normal operating state, i.e. exit of Test Mode.

5.1 Introduction

The physical layer protocol and specifications services are defined in the VDLM2 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 VDLM2 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:

- Transmitter and receiver frequency tuning
- Data reception of the receiver
- Data transmission of the transmitter
- Notification services
- Mode 2 frames
- Data Encoding
- Spectrum Shape
- Modulation rate
- Training sequence
- Header FEC
- Interleaving
- Channel busy to idle detection
- Transceiver interaction

The physical layer of VDLM2 should comply with the VDLM2 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 VDLM2 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:

- Channel access.
- Channel status monitoring.

VDLM2 should comply with the MAC functions defined in Manual on VDLM2 Section 5.2.

The MAC system parameters should be implemented as defined in the Manual on VDLM2 Table 5-1.

6.3 Procedures of the MAC Sub-Layer

The MAC sub-layer should perform the following procedures:

- Channel sensing: As per Manual on VDL2 Section 5.2.4.1.
- Access attempt: As per Manual on VDLM2 Section 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 Manual on VDLM2. 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 Manual on VDLM2 VDL Section 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 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 Manual on VDLM2 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 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.
- 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 Manual on VDLM2 Section 5.3.11.2 for the SREJ procedures.

FRMR frame: See Manual on VDLM2 Section 5.3.11.3 for the FRMR procedures.

UA frame: See Manual on VDLM2 Section 5.3.11.4 for the UA procedures.

TEST frame: See Manual on VDLM2 Section 5.3.11.6 for the TEST procedures.

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 Manual on VDLM2 Section 5.3.3.3.3.

The address type field is described in the Manual on VDLM2 Table 5-2.

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. IATA, on behalf of ICAO, administers to the organizations, which in turn will administer their organization's addressing blocks. Ultimately, the organizations will assign the individual ground station addresses.

COMMENTARY

The information contained in Appendix F is provided for the reader's convenience. In the event of discrepancies between this document and IATA documentation, the IATA documentation will prevail.

7.4.2 Erroneous use of Broadcast ICAO 24 bit Aircraft Address

Avionics designers should incorporate measures to prevent transmission of any VDL Mode 2 frames if the 24 bit ICAO Aircraft Address is configured to be all ones.

A VDL Mode 2 Ground Station should discard without response any received frame carrying a 24 bit source address of all ones.

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 Manual on VDLM2 Section 5.4.4.3. The GSIF also provides the address of the AGR. The AGR address should be the VDL Specific DTE Address (VSDA) of the AGR, not the X.121 Address.

7.5.1 GSIF Parameters

The following parameters should be included with every GSIF (see Manual on VDLM2 Table 5-4a and Section 5.4.2 for definition):

- Public parameter set ID
- Public procedure classes
- HDLC options

- Private parameter set ID
- AVLC specific options
- System Mask
- 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 Manual on VDLM2 during initial implementation. The aircraft should allow dynamic modification and negotiation of these parameters as defined in the Manual on VDLM2 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 should contain each additional frequency supported. The parameter may contain more than one ground station address. 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.

The GSIF should have the “gnd” bit set to one if the Frequency Support List should only be used by Aircraft on the ground.

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.

The aircraft should not reject a GSIF in the event that a parameter that is designated mandatory (per the PICS defined in Attachment 2) is not present. Refer to Section 9.6, Parameter Negotiation, to read the rationale for this behavior.

7.6 Timers

7.6.1 Timer T1

This Section is included to clarify the Manual on VDLM2 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). The value of Timer T1 should be calculated by the following formula:

Timer T1 = T1min + 2T1int + $2TD_{99}$ + min (U(x),T1max)

Where:

T1min and T1max are parameters set by the ground system, as defined in the Manual on VDLM2.

T1int is the propagation delay between the VDL mode components in the CMU and VDR. This term was added to the equation in the Manual on VDLM2 because the Manual on VDLM2 does 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.

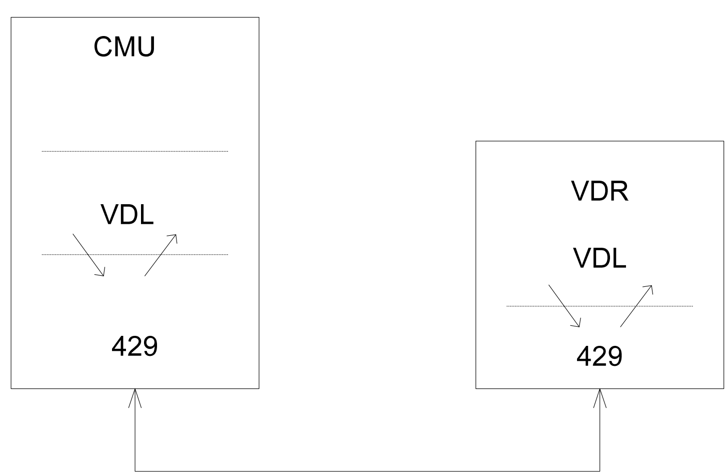


Figure 7.6-1 – CMU-VDR Transfer Delay

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 Manual on VDLM2 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 VDLM2 SARPs.

The percent of time that the channel is busy is represented by u. Channel sensing should be performed as defined in the VDLM2 SARPs and that data should be used to calculate u. The range of values for u is 0 to 0.99 with 0.99 corresponding to a channel that is 99 per cent or greater occupied.

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

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

Where:

T1mult and T1exp are parameters set by the ground system, as defined in the VDLM2 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 be started when any (INFO, RR (P=1), SREJ (P=1) frame) is “queued for transmission” except when the T1 timer is already running. The Timer T1 should be started when a FRMR frame is queued for transmission.

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 Manual on VDLM2 Section 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. T3min, T3max, T3multi, and T3exp. The timer component T1int 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.

7.9 AVLC Specific Option

If the ground station sets bit 6 of the AVLC specific options parameter to one in its GSIF, it indicates that the ground station supports both VDLM2 8208 protocol and non-VDLM2 8208 protocol over the VDL link. Currently, non-VDLM2 8208 protocol should be interpreted to be AOA. Upon receiving a GSIF with bit 6 of the AVLC specific options parameter set to one, if the aircraft responds (via an XID frame) with bit 6 of the AVLC specific options parameter also set to one, then non-VDLM2 8208 service is available on the established link. If the aircraft responds with bit 6 of the AVLC specific options parameter set to zero, then VDLM2 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 one, it may not support VDLM2 8208 and may only support non-VDLM2 8208 due to a phased deployment approach.

If the ground station ONLY supports non-VDLM2 8208 protocol then the VDL Specific DTE Address (VSDA) contained in the ground station's GSIF should be "00 00 00 00 00 00". If the ground station supports non-VDLM2 8208 protocol and VDLM2 8208 then the VSDA contained in the ground station's GSIF should be non-zero. A GSIF from a ground station that supports VDLM2 8208 should not contain a VSDA value of "00 00 00 00 00 00".

A ground station advertises the operational state of available services in it's GSIF through the use of the AVLC Specific Options parameter and the ATN Router NETs parameter. Possible states for available services are:

- VDLM2 8208 only
- non-VDLM2 8208 only
- VDLM2 8208 plus non-VDLM2 8208
- **No Service**

The VDLM2 8208 only state is indicated by setting Bit 6 of the AVLC Specific Options parameter to zero and encoding at least one non-zero parameter value in the ATN Router NETs parameter.

The non-VDLM2 8208 only state is indicated by setting bit 6 of the AVLC Specific Options parameter to one and encoding one all-zeros parameter value in the ATN Router NETs parameter.

The VDLM2 8208 plus non-VDLM2 8208 state is indicated by setting Bit 6 of the AVLC Specific Options parameter to one and encoding one non-zero parameter value in the ATN Router NETs parameter.

The No Service state is indicated by setting Bit 6 (“a”) of the AVLC Specific Options parameter to zero and encoding one all-zeros parameter value in the ATN Router NETs parameter.

If the ground station sets bit 6 of the AVLC specific options parameter to zero in its GSIF, it indicates that the ground station does not support non-VDLM2 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.

Since expedited ground-initiated handoff is not allowed (see Section 4.3.2.2), aircraft should set bit 2 (“v” bit) of the AVLC Specific Options parameter to 0. This setting indicates that aircraft do not accept Call Requests in the Expedited Subnetwork Connection parameters. Likewise, aircraft should set bit 4 (“v” bit) to 0 of the Connection Management parameter.

The ground station sets bit 2 (“v” bit) of the AVLC Specific Options parameter to 0 if the ground station does not accept expedited subnetwork connection. The ground station sets bit 2 (“v” bit) of the AVLC Specific Options parameter to one if the ground station does accept expedited subnetwork connection. Likewise, the ground stations sets bit 4 (“v” bit) of the Connection Management parameter accordingly. If the ground station indicates acceptance of expedited subnetwork connection as described above, then an aircraft can initiate expedited link establishment or air-initiated handoff with this ground station. If the ground station indicates it does not accept expedited subnetwork connection, then an aircraft should initiate subnetwork connection through the explicit process.

If the ground station sets bit 7 (“gnd” bit) of the AVLC specific options parameter to one in its GSIF, it indicates that the frequency support list defined in the GSIF should be used only by aircraft which are on the ground at the airport identified by the airport coverage parameter in the GSIF. If the ground station sets bit 7 (“gnd” bit) of the AVLC specific options parameter to zero in its GSIF, it indicates that the frequency support list defined in the GSIF should be used when the aircraft is airborne.

COMMENTARY

Avionics designed prior to the introduction of the “gnd” bit may use the FSL when airborne or on the ground regardless of the value of the “gnd” bit. It is recommended that the DSP not accept connection on the ground frequency by aircraft that are airborne. See Section 9.8.2.

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 VDLM2 SARPs	As Specified in the VDLM2 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

7.13 Encoding of XID Public Parameters

Attachment 4 provides a description of the bit ordering for the public parameters for which the ISO/IEC 8885 standard was cited in the VDLM2 SARPS. It takes precedence over the ISO/IEC 8885 standard.

7.14 Unrecognized XID Parameters

The aircraft should disregard any unrecognized XID parameters carried in an uplink XID frame, and should process the remainder of the frame as if the unrecognized parameters had not been present.

COMMENTARY

This provision will facilitate introduction of additional XID parameters which may be needed in the future, without disruption to existing avionics. For example, an XID parameter may be needed to identify the default provider supporting communication for ATSC services to non-AOC operators.

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 VDLM2 8208, except as noted below. See Manual on VDLM2, Section 5.

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 Manual on VDLM2. It is mandatory for both aircraft and ground systems.

8.2.2 Expedited Connection Establishment

Both the aircraft and ground LMEs should support expedited subnetwork as described in Manual on VDLM2, Section 5.4.4.12. The initiating DTE should issue CALL REQUESTs for those logical channels that were not initiated by the XID exchange.

COMMENTARY

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 Router (GS + AGR) will consider the link and subnet connection established with the aircraft, while the latter will not have any link or 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).

8.3 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 CALL REQUEST/CALL CONFIRM user data field when the Fast Select facility is set.

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.

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 maintained until the old link is disconnected (upon expiration of timer TG5).

COMMENTARY

When the aircraft hands off and connects to a new air-ground router, connectivity with the old air-ground router should be maintained until TG5 has expired or the new link has been established. Before TG5 times out, the old VC needs to be maintained until new routes are established with the new air-ground router.

8.4.1 Call Redirection for X.121 Based Networks

Even if the ground network supports X.121 addressing, the aircraft should generate the new Call Request with the VSDA address of the specific air-ground router in the address extension field of the Called Address Extension facility.

For JOIN and HANDOFF operations, the avionics should always generate a call request using a VSDA address in the Called Address Extension facility.

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 (CLAMN) facility as specified in the Manual on VDLM2, Section 5.6.3.3. Note that a CLAMN facility can be used to modify the address for reasons other than redirection.

Call redirection should only be used in case of faults related to the air-ground router. A service provider should only redirect a call to another address within the same routing domain (i.e. same AGR). That is, a CLAMN will never result in a “redirection” to a different AGR.

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 MSNDCF 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 DATA packet with a bad sequence number (P(s)), it should transmit a REJECT packet, as specified in VDLM2 8208, Section 13.4.

8.7 Priority (QOS)

Priority is not supported by VDLM2.

8.8 DTE Addressing

VDLM2 SARPs supports two addressing options at the subnetwork layer. The default addressing is called VSDA and should be supported by all VDL entities. Optionally, VDLM2 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

COMMENTARY

Particular attention should be paid to Service providers supporting VSDA addressing only. Since some fields of the VSDA address may not be readily BCD encoded the VSDA address advertised in the GSIF should be placed unmodified in the called address extension field.

8.9 PICS

VDLM2 subnetwork PICS are provided in Attachment 3.

8.10 Flow Control Window Closure

A hazard is known to exist by which disruption on the VDLM2 uplink may cause the downlink VDLM2 8208 flow control window to close, followed by loss of AVLC at the ground station. The closure of the downlink flow control window then prevents the aircraft from discovering the loss of the AVLC link, leading to a sustained loss of ATN end-to-end communication.

In order to recover from this condition, an aircraft should detect whenever the SVC flow control window becomes closed. Closure of the flow control window is indicated when

$$P(S) = P(R) + W - 1 \text{ under modulo } 8,$$

where

P(S) is the send sequence number of the last packet sent,

P(R) is the last receive sequence number, and

W is the window size.

In the event that closure of the flow control window persists for greater than 1 minute, the aircraft should consider the underlying AVLC link to have been lost, and commence an air-initiated handoff to another ground station.

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 Manual on VDLM2, Section 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

Manual on VDLM2, Section 5.4.4.1.1 on Frequency Search should be implemented.

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

- Common Signaling Channel (CSC).
- A frequency which is supplied by the ACARS squitter.
- 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 the same Ground System, two Ground Stations connected to different VSDAs (whether ground system supports X.121 addressing or not) should send a handoff (XID_CMD_HO) to the new ground station. In this case, an ISH PDU should be included in the Call Request in order to ensure proper route initiation and exchange of configuration information. An aircraft crossing, within the same Ground System, two Ground Stations connected to the same VSDA (whether the ground system supports X.121 addressing or not) should send a handoff (XID_CMD_HO) to the new ground station. In this case, an ISH PDU should also be included in the Call Request even though route initiation and exchange of configuration information should not occur.

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 VGS and the ground should respond with a Call_confirm packet.

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 VGS 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 Manual on VDLM2, Table 5-46. It is recommended that both avionics and ground stations use the default values specified in the Manual on VDLM2, Tables 5-1, 5-5, 5-21, and 5-45.

Both the avionics and ground stations should not reject an XID frame in the event that a parameter that is designated Mandatory for the sending station (per the PICS defined in Attachment 2) is not present in the frame.

COMMENTARY

The aircraft (and ground stations) are likely to receive messages that do not contain "Mandated" parameters due to variations in the ground system (and avionic) implementations that evolve over time. This may occur because the implementations are based on different standards (e.g. the ICAO Manual on VDLM2 vs. this specification) or different versions of a standard. While it is expected that eventually these inconsistencies will be eliminated, in the Interim it is necessary that the avionics (and ground systems) accept messages with "missing data." Further, the avionics (and ground systems) are obligated to process the remainder of such messages normally even in the absence of the "Mandated" data.

9.7 ATN Router NET Parameter

The ATN Router NET parameter should contain a single VSDA reachable from the ground station broadcasting the GSIF. See Section 8.8 for a description of this parameter.

COMMENTARY

ICAO VDL standards permit the advertisement of multiple VSDAs within a single GSIF. However, Appendix D of this document considers a range of scenarios supporting end-to-end connectivity for ATS and AOC applications, and concludes that the favored approach is to use ground-ground networking to support connectivity between adjacent ATS Providers, and consequently that advertisement of only a single VSDA per VGS is necessary to support current requirements. This strategy avoids the necessity for selection logic in avionics, and ensures interoperability. In the event that it is desired to implement a future ground network architecture that cannot be supported by a single VSDA (e.g., to support separate AOC and ATS A/G Routers), then it will be necessary to ensure that appropriate industry standards are in place to specify criteria by which avionics should select the VSDAs through which connections are required.

Each ground station should periodically broadcast the VSDA of the air/ground router (if present) reachable through it. The VSDA 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.

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.

9.8 Frequency Management

All VDLM2 systems should support the CSC as specified in the ICAO Annex 10 Volume III Part I Section 6.1.2.3.

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 VDLM2 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.

9.8.1 Autotune

A ground system may request an aircraft to switch to an alternate frequency by sending:

- an XID_CMD_HO (P=0), a "ground requested, air-initiated handoff" command as per Manual on VDLM2, Section 5.4.4.9, or
- an XID_RSP_LE (F=1) following link establishment, as per Manual on VDLM2, Section 5.4.4.4, or
- an XID_RSP_HO (F=1) following an air-initiated handoff, as per Manual on VDLM2, Section 5.4.4.6,

containing the Autotune and Replacement Ground Station List parameters. Upon receipt of such a command, and when allowed by the airline preferences for service provider, an aircraft should change the operating frequency of the VDR to the new frequency indicated by the Autotune parameter prior to attempting an air-initiated handoff **by sending an XID_CMD_HO (P=1)** to a ground station listed in the Replacement Ground Station List parameter. The aircraft should make the handoff as defined in Section 4.3 and as specified in Section 10.2.3. **The aircraft should populate and maintain a PECT for the current frequency.**

When attempting an air-initiated handoff in accordance with an autotune command, the aircraft LME should retransmit the XID_CMD_HO (P=1) on the new frequency using the normal retransmission procedures, until either counter N2 is exceeded, or else an XID_RSP_HO (F=1) has been received. If Counter N2 is exceeded, the aircraft should attempt a handoff to another ground station from the Replacement Ground Station List, and if all such stations have been attempted, the aircraft should switch to the CSC to perform link establishment.

COMMENTARY

Ground service providers should be aware that if the Replacement Ground Station List contains a large number of ground stations, the aircraft may take a significant period of time to attempt each ground station in turn, during which time the aircraft will remain out of communication.

In the event that the attempt to perform an autotune is unsuccessful, or if the resulting new link is disconnected by the ground while the aircraft's TG5 timer is running, the aircraft can not assume that the previous link is still valid. The avionics should therefore then attempt to establish a new link on the CSC by scanning the CSC frequency and selecting a ground station for link establishment.

COMMENTARY

Attention is drawn to the provisions of Section 4.2.1.1 to ensure that the aircraft and the DSP silently disconnect any existing links during the process of establishing a new link. This action avoids various potential hazards following failure of an Autotune. If the ground side failed to receive the aircraft's XID_CMD_HO **(P=1)** following the Autotune, the ground side would not commence a TG5 timer, and a link would be maintained at the ground on the original frequency, possibly leading to a dysfunctional ATN route to the aircraft. On the other hand, after tuning to the new frequency, a new link may have been established on the ground side, but not recognized at the aircraft because it failed to receive the uplink XID_RSP_HO **(F=1)**. In this case, a redundant link would exist at the ground on the new frequency. Furthermore, if the aircraft then returned to the original link on the CSC, it would shortly be disconnected silently following expiry of TG5 on the ground, leaving the aircraft without a current link.

If the airline preferences for service provider do not allow the aircraft to perform the autotune, then it should send an XID_CMD_LCR (P = 0) as per ICAO Manual on VDLM2, Sections 5.4.4.4.3, 5.4.4.7, and 5.4.4.9.3, setting the LCR cause parameter as follows:

- 07h – Autotune rejected – service required from multiple providers
- 08h – Autotune rejected – not preferred provider
- The current link on the current frequency should remain unaffected

COMMENTARY

The above LCR cause parameter values are extensions to the values specified by the Manual on VDLM2.

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

COMMENTARY

This provision eliminates the potential hazard of the ground maintaining an IDRP Route that is incapable of reaching the aircraft during an autotune.

Due to ambiguous XID_CMD retransmission rules in the ICAO Manual on VDL Mode 2, Part II, Edition 1, Sections 5.3.4.3 and 5.3.9; it is recommended that a DSP follows its local implementation rules when retransmitting the ground-requested air initiated handoff XID_CMD_HO (P=0).

In the event that the ground receives an XID_CMD_LE or XID_CMD_HO (P=1) containing a CALL REQUEST packet in the Expedited Subnetwork Connection parameter, the ground should process the CALL REQUEST with the aim of establishing an SVC, and issue the appropriate response in an Expedited Subnetwork Connection parameter of the XID_RSP even if the later also contains the Autotune parameter.

COMMENTARY

This action is a deviation from the ICAO VDL Manual and is specified to ensure that, in the event that the aircraft refuses the Autotune, an SVC will be available for the aircraft to use with minimal delay.

9.8.2 Frequency Support List (FSL)

If a FSL is provided in an uplink XID (GSIF or other XIDs), the aircraft should attempt the available frequencies advertised in the FSL to establish and maintain communications with peer ground systems. When the aircraft is airborne it should use the FSL in accordance with Section 9.8.2.1 below and when on the ground in accordance with Section 9.8.2.2

The first frequency/ground station selection is made at random from the FSL, so as to give an equal probability of selecting any entry. If the handoff is not successful and there is another frequency/ground station entry in the FSL then another handoff attempt should be made until each frequency/ground station entry is tried once using normal retransmission logic. The aircraft should populate and maintain a PECT for the current frequency. If the resulting new link is disconnected by the ground while the aircraft's TG5 timer is running, the aircraft cannot assume that the previous link is still valid. In such a case, the aircraft should consider the handoff to have failed and attempt a handoff to another frequency/ground station as described above.

If all of the handoff attempts fail, then the aircraft should switch to the CSC and scan for a link establishment.

COMMENTARY

> The objective is to minimize the number of tries to successfully establish a link. This specification leaves the specific ground station selection process for the second and subsequent frequency/ground stations open in order to maximize the flexibility of the avionics designer. If the link establishment/handoff to the first FSL selection fails, logic could be to make subsequent selections that have the same frequency to optimize the potential for success in subsequent tries.
>
> The probability of achieving a successful link may be higher for ground stations that the avionics hear that meet selection criteria. Avionics are at liberty to attempt to establish a link with ground stations based on hearing them during this time.

Ground stations advertised in the FSL should use the same operating parameters as the transmitting station (similar to Replacement Ground Station List used for the Autotune procedure).

9.8.2.1 Frequency Support List for Aircraft in the Air

If the "gnd" bit in the AVLC options parameter of a GSIF is set to zero then the FSL should be used by aircraft which are airborne. Aircraft in the air should not use an FSL carried in a GSIF with the "gnd" bit set to one.

When airborne, the aircraft should use the FSL either:

a. following transition from the ground to the air, as described in Section 9.8.2.2

b. to perform the frequency recovery, per procedures defined in the ICAO Manual on VDLM2, whenever it is unable to establish or maintain a link on the current frequency or when Timer TM2 expires.

An airborne aircraft should not change to a frequency from the FSL under any other circumstances.

The GSIFs on a ground frequency should contain a FSL and the “gnd” bit should be set to zero.

9.8.2.2 Frequency Support List for Aircraft on the Ground

If the “gnd” bit in the AVLC options parameter of a GSIF is set to one, the frequency support list should only be used by aircraft which are on the ground at the airport identified by the airport coverage parameter in the GSIF. Aircraft which support the “gnd” bit and which are on the ground should attempt a handoff to a frequency and associated ground station(s) in the frequency support list.

When the aircraft is on the ground then it should only use ground stations that advertise coverage for the airport at which the aircraft is located.

In the event that all handoffs on the ground frequency fail, the aircraft should then revert to, and remain on, the CSC (no more attempts to use the ground FSL) until the aircraft takes off. The aircraft is still obligated to change frequency if it receives an autotune.

Once an aircraft on a ground frequency leaves the ground, its LME should handoff to a frequency and associated ground station received from the FSL of a GSIF with the “gnd” bit set to zero. Aircraft in which the data link avionics are unable to determine whether the aircraft is on the ground or in the air should not attempt to use a ground frequency.

It is recommended that the ground system should examine the A/G bit of any downlink AVLC XID frame attempting to establish a link or perform a handoff to a VGS on a ground frequency. In the event that the A/G bit indicates that the aircraft is not on the ground, the link should not be established, and the ground should respond with an XID_RSP_LCR (LCR Cause code 09h).

COMMENTARY

Aircraft compliant with earlier versions of ARINC 631 will ignore the “gnd” bit and accordingly may be expected to attempt to connect to ground stations from the ground frequency support list while in the air. An en-route aircraft at altitude transmitting on the same frequency would reduce link capacity on the ground at all airports within its radio horizon, which might cover a radius of over 200nm. Aircraft at altitude will experience significant degradation in service. When at altitude they will “see” many ground transmitters which by design do not see each other and as such will keep the volume busy. This will allow the aircraft very limited access to the channel.

See “Figure 9.8.2-1 – Ground Frequency Sequence Diagram” for an example of the interactions involved with using the ground frequency. Here is a description of each interaction in that diagram:

1. GSIF received with the “gnd” bit set to 1; since aircraft is in the air, it ignores the frequency support list at this time.
2. The aircraft lands.
3. GSIF received with the “gnd” bit set to 1; since aircraft is now on the ground, it will attempt to handoff to the frequencies mentioned for the randomly-selected frequency in the frequency support list.
4. Aircraft requests to handoff to the randomly-selected ground station entry mentioned in the frequency support list.

   If the handoff is unsuccessful and there is another ground station in the FSL for that frequency then another handoff attempt is made. If all handoffs are unsuccessful then the aircraft switches to the CSC for a link establishment.

1. Ground station for ground frequency responds to handoff request.
   GSIF received with “gnd” bit set to 0 and aircraft retains FSL data for departure.
2. The ground frequency GSIFs should include the FSL, and the “gnd” bit should be set to 0. The FSL parameter should contain the enroute frequency(ies) which could also be the CSC frequency. Eventually the aircraft takes off. Immediately after take off, the aircraft starts an attempt to handoff to an enroute frequency (which may include the CSC) and associated ground stations in the FSL received while using the ground frequency.
3. Aircraft takes off.
4. The aircraft requests to handoff to the enroute frequency (which may be the CSC) and ground station (or randomly-selected if there are multiple entries) in the FSL.
5. The ground station responds to the handoff request.

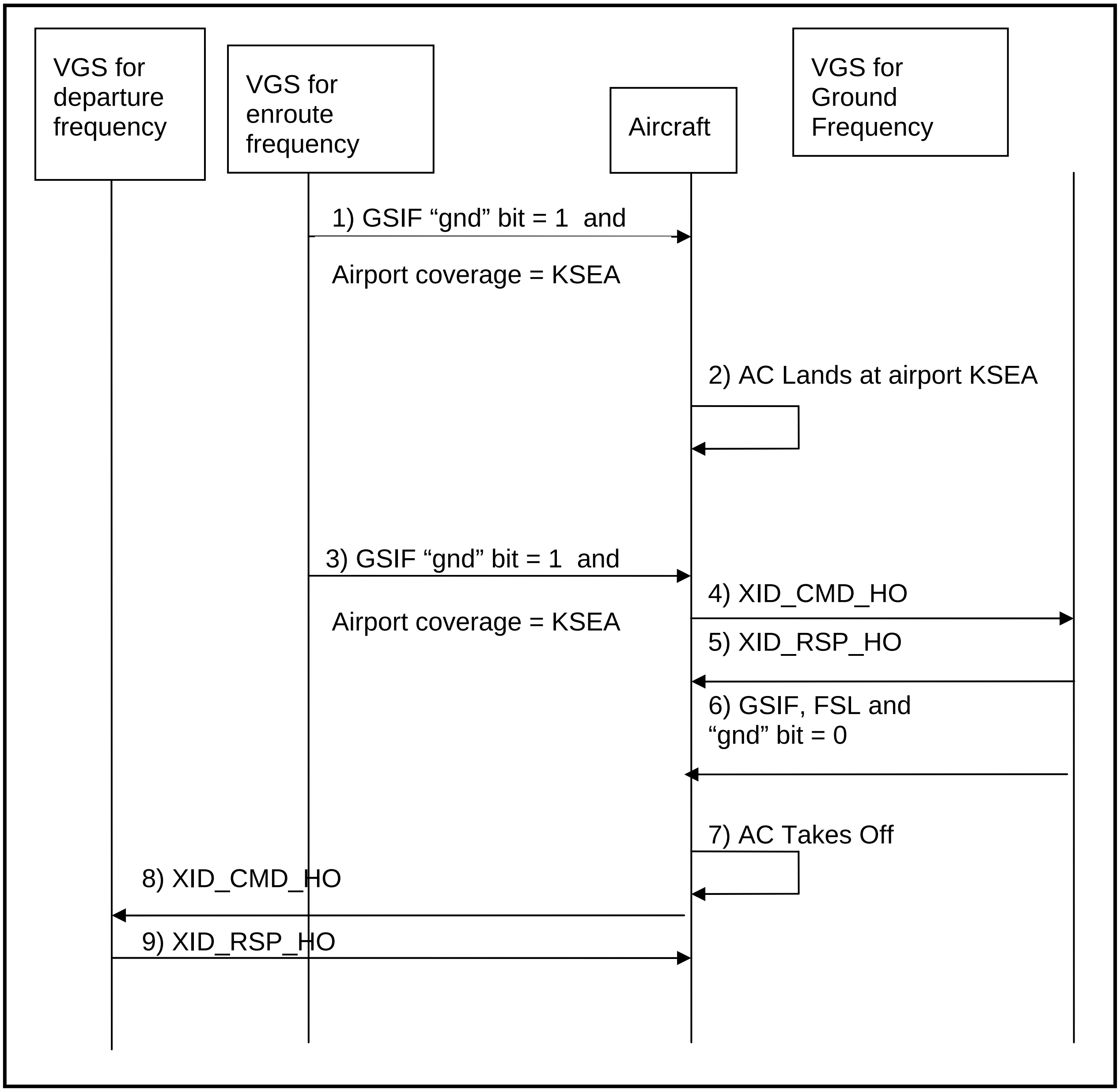


Figure 9.8.2-1 – Ground Frequency Sequence Diagram

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 VGS specific VDLM2 parameters. The VGS entry from PECT should be removed when a VGS becomes unavailable after timer TG2 expires **or after a VHF frequency change.**

10.0 EXTERNAL INTERFACES

10.1 Introduction

This section specifies the external interfaces of VDLM2 with subnetwork system management, the subnetwork access protocol and the VDR.

Appendix I provides guidance for implementers of the subnetwork interface using VDLM2 as the example. It describes a control interface and a data interface. The control interface is between SN-SME and IS-SME and includes Join, Handoff and Leave notifications. The data interface is between the subnetwork access protocol and MSNDCF and includes the establishment and termination of subnetwork connections and data transfer over the connections.

Appendix J provides guidance for maintaining uninterruptible data transport and describes Make-Before-Break.

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 a VSDA or ground system is 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. When 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 subnetwork (VDLM28208) 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 the VSDA of the destination DTE address.

10.2.4 Response to Ground Station Switch Indication

The response to the ground station switch indication primitive is either a ground station switch accepts primitive or a ground station switch reject primitive.

The ground station switch accepts primitive should be sent from the SN-SME to the VME to accept the requested handoff when the requested handoff supports the upper layer policies.

The ground station switch reject primitive should be sent from the SN-SME to the VME to reject the requested handoff if the requested 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 air-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.

10.2.6 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

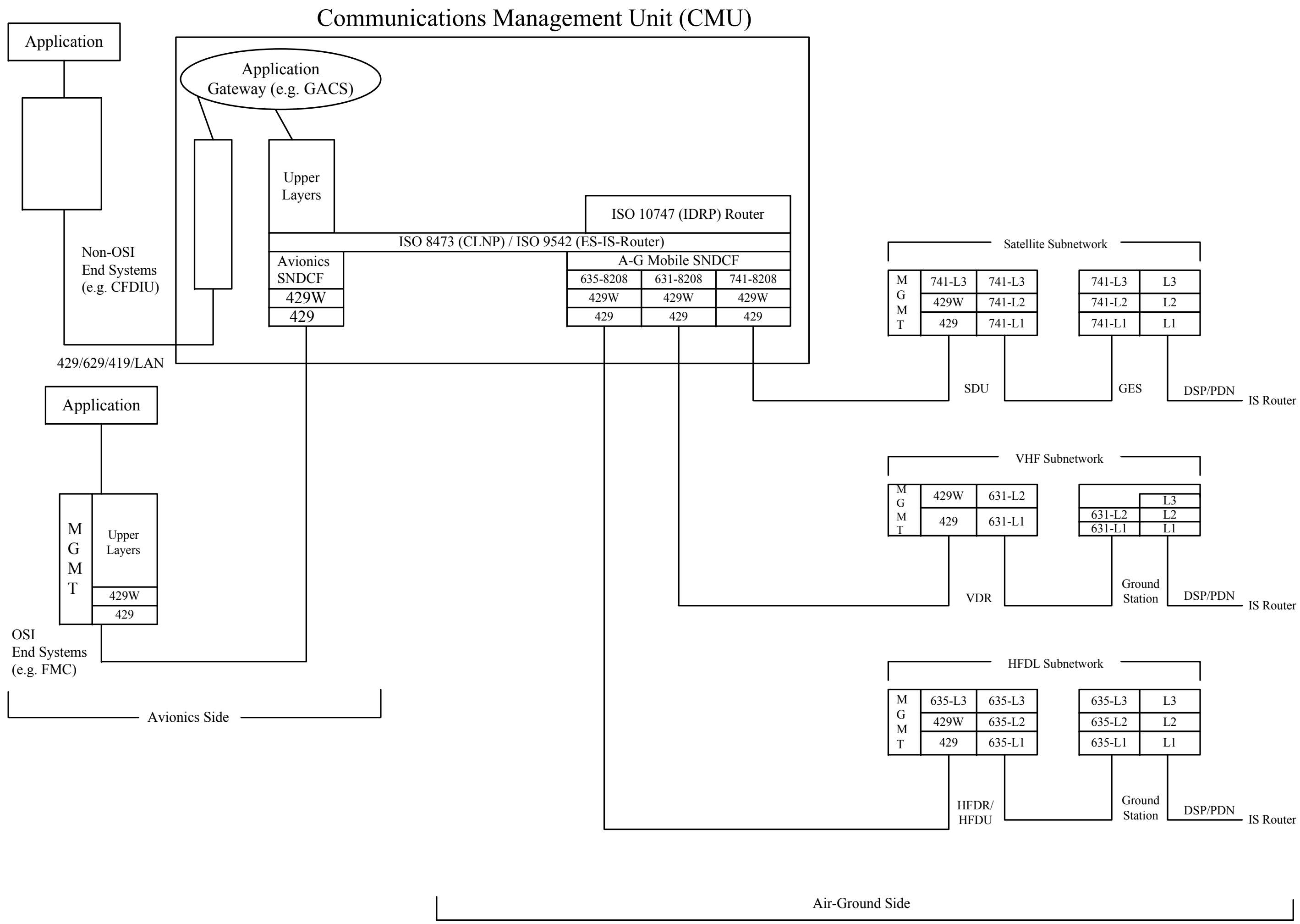
This capability enables an aircraft to switch operational VHF mode to ACARS during the transition phase whenever the VDL ground coverage is not available.

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.



NOTES:

1. This figure appears in the following ARINC standards: 631, 635, 750 and 753. Due to non-synchronous update of these 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.

11 Aug 05

ATTACHMENT 2
DATA LINK LAYER PICS

A2.1 Introduction to Protocol Implementation Conformance Statements (PICS)

The following Protocol Implementation Conformance Statements (PICS) have been selected for the implementation of VDLM2.

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. The receiving station should not reject an XID frame in the event that a parameter that is designated Mandatory for the sending station is not present in the frame.

COMMENTARY

The aircraft (and ground station) is likely to receive messages that do not Contain "Mandated" parameters due to variations in the ground system (and avionics) implementations that evolve over time. This may occur because the implementations are based on different standards (e.g. the ICAO Manual on VDLM2 vs. this specification) or different versions of a standard. While it is expected that eventually these inconsistencies will be eliminated, in the Interim it is necessary that the avionics (and ground systems) accept uplinks (downlinks) with "missing data".

The frame in Table 2-2-1 is sent by each ground station to all aircraft. The parameters that can be included in the GSIF frame are listed in Manual on VDL Mode 2 VDL SARPs Table 5-46a.

In the tables that follow, capability definitions and support alternatives are consistent with VDLM2 SARPs and the Manual on VDLM2 definitions. See Section 1.4.1. The use of terms such as “shall” and “mandatory” are used herein for consistency with the VDLM2 SARPs and the Manual on VDLM2 and only imply the provisions are necessary to achieve interoperability.

Convention:
The PICS 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 VDLM2 SARPs
- : Conditional requirement

If a parameter is marked O in the tables below and the parameter is not included in the message, the parameter default value, if it exists (as defined in VDLM2 SARPs), is assumed by the message recipient.

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

ATTACHMENT 2
DATA LINK LAYER PICS

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.

Table 2-1 – General Capabilities

Item	Capabilities	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
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	O	O	
MAC-csma	Does the MAC sublayer support non-adaptive p-persistent CSMA?	5.2.2.1	M	M	
MAC-cong	Does the MAC sublayer support congestion management?	5.2.2.2	M	M	
DLS-seq	Does the DLS sublayer support frame sequencing?	5.3.2.1	M	M	
DLS-fcs	Does the DLS sublayer support error detection?	5.3.2.2	M	M	
DLS-addr1	Does the DLS sublayer support individual station address?	5.3.2.3	M	M	
DLS-addr2	Does the DLS sublayer support broadcast address?	5.3.2.4	O	O	
DLS-data1	Does the DLS sublayer support data transfer using INFO and XID frames?	5.3.2.5	M	M	
DLS-data2	Does the DLS sublayer support data transfer using UI frames?	6.5.3.11.5	O	O	
DLS-collis	Does the DLS sublayer support unnumbered command frame collision resolution?	5.3.8	M	M	

Table 2-1-2 – Cooperative Channel Utilization

Item	Capabilities	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
CO-MACpers	The aircraft shall use the MAC persistence parameter as suggested by the ground station in the XID_CMD_LPM.	5.4.2.6.4, Table 5-29	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.	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.	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.	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.	5.3.4.2	N/A	M	
CO-k-dn	The aircraft shall use the k-downlink parameter	5.3.4.7	N/A	M	

ATTACHMENT 2
DATA LINK LAYER PICS

Item	Capabilities	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
	to flow control the transmissions of downlink frames as suggested by the ground station in the GSIF.				
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.	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.	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.	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.	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.	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.	5.4.2.6.2	N/A	M	
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.	5.4.2.6.9	N/A	HO_grb: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.	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.	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.	5.4.2.6.1	N/A	M	
CO-gnd	The station shall use bit 7 of the AVLC Options Parameter to identify whether an FSL transmitted in an uplink XID is applicable to air or ground operation.	–	M*	M*	
CO-air-FSL	When operating in the air, the aircraft shall use an FSL uplinked with bit 7 of the AVLC Specific Options Parameter set to 0, to select a frequency/ground station with which to establish a new link during frequency recovery.	5.4.2.7.1 5.4.4.1.2	N/A	M*	
CO-gnd-FSL	When operating on the ground, the aircraft shall switch to a ground frequency selected from an FSL uplinked with bit 7 of the AVLC Options Parameter set to 1, and on becoming airborne shall revert to an air frequency selected from an FSL uplinked with bit 7 of the AVLC Options Parameter set to 0.	–	N/A	M*	

ATTACHMENT 2
DATA LINK LAYER PICS

Table 2-1-3 – Link Establishment and Handoff

Item	Capabilities	VDLM2 SARPS Reference	Ground Station Support	Aircraft Support	Notes
HO-ai	Does the VDL station support aircraft-initiated handoff?	5.4.4.6	M	M	
HO-argi	Does the VDL station support aircraft-requested ground-initiated handoff?	5.4.4.7	X	X	
HO-gi	Does the VDL station support ground-initiated handoff?	5.4.4.8	O, R	M	
HO-grai	Does the VDL station support ground-requested aircraft-initiated handoff?	5.4.4.9	M	M	
HO-tune	Does the VDL station support ground-requested autotune?	N/A	M	M	1
LE-exped1	Does the VDL station support expedited subnetwork connection establishment?	5.4.2.4.2, 5.4.4.12, 6.6.3.2.2, 6.6.3.3.2	O, R	O, R	
LE-explicit	Does the VDL station support explicit subnetwork connection establishment?	6.6.3.2.1, 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.	5.4.4.12	N/A	M	
HO-grb	Does the VDL station support ground-requested broadcast handoffs?	5.4.4.10	O	O	
HO-bl	Does the VDL station support broadcast link handoff?	5.4.4.10	O	O	
HO-bs	Does the VDL station support broadcast subnetwork handoff?	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 5-16	O	N/A	
LPM	Does the VDL station support link parameter modification?	5.4.4.5	O	M	
HO-tg5	Link overlap timer.	5.4.3.5, 5.4.4.6.6, 5.4.4.8.3	M	M	
GSIF.s GSIF.r	Does the VDL station support GSIF frames Transmit Receive and process	5.4.4.3	M N/A	N/A M	
HO-8208	The capability to perform an air-initiated handoff upon detecting VDL 8208 window closure	–	N/A	M*	2

Notes:

1. This capability supports the inclusion of the Autotune parameter within the link establishment response, handoff response, and ground-requested air-initiated command.

