ARINC

AVIATION SATELLITE COMMUNICATION SYSTEM PART 2 SYSTEM DESIGN AND EQUIPMENT FUNCTIONAL DESCRIPTION

ARINC CHARACTERISTIC 741P2-9

PUBLISHED: November 22, 2006

AN ARINC DOCUMENT

Prepared by
AIRLINES ELECTRONIC ENGINEERING COMMITTEE
Published by
AERONAUTICAL RADIO, INC.
2551 RIVA ROAD, ANNAPOLIS, MARYLAND 21401-7435

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Published: November 22, 2006

Prepared by the Airlines Electronic Engineering Committee

Characteristic 741P2	Adopted by the Airlines Electronic Engineering Committee	October 21, 1988

Summary of Document Supplements

Supplement	Adoption Date	Published
Characteristic 741P2-1	October 9, 1991	July 31, 1992
Characteristic 741P2-2	October 19, 1993	February 28, 1994
Characteristic 741P2-3	October 20, 1994	December 30, 1994
Characteristic 741P2-4	October 31, 1995	December 8, 1995
Characteristic 741P2-5	October 22, 1996	November 15, 1996
Characteristic 741P2-6	October 14, 1997	April 30, 1998
Characteristic 741P2-7	June 6, 2003	December 24, 2003
Characteristic 741P2-8	October 4, 2005	May 31, 2006
Characteristic 741P2-9	October 11, 2006	November 22, 2006

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

Aeronautical Radio, Inc. (ARINC) was incorporated in 1929 by four fledgling airlines in the United States as a privately-owned company dedicated to serving the communications needs of the air transport industry. Today, the major U.S. airlines remain the Company's principal shareholders. Other shareholders include a number of non-U.S. airlines and other aircraft operators.

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

The Airlines Electronic Engineering Committee (AEEC) is an international body of airline technical professionals that leads the development of technical standards for airborne electronic equipment-including avionics and in-flight entertainment equipment-used in commercial, military, and business aviation. The AEEC establishes consensus-based, voluntary form, fit, function, and interface standards that are published by ARINC and are known as ARINC Standards. The use of ARINC Standards results in substantial benefits to airlines 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 airline 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.

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APPENDICES

3.0 SYSTEM DESIGN

Part 1 of ARINC Characteristic 741 describes the physical and electrical characteristics of the equipment. This document, Part 2, contains Section 3 (System Design) and Section 4 (Satellite Data Unit (SDU) Design). Section 3, System Design, describes the system as a layered structure of a common physical layer, link layer protocols for packet-mode, and circuit-mode service options, together with the network management facilities used for operational control. Section 4, Satellite Data Unit Design, describes the characteristics of an SDU consistent with the system described in Section 3. The commonalities are reflected in the structure of this document and are depicted in Attachment 2F-0. Both chapters follow the same high level section and paragraph numbering, as outlined below:

System	SDU	Section Content
3.1	4.1	Physical Layer
3.2	4.2	Data Link Layer
3.3	4.3	Packet-mode Services
3.4	4.4	Circuit-mode Services
3.5	4.5	Satellite Network Management

3.0.1 Overview

The Aviation Satellite Communication System (SATCOM) is a worldwide mobile communications system providing voice and data communications services between aircraft subnetworks and ground subnetworks.

The satellite network, in conjunction with avionics implemented in accordance with this document, provides air-ground packet-switched data services and voice communications using conventions and capabilities which are standardized worldwide. The use of circuit-switched channels for data and facsimile services is also possible.

The goal of SATCOM is to provide the civil aviation community with worldwide, high-quality safety and non-safety communications services. It is intended to accommodate Air Traffic Services (ATS), Airline Operational Control (AOC), Airline Administrative Communications (AAC), and Airline Passenger Communications (APC). These four categories are recognized by the International Civil Aviation Organization (ICAO) and the International Telecommunications Union (ITU) which have assigned them priorities for communications purposes (Radio Regulation Article S44 and ICAO Annex 10, Volume II, 5.1.8). The system is to be designed to ensure that aeronautical communications for safety and regularity of flight are not delayed by the transmission and reception of other types of messages.

The SATCOM architecture defines system characteristics to assure a worldwide level of communications interoperability. SATCOM is to be compatible and interoperable with external systems. This presumes the implementation of well-defined gateways and peer-to-peer protocols. Routing and Addressing schemes used are to be compatible worldwide. The ICAO 24-bit aircraft address is to be used throughout SATCOM to ensure compatibility between organizations and systems.

For packet-mode data services, two modes of operation are permitted. These modes are referred to as Data-2 and Data-3 to be consistent with industry standards. Data-2 operation does not include subnetwork layer protocol functions. User data packets are transparently enveloped with a two-octet header and use the RLS link layer services directly. Data-3 operation supports a Switched Virtual Circuit (SVC) subnetwork layer service which operates over the RLS link layer service.

Interoperability has been accomplished by applying the International Standards Organization's (ISO) Open System Interconnection (OSI) Basic Reference Model (ISO 7498). SATCOM data services are expected to conform, in the future, with guidelines for the Aeronautical Telecommunications Network (ATN) currently being developed.

For circuit-mode services, interoperability has been accomplished through the use of layered design techniques in accordance with International Telecommunication Union Telecommunication Standardization Sector (ITU-T) design principles.

3.0.2 Evolution

Because the system capabilities are expected to evolve with time, the initial set of capabilities and functions have been given the designation of 'Initial System' while the capabilities and functions which may be progressively added according to traffic demand and technological evolution have been generally called an 'Enhanced System'. This Enhanced System is, thus, not precisely defined. However, the specified elements of the Initial System and the currently envisaged specifications for the Enhanced System are defined in this document.

COMMENTARY

Although some of the evolutionary steps of one element are inevitably linked with those of other elements, in general the system concept allows the individual elements to evolve independently. The pressures which are expected to lead to this evolution include traffic growth, market awareness, new applications, and new technology.

The Initial System utilizes the following channel rates:

Channel Rates	Notes:
P-channel: 600 bps (ABPSK)	1
R-channel: 600 and 1200 bps (ABPSK)	1
C-channel: 21000 bps (AQPSK)	2
T-channel: 600 and 1200 bps (ABPSK)	3

Notes:

1. Used by all AESs
2. Used by AESs offering circuit-mode services
3. Used by AESs offering packet-mode services

A phased transition is envisaged between the Initial System and the longer-term capabilities of the Enhanced System which may include the following in addition to the basic channel rates for the Initial System:

P-channel	1200 and 2400 bps (ABPSK) 4800 and 10500 bps (AQPSK)
R-channel	2400 bps (ABPSK) 10500 bps (AQPSK)
T-channel:	2400 bps (ABPSK) 10500 bps (AQPSK)
C-channel	5250, 6000 as well as 10500 bps (AQPSK)

COMMENTARY

It is recommended that a capability to add these channel rates be included in equipment implemented for the Initial System. In the interests of economy and implementation schedule for the Initial System, the inclusion of other channel rates (including voice coding rates other than 9.6 kbps) is not essential in equipment implemented for the Initial System.

Because the other elements of the system are expected to evolve with time, the AES capabilities have been defined in a way which provides adequate service levels in the start-up phases, but which can take advantage of improved performance in the other elements as they become available without any significant replacement or upgrade of components. In particular, the reference configuration of the AES is specified with a linear high power amplifier (HPA) for multicarrier operation, and a family of digital channels is defined which are all mutually consistent and compatible.

A linear HPA permits matching the evolution of space segment characteristics allowing the full power of the HPA to be utilized on one channel under adverse conditions while providing for progressively greater numbers of channels with higher performance satellites.

3.0.3 Definitions

Space Segment

The satellite communications transponders supporting ground control equipment and associated frequency bands assigned for use by the Aeronautical Mobile Satellite Service (AMSS).

COMMENTARY

The RF link between the satellite and the aircraft is L-band with the specific frequencies defined in Part 1 of this Characteristic. The RF link between the satellite and the Ground Earth Station (GES) may be C-band or another frequency band.

Aircraft Earth Stations (AES)
Avionics which interface with the space segment (at L-band) for communications with Ground Earth Stations and which interface in the aircraft with other avionics equipment in accordance with the relevant technical and operational specifications.

Aeronautical (Ground) Earth Stations (GES)
Ground-based systems which interface with the space segment and with the terrestrial networks and which are operated in accordance with the relevant technical and operational specifications for communications with the AESs.

Network Coordination Stations (NCS)
Ground-based systems located at designated earth stations which interface with the GESs for the purpose of allocating satellite channels.

Forward Messages and Calls
Those transmitted from the ground (GES) to the aircraft (AES) via the satellite.

Return Messages and Calls
Those transmitted from the aircraft (AES) to the ground (GES) via the satellite.

3.0.3.1 AES Service Levels

The following AES service levels are defined in the ICAO SARPs:

Level 1 AES is capable of operating and supporting the protocols to:

a. Receive a P-channel, and
b. Transmit a T-channel and an R-channel, not necessarily simultaneously at channel rates of 600, 1200, and 2400 bps.

COMMENTARY

An AES with Level 1 capability provides basic packet-mode data communications using one receive and one transmit channel. The initial system does not meet the Level 1 requirements for 2400 bps transmission.

Level 2 AES has the capabilities of a Level 1 system, and additionally to:

a. Receive one P-channel at channel rates of 4800 and 10500 bps, and
b. Transmit a T-channel and an R-channel, not necessarily simultaneously, at the channel rate of 10500 bps.

COMMENTARY

An AES with Level 2 capability provides the Level 1 capability and higher packet-mode data rates using one receive and one transmit channel.

Level 3 AES has the capabilities of a Level 2 system, and additionally to:

a. Be capable of operating and supporting the protocols to receive and transmit data on one C-channel at channel rates of 10500 and 21000 bps.

Simultaneous operation of the C-channel with an R- or T-channel is not required.

COMMENTARY

An AES with Level 3 capability provides digitized voice and circuit-mode data capability on the C-channel in addition to the Level 2 packet-mode capability using two receive and one transmit channels.

Level 4 AES has the capabilities of a Level 3 system and, additionally, the capability for simultaneous operation of one or more C-channels with the R-channel and the capability for simultaneous operation of one or more C-channels with the T-channel. Simultaneous operation of the three channels (C, R, and T) is not required.

COMMENTARY

An AES with Level 4 capability provides digitized voice and circuit-mode data capability on the C-channel(s) simultaneously with packet-mode capability on the R-channel or the T-channel and the P-channel using two or more receive and two or more transmit channels.

All Level AESs monitor the appropriate P-channel continuously once logged onto the satellite subnetwork.

3.0.3.2 AES Installation Classes

An aircraft may be fitted with any combination of the following classes of installations:

Class 1 AES installations utilize a low gain antenna (nominally 0 dBi) and comply with the applicable low rate packet-mode data service requirements of this document. Class 1 installations provide low rate packet-mode data services only.

Class 2 AES installations utilize a high gain antenna (nominally 12 dBi) and comply with the applicable circuit-mode service requirements of this document. Class 2 installations provide telephony and, optionally, circuit-mode data services.

COMMENTARY

Class 2 installations do not conform with the ICAO AMSS SARPS because of the absence of packet-mode data capability.

Class 3 AES installations utilize a high gain antenna and comply with the applicable circuit-mode and packet-mode data service requirements of this document. Class 3 installations provide telephony services, packet-mode data services, and optionally circuit-mode data services.

Class 4 AES installations utilize a high gain antenna and comply with the applicable packet-mode data service technical requirements of this document. Class 4 installations provide packet-mode data services only.

3.1 Physical Layer

The physical layer provides those mechanical, electrical, functional and procedural characteristics necessary to establish, maintain, and de-activate the physical connection between data link entities through the transmission of bit streams. The mechanical and basic electrical properties of the AES are covered in Part 1 of this document.

3.1.1 RF Channel Configuration

The Aviation Satellite Communications System provides access to ground based networks through the Aeronautical (Ground) Earth Stations (GES). The GES provides system synchronization and coordination through ground-to-aircraft transmissions. Four types of RF channels are defined for use with the Aviation Satellite Communication System. Channel designations with a brief description of each follow:

P-channel	Packet-mode time division multiplex (TDM) channel, used in the forward direction (ground-to-air) to carry signaling and packet-mode data. The transmission is continuous from each GES in the satellite network. A P-channel being used for System Management functions is designated Psmc, while a P-channel being used for other functions is designated Pd. The functional designations Psmc and Pd do not necessarily apply to separate physical channels.
R-channel	Random access (slotted Aloha) channel, used in the return direction (aircraft-to-ground) to carry signaling and packet-mode data, specifically the initial signals of a transaction, typically request signals. An R-channel being used for System Management functions is designated Rsmc, while an R-channel being used for other functions is designated Rd. The functional designations Rsmc and Rd do not necessarily apply to separate physical channels.
T-channel	Reservation Time Division Multiple Access (TDMA) channel, used in the return direction only. The receiving GES reserves time slots for transmissions requested by AESs, according to length. The sending AES transmits the messages in the reserved time slots according to priority.
C-channel	Circuit-mode single channel per carrier (SCPC) channel, used in both forward and return directions to carry digital voice or data/facsimile traffic. The use of the channel is controlled by assignment and release signaling at the start and end of each call.

3.1.2 Channel Characteristics

The characteristics of the channel rates and spacing are provided in SDM Module 1, Version 1.45.

COMMENTARY

The channel spacing in SDM Module 1, Version 1.45, make adequate provision for separation to reduce adjacent channel interference and to ensure correct channel tuning in the presence of Doppler shift due to all causes. In the case of the lowest channel rates, the possible spacing for the forward direction (P-channels) and return direction (R- and T-channels) are different due to the presence of uncorrected Doppler shift on forward channels and the use of Automatic Frequency Control (AFC) to minimize Doppler shift in the return direction.

3.1.3 Automatic Frequency Compensation

In order to reduce the frequency errors due to the aircraft motion relative to the selected satellite, Automatic Frequency Compensation (AFC) is performed by the AES on the return signals.

3.1.4 Modulation Methods

Aeronautical satellite channels use digital modulation to efficiently utilize satellite power and bandwidth. The channels use one of two forms depending on the channel rate. Lower channel rates use Aviation Binary Phase Shift Keying (ABPSK) which is a form of differentially encoded BPSK in which alternate modulation symbols are transmitted in notional in-phase (I) and quadrature (Q) channels. The modulation used with higher channel rates is Aviation Quaternary Phase Shift Keying (AQPSK) which is a particular form of Offset QPSK.

3.1.5 Channel Formats

On all channels, data is structured into frames. The channel format is the order in which information appears in the frame of each designated channel.

3.1.6 Information Field Processing

The number of bits in the information field depends on the channel type and rates.

The various processes used for data transmission are described below; complementary processes are required for data reception.

3.1.6.1 Forward Error Correction (FEC)

A number of channels use an error correcting code arranged so that signals detected as being in error are automatically corrected at the receiving terminal before final processing. The FEC coding rate, when used, is indicated in SDM Module 1, Version 1.45.

3.1.6.2 Bit Interleaver

Because of the multipath fading characteristics of the aeronautical transmission path, interleaving is applied to preserve the FEC coding gain. All channels, except those without FEC coding, employ a common structure, variable size interleaver.

3.1.6.3 Bit Scrambling

A pseudo-noise (PN) scrambler with a 15-stage generator register is used for data scrambling before FEC encoding. The concept of a PN scrambler is explained in CCIR Report 384-3, Annex III, Section 3, Method 1.

3.1.7 Performance

The overall physical layer is to be configured such that the average bit error rate is 10^{-5} or less after forward error correction and descrambling for data services, and 10^{-3} or less for voice services.

3.2 Data Link Layer

The data link layer provides for the routing of information between data link service users and the physical transmission media (see Appendix 1, Figure 3). The service users include:

a. Satellite Network Management Function.
b. Packet-mode data service.
c. Circuit-mode services.

This section is structured to permit individual AESs to be configured according to their service needs and GESs according to their service offerings.

The primary responsibility of the data link layer is to transfer Link Service Data Units (LSDU) over the physical link. The data link layer is also expected to detect errors occurring in the physical layer and, as needed, to correct them. This is accomplished through the execution of a set of defined functions which constitute the Link Layer Protocols.

The link layer functions defined by the protocols include the initialization of the data link over the existing physical path, identification of a particular destination or source, delimiting and synchronization of the bit stream, error detection and recovery, data segmentation/reassembly, and other link management functions.

3.2.1 Provision for Different Services

Information is conveyed to aircraft by means of P-channels and C-channels, and from aircraft by R-, T-, and C-channels. All AESs are to possess a P-channel receiver and R-channel transmitter. For classes 1, 3, and 4 installations; the AESs are to also possess at least one T-channel transmitter. If circuit-mode service is desired, the AES is to possess one or more C-channel transmitters and receivers.

3.2.1.1 Data Link Services

The system provides two data link services:

a. The simplest is the Direct Link Service (DLS) in which the data (user-data LSDU or signaling) is transmitted directly on the appropriate channel and delivered at the distant end if it arrives and without requesting retransmission of lost signal units. The Direct Link Service is generally used for broadcast messages (ground-to-air) and for signaling. In the case of signaling, any lost Signal Units are handled within the signaling logic procedures.
b. In Reliable Link Service (RLS), the successful reception of a message in error-free condition is assured by means of selective repeat of any signal units which are lost in the transmission channel.

The Direct Link Service via the P- and R-channels is a mandatory feature of all AES installations. The Reliable Link Service is mandatory only when packet-mode data services are provided (Section 4.2 refers).

3.2.2 Data Link Layer Data Units

Signaling and control information as well as user packet-mode data are carried in the form of Signal Units (SUs). P-, R-, and T-channels carry exclusively Signal Units, and C-channels carry SUs multiplexed with the circuit-mode voice/data. Signal Units are Link Protocol Data Units (LPDUs).

SUs are organized into octets with the last two octets of each SU being a cyclic-redundancy check sequence for error detection.

A Link Service Data Unit (LSDU) that can be accommodated in a single signal unit is formatted into a Lone Signal Unit (LSU). Longer LSDUs are formatted into more than one signal unit, of which the first is an Initial Signal Unit (ISU) followed by a maximum of 63 Subsequent Signal Units (SSU) and is called an SU-set.

The ISU and SSUs that comprise an SU-set are ordered by the Sequence Number in the standard length signal unit, or by the Sequence Indicator in the extended length signal unit; i.e., SUs on the R-channel.

The Link Interface Data Unit (LIDU) is the total information unit transferred across the interface between a Link Service user and the link layer entity in a single interaction. Each LIDU contains Link Interface Control Information (LICI) and may also contain a Link Service Data Unit (LSDU).

The Link Interface Control Information provides the interaction between two adjacent layer entities; i.e., the link layer entity and a link service user.

The Link Service Data Unit (LSDU) is the part of the Link Interface Data Unit whose identity is preserved between two Link Service Users communicating with each other.

3.3 Data-3 Packet-Mode SubNetwork Services

The specified elements of the data communication system are configured in accordance with the ISO Open System Interconnection (OSI) concepts. The OSI model and definitions applicable to this document are described in Appendix 1. The procedures governing the transmission of satellite subnetwork service data units are covered in Section 4.3.

COMMENTARY

This material is concerned with the packet-mode satellite subnetwork services and functions supported by the satellite subnetwork, and specifically with those functions concerned with data transfer over switched virtual circuits which lie between the satellite subnetwork access sublayer (ISO 8208) and the Link Layer Services.

3.3.1 Link Layer Features

The RLS link layer functions of the P-, R-, and T-channels are used for the provision of packet-mode data services.

3.3.2 Packet-Mode Satellite SubNetwork Services

The SubNetwork Service (SNS) provides for transparent transfer of data between SubNetwork Service users. Each SNS user accesses the SNS by means of a SubNetwork Connection (SNC) end point identifier which has significance within the SubNetwork only. In particular, the SNS provides for the following:

a. Independence of underlying satellite link transmission media.
b. End-to-end transfer across the Satellite Subnetwork.
c. Transparency of transferred information.
d. Quality of service (QOS) selection.
e. SNS-user-addressing.
f. Transfer of globally significant Network Service Access Point (NSAP) addresses used for internetwork routing purposes.

The Satellite Subnetwork offers Connection-Oriented Services. It makes invisible to the Higher Layer Entities (HLEs) the way in which supporting communications resources are utilized to achieve this transfer.

3.3.3 Satellite Subnetwork Service Features

The Subnetwork Service offers the following features to an SNS user:

a. The means to establish a Subnetwork Connection (SNC) with another SNS user for the purpose of transferring SNS-user-data in the form of Subnetwork Service Data Units (SNSDUs).
b. The establishment of an agreement between the two SNS users and both SSND sublayer entities for Quality Of Service parameters associated with each SNC.
c. The means of transferring SNSDUs in sequence on an SNC. The transfer of SNSDUs, which consist of an integer number of octets, is transparent and there are no constraints on the SNSDU content imposed by the SNS.
d. The means of transferring separate expedited SNSDUs in sequence. Expedited SNSDUs are limited in length.
e. The means by which the SNC can be returned to a defined state and the activities of the two SNS users synchronized.
f. The unconditional, and therefore possibly destructive, release of an SNC by either of the SNS users or by the SNS provider.

3.3.4 Satellite Subnetwork Access Protocol

For Data-3, the interface between the AES and the HLE should conform to ISO 8208 Packet Layer Protocol (PLP). The HLE contains the Data Terminal Equipment (DTE) functions. The AES is to contain the Data Communication Equipment (DCE) functions.

Notes:

1. The HLE (in addition to the incorporation of a DTE function) also supports additional functions. The HLE incorporates an internetwork function, a transport function and application functions.

2. The satellite subnetwork does not support end-to-end acknowledgement at the ISO 8208 packet layer; therefore, the D-bit is always cleared to zero by the SDU.

3.3.5 Subnetwork Protocol Data Units (SNPDUs)

The SubNetwork Protocol Data Unit (SNPDU) is a combination of the SubNetwork Protocol Control Information (SNPCI) and the SubNetwork Service Data Unit (SNSDU). It is the total information that is transferred between peer Satellite SubNetwork (sub)-Layer (SSNL) entities across the satellite subnetwork.

The SNPCI supports the joint functions of the SSNL peer entities within an AES and a GES communicating with each other.

The general SNPDU format is given in Attachment 2X, Figure 35. Each SNPDU contains an SNPDU type and a Logical Channel Number (LCN) which identifies a connection within the satellite subnetwork. The maximum length of an SNPDU is 506 octets.

3.4 Circuit-Mode Services

3.4.1 General

Circuit-mode services are optional and are provided using a pair of demand-assigned C-channels (one in each direction) assigned by the GES. The bearer service essentially provides a connection-oriented digital circuit which may be used to support a variety of teleservices such as voice, facsimile, and data transmission using the appropriate channel interface equipment as described in Attachment 2Z.

The service capabilities include:

a. Crew ATS communications
b. Crew AOC communications
c. Crew AAC communications
d. Passenger and crew APC communications

In the forward (ground-to-air) direction, calls should be routed based on the incoming call category; all APC calls should be routed to the Cabin Communications System (CCS); and all other categories of calls to the Cockpit AMS. In the Initial System for commercial aircraft, access is restricted to a limited set of authorized callers such as ATS authorities and aircraft operating agencies. This restriction is imposed by the operator of the aircraft either in the GES or elsewhere at the discretion of the GES operator.

In the return (air-to-ground) direction, communications may be initiated by crew or passengers, with several types of service provided.

COMMENTARY

Airline crew may have access to special services and networks according to specifications and procedures developed by the industry. The capabilities should include at least the following:

a. Access to the public switched telephone network (PSTN).
b. Access to specialized services, via private networks, with or without address digits.
c. Ability to preempt an existing call if necessary to make an aircraft, satellite, or GES channel available (for use in cases such as distress calls).
d. Ability to seize the next available aircraft circuit-mode channel but without clearing any calls in progress.

3.4.2 Quality Objectives

The following are quality objectives for all circuit-mode services:

- The network is to be dimensioned so that the design probability of there being no satellite channel available for a call is less than 1 in 50 attempts in the busy hour of the average day; i.e., blocking probability ≤ 0.02.

The following are quality objectives for the voice services:

- The output voice quality should be acceptable to most people (as demonstrated by an MOS rating of 3.25 or better) where the input BER to the voice codec is no worse than 10^{-3}.
- The codec back-to-back processing delay should be no more than 65 milliseconds.

The following are quality objectives for the facsimile and data services:

- The bit error rate of the satellite channel should be better than 10^{-5} measured after forward error correction decoding and descrambling.

3.4.3 Link Layer Features

The DLS link layer functions of the P-, R-, and sub-band C-channels described in Section 4.2 are used for the provision of circuit-mode services.

3.4.4 Satellite Subnetwork Layer Features

The satellite subnetwork layer has the means to:

a. Allocate a pair of C-channels for the duration of a connection.
b. Establish and terminate circuit-mode connections between users.
c. Change over the connection from basic voice mode to alternate data and facsimile modes.
d. Transfer user-to-user information while a connection exists between the users.
e. Provide a prioritized service, with preemption capability, to different classes of users.

3.4.5 Subnetwork Access Interface

The Integrated Services Digital Network (ISDN) user-network interface D-channel Layer-3 protocol, described in ITU-T Recommendation Q.931/932, is to be used for circuit-mode connection control signaling between the SDU and the Cabin Communications System (CCS) described in **ARINC Characteristic 746**: *Cabin Communications System*.

Call control signaling between the SDU and the Cockpit Communications Systems is to be by means of manufacturer specific user menus on one or more SCDUs/WSCs. The SDU is to control the Lamp and Chime annunciators within the cockpit, for circuit-mode call control.

3.5 Satellite Network Management

The principal satellite network management functions which are to be performed in an AES are as follows:

a. AES Table Management
b. Log Status Management
c. Channel Resource Management
d. Test and Maintenance Functions

3.5.1 Link Layer Features

The DLS link layer functions of the P- and R-channels are used by the Satellite Network Management application.

3.5.2 AES Table Management

The AES table contains the following four categories of information:

a. System Table
b. Log-on Confirm Information
c. Service Capability Dependent Information
d. Owner Requirements Information

All categories are used; however, the last two categories may be empty depending on the AES configuration and service capability installed and the owner's preferences.

3.5.2.1 System Table Category

The system table contains data which is used by the AES to establish initial communication and to carry out the log-on procedure. The currency of the data in this table is maintained by checking its version number and updating the table if there is a new current version. Each satellite region maintains its own system table and revision number. The content of the initial search data is the same for all regions.

3.5.2.2 Log-On Confirm Category

The data in the log-on confirms that information is entered when the AES completes its log-on procedure. The information is updated whenever the AES renews its log-on or there is a data channel reassignment.

3.5.2.3 Service Capability Dependent Category

If the AES has circuit-mode data capability and would like the GES to allocate special data-equipped channel units for all ground-to-air telephone calls, it informs the GES of the expected modem type. If the GES does not support circuit-mode data service, it simply ignores this information. If the GES does support the service, however, it registers the information in its logged-on AES table and retransmits the information for use by other GESs.

3.5.2.4 Owner Requirements Category

If the aircraft owner/operator wishes the aircraft flight number and/or aircraft registration number to be used as the address for ground originated calls, the AES signals this information to the GES at the time of log-on. Initially, this would be the normal way of giving this information to the service provider, but in a later development it could be transferred independently as a consequence of the flight planning procedures. The use of this information in the GES depends on the nature of the services being offered and, thus, is subject to prior arrangement between the aircraft and GES operators.

3.5.3 Log Status Management

Operation of the Aviation Satellite Communications System begins when the AES receives the P-channel of a particular GES. The AES then logs on to the GES to establish the link and exchange information. Operation is terminated when the AES is logged off the system.

3.5.3.1 AES Log-On

Two modes of operation are provided for log-on purposes: automatic and commanded. In automatic mode, log-on is governed by a sequence of pre-set defaults and user preferences programmed into the AES with satellite system log-on and handover procedures being invisible to the aircraft crew. In commanded mode, the crew overrides the choice of satellite service provider and GES selected by the automatic procedure. The normal mode of operation is at the preference of the aircraft operator

However, if log-on cannot be achieved in commanded mode, the AES reverts to automatic mode.

Each AES maintains a System Table which is held in non-volatile memory which provides the information necessary to affect the automatic log-on and handover procedures and to facilitate override of the automatic procedures. Information in the aircraft system table is detailed in Section 4.5.2.1.

3.5.3.2 AES Log-Off

The aircraft should log-off prior to terminating its operation. This log-off may be initiated either in commanded mode or automatically either directly or as a result of some other turn-down procedure associated with the end of an in-service period for the aircraft. The aircraft aborts any calls in progress, and transmits a Request for Log-off to the Log-on GES.

3.5.3.3 Handover Procedures

As the aircraft travels, several handovers may occur, i.e., GES-to-GES, satellite-to-satellite, and spot beam-to-spot beam. Handover is handled as described in Section 4.5.3.4. Both automatic and commanded capabilities should be provided.

3.5.4 Channel Resource Management

3.5.4.1 Channel Unit Management

The information exchanged between the Channel Unit Functions and the Satellite Network Management function is as follows:

Transmit channel units:

- Channel unit number
- Mode (if selectable)
- Bit rate (if selectable)
- Frequency
- Power setting

Selected AES transmit channels should be capable of being turned off by a zero frequency setting by the GES.

Receive channel units:

- Channel unit number
- Mode (if selectable)
- Bit rate (if selectable)
- Frequency
- Receive power level
- Bit Error Rate
- Loss of Clock Synchronization (P- and C-channels)

The Channel Unit Manager has interfaces with other functions in the AES and GES. The interface with the Log Status Management functions are for initial search, assessment of signal quality during log-on, and for channel selection. The interface with the Link Layer functions allows on-going assessment of P-channel signal quality and control of the R/T-channels. The interface with the Circuit Mode Application (see Section 4.4) provides for the control of receivers and transmitters operating in the C-channel mode and for assessment of received signal quality and transmitted power adjustment.

3.5.4.1.1 GNSS Interference Prevention

As required by the RTCA DO-210D Aeronautical Mobile Satellite Services (AMSS) Minimum Operational Performance Standards (MOPS), the AES must ensure that its RF emissions (including intermodulation products) do not cause harmful interference to certain other systems such as the Global Navigation Satellite System (GNSS). For details on how this should be accomplished and the factors that must be taken into consideration, refer to ARINC Characteristic 781 (Mark 3 Aviation Satellite Communication System) Section 3.1.2.4 and its subsections.

3.5.4.2 Channel Power Control

3.5.4.2.1 AES Power Management

The AES has a power budget determined by the maximum power of its transmitting amplifier. The power levels of each of its transmit channels are controllable and the AES ensures that the sum of these falls within the capability of the amplifier.

3.5.4.2.2 Power Setting (R- and T-channels)

Prior to log-on, the AES uses a default power level setting for transmission of the log-on request (see Section 4.5.4.1.1).

R-/T-channel initial EIRP is not to be based on power measurement but on channel bit rate and satellite sensitivity. This power level is passed to the AES in the log-on confirm LSDU as the “initial EIRP” parameter.

Upon receipt of the EIRP setting, the AES adjusts its channel unit power levels accordingly (see Section 4.5.4.1.1).

3.5.4.2.3 Power Setting (C-channels)

Management of this procedure is carried out within the Circuit Mode application (see Section 4.5.4.1.2).

3.5.5 Beam Steering (AES)

In an AES fitted with a high gain antenna, satellite location information from the system table is supplied to the beam steering application in the AES to permit open-loop antenna steering.

3.6 Data 2 Packet-Mode Data Service

Data-2 operation is based on direct access to the RLS link layer service. User data are enveloped and can be any arbitrary set of binary data. The procedures governing the transmission of enveloped messages are covered in Section 4.6.

3.6.1 Link Layer Features

The RLS link layer function of the P-, R-, and T-Channels is used for the provisions of Data-2 packet-mode services.

3.6.2 Data-2 Packet-Mode Services

Data-2 Packet-Mode service provides for the transparent transfer of arbitrary binary data between onboard avionics equipment and the ground user. Once an aircraft is logged on to a GES, a data path exists between the AES and the GES. Packet Priority, Precedence, and Preemption are managed by the next higher entity.

3.6.3 Data-2 Service Features

The Data-2 service provides the following features to onboard avionics equipment:

- The means to establish a connection between onboard avionics units and a ground service provider for the purpose of transferring messages.
- The means of transferring messages from the aircraft to the ground. The transfer is transparent to the end users and there are no constraints on the content imposed by the Data-2 service.
- ACARS message protocol as defined in Section 3 of ARINC Specification 618 is unchanged.

3.6.4 Data-2 Access Protocol

Messages are inserted or collected at the link service interface in the AES. LSDUs are to be sent with the Reliable Link Service (RLS) quality of service. Data-2 messages are to be set at a default Q Precedence level of 7. See Section 4.6.1.

3.6.5 Data-2 Message Format

The general format of a Data-2 Packet-Mode message is given in Attachment 2F-44. Each NPDU contains a two octet header ($FFFF_h$) followed by the message.

4.0 SATELLITE DATA UNIT (SDU) DESIGN

The avionics described in this document permits digital voice and data communications according to the needs of the user. The AES installation consists of a Satellite Data Unit (SDU), the Radio Frequency Unit (RFU) and RF distribution units as described in Section 1.5. The Satellite Data Unit (SDU) and Radio Frequency Unit (RFU) serve as a functional doublet providing all essential services to accommodate effective air/ground communications, via satellite, using the antenna and related RF components described in Part 1. The SDU manages the RF link protocols on the satellite side and provides the appropriate interface with communications management avionics as illustrated in Attachment 1-1, contained in Part 1 of ARINC Characteristic 741. The SDU should be designed in full compliance with the Open System Interconnection (OSI) concepts established in Section 3.

The material contained in this section describes the functions to be performed by the SDU.

COMMENTARY

The functional and procedural properties of the satellite avionics package are divided between the SDU and the RF components of the system. While the functions defined in this Section can be performed in the SDU, emphasis is placed on the nature of the function rather than physical location. It is conceivable that some of the functions described in this Section should be performed in the RFU rather than in the SDU.

4.1 Physical Layer

The Physical Layer defines how the system conveys bits of information through the physical medium. This section provides modulator and demodulator related specifications such as data rates, modulation formats, burst timing, preamble/postamble, error correction coding, and doppler frequency compensation.

For the specific data rates supported by the equipment, the modulation and demodulation characteristics should conform to the specifications of the following sections of the Inmarsat Aero SDM (versions as specified in Section 1.2.2).

- Module 1, Section 3
- Module 1, Tables 1 through 7
- Module 1, Figures 1 through 8
- Module 2, Sections 4 and 5
- Module 2, Figures 1 through 6

4.2 Data Link Layer

The satellite data system provides two types of quality of services at the link layer; i.e., the Direct Link Service (DLS) and Reliable Link Service (RLS).

With either type of quality of service, it is the responsibility of the link layer to transfer information contained in the Link Service Data Units (LSDU) and to annunciate any errors encountered in the transmission. This responsibility includes the following:

- Link Protocol Data Unit assembly
- Synchronization, where required
- Address recognition
- Rejection of invalid signal units
- (For RLS only) Perform selective repeat ARQ functions to supervise correct message reception

The internal structure of the Link Layer comprises a Channel Interface sublayer which passes signal units (SUs) to and from the channel units, a Priority and Routing sublayer which transmits SUs in priority order and reassociates SUs correctly on receipt, and a Link Service Data Unit (LSDU) Segmentation and Reassembly sublayer which converts between lone SUs, sets of SUs and LSDUs. In addition, when RLS is supported, there is a Reliability sublayer located between the Priority and Routing sublayer and the LSDU Segmentation and Reassembly sublayer, which ensure correct reception of sets of SUs. RLS is used when packet-mode data service is provided.

In addition, Link Management functions are defined to provide for:

- **Resource management** - these are functions that control the transmission resources (i.e., channel and time-slot allocations) on the basis of predefined information or received data.
- **Channel unit control** - these are functions that control the use of channel units, including synchronization of T-channel bursts with the time plan and enabling more than one priority and routing sublayer to make use of a single multi-function channel unit, in a defined priority order.

The basic routing paths within this structure are illustrated in Attachment 4X, Figures 33A and 33B.

The functions required by the Priority and Routing sublayer are defined by a Transmit process and Message Assembler processes.

The functions required by the Reliability sublayer are defined by a Queuing Unit process and an AcKnowledge process.

Because the time of dispatch of any particular SU-set is rather uncertain in a Queuing Unit process (the reliability sublayer), the associated Transmit process informs the Queuing Unit at the moment when either the last SU of the set or selected link layer LSUs are dispatched. This allows accurate and, thus more efficient use of timeouts in the LSDU transmission protocol.

4.2.1 Link Layer Formats and Protocols

Signaling and user data LSDUs on the P-, T-, and sub-band C-channels are formatted into standard length signal units of 96 bits (12 octets). This signal unit size allows for the most common transactions to be carried out within only one signal unit with a minimum of spare unused capacity. More complex LSDUs can be carried by a set of several signal units, up to a maximum of 64.

Signaling and user data LSDUs on the R-channel are formatted into extended length signal units of 152 bits (19 octets).

The P-channel protocol applies to the transfer of all types of LSDUs in the forward direction.

The R-channel protocol only applies to short LSDUs which are sent entirely on the R-channel as a series of independent bursts, up to a limit of three bursts.

The T-channel protocol applies to longer LSDUs. A T-channel reservation is made to allow the transmission of the complete LSDU without danger of interference from other traffic.

4.2.2 Link Interface Data Unit

The list of parameters which may compose the LIDU is the following:

- LSDU or LSDU identity for signaling.
- Q precedence level for transmission, or of reception.
- Link Service requirement (i.e., RLS/DLS).
- Transmission quality achieved (error/no error - receive only).
- Application Reference Number assigned by the link service user (when applicable).
- GES ID.
- Transmission acknowledgement (ACK/NACK).
- Flow control parameter (as required).

Attachment 2X, Figure D1a summarizes the LIDU types and which parameters are used by each LIDU.

4.2.3 Link Protocol Data Units (SUs)

Link Protocol Data Units are termed Signal Units (SU).

Three lengths of SUs are defined:

- 48 bits, 6 octets: burst identifier SU (used for T-channels only)
- 96 bits, 12 octets: standard length SUs (used for C-, P- and T-channels)
- 152 bits, 19 octets: R-channel SUs

The formats of the signal units in terms of the information elements they contain are given in Attachment 2X, Figures S1 to S36A, T1 and T2, while the coding of the information elements for those signal units is given in Attachment 2X, Annex 1. The convention for signal unit field mapping and the order of bit transmission is given in Attachment 2X, Figure S0. The use of the standard bit coding rules for some example SUs is illustrated on Attachment 2F-13A.

4.2.3.1 Checks Bits (ITU-T CRC)

Each signal unit includes 16 check bits (the last two octets) for error detection, these being calculated from the first 10 octets of a standard length Signal Unit, or from the first 17 octets of an extended length Signal Unit, or from the first 4 octets of the burst identifier, using the following generator polynomial:

$$x^{16} + x^{12} + x^{5} + 1$$

See ARINC Specification 429, Sections 2.5.12.1 and 2.5.12.2 for the method of calculation, the bit order and error checking.

At the receiver for any channel, the remainder for each received Signal Unit is calculated using the same generator polynomial. If this remainder is different from the expected one; i.e., 0001 1101 0000 1111 - X^{15} through X^{0}, then the received Signal Unit is discarded.

4.2.3.2 SU Format Identifier

The format and function of every Signal Unit is initially identified by the first octet.

4.2.3.2.1 C-, P- and T-channels

Standard length Signal Units are differentiated by the value of their first octet which contains either:

- Message Type (value 0 to $3F_h$).
- A code (value 40_h to FF_h) which identifies the SU as one of the subsequent signal units (SSU) belonging to a multi-SU-set.

A Signal Unit containing a Message Type field may be a Lone Signal Unit (LSU) or the Initial Signal Unit (ISU) of a multi-SU-set.

4.2.3.2.2 R-channel

On the R-channel, the first octet of every Signal Unit consists of:

- A Sequence Indicator (bits 8 to 5) plus
- An SU Type field (bits 4 to 1)

The SU Type field distinguishes between SUs carrying packet-mode data and SUs carrying signaling which have a Message Type field starting at octet 3 which defines the format of the remainder of the SU. See Attachment 2X, Annex 1, for the SU Type and Message Type Coding.

4.2.3.3 Message Type

The Message Type field is used by the AES to route SUs to the appropriate service user.

4.2.3.4 Link Layer Addressing

4.2.3.4.1 Aircraft Earth Station (AES)

The AES ID used in SUs is the 24-bit ICAO aircraft address.

4.2.3.4.2 Aeronautical Ground Earth Station (GES)

The GES ID used in SUs is an 8-bit address defining each GES within the particular satellite region being used.

4.2.3.5 Q Value and Reference Number

In order to allow high priority messages (LSDUs) to interrupt lower priority messages, each message is given a Q number (precedence) in the range 0 (low) to 15 (high). Most signal units incorporate a 4 bit field which explicitly identifies to which precedence the signal unit belongs. For other SUs, the Q number is implicit (function of the message type). The Link Reference Number field logically associates all signal units relating to a particular SU-set transfer. A Link Reference Number with value 0 may not be encoded within the SU. Q Number (precedence) and Link Reference Number are assigned by the Link layer entity.

4.2.3.6 SU Ordering

The ISU and SSUs that comprise a message are ordered by the Sequence Number in the standard length signal unit or by the Sequence Indicator in the extended length signal unit; i.e., SUs on the R-channel.

4.2.4 Channel Unit Interface Sublayer

This sublayer is common to all classes of AESs and is provided in all installations. Its function is to provide an interface between the sublayer above and the physical channel unit hardware.

One instance of this sublayer is associated with each item of physical channel unit hardware in an AES.

4.2.4.1 Universal Receive Functions

At the receive end, this sublayer takes the defined pattern of bits from the receive hardware and calculates whether the check bits for each received Signal Unit are correct. If they are incorrect, the Signal Unit is discarded. All error free SUs are then passed on to the next sublayer.

4.2.4.2 Universal Transmit Functions

At the transmit end, this sublayer takes the information content of the next Signal Unit for transmission, inserts the ITU-T CRC check bits, and provides the resultant pattern of bits corresponding to the completed SU to the transmit hardware at the correct time.

At SDU turn-on, or after receiving a new set of R_d channel frequencies at log on, the frequency to be used for the first R-channel burst is chosen at random from this assigned set. This R-channel selection is unchanged after a successful transmission. However, if a transmission is unsuccessful (detected by time-out) the R-channel for the next burst is again selected at random from this assigned set.

4.2.5 Priority and Routing Sublayer

This sublayer is common to all classes of AESs and is provided in all installations.

4.2.5.1 Instances

4.2.5.1.1 P-channels

One instance of this sublayer is associated with each P-channel.

4.2.5.1.2 R-channels

One instance of this sublayer is associated with a group of R-channel frequencies. The grouping of the R-channels is in accordance with either the Log-on Confirm or data channel reassignment signaling information.

4.2.5.1.3 T-channels

One instance of this sublayer is associated with each group of T-channel frequencies. The grouping of the T-channels is in accordance with either the Log-on Confirm or data channel assignment signaling information.

4.2.5.1.4 C-channels

One instance of this sublayer is associated with the sub-band of each item of physical channel unit hardware which is able to operate as a C-channel.

4.2.5.2 Receive Functions

The functions of this sublayer at the receive end of a link are as follows:

- Receive Signal Units from the Channel Interface sublayer.
- Correctly reassociate received sets of Signal Units with each other even if some are missing due to channel errors.
- Deliver the Signal Units, either individually (for LSUs) or in sets (ISU plus SSUs) to the reliability sublayer (if RLS is in use, see Section 4.2.7) or directly to the Link Service Data Unit (LSDU) Segmentation and Reassembly sublayer.

4.2.5.3 Transmit Functions

The function of this sublayer at the transmit end of a link is to receive Signal Units from the reliability sublayer (RLS) or from the LSDU Segmentation and Reassembly sublayer (DLS), and to ensure that they are delivered in the correct order of precedence to the Channel Interface sublayer. The SUs received from the higher sublayers may be Lone Signal Units (LSUs) or sets comprising an Initial Signal Unit and one or more Subsequent Signal Units (ISU plus SSUs). The transmit function uses a set of first in, first out buffers (queues), one for each Q value.

4.2.5.3.1 Transmission Order (P-, R-, T-channels)

The SU or set of SUs is placed at the tail of the appropriate queue according to the precedence (Q) value, such that the ISU is transmitted first. The Transmit process then transmits these SU by SU with the SU of highest Q value always having precedence at the time of SU transmission. Thus, a multi-unit set of SUs (ISU plus one or more SSUs) may be interrupted, but only by signal units of a higher precedence (Q) level.

For the R-channel, no burst is sent if no traffic SU is ready when the channel becomes available.

4.2.5.3.2 SU Transmitted Timing Signal

For a set of SUs using RLS or link signaling SUs, a supplementary function of this sublayer at the transmit end of a link is to provide a timing signal when the set of SUs has been transmitted. In the case of the R-channel, this signal is provided after each SU of the set has been transmitted. This allows accurate and thus more efficient use of timeouts in the higher layer protocols.

4.2.5.4 Signal Unit Processing

At the transmitting end, the functions of this sublayer are performed by a Transmit process, whereas at the receiving end, they are performed by a receive process called a Message Assembler.

4.2.5.4.1 P-channel Receive Process

The functions used by this sublayer are defined in Attachment 4X, Figure 40C, Process PMA. The process uses a last in, first out stack to save and retrieve the SU(s) currently being processed and their Q numbers.

Upon receiving a Signal Unit, PMA examines the first octet and identifies whether the SU is an SSU or an LSU/ISU. Broadcast SUs, including SUs of the System Table broadcast, are processed as LSUs. System Table SUs, Log Verification SUs, and Fill-in SUs are processed as having a Q value less than 0.

The processing of the SUs then follows the logic given in Attachment 4X, Figure 40C.

4.2.5.4.2 R-channel Transmit Process

The functions used by this sublayer are defined in Attachment 4X, Figure 41B, Process RTP. Tasks of storage and retrieval of SUs are included. These tasks work with a set of sixteen first in/first out queues, one queue for each priority level of the system.

4.2.5.4.3 T-channel Transmit Process

The functions used by the AES T-channel transmit process sublayer are defined in Attachment 4X, Figure 42B, Process TTP. Tasks of storage and retrieval of SUs are included. These tasks work with a set of sixteen first in/first out queues, one queue for each priority level of the system.

Reservation request LSUs or sets of SUs are placed at the tail of the appropriate queue according to their precedence level. This process transmits SUs in reserved slots; according to the time reservations communicated by the T-channel Reservation protocol of the Resource Management functions (refer to Section 4.2.8.1). A transmission is not to be started on the T-channel until a T-channel slot allocation is reached which has previously been notified to the AES by the GES.

An instance of the process TXSU is created to supervise each burst.

Process TXSU generates the initial burst SU (i.e., the burst identifier, signal unit S24) and then continues to select SUs from the queues or fill-in SUs until the slots in the burst are completely filled. As SUs are selected by process TXSU according to their precedence from the queues, it is possible for bursts on the T-channel to carry data from LSDUs other than those which initiated the original reservation request.

TXSU terminates when the current time slot allocation ends.

If all Q buffers are empty at the start of a burst, the T-channel Transmit process (TTP) does not start the transmission. If all Q buffers are empty after a T-channel burst has started, TTP sends fill-in SUs.

4.2.5.4.4 C-channel Receive Process (AES)

The functions used by this sublayer are defined in Attachment 4X, Figure 44B, process FSMA. The process uses a last in, first out stack to save and retrieve the SUs currently being processed.

Upon receiving an SU, the process examines the first octet and identifies whether the SU is an SSU, an ISU/LSU, or a Fill-in SU and examines its Q number. Fill-in SUs are processed as having a Q value of less than 0.

The processing of the SUs then follows the logic given in Attachment 4X, Figure 44B.

4.2.5.4.5 C-channel Transmit Process (AES)

The functions used by this sublayer are defined in Attachment 4X, Figure 45A, process RSCTP. Tasks of storage in and retrieval from the transmit buffer are included.

Signal units are taken from the buffer and are sent for transmission. If there are no signal units waiting to be sent, then fill-in signal units are transmitted.

4.2.6 LSDU Segmentation and Reassembly Functions

The LSDU Segmentation and Reassembly sublayer performs two functions:

- Conversion between LSUs or sets of SUs, and LSDUs.
- SU-sets and LSDU Routing.

SU-sets routing is performed according to the link service need. The routing task of delivering the LSDUs to the correct link service user is performed using the Message Type field contained in all LSUs and ISUs.

4.2.6.1 P-/C-channel LSDU Reassembly

One instance of this sublayer is provided for each P-channel and each forward (ground-to-air) sub-band C-channel in the AES.

4.2.6.1.1 LSDU Reassembly

An LSDU is built from a single LSU by removing the link protocol information, and the associated Link Interface Control Information is created.

Sets of SUs from the Reliability sublayer of the Packet-Mode service (for RLS) or from the priority and routing sublayer (for DLS) are processed as follows:

- Each set of SUs is examined for completeness.
- An LSDU is reassembled by removing the link protocol control information and merging the set of SUs into a single entity.
- The associated Link Interface Control Information is created using link protocol information.

4.2.6.1.2 LSDU Routing

The message type in the LSU or the ISU of a set determines the routing of the LSDU derived from the LSU or the set of SUs. Routing by message type is according to the coding in Attachment 2X, Annex 1.

4.2.6.2 R-/T-/C-channel LSDU Segmentation

One instance of this process is provided for each group of (up to) eight R-channels and (up to) four T-channels associated with a Pd-channel, and each return (air-to-ground) sub-band C-channel at the AES.

4.2.6.2.1 LSDU Segmentation

LSDUs are converted to either a set of SUs or to an LSU. The processing includes:

- Addition of link protocol information, using the associated Link Interface Control Information.
- Assignment of a link reference number to aid association of set members and of retransmissions.

4.2.6.2.2 LSDU and SU-set/LSU Routing

LSDU Routing

In the AES, LSDU routing is the process of selecting, for each LSDU to be sent, the channel to be used. These functions of LSDU routing between R- and T-channels are performed according to the LSDU length.

If the LSDU is short (i.e., up to 264 bits), it may be sent entirely via the R-channel. For long LSDUs, the LSDU is routed to the T-channel.

LSDUs using RLS action are buffered if flow control, as defined in Section 4.2.6.2.5, is not met. Buffered LSDUs are subsequently transmitted so that the first in, first out order is maintained.

SU-set/LSU Routing

On each channel type or group of R- or T-channels, LSUs and sets of SUs are routed to either the priority and routing sublayer for DLS quality of service or to the Reliability sublayer for RLS quality of service.

4.2.6.2.3 Link Reference Numbers

In converting the LSDU into a set of SUs, the link layer entity assigns a Link Reference Number to the SU-set. The allocation by the link layer entity is performed independently for LSDUs sent via the R-channel and T-channel. Once assigned, the couple (Precedence level (Q), Reference number) is used for reassembly purposes at the receiving end, and in subsequent acknowledgement, retransmission, and request for acknowledgement to guard against confusion or duplication. These values are called Q number of message (and Reference number of message, as required) in related signaling transactions. Such related signaling transactions may be transmitted at a different precedence level.

Link reference number series are maintained in each AES for each type of channel by Q precedence level for air-to-ground transfers.

If, temporarily, there is no link reference number available to be allocated, then the LSDU is buffered until a link reference number is released.

On the R-channel, a Link Reference number is released as soon as either the LSDU is passed for transmission (DLS) or the receipt of the LSDU has been acknowledged as correct (RLS) by the peer entity. On the T-channel, an alternate reference number (refer to Section 4.2.6.2.4 below) is released when both the LSDU transmission protocol and the reservation protocol for that LSDU have been satisfied.

4.2.6.2.4 Reference Number Assignment Algorithm

For the R-channel and within each precedence Q level, the Link Reference Number equal to zero is always available, but reserved to the DLS LSDUs which are converted into Lone Signal Units (LSUs) for transmission. Any other Reference Number assignment for each channel type should meet the following specifications. Reference numbers are allocated independently within each Q level. For the R-channel, a newly allocated reference number, different from zero, cannot be equal to the previous most recently deallocated Reference Number. For the T-channel, the 16 possible reference number values are defined in even/odd pairs and the allocation of one value from a pair cannot be made until the other member of the pair has been de-allocated.

On the R-channel, a suitable algorithm to achieve this is to place all non-zero values in a First In First Out (FIFO) register, and take the next value to be used from its output. The FIFO should always contain at least one reference number. On release of a Reference Number value, it would be placed at the input of the FIFO register.

On the T-channel, a suitable algorithm to achieve this is to place all possible even values in a First In First Out (FIFO) register, and take the next value to be used from its output. On release of a Reference Number value, its alternate (i.e., the other member of that even/odd pair) would be placed at the input of the FIFO register.

4.2.6.2.5 Flow Control Requirements

In the AES, flow control is defined independently on the R- and T-channel as follows:

At each Q level, the R-channel protocol is capable of handling only one RLS LSDU at a time. If an RLS LSDU is submitted to the link layer before the previous RLS LSDU at that Q level has been acknowledged, the new LSDU is buffered and forwarded as soon as the acknowledgement of the previous one is received.

While the T-channel protocol is capable of handling up to 8 RLS LSDUs at each Q level, limits on the submission of LSDUs are set according to the maximum T-channel rate. These limits limit the flow of Request signals on the R-channel, as well as the extent of the GES time plan necessary to service the traffic. Variation according to the T-channel rate is used because of the widely differing performance of the lowest and highest T-channel rates.

The limits are expressed in terms of both number of LSDUs and data volume (SUs). They are given in the table below:

Maximum T-Channel	LSDU Limit	SU Limit
600 bps	4	70
1200 bps	6	140
2400 bps	8	210
10500 bps	8	280

When a new LSDU is submitted to the link layer, limits apply if:

- The number of preceding LSDUs is equal to or higher than the LSDU limit, or,
- The number of SUs corresponding to these same LSDUs is equal to or higher than the SU limit.

Then, the new LSDU should be buffered without requesting a reservation. Reservation is requested when the LSDU is effectively processed for transmission.

For the purpose of this section, preceding LSDU means LSDUs at the same Q level or above which have not yet been acknowledged with a Success, Fail, or DLS Transmitted signal.

4.2.7 Reliability Sublayer

This sublayer is common to all classes of AESs which offer the Reliable Link Service.

One instance of this sublayer is associated with each P-channel, group of R-channels, and group of T-Channels.