2. See Sections 4.2 and 8.10.

The VDL protocol entity should be able to send and receive the frames in Table 2-1-4.

Table 2-1-4 – AVLC Frames

Item	Frame	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support
	INFO (Information)			
INFO-cmd	Sent and received as command?	5.3.7.2	M	M
INFO-rsp	Sent and received as response?	5.3.11.2	M	M
	RR (Receive Ready)			
RR-cmd	Sent and received as command?		M	M
RR-rsp	Sent and received as response?	5.3.7.2	M	M
	XID (Exchange Identity)			
XID-cmd	Sent and received as command?		M	M
XID-rsp	Sent and received as response?	5.3.9	M	M
	TEST			
TEST-cmd	Sent and received as command?		O	O
TEST-rsp	Sent and received as response?	5.3.11.6	O, R	O, R
	SREJ (Selective Reject)			
SREJ-cmd	Sent and received as command?	5.3.4.4,	M	M
SREJ-rsp	Sent and received as response?	5.3.11.2	M	M
	FRMR (Frame Reject)	5.3.4.4,		
FRMR-cmd	Sent and received as command?	5.3.11.3	M	M
	UI (Unnumbered INFO)			
UI-cmd	Sent and received as command?	5.3.11.5	O	O
	UA (Unnumbered Acknowledge)			
UA-rsp	Sent and received as response?	5.3.11.4	M	M
	DISC (Disconnect)			
DISC-cmd	Sent and received as command (P=0)?	5.3.6.2.1	M	M
	DM (Disconnected mode)			
DM-rsp	Sent and received as response (F=0)?	5.3.6.2.2	M	M

A2.2 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.

The frame in Table 2-2-1 is sent by each ground station to all aircraft. The parameters that can be included in the GSIF frame are listed in Manual on VDLM2 Table 5-46a.

ATTACHMENT 2
DATA LINK LAYER PICS

A2.2.1 Uplink GSIF (P = 0)

Table 2-2-1 – Uplink GSIF (P = 0)

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
Public Parameters					1
GSIF.puid	Public parameter set ID	5.4.2.2.1, Table 5-6	M	M	
GSIF.class	Procedure classes	Table 5-46	M	M	2
GSIF.hdlc	HDLC options	5.4.2.1	M	M	
GSIF.n1dn	N1- downlink (max number of bits in a frame)	5.3.4.5	O	M	
GSIF.n1up	N1- uplink	5.3.4.5	O	M	
GSIF.kdn	K - downlink (window size)	5.3.4.7	O	M	
GSIF.kup	k- uplink	5.3.4.7	O	M	
GSIF.t1	Timer T1- downlink (retransmission timer)	5.3.4.1	O	M	
GSIF.n2	Counter N2 (max number of retransmissions)	5.3.4.6	O	M	
GSIF.t2	Timer T2 (max delay before sending ACK)	5.3.4.2	O	M	
Private Parameters					
GSIF.prid	Private parameter set ID	5.4.2.3, Table 5-9	M	M	
GSIF.avlc	AVLC specific options	5.4.2.4.5, Tables 5-15, 5-16	M	M	
GSIF.t4	Timer T4 (max delay between transmissions; also, max delay between receptions)	5.3.4.4, Table 5-28	O	M	
GSIF.persist	MAC persistence	5.2.3.3, Table 5-29	O	M	
GSIF.m1	Counter M1 (max number of access attempts)	5.2.3.4, Table 5-30	O	M	
GSIF.tm2	Timer TM2 (max time MAC waits after receiving RTS)	5.2.3.2, Table 5-31	O	M	
GSIF.tg5	Timer TG5 (max time for link overlap)	5.4.3.5, Table 5-32	O	M	
GSIF.t3min	Timer T3min (T3: max time to wait for XID_RSP_LE)	5.2.4.6.8	O	M	
GSIF.freq	Frequency support	5.4.2.7.1, Table 5-37	O	M	
GSIF.cover	Airport coverage	5.4.2.7.2, Table 5-38	M	M	3
GSIF.near	Nearest airport ID	5.4.2.7.3, Table 5-39	M	M	3
GSIF.net	ATN router NETs	5.4.2.7.4, Table 5-40	M	M	
GSIF.mask	System mask	5.4.2.7.5, Table 5-41	M	M	
GSIF.tg3	TG3 (max time between ground station transmissions)	5.4.2.7.6, Table 5-42	O,NR	O	
GSIF.tg4	TG4 (max time between GSIF transmissions)	5.4.2.7.7, Table 5-43	O,NR	O	
GSIF.loc	Ground station location	5.4.2.7.8, Table 5-44	M	O,R	

Notes:

1. Encoding of XID public parameters are defined in ISO 8885:1993 except for the deviations defined in Attachment 4 to this Specification.
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.

A2.2.2 Downlink XID_CMD_LE (P=1)

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

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
Public Parameters					
CMD_LE.puid	Public parameter set ID	5.4.2.2.1, Table 5-6	M	M	
CMD_LE.clss	Procedure classes	Table 5-46	M	M	
CMD_LE.hdlc	HDLC options	5.4.2.1	M	M	
Private Parameters					
CMD_LE.prid	Private parameter set ID	5.4.2.3, Table 5-9	M	M	
CMD_LE.mgt	Connection management	5.4.2.4.2, Tables 5-10, 5-11	M	M	
CMD_LE.sqp	SQP	5.4.2.4.3, Table 5-13	O	O	
CMD_LE.seq	XID sequencing	5.4.2.4.4, Table 5-14	M	M	
CMD_LE.avlc	AVLC specific options	5.4.2.4.5, Tables 5-15, 5-16	M	M	
CMD_LE.exp	Expedited SN connection	5.4.2.4.6, Table 5-17	O	O	
CMD_LE.mod	Modulation support	5.4.2.5.1, Table 5-20	M	M	
CMD_LE.gs	Alternate ground stations	5.4.2.5.1.2, Table 5-22	O	O	
CMD_LE.dest	Destination airport	5.4.2.5.3, Table 5-23	O	M	1
CMD_LE.loc	Aircraft location	5.4.2.5.4, Tables 5-24, 5-25	O, R	M	1

Notes:

1. Presence of this field is mandated on such downlink only when valid data is available. In the absence of valid data, the parameter should be omitted.

A2.2.3 Uplink XID_RSP_LE (F=1)

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

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
Public Parameters					
RSP_LE.puid	Public parameter set ID	5.4.2.2.1	M	M	
RSP_LE.clss	Procedure classes	Table 5-6	M	M	
RSP_LE.hdlc	HDLC options	5.4.2.1	M	M	
RSP_LE.n1dn	N1- downlink	5.3.4.5	O	M	
RSP_LE.n1up	N1 – uplink	5.3.4.5	O	M	
RSP_LE.kdn	K – downlink	5.3.4.7	O	M	
RSP_LE.kup	K – uplink	5.3.4.7	O	M	
RSP_LE.t1dn	Timer T1 – downlink	5.3.4.1	O	M	1
RSP_LE.n2	Counter N2	5.3.4.6	O	M	
RSP_LE.t2	Timer T2	5.3.4.2	O	M	
Private Parameters					
RSP_LE.prid	Private parameter set ID	5.4.2.3, Table 5-9	M	M	
RSP_LE.mgt	Connection management	5.4.2.4.2,Tables 5-10, 5-11	M	M	
RSP_LE.sqp	SQP	5.4.2.4.3 Table 5-13	O	O	
RSP_LE.seq	XID sequencing	5.4.2.4.4Table 5-14	M	M	
RSP_LE.avlc	AVLC specific options	5.4.2.4.5 Tables 5-15, 5-16	M	M	
RSP_LE.exp	Expedited SN connection	5.4.2.4.6Table 5-17	O	O, R	
RSP_LE.tune	Autotune frequency	5.4.2.6.1Table 5-26	O	M	
RSP_LE.gs	Replacement ground station	5.4.2.6.2Table 5-27	O	M	
RSP_LE.t4	Timer T4	5.3.4.4 Table 5-28	O	M	
RSP_LE.pers	MAC persistence	5.2.3.3 Table 5-29	O	M	
RSP_LE.m1	Counter M1	5.2.3.4 Table 5-30	O	M	
RSP_LE.tm2	Timer TM2	5.2.3.2 Table 5-31	O	M	
RSP_LE.tg5	Timer TG5	5.4.3.5 Table 5-32	O	M	
RSP_LE.t3min	Timer T3min	5.4.3.3, 5.4.2.4.8	O	M	
RSP_LE.freq	Frequency support	5.4.2.7.1 Table 5-37	O	M	
RSP_LE.cover	Airport coverage	5.4.2.7.2 Table 5-38	O	O	2
RSP_LE.near	Nearest airport ID	5.4.2.7.3 Table 5-39	O	O	2
RSP_LE.net	ATN router NETs	5.4.2.7.4 Table 5-40	M	M	
RSP_LE.mask	System mask	5.4.2.7.5 Table 5-41	M	M	
RSP_LE.tg3	TG3	5.4.2.7.6 Table 5-42	O, NR	O	
RSP_LE.tg4	TG4	5.4.2.7.7 Table 5-43	O, NR	O	
RSP_LE.loc	Ground station location	5.4.2.7.8 Table 5-44	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.

A2.2.4 Uplink XID_CMD_LPM (P=1)

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

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support
Private Parameters				
CMD-LPM.prid	Private parameter set ID	5.4.2.3, Table 5-9	M	M
CMD-LPM.sqp	SQP	5.4.2.4.3, Table 5-13	O	O
CMD-LPM.seq	XID sequencing	5.4.2.4.4, Table 5-14	M	M
CMD-LPM.t4	Timer T4	5.3.4.4, Table 5-28	O	M
CMD-LPM.pers	MAC persistence	5.2.3.3, Table 5-29	O	M
CMD-LPM.m1	Counter M1	5.2.3.4, Table 5-30	O	M
CMD-LPM.tm2	Timer TM2	5.2.3.2, Table 5-31	O	M
CMD-LPM.tg5	Timer TG5	5.4.3.5, Table 5-32	O	M

A2.2.5 Downlink XID_RSP_LPM (F=1)

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

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support
Private Parameters				
RSP_LPM.prid	Private parameter set ID	5.4.2.3, Table 5-9	M	M
RSP_LPM.sqp	SQP	5.4.2.4.3, Table 5-13	O	O
RSP_LPM.seq	XID sequencing	5.4.2.4.4, Table 5-14	M	M

A2.2.6 Ground-Initiated Handoff (Command)

The Uplink XID_CMD_HO (P=1) command is sent by the proposed ground station to the aircraft when the handoff is ground initiated.

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
Public Parameters					
GCMD_HO.puid	Public parameter set ID	5.4.2.2.1, Table 5-6	M*	M	
GCMD_HO.clss	Procedure classes	Table 5-46	M*	M	
GCMD_HO.hdlc	HDLC options	5.4.2.1	M*	M	
GCMD_HO.n1dn	N1-downlink	5.3.4.5	O	M	
GCMD_HO.n1up	N1-uplink	5.3.4.5	O	M	
GCMD_HO.kdn	k-downlink	5.3.4.7	O	M	
GCMD_HO.kup	k-uplink	5.3.4.7	O	M	
GCMD_HO.t1dn	Timer T1 –downlink	5.3.4.1	O	M	1
GCMD_HO.n2	Counter N2	5.3.4.6	O	M	
GCMD_HO.t2	Timer T2	5.3.4.2	O	M	
Private Parameters					
GCMD_HO.prid	Private parameter set ID	5.4.2.3, Table 5-9	M	M	
GCMD_HO.mgt	Connection management	5.4.2.4.2, Tables 5-10, 5-11	M	M	
GCMD_HO.sqp	SQP	5.4.2.4.3, Table 5-13	O	O	
GCMD_HO.seq	XID sequencing	5.4.2.4.4, Table 5-14	M	M	
GCMD_HO.avlc	AVLC specific options	5.4.2.4.5, Tables 5-15, 5-16	O	M	3, 4
GCMD_HO.exp	Expedited SN connection	5.4.2.4.6, Table 5-17	X	X	
GCMD_HO.gs	Replacement ground station	5.4.2.6.2, Table 5-27	O	O	
GCMD_HO.t4	Timer T4	5.3.4.4, Table 5-28	O	M	
GCMD_HO.pers	MAC persistence	5.2.3.3, Table 5-29	O	M	
GCMD_HO.m1	Counter M1	5.2.3.4, Table 5-30	O	M	
GCMD_HO.tm2	Timer TM2	5.2.3.2, Table 5-31	O	M	
GCMD_HO.tg5	Timer TG5	5.4.3.5, Table 5-32	O	M	
GCMD_HO.t3min	Timer T3min	5.4.3.3, 5.2.4.6.8	O	M	
GCMD_HO.freq	Frequency support	5.4.2.7.1, Table 5-37	O	M	
GCMD_HO.cover	Airport coverage	5.4.2.7.2, Table 5-38	O	O	2
GCMD_HO.near	Nearest airport ID	5.4.2.7.3, Table 5-39	O	O	2
GCMD_HO.net	ATN router NETs	5.4.2.7.4, Table 5-40	M	M	
GCMD_HO.mask	System mask	5.4.2.7.5, Table 5-41	M*	M	
GCMD_HO.tg3	TG3	5.4.2.7.6, Table 5-42	O, NR	O	
GCMD_HO.tg4	TG4	5.4.2.7.7, Table 5-43	O, NR	O	
GCMD_HO.loc	Ground station location	5.4.2.7.8, Table 5-44	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.

3. Since DSP's may provide more than one service (i.e. ATN & AOA), and since the status of the availability of those services may have changed since the last GSIF, it is encouraged that the parameter "AVLC specific options" be included in all XID's for both the aircraft and the ground station. In this manner, the ground station confirms the requested services from the aircraft and the aircraft will receive up to date status of service availability. Alternatively, a DSP may include the parameter "AVLC specific options" only for XID's after a change in service availability.

4. **If the FSL parameter is included in the XID, then the presence of the AVLC parameter is Mandatory so that the aircraft can determine whether the FSL contains ground frequencies or enroute frequencies.**

A2.2.7 Ground-Initiated Handoff (Response)

The Downlink XID_RSP_HO (F=1) response is sent by the aircraft to the new ground station when the handoff is ground initiated.

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
Public Parameters					
GRSP_HO.puid	Public parameter set ID	5.4.2.2.1, Table 5-6	M	M*	
GRSP_HO.clss	Procedure classes	Table 5-46	M	M*	
GRSP_HO.hdlc	HDLC options	5.4.2.1	M	M*	
Private Parameters					
GRSP_HO.prid	Private parameter set ID	5.4.2.3, Table 5-9	M	M	
GRSP_HO.mgt	Connection management	5.4.2.4.2, Tables 5-10, 5-11	M	M	
GRSP_HO.sqp	SQP	5.4.2.4.3, Table 5-13	O	O	
GRSP_HO.seq	XID sequencing	5.4.2.4.4, Table 5-14	M	M	
GRSP_HO.avlc	AVLC specific options	5.4.2.4.5, Tables 5-15, 5-16	M	O	1
GRSP_HO.exp	Expedited SN connection	5.4.2.4.6, Table 5-17	X	X	
GRSP_HO.dest	Destination airport	5.4.2.5.3, Table 5-23	O	O	
GRSP_HO.loc	Aircraft location	5.4.2.5.4, Tables 5-24, 5-25	O	O	

Note:

1. Since DSP's may provide more than one service (i.e. ATN & AOA), and since the status of the availability of those services may have changed since the last GSIF, it is encouraged that the parameter "AVLC specific options" be included in all XID's for both the aircraft and the ground station. In this manner, the ground station confirms the requested services from the aircraft and the aircraft will receive up to date status of service

availability. Alternatively, a DSP may include the parameter "AVLC specific options" only for XID's after a change in service availability.

A2.2.8 Air-Initiated Handoff (Command)

This Downlink XID_CMD_HO (P=1) command is sent by the aircraft to the proposed ground station when the handoff is aircraft initiated.

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
Public Parameters					
ACMD_HO.puid	Public parameter set ID	5.4.2.2.1, Table 5-6	M	M*	
ACMD_HO.clss	Procedure classes	Table 5-46	M	M*	
ACMD_HO.hdlc	HDLC options	5.4.2.1	M	M*	
Private Parameters					
ACMD_HO.prid	Private parameter set ID	5.4.2.3, Table 5-9	M	M	
ACMD_HO.mgt	Connection management	5.4.2.4.2, Tables 5-10, 5-11	M	M	
ACMD_HO.sqp	SQP	5.4.2.4.3, Table 5-13	O	O	
ACMD_HO.seq	XID sequencing	5.4.2.4.4, Table 5-14	M	M	
ACMD_HO.avlc	AVLC specific options	5.4.2.4.5, Tables 5-15, 5-16	M	O	1
ACMD_HO.exp	Expedited SN connection	5.4.2.4.6, Table 5-17	O, R	O, R	
ACMD_HO.gs	Alternate ground stations	5.4.2.5.2, Table 5-22	O	O	
ACMD_HO.dest	Destination airport	5.4.2.5.3, Table 5-23	O	M	2
ACMD_HO.loc	Aircraft location	5.4.2.5.4, Tables 5-24, 5-25	O	M	2

Note:

1. Since DSP's may provide more than one service (i.e. ATN & AOA), and since the status of the availability of those services may have changed since the last GSIF, it is encouraged that the parameter "AVLC specific options" be included in all XID's for both the aircraft and the ground station. In this manner, the ground station confirms the requested services from the aircraft and the aircraft will receive up to date status of service availability. Alternatively, a DSP may include the parameter "AVLC specific options" only for XID's after a change in service availability.

2. Presence of this field is mandated on such downlink only when valid data is available. In the absence of valid data, the parameter should be omitted.

A2.2.9 Air-Initiated Handoff (Response)

The Uplink XID_RSP_HO (F=1) response is sent by the new ground station to the aircraft when the handoff is aircraft initiated.

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
Public Parameters					
ARSP_HO.puid	Public parameter set ID	5.4.2.2.1, Table 5-6	M*	M	
ARSP_HO.clss	Procedure classes	Table 5-46	M*	M	
ARSP_HO.hdlc	HDLC options	5.4.2.1	M*	M	
ARSP_HO.n1dn	N1-downlink	5.3.4.5	O	M	
ARSP_HO.n1up	N1-uplink	5.3.4.5	O	M	
ARSP_HO.kdn	k-downlink	5.3.4.7	O	M	
ARSP_HO.kup	k-uplink	5.3.4.7	O	M	
ARSP_HO.t1dn	Timer T1 – downlink [1]	5.3.4.1	O	M	
ARSP_HO.n2	Counter N2	5.3.4.6	O	M	
ARSP_HO.t2	Timer T2	5.3.4.2	O	M	
Private Parameter					
ARSP_HO.prid	Private parameter set ID	5.4.2.3, Table 5-9	M	M	
ARSP_HO.mgt	Connection management	5.4.2.4.2, Tables 5-10, 5-11	M	M	
ARSP_HO.sqp	SQP	5.4.2.4.3, Table 5-13	O	O	
ARSP_HO.seq	XID sequencing	5.4.2.4.4, Table 5-14	M	M	
ARSP_HO.avlc	AVLC specific options	5.4.2.4.5, Tables 5-15, 5-16	O	**M**	3**, 4**
ARSP_HO.exp	Expedited SN connection	5.4.2.4.6, Table 5-17	O, R	O, R	
ARSP_HO.tune	Autotune frequency	5.4.2.6.1, Table 5-26	O	M	
ARSP_HO.gs	Replacement ground station	5.4.2.6.2, Table 5-27	O	M	
ARSP_HO.t4	Timer T4	5.3.4.4, Table 5-28	O	M	
ARSP_HO.pers	MAC persistence	5.2.3.3, Table 5-29	O	M	
ARSP_HO.m1	Counter M1	5.2.3.4, Table 5-30	O	M	
ARSP_HO.tm2	Timer TM2	5.2.3.2, Table 5-31	O	M	
ARSP_HO.tg5	Timer TG5	5.4.3.5, Table 5-32	O	M	
ARSP_HO.t3min	Timer T3min	5.4.3.3, 5.2.4.6.8	O	M	
ARSP_HO.freq	Frequency support	5.4.2.7.1, Table 5-37	O	M	
ARSP_HO.cover	Airport coverage (list of airport identifiers)	5.4.2.7.2, Table 5-38	O	O	2
ARSP_HO.near	Nearest airport ID	5.4.2.7.3, Table 5-39	O	O	2
ARSP_HO.net	ATN router NETs	5.4.2.7.4, Table 5-40	M	M	

ATTACHMENT 2
DATA LINK LAYER PICS

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
ARSP_HO.mask	System mask	5.4.2.7.5, Table 5-41	M	M	
ARSP_HO.tg3	TG3	5.4.2.7.6, Table 5-42	O, NR	O	
ARSP_HO.tg4	TG4	5.4.2.7.7, Table 5-43	O, NR	O	
ARSP_HO.loc	Ground station location	5.4.2.7.8, Table 5-44	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.

3. Since DSP’s may provide more than one service (i.e. ATN & AOA), and since the status of the availability of those services may have changed since the last GSIF, it is encouraged that the parameter “AVLC specific options” be included in all XID’s for both the aircraft and the ground station. In this manner, the ground station confirms the requested services from the aircraft and the aircraft will receive up to date status of service availability. Alternatively, a DSP may include the parameter “AVLC specific options” only for XID’s after a change in service availability.

4. **If the FSL parameter is included in the XID, then the presence of the AVLC parameter is Mandatory so that the aircraft can determine whether the FSL contains ground frequencies or enroute frequencies.**

A2.2.10 Ground-Requested-Air-Initiated Handoff (Command)

The Uplink XID_CMD_HO (P=0) 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).

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
GrCMD_HO.puid	Public parameter set ID	5.4.2.2.1, Table 5-6	M*	M	
GrCMD_HO.clss	Procedure classes	Table 5-46	M*	M	
GrCMD_HO.hdlc	HDLC options	5.4.2.1	M*	M	
GrCMD_HO.n1dn	N1-downlink	5.3.4.5	O	M	
GrCMD_HO.n1up	N1-uplink	5.3.4.5	O	M	
GrCMD_HO.kdn	k-downlink	5.3.4.7	O	M	
GrCMD_HO.kup	k-uplink	5.3.4.7	O	M	

ATTACHMENT 2
DATA LINK LAYER PICS

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
GrCMD_HO.t1dn	Timer T1 –downlink [1]	5.3.4.1	O	M	
GrCMD_HO.n2	Counter N2	5.3.4.6	O	M	
GrCMD_HO.t2	Timer T2	5.3.4.2	O	M	
GrCMD_HO.prid	Private parameter set ID	5.4.2.3, Table 5-9	M	M	
GrCMD_HO.mgt	Connection management	5.4.2.4.2, Tables 5-10, 5-11	M	M	
GrCMD_HO.seq	XID sequencing	5.4.2.4.4, Table 5-14	M	M	
GrCMD_HO.avlc	AVLC specific options	5.4.2.4.5, Tables 5-15, 5-16	O	M	2, **3**
GrCMD_HO.tune	Autotune frequency	5.4.2.6.1, Table 5-26	**M**	M	
GrCMD_HO.gs	Replacement ground station	5.4.2.6.2, Table 5-27	**M**	M	
GrCMD_HO.t4	Timer T4	5.3.4.4, Table 5-28	O	M	
GrCMD_HO.pers	MAC persistence	5.2.3.3, Table 5-29	O	M	
GrCMD_HO.m1	Counter M1	5.2.3.4, Table 5-30	O	M	
GrCMD_HO.tm2	Timer TM2	5.2.3.2, Table 5-31	O	M	
GrCMD_HO.tg5	Timer TG5	5.4.3.5, Table 5-32	O	M	
GrCMD_HO.t3min	Timer T3min	5.4.3.3, 5.2.4.6.8	O	M	
GrCMD_HO.freq	Frequency support	5.4.2.7.1, Table 5-37	O, **R**	M	
GrCMD_HO.net	ATN router NETs	5.4.2.7.4, Table 5-40	M*	M	
GrCMD_HO.mask	System mask	5.4.2.7.5, Table 5-41	M*	M	
GrCMD_HO.tg3	TG3	5.4.2.7.6, Table 5-42	O, NR	O	
GrCMD_HO.tg4	TG4	5.4.2.7.7, Table 5-43	O, NR	O	
GrCMD_HO.loc	Ground station location	5.4.2.7.8, Table 5-44	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. Since DSP’s may provide more than one service (i.e. ATN & AOA), and since the status of the availability of those services may have changed since the last GSIF, it is encouraged that the parameter “AVLC specific options” be included in all XID’s for both the aircraft and the ground station. In this manner, the ground station confirms the requested services from the aircraft and the aircraft will receive up to date status of service availability. Alternatively, a DSP may include the parameter “AVLC specific options” only for XID’s after a change in service availability.

3. **If the FSL parameter is included in the XID, then the presence of the AVLC parameter is Mandatory so that the aircraft can determine whether the FSL contains ground frequencies or enroute frequencies.**

A2.2.11 Broadcast Ground-Requested-Air-Initiated Handoff (Command)

The Uplink XID_CMD_HO (P=0) command is broadcast by the new ground station to all aircraft to request handoff.

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
Public Parameters					
BgrCMD_HO.puid	Public parameter set ID	5.4.2.2.1, Table 5-6	M*	M	
BgrCMD_HO.clss	Procedure classes	Table 5-46	M*	M	
BgrCMD_HO.hdlc	HDLC options	5.4.2.1	M*	M	
BgrCMD_HO.n1dn	N1-downlink	5.3.4.5	O	M	
BgrCMD_HO.n1up	N1-uplink	5.3.4.5	O	M	
BgrCMD_HO.kdn	k-downlink	5.3.4.7	O	M	
BgrCMD_HO.kup	k-uplink	5.3.4.7	O	M	
BgrCMD_HO.t1dn	Timer T1 – downlink [1]	5.3.4.1	O	M	
BgrCMD_HO.n2	Counter N2	5.3.4.6	O	M	
BgrCMD_HO.t2	Timer T2	5.3.4.2	O	M	
Private Parameters					
BgrCMD_HO.prid	Private parameter set ID	5.4.2.3, Table 5-9	M	M	
BgrCMD_HO.mgt	Connection management	5.4.2.4.2, Tables 5-10, 5-11	M	M	
BgrCMD_HO.seq	XID sequencing	5.4.2.4.4, Table 5-14	M	M	
BgrCMD_HO.avlc	AVLC specific options	5.4.2.4.5, Tables 5-15, 5-16	O	M	3, 4
BgrCMD_HO.t4	Timer T4	5.3.4.4, Table 5-28	O	M	
BgrCMD_HO.pers	MAC persistence	5.2.3.3, Table 5-29	O	M	
BgrCMD_HO.m1	Counter M1	5.2.3.4, Table 5-30	O	M	
BgrCMD_HO.tm2	Timer TM2	5.2.3.2, Table 5-31	O	M	
BgrCMD_HO.tg5	Timer TG5	5.4.3.5, Table 5-32	O	M	
BgrCMD_HO.t3min	Timer T3min	5.4.3.3, 5.2.4.6.8	O	M	
BgrCMD_HO.filter	Address filter parameter	5.4.2.6.9, Table 5-34	M	M	
BgrCMD_HO.conn	Broadcast connection parameter	5.4.2.6.10, Tables 5-35, 5-36	HO_grb:M	HO_grb:M	
BgrCMD_HO.freq	Frequency support	5.4.2.7.1, Table 5-37	O	M	
BgrCMD_HO.cover	Airport coverage	5.4.2.7.2, Table 5-38	O	O	2
BgrCMD_HO.near	Nearest airport ID	5.4.2.7.3, Table 5-39	O	O	2
BgrCMD_HO.net	ATN router NETs	5.4.2.7.4, Table 5-40	M	M	
BgrCMD_HO.mask	System mask	5.4.2.7.5, Table 5-41	M*	M	
BgrCMD_HO.tg3	TG3	5.4.2.7.6,	O, NR	O	

ATTACHMENT 2
DATA LINK LAYER PICS

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Notes
		Table 5-42			
BgrCMD_HO.tg4	TG4	5.4.2.7.7, Table 5-43	O, NR	O	
BgrCMD_HO.loc	Ground station location	5.4.2.7.8, Table 5-44	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.

3. Since DSP’s may provide more than one service (i.e. ATN & AOA), and since the status of the availability of those services may have changed since the last GSIF, it is encouraged that the parameter “AVLC specific options” be included in all XID’s for both the aircraft and the ground station.In this manner, the ground station confirms the requested services from the aircraft and the aircraft will receive up to date status of service availability. Alternatively, a DSP may include the parameter “AVLC specific options” only for XID’s after a change in service availability.

4. **If the FSL parameter is included in the XID, then the presence of the AVLC parameter is Mandatory so that the aircraft can determine whether the FSL contains ground frequencies or enroute frequencies.**

A2.2.12 Uplink or Downlink XID_CMD_LCR/ XID_RSP_LCR

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

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support	Note
Private Parameters					
LCR.prid	Private parameter set ID	5.4.2.3, Table 5-9	M	M	
LCR.mgt	Connection management	5.4.2.4.2, Tables 5-10, 5-11	M	M	
LCR.seq	XID sequencing	5.4.2.4.4, Table 5-14	M	M	
LCR.cause	LCR cause	5.4.2.4.7, Table 5-18	M*	M*	1

Note 1: See Sections 9.8.1 and 9.8.2.

A2.3 Timers and Counters, Frequency Management

Table 2-3-1 – MAC Parameters - Timers and Counters

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support
	Inter-access delay	5.2.3.1, Table 5-1		
TM1.min	Minimum = 0.5 ms		M	M
TM1.max	Maximum = *125* ms		M	M
TM1.default	Mode 2 default = 4.5		M	M
	Channel busy	5.2.3.2, Table 5-1		
TM2.min	Minimum = 6 s		M	M
TM2.max	Maximum = 120 s		M	M
TM2.default	Mode 2 default = 60		M	M
	Persistance	5.2.3.3, Table 5-1		
P.min	Minimum = 1/256		M	M
P.max	Maximum = 1		M	M
P.default	Mode 2 default = 13/256		M	M
	Maximum number of access attempts.	5.2.3.4, Table 5-1		
M1.min	Lowest value = 1		M	M
M1.max	Highest value = 65535		M	M
M1.default	Mode 2 default = *135*		M	M

ATTACHMENT 2
DATA LINK LAYER PICS

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support
	Delay before retransmission – T1min parameter			
T1min.low	Lowest = 0 s	5.3.4.1, Table 5-5	M	M
T1min.high	Highest = 20 s		M	M
T1min.default	Mode 2 default = 1 s		M	M
	Delay before retransmission – T1max parameter			
T1max.low	Lowest = 1 s	5.3.4.1, Table 5-5	M	M
T1max.high	Highest = 20 s		M	M
T1max.default	Mode 2 default = 15 s		M	M
	Delay before retransmission – T1 Multiplier parameter			
T1mult.min	Minimum = 1	5.3.4.1, Table 5-5	M	M
T1mult.max	Maximum = 2.5		M	M
T1mult.default	Mode 2 default = 1.45		M	M
	Delay before retransmission – T1 exponent parameter			
T1exp.min	Minimum = 1	5.3.4.1, Table 5-5	M	M
T1exp.max	Maximum = 2.5		M	M
T1exp.default	Mode 2 default = 1.7		M	M
	Delay before ACK			
T2.min	Minimum = 25 ms	5.3.4.2, Table 5-5	M	M
T2.max	Maximum = 10 s		M	M
T2.default	Mode 2 default = 500 ms		M	M
	Link Initialization Time – T3min parameter			
T3min.low	Lowest = 5 s	5.3.4.3, Table 5-5	M	M
T3min.high	Highest = 25 s		M	M
T3min.default	Mode 2 default = 6 s		M	M
	Link Initialization Time – T3max parameter			
T3max.low	Lowest = 1 s	5.3.4.3, Table 5-5	M	M
T3max.high	Highest = 20 s		M	M
T3max.default	Mode 2 default = 15 s		M	M
	Link Initialization Time – T3 multiplier parameter			
T3mult.min	Minimum = 1	5.3.4.3, Table 5-5	M	M
T3mult.max	Maximum = 2.5		M	M
T3mult.default	Mode 2 default = 1.45		M	M
	Link Initialization Time – T3 exponent parameter			
T3exp.min	Minimum = 1	5.3.4.3, Table 5-5	M	M
T3exp.max	Maximum = 2.5		M	M
T3exp.default	Mode 2 default = 1.7		M	M
	Max delay between transmissions Aircraft			
aT4.min	Minimum = 1 min	5.3.4.4, Table 5-5	M	M
aT4.max	Maximum = 1440 min		M	M
aT4.default	Mode 2 default = 20 min		M	M
	Max delay between transmissions Ground			
gT4.min	Minimum = 3 min	5.3.4.4, Table 5-5	M	M
gT4.max	Maximum = 1442 min		M	M
gT4.default	Mode 2 default = 22 min		M	M
N1.low	Maximum number of bits in any frame	5.3.4.5, Table 5-5	M	M
N1.high	Lowest = 1144 bits		M	M

ATTACHMENT 2
DATA LINK LAYER PICS

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support
N1.default	Highest = 16504 bits Mode 2 default = 8312 bits		M	M
N2.low N2.high N2.default	Maximum number of transmissions Lowest = 1 Highest = 15 Mode 2 default = 6	5.3.4.6, Table 5-5	M M M	M M M
K.min K.max K.default	Window Size Minimum = 1 frame Maximum = *4* frames Mode 2 default = 4 frames	5.3.4.7, Table 5-5	M M M	M M M

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

Item	Parameters	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support
TG1.low TG1.high TG1.default	Minimum frequency dwell time Lowest = 20 s Highest = 600 s Mode 2 default = 240 s	5.4.3.1, Table 5-45	M M M	M M M
aTG2.low aTG2.high aTG2.default	Maximum idle activity time - aircraft Lowest = 120 s Highest = 360 s Mode 2 default = 240 s	5.4.3.2, Table 5-45	M M M	M M M
gTG2.low gTG2.high gTG2.default	Maximum idle activity time – ground station Lowest = 10 min Highest = 4320 min Mode 2 default = 60 min	5.4.3.2, Table 5-45	M M M	M M M
TG3.low TG3.high TG3.default	Maximum time between ground transmissions Lowest = 100 s Highest = 120 s Mode 2 default = Uniformed between 100-120 s	5.4.3.3, Table 5-45	M M M	M M M
TG4.min TG4.max TG4.default	Maximum time between GSIFs Lowest = 100s Highest = N/A Mode 2 default = N/A	5.4.3.4, Table 5-45	M M M	M M M
iTG5.low iTG5.high iTG5.default	Maximum link overlap time – Initiating Lowest = 0 s Highest = 255 s Mode 2 default = 20 s	5.4.3.5, Table 5-45	M M M	M M M
rTG5.low rTG5.high rTG5.default	Maximum link overlap time - Responding Lowest = 0 s Highest = 255 s Mode 2 default = 60 s	5.4.3.5, Table 5-45	M M M	M M M

ATTACHMENT 2
DATA LINK LAYER PICS

Table 2-3-4 – Transmit Queue Management

Item	Capabilities	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support
TqM1	Maintain 2 queues: one for supervisory and unnumbered frames, one for information.	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.	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.	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.	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.	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.	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.	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.	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.

ATTACHMENT 2
DATA LINK LAYER PICS

Table 2.3-5 – Frequency Management

Item	Capabilities	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support
FM-search1 FM-search2	Does the aircraft initiate frequency search procedure Upon system initialization? After link disconnection and it no longer detects uplink VDL frames in current frequency?	5.4.4.1.1	N/A N/A	O O
FM-search3 FM-search4 FM-search5	Does the aircraft initiate frequency search on The VDL frequency provided on ACARS squitter? The VDL Mode 2 CSC? The predefined frequency table?	5.4.4.1.1	N/A N/A N/A	O O, R O
FM-search6	Does the aircraft initiate frequency recovery procedure when it no longer detects uplink VDL frames in current frequency?	5.4.4.1.2	N/A	M

Table 2-3-6 – ISO 4335 Conformance

Item	Field	VDLM2 SARPs Reference	Ground Station Support	Aircraft Support
FRM-NStx	Frame send sequence number sent	5.3.2.1	M	M
FRM-NSRx	Frame Send Sequence Number checked	5.3.2.1	M	M
FRM-NRtx	Frame receive sequence number sent	5.3.2.1	M	M
FRM-NRrx	Frame receive Sequence Number checked	5.3.2.1	M	M
FRM-CRCtx	Frame CRC Generated	5.3.2.2	M	M
FRM-CRCrx	Frame CRC checked	5.3.2.2	M	M
FRM-pf	Final bit send in response to poll	5.3.7.1	M	M
FRM-infofinal	Only RR or SREJ with F=1 sent in response to Info P=1	5.3.7.2	M	M
FRM-infopoll	INFO sent with P=1 when window closed	5.3.7.3	M	M
FRM-infopollT4	INFO sent with P=1 when T4 expires	5.3.7.3	M	M
FRM-infopollmin	INFO sent with P=1 at other times	5.3.7.3	O, NR	O, NR
FRM-pollunnum	P set in UI or DISC frames	5.3.7.4	X	X
FRM-Addfilt	Frames sent to other stations ignored	5.3.2.3	M	M
FRM-bcrx	Broadcast frames processed	5.3.2.4	M	M
FRM-aggnd	Air-ground bit set to one when aircraft on ground	5.3.3.3.1	N/A	O
FRM-agair	Air-ground bit set to zero when aircraft airborne	5.3.3.3.1	N/A	M
FRM-agrgs	Air-ground bit set to one for ground stations	5.3.3.3.1	M	N/A
FRM-addlen	Frame addresses 8 bytes, consisting of 4 bytes each for source and destination	5.3.3.2, 5.3.3.3	M	M
FRM-cr	Command-response status bit used to distinguish command and response frames	5.3.3.3.2	M	M
FRM-addtype	Address type set appropriately	5.3.3.3.4, Table 5-2	M	M
FRM-bcaddr	Broadcast address used for GSIF	5.3.3.4	M	X
FRM-bcaddrx	Broadcast address used for any frame except GSIF	5.3.3.4	X	X

3.1 Subnetwork Layer Protocol Implementation Conformance Statements (PICS)

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

Convention

The PICS 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 VDLM2 subnetwork. They are not applicable to other ATN air-ground subnetworks.

Airborne DTE and ground-based DCE (i.e., VDL ground stations) that operate on the VDLM2 subnetwork should comply with these PICS to ensure interoperability.