The receiving Reliability sublayer receives sets of SUs needing RLS quality of service, together with relevant LSUs from the Priority and Routing sublayer, checks whether the set is complete and informs the transmitting Reliability sublayer accordingly. If the set of SUs was incomplete, the missing SUs are retransmitted. The receiving Reliability sublayer then passes corrected sets of SUs to the LSDU Segmentation and Reassembly sublayer (see Section 4.2.6).

4.2.7.1 P-Channel RLS Receive Functions

The sequence for ground-to-air data transfer is shown in Attachment 2X, Figure 24. The complete event tree for the LSDU transfer protocol used in the ground-to-air direction, is in Attachment 2X, Figure 25. Values for the timers used are given in Attachment 2X, Annex 2.

Referring to Attachment 2X, Figure 25, in Epoch 1G the SU-set is sent via the P-channel from the GES. For data length greater than 4 octets, it is sent as one user Data ISU (Attachment 2X, Figure S21) followed by a series of SSUs (Attachment 2X, Figure S21A). For data length of 2, 3, or 4 octets, a lone signal unit of format S21, S21B, or S21C, respectively, is used.

4.2.7.1.1 No Errors

If the complete sequence of ISU plus SSUs arrives without error, the AES responds via the R-channel with a P-channel ACKnowledge LPDU (PACK - Attachment 2X, Figure S31) which indicates by means of the Acknowledge Control field that there are no errors in the received SU-set (Epoch 1A). The SU-set is then forwarded to the LSDU reassembly sublayer.

4.2.7.1.2 SU-set Errored

In the event that part (<= 42 SSUs) of the original SU-set is lost (e.g., one or two SUs out of a 10-SUs set), the AES responds with PACK LPDU(s) (Epoch 1A) which indicates which SUs were lost, and the GES can then format a retransmission SU-set (RTX - Attachment 2X, Figure S22 plus the necessary SSUs, Epoch 2G). If this retransmission arrives error free, the AES inserts the received SUs into the SU-set it is holding, and on finding that the SU-set is now complete sends a PACK LPDU indicating no errors in the received SU-set (Epoch 2A).

In the event that more than 42 SSUs of the original SU-set are lost, the AES response is a PACK LPDU with a request for a complete retransmission of the initial set. The procedure described above then applies with the AES discarding any duplicated received SUs.

4.2.7.1.3 Retransmission Errored

In the event that the retransmission also suffers loss of SUs or that the PACK LPDU was not completely received due to channel errors, the new PACK LPDU indicates the revised list of retransmissions required using the procedure defined in Section 4.2.7.1.2 above.

4.2.7.1.4 Request for Acknowledgement

The AES may receive a ReQuest for Acknowledgement (RQA-Attachment 2X, Figure S15) resulting from the following cases:

- Initial SU-SET loss: the corresponding SU-SET correction is not in progress and the RQA does not refer to an SU-SET which has been processed just before.
- Negative acknowledgement loss or retransmission loss: the corresponding SU-SET correction is in progress.

- Positive acknowledgment loss: the RQA refers to an SU-SET which has been processed just before.

Depending on the case, the AES response to an RQA is either a PACKe LPDU with a request for a complete retransmission, indicated by the Acknowledge Control field (case a), or the repeat of previously sent PACKe LPDU(s), on a randomly selected R-channel (case b), or the repeat of previously sent PACKo LPDU, on a randomly selected R-channel and indicating that the corresponding SU-set has been correctly received and forwarded to the link service user (case c).

4.2.7.1.5 RQA or Retransmission Lost

The AES applies time supervision so that if an RQA or retransmission is lost, the PACKe LPDU(s) is (are) repeated again. The AES sends the PACKe LPDU(s) a maximum of 5 times without receiving a response from the GES, after which the partially received SU-set is discarded.

4.2.7.2 R-channel RLS Transmit Functions

The sequence for R-channel data transfer is shown in Attachment 2X, Figure 26. The complete event tree for the LSDU transfer protocol used on the R-channel, in the air-to-ground direction, is in Attachment 2X, Figure 28. Values for the timers used are given in Attachment 2X, Annex 2.

An Air-to-Ground LSDU is formatted into one User Data ISU (Attachment 2X, Figure S25) followed by 0, 1, or 2 SSUs (Attachment 2X, Figure S25) and sent on the R-channel (Epoch 1A).

When a set of SUs which requires RLS is received from the LSDU Segmentation and Reassembly sublayer, and if no other RLS LSDU exists for the Q level on which the set of SUs is being transmitted, it is passed to the Priority and Routing sublayer and a copy of the set of SUs is retained in case it is necessary to retransmit any of them.

For sets of SUs requiring Reliable Link Service on the R-channel, the link layer provides the necessary repeat attempt control needed because of possible collisions with other users. Under normal operation if the first transmission is unsuccessful this is detected by timeout and an R-channel is selected at random and a repeat transmission is attempted automatically. The actual duration of the timeout includes the duration of a random number 0 to Zk of R-channel slots at the bit rate of the R-channel in use, in addition to the basic time-out from the previous transmission. The basic timeout period given in Annex 2. The value of Zk may be expressed as:

$Zk = Zo*2^K$ where Zo = 4 and K is the number of the attempt (initially k = 0).

Thus, the randomization index Zk starts off at 4 slots, and doubles for each succeeding attempt. Repeat bursts are transmitted up to a maximum of four (4) reattempts, after which the attempt is deemed to be unsuccessful.

If five repeat transmissions are unsuccessful (no acknowledgement is received), then the error is reported to the higher layer, by means of a fail indication LIDU and the link reference number is released.

The acknowledgement from the GES may indicate that the set of SUs has been received without error (RACKo), or that the transmission contained errors, thus one or two SUs are to be retransmitted (RACKe).

Reception of a RACKe LPDU results in the reliability sublayer in the AES formating a retransmission set containing the lost SU(s) which was (were) indicated in the RACKe LPDU and passing the transmission set to the Priority and Routing sublayer. The value of K is reset to zero and the procedure is repeated until the AES receives a RACKo LPDU.

4.2.7.3 T-channel RLS Transmit Functions

The sequence for T-channel data transfer is shown in Attachment 2X, Figure 27. The event tree for the LSDU transfer protocol is depicted in Attachment 2X, Figures 29A and 29B. Values for the timers used are given in Attachment 2X, Annex 2. AES process TTXPROC for the RLS protocol is defined in Attachment 4X, Figure 42A.

There are two protocols, one (Attachment 2X, Figure 29A) for the request of T-channel capacity (the resource management functions refer to Section 4.2.8.1), and the other (Attachment 2X, Figure 29B) for the transmission of the set of SUs. The latter starts on the T-channel, once the AES has received a T-channel slot allocation.

When a set of SUs which depend upon RLS is received from the LSDU Segmentation and Reassembly sublayer, it is passed to the Priority and Routing sublayer and a copy of the set of SUs is retained in case they are to be retransmitted. A reservation is to be made to counter for the capacity used by these SUs on the T-channel.

The acknowledgment from the GES may indicate that the set of SUs has been received without error (TACKo) or that the transmission contained errors, thus one or more SSUs are to be retransmitted (TACKe-set), or that transmission of the whole set is to be repeated (TACKr).

4.2.7.3.1 No Errors

If the AES receives a T-channel ACKnowledge LPDU (TACK - Attachment 2X, Figure S16B) which indicates by means of the Acknowledge Control field that there are no errors in the received SU-set (Epoch 1G), the sequence is finished (Epoch 2A), and a Success indication is sent to the link service user in the AES.

4.2.7.3.2 SU-set Partial Loss

If the AES receives a T-channel negative AcKnowledgement set consisting of 1 or more TACKe (Attachment 2X, Figure S16B), giving the list of the SSUs to be retransmitted, it then formats a retransmission SU-set (RTX - Attachment 2X, Figure S22 plus the necessary SSUs, Epoch 2A).

The AES also receives a T-channel slot reservation, sufficient to enable the retransmission of the (faulty) signal units.

4.2.7.3.3 Acknowledgement Lost

If the TACK LPDU from the GES is lost, the AES times out (Epoch 2A) and sends a ReQuest for Acknowledge (RQA - Attachment 2X, Figure S30) on the R-channel. The AES continues to apply time supervision so that if either the RQA LPDU is lost in the R-channel transmission or the TACK is lost a second time, the RQA is repeated again, on a randomly selected R-channel, and so on. The AES sends the RQA a maximum of 5 times, after which a Fail indication LIDU is sent to the link service user in the AES.

4.2.7.3.4 SU-set Complete Loss

If the SU-set is not received at all, at the GES, the AES times out and sends an RQA LPDU (Epoch 2A). As a result, the AES receives a TACKr LPDU from the GES (Attachment 2X, Figure S16B) requesting the retransmission of the complete SU-set, from which the protocol returns to its starting point. A T-channel reservation for the retransmission of the complete SU-set is also received. If the RQA or TACKr LPDU is lost, the RQA is repeated as described in Section 4.2.7.3.3 above.

4.2.8 T-channel Management Functions

The Link Management functions are as follows:

a. **Resource management functions** - these are functions that control the transmission resources (i.e., channel and time-slot allocations) on the basis of predefined information or received data.
b. **Channel unit control functions** - these control the use of channel units, including synchronization of T-channel bursts with the time plan and enabling more than one upper layer to make use of a single multi-function channel unit, in a defined priority order.

The resource management functions provide the actions and procedures to control the current LSDU routing. These include the request for TDMA slot allocation, as needed, and the control of the received parameters compatible with the TDMA requirements.

Due to the fact that the resource management functions are performed in both the AES and the GES, a T-channel reservation protocol is defined.

4.2.8.1 T-channel Reservation Protocol

The event tree for the T-channel allocation request protocol is depicted in Attachment 2X, Figure 29A. Values for the timers used are given in Attachment 2X Annex 2.

4.2.8.1.1 Access Request

Upon the receipt of an LSDU which uses a TDMA slot allocation, the AES sends an access request to the GES via the R-channel or T-channel (Epoch 1A - Attachment 2X, Figure S29 or Figure S4A respectively). An access request is also sent when the AES detects that a TDMA slot allocation sent after a negative acknowledgement of a previously sent SU-set, has been lost.

The AES applies time supervision so that if it does not receive the requested T-channel reservation, it repeats the process (Epoch 2A). The AES repeats the request on the R-channel for up to four times, after which the request is deemed to have failed and the AES initiates an error recovery procedure by deleting SUs waiting for transmission to counter for the requested capacity not received.

The criterion for deciding whether to use the T-channel or the R-channel for the reservation request, is that if there is a T-channel burst due to start in the current time window (8 seconds) or the AES is currently transmitting a T-channel burst, then the T-channel is used. Otherwise the R-channel is used. When the access request is sent via the T-channel, the requested capacity is increased by one SU for the request itself.

4.2.8.1.2 Reservation Synchronization

At the transmitting end (AES), the TDMA reservation applies to one of the 16 (0.5 second) frames following the current frame number according to the frame number in the reservation (i.e., it does not normally correspond to a whole superframe, but does cross a superframe boundary). The reservation is to be received no more than eight seconds before the intended transmission time. For this reason the GES delays the reservation if necessary. If the AES receives a Reservation Forthcoming (RFC) signal, the AES extends its time supervision, to the expected time of the reservation, thus satisfying the reliable request/reservation protocol.

4.2.8.1.3 Additional T-channel Assignments

The AES also receives a T-channel and time slots to accommodate the capacity used by the retransmission of faulty signal units (Sections 4.2.7.3.2 through 4.2.7.3.4 refer) plus any additional control information associated with the retransmission. Such reservation is received after the associated TACK-set.

The AES may also receive unsolicited reservations (Attachment 2X, Figure S10).

4.2.8.1.4 Recovery Actions During AES Management Operation

The AES management function provides the data link layer entity with AES log-on information by means of AES management interface data units, Attachment 2X, Figure D1b and Attachment 4X, Figure 33C refer.

In the case where the AES is not able to transmit (or complete the transmission of) a T-channel burst during a T-channel reservation, the AES discards a sufficient number of SU(s) from its transmit buffer to counter for the unused capacity.

When an AES has completed a GES-to-GES or satellite-to-satellite handover procedure, the AES releases all link layer resources (i.e., all buffers and stored parameters, all processes, and all T-channel reservations assigned by the old GES).

4.2.8.2 T-channel Unit Control

T-channel bursts are to be controlled in accordance with the time plan received from the GES, commencing the burst at the correct time, and sending the allocated number of SUs. If channel unit hardware in the AES is limited, the Channel Unit Control functions act on the T-channel time plan in relation to the R-channel slots, and provide controls to the channel interface sublayer to enable correct operation of both R- and T-channels on a single channel unit.

4.2.8.2.1 R-/T-channel Arbitration

For each assigned burst, the T-channel hardware is to be informed of when to transmit, and the number of SUs to include in the burst.

In the case of a single multi-mode R-/T-channel Unit, arbitration is based on the T-channel burst time plan and the R-channel burst slot timing. The Channel unit is always available for transmission of an R-channel burst, unless some part of that burst would overlap with some part of an assigned T-channel burst. Thus, assigned T-channel bursts have priority in the use of the channel unit hardware.

4.2.9 Timing

4.2.9.1 P- to R-channel Turnaround Timing

Upon receiving a set of SUs (or a single SU) from a GES on the P-channel for which a response is provided on an R-channel, the AES should issue the first SU of the provided response within the number of R-channel slots specified in the tables below.

<u>P-channel rate = 600 bps</u>

Number of SUs (or last SU in the frame)	1	2	3	4	5	6
R-Channel slot for response						
600 bps R-channel	2	2	3	3	3	4
1200 bps R-channel	3	4	5	5	6	7
2400 bps R-channel	6	8	9	10	11	13
10500 bps R-channel	12	15	17	20	22	26

<u>P-channel rate = 1200 bps</u>

Number of SUs (or last SU in the frame)	1	2	3	4	5	6
R-channel slot for response						
600 bps R-channel	1	2	2	2	2	2
1200 bps R-channel	2	3	3	3	4	4
2400 bps R-channel	4	5	6	6	7	8
10500 bps R-channel	8	10	11	12	13	15

<u>P-channel rate = 2400 bps</u>

Number of SUs (or last SU in the frame)	1	2	3	4	5	6

R-channel slot for response

600 bps R-channel	1	1	1	2	2	2
1200 bps R-channel	2	2	2	3	3	3
2400 bps R-channel	4	4	4	5	5	5
10500 bps R-channel	7	8	8	9	10	10

<u>P-channel rate = 4800 bps</u>

Number of SUs (or last SU in the frame)	1	2	3	4	5	6

R-channel slot for response

600 bps R-channel	1	1	1	1	1	1
1200 bps R-channel	2	2	2	2	2	2
2400 bps R-channel	3	4	4	4	4	4
10500 bps R-channel	6	7	7	7	8	8

<u>P-channel rate = 4800 bps (cont'd)</u>

Number of SUs (or last SU in the frame)	7	8	9	10	11	12

R-channel slot for response

600 bps R-channel	1	2	2	1	1	1
1200 bps R-channel	2	3	3	3	3	3
2400 bps R-channel	4	5	5	5	5	5
10500 bps R-channel	8	9	9	9	10	10

<u>P-channel rate = 10500 bps</u>

Number of SUs (or last SU in the frame)	1	2	3	4	5	6

R-channel slot for response

600 bps R-channel	1	1	1	1	1	1
1200 bps R-channel	2	2	2	2	2	2
2400 bps R-channel	3	3	3	4	4	4
10500 bps R-channel	6	6	6	7	7	7

<u>P-channel rate = 10500 bps (cont'd)</u>

Number of SUs (or last SU in the frame)	7	8	9	10	11	12

R-channel slot for response

600 bps R-channel	1	1	1	1	1	1
1200 bps R-channel	2	2	2	2	2	2
2400 bps R-channel	4	4	4	4	4	4
10500 bps R-channel	7	7	7	7	8	8

P-channel rate = 10500 bps (cont'd)

Number of SUs (or last SU in the frame)	13	14	15	16	17	18
R-channel slot for response						
600 bps R-channel	1	1	1	1	2	2
1200 bps R-channel	2	2	2	2	3	3
2400 bps R-channel	4	4	4	4	5	5
10500 bps R-channel	8	8	8	8	9	9

P-channel rate = 10500 bps (cont'd)

Number of SUs (or last SU in the frame)	19	20	21	22	23	24
R-channel slot for response						
600 bps R-channel	2	2	2	2	2	2
1200 bps R-channel	3	3	3	3	3	3
2400 bps R-channel	5	5	5	5	5	5
10500 bps R-channel	9	9	9	9	9	10

P-channel rate = 10500 bps (cont'd)

Number of SUs (or last SU in the frame)	25	26
R-channel slot for response		
600 bps R-channel	2	2
1200 bps R-channel	3	3
2400 bps R-channel	5	5
10500 bps R-channel	10	10

4.2.9.2 Multiple R-channel SUs Transmission Timing

In the case where an AES has a set of SUs to transmit on an R-channel, the AES should issue these SUs in consecutive R-channel slots and on the same R-channel unless an R-channel congestion has been detected by a higher layer.

4.2.9.3 Pd/T-channel Slot Assignment Response Time

The AES should be able to issue a T-channel burst of a defined number of Signal units (S21, S21A) within TPT seconds following the correct reception of a T-channel assignment (S11) and providing the assignment corresponds to this time slot.

This timing is defined as follows:

TPT = TT - TP

TT = Time when the leading edge of the return burst preamble is delivered to the antenna

TP = Time when the trailing edge of the unique word preceding S11 passes the antenna, S11 being sent in first position within the P-channel frame

TPT value depends on the P-channel bit rate and is given in the table below.

P-Channel rate (bps)	600	1200	2400	4800	105000
TPT (seconds)	1.8	1.2	1	1	1

4.2.9.4 R-/T-Channel Switch-Over Timing

Note: This timing only applies for AESs with a single R-/T-channel unit.

The AES should switch from an R-channel configuration to a T-channel configuration within 0.2 second preceding the start of a T-channel reservation.

The AES should not start the transmission of an R-channel burst if a T-channel reservation has been received for start within the following R-channel plus the time required to switch from an R-channel configuration to a T-channel one.

4.2.9.5 T-/R-Channel Switch-Over Timing

Note: This timing only applies for an AES with a single R-/T-channel unit.

The AES should switch from a T-channel configuration to an R-channel configuration within 0.2 second following the end of a burst, providing no other T-channel reservation has been received for the next slot window. The slot window is defined as the time between the current time and the end of the following R-channel slot plus the time to switch from an R-channel configuration to a T-channel one.

4.2.10 Buffer Size Requirement

4.2.10.1 Minimum Buffer Size

The following specifications should be met by all class of AES.

4.2.10.2 Buffer Size Requirement for Packet-Mode Data Services

Note: These specifications do not take into account worst case conditions which are expected to be not realistic, such as SU-sets of all possible Q precedence levels and of maximum length interrupting each other. Furthermore, it is expected that dynamic buffer allocation applies; i.e., a buffer is not permanently associated to SU-sets at a given Q precedence level.

The AES should be able to simultaneously process at least any valid combination of SU-set lengths and Q precedence levels, subject to one SU-set per Q precedence level, within a total of 200 SUs when these SU-sets have been received with errors via a P-channel (P-channel acknowledge and correction processes).

The AES should be able to temporarily store a minimum of 160 P-channel SUs received on the P-channel (P-channel message assembler process).

The AES should be able to simultaneously process at least 8 T-channel SU-sets with a total of 160 SUs and in addition be able to store 8 T-channel LSDUs with a total of 1,300 octets for later processing (T-Channel Request Generator/T-Channel Queuing Unit processes).

The AES should be able to temporarily store a minimum of 160 T-channel SUs for transmission on the T-channel (T-channel Transmit process).

The AES should be able to simultaneously process at least five R-channel SU-sets (of different Q precedence levels) of 3 SUs each and in addition be able to store five R-Channel LSDUs (one per currently processed Q precedence level) with a total of 165 octets for later processing (T-channel Request Generator process).

The AES should be able to temporarily store a minimum of 25 R-channel SUs for transmission on the R-channel (R-channel Transmit process).

4.2.11 Delayed Echo Application

COMMENTARY

In view of the complexity of the signaling and communications protocols of the aviation satellite system, a set of standard tests may be used to demonstrate compliance with the system specifications. Use of these test procedures should relieve manufacturers and integrators of the need to develop separate procedures and greatly reduce the time to review the test plan and procedures for a new AES design.

The approach used in developing detailed test cases for link layer tests is to assume the existence in the unit under test of a function called the Upper Tester which resides at the top of the link layer and responds to stimuli received from a Lower Tester. In this case, the Upper Tester comprises functions built into the AES, and the lower tester is logic incorporated in a GES simulator or similar bench test set. The standard Upper Tester is called the Delayed Echo Application (DEA).

Tests have been developed using the ISO 9646 standardized test methodology and are published by satellite service providers.

The DEA is an optional function, but to take advantage of the standardized link layer detailed test cases, an AES manufacturer/integrator has to provide the necessary DEA in the AES.

4.2.11.1 Overview

The DEA Protocol is based on the principle of parameterized echo: a DEA Protocol Data Unit is included in the user data parameter of any set of SUs which may contain user data. This is used to dictate the behavior of the System Under Test (SUT).

The echo is parameterized in the sense that:

a. The expected reaction is determined by the received DEAPDU. The expected reaction is in general to pass data to the link layer for downlink transmission.
b. The DEAPDU also indicates the parameters to be used for downlink transmission.
c. The DEAPDU also indicates what user data is to be downlinked.

Additionally, the expected reaction may be delayed.

4.2.11.1.1 Reaction Queue

The DEA maintains a queue of reactions to be processed according to the delay parameter value associated with each delayed reaction. The queue has to be able to hold a minimum of five responses with a total of 600 octets.

The reaction queue can be purged under command from the Lower Tester.

The execution of the queue is triggered by a command from the Lower Tester.

4.2.11.1.2 Additional Buffer

In addition to the reaction queue, the DEA has to memorize at least the two last received Link Interface Data Units (LIDUs) for the report function.

4.2.11.2 Service Assumed from the Link Layer Under Test

The service assumed is the service described in Sections 4.1 through 4.3.5.2.

4.2.11.3 Definition of the DEAP

4.2.11.3.1 Implicit Reactions

The DEA takes no action (other than memorizing the LIDU) if it receives:

a. Either a DEAPDU whose LICI indicates that it has been received in error (when using DLS).
b. An LIDU which indicates that an R-/T-channel transmission has failed (RLS).
c. An LIDU which indicates that an R-/T-channel message has been acknowledged by the ground (RLS).
d. An LIDU which indicates that transmission of an R-/T-channel message has been completed (DLS).

The DEA purges the queue if it receives an LIDU indicating that a P-channel degradation has been detected. A DEA protocol error results in a do nothing reaction.

4.2.11.3.2 Explicit Reactions

The Lower Tester uses the DEAP to inform the DEA how to react to the LIDU it has received. Each DEAPDU, therefore, includes a reaction code. The DEA reacts both to the DEAPDUs just received and to the reactions which have been previously stored in the queue.

4.2.11.3.2.1 Definition of DEAPDU Sent by the Lower Tester

There is only one DEAPDU type sent by the Lower Tester and received by the DEA. The coding of such DEAPDU is given in Attachment 2X, Figure D2. The DEAPDU has the following parameters:

REACTION	This parameter indicates the reaction expected. The possible values of the REACTION parameter are as follows: • Send data • Execute queue • Purge queue • Do nothing
DELAY (D)	If the delay flag is true then the LIDU built according to the REACTION parameter is to be stored in the reaction queue; a delay parameter value is then included in the RES-PAR-VAL field of the DEAPDU. If false, the LIDU is to be passed immediately to the link layer entity. The delay flag can only be set to true in a DEAPDU whose reaction parameter is set to Send Data.
RES-DAT-TYP	The RESponse-DATa-TYPe para-meter indicates the data to be put into the user data field of the LSDU sent back to the lower tester. This can indicate that the DEAPDU should be echoed back or that the DEA should send a report DEAPDU, indicating the Link Interface Data Unit which has been received just before the one which contains the current DEAPDU.
RES-PAR-VAL	The RESponse-PARameter-VALue consists of a series of TLV (type, length, value) fields, each of which corresponds to a link layer parameter to be used for the data transmission which may be different from the ones which have been used in the forward direction. If the delay flag is true, one of the TLV fields also contains the delay parameter value for echoed DEAPDU.
DATA	This field contains transparent user data, up to the end of the data field of the received DEAPDU.

RES-DAT-TYP, RES-PAR-VAL parameter fields are only present in a DEAPDU whose reaction parameter is set to Send Data.

4.2.11.4 Processing of Valid Explicit Reaction

When processing a valid explicit reaction, the DEA memorizes temporarily the associated LIDU and does one of the following:

a. If the REACTION parameter of the received DEAPDU is do nothing, the DEA simply absorbs the DEAPDU.

b. If the REACTION parameter of the received DEAPDU is purge queue, the reaction queue is emptied and stored reactions are not processed.
c. If the REACTION parameter of the received DEAPDU is execute queue, the DEA follows the procedure defined in Section 4.2.11.4.1 below.
d. If the REACTION parameter of the received DEAPDU is send data, the DEA follows the procedure defined in Section 4.2.11.4.2 below.

4.2.11.4.1 Processing an Execute Queue

The DEA executes this procedure when it receives a correct DEAPDU whose reaction parameter is set to execute queue.

When executing this procedure, if the reaction queue is empty, the DEA terminates the procedure, otherwise, the following actions are taken:

a. The DEA starts a timer and processes the reactions which have been stored in the reaction queue.
b. When the timer value is equal to the delay parameter value of a stored reaction, the DEA transmits to the link layer a LIDU containing the DEAPDU.
c. When all the queued reactions have been processed, the timer is stopped (and reset).

4.2.11.4.2 Processing a Send Data

4.2.11.4.2.1 Delayed Reactions

When the DEA receives a DEAPDU with delay flag set to true, the DEA builds an LIDU according to the procedure described in Section 4.2.11.5 below and stores it into the reaction queue.

4.2.11.4.2.2 Immediate Reactions

When the DEA receives a DEAPDU with delay flag set to false, the DEA acts immediately on the reaction code. The DEA builds an LIDU according to the procedure described in Section 4.2.11.5 below and transmits it immediately to the link layer.

4.2.11.5 Building a Reaction

4.2.11.5.1 Building the Link Interface Control Information

The Link Interface Control Information is built according to the fields received in the RES-PAR-VAL parameters. Each field contains the value to be used for each parameter of the LICI. All parameters, other than the delay parameter, are always present.

4.2.11.5.2 Building User-Data (DEAPDU Sent by the DEA)

When the response LIDU is built, the following rules apply:

a. If the RES-DAT-TYP parameter specifies ECHO, user data is built according to the procedure described in Section 4.2.11.5.2.1 and passed as the link service data unit field of the built LIDU.

b. If the RES-DAT-TYP parameter specifies REPORT, user data is built according to the procedure described in Section 4.2.11.5.2.2 and passed as the link service data unit field of the built LIDU.

4.2.11.5.2.1 Echo

The Link Service Data Unit is built according to the following procedure:

a. If the first octet of the DATA parameter of the received DEAPDU is equal to FF (hexadecimal value), the LSDU put into the built LIDU is composed of the first N octets of the received DEAPDU where N is a number ranging from 1 to 255 and coded in the second octet of the DATA parameter of the received DEAPDU.
b. If the first octet of the DATA parameter of the received DEAPDU is different from FF (hexadecimal value), the Link Service Data Unit contains the LSDU as received in the LIDU; i.e., the entire DEAPDU is echoed including the header of the received DEAPDU and up to and including its DATA parameter.

4.2.11.5.2.2 Reporting

The Link Service Data Unit contains a Report DEAPDU, indicating the Link Interface Data Unit which has been received just before the one which contains the current DEAPDU and is coded according to rules given in Attachment 2X, Figure D3. Its parameters are built as follows:

RECEIVED-LIDU	Contains a code identifying the received LIDU (see Attachment 2X, Figure D3).
RECEIVED-PAR	The RECEIVED-PARameter contains a list of TLV encoded values, each of which represents a parameter of the received LIDU. The list which is to be included is specified in Figure D1a, using the entry designating the LIDU. All parameters listed in the entry are to be present and in the same order. No extra parameter can be included, even with a null length.

4.3 Packet-Mode Data Services

This section specifies the procedures which have to be performed by the SDU for the establishment, use, and release of Switched Virtual Circuits (SVCs) within the Satellite SubNetwork, and the interworking between satellite SubNetwork Protocol Data Units (SNPDUs), and packets defined in ISO 8208 Packet Layer Protocol (PLP) for providing Connection-Oriented SubNetwork Service to the satellite SubNetwork Service (SNS) user.

4.3.1 Link Layer Functions

The packet-mode data service makes use of the Reliable Link Service (RLS) for the transmission of SubNetwork Protocol Data Units over either the P-Channel (forward direction) or the R- and T-Channels (return direction). The SDU should then provide the Reliability Sublayer of the link layer (Section 4.2.7 refers).

4.3.2 Satellite SubNetwork Layer Structure

Attachment 2X, Figure 34 illustrates the essential elements of the satellite subnetwork and their relationship to the user of the subnetwork. The user accesses the satellite subnetwork by means of the satellite SubNetwork Access (SNAc) sublayer (Interface 1 of Attachment 2X, Figure 34). The SDU Satellite SubNetwork Layer (SSNL) entity both communicates with its counterpart on the ground using a peer-to-peer protocol, named Satellite SubNetwork Dependent (SSND) protocol, and provides interworking functions between the SNAc protocol and the SSND protocol.

4.3.2.1 SubNetwork Access Sublayer

The satellite SubNetwork Access (SNAc) sublayer for packet-mode data services is an ISO 8208 Packet Layer Protocol (PLP) conformant interface implementing the features listed below. That part of the SDU which manages the user interface function contains the DCE. The Higher Layer Entity (HLE) contains the DTE functions.

All information either received by the SSNL from the HLE or transferred to the HLE are organized within ISO 8208 packets.

Note: The operation of the SDU as specified in this standard assumes that the HLE:

a. Supports the operations of the DTE as specified in ISO 8208.
b. Is able to initiate, accept, and terminate calls via the interface.
c. Is prepared to accept error messages from the AES.
d. Monitors the AES operation in case of unrecoverable error conditions and reinitializes the AES as necessary.

Note: The Satellite Subnetwork does not support end-to-end acknowledgement at the ISO 8208 packet layer; therefore, the D-bit is always cleared to zero by the SDU.

4.3.2.1.1 ISO 8208 Protocol Implementation Conformance Statement

The interface between the HLE and the AES should conform to ISO 8208 with the following characteristics. It should provide for:

a. A User Data Field (in the CALL REQUEST, DATA, CLEAR REQUEST and CALL ACCEPT packets) of up to 128 bytes.
b. Expedited Data Delivery; i.e., the use of INTERRUPT packets with a User Data Field of up to 32 bytes.
c. Called and Calling User Address Extension Facility.
d. Fast Select.
e. Fast Select Acceptance.
f. Throughput Class Negotiation.
g. Transit Delay Selection and Indication.
h. End-to-End Transit Delay Negotiation.
i. Minimum Throughput Class Negotiation.
j. Default packet size of 128 bytes.

k. Modification of the returned Called NSAP.
l. Priority on data on a connection.

4.3.2.1.2 AES Specific Service Interface Requirements

In addition to the above facilities, the interface between the HLE and the AES should provide for Two Way Virtual Calls using predefined logical channel numbers in the range of 2565 to 2816 as defined in Attachment 2F-39.

4.3.2.2 Satellite SubNetwork Sublayer

The SSNL is the peer entity of the SSNL contained within the GES. The two processes control the transfer of SNPDUs to and from the AES. The SSND protocol used to accomplish this is closely patterned after the operation of an ISO 8208 interface for Switched Virtual Circuits (SVC).

The state transition diagram of each logical channel in the SSNL entity, under normal operation, is shown in Attachment 2X, Figures 36A, 36B and 36C. The formats of the SubNetwork Protocol Data Units (SNPDUs) used by the SSNL in performing its functions are shown in Attachment 2X, Figures 37/1 to 37/5.

4.3.2.2.1 SubNetwork Protocol Data Unit (SNPDU)

All information either received by the SSNL from its peer entity or transferred to its peer entity over the satellite link is organized into SubNetwork Protocol Data Units (SNPDUs).

The formats of the various facility fields used in SNPDUs during the connection set-up phase, are shown in Attachment 2X, Figures 38/1 to 38/6. The format of the NSAP addresses carried in SNPDUs during the connection set-up phase are shown in Attachment 2X.

Figures 39/1 and 39/2. The SNPDU Type codes are summarized in Attachment 2X, Table 14. All SubNetwork Protocol Data Units use the Reliable Link Service (RLS) and are passed in both directions at a Q precedence level determined from the priority of data on a connection facility specified during the call setup phase.

4.3.2.2.2 Logical Channel Number

Connections (virtual calls) within the satellite subnetwork are identified by their Logical Channel Number (LCN) which is a number in the range from 1 through 255. Allocation of logical channel numbers is carried out in the SSNL during the connection setup phase.

Call attempts from an HLE are identified by a DTE/DCE logical channel identifier and a DTE address. For a new ground-to-air connection setup, the GES SSNL entity allocates a logical channel number in the range 1 to 127. For a new air-to-ground connection setup, the AES SSNL entity allocates a logical channel number in the range 128 to 255 by choosing the highest numbered logical channel in the Ready state in that range.

Each SSNL maintains its own series of satellite logical channel numbers, for each AES and GES communicating with each other. In the AES, when multiple DTE/DCE interfaces are supported, the DTE address is used to extend the LCI/LCN pairing.

Each SSNL maintains the correspondence between the logical channel number (LCN) used by the satellite subnetwork and the DTE/DCE logical channel identifier of the interfacing HLE while the channel is active.

Logical Channel Numbers are released by an SSNL after receipt of a CONNECTION RELEASE COMPLETE SNPDU (release originated from the local SSNL) or transmission of a CONNECTION RELEASE COMPLETE SNPDU (release originated from the remote SSNL).

4.3.3 SSND Protocol Description

Attachment 2X, Tables 16.1 through 16.4 defines the states of the SSNL and its actions based on the reception of an SNPDU from its peer SSNL within the GES.

The following procedures are defined for proper operation of the SSNL.

4.3.3.1 Connection Establishment

For the procedures to succeed, the AES involved in the connection establishment should have completed an initial log-on procedure and not be engaged in a log-on renewal/handover procedure.

The satellite SubNetwork never originates a connection setup.

The CONNECTION REQUEST/ CONNECTION CONFIRM SNPDU may contain SNS-User-Data (128 octets maximum) provided by the calling/ called HLE, respectively.

4.3.3.1.1 Procedure for Originating SSNL

When the satellite SubNetwork layer receives a CALL REQUEST packet from the DCE, it processes the facility field and determines whether a connection can be established or not.

A connection is not established if resources are not available, or if an invalid facility value is requested (Section 4.3.4.5 refers). In such cases, the SSNL transmits to the DCE a CLEAR INDICATION packet, with the cause field set to SSNL originated (out of order or network congestion or invalid facility request).

In all other cases, the SSNL allocates a logical channel which is in the Ready state, forwards the call request on to the peer SSNL by means of a CONNECTION REQUEST SNPDU and places the logical channel into the HLE Call Request state. The logical channel is identified by its LCN.

Upon receipt of a CONNECTION CONFIRM SNPDU, the SSNL places the logical channel in the Data Transfer/Flow Control Ready state and forwards a CALL CONNECTED packet to the DCE.

4.3.3.1.2 Procedure for Receiving SSNL

When the SSNL receives a CONNECTION REQUEST SNPDU from its peer SSNL, it places the logical channel selected by the originating SSNL entity in the Incoming Call state. The SSNL constructs an INCOMING CALL packet and transfers it to the DCE.

When the SSNL receives a CALL ACCEPTED packet from the DCE, it forwards a CONNECTION CONFIRM SNPDU to its peer SSNL and places the logical channel in the Data Transfer/Flow Control Ready state when it receives from the interfacing link layer the information that the CONNECTION CONFIRM SNPDU has been processed (receipt of a Success LIDU).

If the receiving SSNL cannot support the request (e.g., resources are not available), it transmits a CONNECTION RELEASED SNPDU to the originating SSNL and places the logical channel in the Local Clear Request state.

4.3.3.2 Connection Release

A SubNetwork Connection (SNC) may be released at any time by any party. The SSNL may release an SNC to indicate, for example, its inability to establish the requested SNC. The HLE may release an SNC before having received a CALL CONNECTED packet.

The CONNECTION RELEASED SNPDU may contain SNS-User-Data (128 octets maximum) provided by the HLE.

4.3.3.2.1 Procedure for Release Originated by the HLE

When the SSNL receives a CLEAR REQUEST packet from the DCE, it places the logical channel in the Local Clear Request state, generates a CONNECTION RELEASED SNPDU, and forwards it to the peer SSNL. The only SNPDUs it then accepts are a CONNECTION RELEASED SNPDU and a CONNECTION RELEASE COMPLETE SNPDU. It discards all other SNPDUs.

When it receives a CONNECTION RELEASE COMPLETE or a CONNECTION RELEASED SNPDU, it returns the logical channel to the Ready state. If the SSNL receives a CONNECTION RELEASED SNPDU from the peer SSNL, it does not expect to receive a CONNECTION RELEASE COMPLETE SNPDU.

The SSNL times out (see tN6, in Attachment 2X, Table 15.1) if it does not receive a response from the remote SSNL and returns the logical channel to the Ready state.

4.3.3.2.2 Procedure for Receiving SSNL

When the SSNL receives a CONNECTION RELEASED SNPDU, it enters the Remote Clear Request state, constructs the relevant CLEAR INDICATION packet and forwards it to the DCE. It also constructs a CONNECTION RELEASE COMPLETE SNPDU, sends it to the originating SSNL, and returns the logical channel to the Ready state.

4.3.3.2.3 SSNL Initiated Release

If the SSNL entity is to disconnect an SNC, it places the logical channel in the Local Clear Request state, signals a CLEAR INDICATION packet to the DCE and transmits a CONNECTION RELEASED SNPDU to the remote SSNL. It expects to receive a response from the remote SSNL (a CONNECTION RELEASE COMPLETE or CONNECTION RELEASED SNPDU), and returns the logical channel to the Ready state when either it is received or it times out (see tN6, in Attachment 2X, Table 15.1).

4.3.3.3 Data Transfer and Expedited Data Transfer Procedures

For the procedures to succeed, the logical channel should have completed connection establishment, and not be engaged in a release or reset procedure. The data/ expedited data transfer procedure applies independently to each logical channel which is in the Data Transfer/Flow Control Ready state. In addition, the expedited data transfer procedure also applies when data flow is suspended on the logical channel.

4.3.3.3.1 Data Transfer Procedure

SNS-user-data is forwarded transparently and in the same order between users of the SubNetwork Connection via the satellite subnetwork.

The end of a complete packet sequence on the ISO 8208 interface is determined by the M-bit set to 0, whereas an M-bit set to one (1) denotes that the SNS-user-data field continues in the subsequent DATA packet.

Upon receipt of one or more DATA packets belonging to one complete packet sequence from the DCE, the SSNL generates a sequence of one or more DATA SNPDUs. The number of DATA SNPDUs needed in the sequence depends on the amount of SNS-User-Data in the complete packet sequence, considering that the maximum User Data Field length of a DATA SNPDU is equal to 503 octets. Each DATA SNPDU, except the last one, should have the exact maximum User Data Field length and its M-bit set to 1. The User Data Field of the last SNPDU which belongs to the sequence may have less than the maximum length and its M-bit set to 0. Such a sequence is called an M-bit sequence (MBS).

The originating SSNL assigns an SNPDU number to each individual DATA SNPDU, independently from the SNPDU number assigned in the other direction of data transmission. SNPDU numbers are consecutive over a given connection. The sequence numbering of DATA SNPDUs is performed modulo 256 and the SNPDU numbers cycle through the entire range from 0 through 255. The first DATA SNPDU to be transmitted over the satellite link, when the logical channel has just entered the Flow Control Ready state, has an SNPDU number equal to 0.

The originating SSNL has access to a data buffer (see Section 4.3.6). Each time a DATA SNPDU is forwarded to the link layer, timer tN2 (see Attachment 2X, Table 15.1) is restarted and a copy of the DATA SNPDU is placed in the buffer. If there is not sufficient room in the buffer then the oldest SNPDU(s) in the buffer is (are) deleted to make space. When timer tN2 expires, all SNPDUs in the buffer corresponding to that virtual connection are deleted. The purpose of this arrangement is to enable the peer SSNL entity to maintain synchronism if flow control is invoked.

When an SSNL entity receives a DATA SNPDU sequence, it constructs a complete packet sequence, containing one or more DATA packets as necessary, using the M-bit to indicate a following packet of the same sequence and forwards it to the DCE.

Error detection/recovery in a DATA SNPDU sequence is described in Section 4.3.3.5.1.2.

4.3.3.3.2 Flow Control Procedure

Flow control is provided within the SSNL to recover from events at the receiving end which may cause buffer overflow at the receiving SSNL.

When the receiving SSNL senses that such a condition is occurring, it generates a FLOW CONTROL SNPDU with its control field set to Suspend and the SNPDU number set to the SNPDU number of the last received (and accepted) DATA SNPDU, and sends it to the peer SSNL. When subsequently, the receiving SSNL is able to resume the data transfer, it generates a further FLOW CONTROL SNPDU with its control field set to Resume.

When the SSNL entity receives a FLOW CONTROL SNPDU with its control field set to Suspend, it stops transmitting new DATA SNPDUs on the indicated logical channel, deletes from its data buffer all DATA SNPDUs which have been sent up to and including the one whose SNPDU number is equal to the SNPDU number of the FLOW CONTROL SNPDU and stops tN2. If the SNPDU number in the FLOW CONTROL (SUSPEND) SNPDU is other than that of the last SNPDU transmitted by the sub-layer and the SNPDU which was transmitted immediately after the SNPDU identified in the FLOW CONTROL (SUSPEND) SNPDU is not in its data buffer, the SSNL sub-layer entity initiates a reset of the logical channel.

When the SSNL entity receives a FLOW CONTROL SNPDU with its control field set to Resume, it is able to restart transmitting DATA SNPDUs, if any, on the indicated logical channel starting with any remaining in the buffer. The first (re)transmitted DATA SNPDU has its SNPDU number equal to the SNPDU number of the previously received FLOW CONTROL SNPDU (Suspend) plus one modulo 256, unless a reset procedure has been invoked.

Immediately after a connection set-up or reset operation, the SSNL sub-layer sets the SNPDU number of the last transmitted and last received SNPDUs to be 255. This allows the assertion of flow control to take place before any data SNPDUs have been received and accepted by the SSND sub-layer.

4.3.3.3.3 Expedited Data Transfer Procedure

The expedited data transfer allows an SSNL to transmit SNS-User-Data contained in an INTERRUPT packet to a peer SSNL bypassing any flow control that may have been applied by the SSNL peer entity.

Expedited data is forwarded transparently and in the same order between users of the SubNetwork Connection via the satellite subnetwork.

Only one INTERRUPT SNPDU at a time, with a maximum user data length of 32 octets, is permitted in each direction of a virtual connection over the satellite link.

4.3.3.3.3.1 Procedure for Originating SSNL

When the originating SSNL receives an INTERRUPT packet from the DCE, it places the logical channel in the Data transfer state-local interrupt on going state, generates an INTERRUPT SNPDU and forwards it to the receiving peer SSNL, and awaits an INTERRUPT CONFIRM SNPDU.

Upon receipt of an INTERRUPT CONFIRM SNPDU, the SSNL returns the logical channel to the Data transfer state- no local interrupt pending state and returns an INTERRUPT CONFIRMATION packet to the DCE.

An INTERRUPT SNPDU and INTERRUPT CONFIRMATION packet should be sent as soon as possible.

If no INTERRUPT CONFIRM SNPDU is received, then the originating SSNL times out (see tN4, in Appendix 2X, Table 15.1) and initiate a reset of the logical channel.

4.3.3.3.3.2 Procedure for Receiving SSNL

When the receiving SSNL receives an INTERRUPT SNPDU, it places the logical channel in the Data transfer state- remote interrupt on going state, generates an INTERRUPT packet and sends it to the DCE. Upon receipt of an INTERRUPT CONFIRMATION packet, the SSNL returns an INTERRUPT CONFIRM SNPDU to the originating SSNL and returns the logical channel to the Data transfer state- no remote interrupt pending state.

The INTERRUPT packet and INTERRUPT CONFIRM SNPDU should be sent as soon as possible.

4.3.3.4 Reset Procedure

The reset procedure applies to each logical channel and can apply only in the Data transfer phase. The reset procedure is used to resynchronize an SNC and/or to report the detection of unrecoverable loss of data.

When a satellite subnetwork connection has just been reset, the following actions relative to the logical channel are taken:

a. The DATA SNPDUs are flushed from the data buffer and tN2 is stopped.
b. The DATA SNPDUs which have not been passed to the link layer, but which belong to an M-bit sequence for which some have been passed to the link layer are flushed from the queue of DATA SNPDUs awaiting transmission.
c. The SNPDUs that have been received prior to receiving a RESET SNPDU, but which do not constitute an entire sequence are flushed from the reassembly area.
d. The SNPDU number is reset to 0.
e. Any outstanding INTERRUPT SNPDU to or from the remote SSND remains unconfirmed and tN4 is stopped.
f. When the reset procedure has been initiated by the SNS-user (SN-RESET request), the SSND sublayer indicates when it is ready to receive subsequent data by sending a RESET INDICATION packet to the DCE. This may or may not be related to the completion of the reset procedure. Any data or expedited data received from the DCE following the RESET INDICATION is transmitted when the reset procedure is complete.

   When the SSNL has sent a RESET INDICATION packet to the DCE, the DCE replies with a RESET CONFIRMATION packet when it is ready to receive and transmit further data. Any data or expedited data received by the SSNL following the RESET CONFIRMATION packet is transmitted when the reset procedure has completed.

4.3.3.4.1 Procedure for Originating SSNL

When the SSNL either receives a RESET REQUEST packet from the DCE or detects an error in the SSNL operation for which its action is to reset the virtual circuit then, it places the logical channel into the Local Reset state, transmits to the remote SSNL a RESET SNPDU, flush the appropriate SNPDUs, reset the next SNPDU number to 0 and starts a timer tN3 (see Attachment 2X, Table 15.1) when it receives from the interfacing link layer the information that the RESET SNPDU has been successfully transmitted (refer to Attachment 2X, Table 15.2 for corrective actions upon receipt of a Fail LIDU). When the reset has been internally generated, the SSNL entity might also inform the SNS user by transmitting a RESET INDICATION packet to the DCE, depending on the current state and/or error type (refer to Section 4.3.3.5.1 and Attachment 2X, Table 16.4).

Upon receipt of either a RESET CONFIRM SNPDU or a RESET SNPDU, it returns the logical channel to the Data Transfer state.

The SSNL entity times out tN3 if it does not receive a response from the remote SSNL entity. It then initiates a connection release procedure.

4.3.3.4.2 Procedure for Receiving SSNL

When the SSNL receives a RESET SNPDU while in the Data Transfer state, it places the logical channel into the Remote Reset state, transmits to the DCE a RESET INDICATION packet, as necessary (see Attachment 2X, Table 16.4). After processing the RESET SNPDU, the SSNL entity transmits a RESET CONFIRM SNPDU to its peer SSNL and returns the logical channel to the Data Transfer state (flow control ready/no interrupt pending) when it receives from the interfacing link layer the information that the RESET CONFIRM SNPDU has been successfully transmitted (refer to Attachment 2X, Table 15.2 for corrective actions upon receipt of a Fail LIDU).

When the SSNL receives a RESET SNPDU while in the Local Reset state, the SSNL does not transmit nor expect to receive a RESET CONFIRM SNPDU and considers that the resetting is completed. The SNS user might be informed of either reset (refer to Section 4.3.3.5.1), by transmitting a RESET INDICATION packet to the DCE.

4.3.3.5 Error Procedure

Errors which are recognized by the SSNL may be the result of the following events:

a. Log on renewal/Log-off
b. Link congestion
c. Transmission error
d. Peer SSNL protocol error

Error handling depends on the current logical channel states. When an error is detected, the SSNL can either reset or clear the relevant connection.

Errors are notified to the HLE by means of cause and diagnostic parameters within the relevant packet. They are notified to the remote SSNL by using the corresponding fields of the SNPDUs; i.e., reset or clearing cause and diagnostic codes.

The following procedures are to be used by the SSNL when generating cause codes:

a. All protocol errors detected by the SSNL result in a clear or a reset with a cause code of SSNL local link error.
b. A cause code of network congestion is used if a connection is cleared due to lack of resources, if a reset is generated by the SSNL due to flow control problems, or if a connection is reset or cleared due to a transmission error (time out or fail LIDU reception).
c. A cause code of invalid facility request is used if a requested SSNL facility is not provided by the SSNL implementation in the connection establishment phase.
d. No other cause codes are generated by the SSNL.

Attachment 2X, Table 18.1 gives the coding values of the cause field which are passed to the remote SSNL entity.

Attachment 2X, Table 18.2 gives the coding values of the corresponding Diagnostic Code field.

4.3.3.5.1 Error Handling

4.3.3.5.1.1 Log-On Renewal/AES Log-off

The AES management function provides the SSNL entity with AES log-on information by means of AES management interface data units, Attachment 2X, Figure D1b and Attachment 4X, Figure 33C refer.

When the AES renews its log-on to the same GES, the SSNL sub-layer places each logical channel from data transfer-flow control ready state to the data transfer-flow control not ready state. The SSNL should not pass an SNPDU (original or retransmission) to its interfacing link layer until the SSNL has received information regarding the completion of the AES log-on to the GES. After the SSNL has received information regarding the completion of the AES log-on to the GES, it transmits a FLOW CONTROL (suspend) NPDU followed by a FLOW CONTROL (resume) SNPDU. For logical channels in states other than data transfer, the SSND sublayer considers each outstanding status LIDU from its interfacing link layer as a failure LIDU then acts according to Attachment 2X, Table 15.2. For logical channels in the Data Transfer state, the SSNL considers each outstanding LIDU, except those associated with a DATA or FLOW CONTROL (suspend) SNPDU, as a failure LIDU and then acts according to Attachment 2X, Table 15.2. However, the SNPDU to be transmitted or retransmitted as a result of the action of Table 15.2 is not forwarded to the link layer until the SSNL receives information regarding AES log-on from the subnetwork management function.

When the AES logs on to a new GES, the SSNL clears all connections associated with the GES from which the AES is logging off, by transferring a CLEAR INDICATION packet on each relevant connection to the DCE and releases all the resources associated with these SNCs.

The logical channels released by this procedure should be returned to the Ready state.

COMMENTARY

When the GES receives a log-off from the AES or is notified of a log-on renewal by the AES to another GES, the GES SSNL clears all the SubNetwork Connections associated with that AES.

When the AES logs off (see Section 4.5.3.2), the SSNL clears all connections (either by transferring a RESTART INDICATION packet to the DCE(s) or a CLEAR INDICATION packet on each relevant connection) and releases all resources allocated to all SubNetwork Connections (SNCs). All Switched Virtual Channels are returned to the ready state.

4.3.3.5.1.2 Transmission Error

A transmission error at the SubNetwork layer occurs when an SNPDU is delayed or lost.

Loss of SNPDUs may occur when the maximum number of retransmission attempts by the link layer is exceeded. The originating SSNL entity is then informed of the error (fail LIDU).

a. Receiving SSNL Error Recovery

   Upon receipt of an out-of-sequence DATA SNPDU; i.e., when the SNPDU number of a DATA SNPDU is different from the one expected, but not equal to the SNPDU number of the last received DATA SNPDU, the SSNL entity initiates a reset of the connection.

   Upon receipt of a duplicated DATA SNPDU; i.e., when its SNPDU number is equal to the SNPDU number of the last received DATA SNPDU, the SSNL entity discards it.

b. Originating SSNL Error Recovery

   Transmission errors, resulting from the loss or delay of SNPDUs are detected either by time-out when a response is expected or by the fail LIDU reported by the link layer.

Attachment 2X, Table 15.1 summarizes the actions the SSNL entity follows upon time-out.

Attachment 2X, Table 15.2 summarizes the actions the SSNL entity follows when it is informed by the link layer that the transmission of an SNPDU has failed.

4.3.3.5.1.3 Protocol Error

Two types of protocol error may occur at the SSNL. These are:

a. Syntactical errors which occur when a received SNPDU does not conform to the format specifications over the Satellite SubNetwork.
b. Logical errors which occur when the SSNL entity receives from the peer entity an SNPDU that is not an acceptable input to the current state of the logical channel.

Attachment 2X, Tables 16.1 to 16.4 summarize the actions the SSNL follows upon detection of either a syntactical or a logical error, depending on the current state of the relevant logical channel.

4.3.4 Mapping Process Description

4.3.4.1 SNPDUs to Packets Mapping

The SNPDUs which are mapped into an ISO 8208 packet for transmission to the DCE, are the following:

a. CONNECTION REQUEST SNPDU
b. CONNECTION CONFIRM SNPDU
c. CONNECTION RELEASED SNPDU
d. RESET SNPDU
e. DATA/INTERRUPT/INTERRUPT CONFIRM SNPDU.

All other SNPDUs do not result in a packet being forwarded to the DCE.

4.3.4.1.1 CONNECTION REQUEST SNPDU

When the SSNL receives a CONNECTION REQUEST SNPDU from the peer SSNL entity, it maps the SNPDU into an INCOMING CALL packet, using the following rules:

a. The D-bit of the GFI (bit 7 of octet 1) is always set to 0, whether the delivery confirmation indication of the CONNECTION REQUEST packet is set to 0 or 1.
b. The SSNL entity may perform DTE address decompression on the called DTE address, as defined in Section 4.3.4.3.3 below.
c. While processing the QOS parameters field, the SSNL regenerates both the ones which correspond to default values (Section 4.3.4.5 refers) and the Q priority requirement. It memorizes the Q precedence level for inclusion in the LICI accompanying a possible CONNECTION RELEASED SNPDU which may be sent before the call has been successfully setup. The SSNL also regenerates, as necessary, the facility code field and parameter length of the Calling/Called NSAP Addresses before inclusion in the facility field of the INCOMING CALL packet and transparently transfers from the SNPDU to the packet the facilities which have been forwarded, within the SNPDU, by the SSNL peer entity.
d. User Data, if present, is transparently transferred from the SNPDU to the packet.