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

ISO 8208 Packets Used in VDL Mode 2 Subnetwork

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

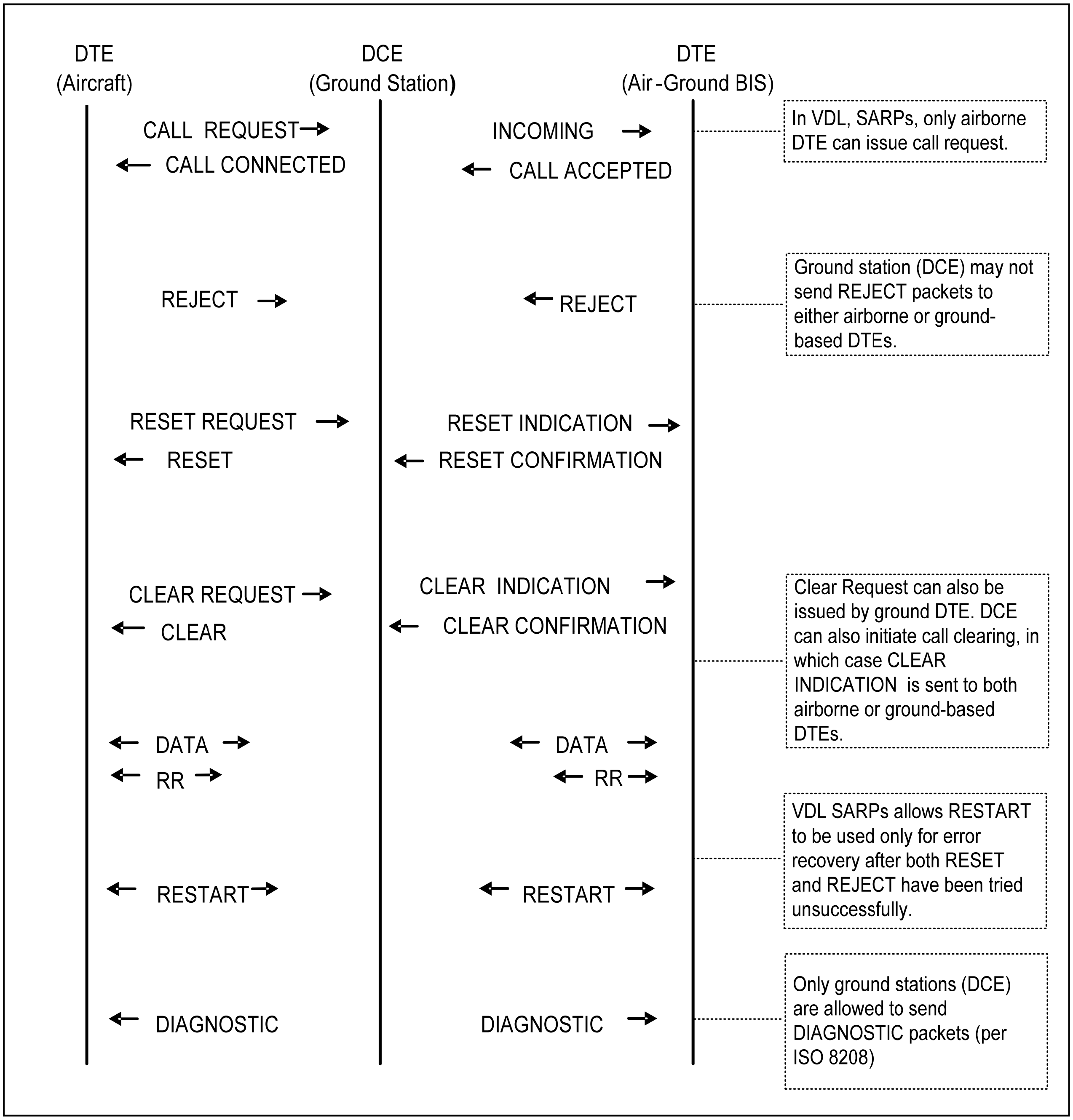


Figure 3-1 – VLD Mode 2 ISO 8208 Packets

ATTACHMENT 3
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	Notes
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	10	X	X	1
L2	Can packets consisting of a non-integral number of octets be received from the link layer?	12.1	X	X	2

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.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
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
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
SUBNETWORK LAYER PICS

Table 3-6 – Call Clearing

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support	Notes
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	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	12.2.5.1, 12.2.5.2	O	O	2
CP4b	DTE receives CLEAR CONFIRMATION, basic format	12.2.6.1	M	M	
CP4e	DTE receives CLEAR CONFIRMATION, extended format	12.2.6.1, 12.2.6.2	X	X	1

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.

ATTACHMENT 3
SUBNETWORK LAYER PICS

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

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

ATTACHMENT 3
SUBNETWORK LAYER PICS

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

Table 3-12 – Values of Cause and Diagnostic Code Fields

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support	Notes
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	12.2.3.1.1, 12.2.3.1.2, Tables 24 - 25	M	M	1

ATTACHMENT 3
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	Notes
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).

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: VDL SARPs only allows airborne DTE to send CALL REQUEST packets.

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: 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

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

ATTACHMENT 3
SUBNETWORK LAYER PICS

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support
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: Since the airborne DTE always initiates the call request, it never receives INCOMING CALL packets.

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	Notes
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	13.26, 15.2.2.12	M	M	1
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	14.2, 15.3.2.2	X	X	2
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	

ATTACHMENT 3
SUBNETWORK LAYER PICS

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	Notes
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	14.2, 15.3.2.2	M	M	1

Notes:

1. For those DSPs supporting X.121 addressing
2. Table 3-19 Facilities Received in CLEAR CONFIRMATION Packets (DTE to DCE)

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

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

Item	Function	ISO/IEC 8208 Reference	Ground DCE Support	Air DTE Support	Notes 1
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	X	X	
T25	Window Rotation Timer	18, Table 26	X	X	
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.

ATTACHMENT 4
ENCODING OF XID PUBLIC PARAMETERS

Attachment 4 provides a description of the bit ordering for the public parameters for which the ISO/IEC 8885 standard was cited in the SARPS. It takes precedence over the ISO/IEC 8885 standard.

Table 4-1A – Classes of Procedures

first bit transmitted ⇓

PI	0	0	0	0	0	0	1	0
PL	0	0	0	0	0	0	1	0
	0	0	0	0	0	0	0	0
	0	a	b	c	d	e	f	g

Table 4-1B – Classes Bit Encoding

Bit	Name	Function	Mandatory Value
a	Two-way simultaneous	indicates support of two way simultaneous data communication	0
b	Two-way alternate	indicates support of two way alternate data communication	0
c	Unbalanced ARM-Sec	indicates support of a secondary station in Asynchronous Response Mode (ARM)	0
d	Unbalanced ARM-Pri	indicates support of a primary station in Asynchronous Response Mode (ARM)	0
e	Unbalanced NRM-Sec	indicates support of a secondary station in Normal Response Mode (NRM)	0
f	Unbalanced NRM-Pri	indicates support of a primary station in Normal Response Mode (NRM)	0
g	Balanced – ABM	indicates support of Asynchronous Balanced Mode	1

Table 4-2A – HDLC Optional Functions

first bit transmitted ⇓

PI	0	0	0	0	0	0	1	1
PL	0	0	0	0	0	0	1	1
	0	0	b_B	p_D	p_C	p_B	p_A	n_B
	n_A	m	k	j	i_B	i_A	h	g
	f_B	f_A	e	d	c	b_A	a	0

ATTACHMENT 4
ENCODING OF XID PUBLIC PARAMETERS

Table 4-2B – HDLC Bit encoding

Bit	Name	Function	Mandatory Value	Notes
a	REJ cmd/resp	indicates support of the Reject frame	0	
b_A	SREJ cmd/resp single frame	indicates support of Selective Reject frames requesting the re-transmission of one frame.	0	
b_B	SREJ cmd/resp multiple frame	indicates support of Selective Reject frames requesting the re-transmission of multiple frames.	1	3
c	UI cmd/resp	indicates support of Unnumbered Info frames.	X	2
d	SIM cmd/RIM resp	indicates support of the Set Initialization Mode and Request Initialization Mode frames.	0	
e	UP cmd	indicates support of the Unnumbered Poll frame	0	
f_A	Basic Address	indicates support of the basic address field (1 octet)	0	
f_B	Extended Address	indicates support of extended address field	1	4
g	Delete resp I		0	
h	Delete cmd I		0	
i_A	modulo 8	indicates support of modulo 8 sequence numbering	1	
i_B	modulo 128	indicates support of modulo 128 sequence numbering	0	
j	RSET cmd	indicates support of the Reset Command	0	
k	TEST cmd/resp	indicates support of TEST frames	X	2
m	RD resp	indicates support of the Request Disconnect frame	0	
n_A	16-bit FCS	indicates support of the 16 bit FCS	1	
n_B	32-bit FCS	indicates support of the 32 bit FCS	0	
p_A	Synchronous transmission		0	
p_B	Stop/Start transmission with basic transparency		0	
p_C	Start/stop transmission with basic and flow control transparency		0	
p_D	Start/stop transmission with basic and control-character octet transparency		0	

ATTACHMENT 4
ENCODING OF XID PUBLIC PARAMETERS

Notes:

1. Reserved Note

2. Those bits indicate optional capabilities (X) of the transmitting stations. The stations should accept link establishments and handoffs even when the capabilities of the stations are not the same. Aircraft that do not support the UI frame option should be able to connect to ground system that supports that option.

3. Taken here to mean the enhanced multi-selective reject as per SARPs 6.5.3.11.2.

4. Taken here to mean the address field format specified in the SARPs figure 6-2.

Table 4-3 – N1 – Downlink

first bit transmitted ⇓

PI	0	0	0	0	0	1	0	1
PL	0	0	0	0	0	0	1	0
	n_{16}	n_{15}	n_{14}	n_{13}	n_{12}	n_{11}	n_{10}	n_9
	n_8	n_7	n_6	n_5	n_4	n_3	n_2	n_1

The parameter value is the maximum downlink frame size in bits.

Table 4-4 – N1 - Uplink

first bit transmitted ⇓

PI	0	0	0	0	0	1	1	0
PL	0	0	0	0	0	0	1	0
	n_{16}	n_{15}	n_{14}	n_{13}	n_{12}	n_{11}	n_{10}	n_9
	n_8	n_7	n_6	n_5	n_4	n_3	n_2	n_1

The parameter value is the maximum uplink frame size in bits.

Table 4-5 – k-Downlink

first bit transmitted ⇓

PI	0	0	0	0	0	1	1	1
PL	0	0	0	0	0	0	0	1
	0	0	0	0	0	k_3	k_2	k_1

The parameter value is the downlink frame window.

ATTACHMENT 4
ENCODING OF XID PUBLIC PARAMETERS

Table 4-6 – k-Uplink

first bit transmitted ⇓

PI	0	0	0	0	1	0	0	0
PL	0	0	0	0	0	0	0	1
	0	0	0	0	0	k_3	k_2	k_1

The parameter value is the uplink frame window.

Table 4-7 – Counter – N2

first bit transmitted ⇓

PI	0	0	0	0	1	0	1	0
PL	0	0	0	0	0	0	0	1
	0	0	0	0	n_4	n_3	n_2	n_1

The parameter value is the maximum number of attempts to transmit an I-frame.

Table 4-8 – Timer – T2

first bit transmitted ⇓

PI	0	0	0	0	1	0	1	1
PL	0	0	0	0	0	0	1	0
	t_{16}	t_{15}	t_{14}	t_{13}	t_{12}	t_{11}	t_{10}	t_9
	t_8	t_7	t_6	t_5	t_4	t_3	t_2	t_1

The parameter value is the maximum delay in acknowledgement in milliseconds.

ATTACHMENT 4
ENCODING OF XID PUBLIC PARAMETERS

Table 4-9 – Default Values

The following table provides the default settings of the Public Parameters.

Field	Hex	Comments
Public Group Identifier	80	identifies the following parameters as Public Parameters
Length of Public Group	00	The numbers of octets in the Public Group
	14	(20)
Public Parameter Set ID	01	
length	09	
	38	The representation of the ASCII string
	38	‘8885:1993’
	38	
	35	
	3A	
	31	
	39	
	39	
	33	
Procedures Classes	02	
length	02	
	00	
	01	Support of ABM
HDLC optional functions	03	
	03	
	20	SREJ multi-frame
	84	16-bit FCS and modulo 8
	80	Extended address

APPENDIX A
TERMS AND ACRONYMS

A-1.1 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.

A-1.2 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
AOA	**ACARS Over AVLC**
AOC	Airline Operational Control
APC	Airline Passenger Communications
ARINC	Aeronautical Radio Inc

APPENDIX A
TERMS AND ACRONYMS

ARQ	Automatic Repeat Request
ATC	Air Traffic Control
ATM	**Air Traffic Management**
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
CFDIU	Central Fault Display Interface Unit
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
CMD	**Command**
CMU	Communications Management Unit
CNS	Communications, Navigation and Surveillance
COTP	Connection Oriented Transport Protocol
COTS	Commercial Off-the-shelf
CPDLC	Controller/Pilot Data Link Communications
CSC	Common Signaling Channel
CSMA	Carrier Sense Multiple Access
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

APPENDIX A
TERMS AND ACRONYMS

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
FSL	Frequency Support List
GACS	Generic ATN Communications Service
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

APPENDIX A
TERMS AND ACRONYMS

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 Standardized Profiles
IS-SME	Intermediate System - System Management Entity
ITU	International Telecommunications Union
LACK	Logical Acknowledgement
LAPB	Link Access Procedure - Balanced
LE	**Link Establishment**
LIDU	Link Interface Data Unit
LLC	Logical Link Control
LLC-I	Logical Link Control Type I
LME	Link Management Entity
LREF	Local Reference (table or compression, depending on usage)
LRU	Line Replacement Unit
MAC	Media Access Control
MASPS	**Minimum Aviation System Performance Standards**
MCDU	**MultiPurpose Control and Display Unit**
MIB	Management Information Base
MO	Managed Object
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

APPENDIX A
TERMS AND ACRONYMS

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(s)
PLP	Packet Layer Protocol
PPP	Point to Point Protocol
QOS	Quality of Service
RD	Routing Domain
RF	**Radio Frequency**
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	Société International de Télécommunications Aéronautiques
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

APPENDIX A
TERMS AND ACRONYMS

UA	Unnumbered Acknowledgement
VC	Virtual Circuit
VDL	VHF Digital Link
VDLM2	VDL Mode 2
VDR	VHF Data Radio
VHF	Very High Frequency
VME	VDL Management Entity
VMF	VDL Management Function
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.

Note: To determine the VDL_SysID of a given Ground Station, the avionics should perform a Bitwise ANDing between the Ground_Station_Address and the System_Mask advertised by the Ground Station.

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 or Handoff 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 the same Ground System, two Ground Stations connected to different VSDAs (whether the ground supports X.121 addressing or not) will send a handoff (XID_CMD_HO) to the new ground station. In this case, a ISH PDU should be included in the Call Request in order to ensure proper route initiation and exchange of configuration information. An aircraft crossing, within the same Ground System, two Ground Stations connected to the same VSDA (whether the ground system supports X.121 addressing or not) should send a handoff (XID_CMD_HO) to the new ground station. In this case, an ISH PDU should also be included in the Call Request even though route initiation and exchange of configuration information should not occur. Refer to Figure 2 and Figure 3.

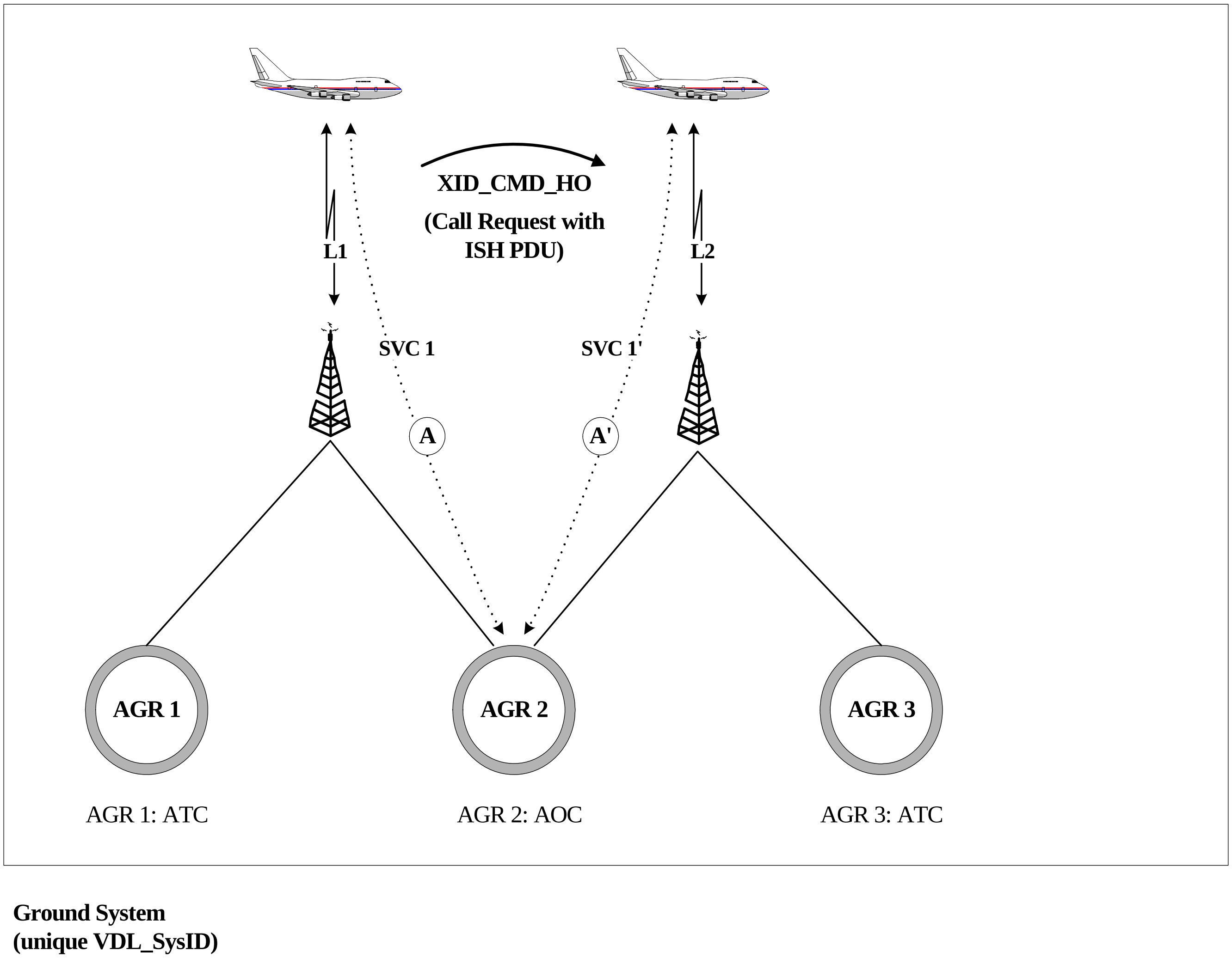


Figure B-1 – Handoff event sent with ISH PDU Same AGR

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

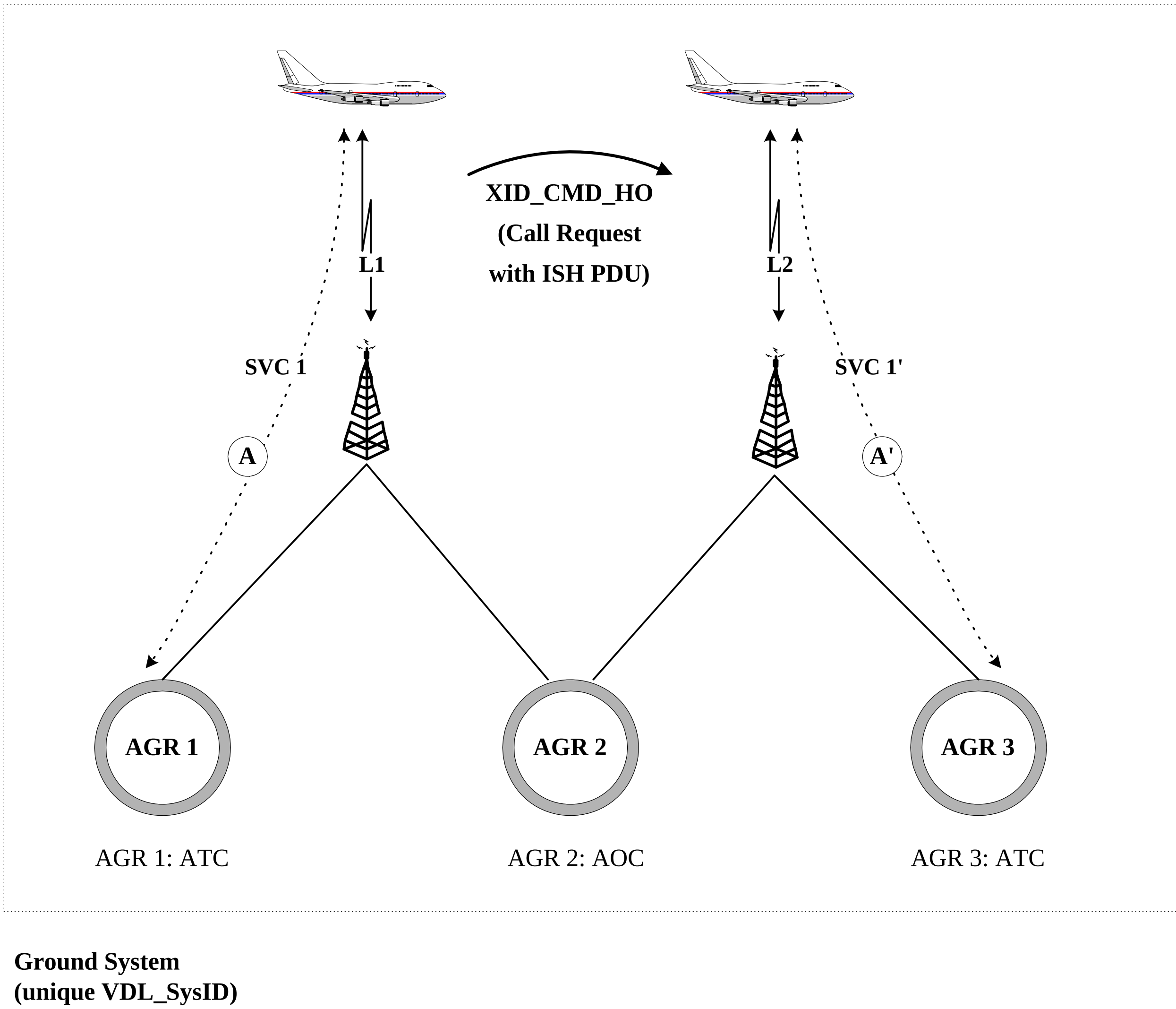
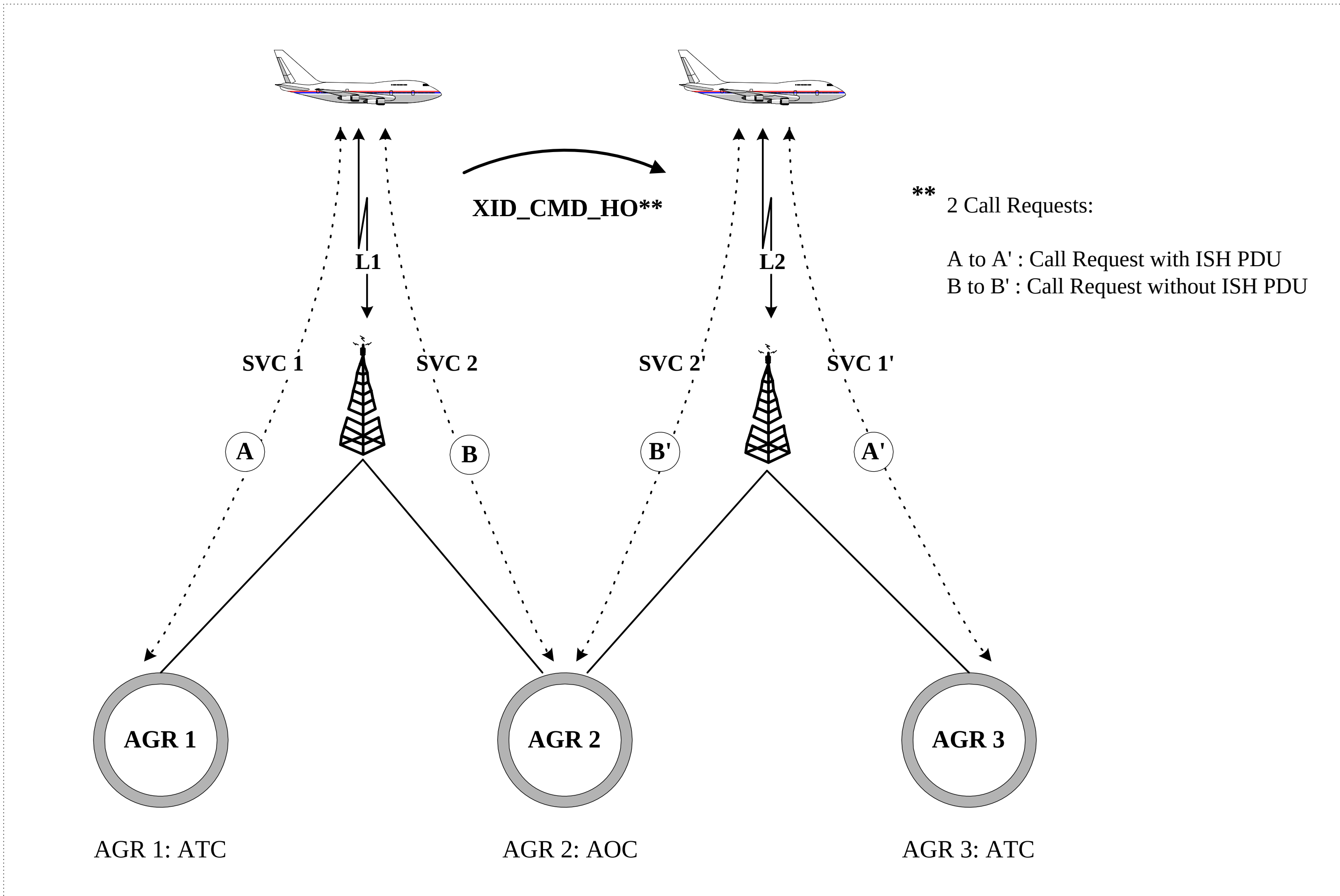


Figure B-2 – Handoff event sent with ISH PDU (first example) 2 AGRs, 1 SVC

APPENDIX B
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)
(Different AGRs, 2 SVCs)

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

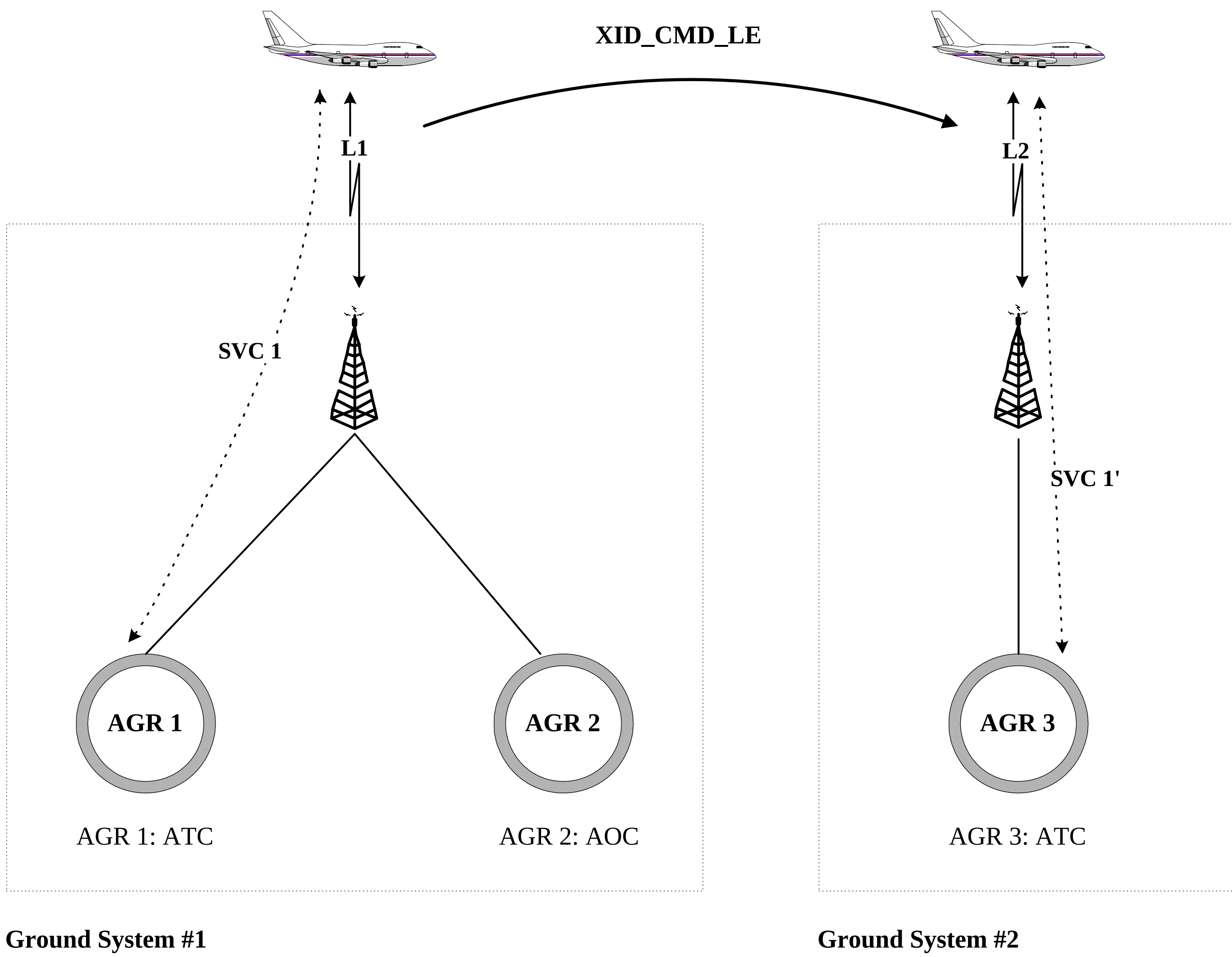


Figure B–4 – Leave Event – Crossing Ground Systems

APPENDIX C
MESSAGE SEQUENCE CHARTS

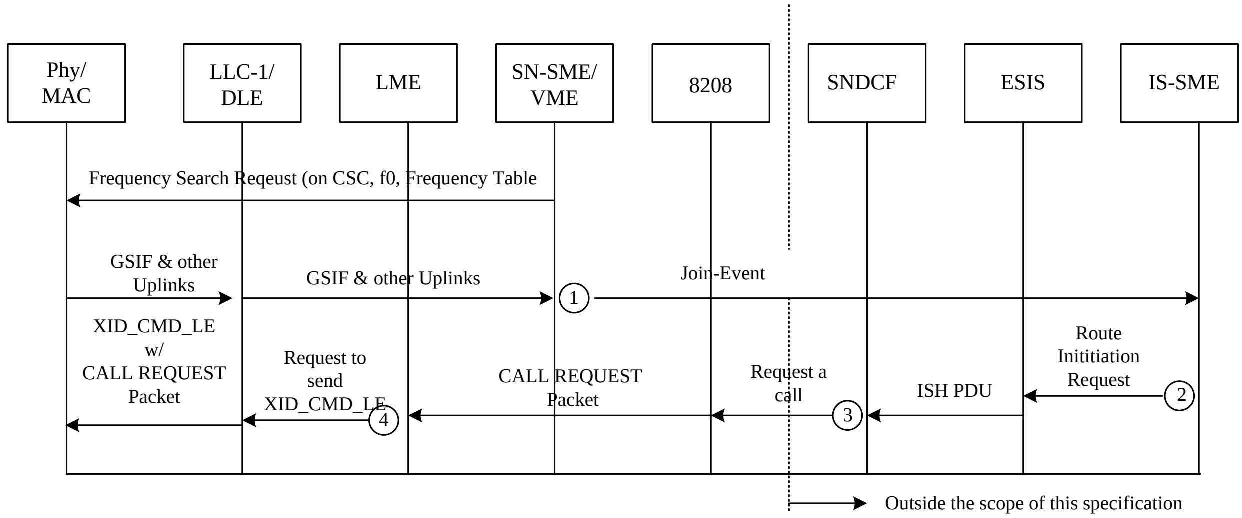


Figure C-1 – AVLC Link and Subnetwork Connection Establishment (Expedited Subnetwork Connection) – Part I

Notes:

1. Creates a join-event based on local policy. It consists of 1) DSP ID, 2) VDL Specific DTE address 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 and DTE address of ground router and ground station ID. ESIS then creates and 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 = ISH PDU and SNDCF header). Starts T3 (XID_CMD_LE retransmission timer).

APPENDIX C
MESSAGE SEQUENCE CHARTS

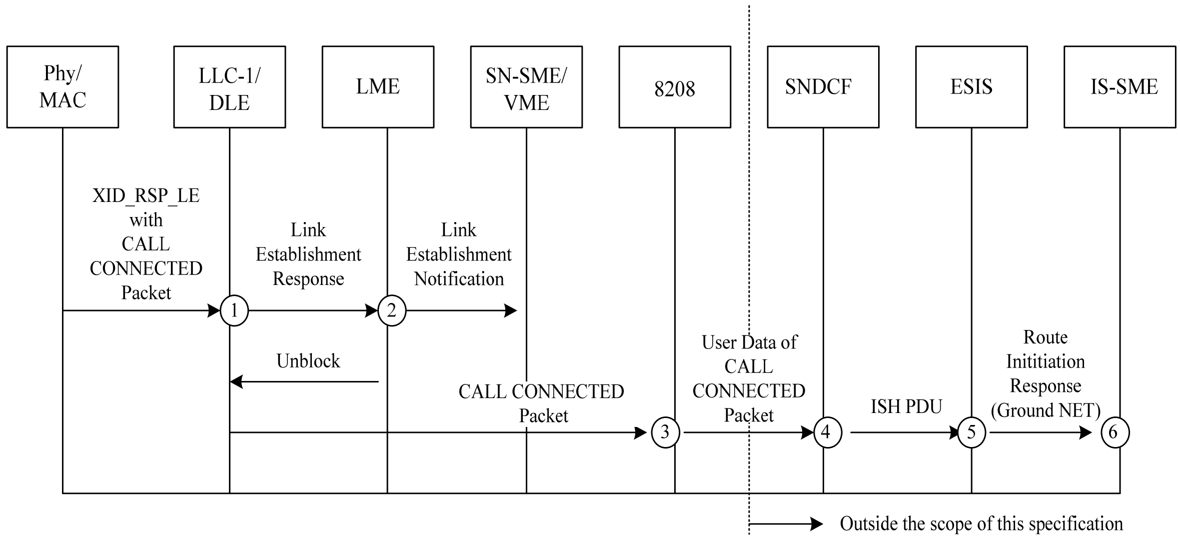


Figure C-2 – AVLC Link and Subnetwork Connection Establishment (Expedited Subnetwork Connection) – Part II

Notes:

1. Receives the XID_RSP_LE frame from MAC. Validates the syntax/semanities 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 is established. Unblocks DLE so that it is ready for data transfer, and notifies SN-SME/VMEthat 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.

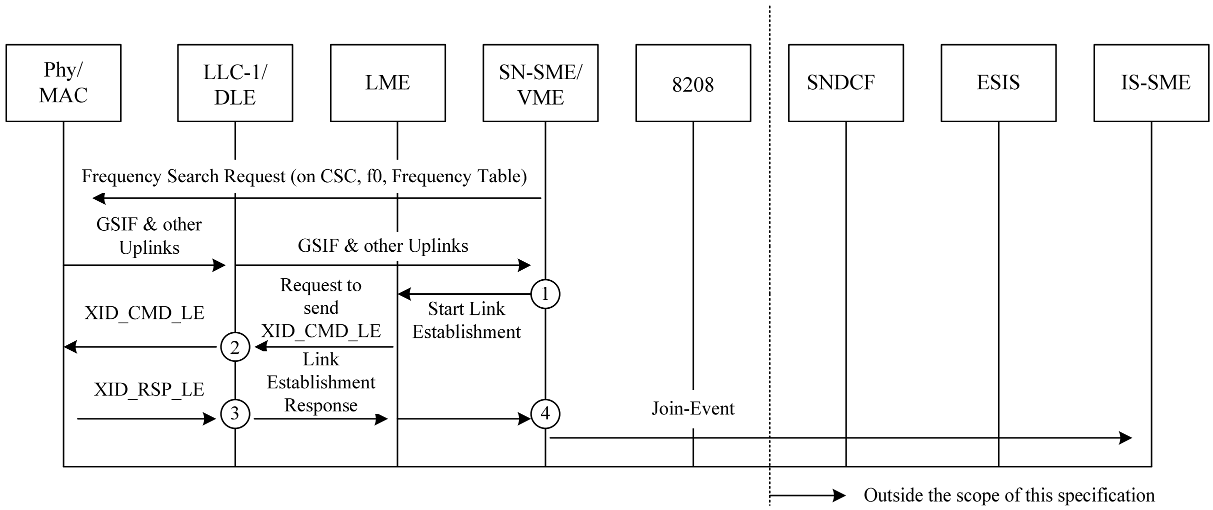


Figure C-3 – AVLC Link and Subnetwork Connection Establishment (Explicit Subnetwork Connection) – Part I

Notes:

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_RP_LE, it will send a link-up notification to IS-SME; otherwise, it will send an XID_CMD_LCR to the responding ground station.

APPENDIX C
MESSAGE SEQUENCE CHARTS

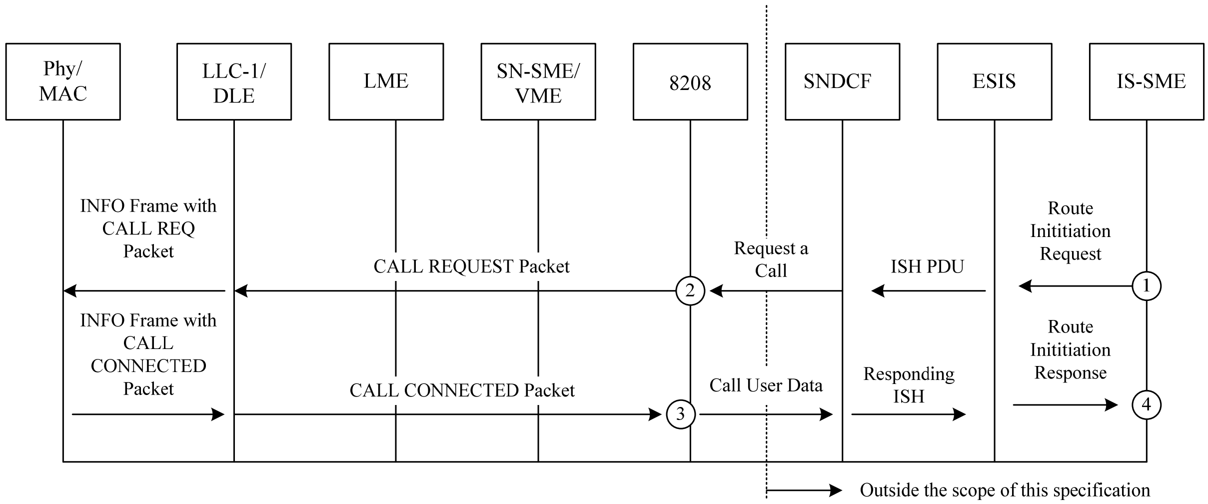


Figure C-4 – AVLC Link and Subnetwork Connection Establishment (Explicit Subnetwork Connection) – Part II

Notes:

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.

APPENDIX C
MESSAGE SEQUENCE CHARTS

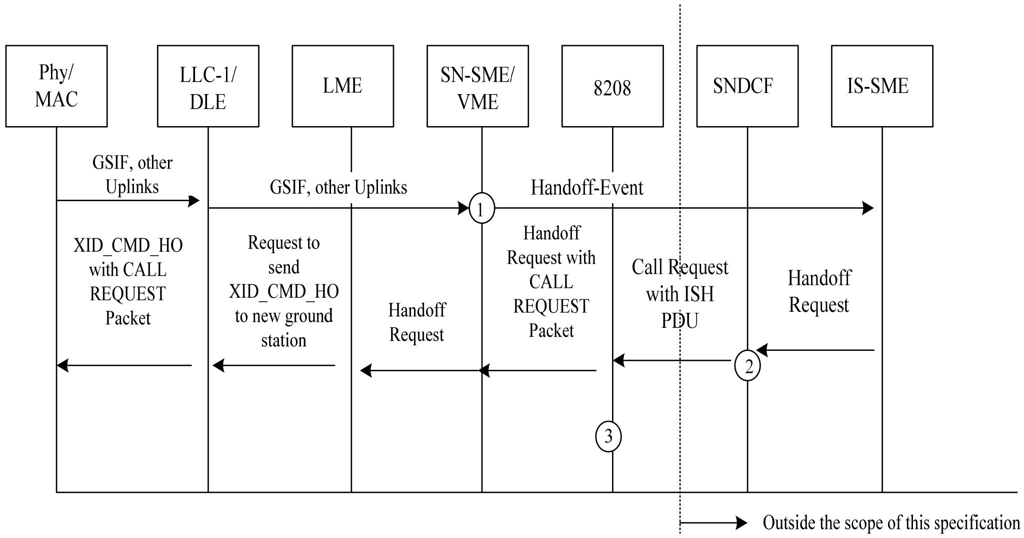


Figure C-5 – Aircraft-Initiated Handoff - Same Air-Ground Router (Expedited Subnetwork Connection) – Part I

Notes:

1. 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-event to SNDCF (same ADM/ARS).