4.3.4.1.2 CONNECTION CONFIRM SNPDU

When the SSNL receives a CONNECTION CONFIRM SNPDU from the peer SSNL entity, it maps the SNPDU into a CALL CONNECTED packet, using the following rules:

a. The D bit of the GFI is always set to 0.
b. The LCN for the DTE/DCE connection is determined from the LCN in the SNPDU.

c. The SSNL entity performs address regeneration on the DTE addresses, using the called/calling DTE addresses of the corresponding CALL REQUEST packet.

d. The SSNL also processes the responding NSAP address as defined in Sections 4.3.4.4 and 4.3.4.4.2 below and transparently transfers from the SNPDU to the packet the facilities which have been forwarded within the SNPDU by the SSNL peer entity, and regenerates as necessary the Q priority, the fast select facility and/or the Expedited Data Negotiation facility fields. It memorizes the Q precedence level for inclusion in all LIDUs over the connection.

e. User Data, if present, is transparently transferred from the SNPDU to the packet.

4.3.4.1.3 CONNECTION RELEASED SNPDU

When the SSNL receives a CONNECTION RELEASED SNPDU from the peer SSNL entity, it maps the SNPDU into a CLEAR INDICATION packet using the following rules:

a. The LCN for the DTE/DCE connection is determined from the LCN in the SNPDU.

b. The SSNL regenerates the called NSAP address as defined in Sections 4.3.4.4 and 4.3.4.4.2 below.

c. The clearing cause and diagnostic code are transferred from the values in the SNPDU.

d. User Data, if present, is transparently transferred from the SNPDU to the packet.

4.3.4.1.4 RESET SNPDU

When the SSNL receives a RESET SNPDU from the peer SSNL entity which is to be forwarded to the DCE, it maps the SNPDU into a RESET INDICATION packet, using the following rules:

a. The LCN for the DTE/DCE connection is determined from the LCN in the SNPDU.

b. The resetting cause and diagnostic code are transferred from the SNPDU to the packet.

4.3.4.1.5 DATA/INTERRUPT/INTERRUPT CONFIRM SNPDUs

When the SSNL receives a DATA SNPDU from the peer SSNL entity, it maps the SNPDU into one or more DATA packets according to the following rules:

a. The LCN for the DTE/DCE connection is determined from the LCN in the SNPDU.

b. In the GFI, the Q and D bits are set to 0.

c. The M bit in the packet is set to 1 unless the M bit in the SNPDU is set to 0 and the packet contains all of the remaining User Data to be transferred from the SNPDU.

d. The User Data is transparently transferred from the SNPDU to the packet.

When the SSNL receives an INTERRUPT SNPDU from the peer SSNL entity, it maps the SNPDU into an INTERRUPT packet according to the following rules:

a. The LCN for the DTE/DCE connection is determined from the LCN in the SNPDU.
b. The User Data is transparently transferred from the SNPDU to the packet.

When the SSNL receives an INTERRUPT CONFIRM SNPDU from the peer SSNL entity, it maps the SNPDU into an INTERRUPT CONFIRMATION packet according to the following rules:

a. The LCN for the DTE/DCE connection is determined from the LCN in the SNPDU.

4.3.4.2 Packets to SNPDUs Mapping

The packets which are transmitted from the DCE to the SSNL are the following:

a. RESTART REQUEST packet
b. CALL REQUEST packet
c. CALL ACCEPTED packet
d. CLEAR REQUEST packet
e. RESET REQUEST packet
f. DATA/INTERRUPT/INTERRUPT CONFIRMATION packet

All other packets are not forwarded to the SSNL.

4.3.4.2.1 RESTART REQUEST Packet

When the SSNL receives a RESTART REQUEST packet from the DCE, it executes the connection release procedure defined in Section 4.3.3.2.1 above for each switched virtual circuit associated with the originating DTE to the relevant GES(s).

4.3.4.2.2 CALL REQUEST Packet

When the SSNL receives a CALL REQUEST packet from the ISO 8208 interface, it processes the facility field of the CALL REQUEST packet to either provide the required SubNetwork QOSs which are imposed by the SNS user (such as Q priority), or to contribute to the establishment of an agreement between the two SNS users and itself for the optional QOS associated with the SubNetwork Connection, and maps the packet into a CONNECTION REQUEST SNPDU, using the following rules:

a. The delivery confirmation indication (bit 7 of octet 1) is always set to 0, whether the D-bit of the CALL REQUEST packet is set to 0 or 1.
b. The more data bit (M-bit) is set to 0.
c. The SSNL entity performs DTE address compression on the calling DTE address, as defined in Section 4.3.4.3.3 below and memorizes the Called/Calling DTE addresses for later inclusion in the corresponding CALL CONNECTED packet.
d. The SSNL entity deletes from the facility field, both the facilities which are set to default values and the priority (see Section 4.3.4.5). It memorizes the Q precedence level for inclusion in the LICI accompanying a possible CONNECTION RELEASED SNPDU which may be sent before the call has been successfully setup. The SSNL entity also processes the Calling/Called Address extension as defined in Section 4.3.4.4 below.

e. Field activation flags are used to determine both whether an optional field is present or not and whether fast select with restriction on response applies or not for the constructed CONNECTION REQUEST SNPDU.
f. User Data, if present, is transparently transferred from the packet to the SNPDU.

4.3.4.2.3 CALL ACCEPTED Packet

When the SSNL receives a CALL ACCEPTED packet from the ISO 8208 interface, it maps the packet into a CONNECTION CONFIRM SNPDU, using the following rules:

a. The delivery confirmation indication (bit 7 of octet 1) is mapped from the D-bit of the CALL ACCEPTED packet; i.e., is set to 0.
b. The more data bit (M-bit) is set to 0.
c. The SSNL does not transmit the DTE address information across the satellite link.
d. The SSNL entity processes the Called Address extension field as defined in Sections 4.3.4.4 and 4.3.4.4.2 below and deletes from the facility field, both the facilities which are set to default values and the priority (see Section 4.3.4.5). The SSNL entity memorizes the Q precedence level for inclusion in all LIDUs over the connection. Any other selected facilities are transparently transferred from the packet to the SNPDU.
e. Field activation flags are used to determine whether an optional field is present or not in the constructed CONNECTION CONFIRM SNPDU.
f. User Data, if present, is transparently transferred from the packet to the SNPDU.

4.3.4.2.4 CLEAR REQUEST Packet

When the SSNL receives a CLEAR REQUEST packet from the ISO 8208 interface, it maps the packet into a CONNECTION RELEASED SNPDU, using the following rules:

a. Both the delivery confirmation indication (bit 7 of octet 1) and the more data bit (bit 8 of octet 1) are always set to 0.
b. The SSNL processes the Called Address extension field (if present) as defined in Sections 4.3.4.4 and 4.3.4.4.2 below, and does not transmit the facility field.
c. Field activation flags are used to determine whether an optional field is present or not in the constructed CONNECTION RELEASED SNPDU.
d. Clearing Cause and Diagnostic Code fields are transferred without modification from the ISO 8208 packet to the SNPDU.
e. User Data, if present, is transparently transferred from the packet to the SNPDU.

4.3.4.2.5 RESET REQUEST Packet

When the SSNL receives a RESET REQUEST packet from the ISO 8208 interface, it maps the packet into a RESET SNPDU, using the following rules:

a. Both the delivery confirmation indication (bit 7 of octet 1) and the more data bit (bit 8 of octet 1) are always set to 0.

b. Resetting Cause and Diagnostic Code fields are transferred without modification from the ISO 8208 packet to the SNPDU.

4.3.4.2.6 DATA/INTERRUPT/INTERRUPT CONFIRMATION Packets

When the SSNL receives a DATA, an INTERRUPT or INTERRUPT CONFIRMATION packet from the ISO 8208 interface, it maps the packet into a DATA, INTERRUPT or INTERRUPT CONFIRM SNPDU respectively. The SNS-User data is transferred unmodified from the packet(s) to the SNPDU(s).

A complete (DATA) packet sequence is mapped into an M-bit (DATA SNPDU) sequence as defined in Section 4.3.3.3.1 above.

4.3.4.3 DTE Addresses

4.3.4.3.1 DTE Address Format and Characteristics

Attachment 2X, Appendix 7, defines the DTE addressing plan. The optional on-board terminal number (the D digit) is defined as follows:

Code	Terminal
None	CMU (port MP1G/J/K/MP3G/H)
0	CMU (port MP1G/H/J/K/MP3G/H)
1-7	Spare
8	CPDF (port MP1E/F/MP9A/B)
9	Cabin CEPT-E1 (port MP2J/K/MP3A/B)

The format and characteristics of both the DTE addresses length field and the DTE addressed fields in an SNPDUs and in an ISO 8208 packet are identical. In particular, the combined length of the Called and Calling DTE address fields in the SNPDU are to consist of an integer number of octets. Therefore if, after compression, the Called or Calling DTE address, but not both, consists of an odd number of semi-octets the four least significant bits of the last octet (bits 1 to 4) of the Calling DTE address are zero-filled in order to maintain octet alignment.

4.3.4.3.2 DTE Address Processing

The SSNL transfers the DTE addresses between the packet and the corresponding SNPDU. Routing performed within the aeronautical subnetwork is based, exclusively, on the analysis of the DTE addresses.

The DTE address and DTE addresses length fields are always present in the CONNECTION REQUEST SNPDU, but never transmitted in the CONNECTION CONFIRM/CONNECTION RELEASED SNPDU across the satellite link. The DTE addresses are regenerated as necessary by the receiving entity.

4.3.4.3.3 DTE Address Compression and Expansion

The only type of address which undergoes compression/expansion is the AES DTE address. All other types of address are directly mapped between the packet and the SNPDU. Address compression/expansion function, when appropriate, is always performed before mapping the DTE address fields between packets and corresponding SNPDUs.

The only portion of the AES DTE address that is transmitted within the SNPDUs is the D digit, when present. Therefore, the length of the compressed AES DTE address is either 0 or 1 semi-octet.

When the SSNL entity receives an SNPDU with a compressed AES DTE address, it reconstructs the complete AES DTE address, using the received D digit, the fixed fields specified in Attachment 2X, Appendix 7, Section 1.4.1.1, the satellite ID for the S digit (for compatibility with the Join/Leave message specified in Section 4.7.3.3), and the AES ID.

4.3.4.4 NSAP Addresses

The Called/Calling/Responding Address Extension fields in the ISO 8208 packets are mapped to/from the Called/Calling/Responding NSAP Address fields in the corresponding SNPDUs. These may be coded for example according to the ATN numbering plan.

These optional user facilities, when present, are removed from the facility field of a packet, and are carried within the relevant SNPDU in a dedicated field. When both are present in the SNPDU, the called NSAP Address always precedes the calling NSAP address and therefore, their Facility Code field is not transmitted. The Facility Parameter length field is also not transmitted, as this information is redundant with the length indicator carried within the first octet of the facility field.

4.3.4.4.1 NSAP Address Format and Characteristics

Within the SNPDU, the NSAP address consists of:

a. An address coding/length octet, bits 6 to 1 indicating the number of semi-octets (up to a maximum of 40) of the remainder of the NSAP address field. This address-length indicator is binary coded, where bit 1 is the low-order bit, and bits 8 and 7 giving the type of the NSAP address (see Attachment 2X, Figure 39/1,2).
b. The relevant fields of the NSAP address format. Each digit of an NSAP address is coded in a semi-octet in binary-coded decimal, where bit 5 or 1 is the low-order bit of the digit. Starting from the high-order digit of the address, the address is coded in successive octets, with two digits per octet. In each octet, the higher-order digit is coded in bits 8, 7, 6, and 5. This field in the SNPDU consists of an integer number of octets. Therefore, if the NSAP address consists of an odd number of semi-octets the four least significant bits of the last octet (bits 1 to 4) are zero-filled in order to maintain octet alignment.

COMMENTARY

ARINC Specification 637 defines the Aeronautical Telecommunication Network (ATN) Network Service Access Point (NSAP) address structure.

4.3.4.4.2 NSAP Address Processing

The SSNL entity transparently transfers the NSAP addresses, if present, between the packet and the corresponding SNPDU.

If the responding NSAP address (where explicitly supplied) in either the CALL ACCEPTED packet or the CLEAR REQUEST packet is equal to the called NSAP address of the corresponding INCOMING CALL packet, then it is not transmitted via the CONNECTION CONFIRM/ CONNECTION RELEASED SNPDU across the satellite link and the called NSAP address information is regenerated by the receiving SSNL entity. Otherwise, the responding NSAP address is encoded in the relevant SNPDU, using the format defined in Section 4.3.4.4.1 above.

4.3.4.5 Facility Field

4.3.4.5.1 SNC Priority

COMMENTARY

> The SNC priority code establishes a single level of priority for all data packets exchanged for the duration of the connection. If more than one level of priority is used for the exchange of data packets with a given end user, then more than one Network Connection (NC) with that end user may be needed. For example, if a higher priority level is used for the delivery of packets containing tactical ATC messages (e.g., new altitude, holding, or special assignments) than for the delivery of packets containing exchanges of flight planning data or full IFR clearances, then two network connections each with the appropriate priority level, should be established.

The range of specified values for the priority of data on a connection is 0 (lowest priority) to 14 (highest priority). The value 255 indicates unspecified. All other values are reserved, whereas the Q precedence values for data communication within the satellite subnetwork are limited to 0-3, 5-8, 11, 14. Conversion between values for the priority of data on a connection and Q precedence values is defined in Attachment 2X, Table 17.

If the priority is not requested by the HLE, a default Q precedence value (Q = 0) is used for sending all SNPDUs over the connection.

The priority field is not encoded within the facility field of an SNPDU.

The Q precedence value to be used for sending a CONNECTION REQUEST SNPDU is determined from the target (CALL REQUEST packet) value for the priority of data on a connection and is passed to the link layer within the corresponding LICI.

The Q precedence value to be used for sending a CONNECTION RELEASED SNPDU, before the connection has been successfully set up, is determined from either the target (CALL REQUEST packet) or the LICI accompanying the CONNECTION REQUEST SNPDU which is passed by the link layer. This value is also used to encode the available value for the priority of data on a connection within the INCOMING CALL packet, unless its value is set to 0.

The Q precedence value to be used for sending all SNPDUs once a connection has been established is determined from either the selected (CALL ACCEPTED packet) value for the priority of data on a connection or the LICI accompanying the CONNECTION CONFIRM SNPDU which is passed by the link layer. This value is also used to encode the selected value for the priority of data on a connection within the CALL CONNECTED packet. If an SNPDU is subsequently received with a priority in the accompanying LICI which is different to that established at connection set-up, the receiving SSNL releases the connection with a cause code of Connection rejection - requested quality of service not available (permanent condition).

If a requested priority value (target or selected) is invalid; i.e., the corresponding Q precedence level is not allowed for data communication, the SSNL entity rejects the call set-up. The diagnostic code in the CLEAR INDICATION packet/CONNECTION RELEASED SNPDU (if sent) is set to connection rejection- requested quality of service (QOS) not available/permanent condition.

4.3.4.5.2 Throughput Class Negotiation

The throughput negotiation applies on a per SubNetwork Connection basis, independently in each direction, and is negotiated by both SNS users and the SNS provider.

The format and characteristics of both the throughput class negotiation (TCN) and the minimum throughput class negotiation (MTCN) facility field in a packet and the corresponding SNPDU are identical. Attachment 2X, Figures 38/3 and 4, indicate the format of these facility fields.

These fields are transparently mapped from/to a packet to/from the corresponding SNPDU.

4.3.4.5.3 Transit Delay

The transit delay negotiation applies to both directions of transfer.

The Transit Delay Selection and Indication (TDSAI) and End to End Transit Delay negotiation facilities are transparently mapped from/to a packet to/from the corresponding SNPDU (format and characteristics are preserved). Attachment 2X, Figures 38/1 and 2, indicate the format of these facility fields.

4.3.4.5.4 Expedited Data Negotiation

During conversion from CALL REQUEST and CALL ACCEPTED packets to the corresponding CONNECTION REQUEST and CONNECTION CONFIRM SNPDUs, the SSNL examines the Expedited Data Negotiation facility parameter field.

If this field is present, and the parameter value indicates that expedited data is used (default value), then the facility field is deleted in converting the packet to an SNPDU. Otherwise, the Expedited Data Negotiation facility field is mapped unmodified within the facility field in the relevant SNPDU.

During conversion from CONNECTION REQUEST and CONNECTION CONFIRM SNPDUs to the corresponding INCOMING CALL and CALL CONNECTED packets, if Expedited Data Negotiation facility field is not present, the SSNL regenerates it indicating that this facility is used. Otherwise the Expedited Data Negotiation facility field is mapped unmodified within the facility field in the relevant packet.

4.3.4.5.5 Fast Select

During conversion from a CALL REQUEST packet to the corresponding CONNECTION REQUEST SNPDU, the SSNL examines the Fast Select facility parameter field.

If this field is present, and the parameter value indicates that fast select without restriction on response is used (default value), then the facility field is deleted in converting the packet to an SNPDU.

If this field is present, and the parameter value indicates that fast select with restriction on response is requested, and then the facility field is deleted in converting the packet to an SNPDU. Request of such service is identified by a different set of SNPDU type codes for CONNECTION REQUEST SNPDUs (Attachment 2X, Table 14 refers).

Otherwise, the Expedited Data Negotiation facility field is mapped unmodified within the facility field in the relevant SNPDU.

During conversion from CONNECTION REQUEST SNPDU to the corresponding INCOMING CALL packet, the SSNL regenerates the field using the reverse procedure (using the default value if nothing indicates which type of service is required).

4.3.4.5.6 Data Qualifier (Optional)

This parameter is used in DATA packets to indicate that the associated data is qualified in some way, e.g., control rather than user data. If present in a DATA packet received from the DCE, the Q-bit (bit 3) in the SNPDU type field is set to one in the associated SNPDU DATA sequence. The receiving SSNL regenerates this parameter in the DATA packet if the Q-bit is set to one in the received SNPDU data sequence. If the Q-bit is cleared, no parameter is present.

If an invalid DATA packet sequence is received, i.e., with different Q-bit values, the receiving SSNL should reset the connection with a diagnostic value of inconsistent Q-bit settings.

The support of this parameter is optional. If support is not implemented, the Q-bit in the SNPDU should always be set to 0.

4.3.5 Timing Requirement

In all cases where the AES is logged on, the AES operations should not take longer than 0.25 seconds for regular traffic. This interval is defined as follows:

a. The time that a DATA packet with a user data field of 128 bytes is presented to the Satellite SubNetwork Layer (SSNL) for downlink transfer and the time that the corresponding Link Interface Data Unit (LIDU) is passed to the link layer for transmission.
b. The time that an LIDU which contains a DATA SNPDU with a user data field of 128 bytes, is passed to the Satellite SubNetwork Layer and the corresponding packet; i.e., a DATA packet of 128 bytes is available for delivery to the Higher Layer Entity (HLE).

In all cases where the AES is logged on, the AES operations should not take longer than 0.125 seconds for expedited traffic. This interval is defined as follows:

a. The time that an INTERRUPT packet with a user data field of 32 bytes, is presented to the Satellite SubNetwork Layer for downlink transfer, and the time that the corresponding Link Interface Data Unit (LIDU) is passed to the link layer for transmission.
b. The time that a LIDU which contains an INTERRUPT DATA SNPDU with a user data field of 32 bytes, is passed to the Satellite SubNetwork Layer and the time that the corresponding packet; i.e., an INTERRUPT packet of 32 bytes, is available for delivery to the HLE.

4.3.6 Buffer Requirement

Depending on the AES implementation, buffers to operate a virtual channel may be assigned separately for each process within the satellite subnetwork access layer, the interworking function and the satellite specific subnetwork or may exist in a common area. The following applies to the entire layer 3 satellite subnetwork.

The AES should have enough buffer space available to operate simultaneously a minimum of [32] Switched Virtual Circuits.

As an example, the AES could provide sufficient buffer space to hold either 12 DATA SNPDUs of total length of 131 octets each (user data plus control information) or 3 DATA SNPDUs of total length of 506 octets, or any equivalent configuration, in the downlink and uplink direction per Switched Virtual Circuit.

In addition, the AES should provide enough buffer space to hold 1 INTERRUPT SNPDU having a length of 34 octets (user data plus control information) in the downlink and in the uplink direction per Switched Virtual Circuit.

4.3.6.1 Overall Buffer Size Requirement

The size of the Data Buffer which is used to maintain synchronism between the two peer SSNL entities, if flow control is invoked (see Section 4.3.3.3.1), should be as defined in the following:

Transmit Channel Rate (bps)	AES Buffer Size (Octets) (Requirement is the minimum of the two values)	
	Per Virtual Circuit (VC)	Total
600	2k	15k
1200	3k	20k
2400	4k	25k
4800	n/a	n/a
10500	4k	25k

4.4 Circuit-Mode Services

This section defines the functions of the SDU used for the provision of circuit-mode services.

4.4.1 Link Layer Functions

The DLS link layer functions of the P-, R-, and sub-band C-channels are used for the provision of circuit-mode services.

4.4.2 Satellite SubNetwork Dependent Functions

4.4.2.1 Channel Management Procedures

The SDU receives the called number (and in the case of passenger calls, the credit card data) prior to starting the request process. The SDU then reserves a channel unit and checks that HPA power is available for the call (refer to Section 4.5.4.1). If power or a channel unit is not available, the caller is given the appropriate response according to whether the call is of high priority or not.

4.4.2.2 Connection Control Protocol, Air-to-Ground Call

The sequences used to establish the circuit mode connection are standardized in order to ensure worldwide interoperability of AES and GES. The sequence includes the following:

a. Billing arrangement - airline or customer credit
b. Credit card validation - where appropriate
c. Request for circuit assignment
d. Channel assignment
e. Address identification
f. Application of test signals
g. Connection establishment

In Attachment 2X, the basic sequences for air-to-ground call setup are shown in Figures 13A, 13B, 14A and 14B, with the corresponding event trees showing the complete protocol to handle abnormal events in Figures 15A and 15B. The sequences for user switch hook signaling, including call clearing, are given in Figure 16.

An initial request is sent using the Rd-channel to the GES where the AES is logged on, and a channel assignment is received on the corresponding Pd-channel. The communications channel is then set up, tested using signals on the sub-band channel, and the called party address (plus the credit card number if applicable) is transmitted via the sub-band channel. To provide secure transfer of the address and credit card data, the signal units which are sent by the AES for testing are the called party address (plus the credit card number if applicable). These signal units are sent consecutively and continuously until receipt of the call attempt result or until a time out expires. In the case where the called party address is less than three digits, digit two is set to the end code.

If credit card information is sent from the AES to the GES, it follows the format and coding rules described in Attachment 2X, Annex 1 and Figure T1. Reference should be made to ITU-T Recommendation E.118 for useful guidance on the operation of an international telephone credit card system.

If the Air-to-Ground call is to the log-on GES, then all the access request and channel assignment transactions are carried via the Rd- and Pd-channels only.

However, if the call is to a GES other than the one where the AES logged-on, then the log-on GES forwards the access request (from the AES) to the called GES, over the inter-station link.

The called GES allots a channel from its pool and transmits the channel assignment information over the inter-station link. The log-on GES then forwards the information to the AES over the Pd-channel.

In the normal case, when the call is ended both users proceed to the on-hook condition. The on-hook signal from the calling party's handset in the AES initiates a series of channel release signals on the sub-band C-channel. The AES removes its carrier after ending the series of Channel Release signals. The GES monitors the carrier to confirm that it stops. If the carrier persists, the GES detects this by time-out and sends a further series of channel release signals on the sub-band C-channel, and also a channel release on the Pd-channel where the AES is logged on. If the AES is logged onto another GES, the Channel Release signal is sent to the log-on GES via the appropriate inter-station signaling link.

4.4.2.3 Connection Control Protocol, Ground-to-Air Call

The sequences used to establish the telephone link are standardized in order to ensure worldwide interoperability of AES. The sequence includes the following:

a. Call announcement
b. Channel assignment
c. Application of test signals
d. Alerting signal
e. Connection establishment

In Attachment 2X, the sequences for Ground-to-Air telephone call set-up are shown in Figures 17A, 17B, 18A, and 18B covering various cases including use of a Network Coordination Station (NCS). The corresponding event tree, showing the complete protocol to handle abnormal events, are given in Figure 19. The sequences for user switch-hook signaling, including call clearing, are given in Figure 20.

All outbound calls to the AES are similar with the GES sending the call announcement and channel assignment information to the AES over the Pd-channel. The AES allocates a channel unit and checks that HPA power is available. If power or a channel is not available, the AES returns a Call Result signal via the Rd-channel, with the appropriate cause code. If both a channel unit and power are available, the continuity check for proper channel set-up and the channel release functions over the satellite link are carried out using signals on the sub-band channel.

In the case of a call from a log-on GES to an AES, the only channel used prior to setting up the call is the Pd-channel. However, if the call is from a GES other than where the AES has logged on the originating GES (other GES) sends the call announcement and channel assignment information to the log-on GES over the inter-station link. The log-on GES then forwards this information to the AES over the Pd-channel.

The procedure for call clearing is initiated by the fixed network user sending a forward clearing signal. Upon receipt of the Clear Forward the GES sends a sequence of Channel Release signals on the sub-band C-channel. On receipt of one of these Channel Release signals, the AES responds with a series of channel release signals on the sub-band C-channel and removes its carrier. When the GES detects that the AES carrier has ended it returns the channel to the pool.

4.4.2.4 C-channel Power Control Signaling

Power control for C-channels enables the AES to provide additional channels under favorable link conditions while maintaining reliable service with a fewer number of channels (possibly only one) when link conditions are unfavorable.

The sequence for power control of the link uses an exchange of signals between GES and the AES as shown in Attachment 2X, Figure 23. Power control decisions for both directions of transmission are made in the GES.

The basic method is to carry out a timed series of power control sequences commencing immediately after call set-up and continuing until the call clears.

Refer to Section 4.5.4.1.2 3 for further details.

4.4.2.5 Supplementary Signaling

The provision of supplementary signaling capability is an optional enhancement to both the AES and GES. It enables the transfer of additional information between the AES and GES during the connected state of a telephone call.

In Attachment 2X, the basic sequence for the transfer of supplementary signaling information in the air-to-ground direction is shown in Figure 20B, and the corresponding event tree is given in Figure 20C.

4.4.2.5.1 DTMF Digit Transfer

It is sometimes necessary to send a sequence of Dual Tone Multi-Frequency (DTMF) signals from the AES to the distant end, as a means of signaling to the connected end party or to the terrestrial network, during the connect state of a call. The DTMF Digit Transfer facility enables the transfer of a set of code values, representing the DTMF signals, to be transferred in a SU-set (refer to Attachment 2X, Figures S36, S36A) over the sub-band C-channel. The GES, upon receipt of the message, transmits the DTMF tones to the terrestrial network.

The definition and technical characteristics of DTMF tone signaling are given in ITU-T Recommendations Q.11, Q.16, and Q.23.

4.4.3 Circuit-Mode Data Service

4.4.3.1 General

Circuit-mode data service is an optional enhancement to the aeronautical system. The capability to support this service is optional for GESs, as well as AESs. However, when provided, the implementation conforms to this specification.

The service provides a basic circuit-mode data channel on the space segment, for the duration of a call. The circuit-mode service bearer capability may be used to support a variety of communication applications that use the allocation of dedicated channel capacity for the call duration, such as interactive or bulk data communication, encrypted voice/data communication, and facsimile transmission.

The nature of the end-to-end data service, between the mobile and fixed users is dependent on the type of interconnection of the satellite system with the terrestrial (and avionics) networks. Data Interface Units (DIUs) or Terminal Interface Function Units (TIFUs) are used with voice-band analog modems for the analog-interconnect data service, whereas a direct digital interconnection is used for the digital-interconnect data service. The function of the TIFU and DIU is described in Attachment 2Z.

4.4.3.2 Circuit-Mode Data Call Control

4.4.3.2.1 Call Setup Procedure

The call setup sequence for a circuit-mode data call is identical to a standard telephone call setup, as defined in Sections 4.4.2.2 and 4.4.2.3.

When the TIFU option is implemented, for user data rates of 4800 bit/s or less, there is no necessity to identify to the GES that circuit-mode data operation may be invoked some time during the call. However, where the TIFU option is implemented for user data rates of 7200 or 9600 bit/s, it is necessary to indicate that circuit-mode data operation may be invoked at some point during the call by in-band signaling for both air-to-ground and ground-to-air calls, to enable a higher quality C-channel to be established. Further details are [TBD].

Where the DIU option is implemented, the Access Request message for air-to-ground circuit-mode data calls identifies, to the GES, that circuit-mode data operation may be invoked sometime during the call. For ground-to-air calls, such information may not be conveyed to the GES by the terrestrial network signaling system. It may, therefore, be necessary to interrogate the logged-on AES table at the GES, to determine whether the called AES is equipped for circuit-mode data operation and if so, its preferred default DIU type. The GES assigns a channel to the call and, at the option of the GES operator, reserves the required DIU equipment. At the option of the GES operator, the GES may either reject the call or assign a standard voice channel, if DIU equipment is either not available or not supported.

4.4.3.2.2 Data Mode Activation Procedure (DIU)

> Note: Circuit mode data activation within the TIFU using in-band signaling is described in Attachment 2Z.

In Attachment 2X the basic sequence for the data mode activation procedure is given in Figure 30B, and the corresponding event tree showing the complete protocol to handle abnormal events is given in Figure 30C. The data mode of operation may be activated only from the AES, once the end-to-end telephone connection has been established. Data mode may be initiated either manually, or automatically by detection of suitable call setup tones from the terminal equipment (e.g., CNG/CED tones from G-3 facsimile machines).

Once data mode has been initiated, the AES switches out the voice codec and continuously sends Data Mode (activate) signal units (Attachment 2X, Figure S6F) on the sub-band C-channel until it receives a Data Mode (activate) signal unit from the GES acknowledging receipt. The signal units indicate the mode of operation of the GES DIU; i.e., originate/answer mode, transmission rate, and modem type.

Upon receipt of one of these signal units, the GES switches out the satellite channel voice codec, and switches in the DIU. In the case of digital-interconnect facsimile service, the GES immediately acknowledges with a series of six Data Mode (activate) signal units. However, in the case of the analog-interconnect data service, the GES does not return any Data Mode Signal units until after the GES DIU has established synchronization with the far-end modem, or a time-out occurs, as further explained below.

In the case of analog-interconnect data service, if synchronization is achieved, the GES switches in the required rate adaption unit and sends a series of six Data Mode (activate) signal units (S6F) on the sub-band C-channel. If synchronization is not achieved before a timeout, the GES sends a series of six Data Mode (activate) signal units (S6F) on the sub-band C-channel, indicating the negotiated transmission rate of zero. In either case, the data rate information element of the Data Mode (activate) signal units sent by the GES to the AES indicates the actual transmission rate negotiated between the GES DIU and the far-end modem.

A GES that does not support the circuit-mode data service simply takes no action upon receipt of the Data Mode (activate) signal units (S6F).

The AES stops transmitting the Data Mode (activate) signals units, as soon as it receives the first like signal from the GES. It also switches in the DIU and, in the case of analog-interconnect data service, sets the rate of adaption to the appropriate value.

4.4.3.2.3 Data Mode Deactivation Procedure (DIU)

Note: Circuit-mode data deactivation within the TIFU using in-band signaling is described in Attachment 2Z.

In the initial system, only the AES is allowed to terminate the data mode operation. The basic sequence for the data mode deactivation procedure is given in Attachment 2X, Figure 30B. The corresponding event tree showing the complete protocol to handle abnormal events is given in Attachment 2X, Figure 30D.

The AES user initiates the deactivation of data mode to return to voice mode, whereupon the AES continuously sends Data Mode (deactivate) signal units (Attachment 2X, Figure S6F) on the sub-band C-channel. The GES switches out the DIU, switches in the satellite channel voice codec and responds with a series of six Data Mode (deactivate) signal units (S6F) on the sub-band C-channel. Upon receipt of one of these the AES stops sending the signal units, switches out its DIU and switches in the voice codec.

A GES that does not support circuit-mode data service simply takes no action upon receipt of Data Mode (deactivate) signal units (S6F).

4.4.3.2.4 Call Termination Procedure

User initiated call termination may occur when the call is in either the data or voice mode, using the procedures defined in Sections 4.4.2.2 and 4.4.2.3.

4.4.3.3 Analog-Interconnect Services

Analog-interconnect services are a class of circuit-mode data service which involve the interconnection of the GES with the terrestrial network, by means ITU-T V series voice-band data modems. The services may be offered on both air-to-ground and ground-to-air calls. The TIFU circuit-mode option enables both directions of calling to be catered for. With the DIU option which uses sub-band signaling, activation and deactivation of data mode can only be initiated by the AES.

There are two basic services possible under this category:

a. Data Service, which uses either a Terminal Interface Function Unit (TIFU) or a Data Interface Unit (DIU) in both the AES and GES.
b. Facsimile Service, which uses a Terminal Interface Function Unit (TIFU) in both the AES and GES.

The DIU uses a circuit-mode data channel format as described below; the data channel format for the TIFU is described in Attachment 3X.

4.4.3.3.1 Circuit-Mode Data Channel Format (DIU Option)

Each circuit-mode data call utilizes a pair of C-channels, for the duration of the call. The digital information bit stream of the C-channels, without the use of voice band modems over the satellite channel, is directly employed to transport the data traffic. Voice coding/decoding equipment, normally associated with the C-channels, is not used during the data transfer state. Rate adaptation is performed to match the user data bit rate, taking into account clock rate variations, to the bit rate of the primary band of the assigned C-channels.

4.4.3.3.2 Forward C-channel Burst Mode Operation (DIU Option)

The forward C-channel carrier is operated in burst mode for circuit-mode data services.

In the case of data service, carrier activation is controlled by the GES DIU. Specifically, circuit 109 (CF) is defined in ITU-T Recommendation V.24 (termed DCD in EIA RS-232C), from the PSTN modem in the GES DIU controls the activation interface of the C-channel. The active state is signaled when the call enters data mode, which is indicated by the circuit 109 transition to ON state. The signal normally remains in active state until deactivation of data mode by the AES. If, however, the circuit 109 does change to the OFF state indicating loss of received carrier from the far-end modem, the not active state is signaled after completion of transmission of the contents of the plesiochronous buffer. The signal state would revert to active when/if the GES DIU modems circuit 109 changes to the ON state.

4.4.3.4 Digital-Interconnect Data Service

The digital-interconnect data service may be available in cases where a digital path exists from the GES, through the terrestrial network (circuit switched digital data network, dedicated digital network or ISDN), to the distant end user.

The signaling sequence for air-to-ground calls would be the same as in Section 4.4.2.2. The Access Request-Telephone signal (Attachment 2X, Figure S4B) indicates that the digital data mode may be invoked during the call, and the data rate to be used.

Direct digital rate adaption is used at the GES, to convert between the user data rate and the terrestrial network access rate. The rate adaptation scheme for access to the ISDN is defined in ITU-T Recommendation I.460.

4.4.4 SubNetwork Access Protocol and Interworking Arrangements

The SDU is interconnected with both cockpit and cabin communication systems, for the provision of circuit-mode communication services to both areas.

4.4.4.1 Physical Interconnection Scheme

For cabin communications services, the Cabin Communications System (CCS), described in **ARINC Characteristic 746:** *Cabin Communications System (CCS)*, is interconnected to the SDU by means of a CEPT E1 digital link. The E1 link is capable of supporting 30 PCM channels.

For cockpit communication services, the cockpit audio management panel (AMP) is directly connected to the SDU. SCDUs/WSCs are connected to the SDU by means of ARINC 429 digital data buses. This interconnection scheme is shown in Attachment 2F-40.1.

The SDU audio circuits may also be shared with cabin analog telephones; if so, switching in the SDU connects the SDU CODECS to either the cockpit AMS or the cabin analog telephones, based on dedication and priority criteria specified in the Owner Requirements Table.

4.4.4.2 SubNetwork Access Protocol

The SDU access protocol for call control of circuit-mode services to the CCS is the ITU-T Q.931/932 network layer protocol. The detailed implementation of this protocol for the SDU as well as the CCS is defined in ARINC Characteristic 746, Attachment 11.

Cockpit call signaling is communicated between the SDU and one or more SCDUs/WSCs utilizing manufacturer specific user menus. In addition, the cockpit AMP is also connected to the SDU for switch, lamp and chime control/annunciation.

4.4.4.3 Protocol Interworking Scheme

4.4.4.3.1 Reserved

4.4.4.3.2 Cockpit Services

The SDU implements procedures for interworking between the cockpits Lamp/Chime and Switch control lines and the satellite network protocol for the provision of cockpit voice services. The basic interworking procedure is shown in Attachments 2F-40.6 to 2F-40.9. Also, reference Attachment 2F-42.

COMMENTARY

Although the AES presents as much as possible the same man-machine interface as for HF and VHF radio, it nonetheless operates as an addressed, point-to-point telephony service; VHF emulation, if ever used, should be implemented by a ground system conference call arrangement and not affect the AES design.

4.4.4.3.2.1 Connection Establishment: Air-to-Ground Call

A call is initiated via the SCDU/WSC (or possibly via an Audio Control Panel after selection of the destination on the SCDU/WSC) by means of manufacturer-specific user menus. If two channels are available, the request should include the desired channel number.

A means should be provided (ORT item o) to initiate a call via the ACP to a number stored in the ATC Call Register in the SDU that contains ATC phone numbers. Reference Section 4.13.

Call progress and completion/failure annunciations should be displayed on the SCDU/WSC, and by in-band tones and/or speech messages. A mixture of far-end and locally-generated sounds are to be used for compatibility with all existing terrestrial telephone networks.

The lamp is activated (flashing or steady, depending on System Configuration pin wiring) and the Chime is sounded (single or multi-stroke, again depending on System Configuration pin wiring) upon receipt of the Call Attempt Result SU (S6D) or Connect SU (S6B) from the GES (whichever occurs first, but not both). If the CALL LIGHT ACTIVATION (Strap Option TP10K) option is selected, the call lamp should be activated upon call initiation rather than call connection. The call light should not be asserted in response to a Place ATC Call input if the system is not logged on, or if there are no resources to make the call. In the case of the flashing Lamp or multi-stroke Chime option, the Lamp goes steady and the Chime is silenced when any of the following signals is received by the SDU:

a. The Cockpit Voice Mic On Input (channel #1 or #2, as appropriate) has continuity to ground (for TP13K = 0, the Latched ACP SATCOM mic switch option),
b. The Cockpit Voice Mic On Input (channel #1 or #2, as appropriate) makes a transition (the first one after the Lamp/Chime call annunciation) from an open circuit to a ground closure (for TP13K = 1, the Switched PTT option), or
c. An answer call line select key switch is activated on the SCDU/WSC. (Case (c) is required for aircraft having no PTT or Mic-On switch available for the SDU.).

The cockpit then enters the conversation mode. It is also possible (although not necessary) to silence the multi-stroke chime by activation of the Cockpit Voice Go-Ahead Chime Signal Reset discrete; however, this does not steady the flashing Lamp, nor enable the conversation mode (i.e., not cause transition to the off-hook state).

If the call cannot be connected, the Lamp and Chime are activated in the normal manner, and the SCDU/WSC displays a brief description of the reason; a manually-selected option could be provided to automatically redial such a call until the connection is made. If all available AES resources for making the call are busy, the call automatically enters into a camp-on state, with the option of manually preempting or canceling the call.

The SDU should generate unambiguous user messages to indicate call progress signaling.

4.4.4.3.2.2 Connection Establishment: Ground-to-Air Call

Ground-to-Air calls are handled largely by the AMP, with little involvement of the SCDU/WSC. However, the SDU may display call information on the SCDU/WSC; e.g., priority of the incoming call.

Receipt of the Call Announcement signal unit triggers the interworking process at the SDU. The SDU routes the call according to priority. Priority 1, 2, and 3 calls are routed to the AMS.

Priority 4 calls are either rejected or routed to the cockpit AMS (using the preferred channel if available), analog cabin telephones or digital cabin telephones, according to the Owner Requirements Table as described in Section 4.5.2.3, items h and i.

For Priority 4 calls routed to the analog cabin telephones or digital cabin telephones, the SDU analyzes the 'Called Terminal' information element present in the Call Announcement signal unit as described in Section 4.4.5.2.

The Lamp/Chime annunciation occurs as soon as the satellite voice channel has been assigned and its continuity verified.

Note: Call priorities and associated Q precedence levels are defined in Attachment 2F-42.

If available resources for a new ground-initiated call are all busy and the new call has a higher priority than an existing call, the new call is accommodated by preempting the lowest priority existing call. If the new call has the same or lower priority than all existing calls, the SDU indicates busy to the GES.

System Configuration pin TP13K determines the type of AMS hook switch signaling applicable in the aircraft. For compatibility with either type, the SDU senses off hook upon either (i) the first open-to-closed transition on the appropriate Cockpit Voice Mic On Input discrete, or (ii) operation of an answer call SCDU/WSC line select key switch. The SDU recognizes the off hook state, silences the multi-stroke Chime (if applicable), changes the Lamp from flashing to steady (if applicable), and sends the Connect signal unit to the GES.

Call lights and chime are to be inhibited during takeoff and landing flight phases by monitoring the Chime/Lamps Inhibit discrete input.

4.4.4.3.2.3 Connection Termination: Air/Ground Initiated

The call clearing sequence is fully symmetric for both cases of clearing - air and ground initiated, and regardless of the direction of the call setup.

In the former case, the cockpit indicates the end of call in one of two ways, depending on System Configuration pin TP13K. TP13K state 1 indicates that the call is terminated by use of an End Call button on the SCDU/WSC. TP13K state 0 indicates that the Cockpit Voice Mic On Input discrete is latched in the closed state for the duration of the call, and that termination is commanded when that discrete input returns to the open state. For either option, the SDU disconnects the voice channel and sends a series of Channel Release signal units to the GES to clear the satellite channel. Alternatively, the call can be cleared by activating the Place/End Call discretes associated with the SATCOM Call lights if available.

In the latter case, a Channel Release signal unit from the satellite channel causes the SDU to disconnect the voice channel.

The Chime is not used in call clearing. The Lamp is extinguished upon call termination.

4.4.4.3.2.4 Other Call Signaling Requirements

A pilot should always have the option to end or cancel any call at any time.

4.4.5 Numbering and Access Arrangements

4.4.5.1 Air-to-Ground Call Procedures

The dialing procedures described in this section allows a crew member or passenger to set up a circuit-mode call within the international public network. At the discretion of the aircraft operator, a procedure may be used to permit the crew or passengers to request:

a. Access to private lines or special services.
b. Access to public international networks.
c. Selected call routing.

Calls for crew members may be set up by entering the full international number; i.e., 00 followed by the country code and the national (significant) number. This is the ADDRESS. In this case, the call is to be routed through the preferred GES.

Alternatively, at the option of the airline, the customer can select the GES through which the call is set up. This is achieved by entering a special code followed by the GES address (2 decimal digits) and the ADDRESS as defined above. The 2-digit GES address is equivalent to the octal representation of the six least significant bits (LSB) of the binary GES ID. In the event that this GES cannot be accessed or this GES does not support the service, the call set-up fails and the appropriate tone and/or other indication is returned to the customer.

COMMENTARY

On-board call procedures vary, depending on the origin of the call. Attachment 2F-42, Operational Description of Aviation Satellite Audio Channels provides guidance on possible approaches for telephony.

The AES sets the appropriate values for the various fields in the signaling units associated with the call set-up:

Network ID	0001;
GES ID	As appropriate; and
Address	The entire ADDRESS sequence starting from the 00 is placed in the Digit fields of the Access Request and Service Address signal units from Digit 0 onwards.

The customer may also access public telephone operator services by entering 11 and directory inquiries by entering 12. The call would normally go to the preferred GES, but the customer can select the GES to which the call is addressed. In this case, the ADDRESS will be 11 or 12. Further digits if applicable may be included after these codes as follows:

Network ID	0001;
GES ID	As appropriate; and
Address	11 or 12 in Digit 0 and 1 fields. Further digits as necessary are included in the SU fields corresponding to Digit 2 onwards.

The preferred GES is obtained from the Owners Requirements Table in the AES, based on the analysis of the ADDRESS. The first 3 digits after the 00 are compared to a list of country codes and the appropriate GES ID found. The AES operator may set this list such that the preferred GES for use is not necessarily the GES which is geographically nearest to the called number.

In the event that the preferred GES set in an AES for a region is out of service, all call attempts to that region fail. For passenger traffic there is no automatic re-routing capability provided; however, if the existence of the problem is known, the crew could update the Owner Requirements Table with a new preferred GES. For crew traffic, the ability to select the GES for a call enables an alternative GES to be tried. For distress traffic the Satellite Network provides an additional level of security to ensure that all calls are processed.

In the event that a private line service is used (restricted to crew only) a suitable special code should be entered, followed by a two-digit identifier of a private line and any further address digits (if applicable) in the numbering plan of the called private line. The private line identifier is associated with the airline operating the AES and is recognized by any GES, i.e., more than one airline can use the same code. The ambiguity is resolved by cross-referencing this code and the private line list associated with the airline operating the AES.

The AES sets the appropriate values for the various fields in the signaling units associated with the call set-up as follows:

Network ID	Value indicating the AES wishes to access a private line.
GES ID	Value, as identified in a look-up table, corresponding to the GES with the required private line.
Address	2-digit identifier of private line in Digit 0 and 1 fields, and further address digits as necessary in SU fields corresponding to Digit 2 onwards.

Special services can be accessed by the crew using selected GESs in accordance with service agreements between the operators of the AES and the GES. This is achieved by entering the appropriate special codes followed by the 2-digit code of the GES, the code for the service where the code is as defined in an ITU-T Recommendation and additional digits as appropriate.

The AES sets the appropriate values for the various fields in the signaling units associated with the call set-up as follows:

Network ID	Value indicating the AES wishes to use a Special GES service.
GES ID	2-digit code of relevant GES.
Address	The code as defined in an ITU-T Recommendation in Digit 0 and 1 fields, and further address digits as necessary in SU fields corresponding to Digits 2 onwards.

4.4.5.2 Ground-to-Air Call Procedures

The numbering plan for ground-to-air calling from the Public Switched Telephone Network (PSTN) is given in Attachment 2X, Appendix 5. It is based on knowledge by the calling PSTN subscriber of a telephone dialing sequence that includes the identification of the destination aircraft. Two formats have been adopted for the destination aircraft identification: the 8-digit aircraft's mobile number, which is a direct representation (in octal) of its ICAO 24-bit aircraft address, and, when allocated, a 6-digit alternate mobile number. Both numbers are assigned at the time the AES is commissioned.

The numbering plan also facilitates direct dialing in (DDI) to individual terminals onboard the aircraft, as employed in conjunction with the aircraft's or alternate mobile number identification capabilities. As part of its hundreds, tens, and units semi-octet positions, the Called Terminal field of the Call Announcement signal unit conveys the Binary Coded Decimal (BCD) representation of all user-specified DDI digits. The Called Terminal field therefore serves to indicate to the AES the selected terminal onboard the aircraft. The standard numbering scheme allows either none or exactly three DDI digit(s), for future compatibility with ISDN, to be dialed in by ground users after the aircraft's mobile number. It also specifies that alternate mobile numbers are to be followed by exactly two DDI digits instead.

The GESs reject all incoming calls that present a non-standard DDI digit sequence length.

Upon receipt of the Call Announcement signal unit, the SDU extracts the DDI digits sequence representation from the Called Terminal field and passes it to the CTU. Considering the standard numbering options described above, the following coding conventions apply onboard the aircraft:

Standard numbering Option (as dialed by ground PSTN subscribers)	Call Announcement Signal Unit (S4C) H T U	Onboard Called Terminal Identification (SDU to CTU)
Aircraft's mobile number followed by no DDI digit	0 0 0	0000
Aircraft's mobile number followed by DDI digits sequence 123	1 2 3	0123
Alternate mobile number followed by DDI digits sequence 12	0 1 2	0012

Note: In the second column heading in the table above.

H = Hundreds
T = Tens
U = Units

4.5 Satellite Network Management

4.5.1 Link Layer Features

The Satellite Network Management functions utilize the DLS link layer functions of the P- and R- channels.

4.5.2 AES Table Management

The AES table contains the following four categories of information:

a. System Table
b. Log-on Confirm Information
c. Service Capability Dependent Table
d. Owner Requirements Table

All categories are used; however, the last two categories may be empty depending on the AES configuration and service capability installed and the owner's preferences.

4.5.2.1 System Table

The content of this table should be as specified in the Inmarsat Aero SDM, Module 1, Section 5.5.5 (version as specified in Section 1.2.2 and Section 5.5.1). The means of updating of the System Table should be as specified in the Inmarsat Aero SDM Module 1, Section 5.2.11 and its subsections.

4.5.2.2 Service Capability Dependent Table

The following information is held in this category:

a. Class/Level of AES (If an AES is capable of operating in more than one Class, the current Class of operation is used.)
b. AES channel configuration
c. Voice-channel characteristics
d. Circuit-mode data needs (i.e., analog-interconnect, or digital-interconnect, or null)
e. Data channel rate capability

4.5.2.3 Owner Requirements Table

This table accommodates at least the items identified in a. through f. and item i. Remaining items are optional:

a. Log-on/Handover policy (automatic or user commanded).
b. Deleted
c. Order of preference of GESs for log-on.

d. Response capability to log-on interrogation.

e. Use and value of flight ID (i.e., airline identifier and flight number).

f. Use of circuit-mode data on ground-to-air calls.

g. Dedication of SDU codec’s to cockpit AMS, cabin analog phone, or automatic sharing.

h. Preferred cockpit voice channel for ground-initiated calls when two channels are available. In a dual SATCOM system, this item refers to a single AMS/ACP logical channel in the context of the combined dual system.

i. If ground-initiated Public Correspondence calls should be accepted, and if so, whether such calls should be routed to the cockpit AMS, CCS or cabin analog telephones.

j. If camped-on cockpit AMS calls should stay camped-on indefinitely, or only until a timeout, and if the latter case, what the timeout period should be.

k. Whether noise insertion should be employed in the ground-to-air direction on AMS calls (to minimize noise modulation effects), and if so, at which level (from the choices -40, -50, and -60 dBm0, as well as off).

l. Whether an air-to-ground cockpit call is immediately initiated when the number is selected on an MCDU menu; or the MCDU action merely pre-selects the number, with the call not initiated until after activation of the Audio Control Panel SATCOM mic select switch, whereupon the call to the pre-selected number is initiated. The latter case requires that System Configuration Pin TP13K (reference Part 1 Attachment 1-4C) be in the Latched ACP SATCOM Mic Switch state.

m. In the case of system configuration pin TP13K being in the 0 state (latched ACP SATCOM Mic-Sw hook switch signaling), whether SCDU line select key prompts should be provided for air-initiated call setup acknowledgement and call clear, and for ground initiated call answer and call reject; or whether all such prompts should be blanked (due to being redundant to discrete signaling provisions).

n. Whether bit 14 of label 270, SDU to ACARS, and the chime discrete is set for air-to-ground calls upon call set up. The options to set bit 14 and the chime discrete for air-to-ground calls should be:

   1. Always
   2. Only after a camp on
   3. Never

o. Reference Section 4.13. Whether or not the SDU provides the Place ATC Call capability, by interpreting the Mic-On inputs as a function of the Call Light as described below.

   For TP13K=0 (Latched Mic-On input) the Mic-On input going low while the Call Light is off means Place ATC Call to the number stored in the ATC Call Register.

   For the case where TP13K=1 (Switched PTT) the Place/End Call discretes are interpreted as Place ATC Call when exercised with the call light off.

   ATC call initiation should be available from either channel. If resources are tied up by the cabin, then the ATC call should preempt the cabin.

p. For a dual SATCOM system, whether the cockpit voice functional interfacing between the SDU physical channels and the AMS/ACP logical channels is fixed (i.e., each logical channel is interfaced with only one physical channel in only one SDU) or shared (i.e., each logical channel is interfaced with the same numbered physical channel in both SDUs).

q. For an AES capable of high-rate packet data service, whether the AES should request not to be assigned high-rate return data channels while operating in the global beam.

This table is held in non-volatile memory. The table information can be updated and verified with the SDU installed on the aircraft. These updates can occur statically by means of a portable or cockpit-installed data entry device.

COMMENTARY

The static changes to the table would be made by a maintenance technician with either a portable data-loading device or through a cockpit-installed device. The installed device could be an MCDU, or other cockpit I/0 device, with the information either keyed in manually or loaded from a floppy disk.

The table and the method of update are handled by the AES owner. If no information is provided, then default settings are used as follows:

a. Automatic log-on/handover.
b. Deleted
c. GES selection according to pseudo-random choice algorithm with a uniform probability distribution.
d. Response capability to log-on interrogation assumed.
e. No use of flight ID
f. No use of circuit-mode data on ground-to-air calls.
g. The first codec is dedicated to the AMS; the second codec, if provided, is shared.
h. The preferred channel for ground-initiated calls is #1.
i. Ground-initiated Public Correspondence calls should be routed to the cockpit AMS.
j. The camp-on lasts indefinitely (i.e., the call would have to be manually canceled).
k. Noise insertion should be employed, at a level of -50 dBm0.
l. Calls are immediately initiated when the number is selected on an MCDU menu. The SDU mic-on input from the Audio Control Panel retains its call answer, acknowledgement and termination functions as determined by the System Configuration Pin TP13K.
m. The listed SCDU line select key prompts are provided.
n. Always
o. No ATC Call initiation from ACP
p. Fixed
q. Allow assignment of high-rate return data channels while operating in the global beam.

4.5.2.4 Log-On Confirm Table

The content of the information for the log-on GES is as follows:

a. Primary Log-on GES Identity
b. Initial EIRP for R/T-channel
c. Pd channel frequency and rate
d. Rd channel frequencies and rates (up to 8 frequencies)
e. T-channel frequencies and rates (up to 4 frequencies)

and for the AES own status is:

f. Satellite identification
g. Spot beam identification
h. Number of C-channels supportable for simultaneous transmission

Note: Optionally, the AES may log-on to a second GES if it has sufficient capacity, in which case the above GES related information is repeated for the second GES.

4.5.2.4.1 Update

The data in the log-on confirm information is entered when the AES completes its log-on procedure. The information is updated whenever the AES renews its log-on or there is a data channel reassignment.

4.5.3 Log Status Management

4.5.3.1 AES Management

The AES management arrangements are designed so as to be compatible with a wide range of potential satellite types and GES configurations, including global beam and spot beam satellites. At any time, different satellite regions may have different satellite configurations. In these configurations, all satellites have global beam capability for a P_{smc}-Channel for every GES. In the spot beam satellite case, mixed global beam/spot beam operation (whereby an AES uses both global beam and spot beam channels simultaneously) is also possible. Selected P-Channels are designated by Inmarsat for satellite selection, as detailed in the following paragraphs.