2. 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.

3. 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.

4. 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.

APPENDIX C
MESSAGE SEQUENCE CHARTS

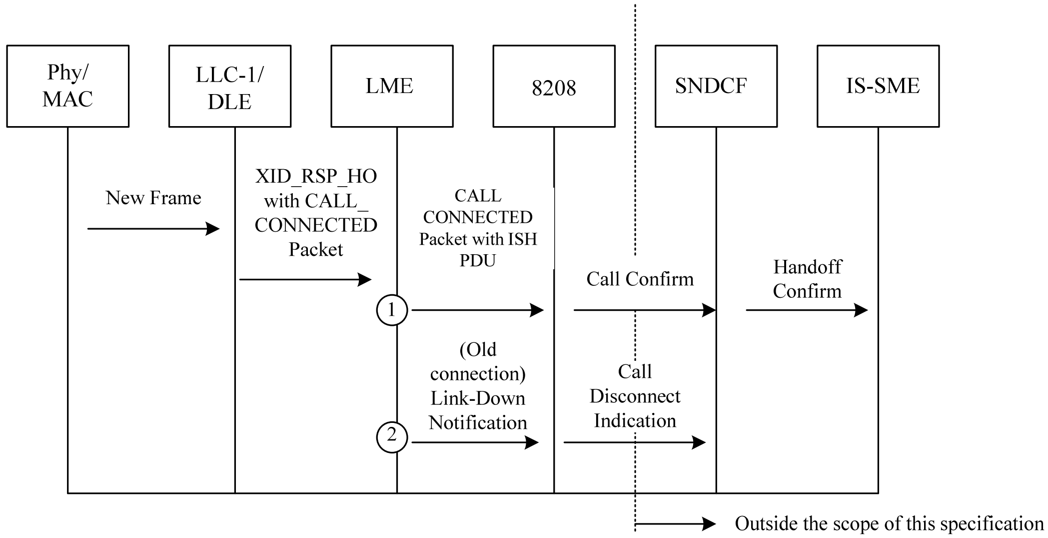


Figure C-6 – Aircraft-Initiated Handoff - Same Air-Ground Router (Expedited Subnetwork Connection) – Part II

Notes:

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.

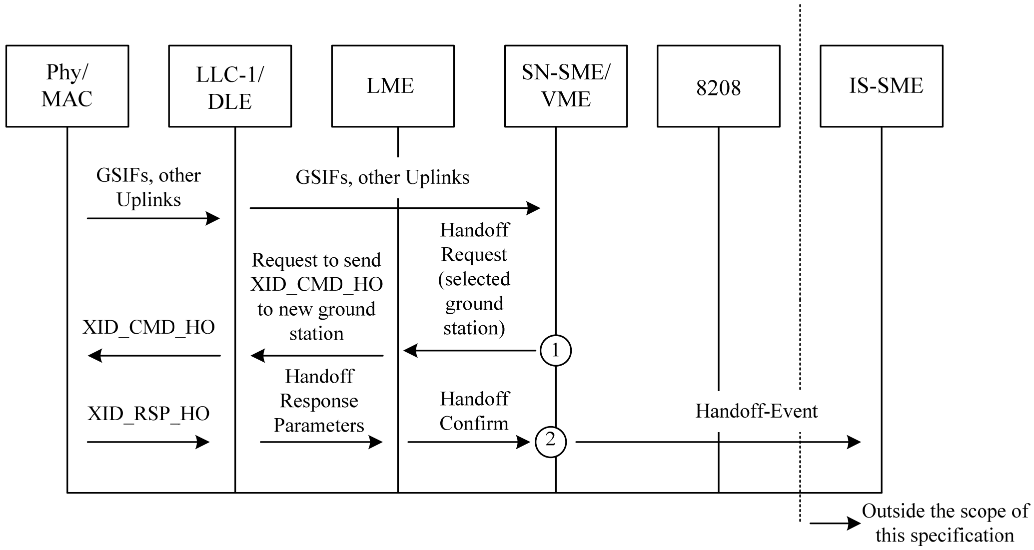


Figure C-7 – Aircraft-Initiated Handoff - Same Air-Ground Router (Explicit Subnetwork Connection) – Part I

Notes:

1. The MSC 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.

2. 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.

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

APPENDIX C
MESSAGE SEQUENCE CHARTS

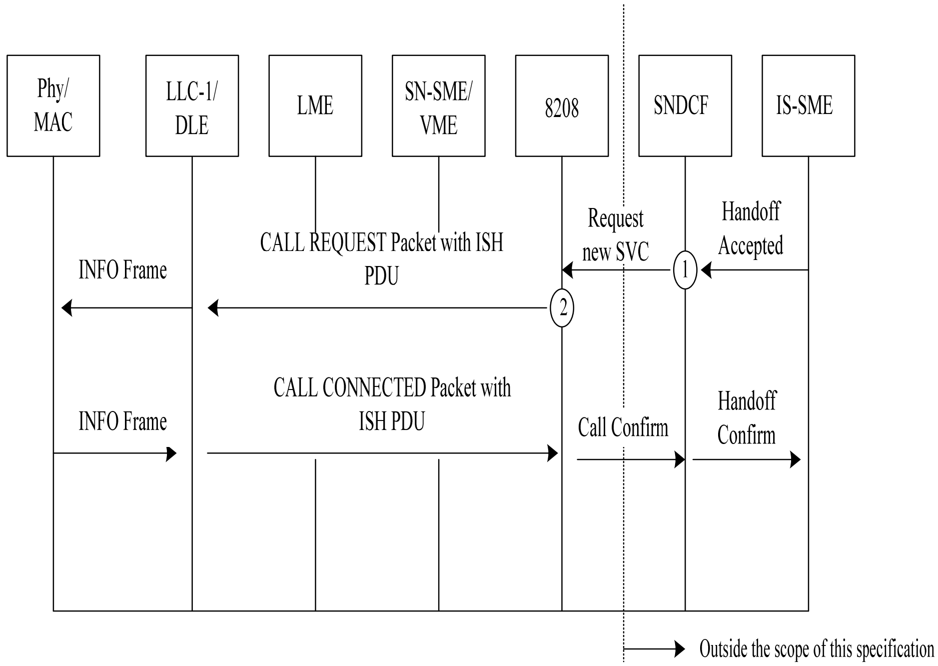


Figure C-8 – Aircraft-Initiated Handoff - Same Air-Ground Router (Explicit Subnetwork Connection) – Part II

Notes:

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

   If the ground systems support 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.

Figure C-9 – Reserved

COMMENTARY

The figure illustrating Ground-Initiated Handoff - Explicit on Uplink, Expedited on Downlink was deleted in Supplement 4.

APPENDIX C
MESSAGE SEQUENCE CHARTS

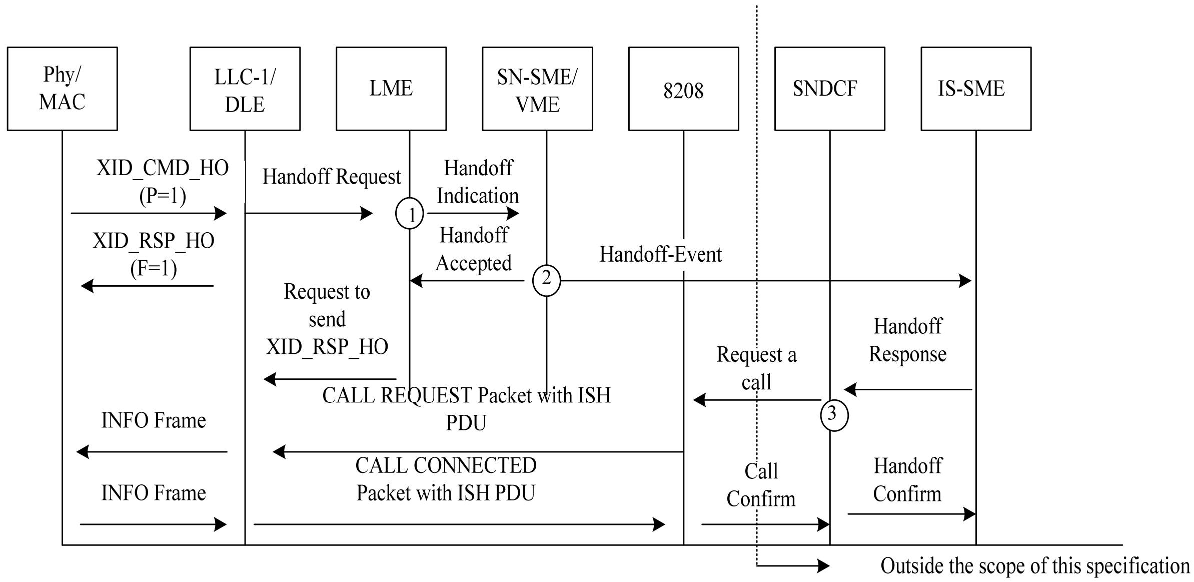


Figure C-10 – Ground-Initiated Handoff - Explicit Subnetwork Connection (Only Explicit Subnetwork Connection Is Used In Ground-Initiated Handoff)

Notes:

1. 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.

2. 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.

3. 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.

4. 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-1.0 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.

It is also necessary to recognize that ATC Communication Management requires an aircraft to establish a Controller/Pilot Data Link Communications (CPDLC) connection with the Next Data Authority prior to leaving the jurisdiction of the Current Data Authority. In general, this necessitates that an aircraft has connectivity with certain adjacent ATS Providers in addition to the one currently handling the aircraft.

In this Appendix, several scenarios are presented. The first scenario identifies the problem while the second and third scenarios present alternative approaches that seek to overcome the limitations of the first scenario, but which still present some drawbacks. Finally, the last section of this Appendix presents an alternative architecture based on more extensive ground-ground networking, which is the approach in currently deployed systems requiring a single VSDA per VGS as specified in this document.

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

Assumptions:

1. All VSDAs announced by a VGS 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).

D-2.0 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.

APPENDIX D
VSDA CONFIGURATION ISSUE

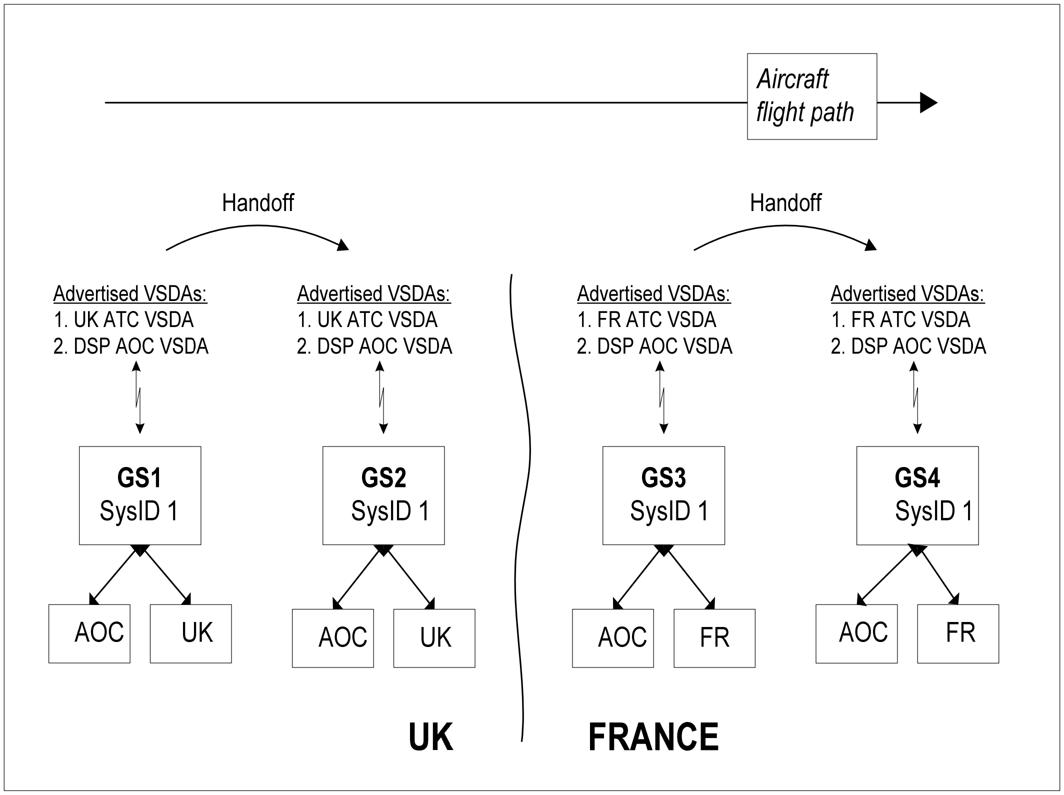


Figure D-1: Scenario 1 – Identification of the problem

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.

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.

D-3.0 Scenario 2

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 ground topology may be set as illustrated in Figure D-2.

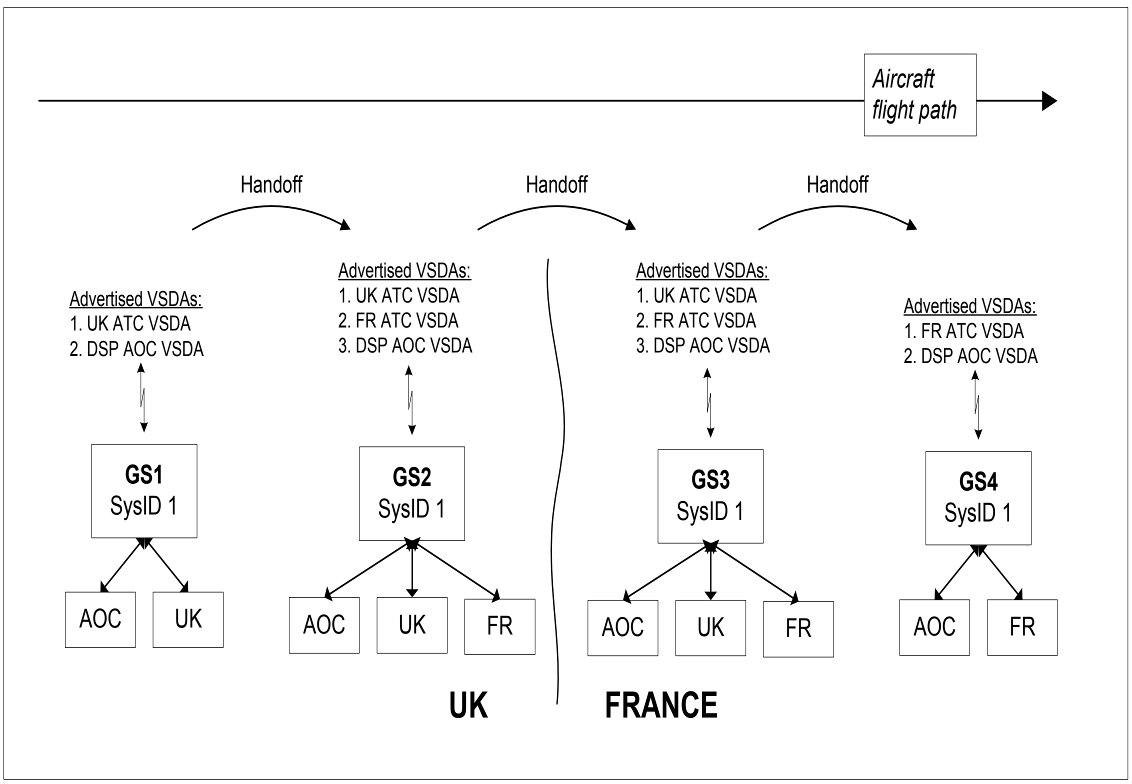


Figure D-2 – Scenario 2

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 and to the UK ATC router (and advertises 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.

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.

Drawbacks

In order to support connectivity with the next ATS provider, it would be necessary for the aircraft to maintain adjacencies with more than one ATC A/G router. Since each adjacency incurs a certain overhead over the A/G link, due to the establishment of the adjacency and the exchange of IDRP keep-alive PDUs, this approach would create undesirable additional load on the RF channel.

Furthermore, as highlighted above, in some regions, an aircraft may see a significant number of national ATC routers advertised in the GSIF, many of which would not be relevant to the aircraft's intended flight plan. In order to minimise the overhead mentioned above, some selection logic would be required in the avionics to determine the VSDAs with which the aircraft should connect. At the time of writing, no such selection criteria have been specified by either ICAO or industry standards.

APPENDIX D
VSDA CONFIGURATION ISSUE

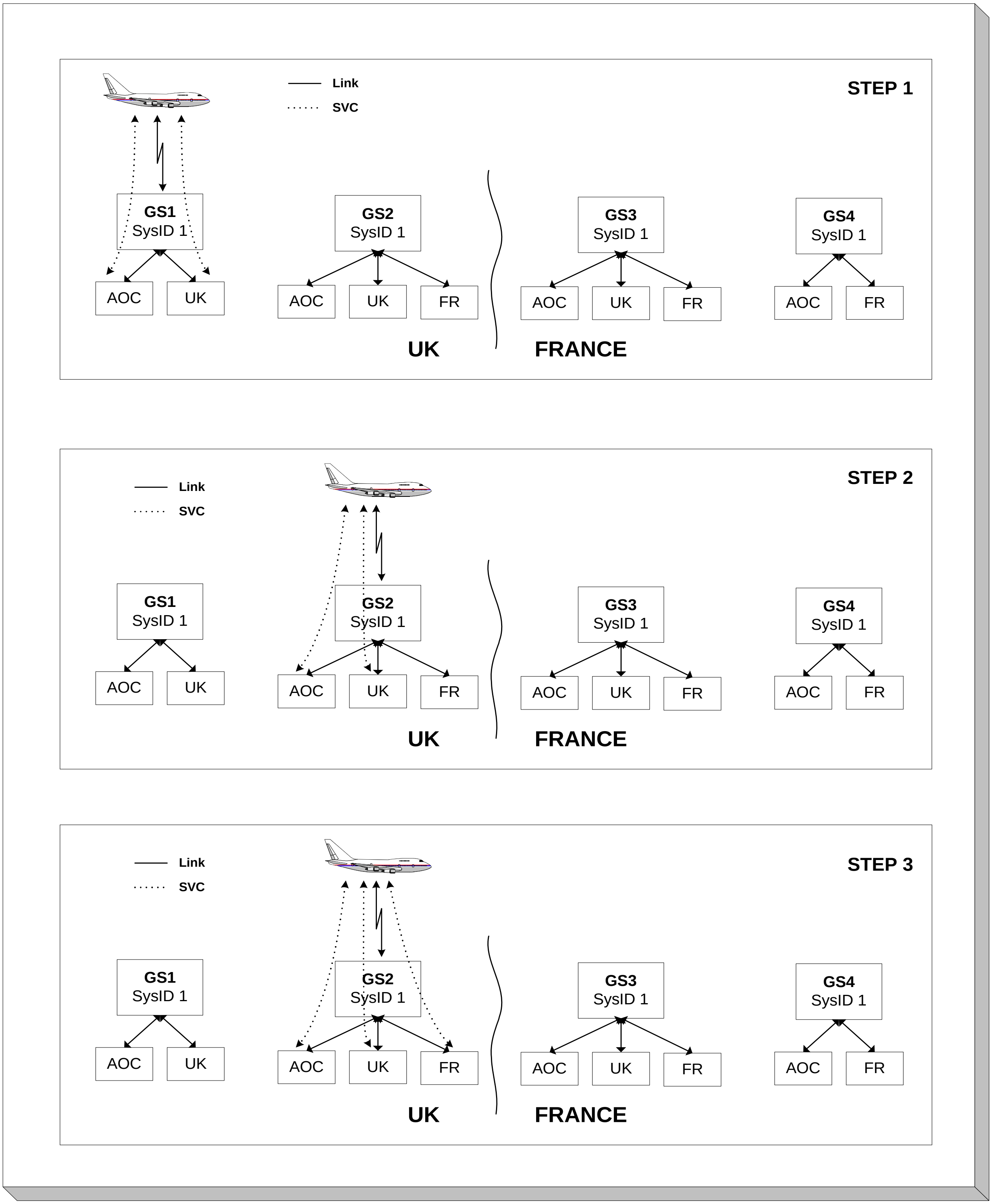


Figure D-3 - Part 1 – Scenario 2, Step-by-Step

APPENDIX D
VSDA CONFIGURATION ISSUE

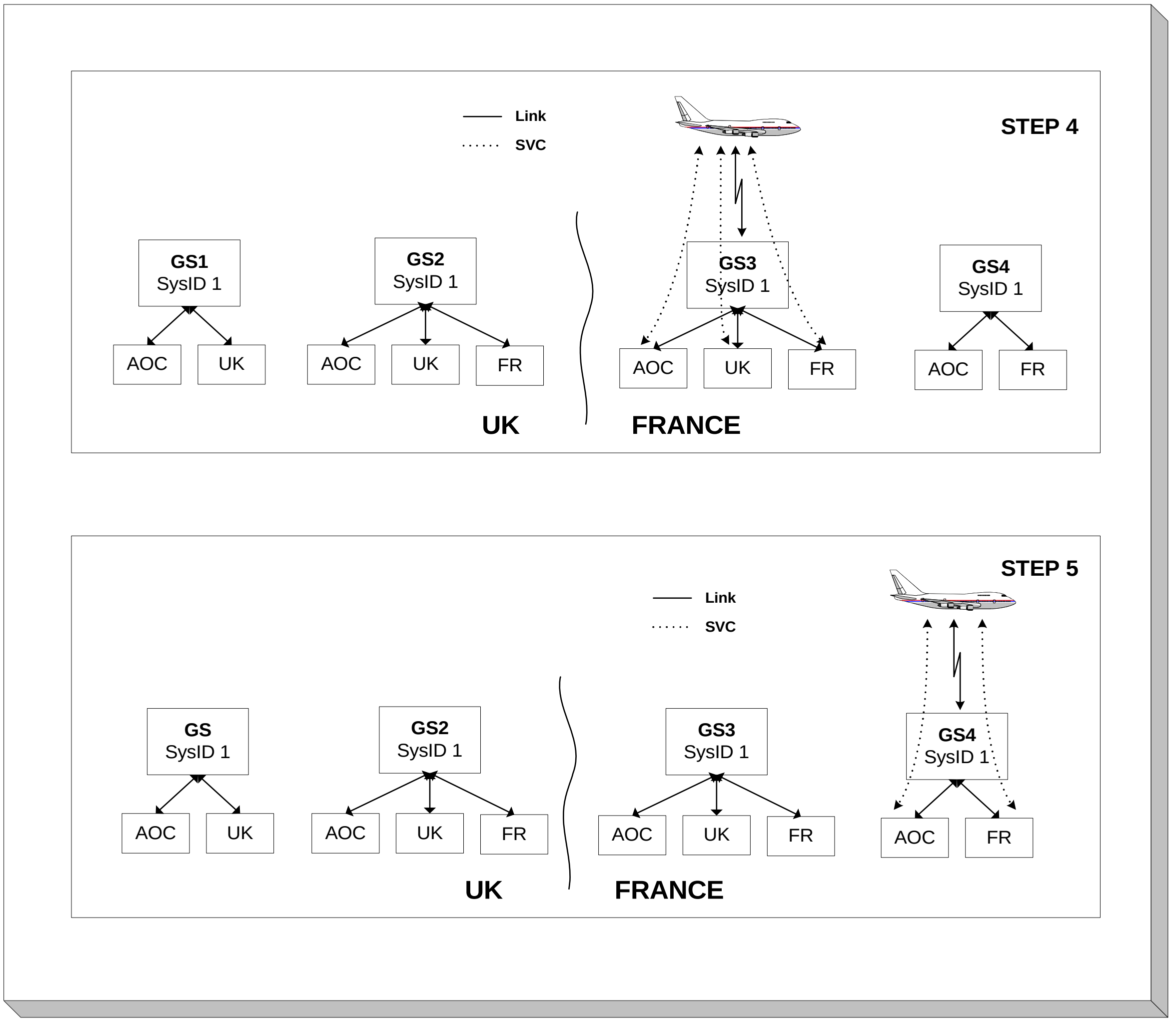


Figure D-3 - Part 2 – Scenario 2, Step-by-Step

D-4.0 Scenario 3

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 approach for a service provider to ensure continuing ATC service through different states having different ATS authorities. While ensuring proper services, this approach 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.

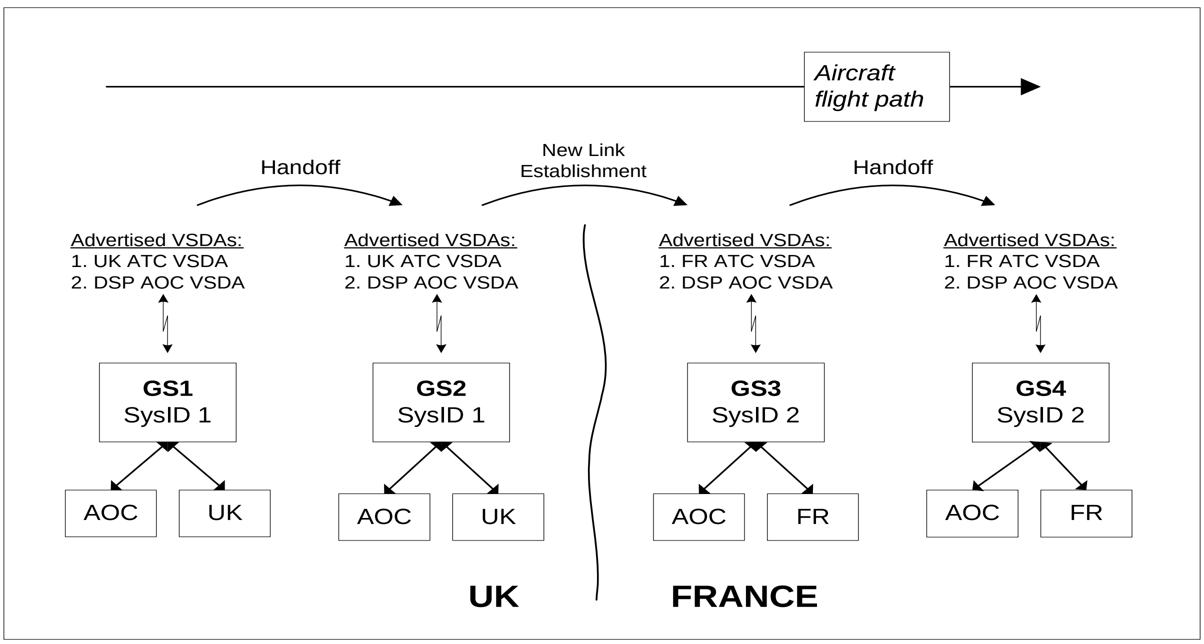


Figure D-4 – Scenario 3

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
VSDA CONFIGURATION ISSUE

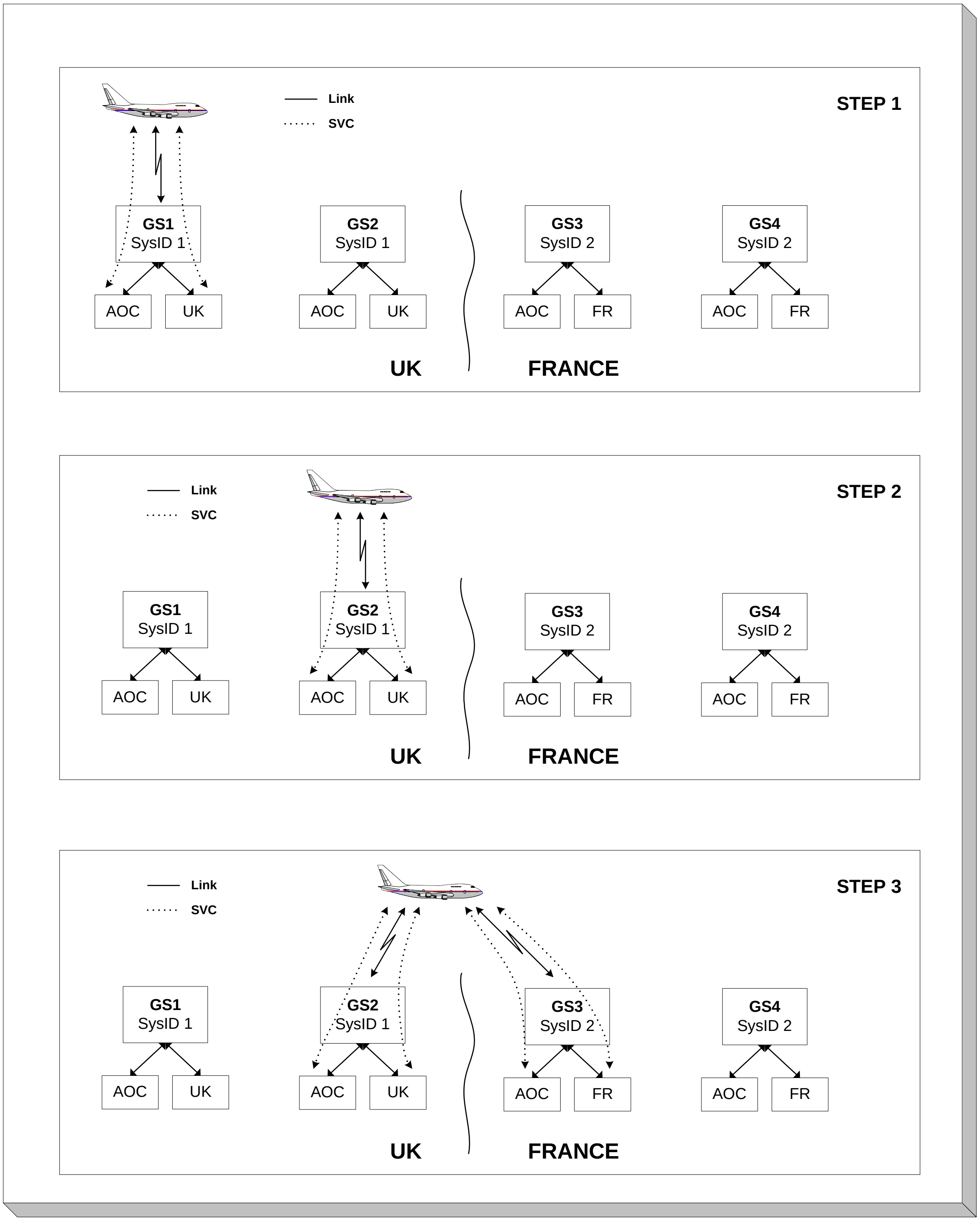


Figure D-5 - Part 1 – Scenario 3, Step-by-Step

APPENDIX D
VSDA CONFIGURATION ISSUE

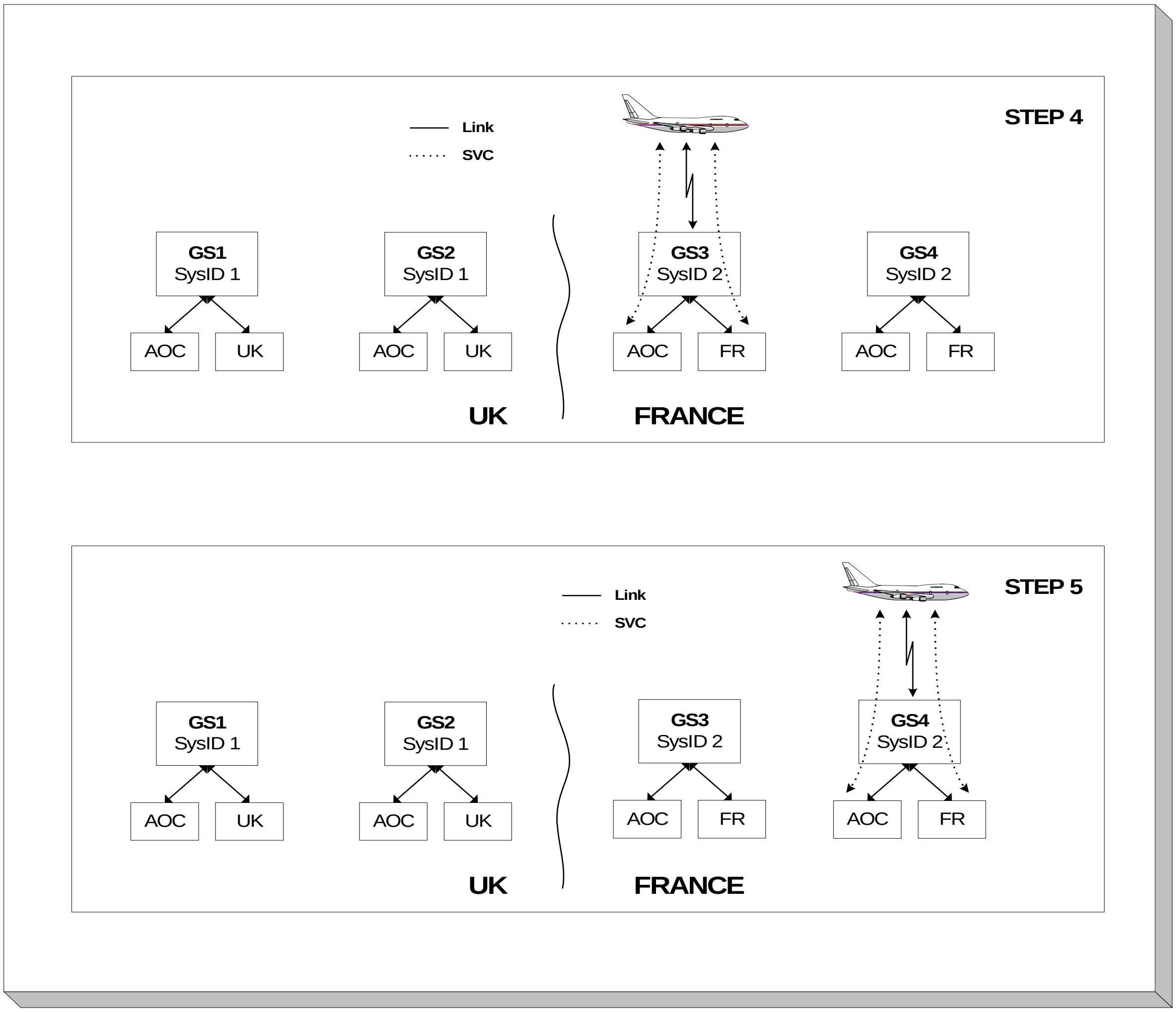


Figure D-5 – Part 2 – Scenario 3, Step-by-Step

Drawbacks

Nevertheless, this scenario suffers similar drawbacks to those recognized in Scenario 2, namely that additional RF overhead would be incurred due to the multiple IDRP adjacencies when connecting to the next ATS provider, and the need for sophisticated selection criteria in the aircraft to determine with which ground systems the aircraft should connect.

D-5.0 Scenario 4 – Use of Ground-Ground Networking

In recognition of the issues described above, a more appropriate means to ensure availability of the required end-to-end connectivity to support ATS communication, consistent with the ATN philosophy, is to provide ground-ground connectivity. In the general case, this might be as shown in Figure D-6 below, although other configurations are also possible, depending on the organizational architecture.

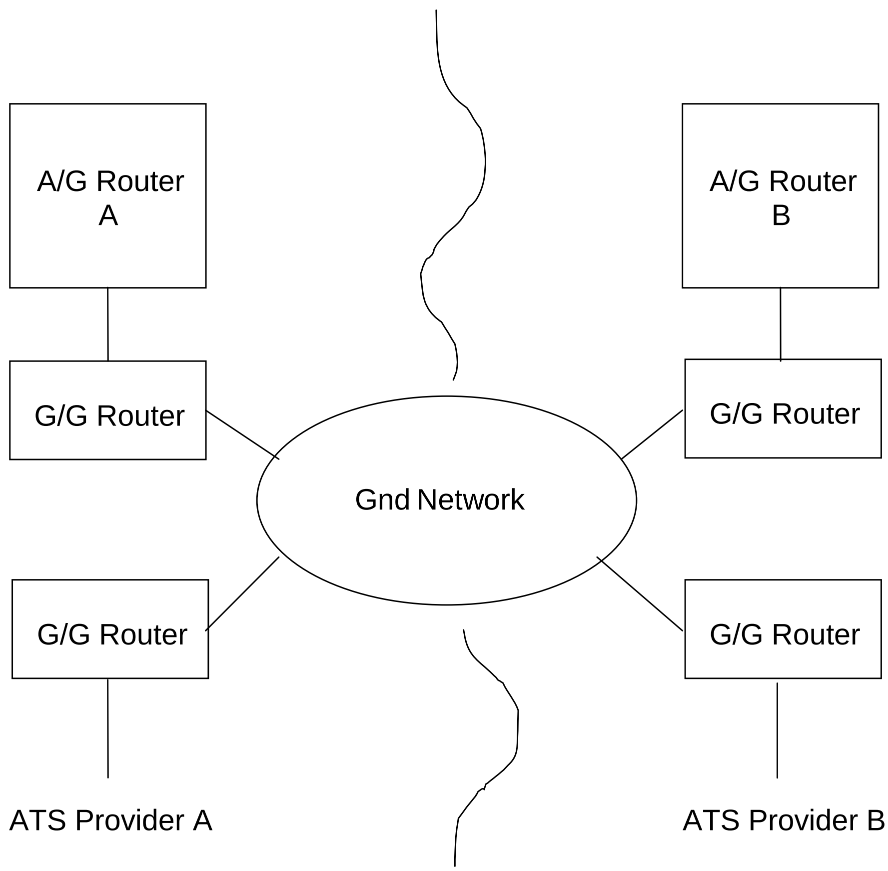


Figure D-6 – Use of Ground-Ground Networking

In this scenario, each VGS advertises only a single VSDA associated with an A/G Router associated with the Ground System. That A/G Router is in turn connected via a ground network of several G/G Routers to provide end-to-end connectivity with both current and adjacent ATS Providers.

While the aircraft is connected via A/G Router A, and under the jurisdiction of ATS Provider A, it is possible to establish a CPDLC connection with ATS Provider B (e.g. as Next Data Authority) through the same A/G Router by means of the Ground-Ground Network. Furthermore, when the aircraft performs a VDL Handoff and connects via A/G Router B, no disruption to existing CPDLC connections occurs.

Since the aircraft needs to maintain only one IDRP adjacency at a time, the overhead on the RF link is reduced. No selection criteria are required on the aircraft to determine through which Ground System or VSDA the aircraft should connect.

This architecture is currently being deployed within the EUROCONTROL LINK2000+ programme implementing CPDLC over ATN/VDL Mode 2 within the core area of Europe.

At present, AOC communication is transferred outside the context of the ATN by means of the AOA protocol, and does not impact on the architecture illustrated in Figure D-6.

In the event that future plans are formulated to implement AOC ATN applications, there is no fundamental reason why AOC communication should not be handled by the same ATN A/G Routers shown in the figure. However, it may be administratively convenient to implement separate A/G Routers to provide the necessary connectivity, in which case, it would be necessary to advertise more than one VSDA. However, before such a scheme could be implemented effectively, industry standards would be required to ensure that all avionics are capable of recognizing the distinction, and of establishing the appropriate air/ground adjacencies.