Every AES logs on to a GES for entering into the Aeronautical System and logs off as part of terminating its operation in the system and before initiating handover. The log-off is initiated by AES user command, as part of normal operational procedures; the AES should not log-off if handover is initiated due to P-Channel loss or degradation. When an AES changes its log-on GES, accessing satellite or accessing spot-beam of a satellite, the AES and GES follows the handover procedure specified below in this section.

Every GES maintains an up-to-date status table of AESs which have logged on to the GES, and has an inter-GES and GES-NCS signaling facility, so that every GES is able to set up calls to and from any AES operating to the same satellite as that GES, and to manage AESs in the handover process.

Two modes of operation are provided for; automatic and user commanded. In the automatic mode, the operation of the AES is fully automatic, with satellite system log-on and handover procedures occurring without external control. In the user commanded mode, the crew or flight control system is able to explicitly select the satellite and GES for log-on and handover, and to initiate handovers at any time. The normal mode of operation is expected to be the automatic mode.

4.5.3.2 Log-on and Handover Procedures

Further to the system table and spot beam table the AES also has additional information necessary to effect the automatic log-on and handover procedures, and facilities to enable convenient user override of the automatic procedures. The additional information needed for these functions is referred to as an Owner/Operator Requirements Table (reference Section 4.5.2.3).

4.5.3.2.1 System Log-on/Log-off

The log-on/log-off of an AES to and from the Aeronautical System provides the GES with the ability to manage the number of AESs receiving one forward P-Channel (Pd) and transmitting on each R-Channel (Rd), thus controlling the queuing delays and burst collision probabilities experienced.

When the AES is turned on, it enters a selection mode if the Log-on Policy is set to automatic, to select the most preferred GES operating to a visible satellite region; that satellite is selected for log-on. If the Log-on Policy is not set to automatic, the AES awaits user input in the user commanded mode, for explicit GES and satellite selection or reversion to automatic mode operation.

Having selected a satellite, the AES attempts to acquire one of the satellite identifying P-Channel frequencies (a satellite identifying P-Channel may be either a dedicated global beam P-Channel or the P_{smc}-Channel of a designated GES) which are in its current System Table (Reference Aero SDM Module 1 Section 5.5.1); typically there would be two frequencies per satellite (or group of satellites if several satellites provide service to essentially one region). The AES receives that P-Channel until one of the System Table Broadcast signal units is received, allowing the AES to check whether the Revision Number of the System Table it is using is currently valid. If the revision number is out of date, the AES receives the entire System Table Broadcast Sequence and stores the data. AESs which are capable of spot beam operations similarly should check whether the revision number of the Spot Beam Map they are using is still valid. If the revision number is out of date, a similar procedure as described above is followed. Checking the revision number of the Spot Beam Map Broadcast is not necessary if no GESs in the ocean region support spot beam operation.

Having ensured that the System Table and the Spot Beam Map revision numbers are correct, the AES is ready to log-on to the system using the selected GES.

The log-on procedure is initiated by tuning to the (global beam) P_{smc}-Channel of the selected GES, and sending a Log-on Request signal unit on one of the corresponding R_{smc}-Channels. In the event that the Log-on Request cannot be accepted by the GES, due to reasons such as GES overload, invalid message, unauthorized access, etc., the GES responds with a Log-on Reject signal unit which includes the cause of the rejection.

In the Log-on Request signal unit, the AES provides the chosen GES with its own identification (in the form of the ICAO 24-bit aircraft address) plus the identification of the spot beam in which the AES is currently located. The AES identifies the spot beam in which it is located by checking its current position against the Spot Beam

Map. The zero value is used in the spot beam ID field of the Log-on Request message if that spot beam is not supported by the chosen GES or if the AES is outside all spot beam coverage areas. The AES also informs the GES of the number of C-Channels for which the AES is equipped, the bit rate/coding algorithm in use on the voice channels, and the data bit rate capability for P-, R- and T-Channels. This information, except for the number of C-Channels and the data bit rate capability, is repeated in the Log-on Confirm signal for use by other GESs.

If the AES owner/operator wishes the aircraft flight identification to be used as the address for ground originated calls, the AES provides the GES with its flight identification number at the time of log-on. The use of this information in the GES depends on the nature of the services being offered and, thus, is at the discretion of the GES operator.

If the GES is using more than one set of R-Channel frequencies, and assigns new Rd-Channels to this aircraft, the GES transmits the new channel frequencies (up to eight) to the AES using signaling message(s) subsequent to the Log-on Confirm. In addition, if data services are provided, the GES transmits from one to four T-Channel frequencies to the AES. The decision as to which channels and with which EIRP to assign is made by the GES from the following information:

a. The satellite in use (its return link sensitivity)
b. The class of AES
c. The bit rate capability of the AES

The GES assigns data channels at the highest supportable bit rate, which is provided at both the GES and AES, and supported by the combination of a satellite in use and the class of AES. However, if an AES supports high-rate packet data channels, but prefers not to be assigned such channels in the global beam for the return direction, it may inform the GES of this preference in the Log-on Request. The GES then assigns spot beam channels or lower rate global beam channels if available.

Subsequent log-ons for handover also use R_{smc}- and P_{smc}-Channels in the same way as the initial log-on transaction.

4.5.3.2.1.1 System Log-on Procedure

When a GES receives the Log-on Request from an AES over an R_{smc}-Channel, the GES checks the authorization status of the AES. If the AES is authorized to access the Inmarsat Aeronautical System and if the requested service type is supported, the GES assigns the appropriate Pd-/Rd-Channels and, if necessary, T-Channel(s).

The GES transmits the Log-on Confirm with the Rd-Channel EIRP and, if necessary, P/R-Channel and T-Channel Control Signal Units to the AES over the P_{smc}-Channel, in order to inform the AES of the Pd/Rd/T-Channels it should use. The Rd-Channel EIRP is decided from the channel bit rate assigned and the satellite sensitivity in the return link.

The GES may also reject Log-on due to congestion, and if invalid parameters are included in the Log-on Request. If the AES is rejected from log-on to a GES, it may re-attempt log-on to the same GES depending on the category of the Reason code (Reference Inmarsat Aero SDM Annex 1) in the Log-Reject signal unit, as follows:

Permanent Unavailability	AES may not re-attempt log-on to the same GES for the duration of the current flight, unless specifically selected by user command.
Temporary Unavailability	AES may reattempt log-on to the same GES, only after trying all other GESs in the satellite region.
Invalid Parameters	AES may not reattempt log-on to the same GES with the same parameters in the Log-on Request signal unit.

When the GES receives the Log-on Acknowledge from the AES, the GES transmits a Log-on Acknowledge SU to the AES and initiates a timer. Upon expiry of the timer or upon receipt of an SU other than Log-on Request SU or Log-on Acknowledge SU or Log-on Flight Information SU or Log-off Request SU, the GES updates the Log-on AES table and transmits the Log-on Information over the interstation link to the other GESs operating to the same satellite.

When the GES receives the AES Log-on Information from another GES in the same satellite network where the GES is operating, the GES puts the AES into the log-on AES table according to the received information.

4.5.3.2.1.2 Log-off Procedure

The AES logs off prior to terminating its operation, or performing satellite and/or GES handover. This log-off is initiated manually, either directly or as a result of some other turn-down procedure associated with the end of an in-service period for the aircraft, or as a result of automatic handover procedures. The AES aborts any calls in progress, and transmits a Log-off Request to the Log-on GES. When the GES receives the Log-off Request from an AES, the GES transmits a Log-off acknowledge to the AES over the Pd-Channel and then transmits an AES Log-off Information signal over the interstation link to other GESs operating to the same satellite, depending upon the log-on status of the AES in its log-on AES table. If the AES does not receive a Log-off acknowledge from the GES, the AES re-transmits the Request for Log-off up to four times, then terminates the procedure.

4.5.3.2.1.3 Log-on Verification Procedure

Each GES checks the viability of communications with each AES that is logged on to it. The GES may optionally employ the direct verification procedure. In this case, the GES is capable of discriminating AESs which can not always respond to the Log-on Interrogation by means of information provided in the Log-on Request and stored in the Log-on AES table. A GES without this option could ignore this information.

For the indirect Log-on verification, the GES maintains an activity flag for each AES in the Log-on table which is set to one when the GES receives either the Log-on Request, Telephone Access Request, Log-on Interrogation ACK, or User Data message from an AES. Other SUs may also be used for setting the activity flag.

The GES also provides an absence counter for each AES in the Log-on table which is incremented by one when an activity flag is zero at the time of periodical check in every preset period not less than 60 minutes. The absence counter is reset to zero when an activity flag is one at the periodical check. If the absence period of an AES calculated from the absent count reaches or exceeds 12 hours, the GES deletes this AES from the Log-on table and transmits the AES Log-off Information to other GESs and NCSs in the same satellite region.

If the GES receives Telephone or Data Access Request or R-Channel User Data message from an AES not in the Log-on table, it transmits the Log-on Prompt signal to this AES. When the AES receives the Log-on Prompt, it carries out the log-on procedure.

The direct verification procedure, if employed, is activated when the activity flag for an AES is found to be 0 and this AES is capable of responding to the Log-on Interrogation. If the AES fails to respond to the interrogation after total of 5 repeated attempts, the GES deletes this AES from the Log-on table and transmits the AES Log-off Information to other GESs and NCSs in the same satellite region. If the AES successfully responds to the interrogation, the GES sets the activity flag of this AES to 1.

4.5.3.2.2 Data Channel Re-assignment Procedure

At the GES operator’s option, the GES may include a function which reassigns any data channel(s) assigned to a particular AES. If this function is provided at the GES, the following procedure applies.

When the GES wishes to reassign the data channel(s) (Pd/Rd/T-Channel) assigned to a particular AES at its log-on, the GES transmits the Log Control/Data Channel Reassignment signal to the AES. If the AES responds with the Log Control/Ready for Reassignment, the GES transmits the Log-on Confirm, P/R-Channel Control and/or T-Channel Control with reassigned channel information, as required, to the AES. When the GES receives the Log-on Acknowledge from the AES, the GES returns the Log-on Acknowledge to the AES and takes the same actions as described in Section 4.5.3.2.1.2, except that the Log-on Information is not transmitted over the ISL.

When the AES receives the Log Control/Data Channel Reassignment, the AES responds to the GES with the Log Control/Ready for Reassignment. Then the AES awaits the Log-on Confirm and subsequent P/R-Channel and T-Channel Control as appropriate, and at the reception of them the AES transmits the Log-on Acknowledge on one of the assigned Rd-Channels to the GES. The AES comes into logged-on status after receiving the Log-on Acknowledge returned from the GES.

At the edge of satellite coverage, Pd-Channel is subject to short term degradation or interruption. The procedures given here are to minimize unnecessary initiation of handover arising from temporary loss of signal strength, such as from fading or rapid aircraft maneuver, while restoring communications within a short time when a channel is really unusable.

Degradation of the Pd-Channel signal is declared in the AES when either the received bit error rate rises above 10^{-4} over an averaging period of 3 minutes, or more than 10 short term interruptions (loss of clock synchronization for less than 10 seconds) are experienced in any 3 minute period.

Loss of the Pd-Channel signal is declared in the AES when clock synchronization is lost for more than 10 seconds. If the AES finds degradation or loss of the Pd-Channel signal, it deems itself logged off without transmitting Log-off Request and restarts the complete initialization procedure.

4.5.3.2.3 Handover Procedures

As the AES travels, several handovers may occur, i.e., GES-to-GES, satellite-to-satellite and spot beam handover. When the Log-on GES is changed, the handover is affected by first performing a log-off to the current GES, followed by a log-on to the new GES.

User commanded handover initiation by the AES is employed only if the Log-on Policy field of the Owner/Operator Requirements Table is set to user commanded; otherwise handover initiation is automatic.

4.5.3.2.3.1 Automatic Handover

The automatic handover is initiated by detection of Pd-Channel loss or degradation, or if the AES fails to receive Log-on ACKo from the GES during Log-on or Data-Channel Reassignment process. When handover is initiated, the AES falls back to GES selection, as described in Section 4.5.3.2.1.

Other optional automatic handover criteria, designed to satisfy the AES users' quality of service expectations, may be implemented. The following is an example recommended criterion for automatic handover initiation: The AES operating outside its approved achieved coverage volume for a period greater than ten seconds.

4.5.3.2.3.2 User Commanded GES-to-GES Handover

When an AES changes its Log-on GES to another GES operating to the same satellite, e.g., under command from crew, any previously established communication channels are maintained until clearing. Therefore, an AES which can transmit only one carrier at a time initiates the handover procedure only when the AES is not busy. An AES with a multiple channel transmission capability may proceed with the handover procedure even if the AES has some busy C-Channel(s).

4.5.3.2.3.3 User Commanded Satellite-to-Satellite Handover

In the case of user commanded satellite-to-satellite handover, the AES ensures all communication channels are clear prior to starting signaling for the handover procedure. Immediately prior to the start of the handover procedure, if any calls are in progress the AES applies time supervision of three minutes and then clears any remaining calls. The GES clears any calls in progress with the AES, after an AES Log-on Information message is received from another satellite network. Otherwise, the satellite-to-satellite handover sequence is the same as the user commanded GES-to-GES handover sequence in Section 4.5.3.2.3.2 above.

4.5.3.2.3.4 Spot Beam Handover

The decision to perform spot beam handover is taken by the AES based on the knowledge of its position and of the Spot Beam Map information. A spot beam handover is performed in the following cases:

a. Spot Beam-to-Spot Beam Handover when the AES is:
    1. Logged on to a spot beam;
    2. Outside the nominal boundary of that spot beam; and

3. Within the nominal boundary of at least another spot beam of the same satellite served by the same GES.

b. Spot Beam-to-Global Beam Handover when the AES is:
   1. Logged on to a spot beam;
   2. Outside the nominal boundary of that spot beam; and
   3. Outside the nominal boundary of all other spot beams of the same satellite served by the same GES.

c. Global Beam-to-Spot Beam Handover when the AES is:
   1. Logged on to the global beam;
   2. Within the nominal boundary of at least one spot beam of the same satellite served by the same GES.

The nominal boundary of a spot beam is defined as the perimeter of the polygon representing that spot beam. The AES checks its position periodically against the current Spot Beam Map and initiates the spot beam handover when it detects one of the three conditions listed above. The spot beam handover is performed as a renewal of Log-on to the same GES.

4.5.4 Channel Resource Management

4.5.4.1 Data Channel Power Control

In the Log-on Confirm signal, the AES is given an EIRP setting for Rd-Channels. The AES decides the T-Channel EIRP, if any T-Channel is assigned, according to the R-Channel EIRP assigned, the ratio of R-Channel and T-Channel bit rate and the Differential Beam EIRP adjustment specified in the T-Channel Control SU. The Differential Beam EIRP adjustment value is used to provide for the case when the R-Channel and the T-Channel are through different satellite beams, i.e., one through the global beam and the other through a spot beam.

4.5.4.2 C-Channel Power Control

Power control capabilities for the forward and return directions are used in the AES and GES. The purpose of the power control is to conserve satellite L-band power in the forward direction, and to enable an AES to provide multiple channels when link conditions are favorable, while providing service with a smaller number of channels (e.g., one channel) when link conditions are unfavorable.

4.5.4.2.1 Power Control Management

The initial EIRP of C-Channel is set to be the value derived from the worst case link budget, and is conveyed to the AES in the C-Channel Assignment signal transmitted by the GES over the Pd-Channel. This value may be different for operation through a spot beam and operation through a global one. When an AES under favorable operational condition is establishing a C-Channel in addition to the existing one(s), the AES is still assigned the initial EIRP corresponding to the worst case link budget. If the maximum EIRP available in the AES is less than the initial EIRP setting, the AES initiates the additional C-Channel being established with the maximum available EIRP which must be equal to or higher than the lowest EIRP of any C-Channel currently in operation.

If the AES finds that its power budget would be exceeded, the AES rejects a call attempt or pre-empts one of lower priority, even though there may be a free channel unit.

The maximum EIRP available in the AES for the new call is given by the following formula:

$$EIRP_{available} = EIRP_{max\ allowable} - EIRP_{C\text{-}Channels\ in\ use} - EIRP_{reserved\ for\ R\text{-}/T\text{-}Channel}$$

where:

$EIRP_{max\ allowable}$ = maximum allowable operating EIRP

COMMENTARY

The maximum allowable operating EIRP is the maximum multi-carrier EIRP which the AES may transmit while satisfying the transmitted intermodulation product level specification.

$EIRP_{C\text{-}Channels\ in\ use}$ = The total EIRP already in use for the C-Channel calls that are currently in progress; and

$EIRP_{reserved\ for\ R\text{-}/T\text{-}Channel}$ = The EIRP used to support the highest bit rate R- or T-Channel assigned as derived from the R-Channel specified in the Log-on

Thereafter, the sequence for power control of the link uses an exchange of signals between GES and AES as shown in the Aero SDM Module 1, Figure 23. Each power control signal (forward and return) includes a bit error rate value and an adjustment value (See below); an indication of the validity of the bit error rate value reported is also included. On spot beam C-Channels, the Spot Beam ID is specified by the GES in each power control signal in the forward direction, and echoed back by the AES in the return direction for monitoring purposes. Each power control signal sent by an AES is immediately followed by another signal carrying the current AES position and the current AES antenna gain. It should be possible to disable the position reporting function if so desired by the AES owner/operator. If position reporting is disabled, the AES Position Valid flag is set to zero. The second signal is ignored by the GES and is used for spot beam monitoring purposes only. Power control decisions for both directions of transmission are made in the GES. The basic method is to carry out a timed series of power control sequences commencing immediately after call set-up and continuing until the call clears. The interval between power control sequences is approximately ten seconds.

The GES determines the amount of adjustment (if any) for both directions of transmission.

4.5.4.2.2 AES and GES Requirements for Measuring Bit Error Rate (BER)

In the AES and GES, the received channel bit error rate is measured or estimated in accordance with the following specifications. The steady state measurement or estimated value is equal to the average number of bit errors occurring in 2560 bits. The underlying signal-to-noise ratio (SNR) estimation accuracy is ± 0.2 dB (with a 99% confidence level).

COMMENTARY

This measurement is to be performed over several frames if it is done by counting errors in the received bit stream (i.e., before decoding). The value is used for transmission in the Received Bit Error Rate field of the Channel Status Report signal with the condition that values greater than 255 are coded as 255. The Validity Indicator field indicates whether the reported Received Bit Error Rate value is within the required measurement accuracy.

4.5.4.2.3 Power Control Decision Table

In the GES, the threshold values for deciding to increase or decrease the AES and GES EIRP are adjustable per channel type by operator command, but recommended initial settings for the 21,000 bit/s, rate 1/2 FEC channel used in the Initial System, are as follows:

EIRP	Measured/Reported BER*
Increase by 2 dB	172 BER
Increase by 1 dB	119 BER $<$ 172
Unchanged	76 BER $<$ 119
Decrease by 1 dB	44 BER $<$ 76
Decrease by 2 dB	BER $<$ 44

* BER is expressed as the number of error bits in every 2560 bits.

These values correspond to the input bit error rates to a rate ½ Viterbi decoder as specified for the C-Channel, providing an output bit error rate of 10^{-3} (nominal) to around 10^{-4} (1 dB above nominal), with a 1.5 dB margin.

In order to achieve the necessary accuracy, the BER estimation should consist of at least 21,000 accumulated received bits (before decoding).

4 5.4.2.4 Power Control Operation - Forward Link

After every power control signaling sequence the GES adjusts the GES EIRP according to the BER value received from the AES and the power control decision table (Reference Section 4.5.4.1.3). If no BER value is received from the AES before the next power control signaling sequence, it is recommended that the GES increase its EIRP by 1 dB; if an invalid BER value is received from the AES, it is recommended that the GES keep its EIRP unchanged.

For the forward link, maximum power per carrier is subject to a limit of 4 dB higher than the nominal worst case link condition (5º satellite elevation at the AES, -13 dB/K AES (G/T)). The minimum power level is at least 8 dB lower than the nominal worst case link condition.

4.5.4.2.5 Power Control Operation Return Link

Before every power control signaling sequence the GES determines the AES adjusted transmitted power, based on the BER value measured at the GES. The adjustment is determined from the power control decision table (Reference Section 4.5.4.1.3). Upon receipt of the Channel Status Report signal, the AES adjusts its

EIRP according to the received EIRP adjustment value. The received EIRP adjustment value is echoed back to the GES for monitoring purposes.

4.5.4.3 Transmitter Inhibit

An AES should not transmit any carrier unless at least one of its receivers is correctly demodulating a P-channel radiated by the log-on GES (average BER less than 10^{-5}), with the exception that a Class 2 AES may transmit a C-channel at any time provided that it is successfully receiving the corresponding ground-to-air C-channel (average bit error rate less than 10^{-3}) with no interval of more than 40 seconds in which this rate is exceeded.

4.6 Data-2 Packet-Mode Data Service

This section specifies the procedures and protocol used by the SDU to implement Data-2 Packet-Mode Data Service as defined in INMARSAT SDM Module 0, Appendix 2. Data-2 uses a null satellite SubNetwork Layer whereby the Satellite Link Service Data Unit header is composed of two octets, set to $FFFF_h$, to send an enveloped message.

4.6.1 Link Layer Functions

Messages are transmitted with the Reliable Link Service (RLS) quality of service. Messages are transmitted at the default Q Precedence Level of 7. In order to provide forward compatibility with a standard subnetwork layer, packet communication takes place at the link service interface. The link service user adds a two octet header to the transmitted message to form an LSDU, and extracts a received message from an LSDU by removing the two octet header. Packets for transmission are accepted into the LSDU Segmentation Unit of the LSDU Segmentation and Reassembly Sub-Layer as shown in Attachment 4X, Figure 33A. Received packets are collected from the LSDU Reassembly Unit.

4.6.2 Data-2 Structure

A Link Service Data Unit (LSDU, consisting of a message plus a two octet dedicated header) is injected or collected at the link service interface in the AES.

Enveloped ACARS messages begin with the Start-of-Header (SOH) character (01_h); continue through the End-of-Text (ETX) character (83_h) or End-of-Block (ETB) character (13_h) and the two octet Block Check Sequence; and conclude with a Delete (DEL) character ($7F_h$) (reference ARINC Characteristic 597).

4.6.3 Internetworking Functions

Link Service User data is carried transparently through the GES (where the GES strips off the 2 octet header of $FFFF_h$) between AESs and their corresponding DTEs.

Once an aircraft has logged on to a GES, a data path exists between the AES and the GES. Only one such path is provided for each AES, allowing bidirectional communications. Messages are limited in size to the contents of one LSDU less the two octet identifying header (504 octets). Messages received from other onboard avionics to be sent to the ground, where communications have been established, are sent in their entirety without additional compression.

COMMENTARY

At the ground, a separate Switched Virtual Circuit (SVC) is established for each aircraft between the GES and a predefined subnetwork point of attachment (SNPA) DTE.

The terrestrial connection is established by the GES when the aircraft is logged on at the GES and is cleared when the aircraft is logged off at the GES.

4.6.3.1 Data-2 Transmit

A Data-2 AES transmits to the GES all messages passed from the avionics network interface during the time that the AES is logged on. If the AES is not logged on, any messages passed to the AES are discarded.

4.6.3.2 Data-2 Receive

While the AES is logged on, any messages received from the GES are forwarded to the avionics network interface regardless of the state or availability of the destination avionics equipment.

4.6.3.3 Logged On Status

The connection between the AES and the GES is assumed by the avionics equipment in the aircraft to exist at all times while the AES is logged on.

4.7 ACARS MU/CMU - SATCOM Interface

This section applies for the case of the DTE address D digit being absent or equal to zero (reference Section 4.3.4.3.1).

4.7.1 Overview

An ARINC 429 data bus provides communications between the SATCOM system and the ACARS MU/CMU system. There are two basic types of communications conducted over these circuits. The first type is transfer of messages exchanged with the terrestrial ends of the system. The second type is system and maintenance data request and response messages used for command and control. Messages are identifiable when transferred through the use of the GFI field in the file transfer protocol.

4.7.2 Physical Interface

Data rates, voltage thresholds, and electrical interface specifications are per ARINC Specification 429. Use of High or Low speed 429 is determined by a strapping option.

4.7.3 Link Layer - Broadcast

The SDU and the ACARS MU/CMU should monitor each other’s status by exchanging Label 27x status words (as defined in the subsection which follow) once per second.

4.7.3.1 SDU to ACARS MU/CMU Status Word

The SDU should transmit a Label 270 word as defined below. This SDU output may also be monitored by the EICAS/ECAM/EDU for generating and displaying airframe-specific primary-field-of-view warnings and memos for the SATCOM system.

Bit(s)	Description
9-10	SDI (per ARINC Specification 429 Section 2.1.4)
11	Data Link via MU/CMU Not Available If set, then SATCOM data link is not possible via MU/CMU interface (either due to equipment failure, no active ARINC 429 input buses from the CMU's (as also indicated in bits 12 and/or 19) or no logon). If not set, the MU/CMU should expect to be able to send data over SATCOM.
12	MU/CMU #1 Inactive This bit is set if the MU/CMU #1 transmission of a valid Label 270 is detected as inactive.
13	SATCOM Voice Unavailable If set, the SATCOM is logged off or logged on to the Low Gain System for reasons other than equipment failure, i.e., Low Gain Reversion because of operation in a key hole, very low elevation angles, or blockage. This bit may be used to generate a cockpit advisory message (e.g., >SATCOM VOICE UNAVAILABLE).
14	SELCAL This bit is always used for ground-initiated calls; its usage for air-initiated calls is optional, as governed by ORT item n (reference Section 4.5.2.3). It is not affected in any way by the state of the SDU cockpit voice call light/chime system configuration pins TP13C and TP13D, which only govern the discrete chime output on SDU pins MP14B and MP14C. When set, this bit indicates that a new cockpit voice circuit has been established. Depending on the aircraft type, this may result in a visual annunciation of the new call on the EICAS/ECAM/EDU, as well as activation of the cockpit chime. The crew typically refers to the EICAS/ECAM/EDU to determine which system (SATCOM, HF, etc) is annunciating the call. Bit 14 should remain set until an appropriate acknowledgement is received (i.e., either the mic-on circuit for the respective channel (SDU pin MP8F or MP8H) or an SCDU line select key indicating off-hook, or the Chime Reset discrete (MP14A) being asserted). One appropriate acknowledgement should be received for each call annunciation. For the case of two simultaneous call annunciations, one appropriate acknowledgement should be received for each call before bit 14 is ultimately cleared. To help ensure proper receipt of the states of this bit, and to meet various timing needs at the receiving end, including visibility of the call annunciation on the EICAS/ECAM/EDU (especially for cases where calls are immediately auto-answered), it should be checked and ensured that the bit has been cleared in all transmitted samples for at least two seconds prior to being set, and then set for at least four seconds or until the annunciation is acknowledged, whichever occurs last. For the case of a second call annunciation occurring within four seconds of the first, the annunciation for the first call may be interrupted by the second (in order to most quickly initiate the second annunciation) as long as the first annunciation is active for at least two seconds (with no wait for

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Bit(s)	Description
	acknowledgement) and the minimum four second hold time is still applied to the second annunciation - i.e., bit 14 has been cleared for at least two seconds, then it is set for two to four seconds, then cleared for two seconds, then set the second time for at least four seconds or until both annunciations are acknowledged, whichever occurs last.
15	Message Alert with Chime Setting this bit causes the SATCOM comm alerting message to be displayed, and a chime is automatically rung. This bit is used to alert the crew to refer to SATCOM MCDU/WSC messages for timely information. SATCOM should clear this bit once positive pilot response has been detected.
16	Message Alert without Chime Setting this bit causes the SATCOM comm alerting message to be displayed. No associated aural is provided. This bit is used to alert the crew to refer to SATCOM MCDU/WSC messages for routine information. SATCOM should clear this bit once positive pilot response has been detected.
17	SATCOM Not Logged-On This bit should be set whenever the SATCOM is not logged onto a ground station.
18	SATCOM Master/Slave This bit should not be set if the originating SATCOM is the master or if only one SATCOM is installed. This bit should be set when the originating SATCOM is the slave or the disabled unit in a dual installation.
19	MU/CMU #2 Inactive This bit is set if the MU/CMU #2 transmission of a valid Label 270 is detected inactive.
20	SATCOM Cockpit Fault If set, then no cockpit voice nor MU/CMU data transmissions via SATCOM are possible (due to equipment failure).
21	SATCOM Cockpit Voice Fault If set, then no cockpit voice transmissions via SATCOM are possible due to equipment failure.
22	SATCOM Voice Call 1 If set, the SATCOM has detected a low priority (4) flight deck incoming voice call on channel 1. When the call is answered, the bit should be cleared.
23	SATCOM Voice Call 2 If set, the SATCOM has detected a low priority (4) flight deck incoming voice call on channel 2. When the call is answered, the bit should be cleared.
24	SATCOM Voice Alert 1 If set, the SATCOM has detected a high priority (1, 2, or 3) flight deck incoming voice call on channel 1. When the call is answered, the bit should be cleared.

<table>
<tr><th>Bit(s)</th><th>Description</th></tr>
<tr><td>25</td><td>SATCOM Voice Alert 2

If set, the SATCOM has detected a high priority (1, 2, or 3) flight deck incoming voice call on channel 2. When the call is answered, the bit should be cleared.</td></tr>
<tr><td>26</td><td>SATCOM Cockpit Voice Communication 1

If set, then a cockpit voice communication is connected on channel 1.</td></tr>
<tr><td>27</td><td>SATCOM Cockpit Voice Communication 2

If set, then a cockpit voice communication is connected on channel 2.</td></tr>
<tr><td>28</td><td>SATCOM LGA Subsystem Failure

If set, there has been a failure in the Low Gain SATCOM subsystem. In a dual-SDU system, this bit is only set by the respective LGA-equipped SDU, and only for the reasons of LGA equipment failure and literal LGA test log-on failure (as described below and in Section 4.7.3.4 for Label 276 bit 11), but <u>not</u> for the reason of the test log-on not being initiated. In a dual-SDU system, LGA log-on test failures may be redundantly indicated in this bit and in bit 11 of Label 276 (reference Section 4.7.3.4) (e.g., when the LGA is the slave). If installed, the condition of the Low Gain System should be monitored and reported while the High Gain system is in operation. The LGA System should be exercised, in a manner that detects faults as it would when the LGA is being used for operation, i.e., actually transmit and log on to detect any RF faults. This should be done at power up, and at least once per flight leg (automatically).

Any of the CFDS Bits (shown below) set for the LGA System should set Bit 28:

<table>
<tr><th>Label/Bit</th><th>Fault Reported</th></tr>
<tr><td>350/15</td><td>LGA/HPA</td></tr>
<tr><td>350/18</td><td>LGA Diplexer/LNA</td></tr>
<tr><td>350/23</td><td>LGA (HPA to LGA VSWR Fault)</td></tr>
<tr><td>351/23</td><td>LGA HPA Input Bus</td></tr>
<tr><td>353/20</td><td>LGA HPA Multi-Control Bus</td></tr>
</table>
</td></tr>
<tr><td>29</td><td>SATCOM Data

If set, no declared ACTIVE ACARS MU/CMU is available at the SDU, or the ACTIVE ACARS MU/CMU does not respond with a Loop Word in response to a SATCOM Test Word.

The case of no declared ACTIVE ACARS MU/CMU can be due to:

a. Bus inactivity on all ACARS MU/CMU inputs, or,
b. Bus activity, but no declared ACTIVE ACARS MU/CMU.

Use of the Test/Loop procedure per Williamsburg protocol (ARINC Specification 429 Section 2.5.17.1 and Attachment 11) to check the interface is an optional criterion for setting bit 29.

This bit may be used to set a cockpit advisory message (e.g., >SATCOM DATA) indicating to the flight crew a loss of SATCOM Datalink capability due to a failure in the SATCOM/ACARS MU/CMU interface.</td></tr>
<tr><td>30-31</td><td>SSM (per ARINC Specification 429, Sections 2.1.5 and 2.1.5.3, except that 11 = Not Defined)</td></tr>
</table>

In a dual SATCOM system, all general status bits should have either local significance (i.e., the state of the bit refers only to the SDU providing the Label 270 word) or global significance (i.e., the state of the bit refers to the combined dual system), as specified below.

Bit(s)	Dual System Significance
11	Local (only the master de-asserts this bit)
12	Local
13	Local
14	Local or global (Is global, asserted by the Master only, in order to meet timing constraints of two call annunciations for two (near) simultaneous calls).
15	Local
16	Local
17	Global
18	Local
19	Local
20	Local
21	Local
22	Local
23	Local
24	Local
25	Local
26	Local
27	Local
28	Local
29	Local

4.7.3.2 ACARS MU/CMU to SDU Status Word

The SDU should monitor the Label 270 word transmitted by the ACARS MU/CMU, which is specified in ARINC Characteristics 724, 724B, and 758.

COMMENTARY

The Label 270 word is encoded as follows:

Bit	0	1	Function
9-10			SDI (as per ARINC 429 Section 2.1.4)
11-15			Not Applicable
16			MU/CMU Fail
17-19	OK	Fault	Not Applicable
20	Standby	Active	Active/Standby
21-25			Not Applicable
26	ACARS MU	CMU	CMU/MU Installed
27-29			Not Applicable (reserved)
30-31			SSM (as per ARINC 429 Sections 2.1.5 and 2.1.5.3, except that 11=Not Defined)

4.7.3.3 SDU to ACARS MU/CMU Join/Leave Message

The SDU should transmit a Label 271 Join/Leave message as defined below.

Bit(s)	Description
16-9	GES ID (per Attachment 2X Annex 1 Element 24)
22-17	Satellite ID (per Attachment 2X Annex 1 Element 51)
25-23	Aero service type currently being provided: 000: Aero-L 001: Aero-I 010: Aero-H 011: Aero-H+ 1xx Reserved for future use
28-26	Pad (zero)
29	Data Link via MU/CMU Not Available (identical to Bit 11 in Section 4.7.3.1)
31-30	SSM (per ARINC Specification 429 Section 2.1.5 and 2.1.5.2)

COMMENTARY

Bit 29 indicates whether a data link is Available (a Join message) or Not Available (a Leave message) from the AES to the GES which is identified by the GES ID and Satellite ID fields. The CMU uses this information to initiate network-layer virtual circuits with available ground routers by determining the ground routers' DTE addresses from the provided GES identity. The GES and Satellite ID fields uniquely identify a GES. The Aero Service Type field may be used by the CMU to make routing decisions, e.g., if cost per bit is a routing criterion.

4.7.3.4 SDU to EICAS/ECAM/EDU for Dual SATCOM (Label 276)

The SDU should output status of the Slave in a Dual SATCOM system on the same physical bus that goes to the ACARS MU/CMU on Label 276 at a once per second update rate.

Bit(s)	Description
11	SATCOM Slave Log-On Failure If set, there has been a failure to log-on via the Slave SATCOM System during a test log-on. This applies to slaves with any kind of antenna configuration, including HGA, HGA+LGA, and LGA-only. If installed, the Slave in a Dual SATCOM installation should log-on once per flight cycle to verify that it is available if it has to take over as master in the case of a failure in the master system. This should be done at power up, and at least once per flight leg (automatically). Failure to log-on during the Slave log-on test should set bit 11 in the Master's 276 word (<u>not</u> the Slave's 276 word). The bit should also be set if the log-on test is not initiated or is aborted for reasons such as equipment failure detected by continuous monitoring or other self-tests. In a slave which has more than one antenna subsystem (e.g., HGA+LGA), the bit is <u>not</u> set unless <u>all</u> of the slave's antennas have failed the log-on test (including the cases of not initiating or aborting the test). The bit is cleared upon handover of mastery as well as upon successful test log-on. LGA log-on test failures may be redundantly indicated in this bit and in bit 28 of Label 270 (reference

	Section 4.7.3.1) (e.g., when the LGA is the slave).
12	Disabled SATCOM If set, the SDU is being disabled by an external switch or via the SCDU, or via automatic detection of a fault that causes the system to be disabled.
13	No IRS Data Set bit 13, on Label 276, if the SDU is not receiving valid IRS Data, i.e., no activity, NCD or Test, and the system is programmed for high gain operation. This bit is used to inhibit the SATCOM High Gain Status Message on EICAS when the IRS is off or in the alignment mode.

Each bit should have either local or global significance (as defined in Section 4.7.3.1) as specified below:

Bit(s)	Dual System Significance
11	Global (asserted by the master only)
12	Local
13	Local

4.7.4 Link Layer - Bit Oriented FTP

The Link Layer Protocol used is the “Bit-oriented Communications Protocol” File (BOP, also known as the Williamsburg protocol) as specified in ARINC Specification 429, Section 2.5, and Attachments 10, 11, 11A, 11B, 11C, 12, 13, 14, and 15. All timer values should be the default definitions in ARINC Specification 429, Tables 10-1 and either 10-4 or 10-5 (as appropriate), and only one open file at a time.

In addition, the following BOP options should be used by the SDU for the ACARS MU/CMU interface (reference ARINC Specification 429, Table 10-3**a**):

Option	Value	Notes
O_1	Half	Half or Full Duplex Operation
O_2	Note [1]	High or Low Speed Bus
O_3	No	Automatic CTS when ready
O_4	No	Accept Automatic CTS
O_5	Yes (SDU)	System Priority to Resolve RTS Conflict
O_6	--	Spare
O_7	--	Spare
O_8	Yes	Use of SOLO word (TEST/LOOP)
O_9	--	Spare
O_{10}	Yes	Destination code in RTS/CTS /NCTS/BUSY Used
O_{11}	Yes	Bit-Protocol verification
O_{12}	**No**	**Use Subsystem SAL from ALO word**

Note:

1. SDU System Configuration Pin TP10D (reference Part 1 Attachment 1-4C) specifies the speed of the physical layer ARINC 429 bus. Low or high speed strapping dictates the timing specifications in ARINC Specification 429 of either Table 10-4 or 10-5, respectively. [Physical 429 bus speed is completely independent from the choice of the ARINC 429 link layer protocol version, which is determined by the ALO/ALR

version negotiation. The original ARINC 429 Williamsburg protocol (Version 1) may operate on low or high speed buses; the newer windowed Buckhorn protocol (Version 2) is intended for, but not limited to, high speed bus applications.]

A reception of a SYN word should cause the receiving system to abort any reception or transmission in progress; in addition, if the system was transmitting, it should re-initiate transmission of the FILE that was aborted.

On power-up, systems may transmit SYN words as opposed to sending NAK or ALO words or systems may transmit ALO words as opposed to sending NAK or SYN words. All systems, however, are to respond with an ALR if an ALO is received as defined by Option 11.

COMMENTARY

Since the primary purpose of the ALO/ALR words are to verify the BOP between two systems and BOP is the only protocol used for this interface, transmission of the ALO word is not necessary and SYN may be used.

4.7.4.1 File Formats

The interface is used to pass ACARS messages, 8208 packets, other messages that can be enveloped and command/control messages. To differentiate these types of traffic the Williamsburg General Format Identifier (GFI) of the SOT word should be set as follows:

File Type	To MU/CMU		To SDU		GFI
	Label	Dest. Code	Label	Dest. Code	
Enveloped Mess.	304	M	307	S	$1110_b(E_h)$
8208 Packets	304	M	307	S	$0100_b(4_h)$
Command/Control	304	M	307	S	$0010_b(2_h)$

Williamsburg GFIs are assigned in ARINC Specification 429, Table 11-7A and apply to files transfer in either direction.

4.7.4.2 Data-2 Enveloped Messages

A Williamsburg GFI of 1110_b (E_h) indicates that the message is to be enveloped. No network protocol is used.

One message is transferred per link layer ARINC Specification 429 file. (The enveloped message is passed transparently by the SATCOM AES and GES.)

One type of enveloped message is an ACARS message block, as specified by ARINC Specification 618, starting with the <SOH> character and ending with the two octet computed BCS and <DEL> character as defined in ARINC Specification 618, Section 2.

If, for any reason, the SATCOM SDU is unable to deliver an enveloped message to its destination (ACARS MU/CMU or GES), the SDU should discard the message.

4.7.4.3 8208 Packets

A Williamsburg GFI of 0100_b, (4_h) indicates that the first octet of the NPDU is an initial protocol identifier (IPI) coded per ISO 9577. IPIs used for SATCOM include the sets xx01 $xxxx_b$, for ISO 8208 with modulo 8 packet sequence numbering, xx10 $xxxx_b$, for ISO 8208 with modulo 128 packet sequence numbering and xx11 $xxxx_b$, for ISO 8208 with GFI extension. The usage of GFI 4_h, plus an IPI within any of the three aforementioned sets of codes indicates the presence of an 8208 packet, which uses the Satellite SubNetwork Access Protocol as defined in Sections 3.3.4 and 4.3.4 of this document.

4.7.4.4 Command/Control File

A Williamsburg GFI of 0010_b (2_h) indicates a command/control file. Section 4.7.5 details the command/control interface between the SDU and the ACARS MU/CMU.

4.7.5 Command/Control Interface

4.7.5.1 Command/Control Overview

The applications supported by the command/control interface between the SDU and the ACARS MU/CMU are identified in Table 1. The exchange between the ACARS MU/CMU and the SDU should be in the form of a binary file transfer as defined by ARINC Specification 429, Section 2.5.

4.7.5.2 Command/Control Format

The command/control file format should be a binary format with the first octet as a type designation as defined in the table below. The type designations are used to allow the SDU or ACARS MU/CMU to differentiate the file contents.

SDU		
Code	**Designations**	**Source**
00_h	Reserved	
01_h to BF_h	Reserved; Unassigned	
CO_h to DF_h	Reserved; Manufacturers/ Users	SDU, MU/CMU
EO_h to FE_h	Reserved; Unassigned	
FF_h	Type Designation continued in next octet	SDU, MU/CMU

4.7.6 ACARS Peripheral Functionality

The SDU may optionally transfer manufacturer-specific data files to and from airline ground-based hosts via the ACARS MU/CMU, using any available air/ground subnetwork as per standard ACARS procedures specified in ARINC Specifications 618, 619, and 620.

This capability may be used for a variety of applications, including receiving Owner Requirements Table (ORT) updates, downloading maintenance and event logs, etc. These data files are formatted, addressed and transmitted as for any other ACARS Peripheral, as specified in ARINC Specifications 619 and 620, utilizing the appropriate addressing (i.e., for SDU #1/Left, SDU #2/Right and SDU Designated [Master]). The link layer exchange between the ACARS MU/CMU and the SDU should be in the form of file transfers as defined by ARINC Specification 429, Section 2.5 (Williamsburg Protocol). In order to enable any manufacturer's SDU to utilize this capability with any ground-based airline application, the lower six bits of the first octet of the file is a company ID field as defined in Attachment 9B of ARINC Specification 429. The remaining octets of the file are manufacturer defined, including application coding and any higher-layer provisions for error detection beyond that provided by the link layer.

4.8 Provisions for Dual SATCOM

Dual SATCOM is an optional configuration where two single systems are installed aboard a single aircraft (one example of which is shown in Attachment 1-1A). Each system has all of the equipment necessary (i.e., SDU, RFU, HPA, LNA/Diplexer, and antenna system) to function without the other. Each system may utilize either a low gain or high gain antenna system (i.e., the two systems may be identical or dissimilar -- various configurations are possible in different installations). Dual systems may provide backup redundancy for safety voice and data services, or additional cabin channel capability, or both. Additional external wiring and/or switching may be necessary to realize all of the benefits of a dual system.

Due to the use of the ICAO 24-bit aircraft address for data link layer addressing (AES ID), and due to the general restriction of assigning only one such ICAO 24-bit aircraft address per aircraft, a typical dual SATCOM installation employs a Master/Slave relationship between the two systems, utilizing a single AES ID for channels handled by either system. The Master/Slave concept is further described in Section 4.8.2 below.

4.8.1 SDU #1/SDU #2 Programming Pins

When there are two SATCOM systems installed on an aircraft, one system is always designated as System #1, the other as System #2. SDU rear connector pin TP12E is strapped to indicate whether the SDU is stand-alone, or part of a dual installation. If part of a dual installation, SDU rear connector pin TP12F indicates whether that particular SDU is installed as part of System #1 or System #2.

4.8.2 Master/Slave Definition

The Master system is defined as the system in control. Its functions are to:

a. Support the data interface to the CMU.
b. Supply the P-channel receiver, and R/T -channel transmitters.
c. Control the establishment and release of ALL voice channels.
d. Provide C-channel modems for both cockpit and cabin voice.

The Slave system is only utilized to provide extra C-Channels for circuit-mode services for the cabin and for the cockpit. The C-Channel modems in the Slave system are controlled by the Master.

4.8.3 System Select and Disable Discretes

The System Select and System Disable discretes (along with the SDU Crosstalk bus--reference Section 4.8.5) are used to determine and control the Master/Slave and Disabled states of each system. The two discretes should be cross-connected in the aircraft wiring, such that the System Select discrete pin of one system is wired to the System Disable discrete pin of the partner system.

The System Disable discrete is an input only. This input is pulled low while the other SATCOM system (or the crew) has determined that this system has failed. While this input is held low on one system, this system should be inhibited from making any RF transmissions. It is recommended that the SDU use this input to prevent itself from transmitting by using a simple hardware means, and not depend on functional SDU software.

The System Select discrete is a combination input and open-collector output. While this discrete is pulled low by an external source, it indicates that this system has been selected the sole Master, and should not attempt to utilize its partner system for additional voice channels. In addition, if a system detects that its partner system has failed, it can pull its own System Select discrete low, forcing itself to be sole Master, and disabling the failed partner system.

It may also be possible in some installations for the System Disable inputs to be externally asserted (reference Section 4.8.4) on both systems. This may be done where it is desired to inhibit RF transmissions from both systems for special cases such as the proximity of maintenance or service personnel to the SATCOM antennas. When both systems are thus Disabled other non-RF Master/Slave distinctions may still need to be maintained e.g., Master/Slave indication to the ACARS MU/CMU and certain BIT communications.

4.8.4 Manual System Selection Criteria

The crew should have the capability to manually disable a system which they believe has failed. This is done via a manual entry on the SCDU of the non-failed system that is to assume the Master role. Selection results in the SDU pulling its own System Select discrete (and its partner’s System Disable discrete) low, thereby disabling the partner system.

As an option, an external three position switch can be installed in the aircraft wiring and connected to the System Select/Disable discretes. (See Attachment 1-1A). A Master system can be selected, and its partner disabled, by pulling the appropriate System Select/Disable discrete low. Additional optional external switching (not shown in Attachment 1-1A) may permit the activation of the System Disable inputs to both systems simultaneously (while leaving the System Select inputs open-circuit) for the purpose of disabling both systems simultaneously -- reference Section 4.8.3.

4.8.5 Automatic System Selection Criteria

Each system monitors the health of its partner by means of the SDU Crosstalk bus. The content and speed of this bus is specific to a manufacturer’s implementation, but is expected to use high or low speed ARINC 429 words. This bus should be used to broadcast health information of the LRU’s within its system, enabling the partner system to determine the others fault status. In the event that both systems are fully operational, other command and status information is exchanged via this bus to enable the Master system to utilize the Slave system’s capacity to support additional voice channels.

4.8.6 Recovery Criteria

Once an SDU has detected its partner has failed and has assumed the sole Master role, it should continue as sole Master until the Slave is re-enabled manually via manual SCDU input. However, if the selected Master subsequently fails, it should release its System Select discrete. This allows the partner system to assume the Master role if its original fault has cleared.

COMMENTARY

Since data and voice communication is disrupted during transfer of acting Master, it is desirable to prevent intermittent failure conditions from causing repetitive disruption of data and cockpit voice communication. It is preferable to sacrifice the additional cabin voice capability offered by a Slave System until the intermittent unit can be repaired.

4.8.7 Interface Operation in a Dual System

4.8.7.1 CMU Interface Operation

Message exchanges at the data link layer should only occur between the SATCOM system acting as the Master and the Active CMU. Message transfer is accomplished using the Bit Oriented Communication Protocol specified in ARINC Specification 429, Section 2.5. Addressing is accomplished by use of the destination’s System Address Label (SAL) assigned in ARINC Specification 429, Attachment 14.

The Slave SDU, as well as the Master SDU, should output its Label 270 status word to the CMUs; similarly, the Inactive CMU (inactive as a source or sink of data communicated over the satellite subnetwork), as well as the Active CMU should output its Label 270 status word to the SDUs. Each system may thus independently assess the physical-layer communication health of each of the connected systems without having to wait until it is the Master or Active unit attempting to transfer data across the subnetwork.

Each SDU should only respond to its assigned SAL. The CMU should detect the SATCOM system operating as the Master by examining the SATCOM Master Slave discrete (bit 18) in the Label 270 word transmitted by the SDU. Messages should only be sent to the SDU that is broadcasting a Label 270 word indicating Data Link Available, SATCOM Logon, and SATCOM Master.

Each SDU should receive and acknowledge all LDUs addressed to it according to the ARINC 429 Bit-Oriented Communications Protocol. However, any downlink message received by an SDU that is not acting as the Master should be subsequently discarded.

4.8.7.2 CFDS Interface Operation

Each SDU provides fault information to the CFDS only for the LRUs associated with its system.

4.8.7.3 SCDU/WSC Interface Operation

In a dual SATCOM installation, each SCDU/WSC should have two SATCOM inputs, one from each SDU. The SCDU/WSC output port is paralleled to both SDUs. The SCDU/WSC prompt generated by the SDU may indicate whether the associated system is acting as Master or Slave (e.g., SAT PRI vs. SAT ALT) and/or whether it is system #1 or #2 (e.g., SDU 1 vs. SDU 2). The latter is intended to avoid confusion with SATCOM cockpit voice channels 1 and 2, which are typically designated SAT 1 and SAT 2.

In the event of a detected failure, the SCDU/WSC port of the failed system should remain active (to the extent the failure permits) to assist in system troubleshooting.

4.8.7.4 Cockpit Voice Interface Operation

A particular configuration is shown in Attachment 1-1A, which shows a single cockpit voice channel per SATCOM system (one channel at a time). Other dual configurations, based on the single-system configurations shown in Part 1, Attachment 1-2, may provide 0, 1 or 2 cockpit voice channels in the Master and/or the Slave. ORT (item p) (reference Section 4.5.2.3) specifies how the AMS/ACP logical channels are functionally interfaced with the dual system physical channels.

4.8.7.5 Cabin Telephone Interface Operation

The CTU provides a CEPT E-1 interface to each SDU, and need not be aware of which SDU is acting as Master, Slave, or may be disabled. A ground-to-air call to be routed to the cabin (based on criteria such as priority, Called Terminal ID, etc.) should be forwarded to the CTU via the CEPT E-1 bus originating from whichever SDU was assigned by the Master to receive the call. In the air-to-ground direction, the CTU should request the call via the D-channel of the CEPT E-1 bus connected to either SDU. The CTU should attempt to equalize the RF power demanded on the two systems, thus maximizing the probability of call setup on the first attempt and minimizing call setup time. Possible methods include alternating successive call requests between the two SDUs, or placing a new call through the SDU presently supporting the fewest cabin calls. The SDU either accepts or rejects the call, based on its capability to accommodate the call request. In the event the chosen SDU rejects the call, or does not respond, the CTU should attempt call placement via the CEPT E-1 bus to the alternate SDU.

COMMENTARY

Note that in all cases, call signaling (D-channel) and audio (B-channel) always occurs on the same CEPT E-1 bus. However, the Master SDU is the system actually in control of setting up the call via its R/P-Channel modem. In the event that the CTU requests a call via the slave’s CEPT E-1 bus, the D-channel information is passed to/from the Master SDU via the SDU crosstalk bus to allow the Master system to perform the necessary R/P-Channel protocol to establish or clear the C-Channel. In effect, the Slave SDU is transparent to the D-channel information on its own CEPT E-1 D-channel.

4.9 CPDF - SATCOM Interface

This section applies for the case of the DTE address D digit being equal to 8 (reference Section 4.3.4.3.1).

4.9.1 Overview

This optional ARINC 429 interface provides Data-3 communications between the SATCOM system and the Cabin Packet-mode Data Function (CPDF). The CPDF may be provided by any appropriate actual physical unit or system, including the

Cabin File Server (CFS). This interface supports value-added services such as news, weather, sports and financial reports; reservations for airlines, rental cars and hotels/motels; duty-free and other shopping; and other similar passenger services. These services are provided by the CPDF, utilizing connections to terrestrial networks which the CPDF establishes and maintains through the SATCOM link.

The SDU may provide these data services simultaneously in parallel with those provided for the (C)MU (Data-2 and/or Data-3), which are specified in Sections 4.6 and 4.7, using the same type of interface and protocols as already defined for the Data-3 CMU. Furthermore, the SDU may provide these services simultaneously in parallel with those provided for the CTU (Data-3), which are specified in Section 4.10, or (more likely) as an alternative to the CTU services where the CTU interface is not available.

Status/maintenance messages are also exchanged between the SDU and the CPDF via this interface for system monitoring.

COMMENTARY

In order to interoperate with dual SATCOM configurations (wherein only the Master SDU provides packet-mode data services - see Section 4.8.2 and 4.8.7.1), the CPDF should have provisions for dual inputs (one for each SDU).

4.9.2 Physical Interface

Timing and electrical interface specifications are per ARINC Specification 429 for low-speed operation.

4.9.3 Link Layer - Broadcast

The SDU and the CPDF should monitor each other’s status by exchanging Label 27x status words (as defined in the subsections which follow) once per second.

4.9.3.1 SDU to CPDF Status Word

The SDU Label 270 status word is identical to that specified in Section 4.7.3.1 (for output to the CMU), except that only bits 11 (Data Link via CPDF [rather than MU/CMU] Not Available), 12 (CPDF [rather than ACARS MU/CMU #1] Inactive), 17 (SATCOM Not Logged-On), 18 (SATCOM Master/Slave) and 20 (SATCOM CPDF [rather than cockpit] Fault) are applicable to the CPDF interface; all other status bits should always be cleared to zero. The SSM field should always be set to Normal Operation.