APPENDIX E
STATE MACHINES

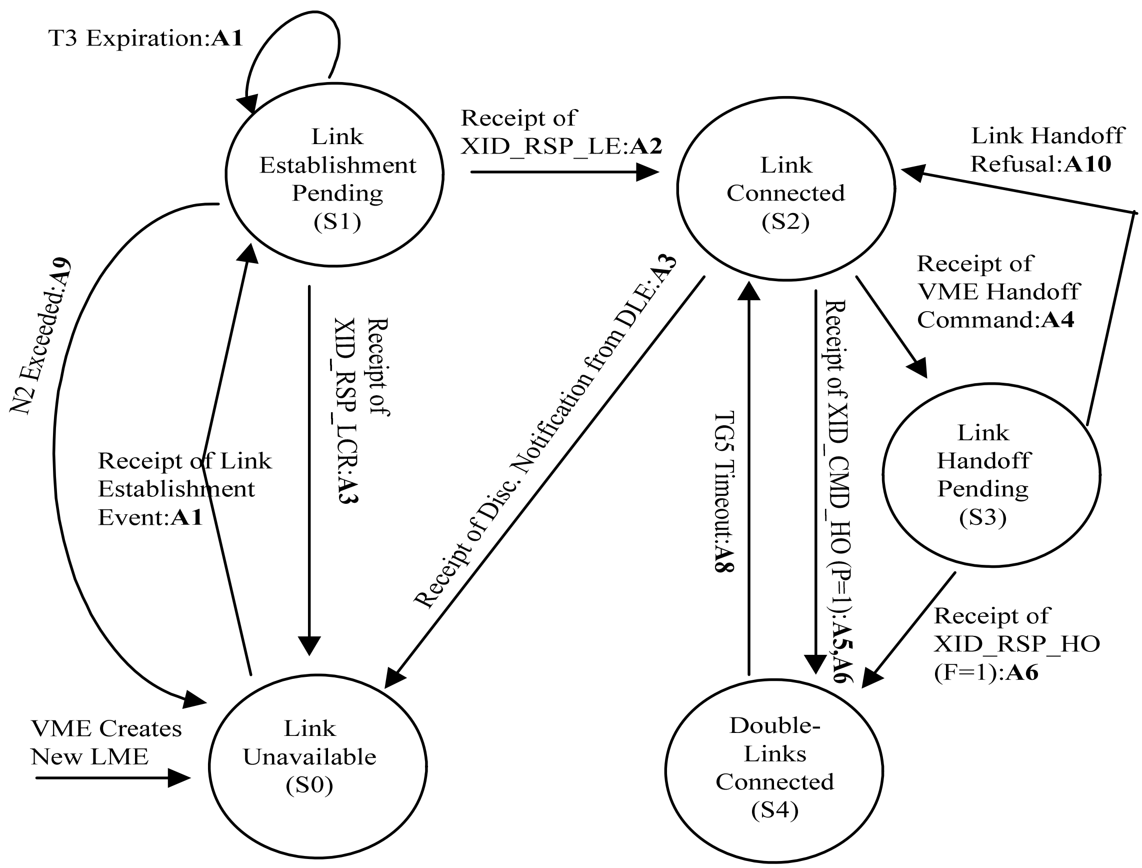


Figure E-1 – LME State Diagram

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 DIX_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: Nofiy VME of a handoff refusal.

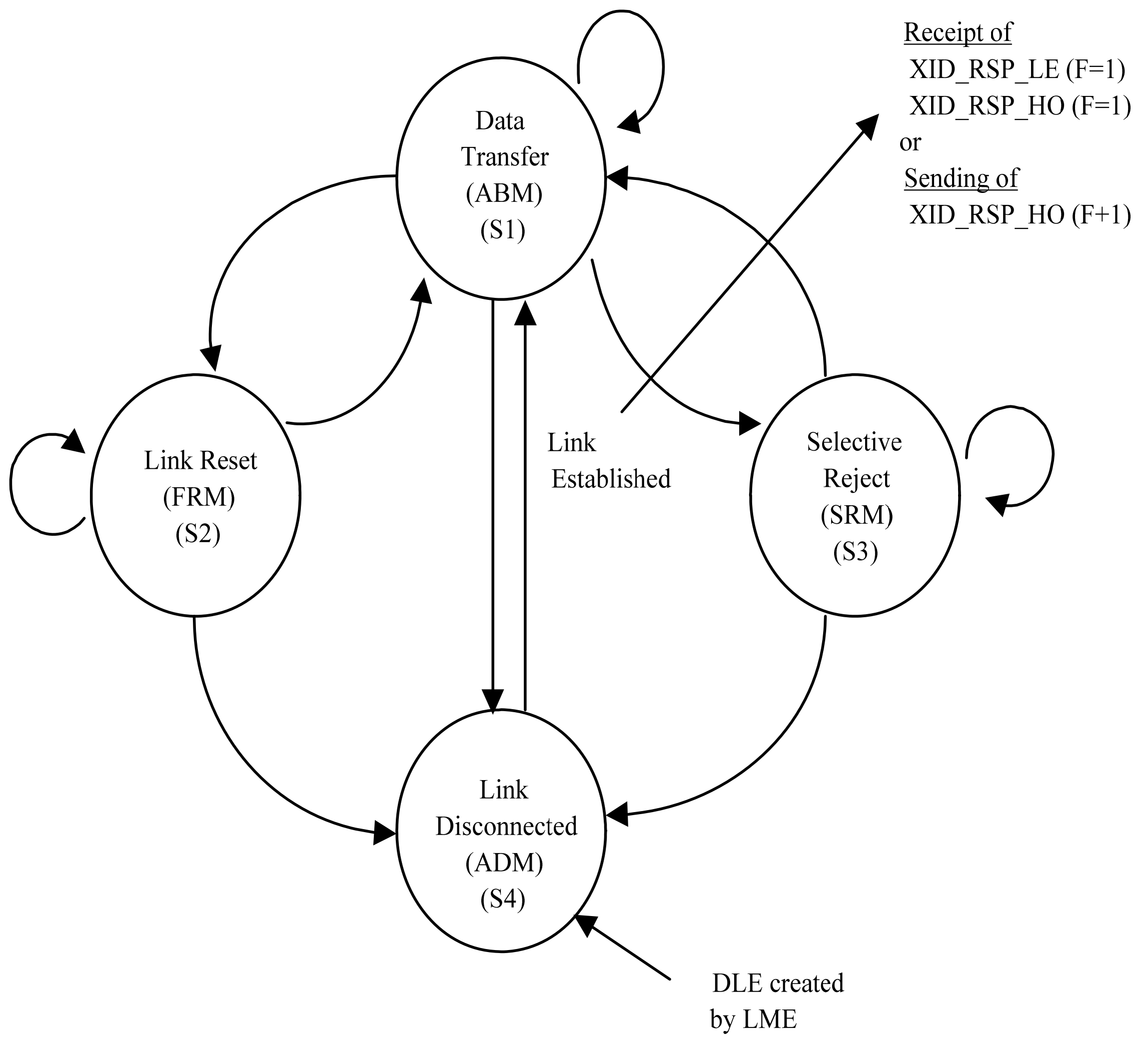


Figure E-2 – DLE Top Level State Diagram

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

APPENDIX E
STATE MACHINES

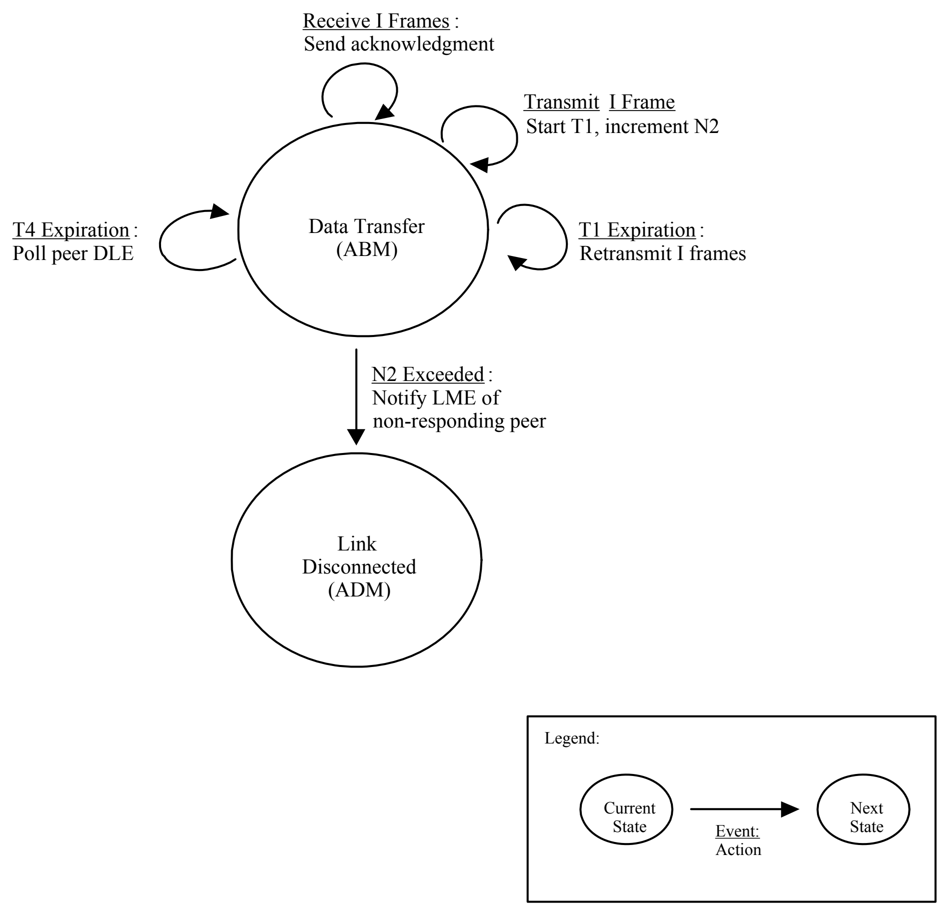


Figure E-3 – DLE Data Transfer (ABM) State Diagram

APPENDIX E
STATE MACHINES

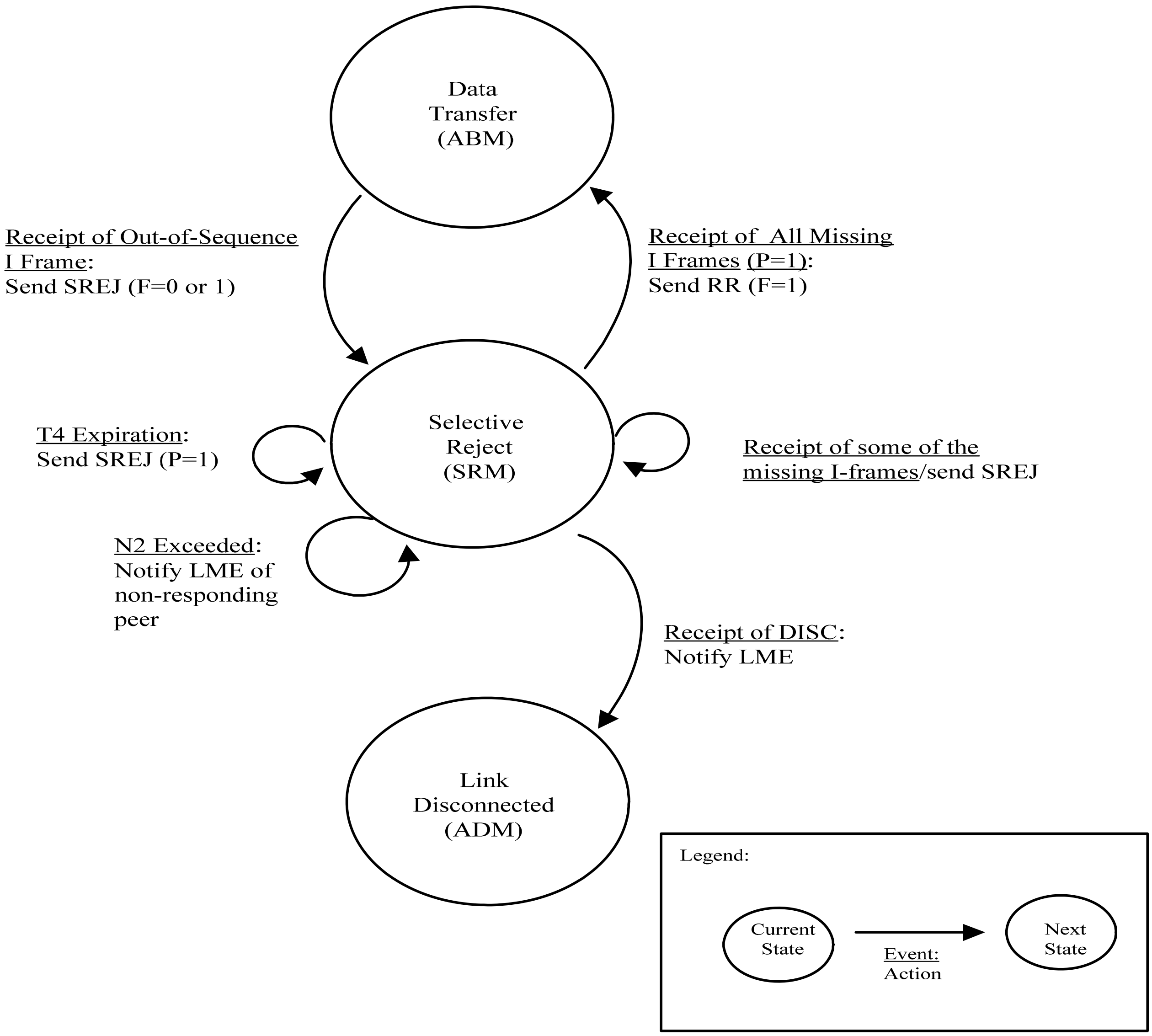


Figure E-4 – DLE Selective Reject (SRM) State Diagram (Sending SREJ)

APPENDIX E
STATE MACHINES

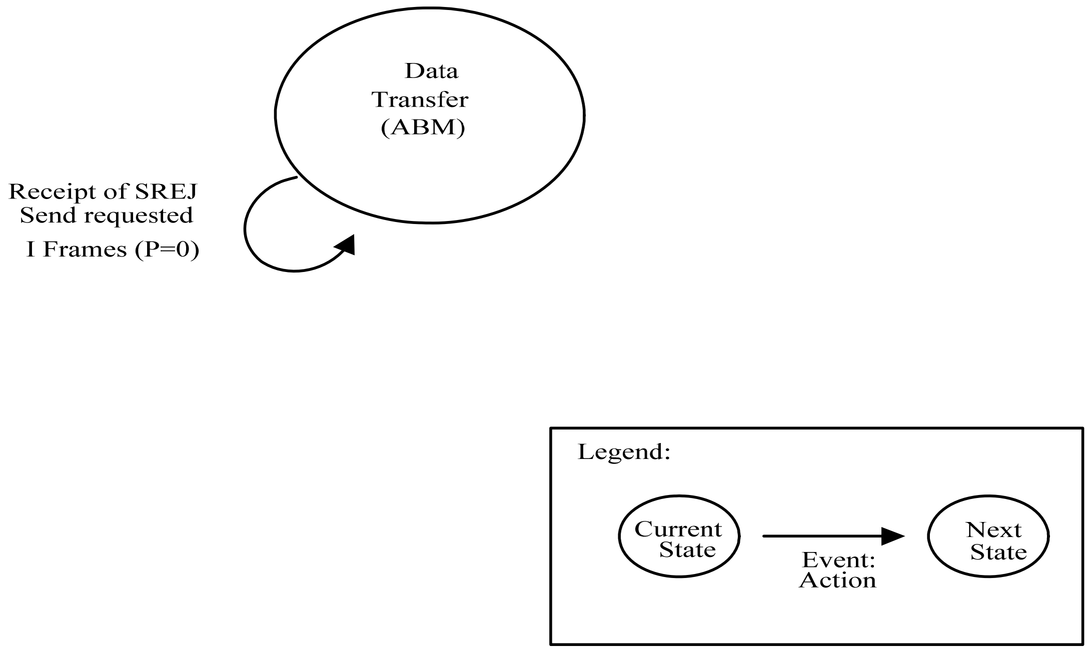


Figure E-5 – DLE Selective Reject (SRM) State Diagram (Receiving SREJ)

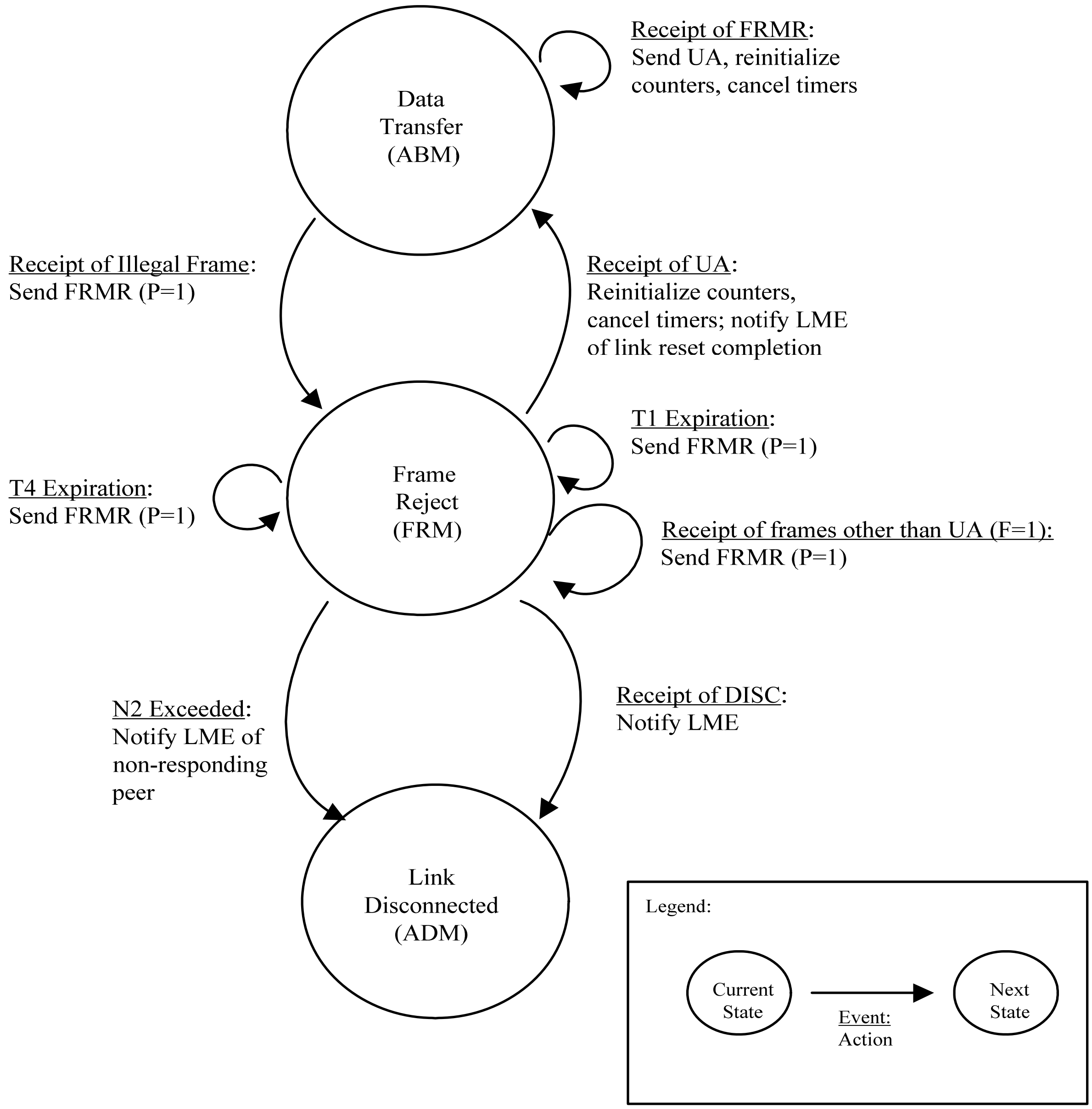


Figure E-6 – DLE Frame Reject (FRM) State Diagram

APPENDIX E
STATE MACHINES

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

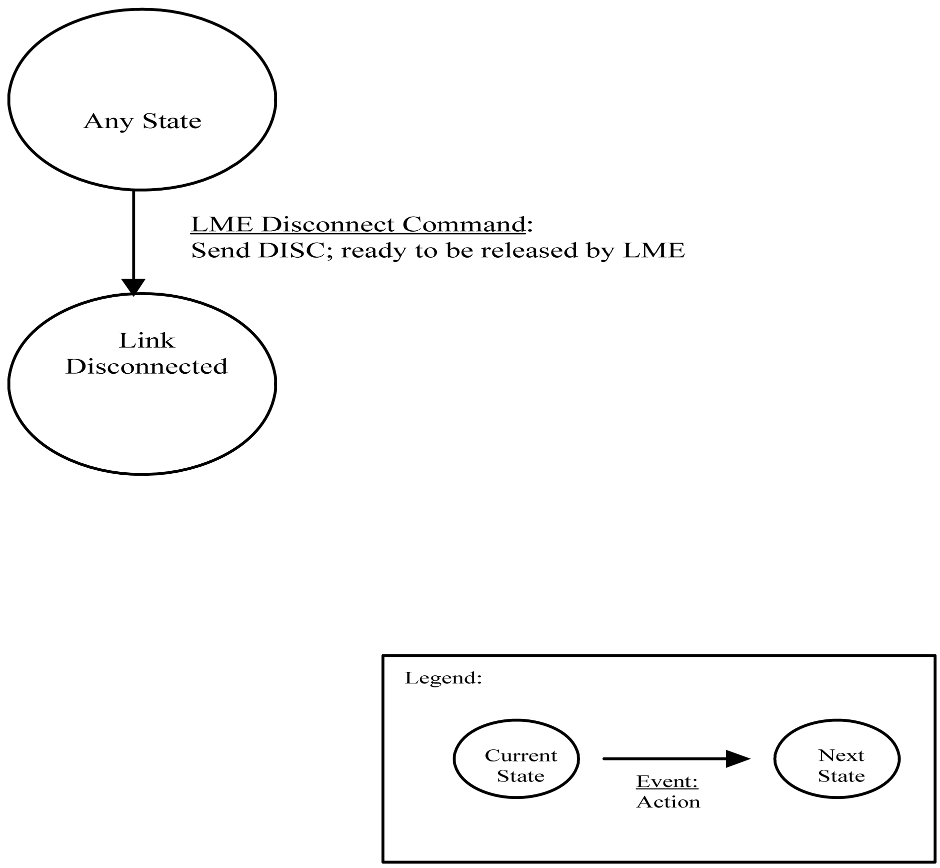


Figure E-7 – DLE Termination

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. The assignments contained in this Appendix are made by IATA on behalf of ICAO. This Appendix is provided for the reader's convenience. In the event of discrepancies between this Appendix and IATA documentation the IATA documentation will prevail. 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:

- 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)
- 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;
- The addresses composed of 24 ZEROs and 24 ONEs are reserved. They will not be assigned to ground station VHF radios

VDLM2 Ground Station DSP Address Assignments	
Organization	**Prefix**
RESERVED	0000 ---- ---- ---- ---- ----
ARINC	0001 ---- ---- ---- ---- ----
SITA	0010 ---- ---- ---- ---- ----
Unassigned	0011 ---- ---- ---- ---- ----
	0100 ---- ---- ---- ---- ----
	0101 ---- ---- ---- ---- ----
	0110 ---- ---- ---- ---- ----
	0111 ---- ---- ---- ---- ----
	1000 ---- ---- ---- ---- ----
	1001 ---- ---- ---- ---- ----
	1010 ---- ---- ---- ---- ----
	1011 ---- ---- ---- ---- ----
	1100 ---- ---- ---- ---- ----
	1101 ---- ---- ---- ---- ----
	1110 ---- ---- ---- ---- ----
AVICOM JAPAN	1111 0000 00-- ---- ---- ----
BRAZIL	1111 0000 01-- ---- ---- ----
Unassigned	1111 0000 10-- ---- ---- ----
CHINA	1111 0000 11-- ---- ---- ----
HONEYWELL	1111 0001 00-- ---- ---- ----
Unassigned	1111 0001 01-- ---- ---- ----
Unassigned	1111 0001 10-- ---- ---- ----
AEROTHAI	1111 0001 11-- ---- ---- ----
TEST DSP	1111 0010 00-- ---- ---- ----

APPENDIX F
ALLOCATION OF GROUND STATION ADDRESSES

VDLM2 Ground Station DSP Address Assignments	
Organization	**Prefix**
	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-- ---- ---- ----
	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-- ---- ---- ----

APPENDIX F
ALLOCATION OF GROUND STATION ADDRESSES

VDLM2 Ground Station DSP Address Assignments	
Organization	**Prefix**
	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-- ---- ---- ----

Note: The Left hand column of the 24-bit pattern represents the most significant bit.

APPENDIX G
FIS-B AND AOA EXTENDED PROTOCOL IDENTIFIER FOR VDL MODE 2 LINK LAYER

G-1.0 Introduction

RTCA SC-195 has developed Minimum Aviation System Performance Standards (MASPS) for Flight Information Services-Broadcast (FIS-B), an automated, digital data link system. The system will provide non-control, advisory information needed by pilots to operate more safely and efficiently in the National Airspace System and in international airspace.

FIS provides to pilots the necessary weather graphics and text, Special Use Airspace (SUA) information, Notices to Airmen (NOTAMs), and other information.

The FIS broadcast data link provides for a connectionless unacknowledged protocol services. This broadcast data link service supports efficiency in spectrum use since there is no need to separately transmit the same information to multiple receivers.

AOA is a connection oriented service that is being used to facilitate the migration of legacy datalink services to the VDL standards. The ACARS messages will be encapsulated within the connection oriented datalink layer protocol (AVLC) of the VDL Mode 2 service in order to deliver over the messages with higher efficiency.

G-2.0 Purpose

Since FIS-B will use the VDL Mode 2 subnetwork (as one of its media), there's a need to uniquely identify this service aside from other services over the same medium such as ATN, AOA and future applications.

The FIS-B MASPS specify a field from within a VDL Mode 2 UI frame to uniquely identify an FIS-B message in accordance with the recommendations of ISO/IEC TR 9577. This field facilitates subnetwork access protocol identification in the event of multiple concurrent subnetwork use. The FIS-B identifier should be recognized adopted by RTCA DO-224A and the ICAO VDL Technical Manual appropriately, to assure that another subnetwork does not adopt the same identifier value.

ISO 9577 Initial Protocol Identifier (IPI) byte encoding of all-ones (0xFF) is reserved by ISO/IEC TR 9577 to allow for the specification of additional subnetwork protocols beyond those explicitly defined in the ISO document. When this form of IPI encoding is employed, a second octet (the Extended Initial Protocol Identifier (EIPI)) is used to specify the actual subnetwork protocol in use. The "ACARS Over AVLC" (AOA) subnetwork protocol (used to provide backwards compatibility for ACARS applications to operate over VDL) currently specifies the EIPI encoding of 0xFF. FIS-B has selected the EIPI encoding of 0xFE (11111110) to avoid conflict with AOA and require a minimum of regulatory co-ordination.

G-3.0 Usage

The VDL Mode 2 subnetwork is capable of supporting ATN, AOA and FIS-B services over the same media. The data link (frame layer) of the VDL Mode 2 system can carry any packet type for its desired service, with a signature component in the appropriate protocol layer to differentiate between the types of application services. Figure 1 illustrates the services using the VDL Mode 2 stack.

VDL 8208 (ATN)	AOA (ACARS Net)	FIS-B (FIS App.)
Data Link Layer (AVLC)		
Physical Layer (D8PSK)		

Figure G-1 – VDL Mode 2 Subnetwork Components

The separation of services occurs at the Subnetwork layer utilizing the mechanism provided by ISO 9577 to differentiate between the services from which specific type codes have been previously allocated from a common standard, such as the ICAO VDL Technical Manual.

The FIS-B and AOA service identifications are shown in Figure 2.

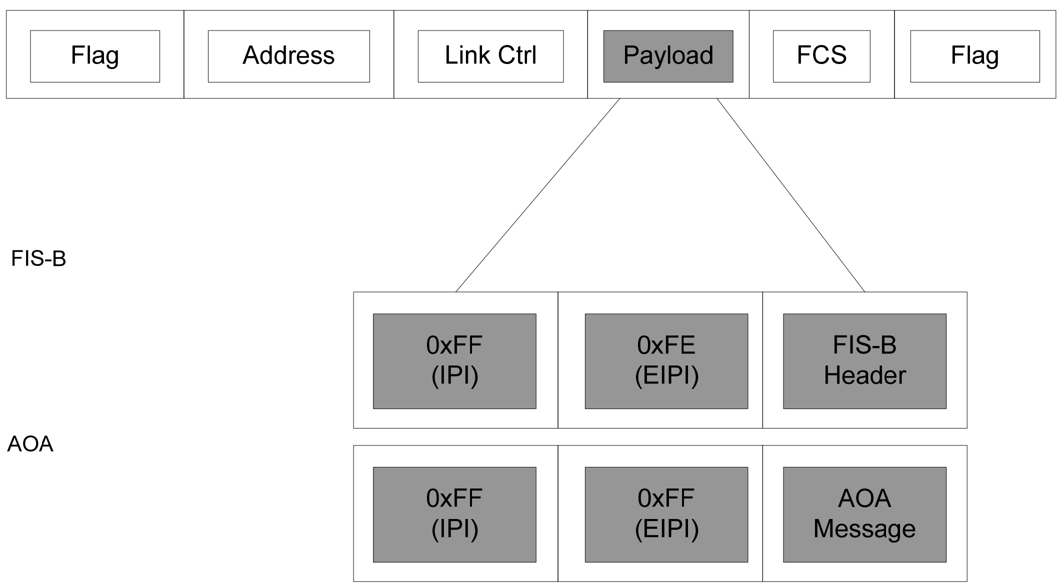


Figure G-2 – FIS-B and AOA Service Identification

The Initial Protocol Identifier (IPI) set to 0xFF indicates that the IPI is extended by one octet. The second octet (EIPI) indicates the payload, or user data, is an FIS-B type message.

G-4.0 Summary

It is recommended that

- RTCA SC-172 consider the adoption of the FIS-B EPI code identified, as 0xFE (FIS-B service) and 0xFF (AOA service) based on the requirements of ISO 9577, for RTCA DO-224A and for the ICAO VDL Technical Manual for VDL Mode 2 implementations.
- RTCA forwards a request to the ISO organization advising them of the two types of messages (FIS-B, and AOA) that will use the IPI and EIPI.

Table G-1 – AOA Message Format

DESCRIPTION		Octet No.	BIT NUMBER 8	7	6	5	4	3	2	1
FLAG		0	0	1	1	1	1	1	1	0
ISO 3309:1996(E) [3]	Destination Address Field	1	d_{22}	d_{23}	d_{24}	d_{25}	d_{26}	d_{27}	A/G	0
		2	d_{15}	d_{16}	d_{17}	d_{18}	d_{19}	d_{20}	d_{21}	0
		3	d_8	d_9	d_{10}	d_{11}	d_{12}	d_{13}	d_{14}	0
		4	d_1	d_2	d_3	d_4	d_5	d_6	d_7	0
	Source Address Field	5	s_{22}	s_{23}	s_{24}	s_{25}	s_{26}	s_{27}	C/R	0
		6	s_{15}	s_{16}	s_{17}	s_{18}	s_{19}	s_{20}	s_{21}	0
		7	s_8	s_9	s_{10}	s_{11}	s_{12}	s_{13}	s_{14}	0
		8	s_1	s_2	s_3	s_4	s_5	s_6	s_7	1
Link Control Field		9				P/F				
Information Field	Initial Protocol Identifier (IPI)	10	1	1	1	1	1	1	1	1
	Extended IPI	11	1	1	1	1	1	1	1	1
	User Data	12..N-2	ARINC 618/620 Message							
Frame Check Sequence Field		N-1	fcs_9	fcs_{10}	MOST SIGNIFICANT OCTET				fcs_{15}	fcs_{16}
		N	fcs_1	fcs_2	LEAST SIGNIFICANT OCTET				fcs_7	fcs_8
Flag		N+1	0	1	1	1	1	1	1	0
Reference VDL SARPs, Figure 6-2										

Initial Protocol Identifier (IPI) set to "1111 1111" indicates that the IPI is extended by one octet.
The second octet, Extended EIPI (EIPI) set to "1111 1111" indicates the payload, or user data, is an ACARS 618/620 block.

Note: The values for the IPI and EIPI are the same for both uplink and downlink frames.

APPENDIX G
FIS-B AND AOA EXTENDED PROTOCOL IDENTIFIER FOR VDL MODE 2 LINK LAYER

Table G-2 – FIS-B Message Format

DESCRIPTION		Octet No.	BIT NUMBER 8	7	6	5	4	3	2	1
FLAG		0	0	1	1	1	1	1	1	0
ISO 3309:1996(E) [3]	Destination Address Field	1	d_{22}	d_{23}	d_{24}	d_{25}	d_{26}	d_{27}	A/G	0
		2	d_{15}	d_{16}	d_{17}	d_{18}	d_{19}	d_{20}	d_{21}	0
		3	d_8	d_9	d_{10}	d_{11}	d_{12}	d_{13}	d_{14}	0
		4	d_1	d_2	d_3	d_4	d_5	d_6	d_7	0
	Source Address Field	5	s_{22}	s_{23}	s_{24}	s_{25}	s_{26}	s_{27}	C/R	0
		6	s_{15}	s_{16}	s_{17}	s_{18}	s_{19}	s_{20}	s_{21}	0
		7	s_8	s_9	s_{10}	s_{11}	s_{12}	s_{13}	s_{14}	0
		8	s_1	s_2	s_3	s_4	s_5	s_6	s_7	1
Link Control Field		9				P/F				
Information Field	Initial Protocol Identifier (IPI)	10	1	1	1	1	1	1	1	1
	Extended IPI	11	1	1	1	1	1	1	1	0
	User Data	12..N-2	FIS-B							
Frame Check Sequence Field		N-1	fcs_9	fcs_{10}	MOST SIGNIFICANT OCTET				fcs_{15}	fcs_{16}
		N	fcs_1	fcs_2	LEAST SIGNIFICANT OCTET				fcs_7	fcs_8
Flag		N+1	0	1	1	1	1	1	1	0
Reference VDL SARPs, Figure 6-2										

Initial Protocol Identifier (IPI) set to “1111 1111” indicates that the IPI is extended by one octet.

The second octet, Extended EIPI (EIPI) set to “1111 1110” indicates the payload, or user data, is an FIS-B block.

Note:

The following is a summary of how the ISO 9577 uses the address extension to address either FIS-B or AOA. ISO 9577 uses two bytes to address the type of service it is supporting. The (1111 1111 1111 1111) is the address extension. The VDL system will take advantage of the extension to reserve addresses in the extension area in order not to conflict with currently identified services. The currently identified addresses for VDL services that need to be reserved are:

ISO 9577 address	ISO 9577 Address extension	Service Name
11111111 11111111	11111111 11111110	FIS-B
11111111 11111111	11111111 11111111	AOA

Other services are being identified and an address will be allocated to them upon approval.

APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5

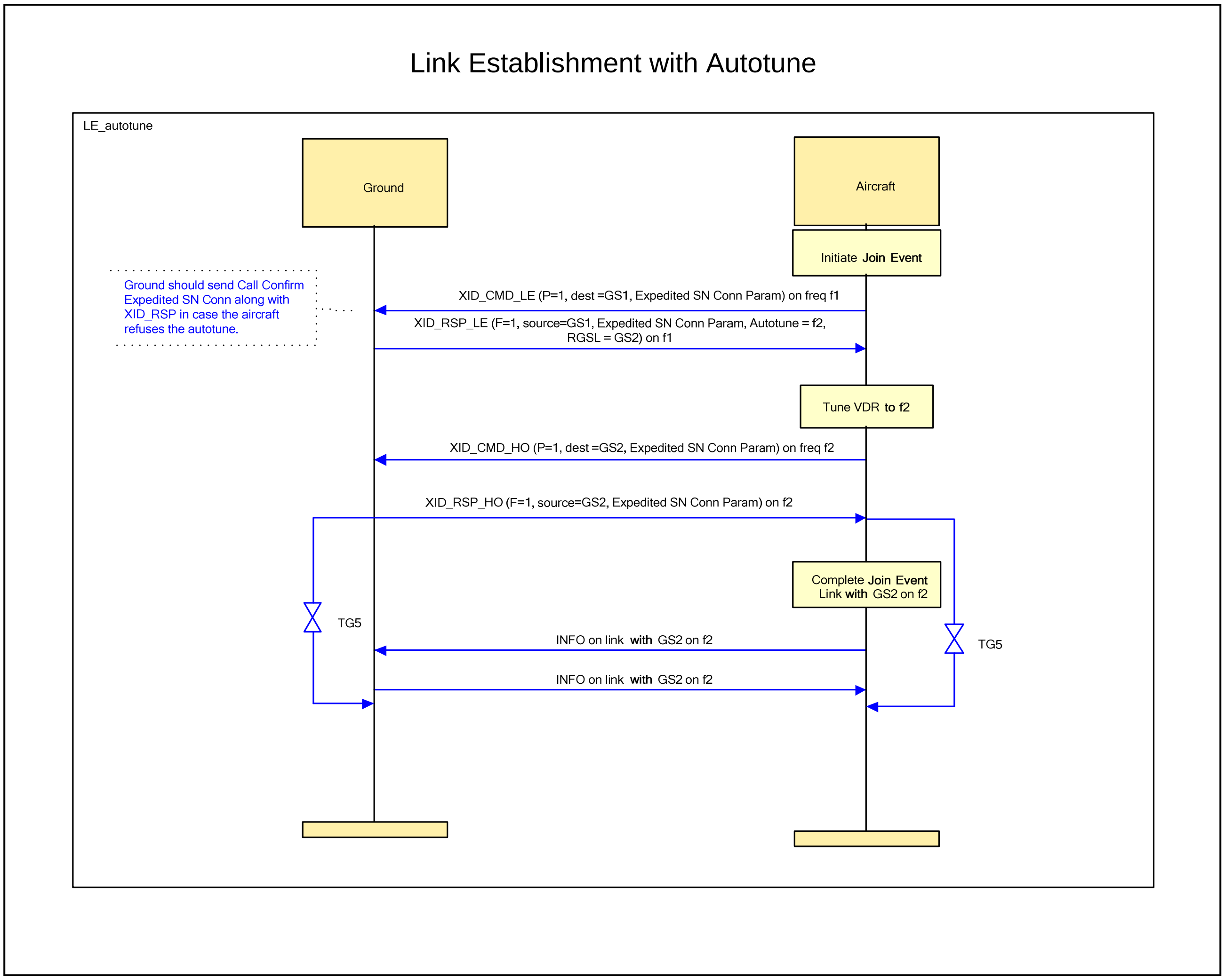
This appendix describes an interpretation and Message Sequence Charts of the VDL2 Technical Manual for Autotune Scenarios.