4.9.3.2 CPDF to SDU Status Word

The SDU should monitor the Label 270 word transmitted by the CPDF which is encoded as follows:

Bit(s)	Description
9-10	SDI (per ARINC 429 Section 2.1.4)
11	Not applicable; ignore
12	0 = OK, 1 = SDU inactive
13-15	Not Applicable; ignore
16	0 = OK, 1 = CPDF Failure
17-29	Not Applicable; ignore
30-31	SSM (per ARINC 429 Sections 2.1.5 and 2.1.5.3, except that 11=Not Defined)

The SDU should determine the active/inactive status of the input bus from the CPDF based on regular receipt of this status word when the CPDF Configuration pin (SDU pin TP10E) indicates that the CPDF is installed. The CPDF is expected to always set the SSM field in its status word to Normal Operation; the SDU should ignore the SSM field.

4.9.3.3 SDU to CPDF Join/Leave Message

The Label 271 Join/Leave message is identical to that specified in Section 4.7.3.3 for transmission to the ACARS MU/CMU.

4.9.4 Link Layer - Bit Oriented File Transfer Protocol

The link layer protocol used is identical to that specified in Section 4.7.4 for the SDU/CMU interface, with the following exceptions:

Option	Value	Notes
O_2	Low	Low speed only (no strap dependency)

In a dual system, only the Master SDU performs packet-mode data communication with the CPDF.

COMMENTARY

The CPDF may determine which SDU is the current Master by examining the SDUs' Label 270 status words, which are output by both the Master and the Slave.

The interface is used to pass Data-3 (ISO-8208) packets, which use the Satellite SubNetwork Access Protocol as defined in Sections 3.3.4 and 4.3. The addressing and General Format Identifier (GFI) of the SOT word should be as follows:

To CPDF		To SDU		GFI
SAL	Dest. Code	SAL	Dest. Code	
375	E	307	S	0100_b (4_h)

Notes:

1. SAL 375 (Cabin Terminal #2) has been selected for the CPDF because 374 (Cabin Terminal #1) is already potentially in use on the same bus for the GSDB SNU. SALs are assigned in ARINC Specification 429, Attachment 14, which takes precedence over the table above.

2. GFIs are assigned in ARINC Specification 429, Table 11-7A, which takes precedence over the table above. The GFI applies to files transferred in either direction.

3. Destination Codes are assigned in ARINC Specification 429, Attachment 11A, which takes precedence over the table above.

Only satellite link layer precedence (Q) values of 0 through 3 are allowed for CPDF data. If not specified, the default Q value is 0. Requests for priority/precedence levels greater than 3 on this interface are rejected at the 8208 network layer (a connection rejection -- quality of service not available (permanent condition) diagnostic code (decimal 230) should be provided).

4.10 CTU - SATCOM Interface for Packet-mode Data

This section applies for the case of the DTE address D digit being equal to 9 (reference Section 4.3.4.3.1).

4.10.1 Overview

This optional CEPT E1 interface, primarily used for circuit-mode applications, as specified in Section 4.4.4 and its subsections and sub references (including **ARINC Characteristic 746:** *Cabin Communications System*), is also capable of supporting packet-mode Data-3 communications between the SATCOM system and the Cabin Telecommunications Unit (CTU) via its D- channels. This interface may support value-added services as described in Section 4.9.1 for the CPDF, and may also support virtual circuit packet-mode data services to individual passengers by means of the routing capabilities of the CTU, utilizing connections to terrestrial subnetworks which the CTU and/or individual users establish and maintain through the SATCOM link. The SDU may provide these data services simultaneously in parallel with those provided for the (C)MU (Data-2 and/or Data-3), which are specified in Sections 4.6 and 4.7, and with those provided for the CPDF (Data-3), which are specified in Section 4.9.

COMMENTARY

The CTU has the flexibility of supporting cabin packet-mode data services using similar aircraft interfaces and protocols through air-ground bearer systems other than SATCOM (e.g., TFTS and NATS).

The details of this interface are defined in ARINC Characteristic 746, Section 4.4.1, and (primarily) Attachment 18.

4.11 HGA With LGA Backup

A low gain antenna subsystem can be installed to provide a low speed data reversion mode in the case of a failure in the HGA system, or the HGA is reporting less than 7 dBi gain.

For the case of a failure in the HGA subsystem, the SDU should switch to the LGA and perform a log-on renewal at Class 1. The system should stay in low gain mode as long as the fault in the HGA system exists.

For the case of the HGA reporting less than 7 dBi gain, the SDU should switch to the LGA and perform a log-on renewal at Class 1. While operating in this reversion mode, the SDU should continue to send open loop steering commands to the BSU so that it can continue to report the gain of the HGA.

When the HGA reported gain stabilizes at or above 7 dBi the SDU should switch to the HGA, complete any data communications in progress, and perform a log-on renewal at Class 2, 3 or 4 as appropriate.

4.12 Use of HGA Below 7dBi Reported Antenna Gain

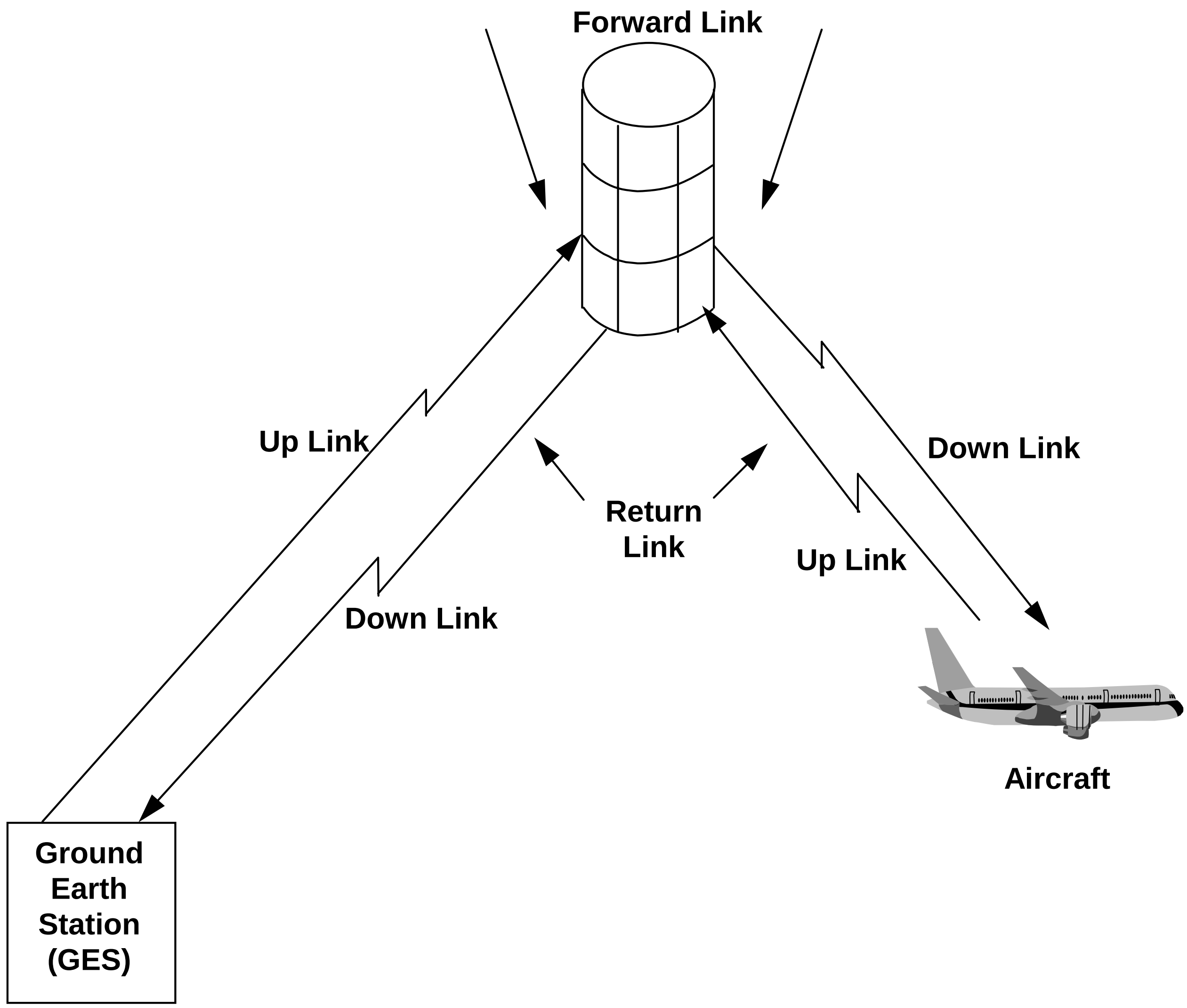
For discrimination reasons, high power channels may not be transmitted through HGA pointing angles offering less than 7 dBic gain. The HGA can be used for low-rate (600/1200 bps) data channels only, when its gain is below 7 dBic, by renewing log-on as a Class 1 AES.

4.13 ATC Call Management

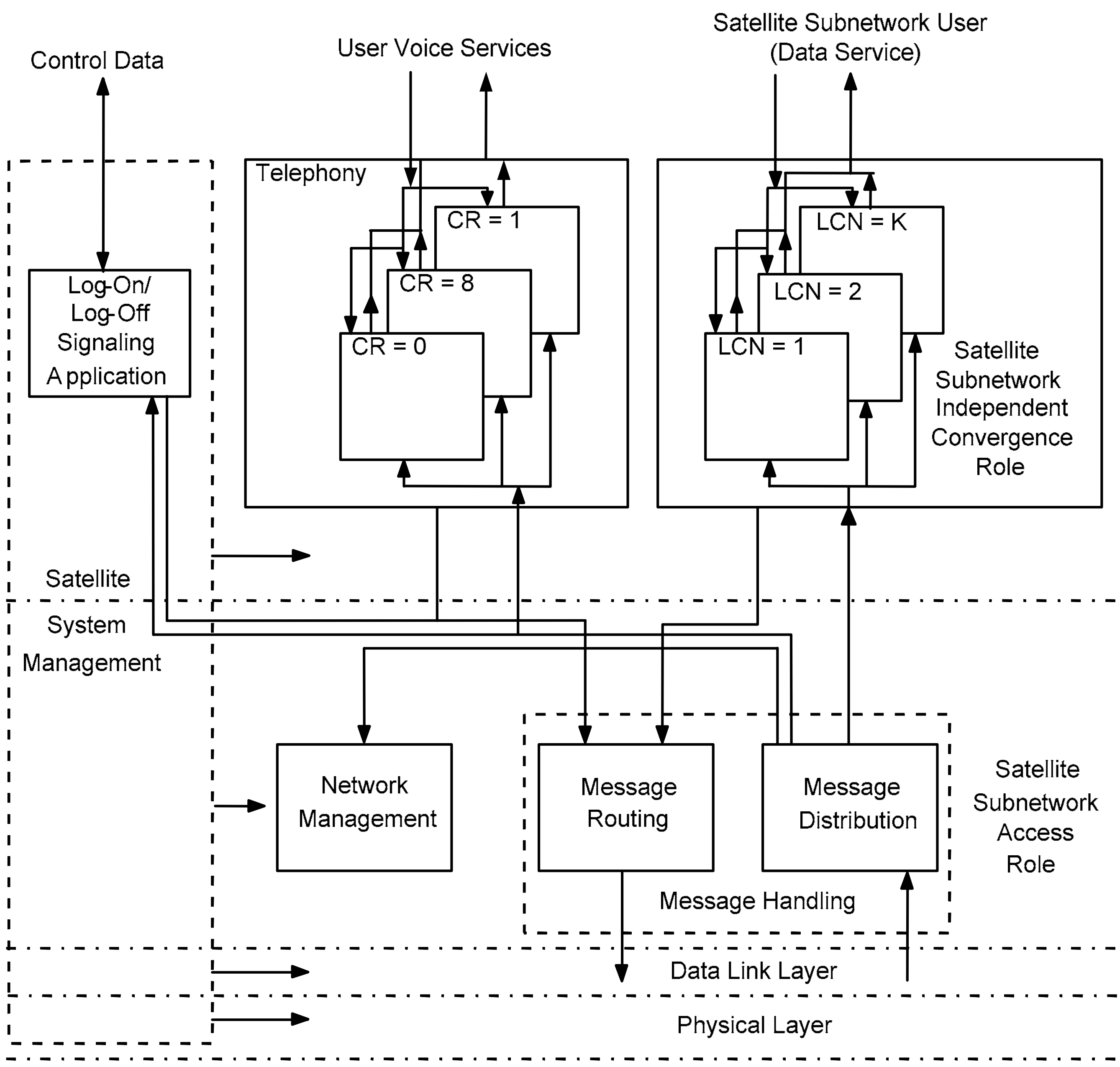
COMMENTARY

A future capability is expected to be defined to automatically accept the phone number for the current ATC Agent, and place the number into the ATC Call Register. The function is being defined by RTCA/SC-165, WG-5.

ATTACHMENT 2C-1
LINK NOMENCLATURE



ATTACHMENT 2F-0
SYSTEM ARCHITECTURE



ATTACHMENT 2F-11.1
X.25 PACKET TYPE IDENTIFIER

Packet Type		Code 8 7 6 5 4 3 2 1
From HLE to SSNL	From SSNL to HLE	
Call Setup and Call Clearing		
CALL REQUEST	INCOMING CALL	0 0 0 0 1 0 1 1
CALL ACCEPTED	CALL CONNECTED	0 0 0 0 1 1 1 1
CLEAR REQUEST	CLEAR INDICATION	0 0 0 1 0 0 1 1
CLEAR CONFIRMATION	CLEAR CONFIRMATION	0 0 0 1 0 1 1 1
Data and Interrupt		
DATA	DATA	x x x x x x x 0
INTERRUPT	INTERRUPT	0 0 1 0 0 0 1 1
INTERRUPT CONFIRMATION	INTERRUPT CONFIRMATION	0 0 1 0 0 1 1 1
Flow Control and Reset		
RECEIVE READY	RECEIVE READY	x x x 0 0 0 0 1
RECEIVE NOT READY	RECEIVE NOT READY	x x x 0 0 1 0 1
RESET REQUEST	RESET REQUEST	0 0 0 1 1 0 1 1
RESET CONFIRMATION	RESET CONFIRMATION	0 0 0 1 1 1 1 1
Restart		
RESTART REQUEST	RESTART INDICATION	1 1 1 1 1 0 1 1
RESTART CONFIRMATION	RESTART CONFIRMATION	1 1 1 1 1 1 1 1
Diagnostic		
	DIAGNOSTIC	1 1 1 1 0 0 0 1

ATTACHMENT 2F-13A
EXAMPLES - SIGNAL UNIT BIT CODING (1 OF 4)

These examples illustrate the loading of specific information into the data fields of selected signal units. The signal units depicted here are provided for illustration only and do not necessarily represent actual conditions.

References for Details and Comments

LOG-ON REQUEST:

SDU → GES

SATCOM Signal Unit

	8	7	6	5	4	3	2	1	Octet	References
										See References below. Source Ref. A, 3.5.3.1, page 7, 4.5.3.1.4, page 45, Att. 2X Fig. 9A, page 177, Fig. S1, page 231
	0	0	1	1	1	1	1	1	1	Seq. Indicator, 0001 (1E), page 270, Fixed=1111 (FH), page 231.
	1	1	0	1	0	0	0	0	2	Q No.=1101 (13), page 267, DLK/RLS=0 or 1, page 263, Ref. Number=0, Ref. A, 4.2.6.2.4, page 18, and page 268
	0	0	0	1	0	0	0	0	3	Message Type=10_h, Log-On Request ISU, page 274
(MSB)	1	0	1	0	1	0	0	1	4	Assume AES ID = 10101001 01010010 01110111 ($A95277_h$)
	0	1	0	1	0	0	1	0	5	
(LSB)	0	1	1	1	0	1	1	1	6	
	0	1	0	0	0	0	1	0	7	Assume GES ID = 01000010, (102 Octal).
	1	1	0	1	0	1	0	0	8	Q No. of Sig. Application=1101 (13), page 267, Spare, LOV=1, page 266, Init/Review=0, page 265, Pri/Sec=0, page 267.
	1	1	1	1	1	1	0	0	9	Prev. Sat. ID = 111111, page 269, Spot Beam ID (MSB) = 00, page 272.
	0	0	0	0	0	0	0	0	10	Spot Beam ID (LSB) = 0000, page 272, Number of C-Channels = 0000, page 266
	0	0	0	0	0	0	0	0	11	Class of AES = 00, (Class 1), page 262, Voice Channel Characteristics = 000000, (ASSUMES = None), page 273.
	0	0	0	0	0	0	0	0	12	Data Rate Cap. = 00000000, page 263, (600 P/R/T, 1200 R/T are mandatory).
	0	0	0	0	0	0	0	0	13	Circuit data Requirements = 0, page 262, Spare.
	0	0	0	0	0	0	0	0	14	Spare
	0	0	0	0	0	0	0	0	15	Spare
	0	0	0	0	0	0	0	0	16	Spare
	0	0	0	0	0	0	0	0	17	Spare
	0	0	1	0	0	0	1	0	18	Ref. A, 4.2.3.1, page 15, Att, 2X, Fig. SO, page 230. Ref. B, Par. 2.2.7, page 163.
FCS	0	1	1	1	0	1	1	1	19	FCS Remainder = $44EE_h$.

SATCOM Signal Unit

Note: Except for FCS all Su's are transmitted Least Significant bit, and lowest numbered byte first. Unless otherwise noted, multi-octet fields in a signal unit are filled most significant byte first.

References:

a. Draft 4 of Supplement 1, Part 2, ARINC Characteristic 741. (SAT-134)

b. CCITT Blue Book, Recommendation X.25, 1988.

c. Draft 1 of Part 4, ARINC Characteristic 741. (SAT-136)

ATTACHMENT 2F-13A
EXAMPLES - SIGNAL UNIT BIT CODING (2 of 4)

References for Details and Comments

LOG-ON CONFIRM:

SDU GES

SATCOM Signal Unit

SDU/GES		8	7	6	5	4	3	2	1		References for Details and Comments
											Source Ref. A, 4.5.3.1.4.3, page 45, Fig. S2, page 232
←		0	0	0	1	0	0	0	1	1	Message Type = 00010001 (11h), page 274.
	(MSB)	1	0	1	0	1	0	0	1	2	Assume AES ID = 10101001 01010010 01110111 (A95277h)
		0	1	0	1	0	0	1	0	3	
	(LSB)	0	1	1	1	0	1	1	1	4	
		0	1	0	0	0	0	1	0	5	Assume GES ID = 01000010 (102 Octal).
		1	1	0	1	0	0	0	0	6	Q No.=1101 (13), page 267, TDMA Msg.=0, page 272, P/R Mag.=0, page 267, Ext.=0, page 264, Flt. Info=0, Page 264.
		1	1	1	1	1	1	0	0	7	Assume Previous Sat. ID = 111111, page 269, Spot Beam ID (MSB) = 00, page 272.
		0	0	0	0	0	0	1	1	8	Spot Beam ID (LSB) = 0000, page 272, Initial EIRP = 0011 (13.5 dBW)
		0	0	0	0	0	0	0	0	9	Class of AES = 00, page 262, Voice Channel Characteristics = 000000, page 273
		1	0	0	1	1	0	0	1	10	Ref. No. = 10011001, page 268. (Same as N6 Ref. No.)
		1	1	1	0	0	1	0	1	11	Ref. A, 4.2.3.1, page 15, Att. 2X, Fig, SO, page 230. Ref. B, Par. 2.2.7, page 163.
	FCS	1	0	0	0	1	1	0	0	12	FCS Remainder = A731h.

SATCOM Signal Unit

ATTACHMENT 2F-13A
EXAMPLES - SIGNAL UNIT BIT CODING (3 OF 4)

References for Details and Comments

LOG-ON ACKNOWLEDGE:

SDU → GES

SATCOM Signal Unit

	8	7	6	5	4	3	2	1	Octet	References for Details and Comments
										Source Ref. A, 4.5.3.1.4.3, page 46, Fig. S34, page 254.
	0	0	0	1	1	1	1	1	1	Seq. Indicator, 0001 (1_h), page 270, Fixed = 1111 (F_h), page 254.
	1	1	0	1	0	0	1	0	2	Q No. = 1101 (13_h), page 267, DLK/RLS = 0 or 1, page 263, Ref No. = 2, page 268.
	0	0	0	1	0	1	0	1	3	Message Type = 0010101 (15_h), Log-On Acknowledge, page 274.
(MSB)	1	0	1	0	1	0	0	1	4	Assume AES ID = 10101001 01010010 01110111 ($A95277_h$)
	0	1	0	1	0	0	1	0	5	
(LSB)	0	1	1	1	0	1	1	1	6	
	0	1	0	0	0	0	1	0	7	Assume GES ID = 01000010, (102 Octal).
	1	1	0	1	0	0	0	0	8	Q No. of Sig. Application = 1101 (13), page 267, Spare.
	0	0	0	1	0	0	0	0	9	Spare, ACK/NAK = 001, page 258, Ref. C, page 63, Spare.
	0	0	0	1	0	0	0	1	10	ACK Message Type = 00010001, (11_h), page 274.
	0	0	0	0	0	0	0	0	11	ACK Message Type = 00000000, (00_h), page 274.
	0	0	0	0	0	0	0	0	12	ACK Message Type = 00000000, (00_h), page 274.
	0	0	0	0	0	0	0	0	13	Spare
	0	0	0	0	0	0	0	0	14	Spare
	0	0	0	0	0	0	0	0	15	Spare
	0	0	0	0	0	0	0	0	16	Spare
	0	0	0	0	0	0	0	0	17	Spare
	0	1	1	1	1	0	0	1	18	Ref. A, 4.2.3.1, page 15, Att. 2X, Fig. SO, page 230. Ref. B, Par. 2.2.7, page 163.
FCS	1	1	1	1	1	1	0	0	19	FCS Remainder = $9E3F_h$.

SATCOM Signal Unit

ATTACHMENT 2F-13A
EXAMPLES - SIGNAL UNIT BIT CODING (4 of 4)

References for Details and Comments

LOG-ON ACKNOWLEDGE:

SDU GES

SATCOM Signal Unit

SDU/GES		8	7	6	5	4	3	2	1		References for Details and Comments
											Source Ref A., 4.5.3.1.4.3, page 46, Fig. S14A, page 240.
←		0	0	0	1	0	1	0	1	1	Message Type = 00010101 (15_h), page 274
	(MSB)	1	0	1	0	1	0	0	1	2	Assume AES ID = 10101001 01010010 01110111 ($A95277_h$)
		0	1	0	1	0	0	1	0	3	
	(LSB)	0	1	1	1	0	1	1	1	4	
		0	1	0	0	0	0	1	0	5	Assume GES ID = 01000010 (102 Octal).
		1	1	0	1	0	0	0	0	6	Q No. = 1101 (13), page 267, Spare
		0	0	0	1	0	0	0	0	7	Spare, ACK/NAK = 001, page 258, Ref. C, page 63, Spare.
		0	0	0	1	0	1	0	1	8	ACK Message Type = 00010101 (15_h), page 274.
		0	0	0	0	0	0	0	0	9	ACK Message Type = 00000000 (00_h), page 274.
		0	0	0	0	0	0	0	0	10	ACK Message Type = 00000000 (00_h), page 274.
		1	1	0	0	0	0	1	1	11	Ref. A, 4.2.3.1, page 15, Att. 2X, Fig. SO, page 230. Ref. B, Par. 2.2.7, page 163.
		FCS								12	FCS Remainder = $C3A2_h$.
		0	1	0	0	0	1	0	1		

SATCOM Signal Unit

ATTACHMENT 2F-37.1
FACILITY FIELD MARKER DEFINITION AND TRANSMISSION ORDER

Facility Length								
X.25 facility field								ZONE 1
0	0	0	0	0	0	0	0	Facility Markers for non-X.25 facilities supported by the called DTE in case of an internetwork call
1	1	1	1	1	1	1	1	
Field for non-X.25 facilities supported by the called DTE in case of an internetwork call								ZONE 2
0	0	0	0	0	0	0	0	Facility Markers for non-X.25 facilities supported by the calling DTE in case of an internetwork call
0	0	0	0	0	0	0	0	
Field for non-X.25 facilities supported by the calling DTE in case of an internetwork call								ZONE 2 (bis)
0	0	0	0	0	0	0	0	Facility Markers for ITU-T - Specified facilities
0	0	0	0	1	1	1	1	
ITU-T - Specified facility field								ZONE 3

When several categories of facilities are simultaneously present, the facility markers are used to separate these categories of facilities from each other. In this case, however, requests for X.25 facilities are to precede the other requests and requests for ITU-T-Specified DTE are to follow the other requests.

ATTACHMENT 2F-38.1
SATELLITE SUBNETWORK SPECIFIC FACILITY FORMATS

	BIT	8	7	6	5	4	3	2	1
Code:		0	0	1	0	0	0	0	0

	BIT	8	7	6	5	4	3	2	1
Parameter Field:		0	0	0	0	Q Priority Level			

Figure F1 - NC Priority Facility Format

	BIT	8	7	6	5	4	3	2	1
Code:		0	0	1	0	0	0	0	1

	BIT	8	7	6	5	4	3	2	1
Parameter Field:		0	0	0	X	0	0	0	X

BIT	5	BIT	1
RLS from Called DTE	0	RLS from Calling DTE	0
DLS from Called DTE	1	DLS from Calling DTE	1

Figure F2 - Reliability Facility Format

Note: Attachments 2F-38.2 and 2F-38.3 have been deleted.

ATTACHMENT 2F-38.4
ADDRESS EXTENSION FACILITY FORMATS

	BIT	8	7	6	5	4	3	2	1
Code:		1	1	0	0	1	0	1	1

BIT	8	7	6	5	4	3	2	1
Octet 1	Address Length + 1. in octets							

BIT	8	7	6	5	4	3	2	1
Octet 2	X	X	Address Length in semi-octets					

BIT 8	BIT 7	
0	0	To carry a entire called/calling OSI NSAP address
0	1	To carry a partial called/calling OSI NSAP address
1	0	To carry a non-OSI called/calling Address extension
1	1	Reserved

BIT	8	7	6	5	4	3	2	1
Octet 3	Address Extension							

BIT	8	7	6	5	4	3	2	1
Octet N	Address Extension							

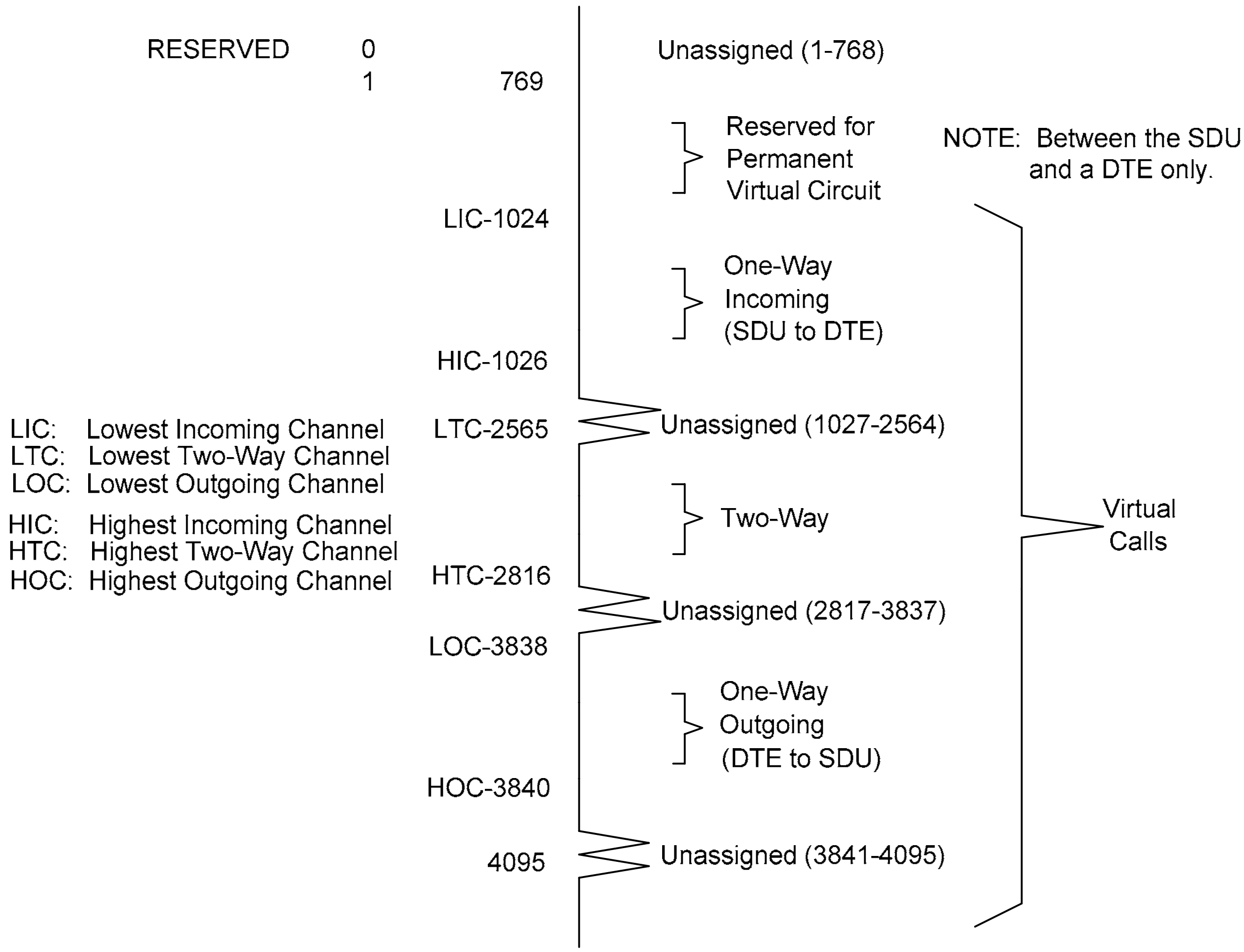
Figure F7 - Calling Address Extension Facility Format

	BIT	8	7	6	5	4	3	2	1
Code:		1	1	0	0	1	0	0	1

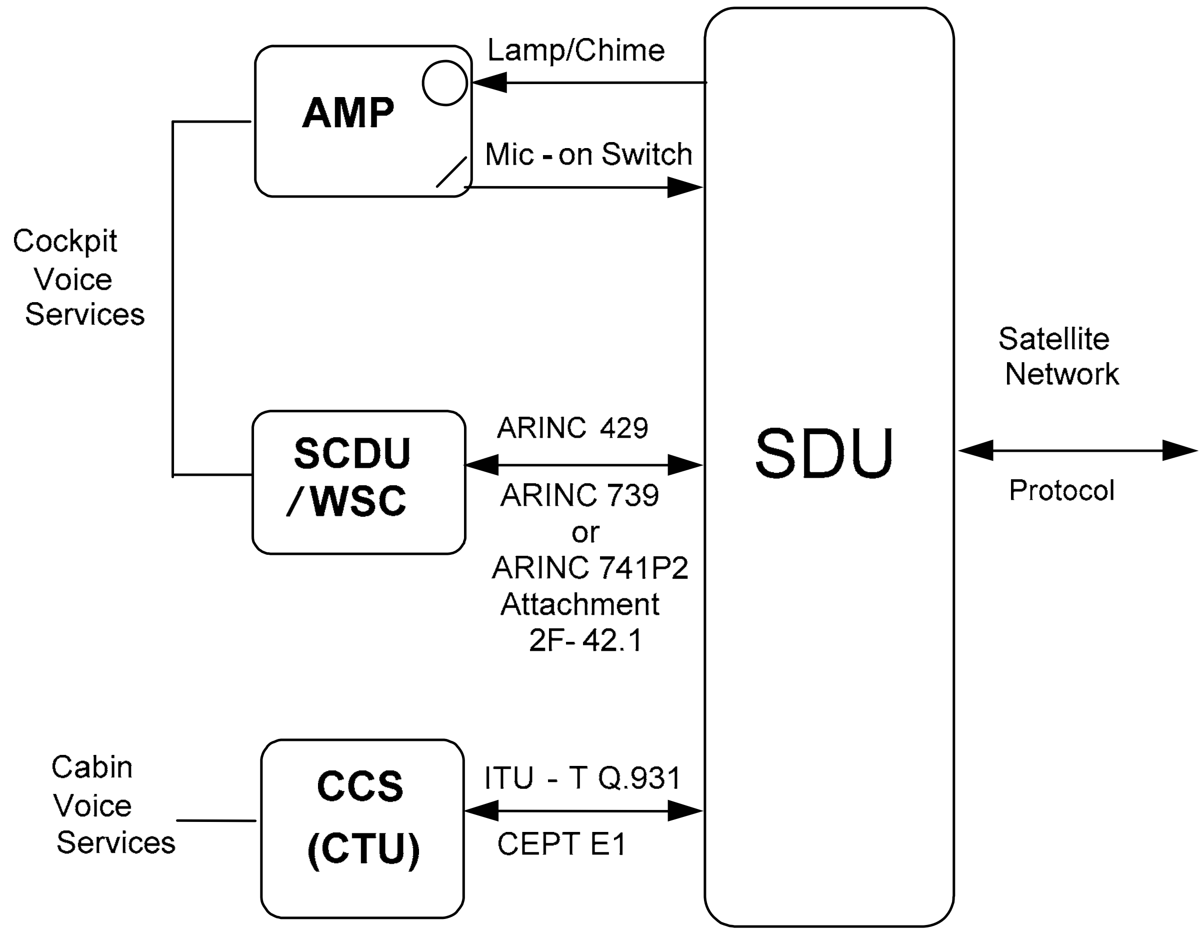
Parameter Field: Refer to Calling Address Extension parameter field

Figure F8 - Called Address Extension Facility Format

ATTACHMENT 2F-39
LOGICAL CHANNEL NUMBER ASSIGNMENT AT AN SDU/DTE INTERFACE

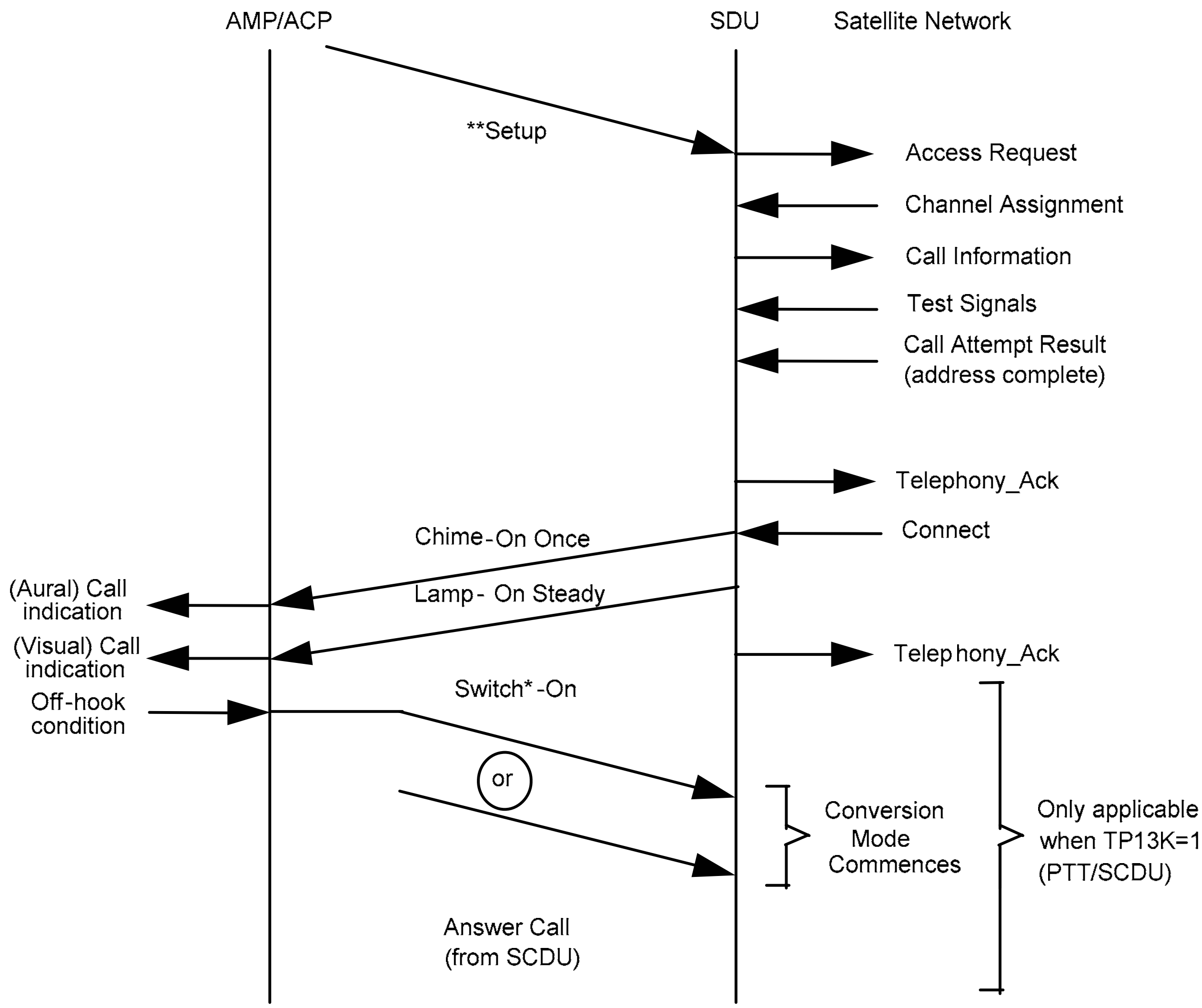


ATTACHMENT 2F-40.1
AVIONICS INTERCONNECTION DIAGRAM
VOICE SERVICES



Note: Attachments 2F-40.2 through 2F-40.5 have been deleted.

ATTACHMENT 2F-40.6
COCKPIT - SATELLITE NETWORK PROTOCOL INTERWORKING
AIR-TO-GROUND CALL ESTABLISHMENT
(FOR MCDU/SCDU, NOT WSCI)



Notes:

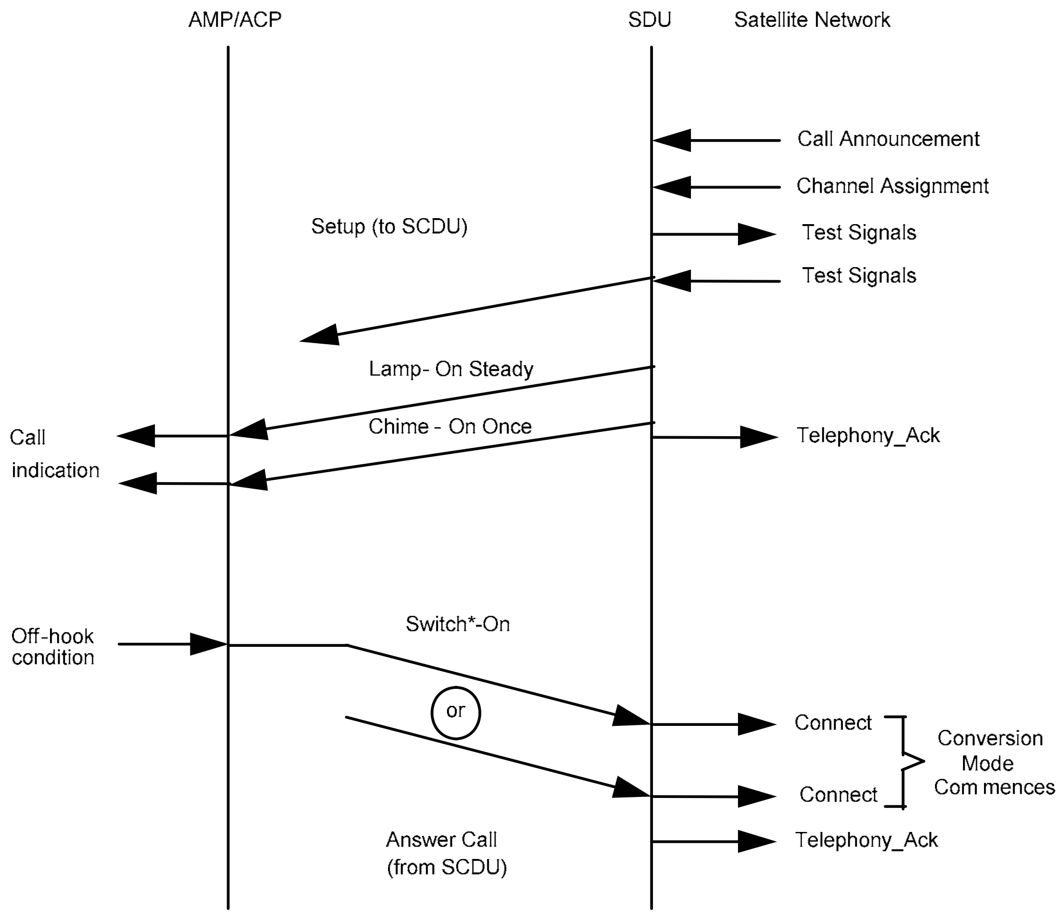
*   Switch = SATCOM PTT switch.

**   From SCDU if TP13K = 1. If TP13K = 0, setup is from SCDU + latched ACP SATCOM switch (immediately off hook).

***   See text for interworking for flashing lamp and multistroke chime options.

**** For WSCI, refer to Attachment 2F-42.1

ATTACHMENT 2F-40.7
COCKPIT - SATELLITE NETWORK PROTOCOL INTERWORKING
GROUND-TO-AIR CALL ESTABLISHMENT
(FOR MCDU/SCDU, NOT WSCI)



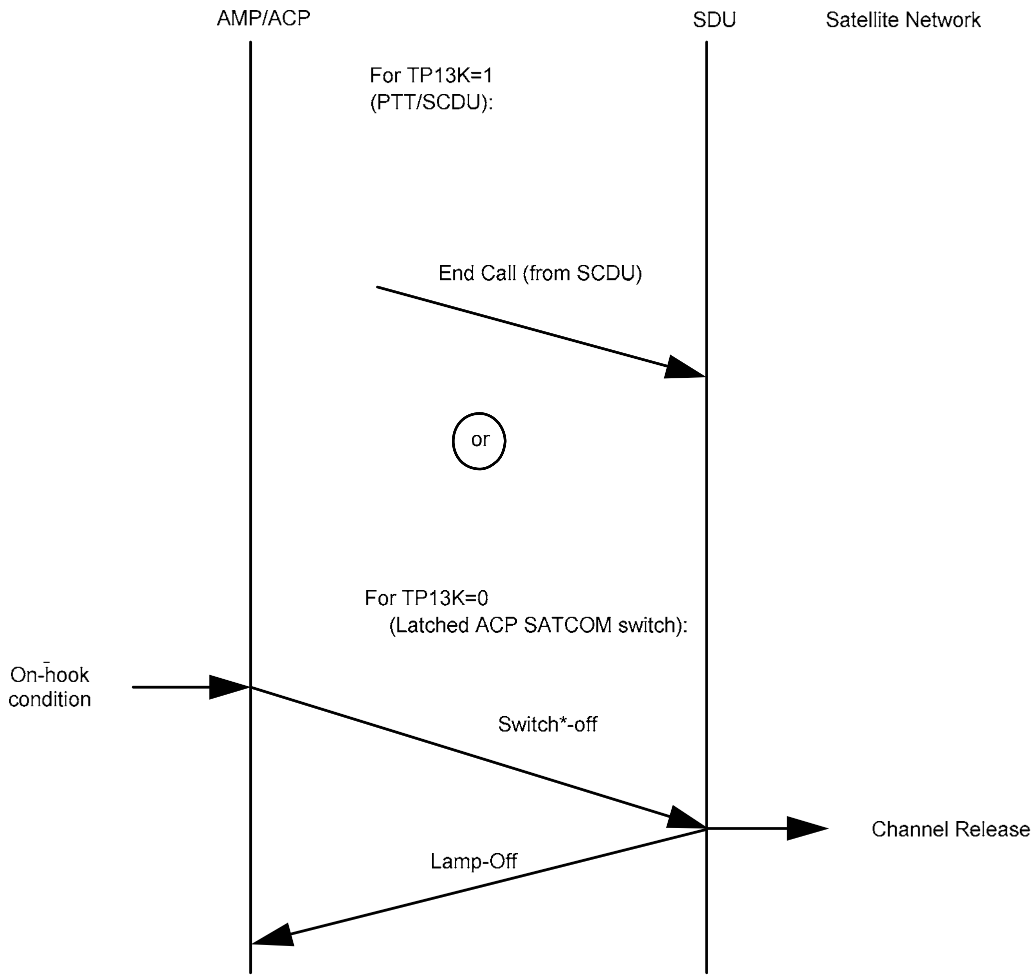
Notes:

* Switch = SATCOM PTT switch or latched ACP SATCOM switch.

** See text for interworking for flashing lamp and multistroke chime options.

*** For WSCI, refer to Attachment 2F-42.1

ATTACHMENT 2F-40.8
COCKPIT - SATELLITE NETWORK PROTOCOL INTERWORKING
AIR INITIATED CALL CLEARING
(FOR MCDU/SCDU, NOT WSCI)

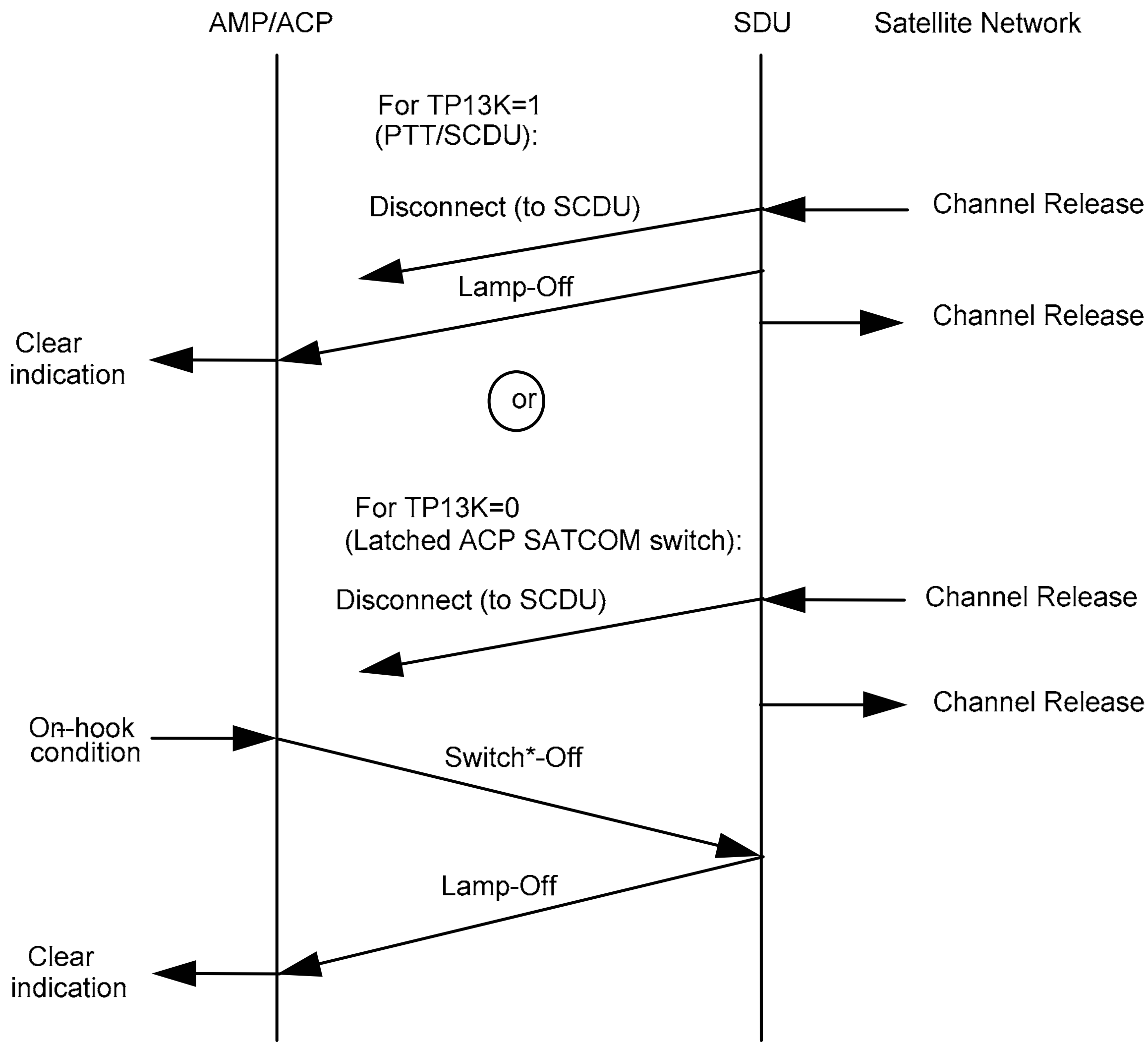


Notes:

*	Switch = Latched ACP SATCOM switch

**	For WSCI, refer to Attachment 2F-42.1

ATTACHMENT 2F-40.9
COCKPIT - SATELLITE NETWORK PROTOCOL INTERWORKING
GROUND INITIATED CALL CLEARING
(FOR MCDU/SCDU, NOT WSCI)



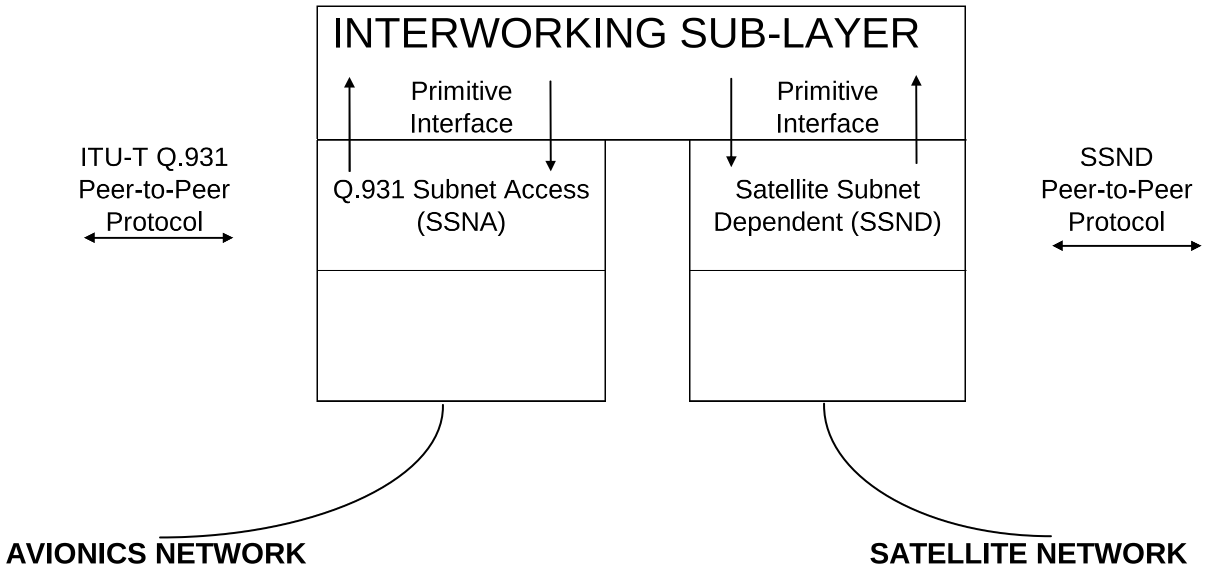
Notes:

* Switch = Latched ACP SATCOM switch

** For WSCI, refer to Attachment 2F-42.1

Attachments 2F-40.10 through 2F-40.14 have been deleted.

ATTACHMENT 2F-40.15
GENERAL INTERNETWORKING STRATEGY
AVIONICS NETWORK - SATELLITE NETWORK



ATTACHMENT 2F-40.16
MAPPING OF Q.931 MESSAGES TO SSND MESSAGES

Q.931 | SSND

SETUP → ACCESS REQUEST

NETWORK SPECIFIC FACILITIES*	
- Q No.	Q NO.
- Service Id.	SERVICE ID.
- Circuit Data Rate	CIRCUIT DATA RATE
CALLED PARTY NUMBER	CALLED PARTY NUMBER (first two digits)
TRANSIT NETWORK SELECTION	NETWORK ID.

SETUP → CALL INFORMATION

NETWORK SPECIFIC FACILITIES*	
- Q No.	Q NO.
- Credit Card Number	CREDIT CARD INFORMATION
CALLING PARTY SUBADDRESS	CALLING TERMINAL NUMBER
CALLED PARTY NUMBER	CALLED PARTY NUMBER (digit 3 on)

SETUP ← CALL ANNOUNCEMENT

NETWORK SPECIFIC FACILITIES*	
- Q No.	Q NO.
- Service Id.	SERVICE ID.
- Circuit Data Rate	CIRCUIT DATA RATE
CALLED PARTY SUBADDRESS	CALLED TERMINAL

* See ARINC Characteristic 746 for Information on Element Coding

ATTACHMENT 2F-40.16a
MAPPING OF Q.931 MESSAGES TO SSND MESSAGES

Q.931 SSND

ALERTING ← (Result)

PROGRESS INDICATOR	
- Coding Standard = 00	S = 0
- Coding Standard = 11	S = 1
- Location	LOCATION*

CONNECT ↔ CALL PROGRESS (Connect)

NO PARAMETERS MAPPED

CONNECT_ACK ←

NO PARAMETERS MAPPED

DISCONNECT ↔ (Channel Rise)

CAUSE	
- Coding Standard = 00	S = 0
- Coding Standard = 11	S = 1
- Location	LOCATION*
- Cause Value	
- Class	CAUSE CLASS*
- Value	CAUSE VALUE*

* Mapping only applies if Coding Standard = 00 or 11.

ATTACHMENT 2F-40.16b
MAPPING OF Q.931 MESSAGES TO SSND MESSAGES

Q.931 SSND

RELEASE COMPLETE (unsuccessful setup) → CALL PROGRESS (Channel Rise)

CAUSE	
- Coding Standard = 00	S = 0
- Coding Standard = 11	S = 1
- Location	LOCATION*
- Cause Value	
- Class	CAUSE CLASS*
- Value	CAUSE VALUE*

DISCONNECT ← CALL PROGRESS (Call Attempt Result) (unsuccessful setup)

CAUSE	
- Coding Standard = 00	S = 0
- Coding Standard = 11	S = 1
- Location	LOCATION*
- Cause Value	
- Class	CAUSE CLASS*
- Value	CAUSE VALUE*

* Mapping only applies if Coding Standard = 00 or 11.