Message Sequence Charts
Autotune Scenarios
Using Expedited Subnetwork Connection

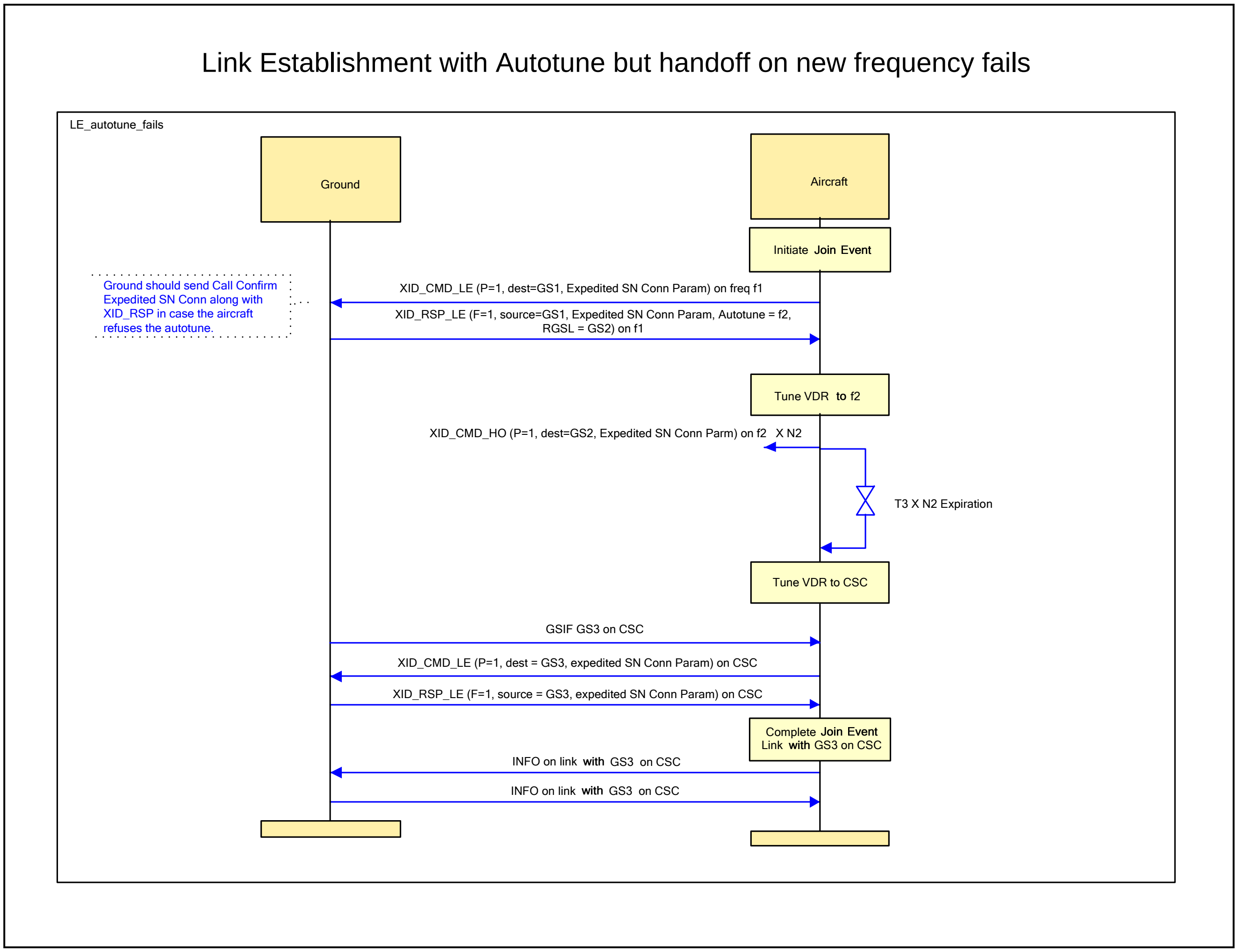
Assumptions

- Single VDR available on aircraft

APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5

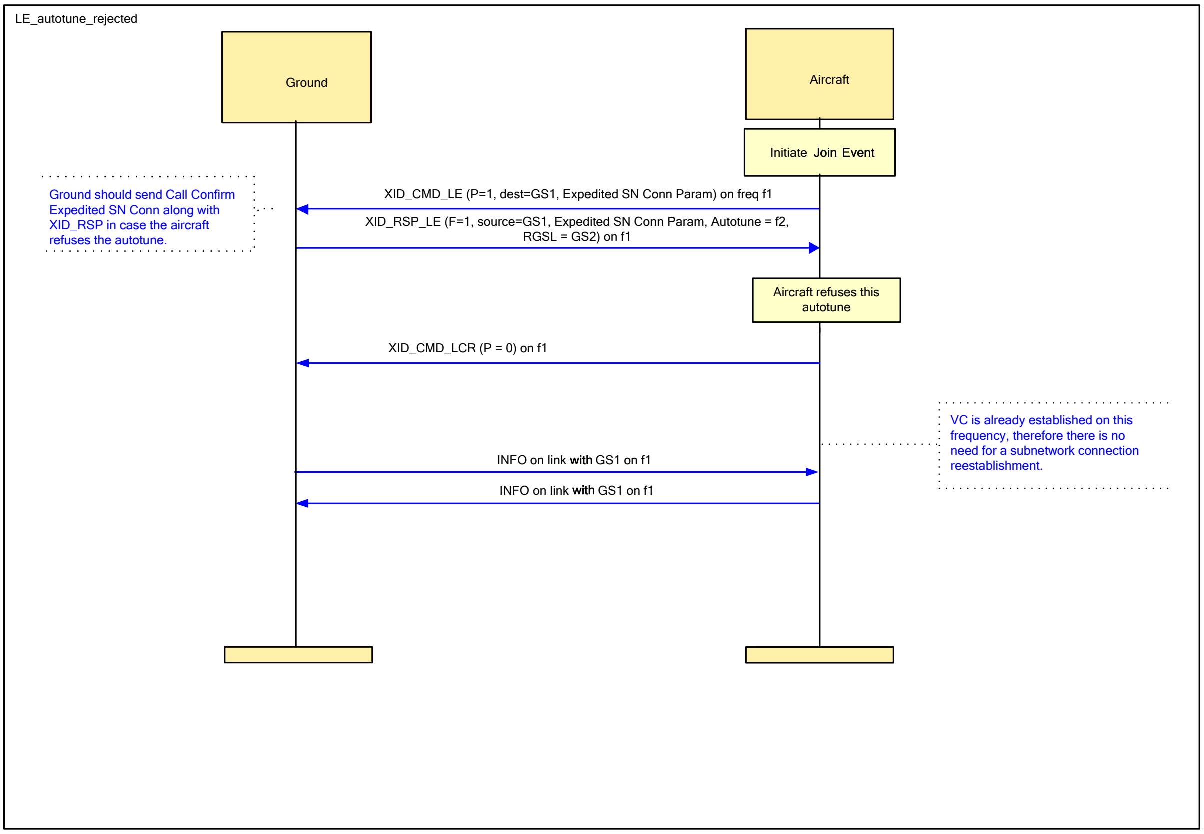


APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5

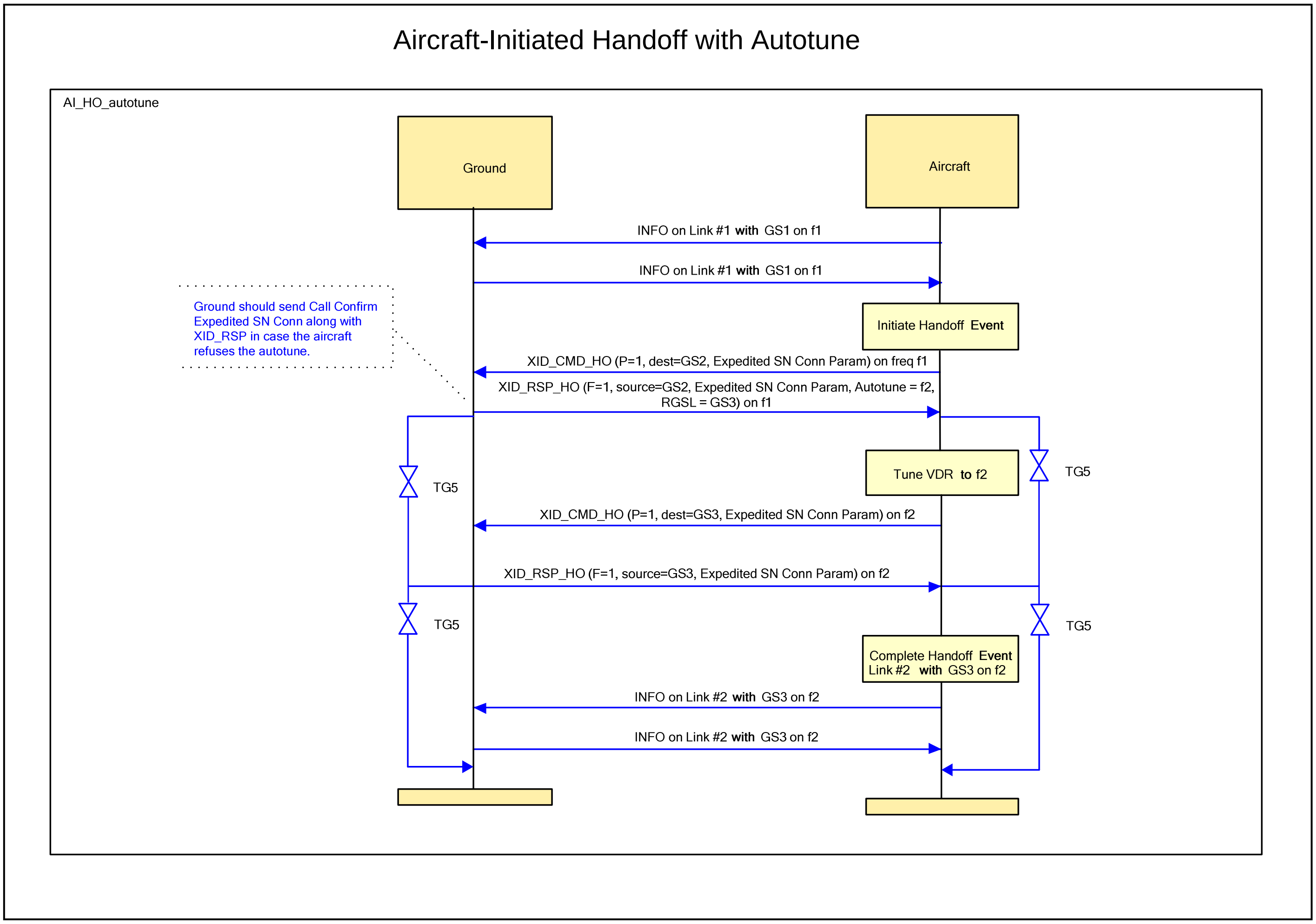


APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5

Link Established with Autotune refused by the Aircraft

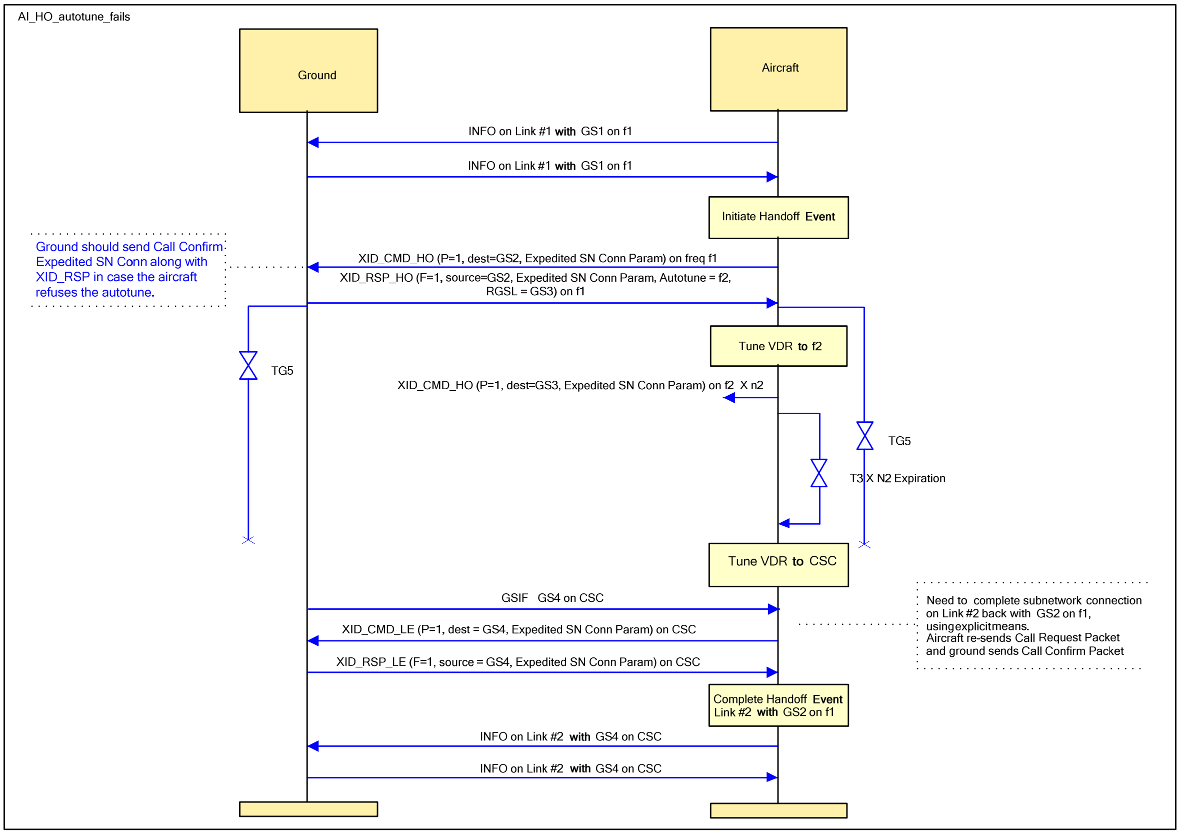


APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5



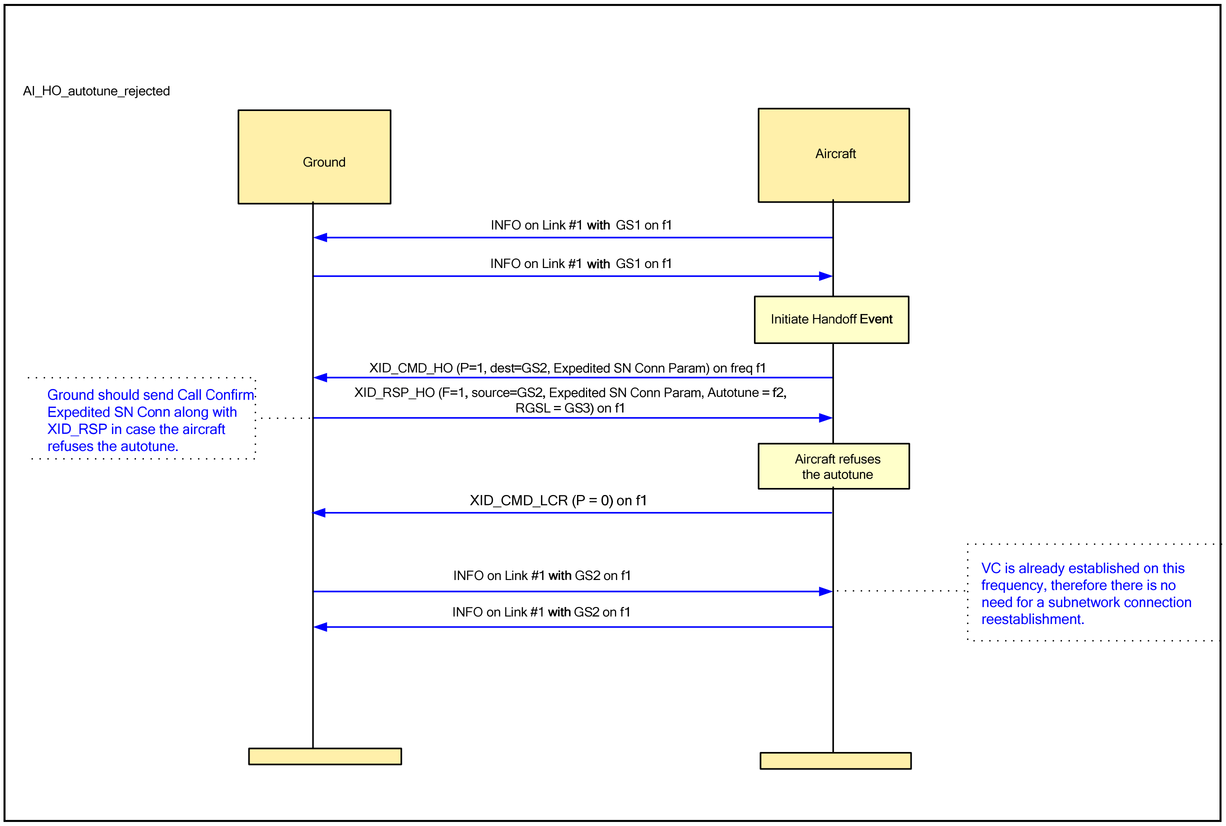
APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5

Aircraft-Initiated Handoff with Autotune but handoff on new frequency fails

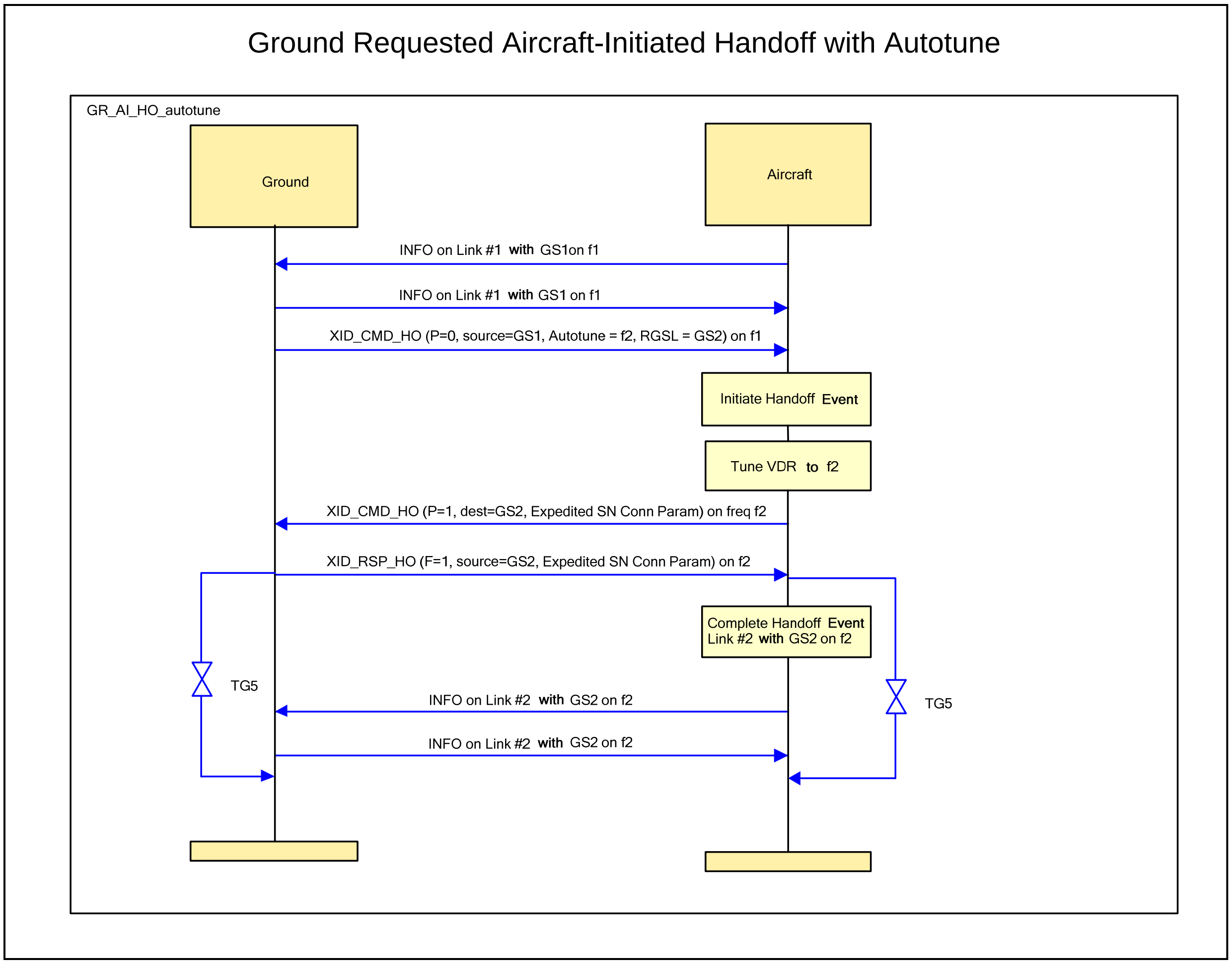


APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5

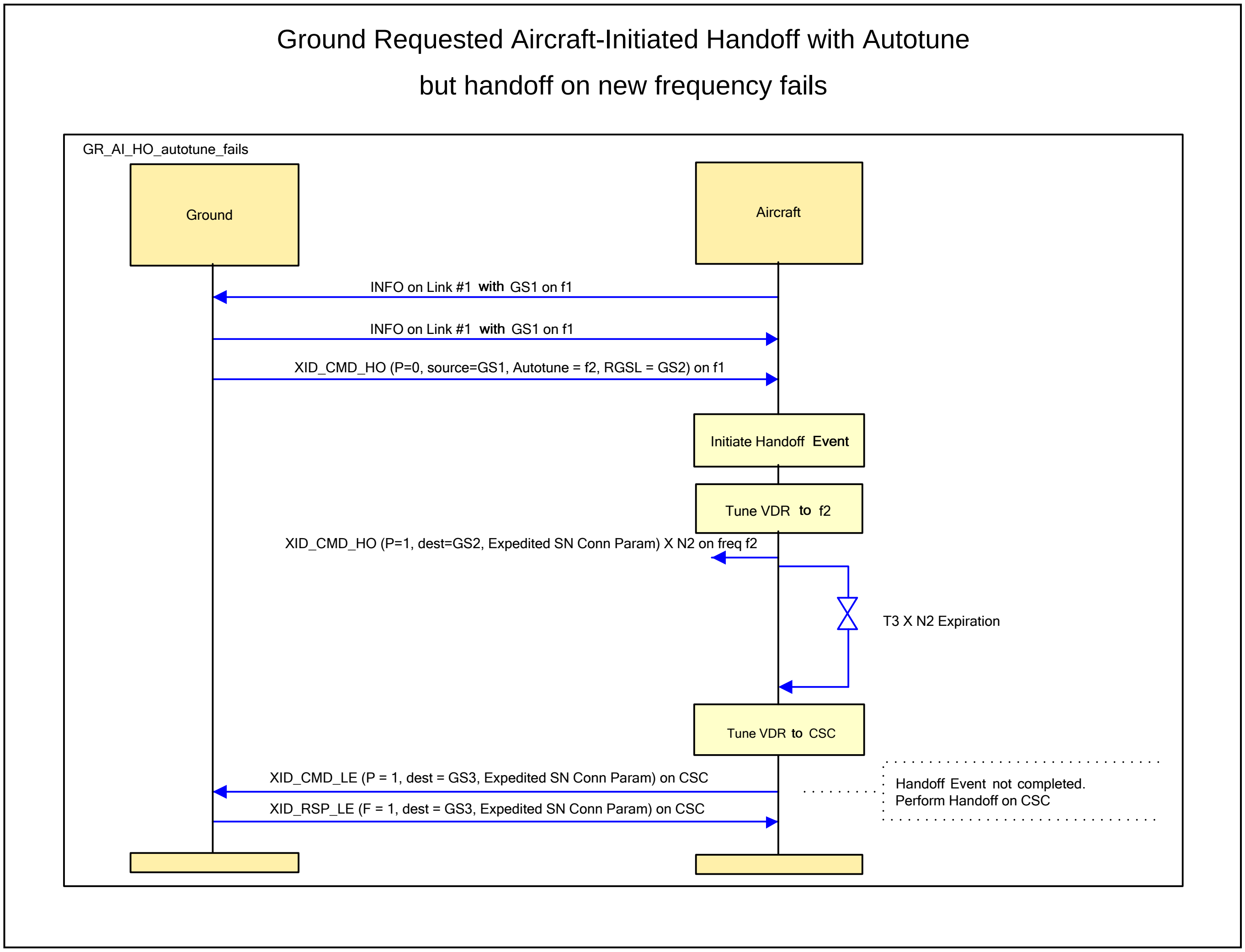
Aircraft-Initiated Handoff with Autotune rejected by the Aircraft



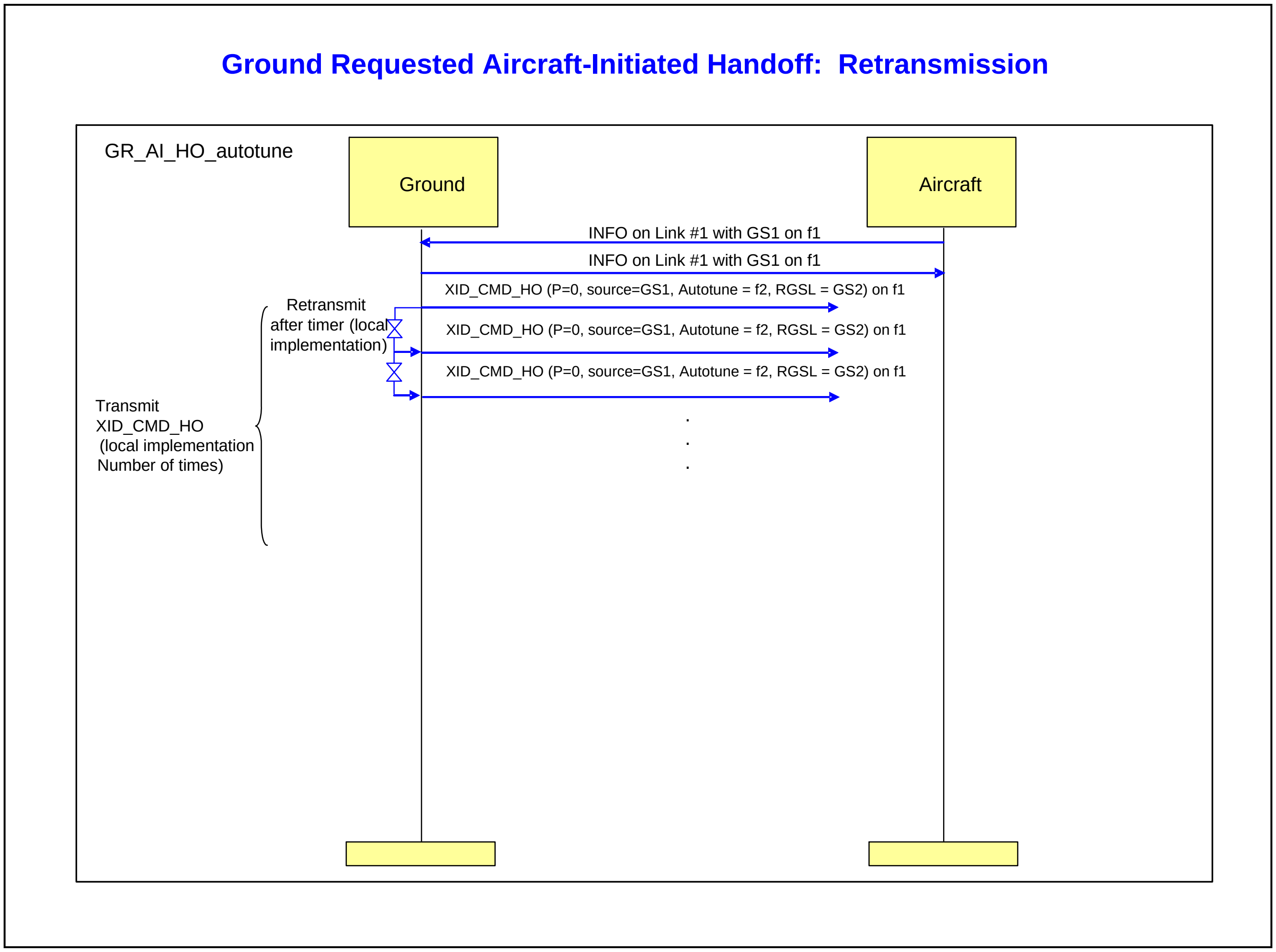
APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5



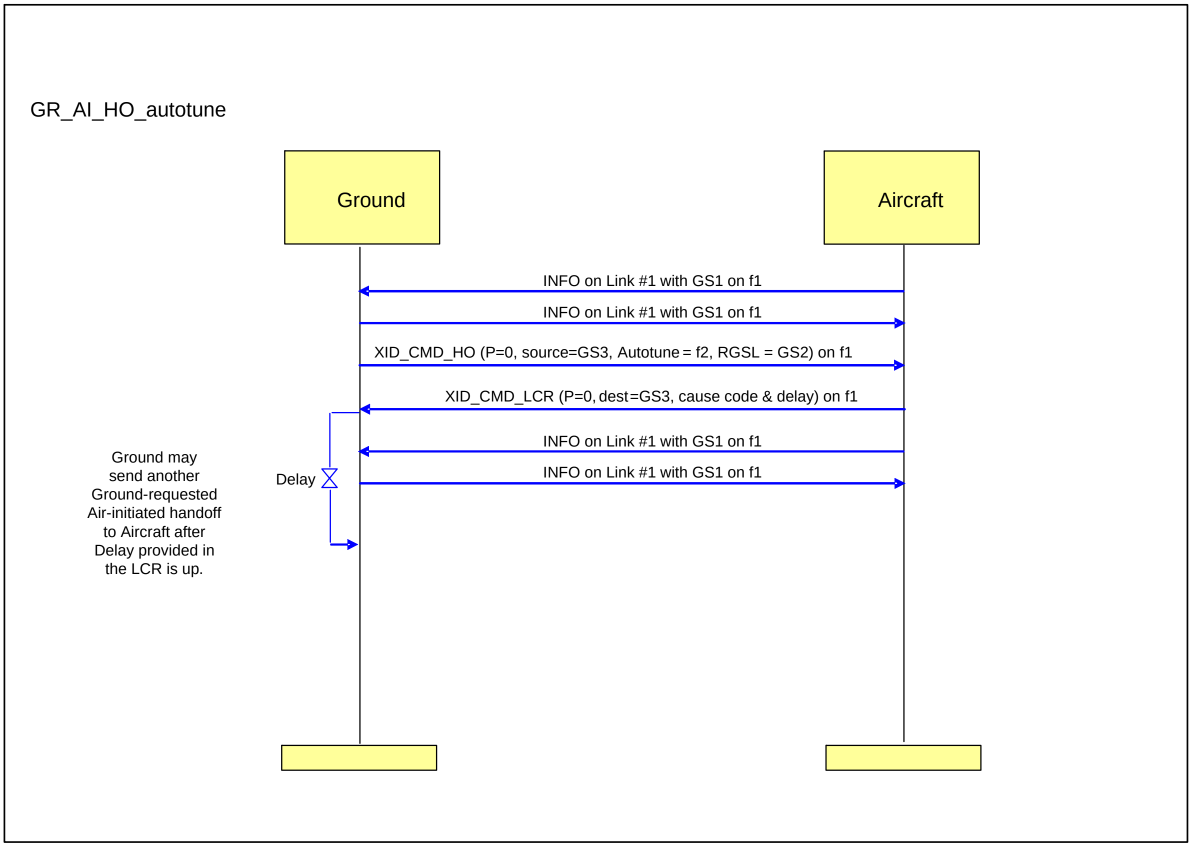
APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5



APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5



Ground Requested Aircraft-Initiated Handoff: Rejection

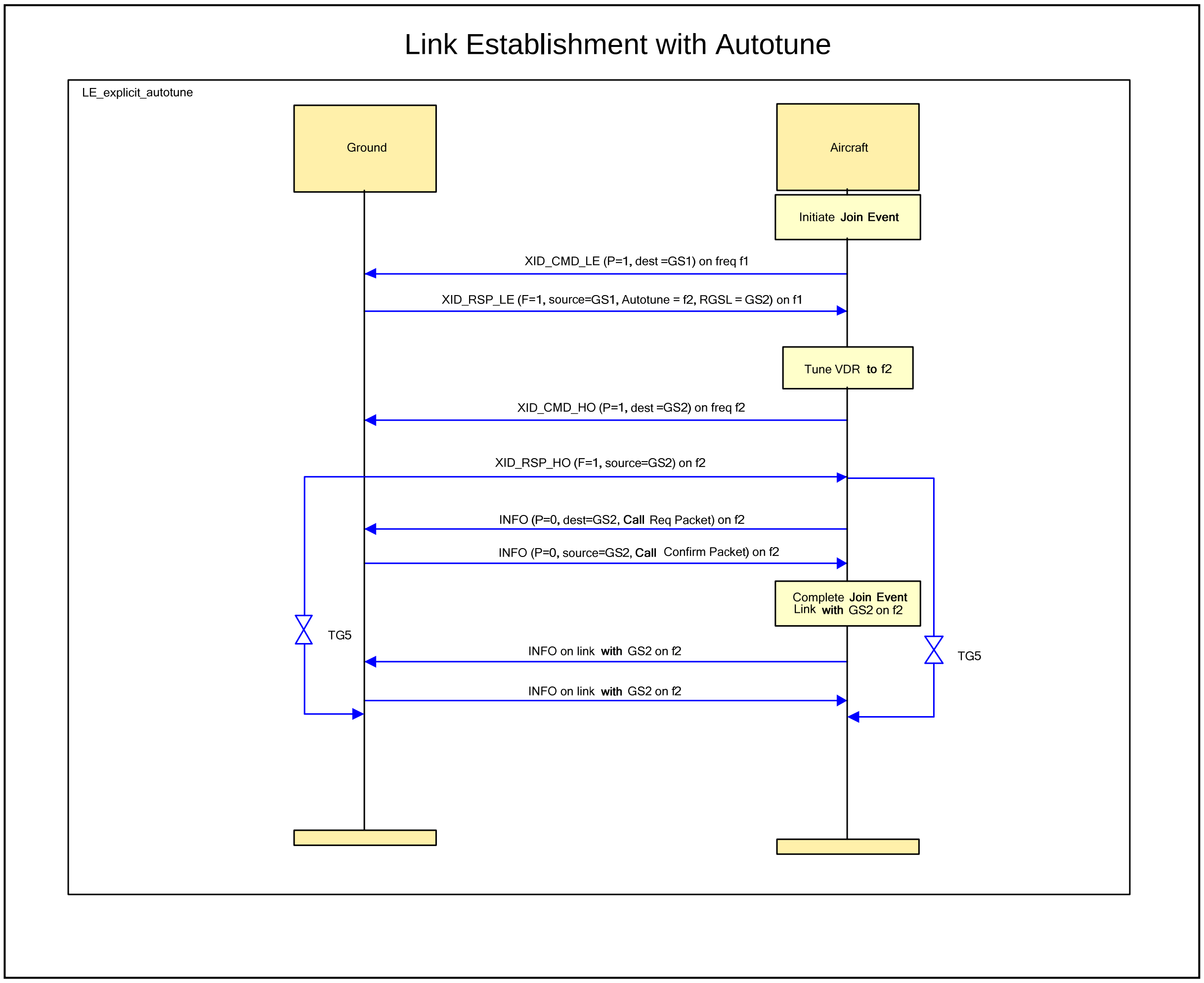


Message Sequence Charts
Autotune Scenarios
Using Explicit Subnetwork Connection

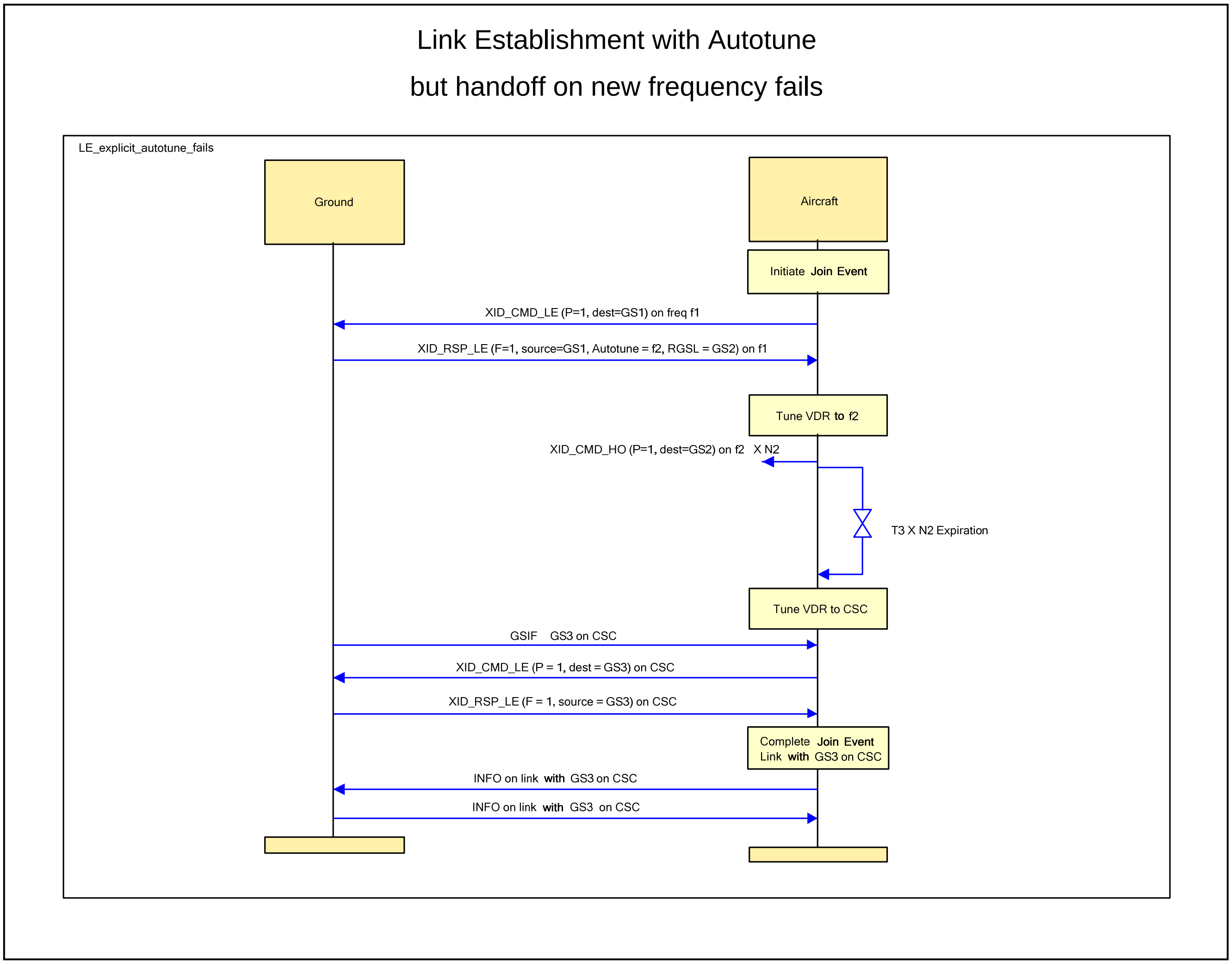
Assumptions

- Single VDR available on aircraft

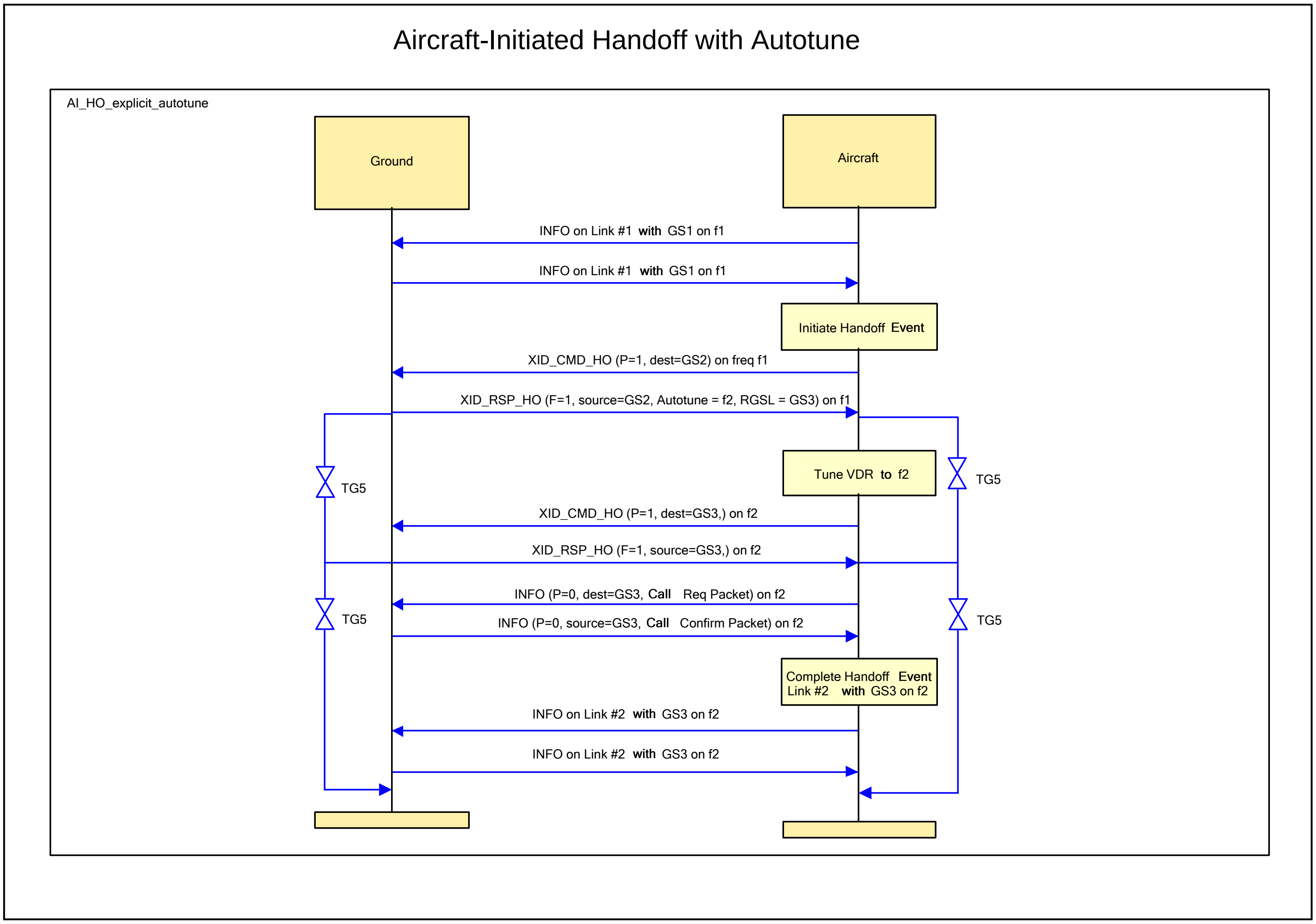
APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5



APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5



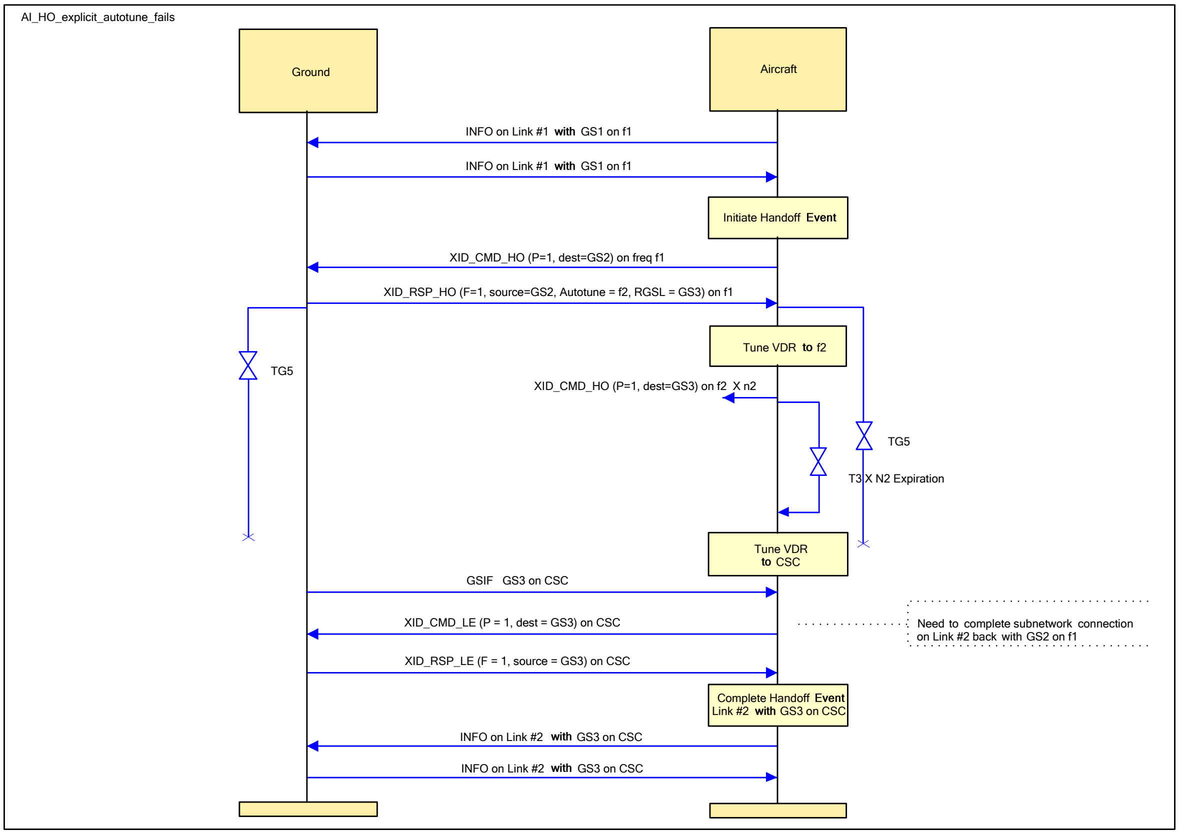
APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5



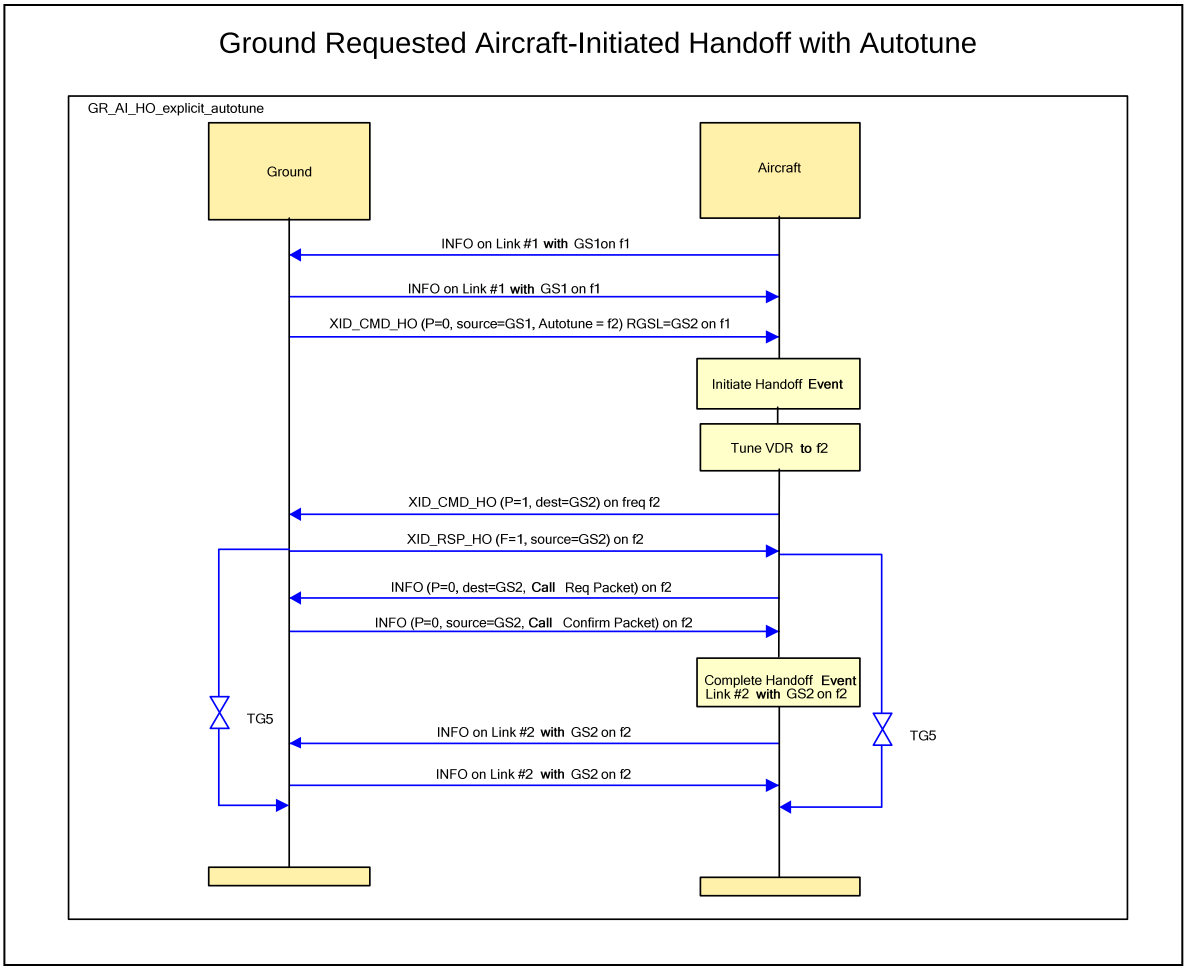
APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5

Aircraft-Initiated Handoff with Autotune

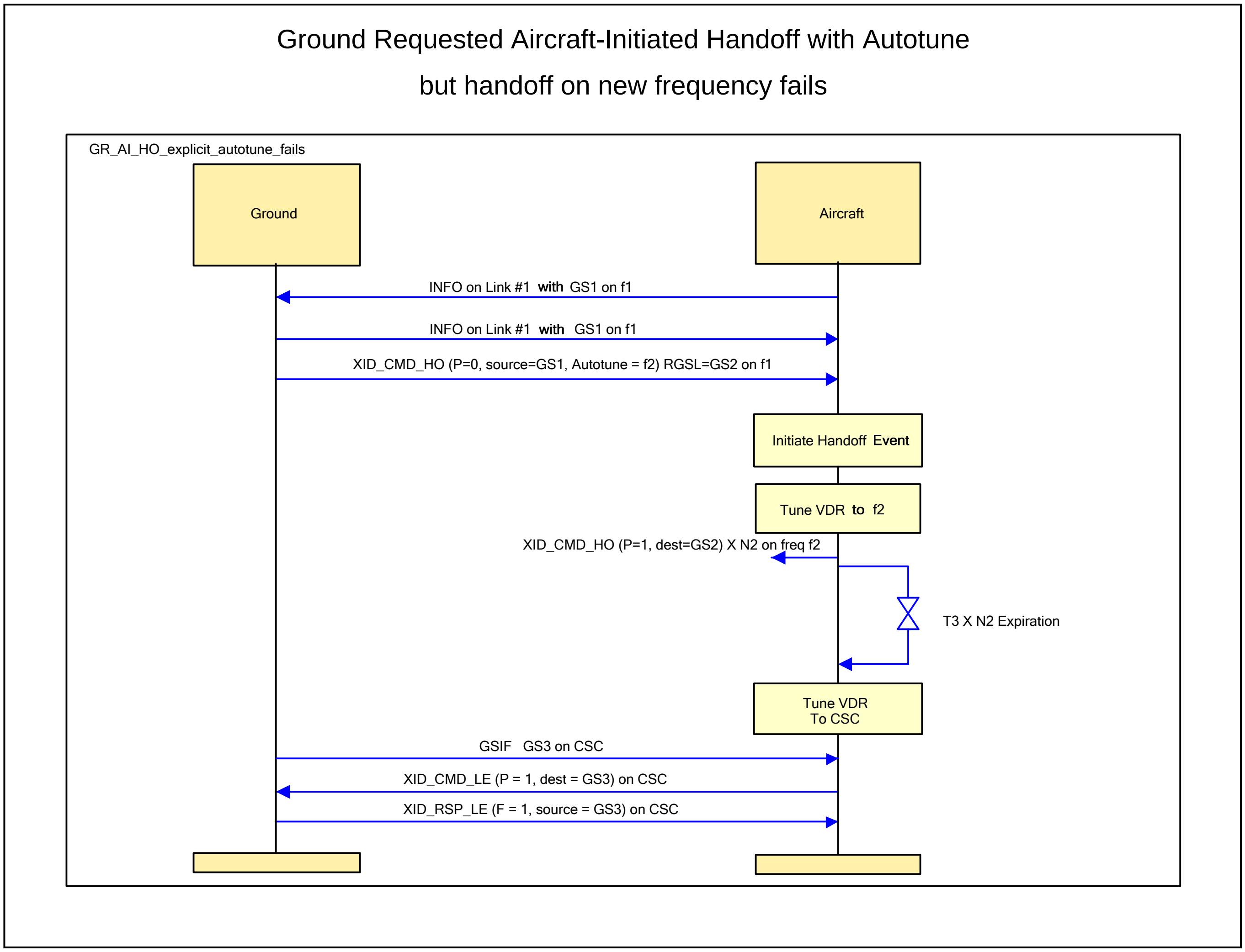
but handoff on new frequency fails



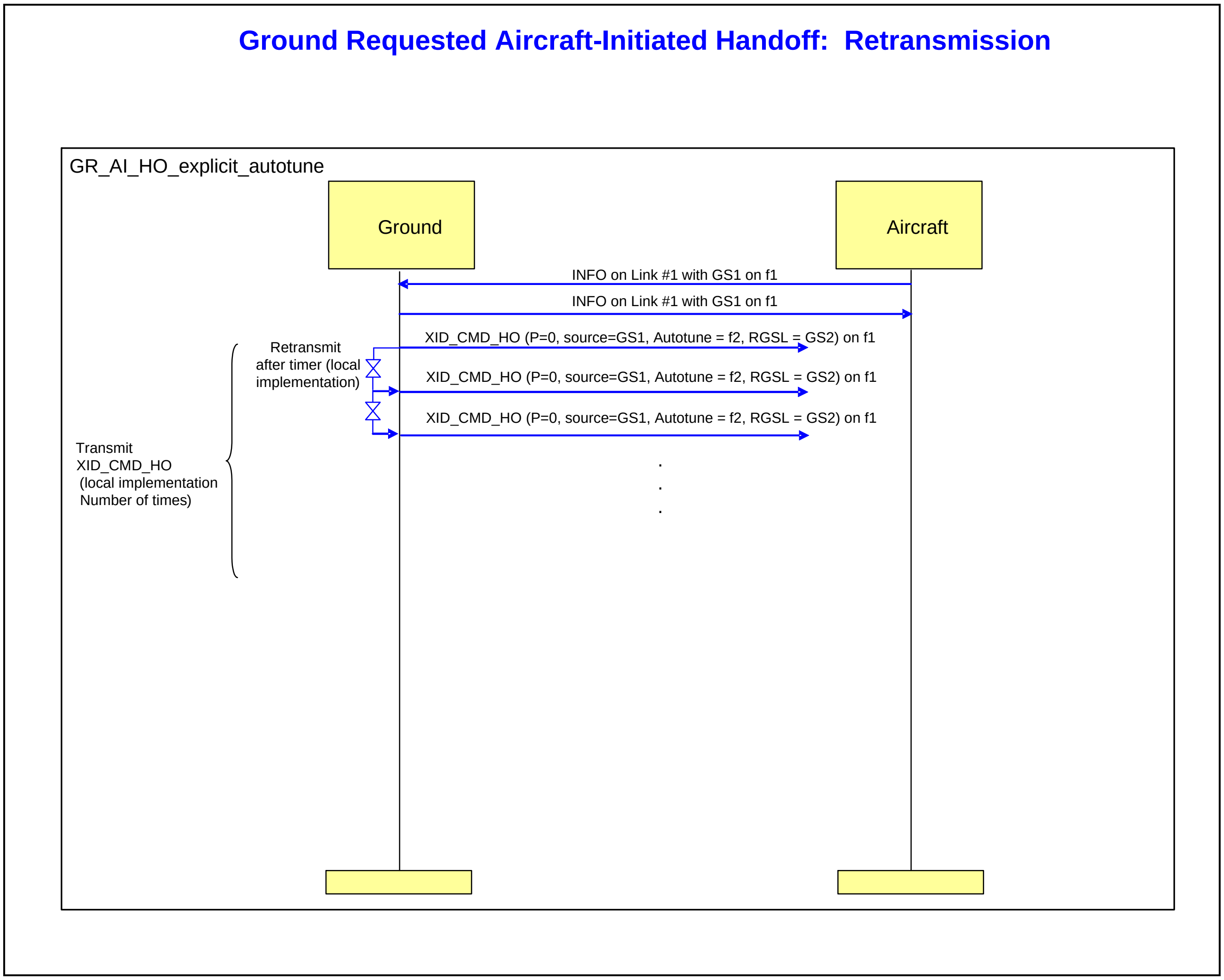
APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5



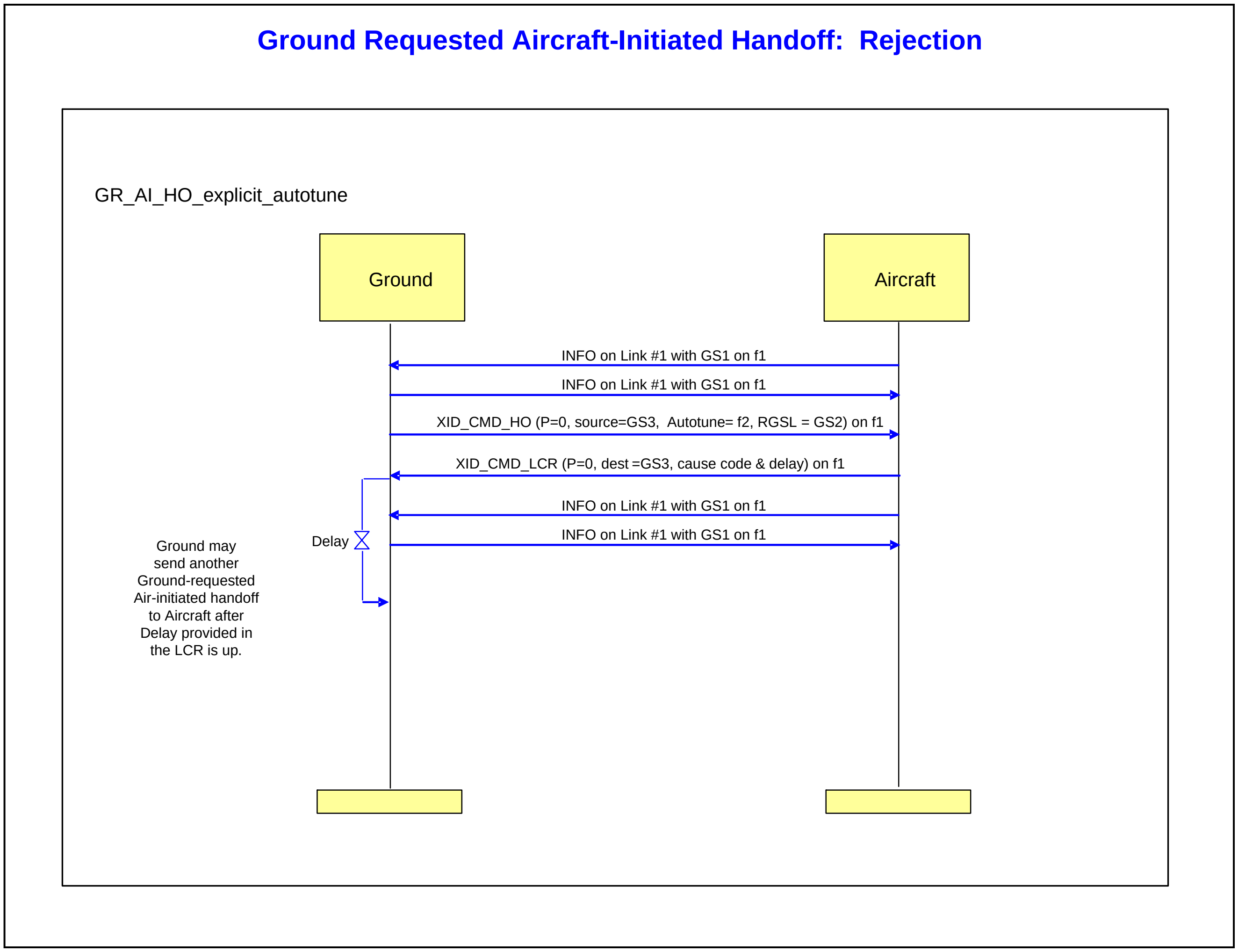
APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5



APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5



APPENDIX H
MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5



APPENDIX I
GENERIC DATA LINK INTERFACE

This Appendix is transferred from ARINC 637, Appendix C. ARINC 637 is classified as a Historical document.

I-1 Overview

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

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

I-2 Subnetwork Interface Architecture

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

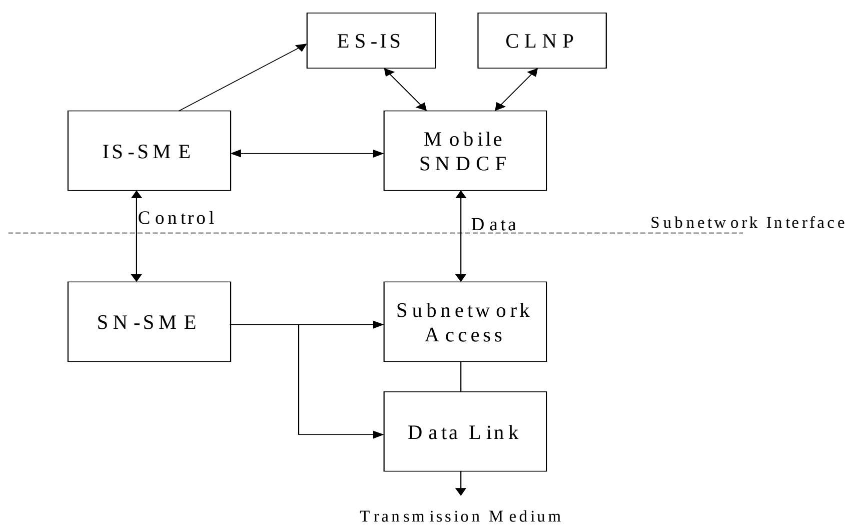


Figure I-1 – Subnetwork Interface Architecture

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

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

APPENDIX I
GENERIC DATA LINK INTERFACE

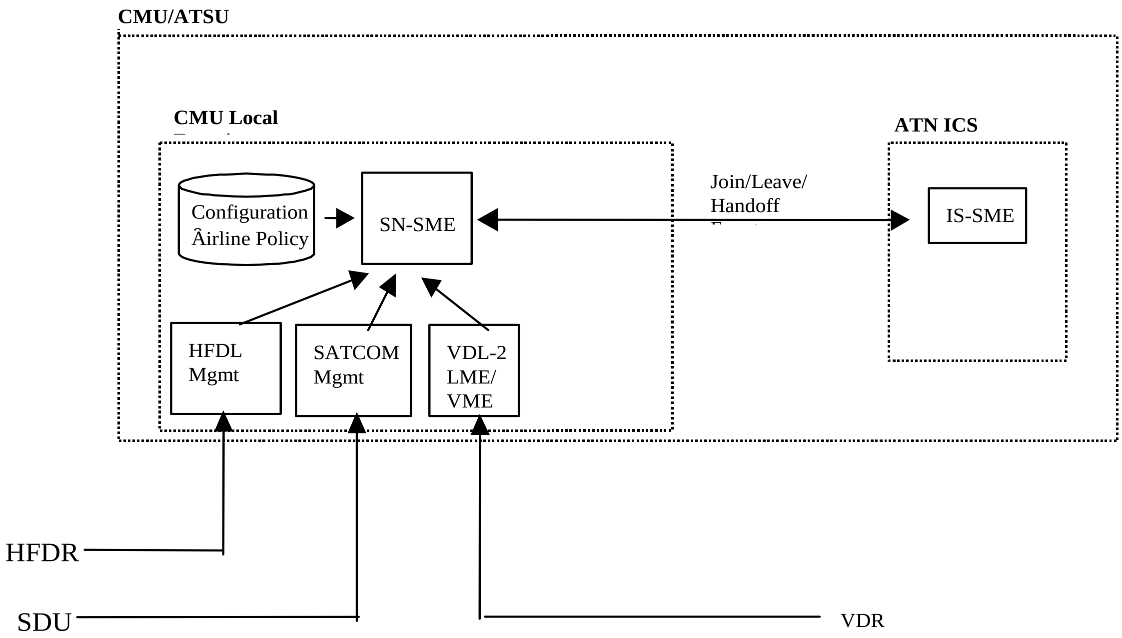


Figure I-2 – Airborne SN-SME Model

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

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

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

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

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

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

The Subnetwork Management Entity (SN-SME) comprises all subnetwork dependent management functions and is the source of the Join, Leave and Handoff events. Each airborne intermediate system has one SN-SME to manage all air-ground subnetworks and to interface to the IS-SME on behalf of these subnetworks. A generic model of the airborne SN-SME is shown in Figure C-2.

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

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

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

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

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

I-3 Control Interface

I-3.1 The Join Event

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

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

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

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

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

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

I-3.2 The Handoff Event

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

- Old data link reference.
- New data link reference.
- List of the subnetwork addresses of ATN routers affected by the Handoff.

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

On receipt of a Handoff Event, the IS-SME checks to see if any such subnetwork connections exist and, it instructs the Mobile SNDCF to establish a new subnetwork connection with each affected Router using the “New Data Link Reference”.

Note that in the case of VDL Mode 2, the Subnetwork Address signaled on the Handoff will be the VDL Specific Address, as this is the address received on the GSIF. However, if X.121 addressing is supported by the subnetwork, then the X.121 address returned on the first subnetwork connection establishment will have to be used as the called address for all subnetwork connections established as a result of a Handoff Event. It is the IS-SME’s responsibility to correlate returned subnetwork addresses (e.g. VDL X.121 addresses) with the Subnetwork Addresses signaled on Join and Handoff events (e.g. VDL Specific Addresses).

I-3.3 The Leave Event

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

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

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

I-4 The Data Interface

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

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

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

APPENDIX J
AIRBORNE ATN SYSTEM ARCHITECTURE

This Appendix is transferred from ARINC 637, Section 2.4.1 through 2.4.3, inclusive. ARINC 637 is classified as a Historical document.

J-1 Make-Before-Break Consideration

J-1.1 General Introduction

In order to maintain uninterrupted air-ground transports in the ATN, the IDRP air-ground connections must be stable. Without an IDRP connection, the aircraft does not know how to forward a downlink message to the ground network, and the ground network does not know how to forward an uplink message to the aircraft (assuming that the “non-use of IDRP option” is not implemented). This condition is a NOCOMM at the router’s level.

The aircraft and ground network should try to maintain the aircraft’s IDRP connection to the same air-ground router (AGR) as long as possible/practical. When an IDRP connection to the existing AGR must be terminated and replaced with a new connection to a different AGR, the new connection should be established before the existing connection is terminated. This concept is called Make-before-Break (MBB).

Since there are situations where MBB cannot always be achieved, it is recommended that airborne and ground-based ATN implementations consider MBB as a best-effort compliance. If MBB can be accomplished, it will minimize disruptions to Air Traffic Service and conserve air-ground subnetwork bandwidth.

The Airline Policy, as implemented in the airborne BIS should be mechanized so as to encourage MBB. That is, an Airline Policy that calls for a single IDRP connection for both AOC and ATC applications, provides the least overhead for maintaining IDRP router connections and thereby reduces the risk for generating a “routing black hole.” Likewise, ground systems should be implemented in keeping with IATA’s policy for Ground Internetworking. That is, “Any aircraft shall be able to exchange ATSC traffic, through any air/ground router (i.e. AOC or ATC AGRs), with any Air Traffic Service Organization (ATSO) offering compatible services.”

Ground systems that support Ground Internetworking allow for simple management of MBB processes.

J-1.2 Make-Before-Break across Different Types of Subnetworks

In scenarios where the same AGR connection will be maintained across subnetwork connection changes, the following should be considered:

When switching from one type of air-ground subnetwork (for example, SATCOM) to the other type (for example, VDL Mode 2), the new subnetwork should be established before the existing subnetwork is terminated. Also, each implementation should endeavor that the router connection is not brought down when the underlying subnetwork is brought down.

J-1.3 Make-Before-Break in VDL Mode 2

When performing a handoff in VDL Mode 2, best effort should be used to ensure that the new virtual circuit is established before Timer TG5 expires (thus bringing down the old virtual circuit). If TG5 expires and the new virtual circuit has not been established, it is possible that the existing IDRP connection may be impacted. The use of the expedited subnetwork connection establishment together with the XID_CMD_HO will ensure that the new virtual circuit is established before TG5 expires.

When operating in VDL Mode 2, if the aircraft needs to establish a new link (i.e., XID_CMD_LE) with a new ground system, knowing that the same AGR can be maintained, it should try to establish the new link before disconnecting the old link. This recommendation assumes that the old ground system and the new ground system (with which the aircraft is establishing a link) can be reached on the same frequency.

In scenarios where the IDRP connection to the existing AGR must be terminated and a new AGR must be connected, the following should be considered:

When the new AGR belongs to a different ground system and can be reached on the same frequency as the existing ground system, MBB can be accomplished by establishing a new link with the new ground system and a new IDRP connection with the new AGR before terminating the old link and the old IDRP connection. That is, in addition to the implementation of Fast Select, the necessary BIS routing information must immediately follow the exchange of the ISH PDUs.

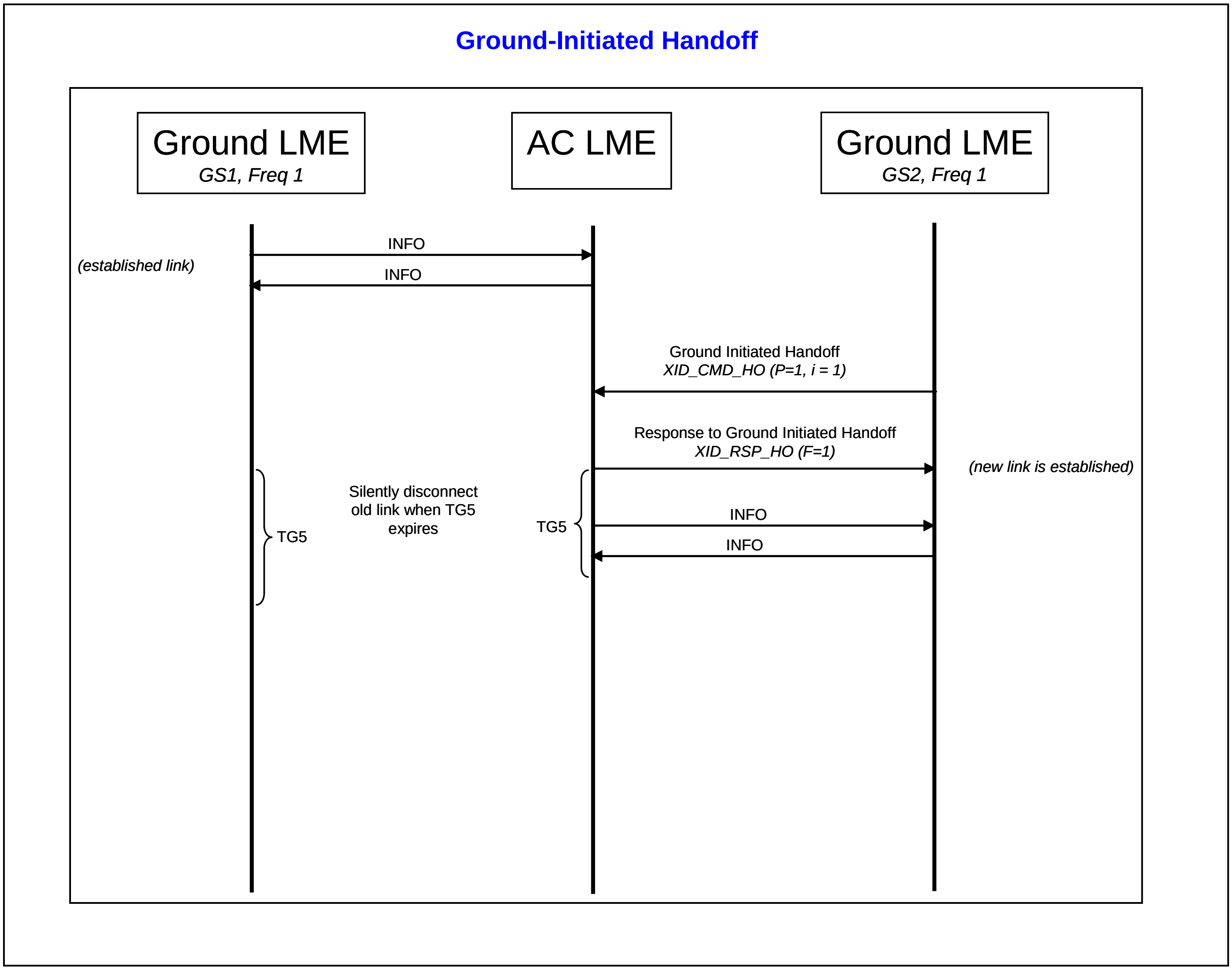
When the new AGR is in the same ground system as the existing AGR, due to the constraint that the aircraft can have only one link with a ground system, the possibility of establishing a new IDRP connection with a new AGR is constrained by timer TG5. If the new IDRP connection can be established (and RIBs/FIBs can be built) before TG5 expires, MBB can be accomplished.

COMMENTARY

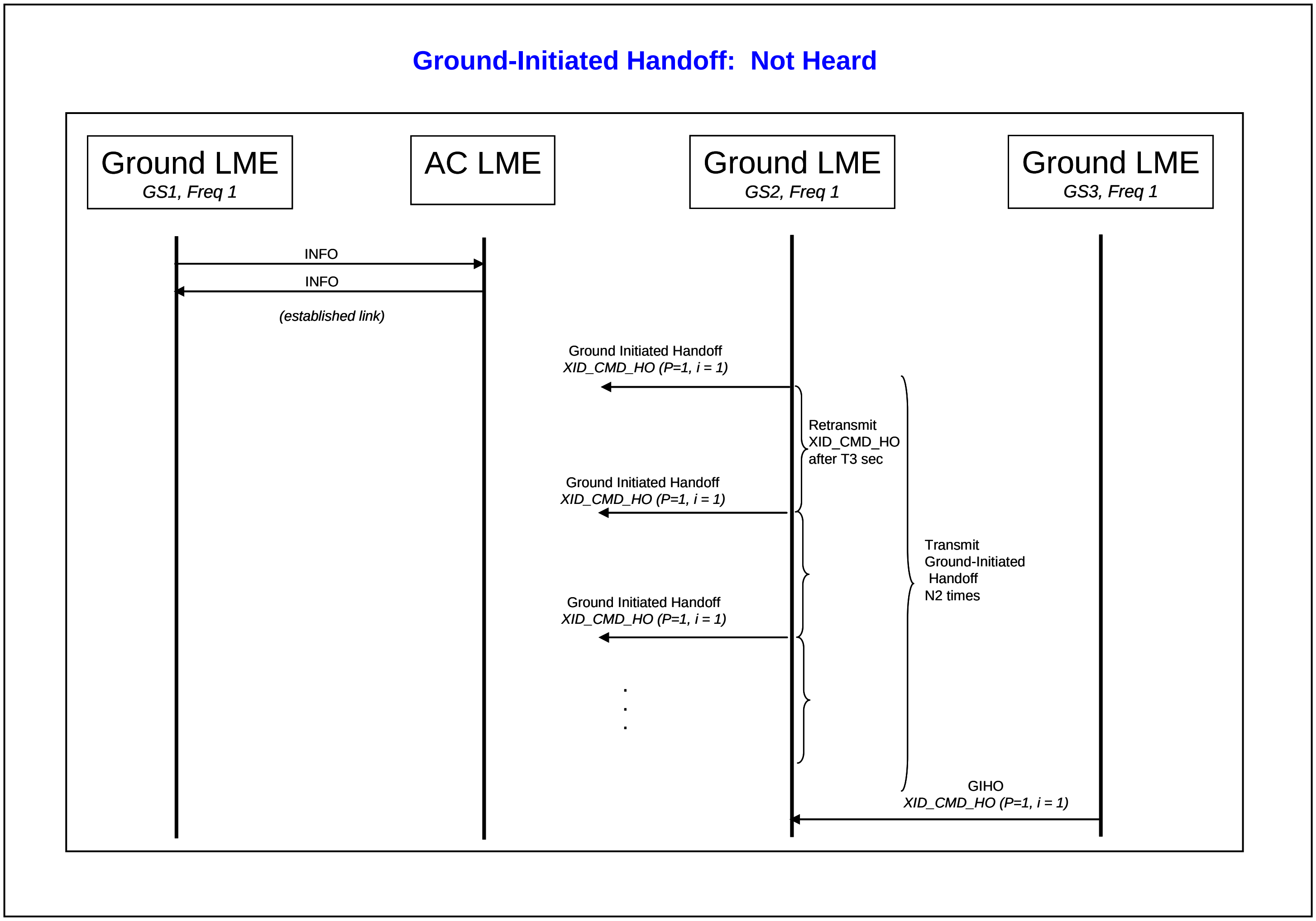
In a single radio scenario, when the aircraft hands off with autotune (i.e., XID_CMD_HO on a different frequency) or when the aircraft establishes a new link (with XID_CMD_LE) on a different frequency, MBB will not be possible. Further, although MBB is not possible in a single radio configuration, it is worth noting that if the “autotune” is to a ground station that is associated with the same AGR, then the IDRP routing information should not have to be resent.

APPENDIX K
MESSAGE SEQUENCE CHARTS FOR GROUND-INITIATED HANDOFF

This appendix describes an interpretation and Message Sequence Charts of the VDL2 Technical Manual for Ground-Initiated Handoff Scenarios.