ATTACHMENT 2F-40.16c
MAPPING OF Q.931 MESSAGES TO SSND MESSAGES

Q.931		SSND
FACILITY	←	CALL PROGRESS (Data Mode)

FACILITY (Return Result component result)* - Circuit Data Rate**	CIRCUIT DATA RATE (negotiated)

INFORMATION	→	SUPPLEMENTARY SIGNAL

KEYPAD FACILITY	DTMF DIGITS

General Notes for Attachment 2F-40.16:
- All messages and parameters not explicitly given are not mapped.
- Call Reference (Q.931) and Reference No. (SSND) are interrelated, but not directly mapped; i.e., values may be different.
- All Q.931 parameters are coded as per the ITU-T Recommendation with network specific coding where allowed.
- Valid contents of SSND parameters are as per standard satellite signal information element coding.

* See ARINC Characteristic 746 for Information Element component coding.
** Null for Deactivation result.

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OPERATIONAL DESCRIPTION OF AVIATION SATELLITE AUDIO CHANNELS

Background

The ARINC 741 Aviation Satellite Communication System includes the capability to provide air/ground audio channels for the crew and passengers. The first implementation is to provide for connection of the flight crew audio system to the air/ground telephone for Air Traffic Service (ATS) and Aeronautical Operational Control (AOC). Subsequently, additional audio channels are to be provided for Aeronautical Public Correspondence (APC) Communications for the cabin crew and the passengers.

This paper presents a set of specifications for the operation of the satellite voice channels in the aircraft. These specifications were initially discussed at the Satellite Protocol and Voice Coding Working Group meeting held June 21-24, 1988 and amended by the Cockpit Voice Issues ad hoc meeting held June 18-19, 1991.

Basic Specifications

- There may not be a handset in the cockpit in many installations; therefore, the concept of off-hook for initiating a call and on-hook for terminating a call is to be performed some other way. NOTE: Off-hook is the equivalent of lifting the handset on a conventional telephone; on-hook means to hang up the telephone.
- Pilot procedures should be as close as possible to those for other communications, such as VHF radio. The standard way of connecting to flight crew audio systems should be supported.
- The satellite system is full duplex (audio can pass in both directions simultaneously). The flight crew audio system is also capable of full duplex (it provides sidetone for transmitters). Current procedures for aeronautical radio systems use half duplex (audio passes in only one direction at a time) because that is the way current radios normally function. Unless there is an operational reason not to use the duplex capability, the pilot conversations are to be full duplex.
- The Satellite Data Unit (SDU) has wiring provisions for two cockpit voice channels. Control is assumed to be from the Satellite Control Display Unit (SCDU) or ARINC 429 Williamsburg SDU Controller (WSC—refer to Attachment 2F-42.1 for specifics regarding the WSC interface [WSCI]) and discretes to/from the Audio Management System. Digital buses are provided to and from the PABX (Cabin Communications System, or CCS) for passenger and cabin crew voice channels and control. The CCS only carries Public Correspondence-priority calls. A potential system configuration using the audio-related connections of the SDU is presented in Figure 1.
- A preemption scheme has been developed to ensure that safety-of-flight and other critical calls can be initiated even if all the available channels are busy.

(This can occur under normal conditions when all channels are in use or near the edge of coverage when only one channel may be available due to power limitations.) Both ruthless preemption (a higher-priority call causes a lower-priority call to be canceled) and camp-on (the new call waits for the next available channel) may be needed. Calls initiated from the ground may also use the priority and preemption capability. Since signaling is conducted on a different air-to-ground channel than voice, it is possible to develop a scheme for an incoming call to be annunciated even if all voice channels are busy. If operationally feasible, the flight crew could then decide whether a current call is to be preempted.

- It is desirable from the standpoint of flight crew operations (in anticipation of SATCOM becoming a vital cockpit communication system) that at least one of the two currently planned SDU voice channels be dedicated for cockpit use only.

Discussion

Pilot Procedures

When a member of the flight crew places a call, he does so using the SCDU/WSC along with the Audio Management System (AMS). A display, similar to Figure 2, provides the pilot with an annunciation of current system status as well as the capability to enter the necessary commands. A call is typically engaged (i.e., circuit goes off-hook) by the first activation (open-to-closed transition) of the push-to-talk (PTT) switch after SATCOM has been selected on the Audio Control Panel (ACP). Alternatively, off-hook may be signaled by activation of an ACP SATCOM mic switch (suitably latched on for the duration of the call), or an SCDU/WSC switch. Although it is possible to manually enter the multi-digit telephone number of the called party, most calls are placed by selecting a pre-programmed identifier (similar to the memory feature on many conventional telephones). The pilot simply presses the Line Select Key next to the name of the party to be called, which initiates the calling process. A data base needs to be provided with the pre-programmed data through a SCDU/WSC by maintenance personnel or, preferably, loaded with a data base loader. A single data base should be provided for all users (both flight and cabin crew).

The pre-programmed numbers also include the necessary toll information if the call is other than Public Correspondence. The pre-programmed numbers also include a priority designation. If all circuits are busy between the airplane and the ground, the priority of the new call relative to the current call determines the preemption action.

The following priority scheme applies:

Priority	Q-Number	Description	Location
1	15	Distress, Urgency	Cockpit
2	12	Flight Safety	Cockpit
3	10	Flight Regularity and Meteorological	Cockpit
4	4, 9 (1)	Public Correspondence	Cabin/Passenger

(1) Q-number 4 is the precedence (implementation of priority) of the priority 4 C-Channel for Public Correspondence. Q-number 9 is the precedence of the signaling for this C-Channel.

Call progress may be annunciated on the SCDU/WSC. When a call is connected, the call light and chime are activated to indicate that the satellite audio channel is ready. The light may be on a SELCAL panel or on the audio select panel. The light continues to illuminate as long as the circuit is available, telling the pilots which circuits are available and serving as a reminder, if the pilot has selected another transmitter, that the line is still open. When the pilot is ready to begin talking, he selects the satellite channel with the active lamp annunciation on his audio control panel. Receive volume is to be selected the same as for any other receiver. At any point during this conversation, he may select any other transmitter (including another

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SATCOM audio channel, if available) on his audio control panel. This is analogous to placing a call on hold on a conventional telephone (actually more like mute since the pilot can continue to hear the other party if the receive volume is set to enable this capability).

At the conclusion, the call is terminated by either party going on-hook. The pilot can go on-hook by selecting this function on the SCDU/WSC or by activating Place/End Call discretes associated with the SATCOM Call lights; alternatively (per System Configuration straps), the ACP mic switch is released to indicate on-hook. Termination of the call by the ground party should cause the airborne system to automatically go on-hook (except in the case where a latched SATCOM ACP switch is used for hookswitch signaling, in which case the pilot manually de-selects the channel due to the switch being latched by the ACP). The former is the normal call termination method since the SCDU/WSC is used for more than just communications control and the pilot should not normally have to select the SCDU/WSC display and explicitly select on-hook.

If an incoming call is received, a chime and the light annunciates the call similar to current SELCAL annunciation; the nature of the annunciation (flashing vs. steady light, single vs. multi-stroke chime) is programmable via the System Configuration straps. The priority of the call may be indicated on a cockpit display (SCDU/WSC, EICAS, etc.). The call is engaged (i.e., go off-hook) by the first pressing (high-to-low transition) of the PTT switch (with SATCOM selected on the ACP) or by a latching of the ACP SATCOM Mic switch after the call annunciation; this action also changes a flashing call light to steady and silences a multi-stroke chime (if either option is used). Alternatively, an SCDU/WSC switch may signal off-hook. If he selects the display on the SCDU/WSC, the pilot can see the priority of the incoming call. All other procedures for received calls are the same as for transmitted calls.

Pilot System Interfaces

The audio channel out of the SDU is analog balanced 600 ohms at a nominal 10 milliwatts RMS, capable of driving an unbalanced load. The input is a carbon microphone interface, the same as the VHF radio (see Section 3.7.4 of ARINC 716). Sidetone is provided, by the SDU. Both audio channels (1 and 2) would be wired to the flight crew audio management system (the audio control panels via the audio accessory unit on most older airplanes). On some airplanes only one channel might be connected. The SDU audio channels may optionally also be wired (shared) to one or two cabin analog telephones (for cabin crew or passenger use), as specified by System Configuration straps, with switching between the two users per channel provided within the SDU. Owner/operator Requirement Table options determine which user, if any, has dedicated use of such shared channels for non-distress calls, or whether this should be on a first-come, first-served basis.

The transition to an off-hook condition is signaled for an incoming call by either an SCDU/WSC line select key activation, or (preferably) by grounding the Cockpit Voice Mic On Input both of which would also reset the multistroke chime and steady the flashing call light) of the channel that is ringing. The latter may be implemented in one of two ways, and is reflected in the programmed state of SDU pin TP13K. For TP13K = 0 (strapped to ground), pressing the SATCOM transmit button on the audio control panel grounds the Cockpit Voice Mic On Input. For TP13K = 1 (open circuit), pressing the SATCOM transmit button on the audio control panel enables the pilot's push-to-talk switch, which is pressed when the pilot is talking, to ground the Cockpit

Voice Mic On Input. The satellite receiver is not disabled during transmit, as is the case with VHF or HF communications.

Once the channel is off-hook, de-selecting the channel on the audio panel does not cause the channel to go on-hook. If the Cockpit Voice Mic On Input is not grounded, the Cockpit Audio Channel Input is only disabled (muted), except in the case where System Configuration pin TP13K is programmed to the 0 state, wherein the open state of the Cockpit Voice Mic On Input is used to indicate that the call should be terminated.

At the end of a call, the pilot may cause a transition to on-hook by selecting END CALL on the SCDU/WSC, or by opening the ACP SATCOM Mic On Input or momentarily grounding the Place/End Call discrete. If call clearing is initiated from the ground, the channel transitions to on-hook without further action by the pilot. The call is terminated even if the pilot has not yet released his SATCOM transmit button (Cockpit Voice Mic On Input still grounded) or not yet selected END CALL on the SCDU/WSC, or not yet activated Place/End Call discretes. It should be noted that for an air initiated call, relying on the ground to terminate the call introduces a one to two minute delay (depending on timers in the ground network) in actually clearing the call.

To initiate a call, a pilot selects a channel number (if more than one channel is provided to the cockpit) and the appropriate called party on the SCDU/WSC. When the call is connected, the chime and light annunciates the same as for an incoming call. The rest of the call progress will be the same as for an incoming call.

Cabin Crew Procedures

Cabin Crew procedures are less defined than those of the flight crew because the systems used to support calls from the cabin are not yet defined and existing cabin interphone systems, which may be used for part of the solution, are uniquely designed for each airframe and may also vary between airlines. Cabin crew services may be provided by analog-connected telephones sharing the SDU codecs with the cockpit, or by the digitally-connected CCS.

One potential cabin configuration would include a handset and a control display unit similar to the cockpit SCDU/WSC. Because a handset is being used, on-hook and off-hook may be more conventionally defined. All conversations are full duplex. As with the flight crew, the capability to place the satellite channel on hold and use the handset for PA or intercom is provided. Other procedures are fairly conventional. Conventional PABX capabilities of call pickup (the incoming call can be accepted at any flight attendant station) and call transfer (a call originated or accepted at one station can be transferred to another station) are required. Any such features are provided by the CCS.

Another potential cabin telephone configuration would eliminate the SCDU/WSC and would use the keypad associated with the handset to place calls. As with conventional ground-based telephones and the cockpit system, memory dialing would be provided.

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Passenger Procedures

One of the potential uses of the satellite audio channels is to provide airborne telephone service for the passengers, similar to that provided today by terrestrial-based systems, but including coverage beyond the current network of ground stations. Existing cabin installation could possibly be integrated with the satellite audio system. The procedures are assumed to be similar to those currently used and would include APC services only. Although the passengers and the cabin crew are both potentially interfaced through the CCS, only crew stations would have access to any memory-dial data base. Incoming APC calls, although theoretically possible, are likely to be prohibited for operational reasons; this (as well as the routing of any such calls) is determined by the Owner Requirements Table.

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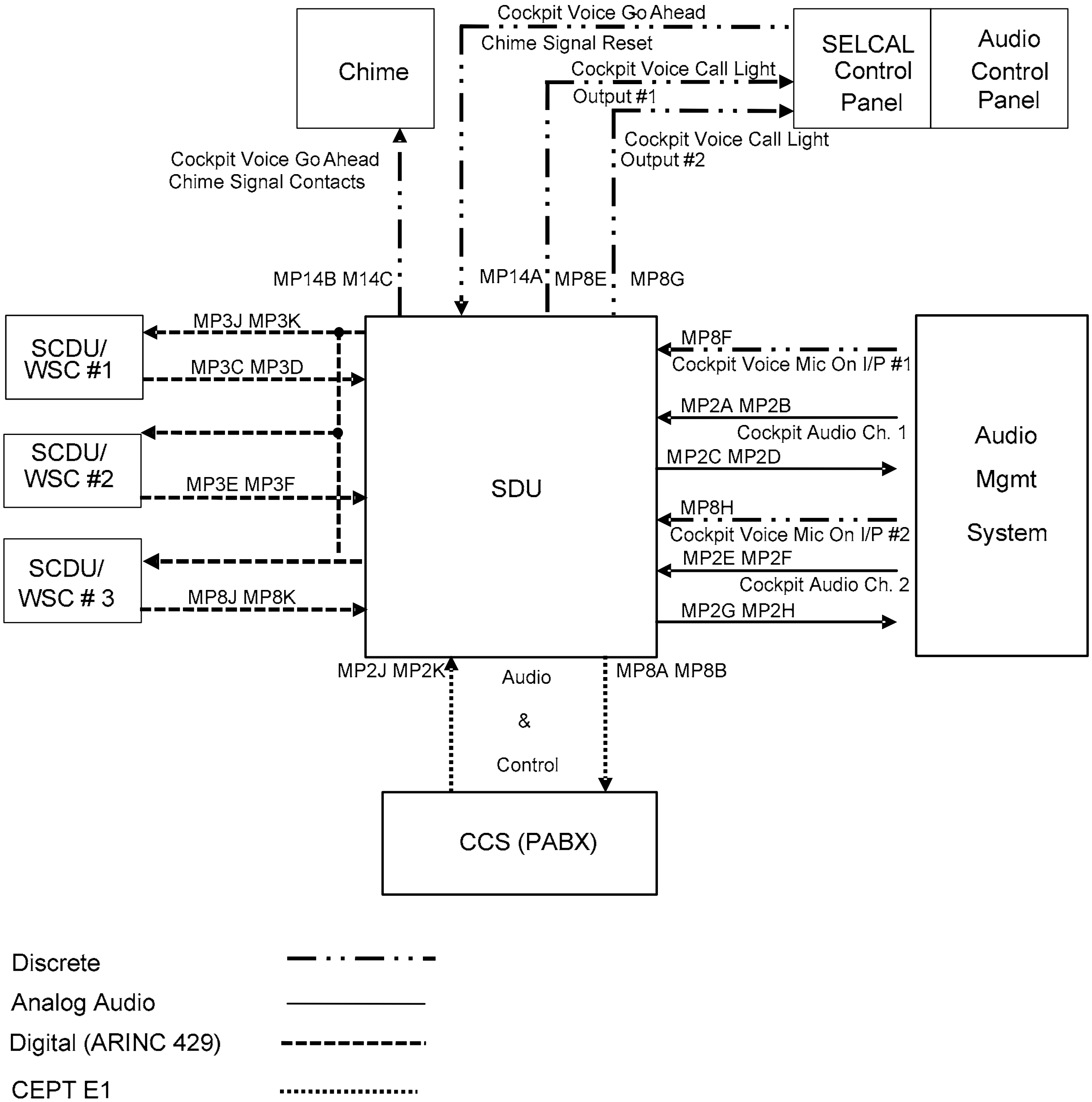

Figure 1 - Satellite Audio System

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OPERATIONAL DESCRIPTION OF AVIATION SATELLITE AUDIO CHANNELS

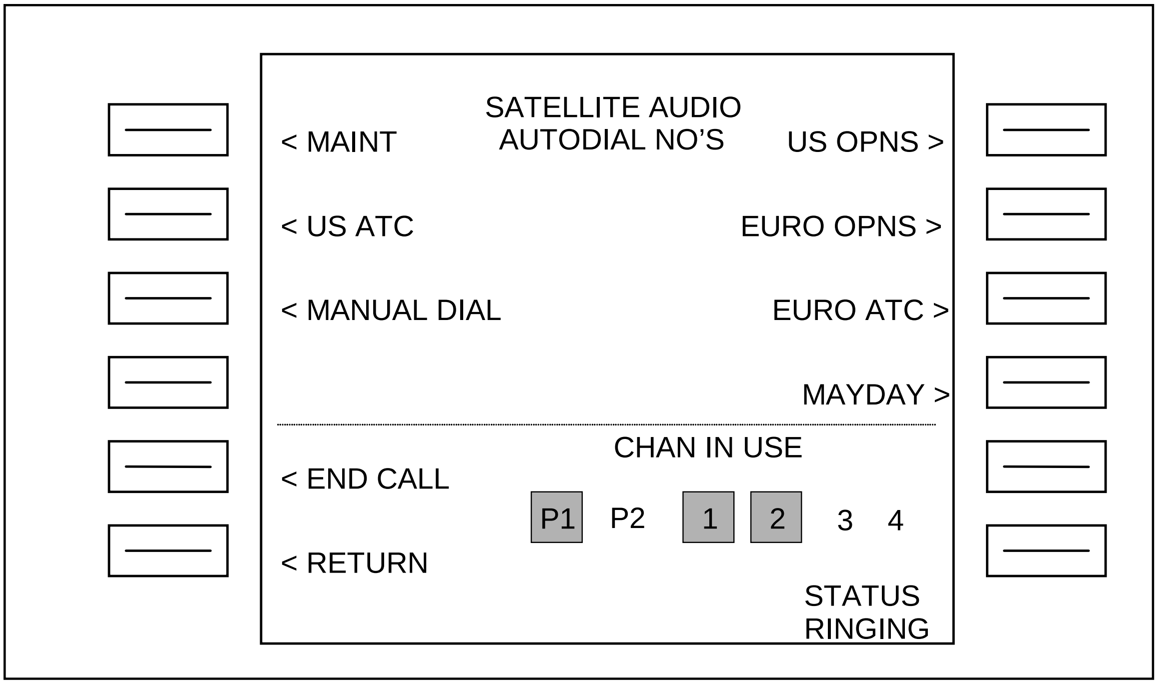

Figure 2 - Satellite Audio SCDU/WSC

ARINC 429 Williamsburg SDU Controller Interface (WSCI)

Rev. C

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

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1 INTRODUCTION

This attachment defines a satcom cockpit voice control/status interface for SDUs in aircraft configurations that do not utilize ARINC 739 multi-function control/display units (MCDUs, including satcom control/display units, or SCDUs, which are defined in ARINC 741 as CDUs that utilize the ARINC 739 protocol but are dedicated to satcom system control/display rather than multi-function). [Throughout this interface definition, the term SCDU is used to refer to any ARINC 739-compatible satcom CDU, whether multi-function or dedicated to satcom.] On the controller side, applications include the Honeywell Primus(TM) Epic(TM) enhanced avionics system (EASy)(TM) modular avionics unit (MAU), the Airbus radio management panel (RMP), and potentially others to be defined.

Although it is possible to perform all satcom cockpit voice (and related) control/status signaling using only the ARINC 429 buses, for the sake of compatibility with controller systems that require discrete signaling (e.g., for audio management systems) in addition to the 429 signaling, this interface definition retains the legacy discrete signaling (Mic-On, Call Light, Chime, Place/End Call), but also provides for the potential elimination of the discrete wiring in possible future generations of controller equipment.

The interface defined in this attachment utilizes Williamsburg link protocol data units (LPDUs, or LDUs as per ARINC 429) as well as ARINC 429 periodic broadcast words and hard-wired signaling discretes. Periodic broadcast words are used to convey the status of parameters that are subject to frequent change, including those for viewing by human users (pilots, engineers and maintenance personnel). Williamsburg LDUs are used to transmit multi-octet messages to initiate or respond to specific telephony and system management (e.g., log-on) events.

Due to its use of the ARINC 429 Williamsburg protocol as opposed to the ARINC 739 protocol, this interface is referred to as the Williamsburg SDU controller interface, or WSCI. A generic A429W SDU controller is referred to as a WSC. This attachment defines protocol details for several specific WSC types.

As the WSCI is used in place of SCDUs, WSCs are wired to the SDU's ARINC 429 output bus formerly designated as Data Bus to SCDU #1, #2, & #3 (MP3J/K) and to one or more of the SDU's ARINC 429 input buses formerly designated as Data from SCDU #1 [or #2 or #3] (MP3C/D, MP3E/F, and MP8J/K, respectively), rather than using dedicated ARINC 429 buses on the SDU. Given that the SCDU/WSC buses to the SDU are fixed at low-speed operation, the buses operate at low-speed in both directions for the WSCI protocol (with TP13B programmed accordingly).

This attachment defines the means of determining which of the above-mentioned SDU ARINC 429 interfaces are wired, and if wired, to which specific type of equipment they are wired, such that the SDU can utilize the protocol appropriate to the interfacing equipment.

The WSCI is designed to accommodate a basic standard while also offering the potential for features, enhancements, etc. that may be unique to a specific type of controller, a specific aircraft or fleet, or a specific type of SDU. This includes the ability to reserve message types for such non-standard features, such that equipment configurations not supporting such features either does not generate the reserved message types and/or ignores them if they are received. The WSCI similarly allows for optional data fields within defined message types, which may be used or ignored, depending on the specific equipment type. The intent is to have provisions for flexibility while retaining interoperability for all basic functions.

As stated above, a single aircraft installation using the WSCI may consist of between one to three WSCs. Depending on their type, all WSCs in a given installation may or may not normally be enabled to perform Williamsburg protocol file transfers simultaneously. A WSC that is currently enabled to perform Williamsburg file transfers is said to be Active, and one that is not is said to be Standby. [This Williamsburg status is distinct from other similar uses of the terms, such as active or inactive ARINC 429 buses at the physical layer -- e.g., a WSC may be Standby in the Williamsburg sense, but the bus may be said to be active at the physical layer by virtue of transmission of periodic broadcast words.] This interface definition addresses requirements for both WSC types, i.e., those that are all enabled simultaneously for Williamsburg file transfers for multiple WSC installations, and those that are not. Unless specified otherwise, the terms Active and Standby in this interface definition refer to the Williamsburg file transfer process being enabled or disabled, respectively.

COMMENTARY

> Some WSCs do not indicate Williamsburg Active until after successful receipt of valid status words from the master SDU, and will not exchange SAL-addressed Williamsburg protocol words with the SDU if the SDU’s status words indicate that the SDU’s input bus from that WSC is inactive. Other WSCs may not have these specific restrictions.

Throughout this attachment, numeric values are indicated with the following suffixes:

b	Binary
o	Octal
h	Hexadecimal
No marking	Decimal, except for ARINC 429 data labels and system address labels (SALs), which are always octal

2 Physical Connections

Hard-wired discretes and the SDU's SCDU/WSC interfaces (ARINC 429) are used to carry the WSCI protocol. The SDU has one SCDU/WSC output bus and three SCDU/WSC input buses.

<u>Note</u>: In most cases, this interface definition only describes the data that <u>is</u> to be transmitted and received. Optional data is identified as such. This does not preclude equipment from transmitting additional specified or unspecified data -- e.g., an SCDU may transmit labels not specified in ARINC 739, and the SDU may transmit status information that may not be required by every type of WSC. Receiving equipment must always be prepared to ignore received data that is unspecified, and to also ignore received data that is specified but is for functionality that is not implemented in the receiving equipment, without declaring any fault or failure condition as a

result of any such data. A possible exception could be excessive data rates beyond those nominally expected, which might cause receiver buffer overrun, processor overload, etc.

2.1 SDU's Determination of its Equipment Configuration

The provisions described in the subsections below allow the SDU to determine its specific equipment configuration on any given aircraft (i.e., how many interfaces are wired; whether the wired interfaces are SCDUs or WSCs; and if WSC(s), which specific type).

2.1.1 Equipment Installed SDU System Configuration Pins

To accommodate the case of WSC configurations, SDU system configuration pins TP12J, TP12K and TP13E are used to indicate whether SCDU/WSCs #1, #2 and #3 are wired to the SDU, respectively. The installed state merely indicates that unspecified devices are installed, and additional information must be obtained (as specified in the next two sections below) to identify the specific type of device.

2.1.2 WSC(s) Installed SDU System Configuration Pin

SDU system configuration pin TP10H is used to identify the general type of controllers connected to the SDU's SCDU ports. The unstrapped (logic 1) state signifies one or more ARINC 739-compatible SCDUs; the strapped (logic 0) state indicates one or more WSCs that are compatible with this interface definition. The installed configuration must be of one type or the other -- a mix of SCDUs and WSCs is not required nor allowed. If ARINC 739-compatible SCDUs are indicated, the equipment configuration determination process is complete, and the SDU operates in accordance with the legacy SCDU mode. The SDU ignores any label 270 words that might be received from an SCDU, as well as any other unspecified data. If WSCs are indicated, one more step must be performed in the equipment configuration determination process, as described in the section below.

2.1.3 WSC Label 270 Status Word

All WSCs (whether Active or Standby) broadcast label 270 status words, as defined in this attachment. In addition to other information, the label 270 words contain a WSC Type field to indicate exactly what type of WSC is installed (e.g., Honeywell MAU, Airbus RMP, etc.). If the WSC(s) Installed SDU system configuration pin is strapped to the WSC(s) state, the SDU receives and decodes the WSC's label 270 words, thereby permitting it to perform any controller-specific functionality.

2.2 Other Equipment Configuration Issues

2.2.1 SDU Label 172 Subsystem Identifier Word

For compatibility with ARINC 739 SCDUs, if any of the SDU's system configuration pins TP12J, TP12K or TP13E are strapped for equipment installed, the SDU outputs label 172 subsystem identifier words (containing its ARINC 429 system address label, or SAL) on its SCDU/WSC output bus. The SAL is 307 (octal) for SDU #1, and 173 (octal) for SDU #2 (if satcom is a dual system with two SDUs).

2.2.2 Label 377 (Equipment ID Word)

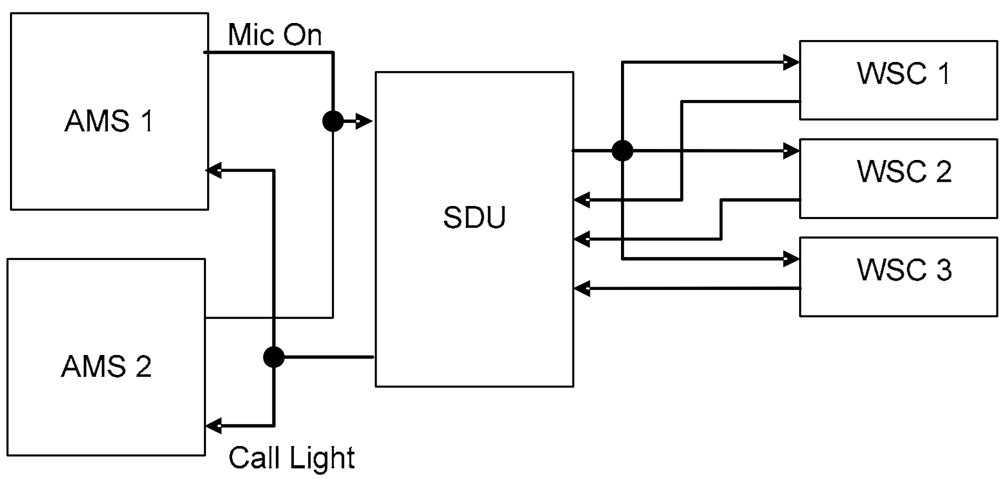
ARINC 739 SCDUs broadcast label 377 equipment ID words to the SDU at a 1 Hz rate. Label 377 contains the three-hex-digit equipment ID code. Equipment ID code 039x indicates an MCDU/SCDU; for this interface definition, this is equivalent to the WSC(s) Installed SDU system configuration pin being left in the unstrapped (logic 1) state. There is no requirement for the WSC to transmit label 377 words, nor for the SDU to process label 377 words on this interface in any way.

However, although there is no requirement for label 377 on this interface, equipment ID code 0C4x has been allocated for the generic A429W SDU controller (WSC) for possible use.

2.2.3 SDU Label 270 Status Word

All WSCI-enabled SDUs (whether master or slave in the case of dual systems) broadcast label 270 status words, as defined in this attachment, as long as SDU system configuration pin TP10H is strapped to the WSC(s) state. In addition to other information, the WSC(s) can determine the active/inactive status of the SDU's input buses from these label 270 words.

2.3 Example Equipment Configuration



This example configuration (only one voice channel shown) has the SDU SCDU/WSC output connected to up to three WSCs (no SCDUs), and discretes connected to two audio management systems (AMSs). The SDU must read system configuration pin TP10H as being strapped to the WSC(s) state, and then receive and decode label 270 status words via the WSCI to determine to what type of WSCs it is connected; the SDU and one or more of the WSCs (depending on their type) then initiate two-way Williamsburg communications using the ALO/ALR processes, after which the periodic and aperiodic WSCI messages defined herein are transferred. The ARINC 429 bus operates at low-speed in both directions (for the sake of symmetrical Williamsburg protocol timers). Data needed to be sent to any one Active WSC may need to be sent to all connected and Active WSCs via independent Williamsburg transfers, as defined for each message type.

The WSC ARINC 429 output bus may also drive other LRUs with other periodic broadcast labels and Williamsburg LDUs using other SALs. The SDU ignores all such data on the WSCI.

2.4 Multiple LRU Issues

2.4.1 Multiple MCDUs/SCDUs

The legacy definition for SDU operation with any number of MCDUs/SCDUs (up to three) remains unchanged by the WSCI augmentation.

2.4.2 Multiple WSCs

For WSC Type = Honeywell MAU, only one WSC is Active at a time; for WSC Type = Airbus RMP, all installed RMPs are normally Active. Specific requirements with regard to data interchanges with multiple Active WSCs are defined in Section 0. In general, the following rules apply for the case of multiple Active WSCs:

- Messages sent to all Active WSCs:
  - Unsolicited Channel Status (upon change)
  - Unsolicited Log-on Status (upon change)
  - Unsolicited Configuration Data (upon change via ORT upload) *
  - Unsolicited Sat/GES Data (upon change via ORT upload) *
  - Unsolicited Phone Directory (upon change via ORT upload) *

    * All three blocks are sent after every ORT User partition upload; the WSCs must request the data at each WSC Williamsburg initialization, which covers the case of change of system configuration pin strapping.
- Messages sent to only the initiating WSC:
  - Acknowledge in response to a Pre-Select Call command
  - Data message(s) in response to a Data Request command
  - Cabin Calls response to a Cabin Calls command

2.4.3 Multiple SDU Configurations

In a dual SDU configuration, both SDUs will transmit and receive periodic broadcast ARINC 429 status words; however, only the master SDU will perform Williamsburg file transfers with the WSCs (i.e., only the master SDU is Active).

Regarding the interface between the SDU and the WSCs, the SDU is flexible in terms of how up to two channels of cockpit voice (as presented to the flight deck crew) can be interwired to the four physical channels provided by two SDUs (e.g., both cockpit channels wired to both channels of both SDUs (paralleled or externally switched), or one channel wired to each SDU).

3 Data Transfer Protocol

WSCI messages are passed between the SDU and the WSC(s) on the SDU's SCDU/WSC ARINC 429 buses. All aperiodic messages are transferred using the ARINC 429 file transfer protocol (FTP) version 1 (Williamsburg) and ALO-ALR (aloha-aloha response) sub-version number 1, as specified in ARINC Specification 429 Part 3-18. As there is no intent to use any other ARINC 429 FTP version, there is no absolute need for the SDU to perform ALO-ALR protocol version negotiation, but it may if desired. The SDU may also perform TEST/LOOP verification if desired.

COMMENTARY

For maximum commonality with the precedent-setting Williamsburg communications between the SDU and the ARINC 724B ACARS MU or the ARINC 758 CMU/ATSU, the SDU typically does initiate ALO and TEST/LOOP. The SDU may not able to perform normal Williamsburg protocol communications until after first completing a successful ALO/ALR process (whether initiated by itself or by the WSC). Some WSCs may not initiate ALO.

General format identifier (GFI) code 2_h (command/control data) is used. ACARS-type Destination character codes (reference ARINC 429 Part 3-18 Attachments 11 and 11A -- provisioned in several types of Williamsburg words) are not used in the WSCI application, and are set to all zeroes (Null) by transmitting equipment and ignored by receiving equipment.

Although the WSCI protocol contains provisions for an interface version number (IVN) in order to manage future changes to the protocol that are not backward compatible with earlier versions, the usage of the IVN is not defined in version zero, and its usage will not be defined until the time that any such incompatible changes become necessary.

The octal system address labels (SALs) for Williamsburg protocol exchanges are as follows:

SDUs:	307 and 173, respectively
WSCs:	261, 262 and 263 for #1, #2 and #3, respectively

The source/destination identifier (SDI) fields for non-Williamsburg ARINC 429 words have no application as destination identifiers, as those words are used for status indication only. As source identifiers, the following binary coding will be used:

Sole SDU:	00
SDU #1 of 2:	01
SDU #2 of 2:	10
WSC:	00 (regardless of #1, #2 or #3)

COMMENTARY

As the source is known by the receiving LRU by virtue of the physical bus on which the data is received, there is no specified application for the SDI field. The above information simply serves to document what can be expected from the sending LRU.

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WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

4 General WSCI Message (Williamsburg LDU) Format

All WSCI protocol Williamsburg LDU messages are composed using at least two octets, as follows:

Octet	Value								Description
	7	6	5	4	3	2	1	0	
0									Message Type
1 to N									Data (one or more octets)

Messages that have a variable length contain a field at a fixed location that can be used to determine the message length and its complete format; otherwise, the format of each message, including its length as well as the locations of its various signal elements (fields) and their coding standards, is determined by the message type field alone.

The following tables list all of the WSCI protocol messages, which are then defined in detail in Section 5, with their signal element coding, defined in Section 5.3. The SDU and WSC must be capable of ignoring any undefined messages that may be received.

Williamsburg LDU Messages:

Message Type Code (1)	Williamsburg Message Type (3)		Message Direction	No. of Data Octets 9	Expected Response Message Type(s)
01_h	Initiate Call	[5.1.1]	to SDU	13	$A1_h$ or $A2_h$
02_h	Pre-Select Call Parameters	[5.1.2]	to SDU	13	62_h
03_h	Telephony Command	[5.1.3]	to SDU	1	$A1_h$ or $A2_h$
04_h	Log-On/Off Command	[5.1.4]	to SDU	2	$A3_h$
05_h	Data Request	[5.1.5]	to SDU	1	Any of 61, $A1\text{-}C1_h$ (4)
06_h	Flight ID	[5.1.6]	to SDU	8	None
61_h	Cabin Calls (8)	[5.1.7]	Both (2)	1	61_h
62_h	Acknowledge	[5.1.8]	Both (2)	1	None
$A1_h$	Channel 1 Status (6)	[5.1.9]	from SDU	4	See Note 5
$A2_h$	Channel 2 Status (6)	[5.1.9]	from SDU	4	See Note 5
$A3_h$	Log-On Status (6)	[5.1.10]	from SDU	3	None
$A4_h$	Configuration Data (6)	[5.1.11]	from SDU	2	None
$A5_h$	ICAO Address (7)	[5.1.12]	from SDU	3	None
$B0_h$-BF_h	Sat/GES Data, for AOR-W, AOR-E, POR and IOR for $B0_h$ to $B3_h$, respectively; and $B4_h$ to BF_h for future satellites as they become defined (6)	[5.1.13]	from SDU	~ 100 each	None
$C1_h$	Phone Directory (6)	[5.1.14]	from SDU	Varies	None
$D1_h$	Reserved		-	-	-

Notes:

1. The numeric ranges are allocated as follows: 00_h-$5F_h$ for the to-SDU direction, 60_h-$9F_h$ for both, and $A0_h$-FF_h for from-SDU.

2. Both means that the message can flow to or from the SDU. The message can be a command to the SDU (61_h), or a response from the SDU for that command or for that data request (61_h), or an acknowledgement from the SDU for a Pre-

Select Call Parameters message (62_h), or an acknowledgement to the SDU for an incoming call annunciation (62_h).

3. The number in square brackets is the attachment section that defines the message type.

4. As appropriate to the data request.

5. The response can be none (if this message is itself an SDU response to a message type 01_h, 02_h or 05_h command/request); or message type 62_h (Acknowledge) followed by either 03_h (Telephony Command, for the case of answering or rejecting an incoming call) or assertion of the Mic On discrete (for answering an incoming call) that is being annunciated by this message.

6. These messages can be sent from the SDU unsolicited (e.g., upon change of status) or as responses (acknowledgements) to commands. This data should be requested by the SDU's controller after the initiation of each Williamsburg session, including any time that the controller's input bus activity (e.g., based on receipt of label 270 words) resumes after having gone inactive (e.g., after three or more seconds).

7. These messages are only sent as responses to specific requests for this data. This data should be requested by the SDU's controller after the initiation of each Williamsburg session, including any time that the controller's input bus activity (e.g., based on receipt of label 270 words) resumes after having gone inactive (e.g., after three or more seconds).

8. This command, and the related Data Request, should only be sent by the WSC if the SDU indicates support of the function in its Configuration Data message.

9. The total number of octets in the message equals the No. of Data Octets plus 1 (in order to count the Message Type octet).

Periodic Broadcast Words:

Label	Periodic Broadcast Word Type		Direction
172	Subsystem Identifier	[5.2.1]	from SDU
270	SDU Status (basic)	[5.2.2]	from SDU
270	WSC Status	[5.2.3]	to SDU
271	Supplementary Log-On Status (log-on class, SQI)	[5.2.4]	from SDU
272	Antenna Status (selected antenna, azimuth, elevation)	[5.2.5]	from SDU

5 WSCI Message Definitions

See Section 5.3 for the definitions of the signal elements defined below.

5.1 Aperiodic Williamsburg LDU Messages

5.1.1 Initiate Call (Message Type Code 01h)

Data Octet	7	6	5	4	3	2	1	0	Description
1	Ch	Sp	Network ID				Priority		This message is used by the WSC to cause the SDU to immediately initiate a call using the designated call parameters (channel, priority, transit GES, phone number and network ID). Digit 0 is the first digit dialed and the left-most as normally written. The WSC should only send Digit codes for BCD digits and the Last Digit flag; the SDU must filter out any other codes (such as dot, dash or space separators) before transmission to the GES. The response is a Channel Status message, including for any non sequitur command or any command with undefined content. For WSC Type = Airbus RMP, the response is sent to all RMPs.
2	Transit GES ID								
3	Digit 1				Digit 0				
4	Digit 3				Digit 2				
5	Digit 5				Digit 4				
6	Digit 7				Digit 6				
7	Digit 9				Digit 8				
8	Digit 11				Digit 10				
9	Digit 13				Digit 12				
10	Digit 15				Digit 14				
11	Digit 17				Digit 16				
12	Digit 19				Digit 18				
13	Digit 21				Digit 20				

Unused digits beyond the last digit are set to F_h (as a Last Digit flag). For the purposes of the WSCI protocol, the last digit to be dialed is either digit 21 (if no Last Digit flags are encountered in digits 0 through 21) or the last digit preceding the first Last Digit flag. Digits 18 through 21 are for future possible growth; with the Inmarsat system definition as of November 2003, the maximum number of digits that can actually be dialed is 18 (Digit fields 0 through 17). Any future use of digits 18 through 21 will require additional changes elsewhere in the avionics; air/ground signaling and terrestrial signaling. Until that time, digits 18 through 21 will always be set to F_h.

5.1.2 Pre-Select Call Parameters (Message Type Code 02h)

Data Octet	7	6	5	4	3	2	1	0	Description
1	Ch	Sp	Network ID				Priority		This message is used by the WSC to cause the SDU to merely pre-select the parameters for a call that will be initiated at a later time via the Mic On or Place/End Call discrete. Digit 0 is the first digit dialed and the left-most as normally written. The WSC should only send Digit codes for BCD digits and the Last Digit flag; the SDU must filter out any other codes (such as dot, dash or space separators) before transmission to the GES. The response is an Acknowledge message. For WSC Type = Airbus RMP, the acknowledgement is sent only to the requesting RMP.
2	Transit GES ID								
3	Digit 1				Digit 0				
4	Digit 3				Digit 2				
5	Digit 5				Digit 4				
6	Digit 7				Digit 6				
7	Digit 9				Digit 8				
8	Digit 11				Digit 10				
9	Digit 13				Digit 12				
10	Digit 15				Digit 14				
11	Digit 17				Digit 16				
12	Digit 19				Digit 18				
13	Digit 21				Digit 20				

Unused digits beyond the last digit are set to F_h (as a Last Digit flag). For the purposes of the WSCI protocol, the last digit to be dialed is either digit 21 (if no Last Digit flags are encountered in digits 0 through 21) or the last digit preceding the first Last Digit flag. Digits 18 through 21 are for future possible growth; with the Inmarsat system definition as of July 2003, the maximum number of digits that can actually be dialed is 18 (Digit fields 0 through 17). Any future use of digits 18 through 21 will require additional changes elsewhere in the avionics; air/ground signaling and terrestrial signaling. Until that time, digits 18 through 21 will always be set to F_h.

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5.1.3 Telephony Command (Message Type Code 03h)

Octet	7	6	5	4	3	2	1	0	Description
1	Ch	Spare			Telephony Command Type				This message is used by the WSC to command the SDU to perform the designated command -- End Call, Preempt Call, Cancel Camp-on, Answer Call, or Reject Call -- on the designated channel. The response to the command is a Channel Status message, including any non sequitur command or any command with undefined content. For WSC Type = Airbus RMP, the Channel Status response is sent to all connected RMPs.

5.1.4 Log-On/Off Command (Message Type Code 04 h)

Octet	7	6	5	4	3	2	1	0	Description
1	Sat ID						Log Cmd		This message is used by the WSC to command the SDU to perform the designated log command with respect to the designated satellite GES. The IDs of the pertinent satellite and GES are designated for the case of manual log-on; for all other cases (i.e., automatic log-on or log-off), the satellite and GES IDs are don't care and are set to $3F_h$ and FF_h, respectively. The response to the command is a Log-On Status message, including any non sequitur command or any command with undefined content. For WSC Type = Airbus RMP, the response is sent to all connected RMPs.
2	GES ID								

5.1.5 Data Request (Message Type Code 05h)

Octet	7	6	5	4	3	2	1	0	Description
1	Data Requested								This message is used by the WSC to request the SDU to respond with the information designated in the Data Requested field. The response to the command is the requested data (Channel Status [separate messages (LDUs) sent for two channels if so equipped], Log-On Status, ICAO Address, Configuration Data, Directory, Sat/GES data, Cabin Calls status). All but Directory and Sat/GES data are transferred as a single LDU per message; Sat/GES data is transferred as multiple LDUs (one per satellite); directory data is transferred using one or more LDUs, as required by the SDU, to divide the total directory into manageable-sized segments. For WSC Type = Airbus RMP, the requested data is transferred only to the requesting RMP. Requests for undefined data types are ignored.

5.1.6 Flight ID (Message Type Code 06h)

<table>
<tr><td rowspan="2">Octet</td><td colspan="8"></td><td rowspan="2">Description</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td colspan="8">Flight ID Character #1</td><td rowspan="8">For aircraft lacking a central maintenance system, this optional message may be used by the WSC to send the SDU a flight ID that has been manually entered via the HMI, for use as log-on information. Character #1 is the left-most as normally written; unused higher-numbered characters are filled with the NUL code (IA5 00_h). There is no response or acknowledgement from the SDU to the WSC. Not applicable for WSC Type = Airbus RMP. Messages with undefined content are ignored.</td></tr>
<tr><td>2</td><td colspan="8">Flight ID Character #2</td></tr>
<tr><td>3</td><td colspan="8">Flight ID Character #3</td></tr>
<tr><td>4</td><td colspan="8">Flight ID Character #4</td></tr>
<tr><td>5</td><td colspan="8">Flight ID Character #5</td></tr>
<tr><td>6</td><td colspan="8">Flight ID Character #6</td></tr>
<tr><td>7</td><td colspan="8">Flight ID Character #7</td></tr>
<tr><td>8</td><td colspan="8">Flight ID Character #8</td></tr>
</table>

5.1.7 Cabin Calls (Message Type Code 61h)

<table>
<tr><td rowspan="2">Octet</td><td colspan="8"></td><td rowspan="2">Description</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td colspan="5">Spare</td><td colspan="3">Cabin Calls</td><td>This message may be sent by the WSC to the SDU to command the SDU to enable or disable cabin calls, but only if the SDU indicates support of this feature in its Configuration Data message. [In the SDU, the functional response to a disable command is TBD.] If this optional feature is implemented in the SDU, the response is the same message type, indicating the accepted cabin call command (and thus the current status). If the feature is not implemented in the SDU but the WSC sends this command anyway, the SDU responds with the status Function not supported. This message is also the response to a Cabin Calls Status data request.</td></tr>
</table>

5.1.8 Acknowledge (Message Type Code 62h)

<table>
<tr><td rowspan="2">Octet</td><td colspan="8"></td><td rowspan="2">Description</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>Ch</td><td colspan="3">Spare</td><td colspan="4">Ack Type</td><td>This message is used as an explicit acknowledgement for certain commands, as identified in the Ack Type field. It is sent by the SDU to acknowledge a Pre-Select Call Parameters message (for WSC Type = Airbus RMP, only to the sending RMP); it is sent by the WSC to the SDU to acknowledge an incoming call annunciation. For the latter, note that this message is only an acknowledgement of message transfer to the WSC (non-receipt of an Acknowledgement on a timely basis permits the SDU to re-send the incoming call annunciation in case it is not received by the WSC for any reason). A Telephony Command message (initiated via the HMI) or activation of the Mic On discrete is required to answer the call.</td></tr>
</table>

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5.1.9 Channel 1 (or Channel 2) Status (Message Type Codes A1h and A2h)

<table>
<tr><th rowspan="2">Octet</th><th colspan="8"></th><th rowspan="2">Description</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>1</td><td colspan="2">Spare</td><td colspan="2">Priority</td><td colspan="4">Channel Status</td><td rowspan="4">This message serves multiple purposes. (1) It can be sent from the SDU as a response to a command to make a call (either an Initiate Call command or appropriate activation of the Mic On or Place/End Call discretes), or (2) it can be sent unsolicited from the SDU whenever the channel status changes (e.g., to signal an incoming call), or (3) status for all wired channels can be sent in response to a Data Request command from the WSC. Cases (1) and (3) require no further response, as this message itself would be a response. The expected response for case (2) is, first, an Acknowledge message (the lack of which, in a timely manner, permits the SDU to re-send the incoming call annunciation in case it is not received by the WSC for any reason), and then either a Telephony Command message (to answer or reject an incoming call) or assertion of the Mic On discrete (to answer an incoming call). [From the SDU's perspective, it is acceptable for an answer or reject response to be received before the Acknowledge message, or for the Acknowledge message to never be sent at all; however, the WSC should always Acknowledge the incoming call annunciation, else the opportunity for the SDU to re-send in case of error would be lost.]
SLCV codes are used to identify the circumstances of a channel release. For WSC Type = Airbus RMP, for cases (1) and (2) above, the message is sent to all connected RMPs (for case (1), to the requesting (commanding) RMP first); for case (3) above, the message is sent only to the requesting RMP. This data should be requested by the WSC after the initiation of each Williamsburg session, including any time that the controller's input bus activity (e.g., based on receipt of label 270 words) resumes after having gone inactive (e.g., after ≥ 3 seconds).</td></tr>
<tr><td>2</td><td colspan="4">Cause Class (C)</td><td colspan="4">Cause Value (V)</td></tr>
<tr><td>3</td><td colspan="4">Standard (S)</td><td colspan="4">Location (L)</td></tr>
<tr><td>4</td><td colspan="8">Reserved</td></tr>
</table>

5.1.10 Log-On Status (Message Type Code A3h)

Octet	7	6	5	4	3	2	1	0	Description
1	Spare				Log-on Status				As for Channel Status, this message serves multiple purposes. (1) It can be sent from the SDU as an acknowledgement to a Log-on Command, or (2) it can be sent unsolicited from the SDU whenever the log-on status changes, or (3) it can be sent in response to a Data Request command. For WSC Type = Airbus RMP, for cases (1) and (2) above, the message is sent to all connected RMPs (for case (1), to the requesting (commanding) RMP first); for case (3) above, the message is sent only to the requesting RMP. This data should be requested by the WSC after the initiation of each Williamsburg session, including any time that the controller's input bus activity (e.g., based on receipt of label 270 words) resumes after having gone inactive (e.g., after three or more seconds). No response or acknowledgement is expected from the WSC.
2	Sp	S/G	Sat ID						
3	GES ID								

5.1.11 Configuration Data (Message Type Code A4h)

Octet	7	6	5	4	3	2	1	0	Description
1	Transit Calls	No. Pre-select	Chan 2 Rsvd	Chan 1 Rsvd	Chan 2 Wired	Chan 1 Wired	Pri 4 Calls	Call Lt Act	This message is used by the SDU to indicate to the WSC the SDU ORT and configuration pin information that is pertinent to SCDU HMI configurations, for potential use in the WSC's HMI. It is sent (1) upon any change to the ORT items that are included in this message (within 10 seconds of a change), and (2) whenever requested by a Data Request message. For WSC Type = Airbus RMP, for case (1), this message is sent to all connected RMPs, and for case (2), it is sent only to the requesting RMP. This data should be requested by the WSC after the initiation of each Williamsburg session, including any time that the controller's input bus activity (e.g., based on receipt of label 270 words) resumes after having gone inactive (e.g., after three or more seconds). Note: For bits reflecting the state of SDU configuration pins, the 0/1 logic of the <u>bits</u> in this message is not necessarily the same as that shown for the corresponding <u>pins</u> in A741P1 Att. 1-4C.
2	Spare	Reserved	Cabin Calls Disable Support	Reserved		Reserved	Chime Activation		

5.1.12 ICAO Address (Message Type Code A5h)

Octet	7	6	5	4	3	2	1	0	Description
1	Least significant 8 bits								Octet 1 bit 0 is the least significant address bit; octet 3 bit 7 is the most significant address bit. Values 00000000_o and 77777777_o are invalid addresses; value 77777777_o is used in this message to mean ICAO address not available. This data should be requested by the WSC after the initiation of each Williamsburg session, including any time that the controller's input bus activity (e.g., based on receipt of label 270 words) resumes after having gone inactive (e.g., after three or more seconds).
2	Middle 8 bits								
3	Most significant 8 bits								

5.1.13 Sat/GES Data (Message Type Codes B0h - BFh)

Octet	7	6	5	4	3	2	1	0	Description
1	Spare		Satellite ID						This data is sent from the SDU to the WSC for possible display applications on the WSC's HMI, e.g., on a log-on control/status display. Character #1 is the left-most as normally written; unused higher-numbered characters are filled with the NUL code (IA5 00_h) (resulting in right-justified text on the WSC). This message is sent (1) upon any change to the corresponding data in the ORT (within 10 seconds of a change), and (2) whenever requested by a Data Request message. For WSC Type = Airbus RMP, for case (1), this message is sent to all connected RMPs, and for case (2), it is sent only to the requesting RMP. This data should be requested by the WSC after the initiation of each Williamsburg session, including any time that the controller's input bus activity (e.g., based on receipt of label 270 words) resumes after having gone inactive (e.g., after three or more seconds).
2	Sat Name Character #1								
3	Sat Name Character #2								
...	...								
15	Sat Name Character #14								
16	No. of GESs for this sat (Ng)								
17	GES ID (1)								
18	GES Name Character #1								
19	GES Name Character #2								
...	...								
31	GES Name Character #14								
32	GES ID (2)								
33 to 46	GES Name Characters #1-14								
47 to [15*Ng + 16]	Rem. GES IDs/Names for this sat								

Message type codes $B0_h$ - $B3_h$ are used for satellite IDs 00_h - 03_h, respectively. The satellite ID field is included in each message as an additional identifier of the data within the message. This may have greater significance in the future if additional satellites are placed into the constellation for which the satellite IDs may not be consecutively and/or contiguously assigned after the range currently specified.

Message type codes $B4_h$ - BF_h are used, in numeric order, for new satellite IDs as they become defined via the System Table, with no necessary correlation between the least-significant digit of the message type code and the satellite ID (e.g., the 5th assigned satellite ID will use message type code $B4_h$, regardless of whether the satellite ID is 04_h or $3F_h$ or anything in between). The SDU will automatically generate such additional Sat/GES Data messages as System Table updates indicate the need to do so, using whatever name data is in the ORT (whether user-specified text or default characters).

5.1.14 Phone Directory (Message Type Code C1h)

Octet	7	6	5	4	3	2	1	0	Description
1	Message segment number (M)								This data is sent from the SDU to the WSC for possible display application on the HMI, e.g., to present a list of phone numbers from which a selection may be made for immediate dialing or pre-selection for later dialing via the Mic On discrete. Character #1 is the left-most as normally written; unused higher-numbered characters are filled with the NUL code (IA5 00_h) (resulting in right-justified text on the WSC). Digit 0 is the first digit dialed and the left-most as normally written. The phone numbers are alphabetized as per the 14-character Entry name. This message is sent (1) upon any change to the corresponding data in the ORT (within 10 seconds of a change), and (2) whenever requested by a Data Request message. For WSC Type = Airbus RMP, for case (1), this message is sent to all connected RMPs, and for case (2), it is sent only to the requesting RMP. This data should be requested by the WSC after the initiation of each Williamsburg session, including any time that the controller's input bus activity (e.g., based on receipt of label 270 words) resumes after having gone inactive (e.g., after three or more seconds).
2	Number of message segments (N)								
3	Number of entries in this message segment (S) (LSByte)								
4	Number of entries in this message segment (S) (MSByte)								
5	Number of entries in the directory (D) (LSByte)								
6	Number of entries in the directory (D) (MSByte)								
7	Entry name character #1								
8	Entry name character #2								
...	...								
20	Entry name character #14								
21	Digit 1				Digit 0				
22	Digit 3				Digit 2				
23	Digit 5				Digit 4				
24	Digit 7				Digit 6				
25	Digit 9				Digit 8				
26	Digit 11				Digit 10				
27	Digit 13				Digit 12				
28	Digit 15				Digit 14				
29	Digit 17				Digit 16				
30	Digit 19				Digit 18				
31	Digit 21				Digit 20				
32	Network ID				Category		Priority		
33 to [6 + 26*S]	Names and digits for all remaining entries for this message segment								

The total phone directory is alphabetized and then segmented as necessary in order to be transferred by one or more Phone Directory messages. The SDU may use up to the maximum number of octets allowed by the Williamsburg protocol per LDU (632.5), and one or more LDUs per message; the SDU determines how to segment the phone directory (different segmentation approaches could be used for the same size directory). The total number of message segments is indicated by N. The sequence of any given message segment is indicated by M. E.g., for the 2nd message segment in a total of 3 message segments, M = 2 and N = 3. M and N both range from 01_h to FF_h (zero is not used).

The total number of phone numbers in any message segment (whether a single message, or one of a sequence of messages) is indicated by S. The S field determines the size of this variable-length message.

The total number of phone numbers in the entire directory is indicated by D. This field is superfluous in the sense that it can be determined after the last message in a sequence is received, but it is included up front for the convenience of any phone directory memory management provisions that may be used by the WSC.

All unused digits beyond the last digit are set to F_h (as a Last Digit flag). For the purposes of the WSCI protocol, the last digit to be dialed is either digit 21 (if no Last Digit flags are encountered in digits 0 through 21) or the last digit preceding the first Last Digit flag. Digits 18 through 21 are for future possible growth; with the Inmarsat system definition as of June 2003, the maximum number of digits that can actually be dialed is 18 (Digit fields 0 through 17). Any future use of digits 18 through 21 will require additional changes elsewhere in the avionics, air/ground signaling and terrestrial signaling. Until that time, digits 18 through 21 will always be set to F_h.

Depending on the aircraft type or user convention, the Category and Priority for any given phone number may be the same or different.

5.2 Periodic Broadcast Messages

All periodic broadcast words are transmitted at a rate of 1 ± 0.5 Hz unless otherwise specified.

5.2.1 Subsystem Identifier Word (Periodic Broadcast Label 172)

The label 172 word is as defined in ARINC 429, Part 1, Supplement 16, Attachment 6, Table 6-34.

5.2.2 SDU Status Word (Basic) (Periodic Broadcast Label 270)

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09	08							01
P	SSM		Spare					SDU Status										Spare				Pad		Label 270							
Parity (Odd)								Inactive Bus WSC #3	Inactive Bus WSC #2	Inactive Bus WSC #1	Cockpit Voice Fault	Master/Slave	Pad	IVN										0	0	0	1	1	1	0	1

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5.2.3 WSC Status Word (Periodic Broadcast Label 270)

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09	08							01
P	SSM		Spare				WSC Status															Pad		Label 270							
Parity (Odd)							Reserved	Reserved	Reserved	Inactive Bus SDU2	Inactive Bus SDU1	Active/Standby	IVN				Pad	WSC Type						0	0	0	1	1	1	0	1

5.2.4 Supplementary Log-On Status Word (Periodic Broadcast Label 271)

32	31	30	29	28	27	26	25	24	23	22	21	20	19							12				08							01
P	Spare												SQI								Class			Label 271							
Parity (Odd)																								1	0	0	1	1	1	0	1

5.2.5 Antenna Status Word (Periodic Broadcast Label 272)

32				28			25							18	17	16							09	08							01
P	Spare				Ant		Elevation								AZ	Azimuth								Label 272							
Parity (Odd)																								0	1	0	1	1	1	0	1

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5.3 Signal Element Definitions

An upper-case X in a numeric field (not a suffix) signifies any value. Unless otherwise specified, least-significant bits are written on the right and, in octet fields, correspond to bit #0.

Ack Type

Acknowledgement Type:	0_h	Pre-select call parameters ack (from SDU)
	1_h	Incoming call ack (to SDU)
	2_h - F_h	Spare

Active/Standby

Active/Standby status: transfer nor 270 to	0_b	Standby -- Williamsburg file protocol not enabled with SDU1 SDU2 -- only broadcasting label each SDU.
	1_b	Active -- Williamsburg file transfer protocol is enabled with master SDU, as well as label 270 periodic broadcast to each SDU.

Ant

Currently selected antenna:	00_b	None
	01_b	LGA
	10_b	IGA
	11_b	HGA

Az

Sign bit for Azimuth:	0	Positive (right or clockwise from nose)
	1	Negative (left or counterclockwise from nose)

Azimuth

Current aircraft-relative antenna azimuth steering angle:

	0 to 180	Binary coding; LSB = 1 degree See also Az (sign bit)

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C or Cause Class

SLCV cause class, and cause value (V):

CCITT Q.931 standard coding:

CAUSE CLASS	CAUSE VALUE	FUNCTION
0	1	Unassigned (unallocated) number
0	3	No route to destination
1	0	Normal clearing
1	1	User busy
1	2	No user responding
1	5	Call rejected
1	11	Destination out of service
1	12	Invalid (incomplete) number format
1	15	Normal, unspecified
2	2	No circuit/channel available
2	6	Network out of order
2	10	Switching equipment congestion
4	2	Channel type not implemented

Satellite-Network-Specific coding:

CAUSE CLASS	CAUSE VALUE	FUNCTION
0	1	Address complete
1	1	Call preempted
2	1	No channel available
2	2	No channel unit available
2	3	Analog data equipment not available
2	4	Digital data equipment not available
3	1	Credit card number rejected
3	2	Invalid/incomplete address
4	1	Destination out of service
4	2	AES not authorized
4	3	Incoming calls barred
5	1	Continuity failure
6	1	Credit card type not supported
6	2	Req'd analog data rate not supported
6	3	Req'd digital data rate not supported
6	4	Voice channel type not supported
6	5	Service type not supported
7	1	User busy
7	2	Unassigned (unallocated) number
7	3	AES absent
7	4	Spot beam handover
7	15	Undefined cause

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

Cabin Calls

	000_b	Disable (command) or Disabled (status)
	001_b	Enable (command) or Enabled (status)
	010_b - 110_b	Spare
	111_b	Function not supported (status only)

Cabin Calls Disable Support

	0_b	Cabin calls disable functionality not supported
	1_b	Cabin calls disable functionality is supported

Call Lt Act

Call light activation:	0_b	Call light on at call connection
	1_b	Call light on at call initiation

Note: This bit is an echo of SDU pin TP10K.

Category	00_b	SDU phone directory category 4 (typically Public)
	01_b	SDU phone directory category 1 (typically Urgent/Distress/Emergency)
	10_b	SDU phone directory category 2 (typically Flight Safety)
	11_b	SDU phone directory category 3 (typically Other Safety)

Cause Class See C.

Cause Value See C.

Ch or Chan

Channel Number:	0_b	AMS Channel No. 2
	1_b	AMS Channel No. 1

Chan 1/2 Rsvd

Resources reserved for AMS channel 1 (or 2):

	0_b	Not reserved
	1_b	Reserved

Note: These bits (for channels 1 and 2) are echoes of the respective ORT item (similar to A741P2 4.5.2.3 item g).

Chan 1/2 Wired

AMS channel 1 (or 2) wired to the SDU:

	0_b	Not wired
	1_b	Wired

Note: These bits (for channels 1 and 2) are an echo of SDU pins TP13F and TP13H, respectively.

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

Channel Status

0_h	Not wired
1_h	Not available
2_h	No resources
3_h	Available
4_h	Dialing
5_h	Connected
6_h	(Status code reserved)
7_h	Camped on (w/ preempt)
8_h	Camped on (w/o preempt)
9_h	Released
A_h	Incoming call
B_h - F_h	Spare

Applicable HMI prompts for the current channel status (per channel):

HMI Prompts > / Channel Status		Make Call	End Call	Preempt Call	Cancel Call	Answer Call	Reject Call
Not wired	0_h						
Not available	1_h						
No resources	2_h	X					
Available	3_h	X					
Dialing	4_h		X				
Connected	5_h		X				
(Status code reserved)	6_h						
Camped with preempt	7_h			X	X		
Camped w/o preempt	8_h				X		
Released	9_h						
Incoming call	A_h					X	X
Spare	B_h-F_h						

In configurations that do not use camp-on, the camped-on states shown above are not indicated, even if, e.g., the SDU implementation involves a state machine with a camped-on state but with immediate timeout and preemption. In such configurations, the indicated channel status transitions from No Resources to Dialing.

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

Chime Activation

Chime activation for air-to-ground calls:

00_b	Always
01_b	Only after a camp-on
10_b	Never
11_b	Spare

Note: These bits are an echo of the respective ORT item (A741P2 4.5.2.3 item n).

Class

Current log-on class:	000_b	Not logged on
	001_b	Class 1 (LGA only; packet-mode data only)
	010_b	Class 2 (HGA or IGA; circuit-mode only)
	011_b	Class 3 (HGA or IGA; circuit- and packet-mode)
	100_b	Class 4 (HGA or IGA; packet-mode data only)
Cockpit Voice Fault	0_h	OK
	1_h	Failure (complete loss of cockpit voice services)

Data Requested

00000000_b	Not Used
$XXXXXXX1_b$	Channel status (for channels 1 and 2)
$XXXXXX1X_b$	Log-on status
$XXXXX1XX_b$	Configuration data
$XXXX1XXX_b$	ICAO address
$XXX1XXXX_b$	Sat/GES data (all satellites and GESs)
$XX1XXXXX_b$	Phone directory (all priorities)
$X1XXXXXX_b$	Cabin calls status
$1XXXXXXX_b$	Spare

Digit

Phone number characters:	0 to 9	Four-bits binary coded decimal (0000_b - 1001_b)
	Spare	1010_b
	Spare	1011_b
	.	1100_b (dot visual number separator)
	-	1101_b (dash visual number separator)
		1110_b (space visual number separator)
	Last Digit	1111_b (all Digit fields following the last digit are set to the Last Digit state)

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

Elevation		
Current aircraft-relative antenna elevation steering angle:		
	± 90	Binary coding LSB = 1 degree MSB = sign (0 = positive [upward in normal flight])
Entry Name Character	00_h - $7E_h$	ISO alphabet #5 character set (NUL and printable characters).
Flight ID Character	00_h - $7E_h$	ISO alphabet #5 character set (NUL and printable characters).
GES ID		
GES Identity:	00_h	Invalid
	01_h to FE_h	As per Inmarsat definition
	FF_h	Invalid specific GES ID; used for don't care
GES Name Character	00_h - $7E_h$	ISO alphabet #5 character set (NUL and printable characters).
Inactive Bus SDU [#1 or 2]	0_h	Bus active
	1_h	Bus inactive

Note: The inactive bus state indicates that no label 270 status words are being received on the respective input bus. Bits are only ever set for buses that are positively indicated as being wired, per the WSC's pertinent standard.

Inactive Bus WSC [#1, 2 or 3]		
	0_h	Bus active
	1_h	Bus inactive

Note: The inactive bus state indicates that no label 270 status words are being received on the respective input bus. Bits are only ever set for buses that are positively indicated as being wired, i.e., for the SDU, per its system configuration pins TP12J, TP12K and TP13E

IVN		
Interface version number:	0_h	Initial version
	1_h - F_h	Spare

L

SLCV location of cause:

For S = Q.931:

0_h	User
1_h	Private network serving the local user
2_h	Public network serving the local user
3_h	Transit network
4_h	Public network serving the remote user
5_h	Private network serving the remote user
7_h	Intermediate network
A_h	Network beyond interworking point
All others	Reserved

For S = satellite-network-specific:

1_h	AES - user network side
2_h	AES - satellite network side
3_h	GES - satellite network side
4_h	GES - fixed network side
5_h	NCMS
6_h	Interworking with the PSTN
All others	Spare with respect to Inmarsat

Location See L

Log Cmd

Log Command:

00_b	Log Off
01_b	Log On – Manual (constrained to designated GES)
10_b	Log On – Automatic sat/GES selection
11_b	Spare

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

Log-on Status

	0_h	Logged off
	1_h	Logged off – rejected
	2_h	Logged off – inop
	3_h	Logging off
	4_h	Logging on – auto
	5_h	Logging on – manual
	6_h	Logging on -- inop – auto
	7_h	Logging on -- inop – manual
	8_h	Logged on – auto
	9_h	Logged on – manual
	A_h	SDU calibrating
	B_h - F_h	Spare
Master/Slave	0h	Master (including sole SDU in a single system)
	1_h	Slave

Network ID

Network Identity:	CODE	FUNCTION
	0	Reserved
	1	E164/E163 (PSTN)
	2	X.121
	3	F.69
	4	Private Network - No Address following
	5	Private Network - Address following
	6 to 15	To be coded for applicable public and private networks (SITA, ARINC, etc.)

No. Pre-select

AMS phone number pre-select:

	0_b	Disabled
	1_b	Enabled

Note: This bit is an echo of the respective ORT item (A741P2 4.5.2.3 item l).

Pad

These are unused bits that have been strategically located for possible future growth in the adjacent signal elements. Pad bits are set to 0.

Priority

Call Priority:	00_b	Priority 4 (Public)
	01_b	Priority 1 (Urgent/Distress/Emergency)
	10_b	Priority 2 (Flight Safety)
	11_b	Priority 3 (Other Safety)

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

Pri 4 Calls

Priority 4 calls to/from cockpit:

	0_b	Disabled
	1_b	Enabled

Note: This bit is an echo of SDU pin TP13A.

S		
SLCV coding standard:	0_b	CCITT/ITU Q.931 standard coding
	1_b	Satellite-network-specific coding
SAL		
System address label:	000o - 377o	Assigned as per ARINC 429P1 Attachment 11.
Sat ID		
Satellite Identity:	00_h	AOR-W
	01_h	AOR-E
	02_h	POR
	03_h	IOR
	04_h - $3E_h$	Spare
	$3F_h$	Null value
Sat Name Character	00_h - $7E_h$	ISO alphabet #5 character set (NUL and printable characters).
S/G		
Spot/Global Beam:	0_b	System is not currently in a spot beam
	1_b	System is currently in a spot beam

SLCV

Standard/Location/Class/Value release code:

	0_h - $1F7F_h$	See S, L, C and V.

Sp or Spare

These are unused bits that can be used for future applications. Spare bits are set to 0.

SQI

Signal Quality Index 0 to 255

Note: 0 represents worst signal quality; 255 represents best.

SSM		
Sign Status Matrix:	00	Normal Operation
	01	No Computed Data
	10	Functional Test
	11	Failure Warning

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

Standard	See S.	
Tel Cmd Type		
Telephony command type:	0_h	End call
	1_h	Preempt call
	2_h	Cancel camp-on
	3_h	Answer call
	4_h	Reject call
	5_h - F_h	Spare
Transit Calls	0_b	Disabled
	1_b	Enabled

Note: This bit is an echo of the respective ORT item.

Transit GES ID		
Transit GES identity:	01_h to FE_h	Explicit identity of the GES to be used for the transit call
	FF_h	Use the log-on GES (no transit call) unless other arrangements pertain (e.g., an ORT option)
Value	See C	
V		
SLCV cause value:	See C	
WSC Type		
Connected type of WSC:	0_h	Spare
	1_h	Honeywell
	2_h	Airbus RMP
	3_h - F_h	Spare

6 WSCI Protocol Operational Processes

This section describes the WSCI protocol processes. In ITU Q.931 terminology, the WSCI protocol function would be referred to as the Network side in the SDU and as the User side in the WSC. The User and Network sides interface to other functions within their respective unit or system using primitives.

User side input primitives originate from pilot selections at the WSC. User side output primitives drive WSC display updates.

Network side input primitives originate from other call processing functional areas within the SDU and from the Mic On or Place/End Call discrete inputs. Network side output primitives are sent to those same SDU functional areas and to Call Light and Chime discrete outputs.

As an example, pilot selection of call functions at the WSC would represent input primitives to the User side. These input primitives are translated into the WSCI protocol by the User side for communication to the Network side. The Network side translates the data received from the User side into output primitives to the satcom functions responsible for resource selection and call establishment.

Figures 2F-42.1-1A through 1I contain specification and description language (SDL) diagrams specific to the Network side (SDU); Figures 2F-42.1-2A through 2K contain User side (WSC) diagrams; and Figures 2F-42.1-3A through 3E contain example sequence diagrams depicting end-to-end call processes. Note that these diagrams are provided for general guidance; they do not necessarily cover every possible condition, nor are they intended to restrict the implementation in neither the SDU nor the WSC to the exact details shown.

6.1 Initialization Process

For the SDU: Upon SDU power up or reset, the SDU starts periodic broadcast of label 172 subsystem identifier words (for MCDU compatibility) and reads system configuration pin TP10H. If TP10H indicates WSC(s) connected, the SDU starts periodic broadcast of its label 270, 271 and 272 status words, and begins monitoring its input(s) for WSC label 270 status words. Upon receipt of WSC label 270 words, the SDU determines the type of WSC equipment connected and checks the WSC's Williamsburg status (Active or Standby). If Active, the SDU may then initiate the Williamsburg ALO/ALR process, using the appropriate SAL (as inferred from the WSC type and number, <u>not</u> from any label 172 words from the WSC). (Either side may initiate ALO; however, if it is initiated by either side, the receiving side must respond with ALR, as per ARINC 429. This includes the case of the SDU responding to the WSC even if the WSC is indicating Williamsburg Standby.) The SDU enters the null state after successful completion of ALO/ALR.

COMMENTARY

Once in the null state, the SDU is enabled for Williamsburg communications for the duration of the power cycle, even if the receipt of label 270 WSC status words should cease or if the WSC should indicate that its input bus from the SDU is inactive, or if WSC status words subsequently return or if the WSC indicates that its input bus from the SDU is once again active.

For the WSC: Upon WSC power up or reset, the WSC starts periodic broadcast of its label 270 status word while monitoring for the SDU label 270 status word. If SDU status words are received, the WSC checks the SDU Master/Slave status. If the SDU is the master (or the sole SDU in a single installation), the WSC may then initiate or respond to the ALO/ALR process. When the ALO/ALR process is successful, the WSC should request needed system data (Configuration Data, Sat/GES Data, etc.) from the SDU before entering the null state.

COMMENTARY

Some WSC types may implement additional (optional) initialization requirements, such as not indicating Williamsburg Active until after receiving indication of active input bus status in the SDU’s label 270 status words for the respective WSC.

6.1.1 Continuous Monitoring

Both the SDU and WSC continuously monitor the other side's label 270 periodic status word broadcasts. Loss of the status word after an appropriate failure confirmation period results in the SDU raising an SDU inactive input bus from WSCx failure (where x = 1, 2 or 3, as appropriate). Status word bits are controlled and processed in accordance with their individual definitions (e.g., Inactive Bus SDU1 bits set in WSC status words for appropriate failure confirmation period results in SDU #1 raising a WSC inactive input bus from SDU1 failure).

6.2 Call Manager Processes

This section describes the processes required to establish, manage and clear cockpit voice calls.

During any call manager process, the SDU responds with the current channel status for both channels upon receipt of an invalid or unrecognized message, whereas the WSC ignores such messages.

6.2.1 Outgoing Call Process

Outgoing calls may be initiated by either of two actions: (1) receipt from the WSC of an Initiate Call message, or (2) detection of a transition from non-asserted to the asserted state of the Mic On discrete or Place/End discrete (as per the state of SDU system configuration pin TP13K). As with SCDUs, case 2 requires SDU ORT item L (reference ARINC 741P2 Section 4.5.2.3) to be set to the pre-select phone number state. Case 2 requires that the SDU contain a stored number, which is normally conveyed from the WSC in a Pre-Select Call Parameters message. If a Pre-Select Call Parameters message does not precede a discrete activation, but an Initiate Call message has occurred, a call will be initiated to the phone number received in the most recent Initiate Call message (i.e., last number redial). If there is no phone number pre-selection and a discrete is activated, a Channel Status message is sent to the WSC with an appropriate SLCV code, and an appropriate voice message is played on the corresponding audio channel. Case 1 may optionally start a timer T1 for message retransmission if not acknowledged before timer expiry.

Upon receiving an Initiate Call message or a discrete transition, the SDU validates the call information, and if call resources are available, responds with a Channel Status message indicating dialing. For the case of an Initiate Call message, the commanded call data is stored in a buffer for possible later use for last number redial. If the call information is valid but insufficient resources exist to support a call, a camp on channel status is reported. If the call information is invalid or some other reason causes the call attempt to fail, a release channel status is reported that contains an SLCV code indicating the reason for the termination.

Upon receiving a channel status message, the WSC stops timer T1 (if used) and waits for further status changes or call termination events.

If the WSC receives a status change to dialing, it informs the HMI and optionally starts the Await Call Connect timer T2. Upon receiving a status change to connected, the WSC indicates it to the HMI, stops timer T2 (if used), and each side enters the active call state.

If, after call initiation, a camp-on status is received, the WSC informs the HMI of the type of camp-on and waits for further status changes or call termination events.

Two camp-on conditions can exist: one where resources could be made available with preemption (camped on with preempt), and one where preemption could not make sufficient resources available (camped on without preempt). The type of camp-on may change while in the camp-on state.

ORT item j determines whether a camp-on should last indefinitely (as long as necessary) or only until timeout of a camp-on timer. For the latter case, ORT item j also specifies the duration of the camp-on timer (which includes an option for immediate timeout). Upon timeout, the action to be taken by the SDU can be to either preempt (if possible) or cancel the camp-on.

If resources become available while camped-on, channel status changes to dialing. If preemption is offered, the WSC can preempt, or a higher priority incoming call can preempt the camped-on call. The WSC may also cancel the camp-on.

6.2.2 Incoming Call Process

When an incoming call is received by the SDU, a channel status message is transmitted to the WSC indicating incoming call, and timer T1 is started.

COMMENTARY

> During the dynamics of allocating resources for an incoming call, the SDU may momentarily indicate no resources (for a new call) just prior to the indication of incoming call. It may be desirable for the WSC to filter out any indication of this transient channel status state on the HMI.

Upon receiving the incoming call channel status message, the WSC responds with an Acknowledge message to the SDU and indicates the incoming call on the HMI.

Upon receipt of the Acknowledge message, the SDU stops timer T1 and waits for an answer or termination event.

The call may be answered by receipt of an Answer Call message from the WSC or by a Mic On discrete transition from non-asserted to the asserted state. The former case may optionally start a timer T1 for message retransmission at timer expiry.

Upon receiving an Answer Call message or discrete transition, the SDU sends a connected channel status message to the WSC and enters the active state.

Upon receiving a connected channel status message, the WSC indicates the condition to the HMI and enters the active state.

6.2.3 Call Clearing Process

A call may be cleared (terminated) by the WSC with the End Call or Reject messages (in response to actions at the HMI) by a transition of the Mic On discrete from the asserted state to the non-asserted state, or by activation of the Place/End Call discrete, to which the SDU responds with a released channel status. The SDU may unilaterally terminate a call using a release channel status message. Regardless of the means by which a call is terminated, the SDU indicates the termination with a release channel status message (with no other intervening channel status message, such as no resources or available).

6.2.4 Timers

Timer	Description	Value, sec
T1	Command Acknowledgement Timer	1.0
T2	Await Call Connect Timer (Inmarsat TA28=10s)	15.0

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

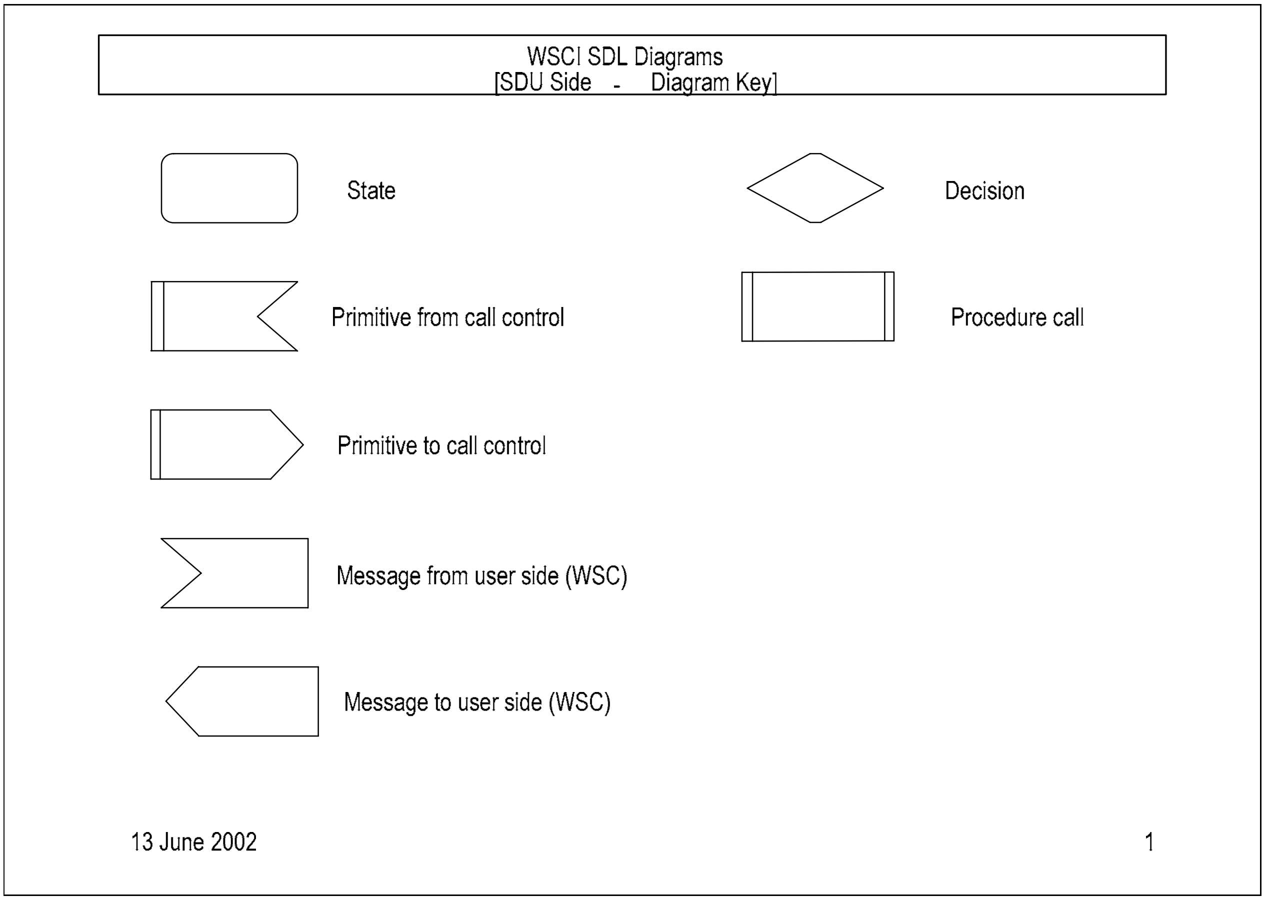

Figure 2F-42.1-1A – WSCI SDL Diagram
[SDU Side–Diagram Key]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

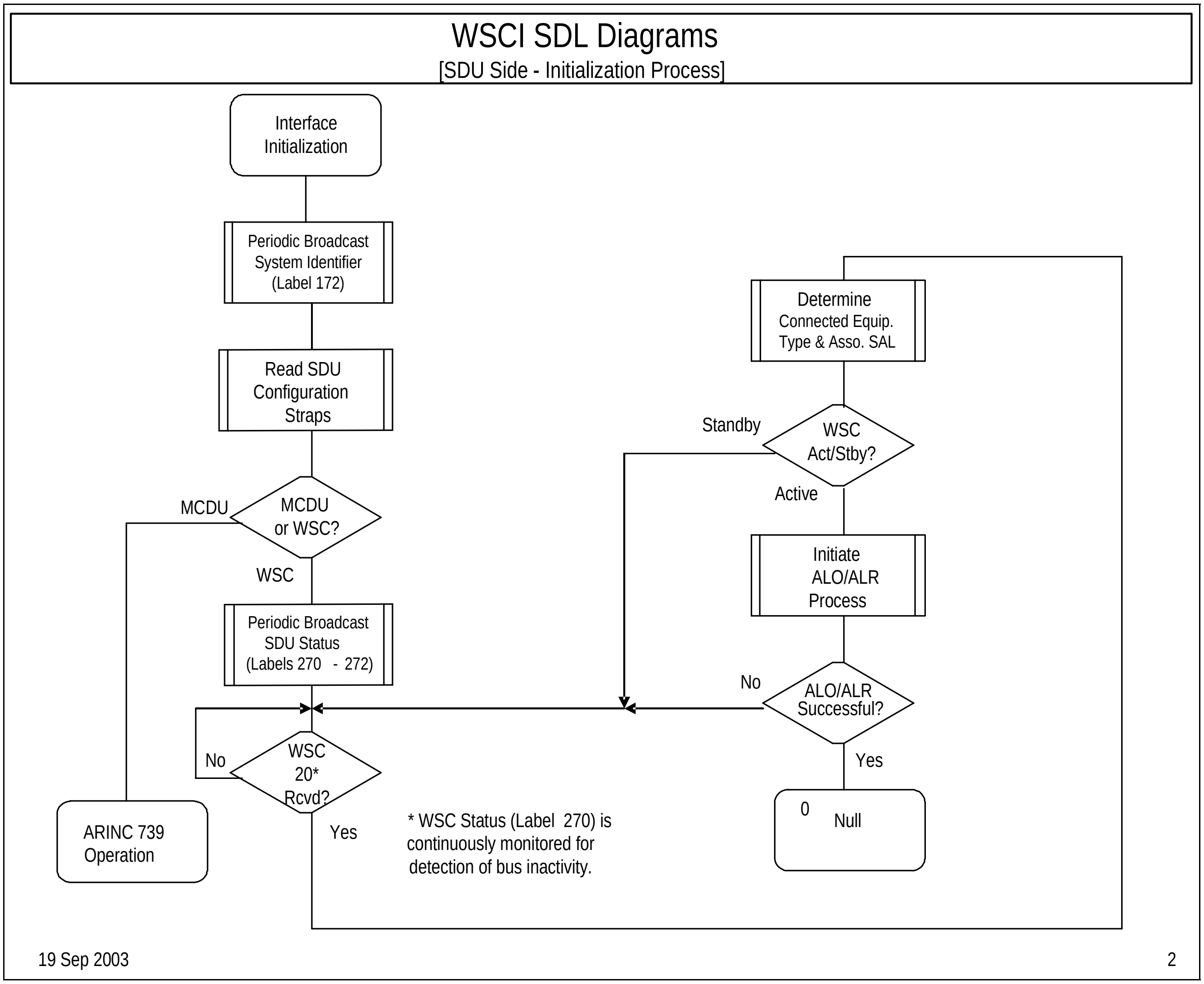

Figure 2F-42.1-1B – WSCI SDL Diagram
[SDU Side-Initialization Process]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

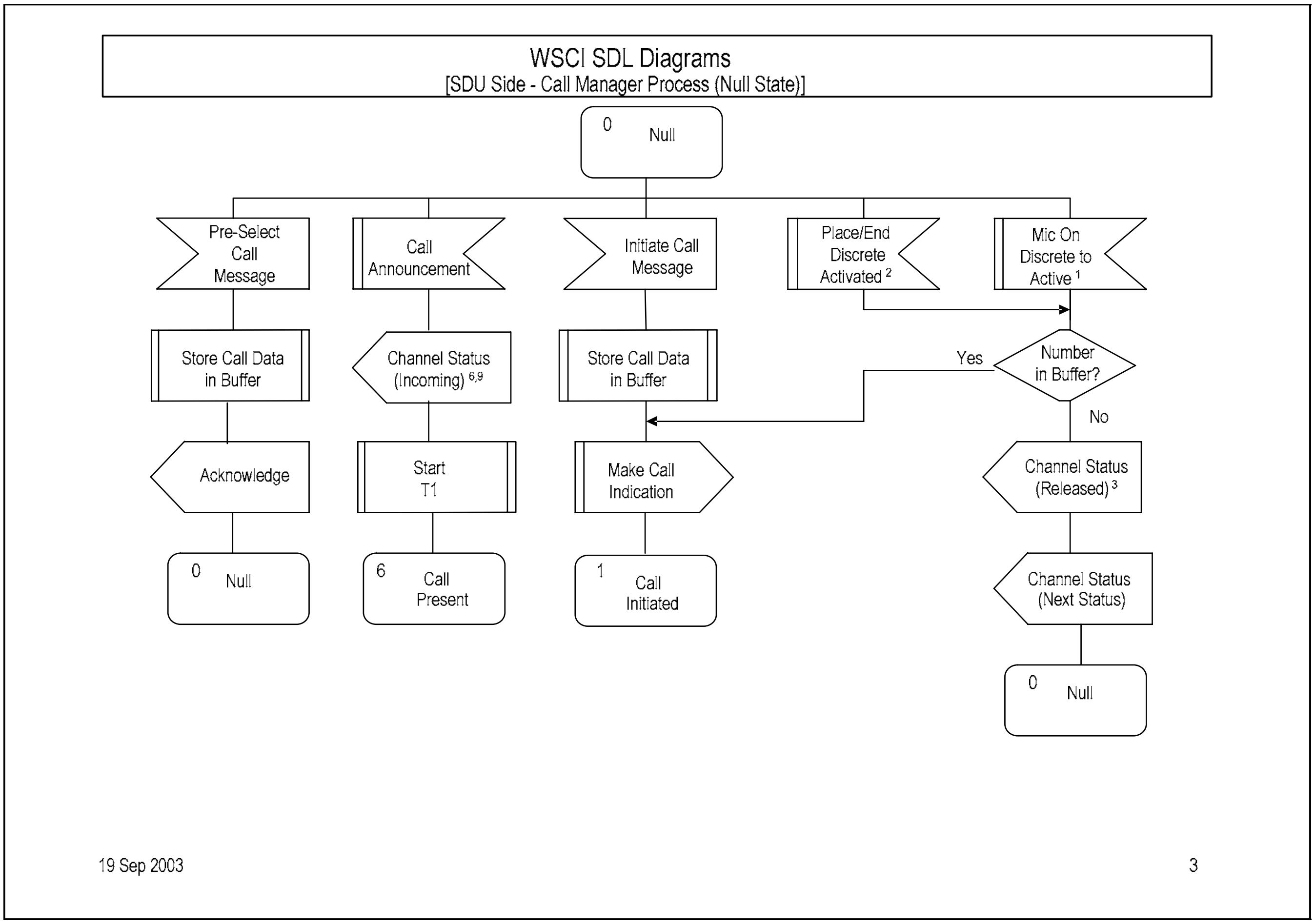

Figure 2F-42.1-1C – WSCI SDL Diagram
[SDU Side-Call Manager Process (Null State)]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

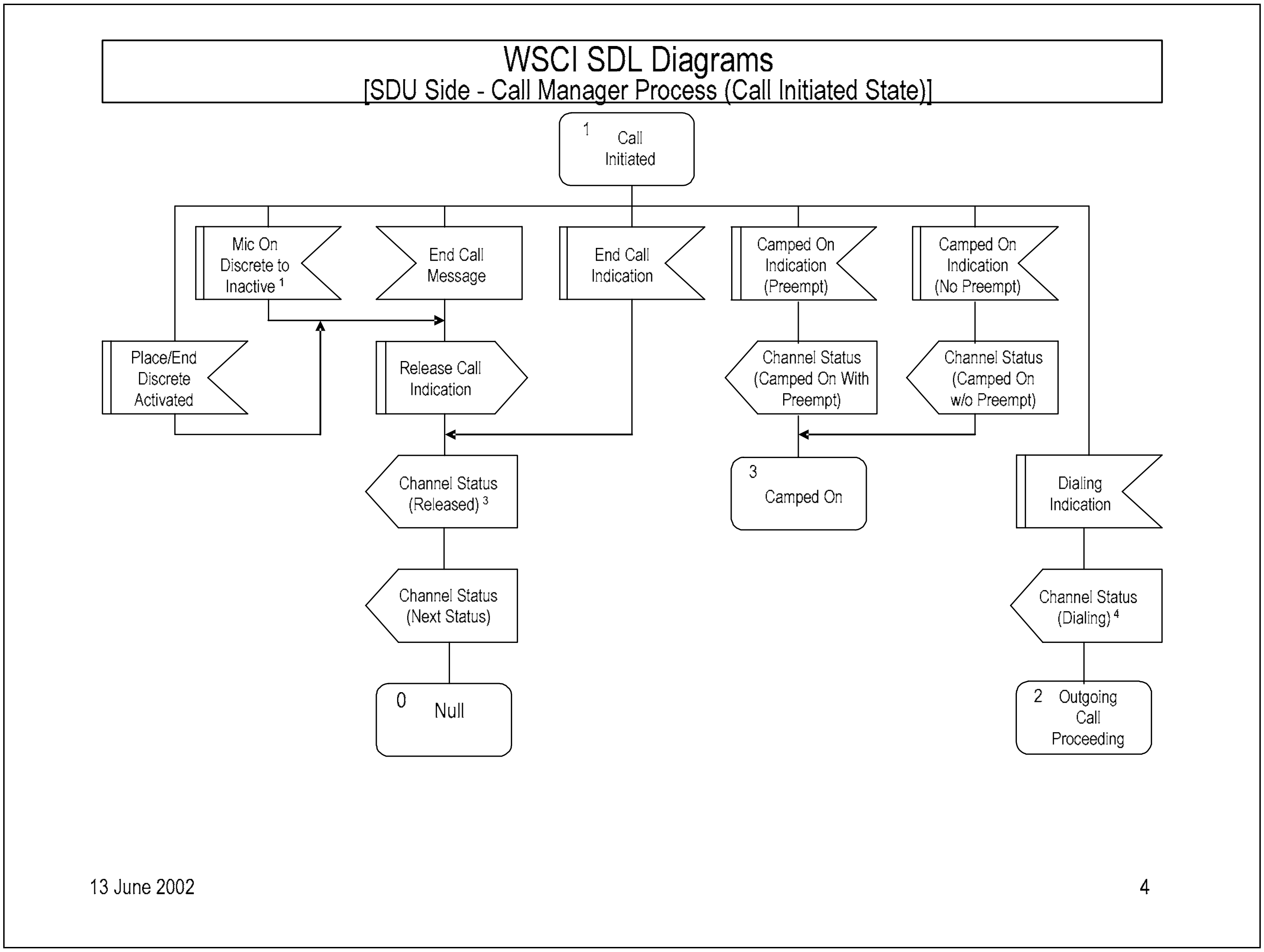

Figure 2F-42.1-1D – WSCI SDL Diagram
[SDU Side-Call Manager Process (Call Initiated State)]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

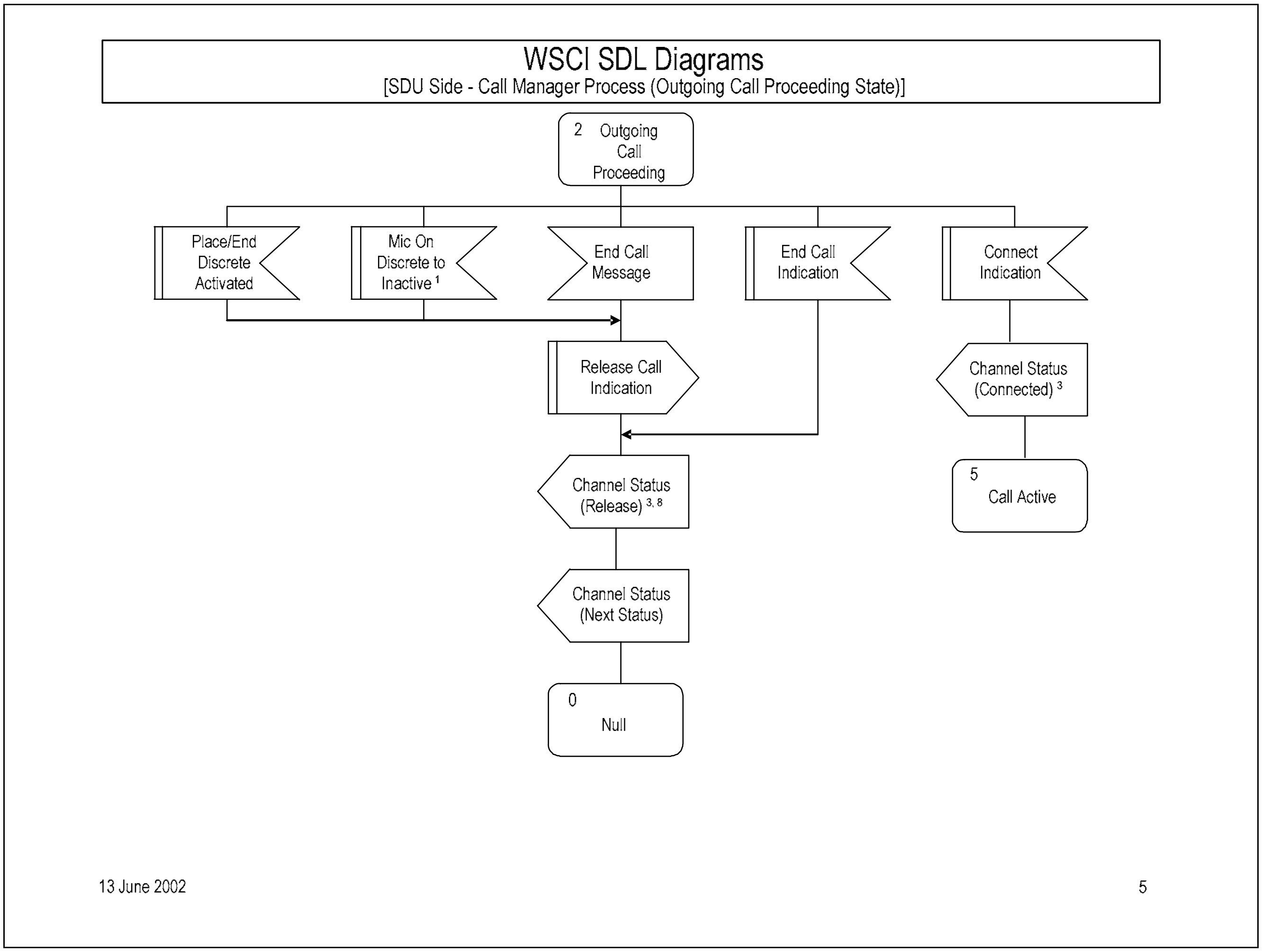

Figure 2F-42.1-1E – WSCI SDL Diagram
[SDU Side-Call Manager Process (Outgoing Call Proceeding State)]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

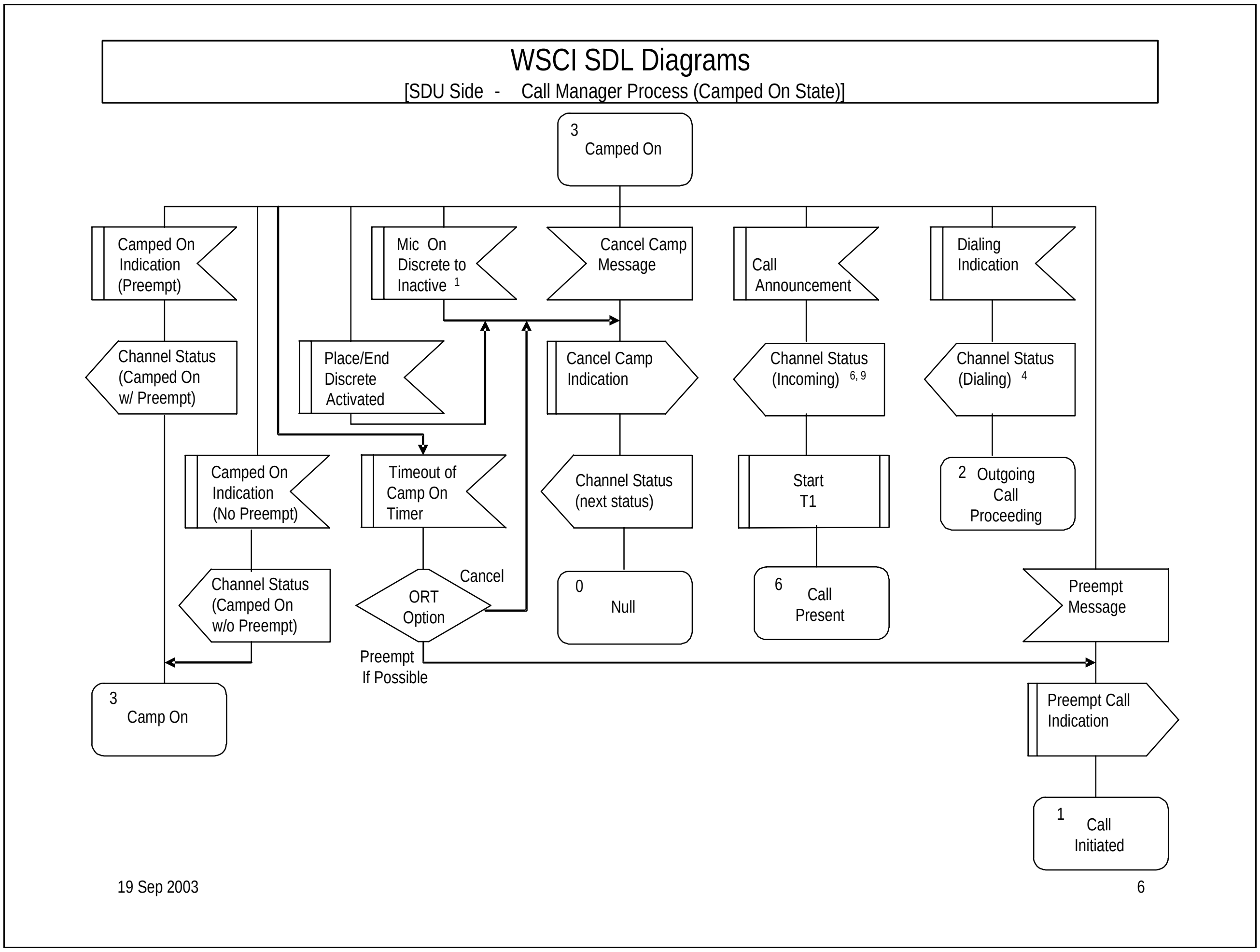

Figure 2F-42.1-1F – WSCI SDL Diagram
[SDU Side-Call Manager Process (Camped On State)]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

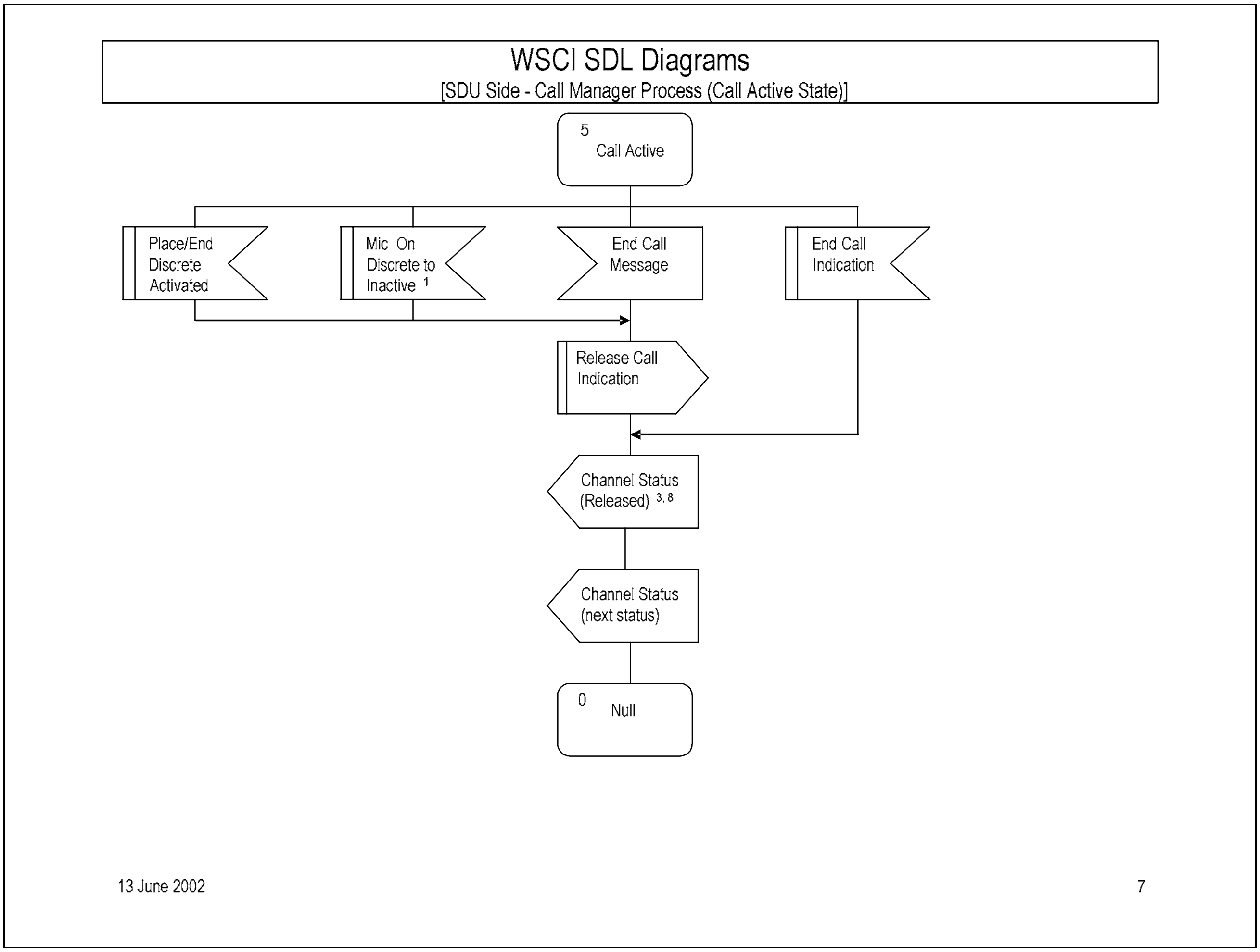

Figure 2F-42.1-1G – WSCI SDL Diagram
[SDU Side-Call Manager Process (Call Active State)]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

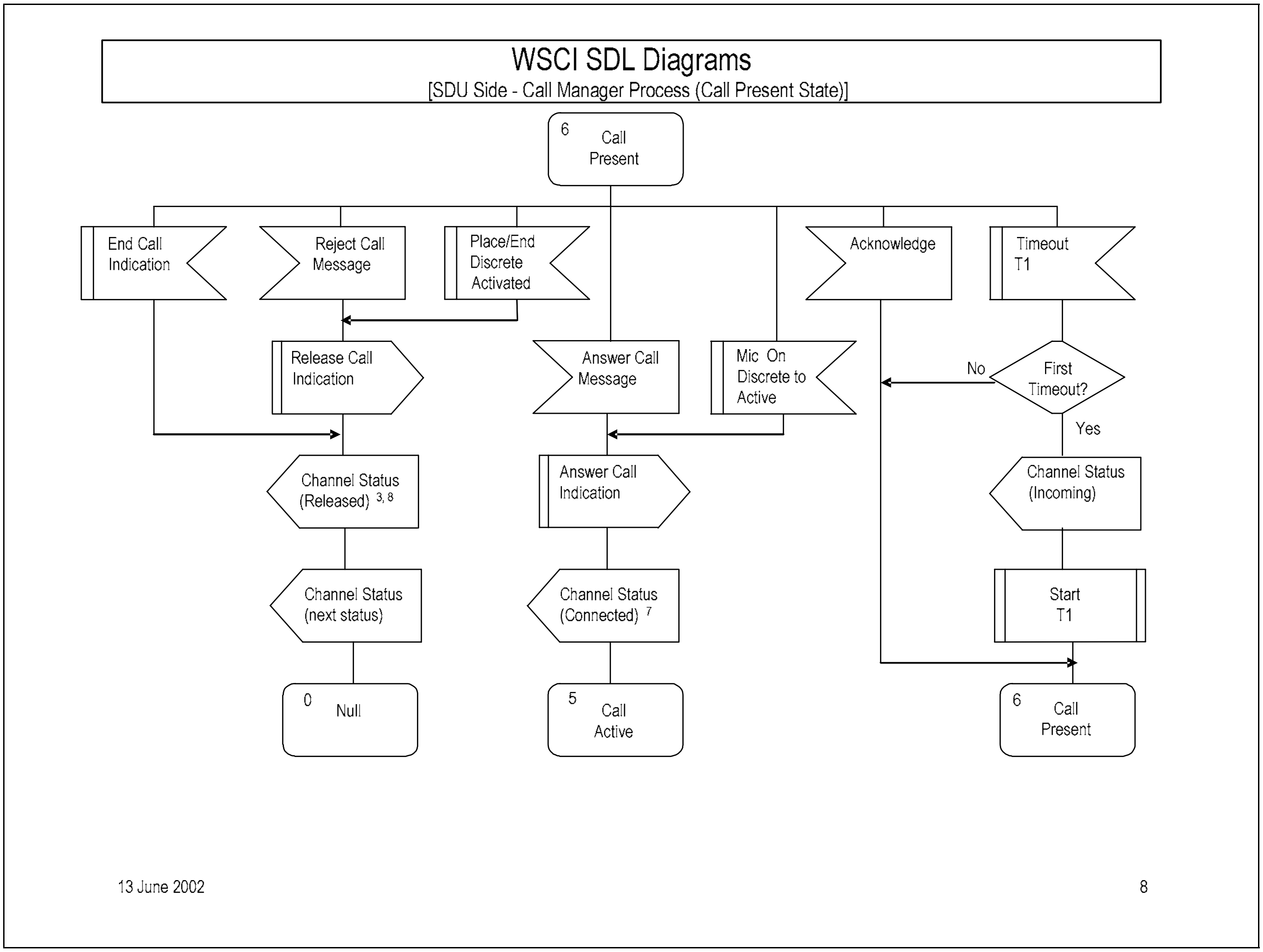

Figure 2F-42.1-1H – WSCI SDL Diagram
[SDU Side-Call Manager Process (Call Present State)]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

WSCI SDL Diagrams
[SDU Side - Note Summary]

Notes
(1) SDU must be strapped for “Latched ACP” hookswitch operation (TP13K=0), ORT items l and o are N/A.
(2) SDU must be strapped for “Switched PTT” hookswitch operation (TP13K=1), ORT items l and o are N/A.
(3) This status is held until any and all SDU generated voice messages are played.
(4) If SDU configuration strap TP10K=0, activate Call Light discrete.
(5) If SDU configuration strap TP10K=1, activate Call Light discrete.
(6) Call Light and Chime discretes activated.
(7) Call Light discrete steady (if flashing), chime off (if repeating).
(8) Call Light discrete off and Chime off (if repeating).
(9) During the dynamics of allocating resources for an incoming call, it is possible for the SDU to momentarily indicate channel status “No Resources” (for a new call) before indicating “Incoming”. It may be desirable for the WSC to filter out any indication of this transient state on the HMI.