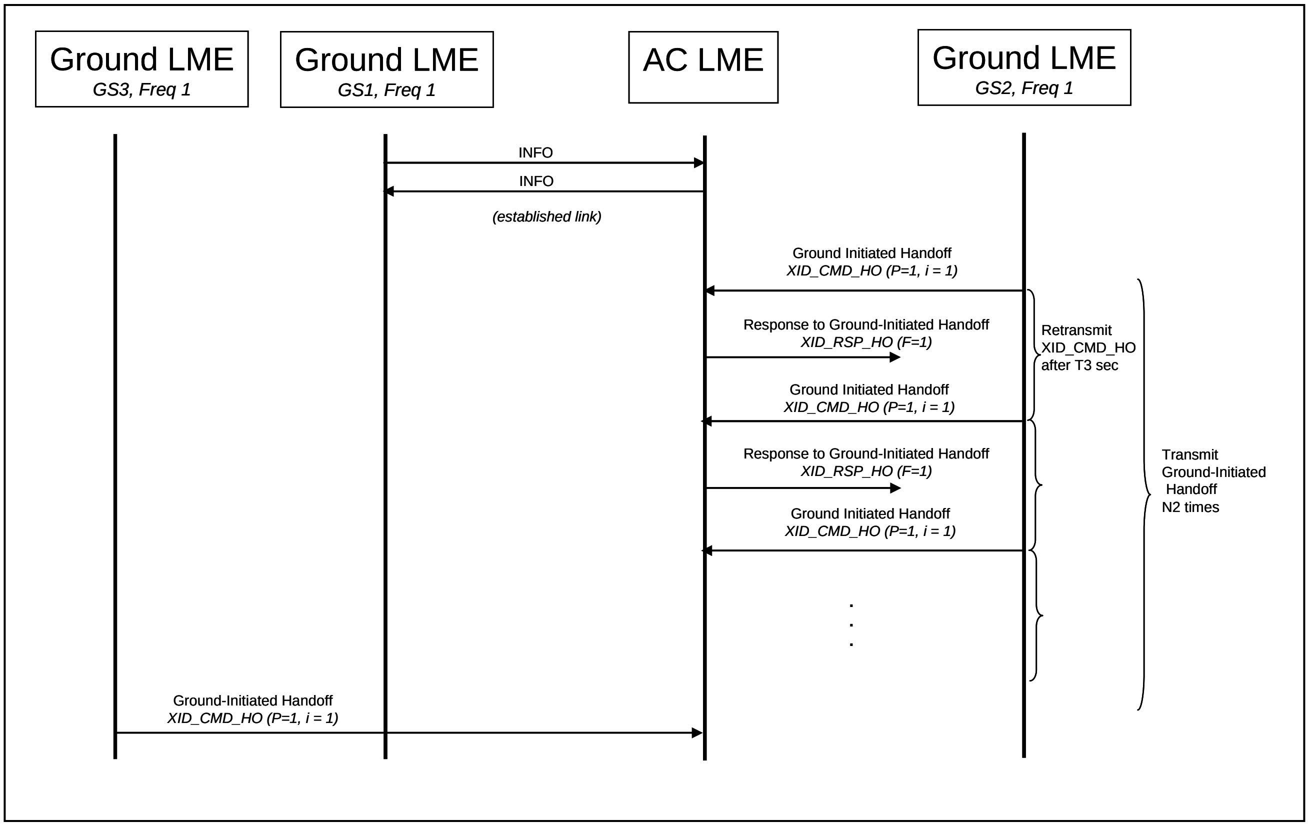


APPENDIX K
MESSAGE SEQUENCE CHARTS FOR GROUND-INITIATED HANDOFF



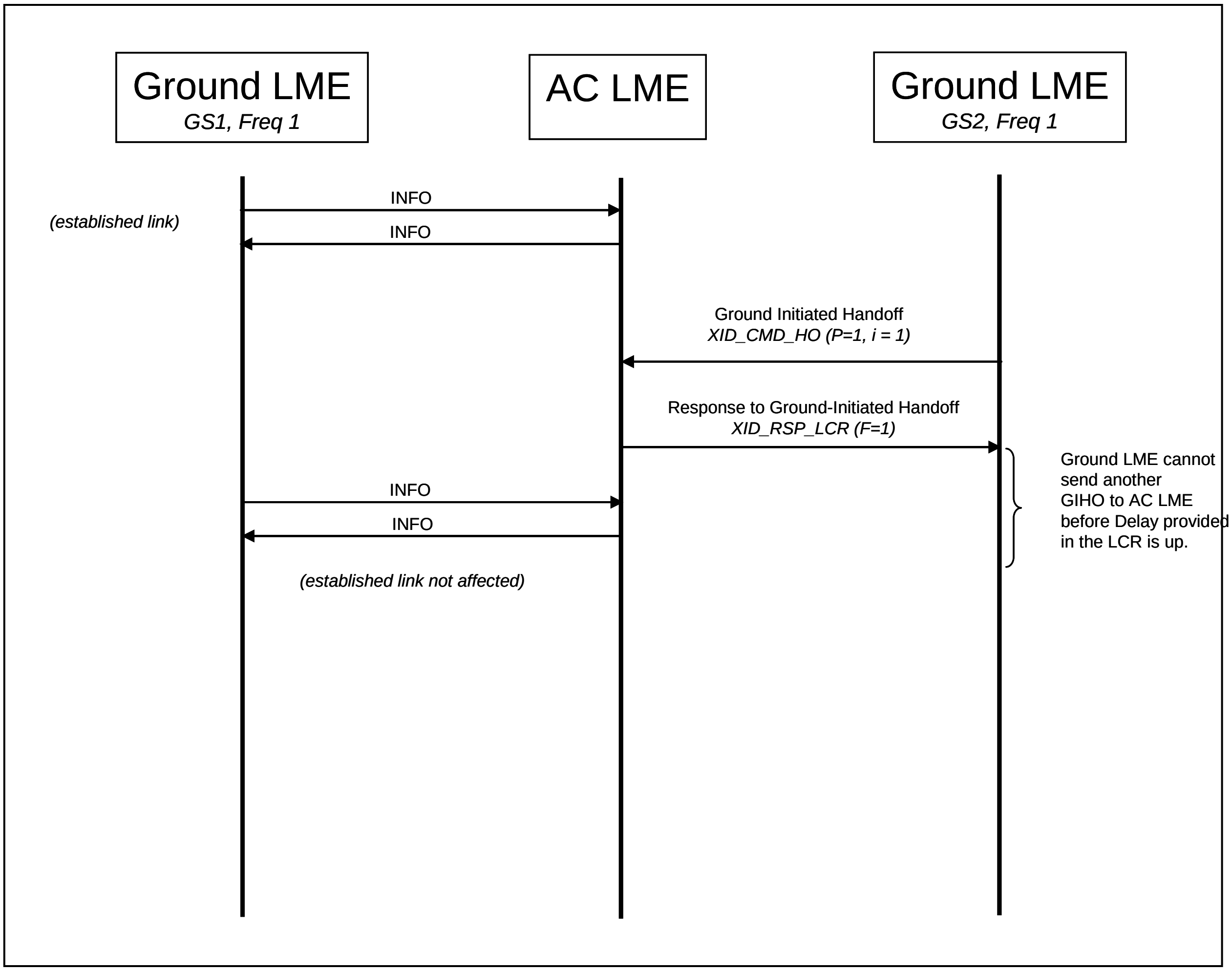
APPENDIX K
MESSAGE SEQUENCE CHARTS FOR GROUND-INITIATED HANDOFF

Ground-Initiated Handoff: Aircraft RSP Not Heard



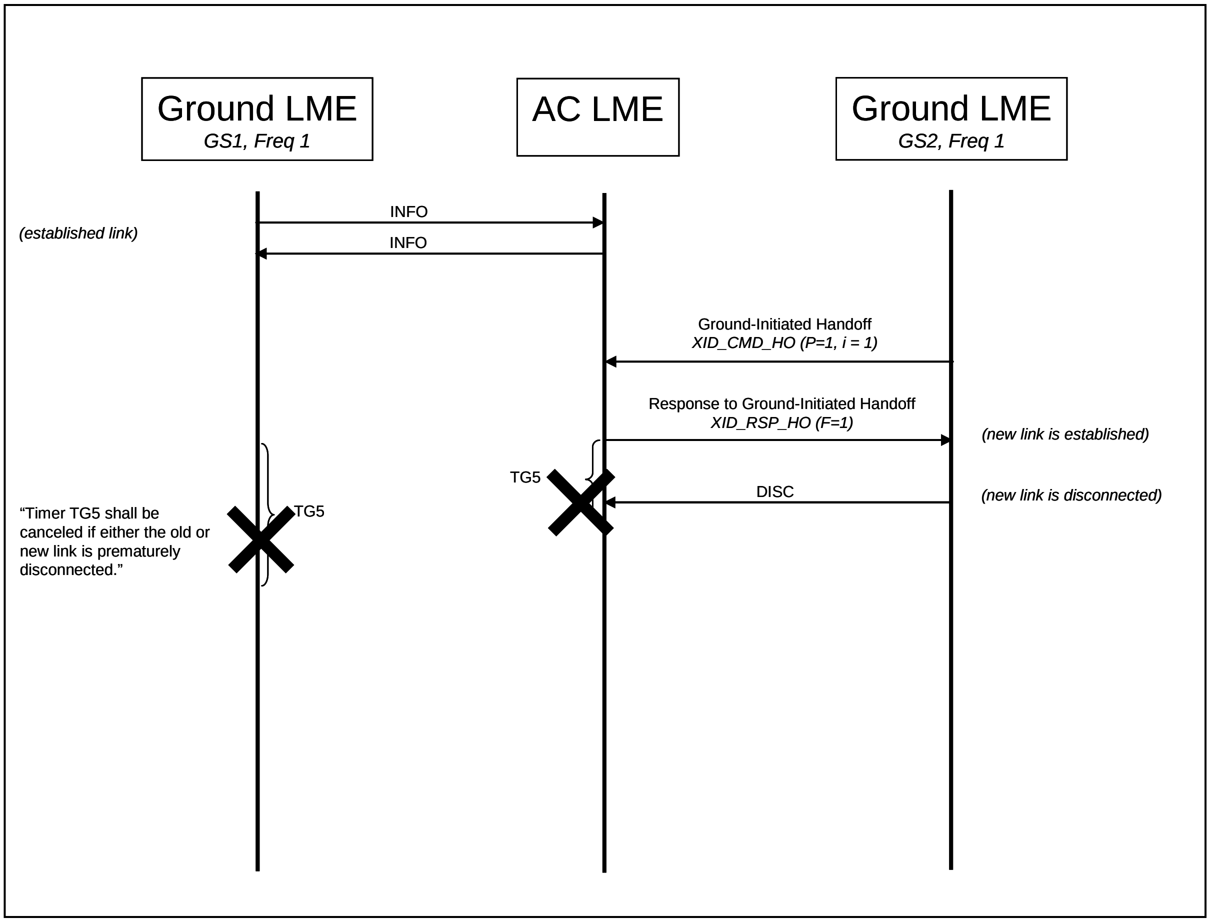
APPENDIX K
MESSAGE SEQUENCE CHARTS FOR GROUND-INITIATED HANDOFF

Ground-Initiated Handoff: Aircraft Rejects Ground-Initiated Handoff



APPENDIX K
MESSAGE SEQUENCE CHARTS FOR GROUND-INITIATED HANDOFF

Ground-Initiated Handoff: Aircraft RSP with Unacceptable Parameters



AERONAUTICAL RADIO, INC.
2551 Riva Road
Annapolis, Maryland 24101-7435

SUPPLEMENT 1
TO
ARINC SPECIFICATION 631

AVIATION VHF PACKET COMMUNICATIONS (AVPAC) FUNCTIONAL DESCRIPTION

Published: January 22, 1993

Prepared by the AEEC

Adopted by the AEEC Executive 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 non-adaptive 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 SUPPLEMENT

In the past, changes introduced by a Supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document, vertical change bars in the margin will indicate those areas of text changed by the current Supplement only.

C. CHANGES TO ARINC SPECIFICATION 631 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this Supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change 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.

AERONAUTICAL RADIO, INC.
2551 Riva Road
Annapolis, Maryland 24101-7435

SUPPLEMENT 2
TO
ARINC SPECIFICATION 631

AVIATION VHF PACKET COMMUNICATIONS (AVPAC) FUNCTIONAL DESCRIPTION

Published: December 1, 1995

Prepared by the AEEC

Adopted by the AEEC Executive 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 SUPPLEMENT

In the past, changes introduced by a Supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document, vertical change bars in the margin will indicate those areas of text changed by the current Supplement only.

C. CHANGES TO ARINC SPECIFICATION 631 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this Supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change 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

This 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.

AERONAUTICAL RADIO, INC.
2551 Riva Road
Annapolis, Maryland 24101-7435

SUPPLEMENT 3
TO
ARINC SPECIFICATION 631

VHF DIGITAL LINK
IMPLEMENTATION PROVISIONS

Published: October 16, 2000

Prepared by the AEEC

Adopted by the AEEC Executive 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 SUPPLEMENT

In the past, changes introduced by a Supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document, vertical change bars in the margin will indicate those areas of text changed by the current Supplement only.

C. CHANGES TO ARINC SPECIFICATION 631 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this Supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

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.

AERONAUTICAL RADIO, INC.
2551 Riva Road
Annapolis, Maryland 24101-7435

SUPPLEMENT 4
TO
ARINC SPECIFICATION 631

VHF DIGITAL LINK (VDL) MODE 2 IMPLEMENTATION PROVISIONS

Published: August 31, 2005

Prepared by the AEEC

Adopted by the AEEC Executive Committee: July 11, 2005

A. PURPOSE OF THIS DOCUMENT

This Supplement incorporates the following changes:

The Aircraft Initiated Handoff procedure and Allocation of a Remote Ground Station Address is added.

The Explicit and Expedited Connection Establishment sections are clarified.

A Section on Encoding of XID Public Parameters is added.

Attachment 1 “Generic OSI Network Architecture” is updated.

Attachment 2 “Data Link Layer PICS” and Appendix B “Definition of VDL Addresses, Ground System, System Mask, and use of these Parameter for VDL Handoff” are revised.

Attachment 4 “Encoding of XID Public Parameters” is added.

Appendices I and J are transferred from ARINC 637: Chapter C and Sections 2.4.1 through 2.4.3, respectively.

Appendix Z noting SARPs Differences is added.

B. ORGANIZATION OF THIS SUPPLEMENT

In the past, changes introduced by a Supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document, vertical change bars in the margin will indicate those areas of text changed by the current Supplement only.

C. CHANGES TO ARINC SPECIFICATION 631 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this Supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

Title Page

The title of ARINC Specification 631 is changed from “VHF Digital Link Implementation Provisions” to “VHF Digital Link (VDL) Mode 2 Implementation Provisions”.

1.3.3 Specification 637

The text of this Section is reformatted as Commentary and a statement added that Specification 637 has been re-classified as Historical.

1.4.1 Relationship to ICAO Documents

The text is revised to describe the current relationship of this Specification to ICAO documents.

2.3 VDLM2/ACARS Protocol Coexistence

In the second paragraph, the second sentence is deleted for accuracy.

4.2.1.1 Expedited Subnetwork Establishment With One Data Service Provider

The last Commentary is deleted because it references the historic ARINC Specification 637.

4.3 Handoff Management

A sentence is added at the end of the Commentary.

A provision on disconnection of the old link is added at the end of this section.

4.3.1.1 Aircraft-Initiated Handoff (Expedited)

“(Expedited)” is added to the Section title.

Under Disconnecting old link, change “receive” to “operate” and “connection” to “link.” Replace “Then the old link will be “uplink only” until the link’ respective TG5 Timer expires” with “Both old link and new link are active until the old link is disconnected by TG5 expiration”.

4.3.1.2 Aircraft Requested Ground-Initiated Handoff

A commentary is added at the end of this section.

4.3.1.3 Ground-Initiated Handoff

The title of Section 4.3.1.3 is changed to “Reserve.” The contents of the section are transferred to Section 4.3.2.2.

4.3.1.4 Ground-Requested Aircraft Initiated Handoff

Delete last sentence of third paragraph.

4.3.2.1 Aircraft Initiated Handoff (Explicit)

Add “(Explicit)” to Section title.

Add first four paragraphs. Replace paragraph “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” with “Both the old Virtual Circuit (VC) and the new VC are active until the old VC is terminated by the old link being disconnected upon TG5 expiration.” Change “ISO” to “VDLM2” in several places.

In paragraph 6, the last phrase is changed from “then the VC is terminated” to “then the old VC is terminated.”

4.3.2.2 Ground-Initiated Handoff

Text in this section is moved from Section 4.3.1.3. In the fourth paragraph, “SNDCF” is changed to “MSNDCF.” In the fifth paragraph, change “current” to “proposed” in second paragraph. Add “mobile” in front of “SNDCF” in fourth paragraph. The second sentence is deleted. A new sixth paragraph is added for the XID command handoff and response to initiate an explicit subnetwork connection. In the seventh paragraph, a reference is made for the ground to follow the subnetwork connection procedure described in Section 4.3.2.1. The paragraph on X.121 addressing supported by the ground system is deleted.

7.3.2 Procedures for Transmission

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

7.4.1 Allocation of a Remote Ground Station Address

Replace last sentence with "IATA, on behalf of ICAO, administers to the organizations, which in turn will administer their organization's addressing blocks. Ultimately, the organizations will assign the individual ground station addresses."

Replace commentary with "The information contained in Appendix F is provided for the reader's convenience. In the event of discrepancies between this document and IATA documentation, the IATA documentation will prevail."

7.5.1 GSIF Parameters

In the next to last paragraph change "… should be duplicated for …" to "… should contain …." Also delete "that is operating on that frequency" from the end of the third sentence.

7.6.1 Timer T1

In the last sentence of the sixth paragraph, change for clarity the range of values from "0 to 1 with 1 corresponding to a channel that is 100 percent occupied" to "0 to 0.99 with 0.99 corresponding to a channel that is 99 percent or greater occupied."

At the end of the next to last paragraph, add for clarity the sentence: "The Timer T1 should be started when a FRMR frame is queued for transmission."

7.9 AVLC Specific Option

Change "ISO" to "VDLM2" in several places.

For clarity, add two paragraphs concerning the "v" bit of the AVLC specific Options parameter. Delete the second commentary. "Currently, a VDL link does not support both ISO 8208 and non-ISO 8208 services simultaneously."

7.13 Encoding XID Public Parameters

This new section is added to reference Attachment 4, which is added as new provisions.

8.1 Introduction

Change "ISO" to "VDLM2" for accuracy.

8.2.1 Explicit Connection Establishment

For clarity, move second through last paragraphs into Commentary of Section 8.2.2, Expedited Connection Establishment.

8.2.2 Expedited Connection Establishment

For clarity, add as Commentary the four paragraphs moved from Section 8.2.1, Explicit Connection Establishment.

8.3 Fast Select

In the first paragraph, change the second sentence to: "…can be included in the CALL REQUEST/CALL CONFIRM user data field when the Fast Select facility is set."

The paragraph after the Commentary is deleted.

8.4 Call Maintenance

The last sentence of the first paragraph is changed to read “The old VC should be maintained until the old link is disconnected. (Upon expiration of timer TG5).”

A Commentary is added at the end of the paragraph for clarity.

8.5 Call Switching Within Some Routing Domain

Change “SNDCF” to “MSNDCF” in second paragraph.

8.6 Call Clearing

Change “ISO” to “VDLM2.”

For accuracy, change the second sentence to: “…receives a DATA packet with a bad send sequence number (P(s)), it should transmit a REJECT packet, …”

8.7 Priority (QOS)

Delete “at this time” from end of sentence.

8.8 DTE Addressing

For clarity, a Commentary is added at the end of the section.

9.4.1 Hand-Off

The next to last paragraph of Section 9.4.1 is reworded.

9.4.1.1 New Call Per Hand-Off

Delete the second paragraph concerning expedited ground-initiated handoffs.

9.8 Frequency Management/Auto-Tune

After the third paragraph, a new paragraph is added for clarity.

10.1 Introduction

Text in this section is added to specify the external interfaces of VDLM2 with subnetwork system management, the subnetwork access protocol and the VDR.

References are added to Appendices J and I, which are transferred from ARINC Specification 637.

10.2.3 Ground Station Switch Indication

Add “The ATN handoff is defined in the ATN SARPs.” at the end of the second paragraph in the Commentary.

Change “ISO” to “VDL” in last paragraph.

In the first paragraph, second sentence “As” is changed to “When”.

In the Commentary, second paragraph, first sentence “As” is changed to “When.”

10.2.4 Response to Ground Station Switch Indication

Revised the section title from “Ground Station Switch Reject” to “Response to Ground Station Switch Indication.” Add the first and second paragraphs. Editorial changes in third paragraph are incorporated.

ATTACHMENT 1 - GENERIC OSI NETWORK ARCHITECTURE

The diagram is revised to be consistent with ARINC 750 and 741.

ATTACHMENT 2 - DATA LINK LAYER PICS

Table 2-1 General Capabilities - Ground Station and Aircraft Support for the DLS-cnls and DLS-data2 items is changed to Optional.

Table 2-1-4 AVLC Frames - change Ground Station and Aircraft Support for the UI-cmd item to Optional.

Table 2-2-1 Uplink GSIF (P = 0) – Expand Note 1.

In Table 2-2-6 Ground-Initiated Handoff (Command) for Private Parameter GCMD_HO.avlc line the Notes column is added and Note 3 is added for the Ground Station Support column.

After Table 2-2-6, Note 3 is added.

In Table 2-2-7 Ground-Initiated Handoff (Response) for Private Parameter GRSP_HO.avlc line the Notes column is added and Note 1 is added in the Aircraft Support column. For the GRSP_HO.exp line under the Ground Station Support and Aircraft Support columns changed “O, R” to “X.”

After Table 2-2-7, Note 1 is added.

In Table 2-2-8 Air-Initiated Handoff (Command) for Private Parameter ACMD_HO.avlc line, the Notes column is added and Note 1 is added in the Aircraft Support column.

After Table 2-2-8, Note 1 is added.

In Table 2-2-9 Air-Initiated Handoff (Response) for Private Parameter ARSP_HO.avlc line, the Notes column is added and Note 3 is added in the Ground station Support and Aircraft Support columns.

After Table 2-2-9, Note 3 is added.

In Table 2-2-10 Ground-Requested-Air-Initiated Handoff (Command) for Private Parameter GrCMD_HO.avlc line, the Notes column is added and Note 2 is added in the Ground Station Support column.

After Table 2-2-10, Note 2 is added.

In Table 2-2-11 Broadcast-Ground-Requested-Air-Initiated Handoff (Command) for Private Parameter BgrCMD_HO.avlc line, the Notes column is added and Note 3 is added in the Ground Station Support column.

After Table 2-2-11, Note 3 is added.

ATTACHMENT 4 – ENCODING OF XID PUBLIC PARAMETERS

Attachment 4 is added to define new provisions.

Table 4-1 is changed to Table 4-1a.

The Table following Table 4-1a is now designated as “Table4-1b Classes Bit Encoding.”

In Table 4-1b a Mandatory Value column is added.

Table 4-2 is changed to Table 4-2a.

The Table following Table 4-2a is now designated as “Table4-2b HDLC Bit Encoding.”

In Table 4-2b, a Mandatory Value column is added.

Added Note [1] Reserved Note. Note [2] following Table 4-2b is completely rewritten.

In Table 4-9, hex column: “A4” was changed to “84” and “88” is changed to”80.”

In Table 4-9, comments column: change: “16 bit FCS TEST frames and modulo 8” to “16 bit FCS and modulo 8.”

APPENDIX A – TERMS AND ACRONYMS

The following new acronyms are added: CFDIU and GACS.

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

At the end of Section B.2 add “Note: To determine the VDL_SysID of a given Ground Station, the avionics should perform a Bitwise ANDing between the Ground_Station_Address and the System_Mask advertised by the Ground Station.”

In Section B.4, third paragraph, second sentence “or Handoff Event” is added after “Joint Event.”

In Section B.4 the last paragraph is revised.

In Figure B-1 “Same AGR” is added to the title.

In Figure B-1 “without” is changed to “with” in two places.

In Figure B-2 “2 AGRs, 1 SVC” is added to the title.

In Figure B-3 “Different AGRs, 2 SVCs” is added to the title.

APPENDIX C – MESSAGE SEQUENCE CHARTS

Charts are identified as Figures C-1 through C-10

In Figure C-5 “Call Request” is changed to “Call Request with ISH PDU” for the line identified as: Outside the scope of this specification.

In Figure C-6 “Call Connected Packet” is changed to “Call Connected Packet with ISH PDU” in one place between LME and 8208.

In the title of Figure C-7, change “Explicited” to “Explicit”.

In Figure C-8 “Call Request Packet” is changed to “Call Request Packet with ISH PDU” in one place between LME and SN-SME/VME.

In Figure C-8 “Call Connected Packet” is changed to “Call Connected Packet with ISH PDU” in one place between LME and SN-SME/VME.

In Figure C-9 “Call Request Packet” is changed to “Call Request Packet with ISH PDU” in one place.

In Figure C-9 “Call Connected Packet” is changed to “Call Connected Packet with ISH PDU” in one place between LME and SN-SME-VME.

Figure C-9 is deleted.

In Figure C-10 “Call Request Packet” is changed to “Call Request Packet with ISH PDU” in one place between LME and SN-SME-VME.

In Figure C-10 “Call Connected Packet” is changed to “Call Connected Packet with ISH PDU” in one place.

In Figure C-10, “When Aircraft or Ground Station Do Not Support Expedited Option” is changed to “Only Explicit Subnetwork Connection Is Used In Ground-Initiated Handoff”.

APPENDIX F - ALLOCATION OF GROUND STATION ADDRESSES

In the first paragraph add the following text: “The assignments contained in this Appendix are made by IATA on behalf of ICAO. This Appendix is provided for the reader’s convenience. In the event of discrepancies between this Appendix and IATA documentation the IATA documentation will prevail.”

Add the list of service providers to the table. Add the following sentence after the table: “Note: The Left hand column of the 24-bit pattern represents the most significant bit.”

APPENDIX G – FIS-B AND AOA EXTENDED PROTOCOL IDENTIFIER FOR VDL MODE 2 LINK LAYER

APPENDIX G is added.

APPENDIX H – MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5

APPENDIX H is added. Change “T5” to “TG5” on second and tenth slides.

Add the following notes as an introduction:

> This appendix describes an interpretation of VDL2 technical manual for Message Sequence Charts Autotune Scenarios.
>
> At the time of approval of Supplement 4, no known plan of deployment of autotune service exists. Therefore, this issue may be revisited when need arises.

APPENDIX I - GENERIC DATA LINK INTERFACE

Appendix I is transferred from ARINC 637, Appendix C. ARINC 637 is classified as a Historical Document.

APPENDIX J - AIRBORNE ATN SYSTEM ARCHITECTURE

Appendix J is transferred from ARINC 637, Section 2.4.1 through 2.4.3, inclusive. ARINC 637 is classified as a Historical Document.

AERONAUTICAL RADIO, INC.
2551 Riva Road
Annapolis, Maryland 24101-7435

SUPPLEMENT 5
TO
ARINC SPECIFICATION 631

VHF DIGITAL LINK (VDL) MODE 2 IMPLEMENTATION PROVISIONS

Published: December 9, 2008

Prepared by the AEEC

Adopted by the AEEC Executive Committee: October 9, 2008

A. PURPOSE OF THIS DOCUMENT

This Supplement provides corrections or updates to …

B. ORGANIZATION OF THIS SUPPLEMENT

In the past, changes introduced by a Supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document **blue bold** text is used to indicate those areas of text changed by the current Supplement only.

C. CHANGES TO ARINC SPECIFICATION 631 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this Supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

1.1 Purpose of this Document

The construction of the ICAO Manual on VHF Digital Link (VDL) Mode 2 Part II was revised. Consequently, the references in this specification were revised accordingly. Throughout this specification, references to the "Manual on VDLM2" have been changed. This change is considered generic and editorial. The changes are marked in text, but are not identified individually in this list of revisions.

1.3 Relationship of this Document to Other ARINC Standards

A reference to ARINC 638 was removed because ARINC 638 is obsolete.

1.3.3 - 1.3.7 ARINC Specifications

The sequence of these sections was changed to place them in numerical order. The titles of ARINC 622 and 623 were inserted. The sections on ARINC 637 and 638 now note that they are not to be used because they have been declared obsolete.

1.4.1 Relationship to ICAO Documents

A note was added to make the reader aware that future changes to the ICAO SARPs and Technical Manual will apply and should be incorporated as the ICAO amendments are issued. For example, the current edition is Edition 1. When edition 2 is published, the references will automatically apply to Edition 2. Throughout this specification, the generic reference to the "Manual on VDLM2" is used. This change is considered generic and editorial and is not identified individually in the text or in this list of revisions.

Text was also added to point out that there are some intentional inconsistencies among this ARINC Standard and the existing ICAO standards. These intentional differences are identified in the body of this specification. If future editions of the ICAO standards eliminate the differences, this specification will be revised accordingly.

3.1 General Description

This standard relies on the ICAO SARPs. Because of the transfer of SARPs material to the Manual on VDLM2, this text was revised to note the existence and equal applicability of the ICAO VDL Technical Manual.

4.1 Radio Frequency Management

The text “Individual frequencies may be either shared by service providers, or else dedicated to individual providers, depending on local allocations.” was added to clarify that the spectrum utilization is not fixed.

Four new paragraphs were added at the end of this section to describe the spectrum utilization under FSL. The authority of DSPs to utilize autotune is introduced. Instructions to the avionics are provided when an aircraft finds itself in RF coverage of two DSPs and one commands the aircraft to autotune. The aircraft will comply only if the command is issued by the DSP with higher priority.

4.2.1.1 Expedited Subnetwork Establishment With One Data Service Provider

New text was added to specify that, when performing a handoff and the loss of the old link is self-evident, it should silently disconnect any existing link. The same is true for the DSP. In this case the DISC is not sent because the closing of the link is not necessary because of the a priori nature of the scenario.

4.3 Handoff Management

The clarifying sentence was added at the end of the second paragraph. “Generally the LME should attempt to handoff to all ground stations of the preferred DSP in the active PECT before disconnecting from the preferred DSP/ground-based system.”

The limiting text was added to clarify aircraft handoff: The aircraft LME should establish a link to a new ground station *belonging to the same DSP or ground system when available* if any of the following events occur” in the sixth paragraph.

A new seventh paragraph was added to define the frequency change from the CSC to the terminal frequency.

The last paragraph and subsequent commentary were added to address a potential ambiguity in ATN Routes over the air-ground link during the transition between one VGS to another VGS when the second VGS is connected to a different ATN Air-ground router.

4.3.1.1 Aircraft-Initiated Handoff (Expedited)

The reference to the ICAO Manual was revised to reflect the most recent numbering scheme.

4.3.1.2 Aircraft-Requested Ground-Initiated Handoff

The reference to the ICAO Manual was revised to reflect the most recent numbering scheme.

4.3.1.4 Ground-Requested Aircraft-Initiated Handoff

An inconsistency with Section 5.4.4.9.3 of the ICAO Manual on VDLM2 Part II Edition 1 is identified.

4.3.2.1 Aircraft-Initiated Handoff (Explicit)

Clarification of the Called Line Address Modification Notification" (CLAMN) facility was made to resolve dissimilar interpretations of the reasons for issuing a CLAMN.

4.4 Provisions for Test DSP

New section and subsections 4.4.1 - 4.4.3 were added.

7.4.2 Erroneous use of Broadcast ICAO 24 bit Aircraft Address

New section added.

7.5 Ground Station Information Frames

The last sentence of the paragraph was added to clarify the reduce role of X.121 addresses.

7.5.1 GSIF Parameters

The third paragraph was inserted to define the selection of a second frequency.

The fifth (final) paragraph was added to recognize that there will be implementations of the link in which the PICS in the ground system are not consistent with those in the aircraft.

7.9 AVLC Specific Option

Five new paragraphs were added to explain the behavior of ground stations that only support VDL (and do not support the traditional ACARS VHF air-ground) protocol. A new tenth (final) paragraph was added to define the frequency change from the CSC to the terminal frequency.

A new final paragraph and associated commentary was added to specify the use of bit 7 of the AVLC specific options parameter in the GSIF to discriminate between "on ground" and "in air" status.

7.14 Unrecognized XID Parameters

New section added.

8.4.1 Call Redirection for X.121 Based Networks

Text describing the Called Line Address Modification Notification" (CLAMN) facility was revised to resolve dissimilar interpretations of the reasons for issuing a CLAMN.

8.10 Flow Control Window Closure

New section added.

9.7 ATN Router NET Parameter

New commentary was added to explain that advertisement of a single VSDA per VGS is sufficient to support current requirements.

9.8.1 Autotune

Formerly a placeholder, this section was revised in its entirety to introduce the autotune function.

9.8.2 Frequency Support List (FSL)

New section and its subsections was added to define the selection of a second frequency by the aircraft without the overhead of an autotune.

9.8.2.1 Frequency Support List for Aircraft in the Air

New section was added to define the selection of a second frequency by the aircraft without the overhead of an autotune.

9.8.2.2 Frequency Support List for Aircraft on the Ground

New section was added to define the selection of a second frequency by the aircraft without the overhead of an autotune.

Attachment 2 Data Link Layer PICS

A new second paragraph was added to recognize that there will be implementations of the link in which the PICS in the ground system are not consistent with those in the aircraft. In this case, the receiving system needs to accept incoming messages as complete (rather than rejecting the entire message because one or more "Mandatory" parameters are missing). The rationale was to address the problem where one station (e.g., the aircraft) would reject the message because the ground station was designed and commissioned based on a standard that has been superseded. The receiving station should accept the message and process the content that is available. The parameters driving this clarification are Public Parameters in Non-LE responses that appear as Mandatory in Supplement 4 (published in 2005) of this specification but Optional in the Manual on VDLM2 (Edition 1) which was published in 2001.

Appendix D VSDA Configuration Issue

D-1.0 Introduction

A new second paragraph was added to remind the reader that network level routing will typically require ground-ground communications when two different ATC routers are involved.

D-3.0 Scenario 2

"Drawbacks" text was added.

D-4.0 Scenario 3

"Drawbacks" text was added.

D-5.0 Scenario 4

"Drawbacks" text was added.

Appendix H

All Figures were modified to reflect FSL.

AERONAUTICAL RADIO, INC.
2551 Riva Road
Annapolis, Maryland 24101-7435

SUPPLEMENT 6
TO
ARINC SPECIFICATION 631

VHF DIGITAL LINK (VDL) MODE 2 IMPLEMENTATION PROVISIONS

Published: January 10, 2011

Prepared by the AEEC

Adopted by the AEEC Executive Committee: October 6, 2010

A. PURPOSE OF THIS DOCUMENT

This Supplement revises the VDLM2 protocol, specifically focusing on multi-frequency provisions.

B. ORGANIZATION OF THIS SUPPLEMENT

In this document **blue bold** text is used to indicate those areas of text changed by the current Supplement only.

C. CHANGES TO ARINC CHARACTERISTIC 631 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this Supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

1.4.2 Relationship to RTCA Documents

RTCA MASPS was updated from DO-224A to RTCA DO-224B.

Added VDLM2 RTCA DO-281A MOPS.

4.3.1.4 Ground-Requested Air-Initiated Handoff

The “Ground Action” and “General Aircraft Response” paragraphs were revised.

A Commentary was added at the end of the section.

7.9 AVLC Specific Option

The “No Service” option was added as a possible state for available services.

A “No Service” state paragraph was added.

9.8.1 Autotune

This section was revised.

9.9 PECT Maintenance

Revised paragraph.

ATTACHMENT 2 – DATA LINK LAYER PICS

A2.2.6 Ground-Initiated Handoff (Command): revised Table 2-2-6 Ground-Initiated Handoff (Command) by adding “4” to the Notes column of Item “GCMD_HO.avlc”; added Note 4.

A2.2.9 Air-Initiated Handoff (Response): revised Table 2-2-9 Air-Initiated Handoff (Response) by replacing “O” with “M” in the Aircraft Support column and by adding “4” to the Notes column of Item “ARSP_HO.avlc”; added Note 4.

A2.2.10 Ground-Requested-Air-Initiated Handoff (Command): revised Table 2-2-10 Ground-Requested-Air-Initiated Handoff (Command) by adding “3” to the Notes column of Item GrCMD_HO.avlc; replaced “O” with “M” in the Ground Station Support column of Items GrCMD_HO.tune and GrCMD_HO.gs; added “R” to the Ground Station Support column of Item GrCMD_HO.freq; added Note 3.

A2.2.11 Broadcast Ground-Requested-Air-Initiated Handoff (Command): revised Table 2-2-11 Broadcast Ground-Requested-Air-Initiated Handoff (Command) by adding “4” to the Notes column of Item “BgrCMD_HO.avlc”; added Note 4.

APPENDIX A – TERMS AND ACRONYMS

A1-1.2 Acronyms: The acronyms list was updated.

APPENDIX C – MESSAGE SEQUENCE CHARTS

Updated notes sequence throughout.

APPENDIX F – ALLOCATION OF GROUND STATION ADDRESSES

Revised VDLM2 Ground Station DSP Address Assignments Table.

APPENDIX H – MESSAGE SEQUENCE CHARTS FOR AUTOTUNE AND TG5

Revised Message Sequence Chart: Link Establishment with Autotune.

Revised Message Sequence Chart: Link Establishment with Autotune but handoff on new frequency fails.

Added new Message Sequence Chart: Link Establishment with Autotune refused by the Aircraft.

Revised Message Sequence Chart: Aircraft-Initiated Handoff with Autotune.

Revised Message Sequence Chart: Aircraft-Initiated Handoff with Autotune but handoff on new frequency fails.

Added new Message Sequence Chart: Aircraft-Initiated Handoff with Autotune rejected by the Aircraft.

Revised Message Sequence Chart: Ground Requested Aircraft-Initiated Handoff with Autotune.

Revised Message Sequence Chart: Ground Requested Aircraft-Initiated Handoff with Autotune but handoff on new frequency fails.

Added new Message Sequence Chart: Ground Requested Aircraft-Initiated Handoff: Retransmission.

Added new Message Sequence Chart: Ground Requested Aircraft-Initiated Handoff: Rejection.

Revised Message Sequence Chart: Link Establishment with Autotune.

Revised Message Sequence Chart: Link Establishment with Autotune but handoff on new frequency fails.

Revised Message Sequence Chart: Aircraft-Initiated Handoff with Autotune.

Revised Message Sequence Chart: Aircraft-Initiated Handoff with Autotune but handoff on new frequency fails.

Revised Message Sequence Chart: Ground Requested Aircraft-Initiated Handoff with Autotune.

Revised Message Sequence Chart: Ground Requested Aircraft-Initiated Handoff with Autotune but handoff on new frequency fails.

Added new Message Sequence Chart: Ground Requested Aircraft-Initiated Handoff: Retransmission.

Added new Message Sequence Chart: Ground Requested Aircraft-Initiated Handoff: Rejection.

APPENDIX K – MESSAGE SEQUENCE CHARTS FOR GROUND-INITIATED HANDOFF

This new section consisting of Sequence Charts was added.

ARINC Standard – Errata Report

1. Document Title

(Insert the number, supplement level, date of publication, and title of the document with the error)

2. Reference

Page Number: ______ Section Number: ______________ Date of Submission: ______________

3. Error

(Reproduce the material in error, as it appears in the standard.)

4. Recommended Correction

(Reproduce the correction as it would appear in the corrected version of the material.)

5. Reason for Correction *(Optional)*

(State why the correction is necessary.)

6. Submitter (Optional)

(Name, organization, contact information, e.g., phone, email address.)

Please return comments to fax +1 410-266-2047 or standards@arinc.com

Note: Items 2-5 may be repeated for additional errata. All recommendations will be evaluated by the staff. Any substantive changes will require submission to the relevant subcommittee for incorporation into a subsequent Supplement.

[To be completed by IA Staff]

Errata Report Identifier: ______________ **Engineer Assigned:** __________________________

Review Status: ____

ARINC IA Project Initiation/Modification (APIM)

1.0 Name of Proposed Project **APIM #: _____**

(Insert name of proposed project.)

1.1 Name of Originator and/or Organization

(Insert name of individual and their organization that initiated the APIM)

2.0 Subcommittee Assignment and Project Support

2.1 Suggested AEEC Group and Chairman

(Identify an existing or new AEEC group.)

2.2 Support for the activity (as verified)

Airlines: (Identify each company by name.)

Airframe Manufacturers:

Suppliers:

Others:

2.3 Commitment for Drafting and Meeting Participation (as verified)

Airlines:

Airframe Manufacturers:

Suppliers:

Others:

2.4 Recommended Coordination with other groups

(List other AEEC subcommittees or other groups.)

3.0 Project Scope (why and when standard is needed)

3.1 Description

(Insert description of the scope of the project.)

3.2 Planned usage of the envisioned specification

Use the following symbol to check yes or no below. ☒

New aircraft developments planned to use this specification yes ❑ no ❑

Airbus: (aircraft & date)

Boeing: (aircraft & date)

Other: (manufacturer, aircraft & date)

Modification/retrofit requirement yes ❑ no ❑

Specify: (aircraft & date)

Needed for airframe manufacturer or airline project yes ❑ no ❑

Specify: (aircraft & date)

Mandate/regulatory requirement yes ❑ no ❑

Program and date: (program & date)

Is the activity defining/changing an infrastructure standard? yes ❑ no ❑

Specify (e.g., ARINC 429)

When is the ARINC standard required?
______(month/year)__________

What is driving this date? _______(state reason)_____________________

Are 18 months (min) available for standardization work? yes ❑ no ❑

If NO please specify solution: _________________

Are Patent(s) involved? yes ❑

If YES please describe, identify patent holder: _________________

3.3 Issues to be worked

(Describe the major issues to be addressed.)

4.0 Benefits

4.1 Basic benefits

Operational enhancements yes ❑ no ❑

For equipment standards:

a. Is this a hardware characteristic? yes ❑ no ❑

b. Is this a software characteristic? yes ❑ no ❑

c. Interchangeable interface definition? yes ❑ no ❑

d. Interchangeable function definition? yes ❑ no ❑

If not fully interchangeable, please explain: _________________

Is this a software interface and protocol standard? yes ❑ no ❑

Specify: _________________

Product offered by more than one supplier yes ❑ no ❑

Identify: (company name)

4.2 Specific project benefits (Describe overall project benefits.)

4.2.1 Benefits for Airlines

(Describe any benefits unique to the airline point of view.)

4.2.2 Benefits for Airframe Manufacturers

(Describe any benefits unique to the airframe manufacturer's point of view.)

4.2.3 Benefits for Avionics Equipment Suppliers

(Describe any benefit unique to the equipment supplier's point of view.)

5.0 Documents to be Produced and Date of Expected Result

One/Two Project Papers are expected to be completed per the table below.

5.1 Meetings and Expected Document Completion

The following table identifies the number of meetings and proposed meeting days needed to produce the documents described above.

Activity	Mtgs	Mtg-Days (Total)	Expected Start Date	Expected Completion Date
Document a	*# of mtgs*	*# of mtg days*	*mm/yyyy*	*mm/yyyy*
	*# of mtgs **	*# of mtg days **		
Document b	*# of mtgs*	*# of mtg days*	*mm/yyyy*	*mm/yyyy*
	*# of mtgs **	*# of mtg days **		

* Indicate unsupported meetings and meeting days, i.e., technical working group or other ad hoc meetings that do not requiring IA staff support.

6.0 Comments

(Insert any other information deemed useful to the committee for managing this work.)

6.1 Expiration Date for the APIM

April/October 20XX

For IA staff use only

Date Received: Jan 15, 2010 IA staff : ____________

Potential impact: ______

*(**A**. Safety **B**. Regulatory **C**. New aircraft/system **D**. Other)*

Resolution: _______

Authorized, Deferred, Withdrawn, More Detail Needed, Rejected)

Assigned to SC/WG:________________