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Figure 2F-42.1-1I – WSCI SDL Diagram [SDU Side-Note Summary]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

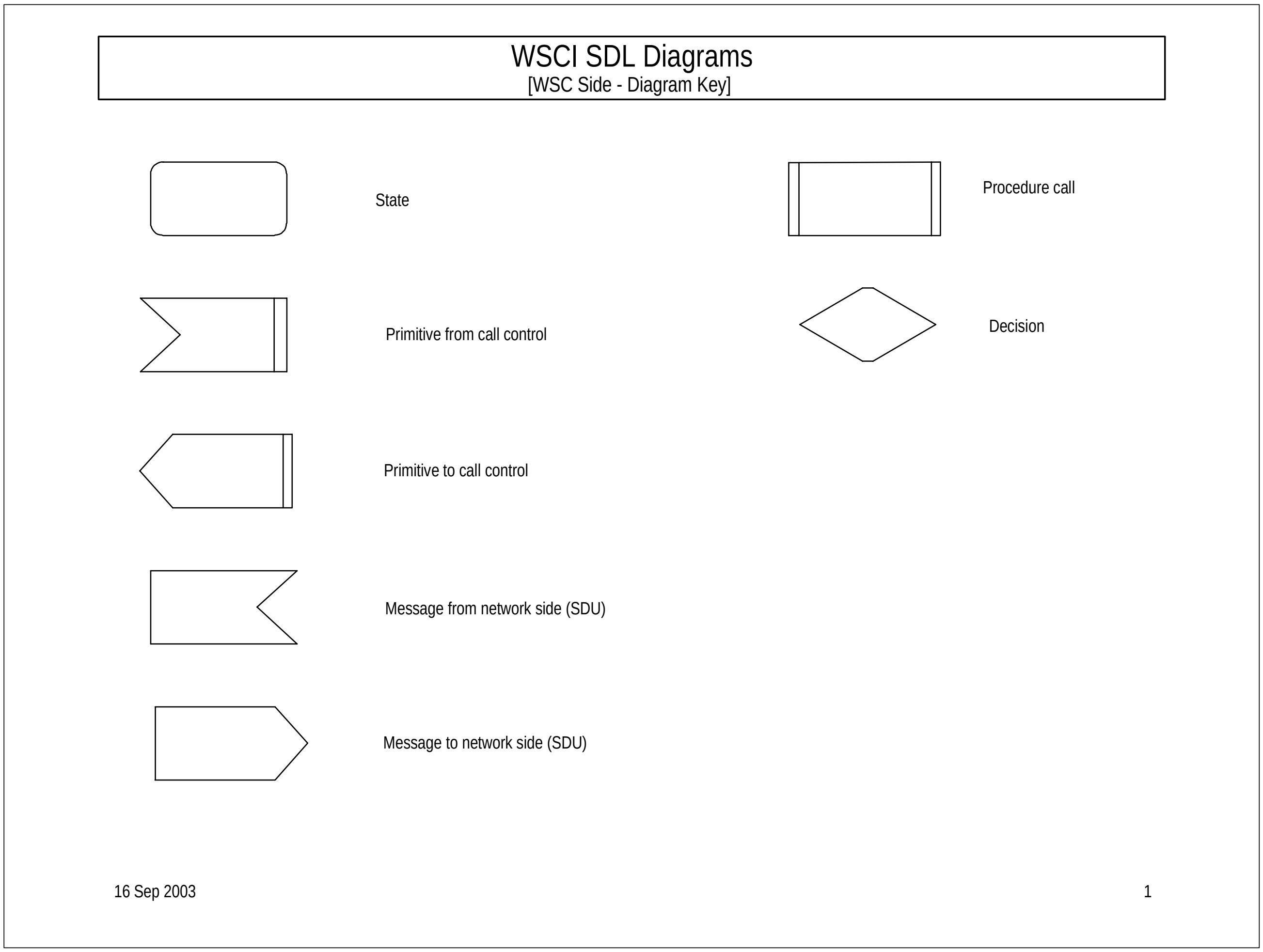

Figure 2F-42.1-2A – WSCI SDL Diagram
[WSC Side-Diagram Key]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

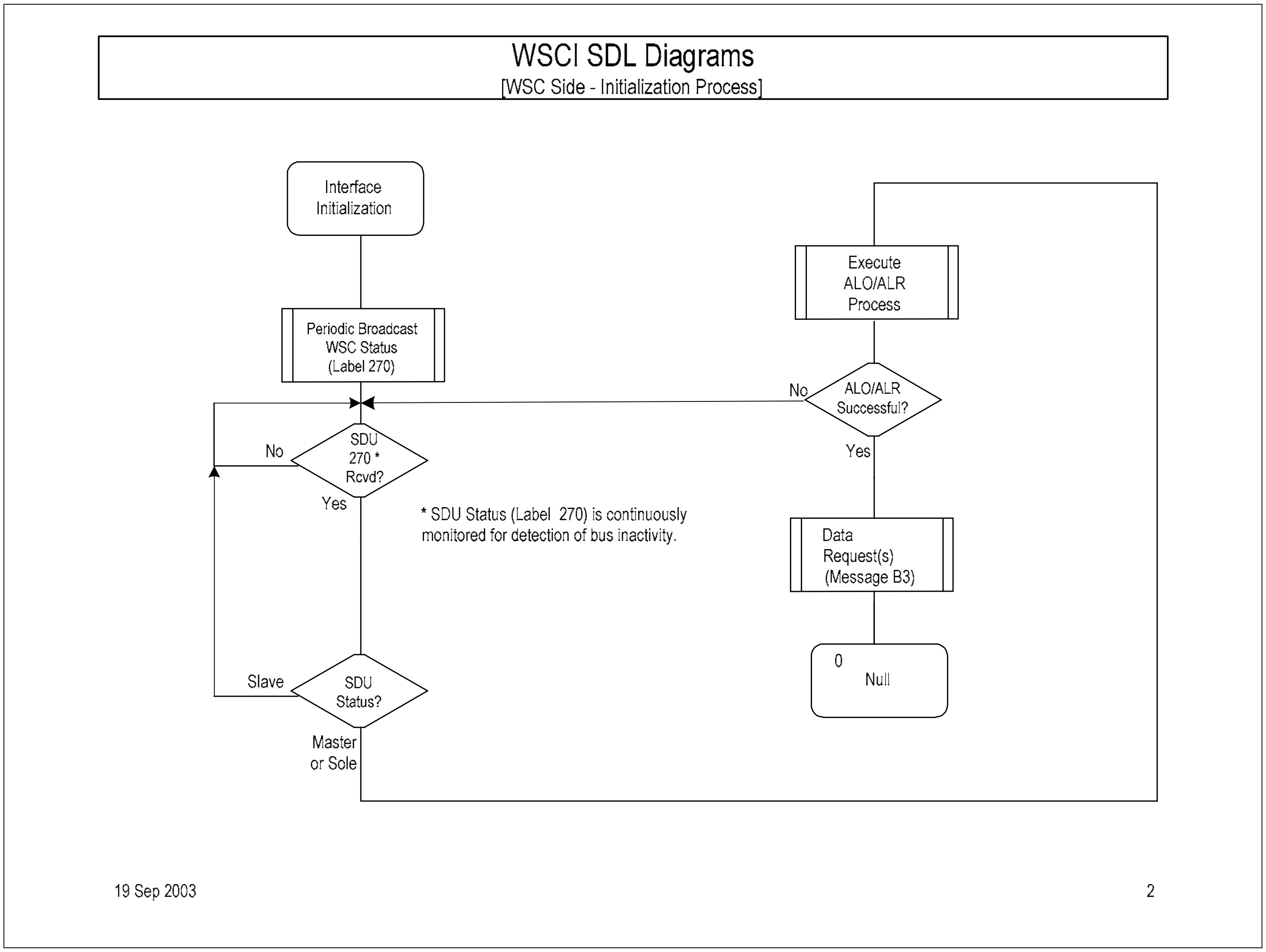

Figure 2F-42.1-2B – WSCI SDL Diagram
[WSC Side-Initialization Process]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

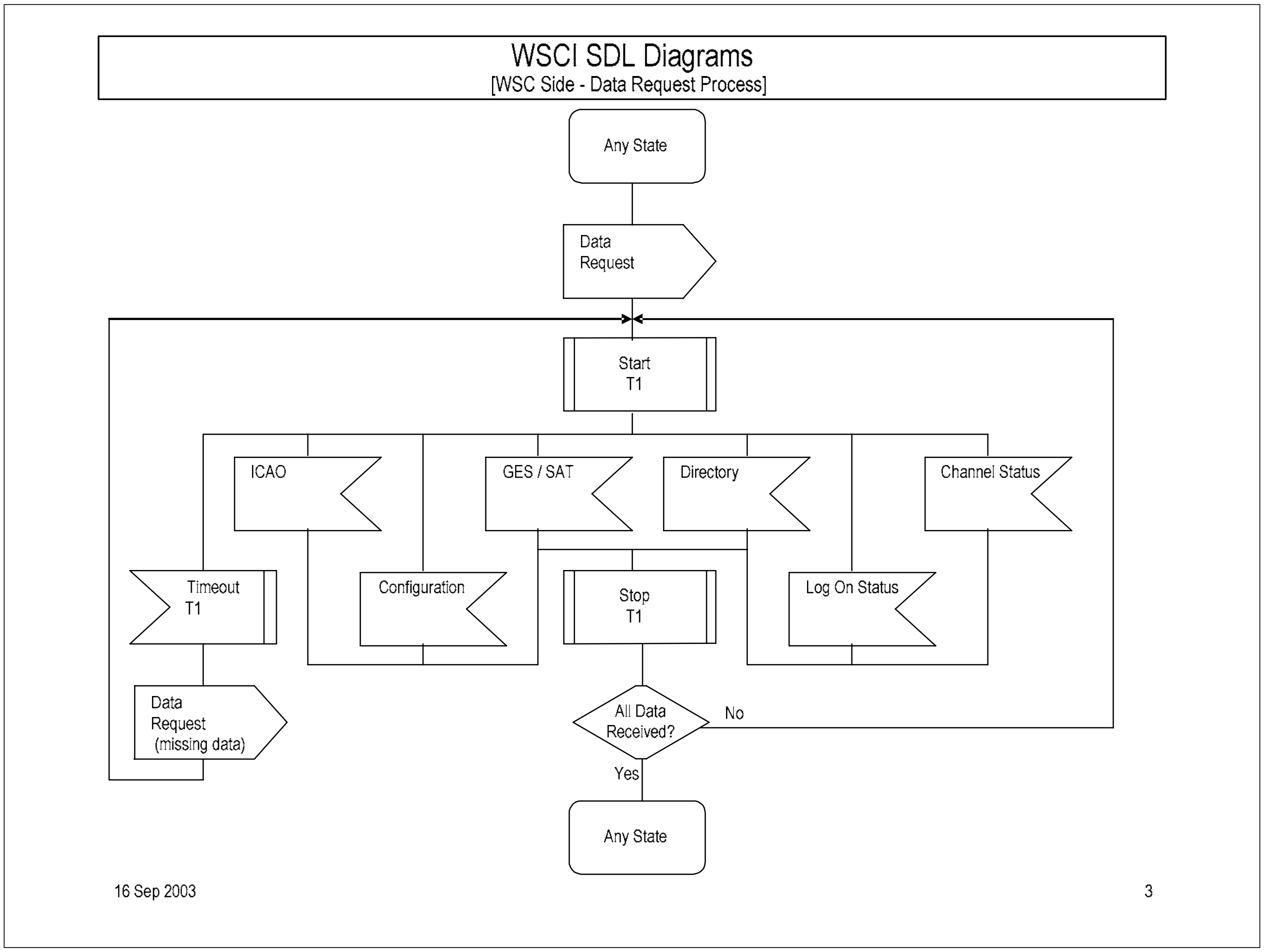

Figure 2F-42.1-2C – WSCI SDL Diagram [WSC Side-Data Request Process]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

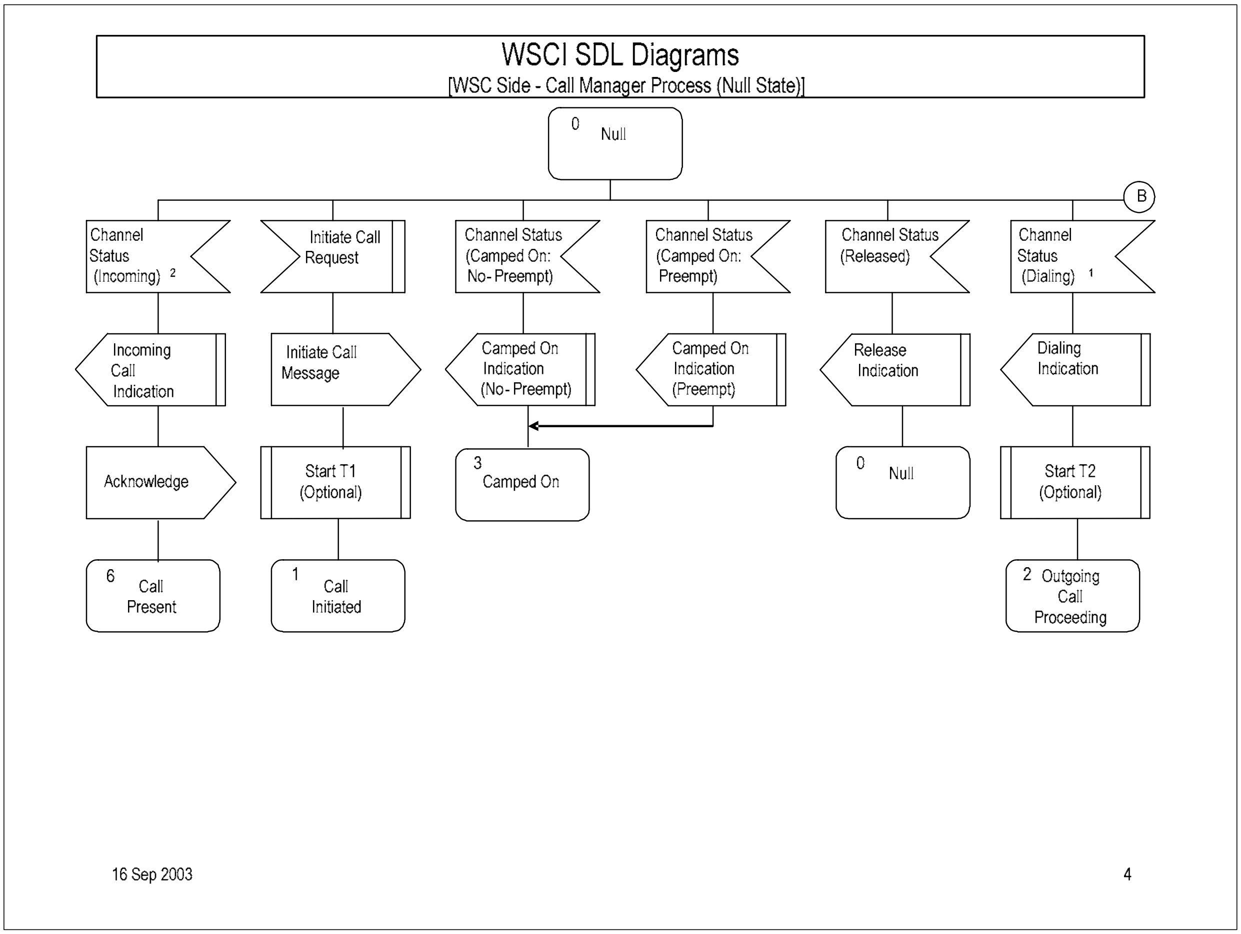

Figure 2F-42.1-2D – WSCI SDL Diagram
[WSC Side-Call Manager Process (Null State)]
1 of 2

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

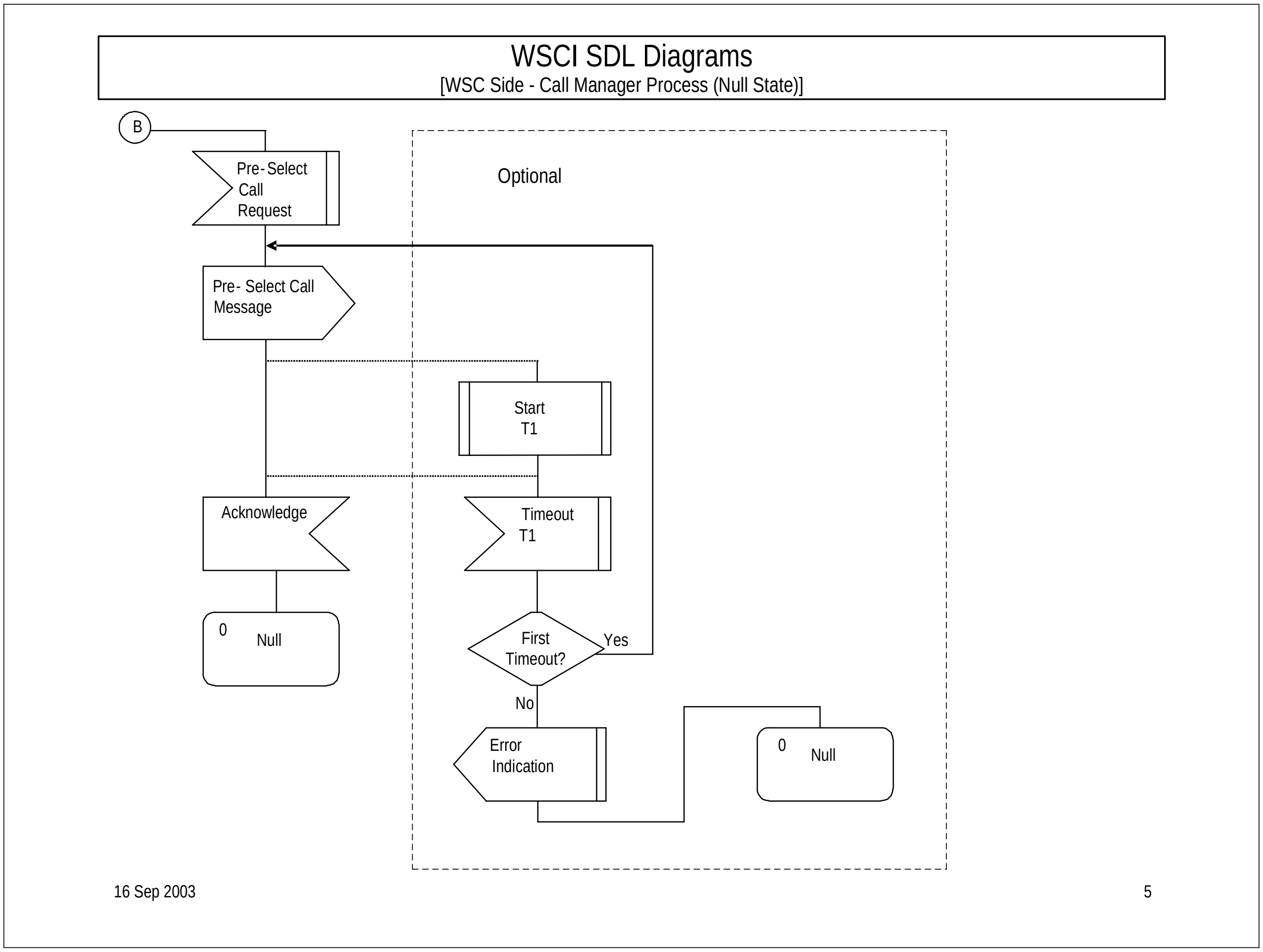

Figure 2F-42.1-2D – WSCI SDL Diagram
[WSC Side-Call Manager Process (Null State)]
2 of 2

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

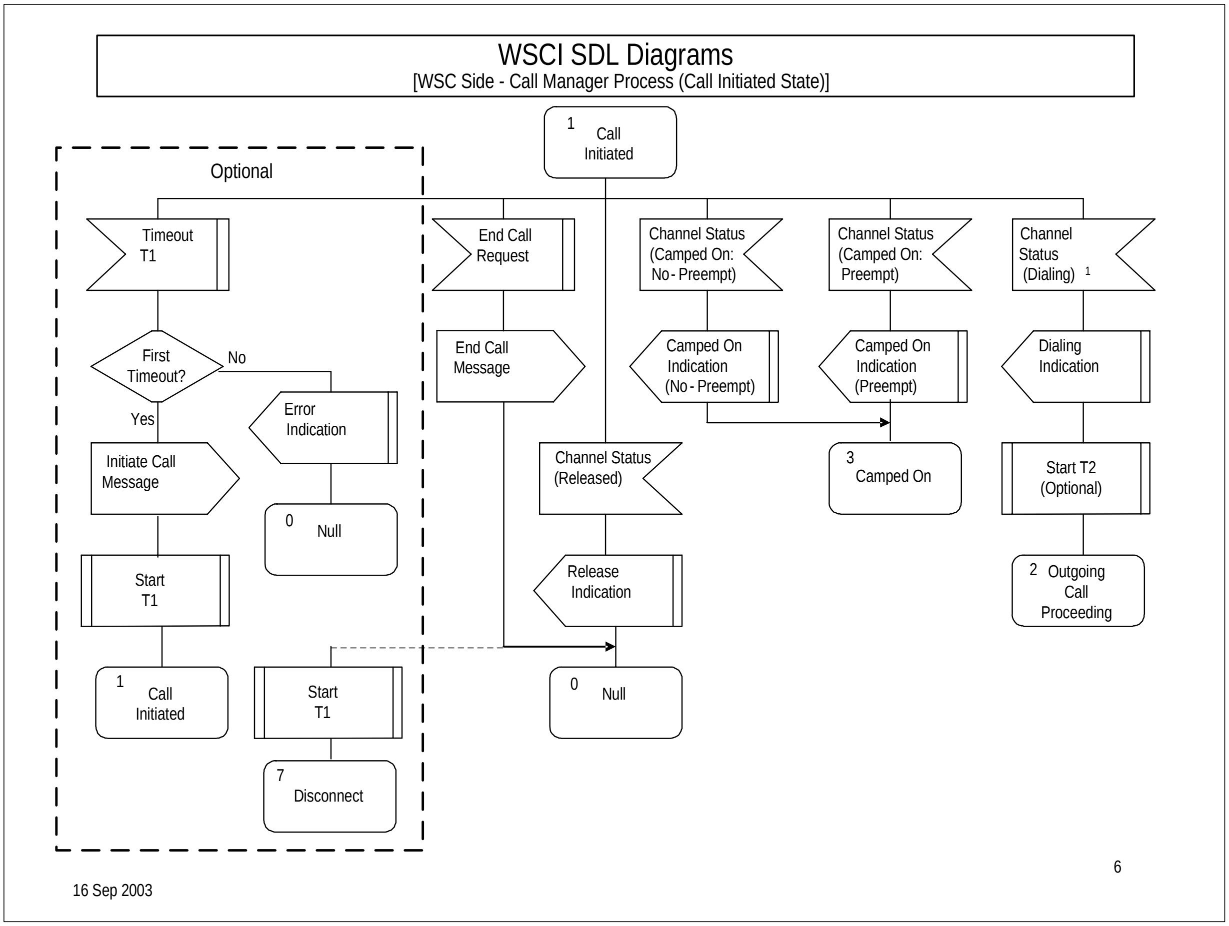

Figure 2F-42.1-2E – WSCI SDL Diagram
[WSC Side-Call Manager Process (Call Initiated State)]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

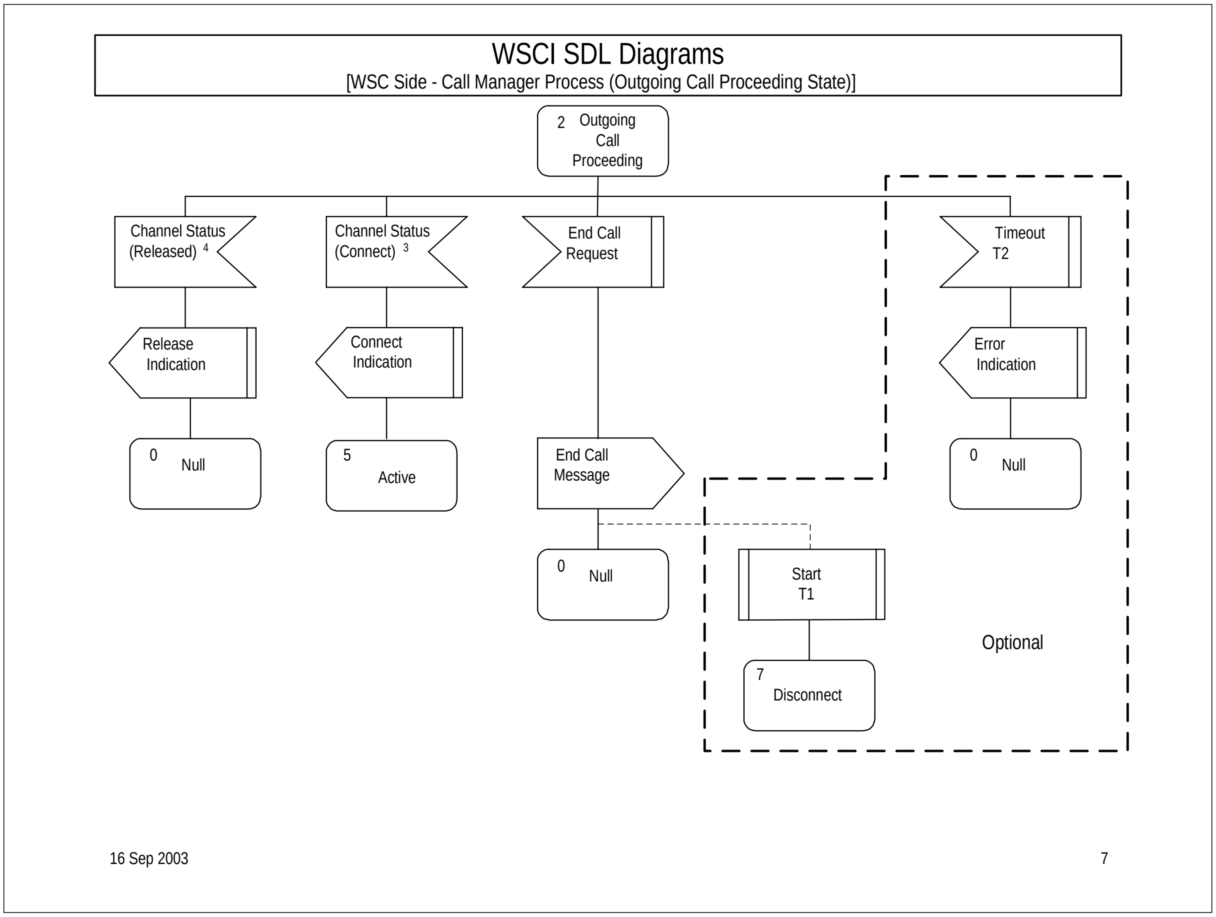

Figure 2F-42.1-2F – WSCI SDL Diagram
[WSC Side-Call Manager Process (Outgoing Call Proceeding State)]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

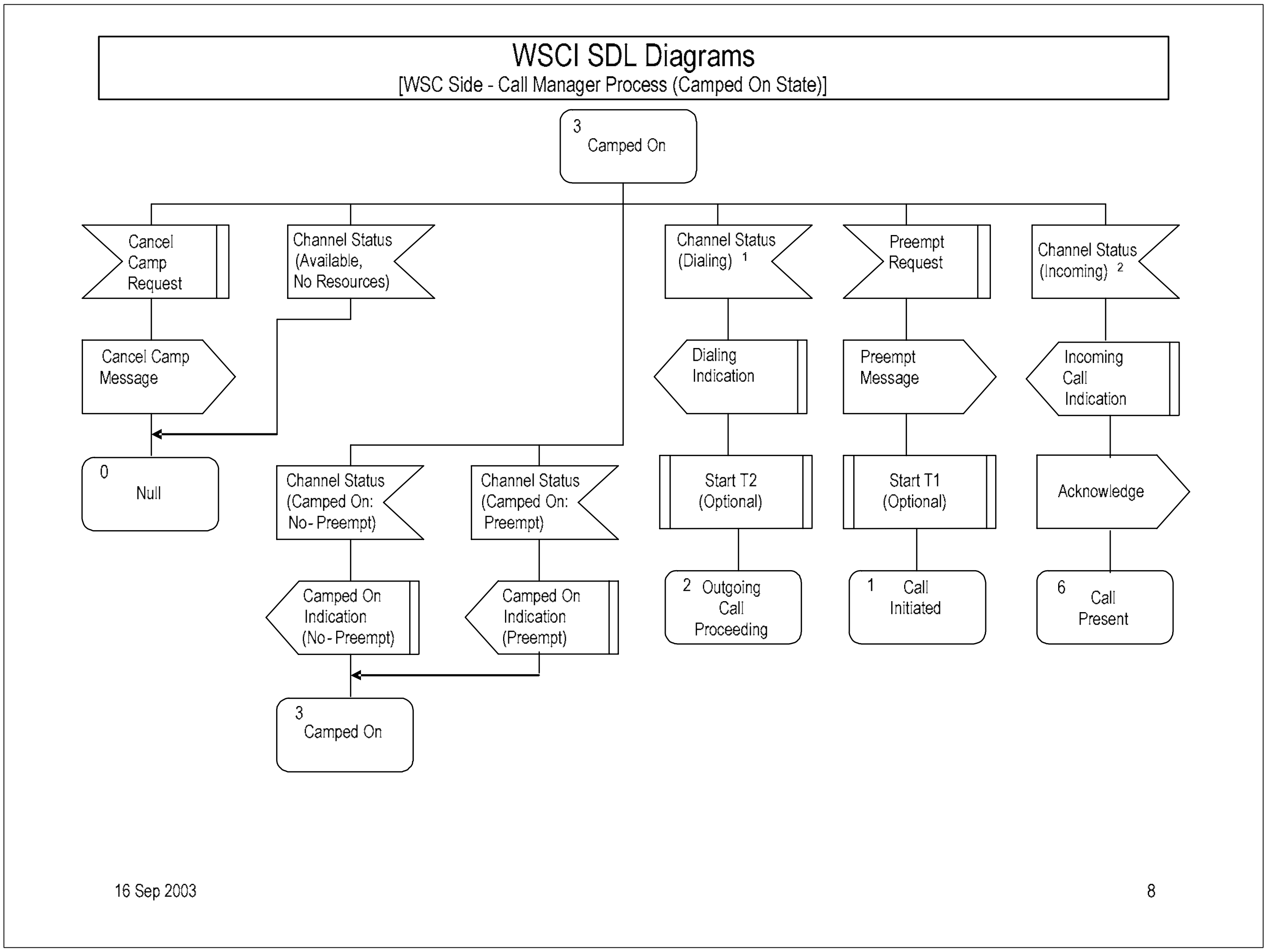

Figure 2F-42.1-2G – WSCI SDL Diagram
[WSC Side-Call Manager Process (Camped On State)]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

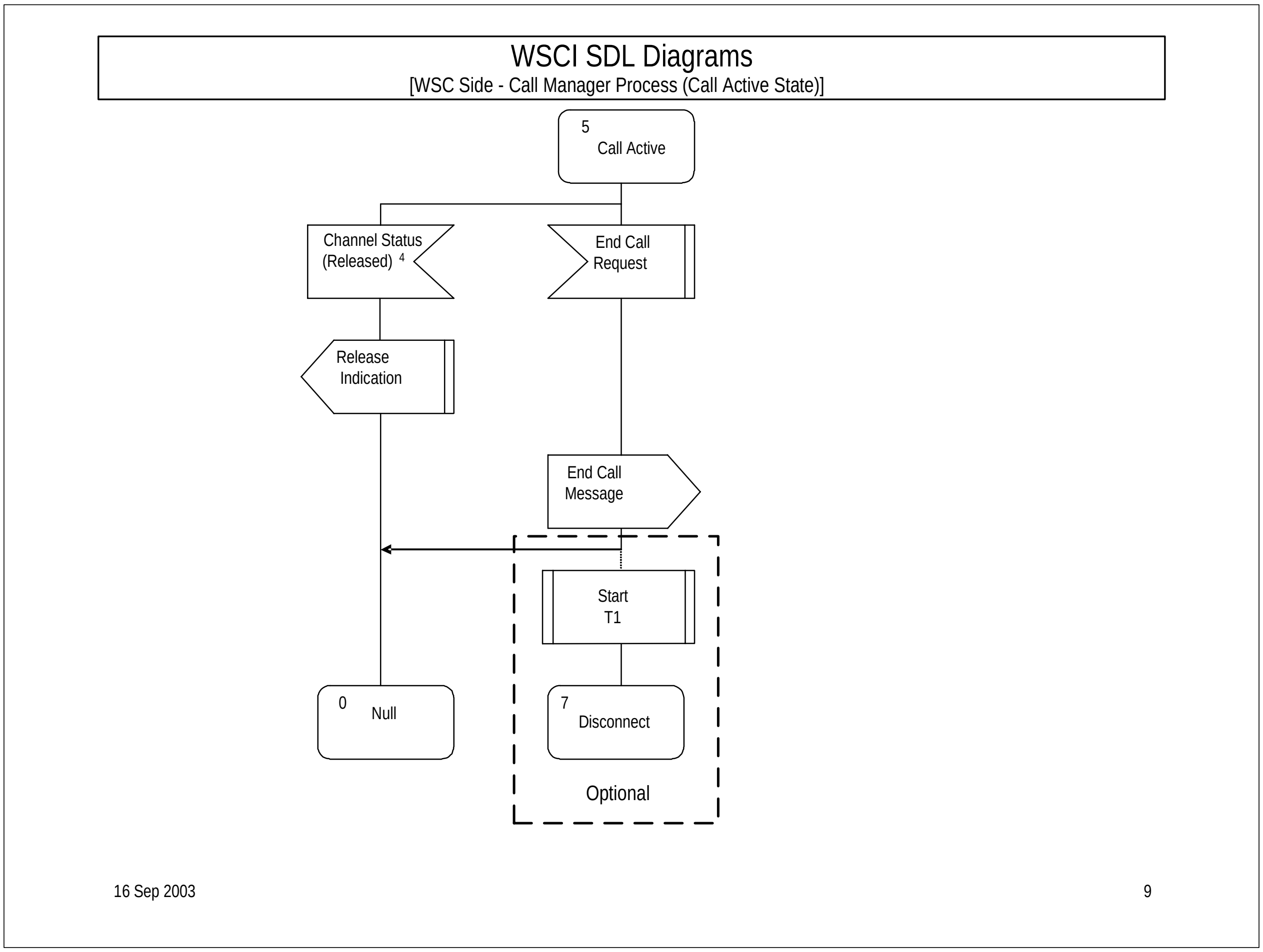

Figure 2F-42.1-2H – WSCI SDL Diagram
[WSC Side-Call Manager Process (Call Active State)]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

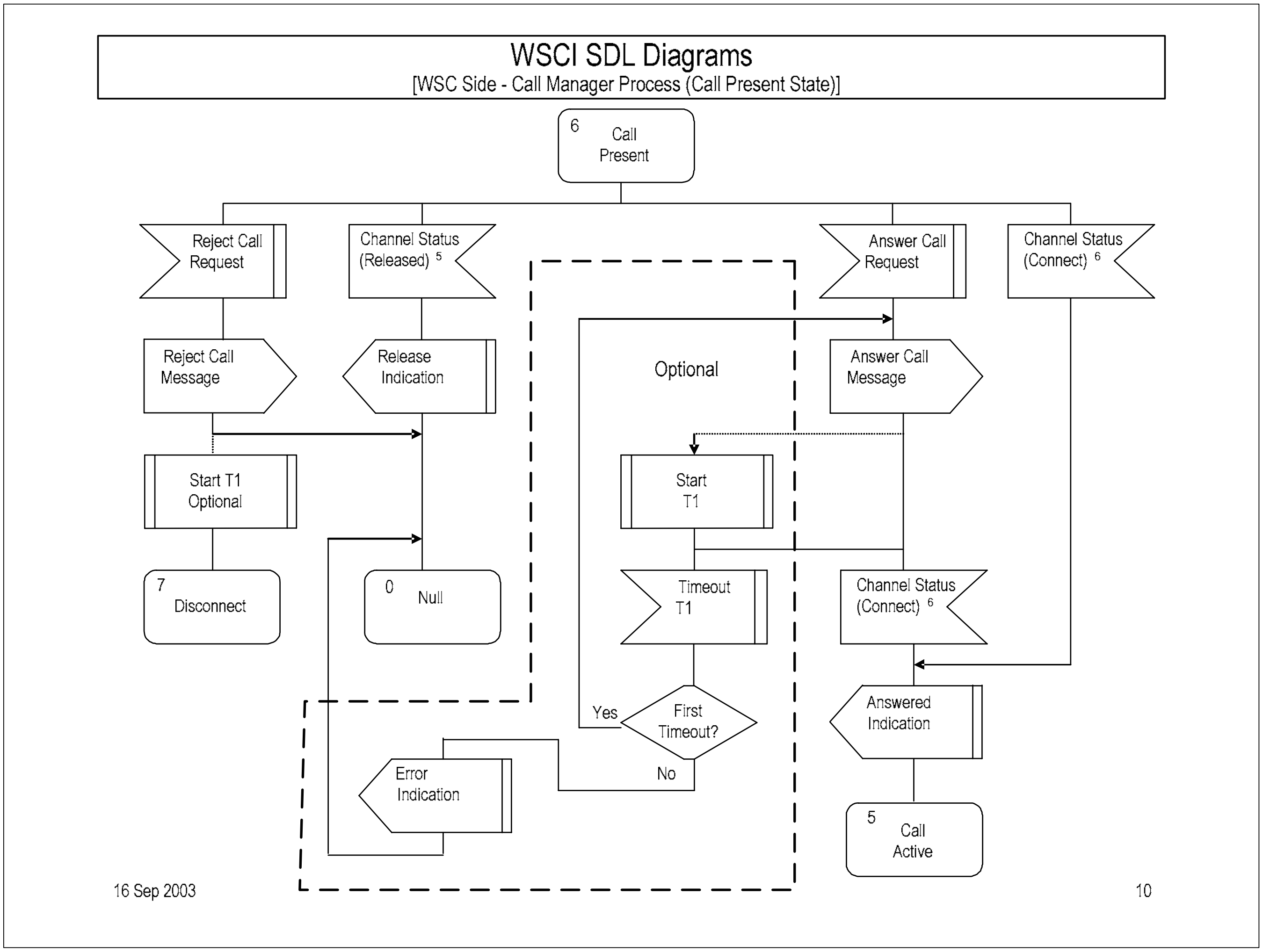

Figure 2F-42.1-2I – WSCI SDL Diagram
[WSC Side-Call Manager Process (Call Present State)]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

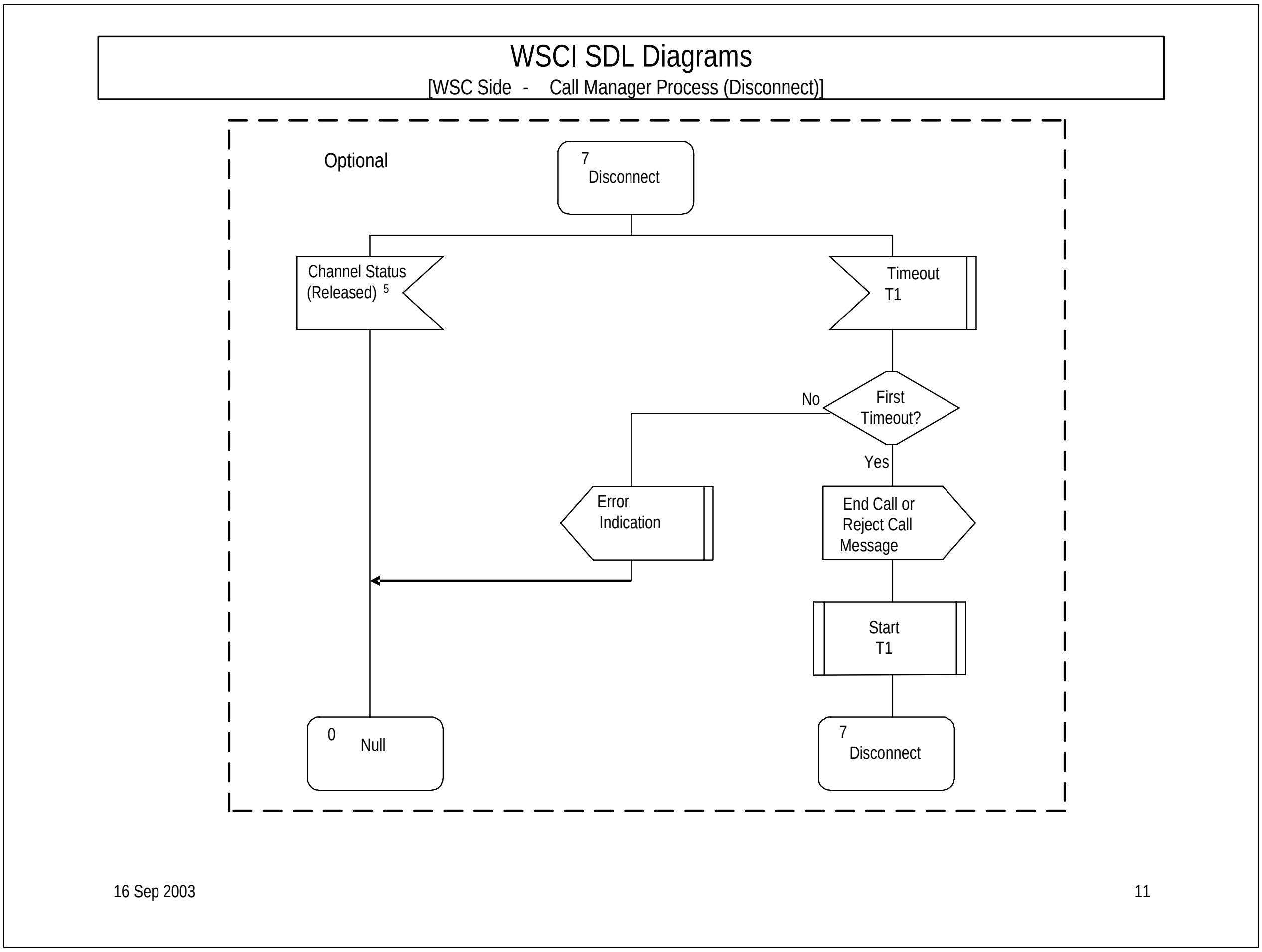

Figure 2F-42.1-2J – WSCI SDL Diagram
[WSC Side-Call Manager Process (Disconnect)]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

WSCI SDL Diagrams
[WSC Side - Note Summary - WSC]

Notes
(1) If SDU configuration strap TP10K=0, Call Light discrete activated.
(2) Call Light and Chime discretes activated.
(3) If SDU configuration strap TP10K=1, Call Light discrete activated.
(4) Call Light discrete deactivated.
(5) Call Light discrete deactivated and Chime reset if repeating.
(6) Chime reset if repeating.

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Figure 2F-42.1-2K – WSCI SDL Diagram
[WSC Side-Note Summary – WSC]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

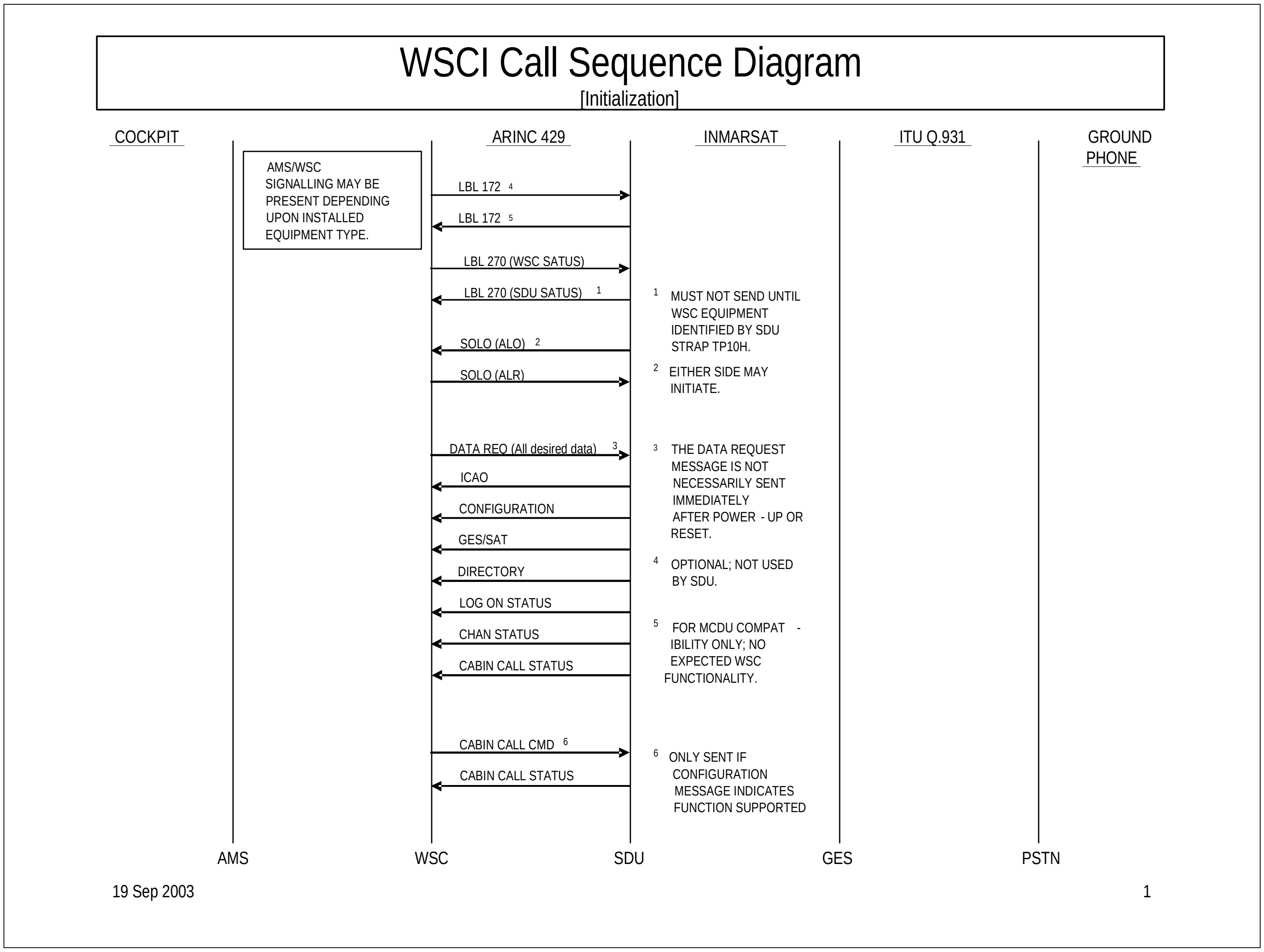


Figure 2F-42.1-3A – WSCI Call Sequence Diagram [Initialization]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

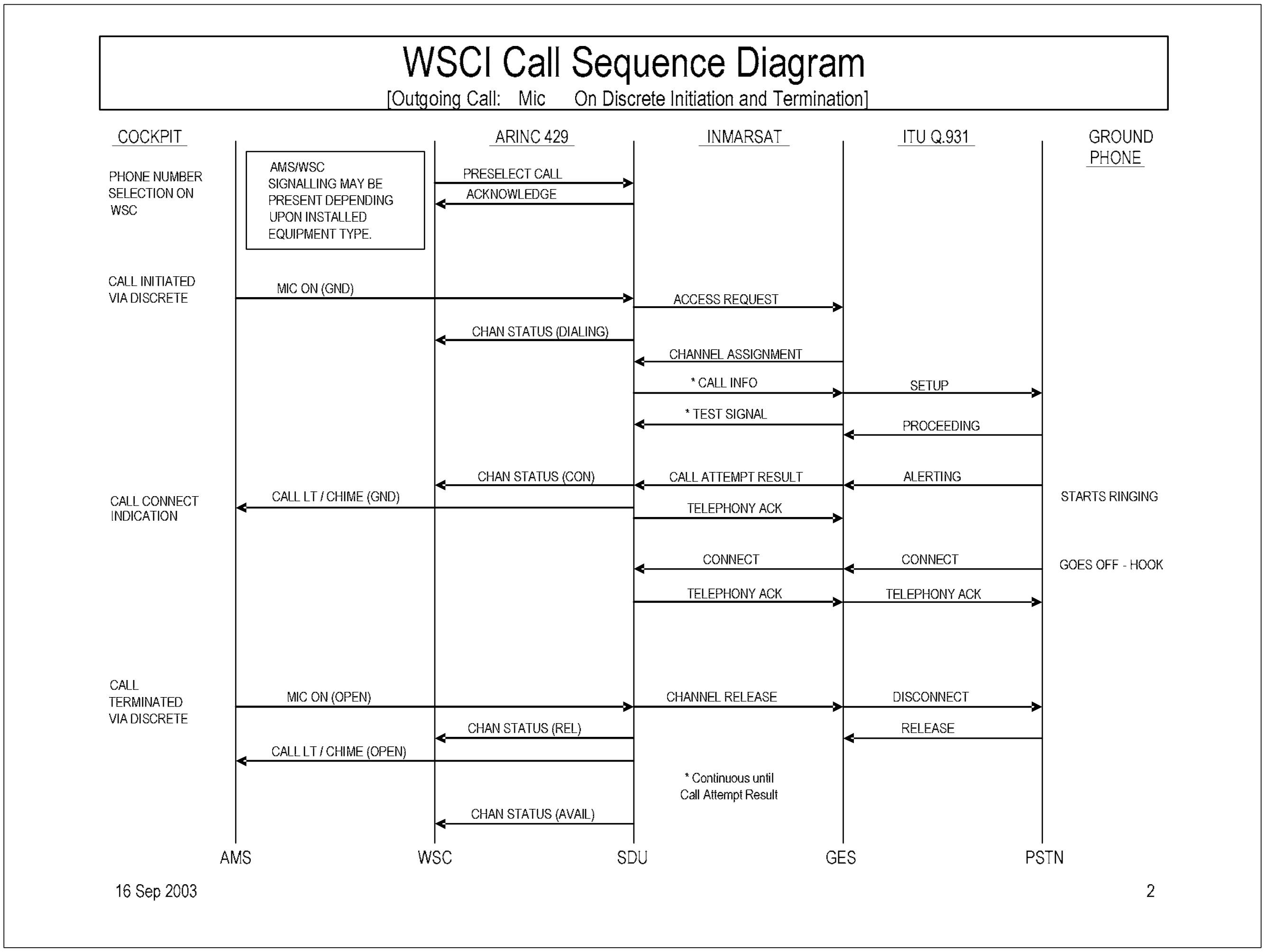


Figure 2F-42.1-3B – WSCI Call Sequence Diagram
[Outgoing Call: Mic On Discrete Initiation and Termination]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

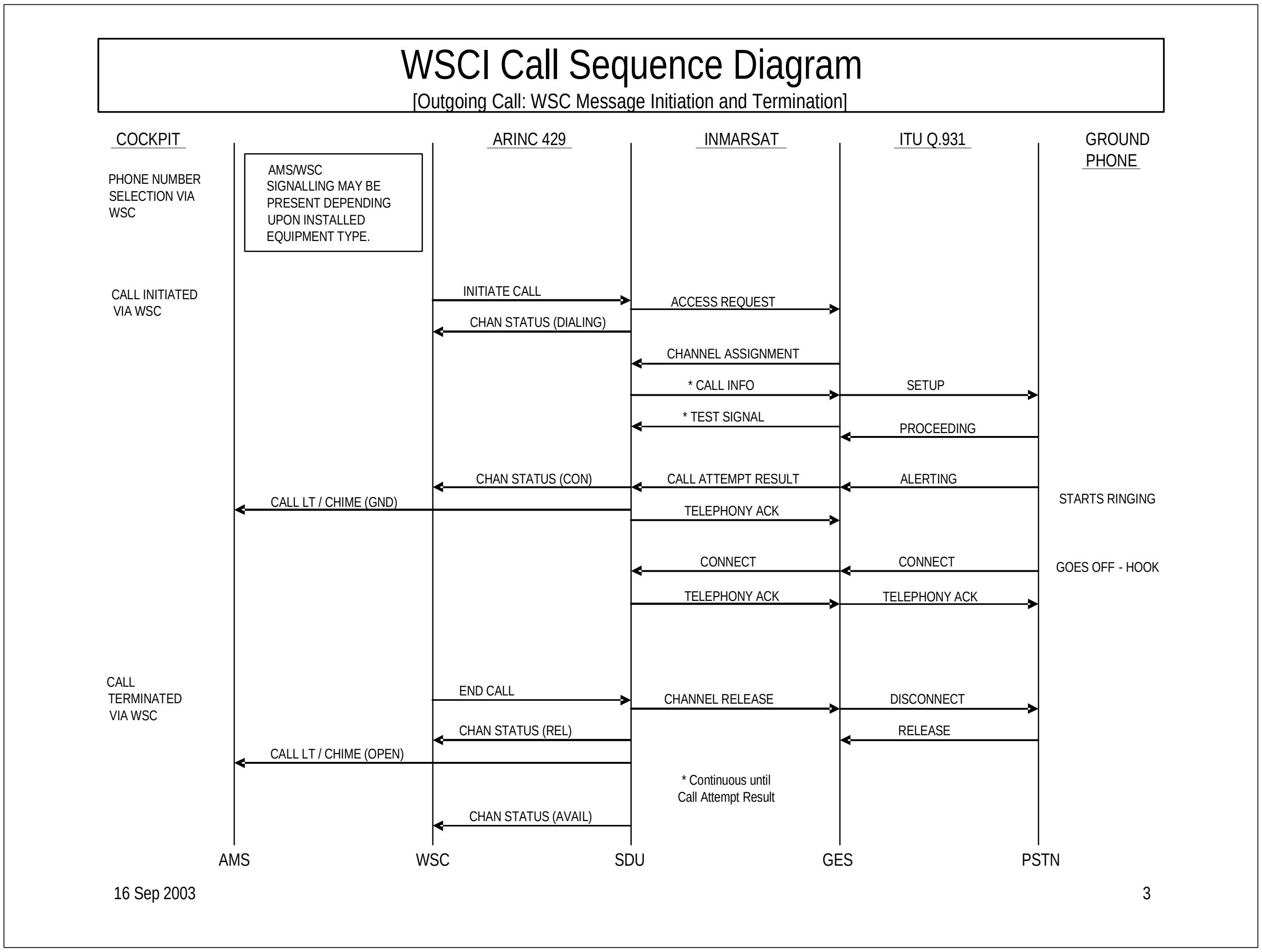


Figure 2F-42.1-3C – WSCI Call Sequence Diagram
[Outgoing Call: WSC Message Initiation and Termination]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

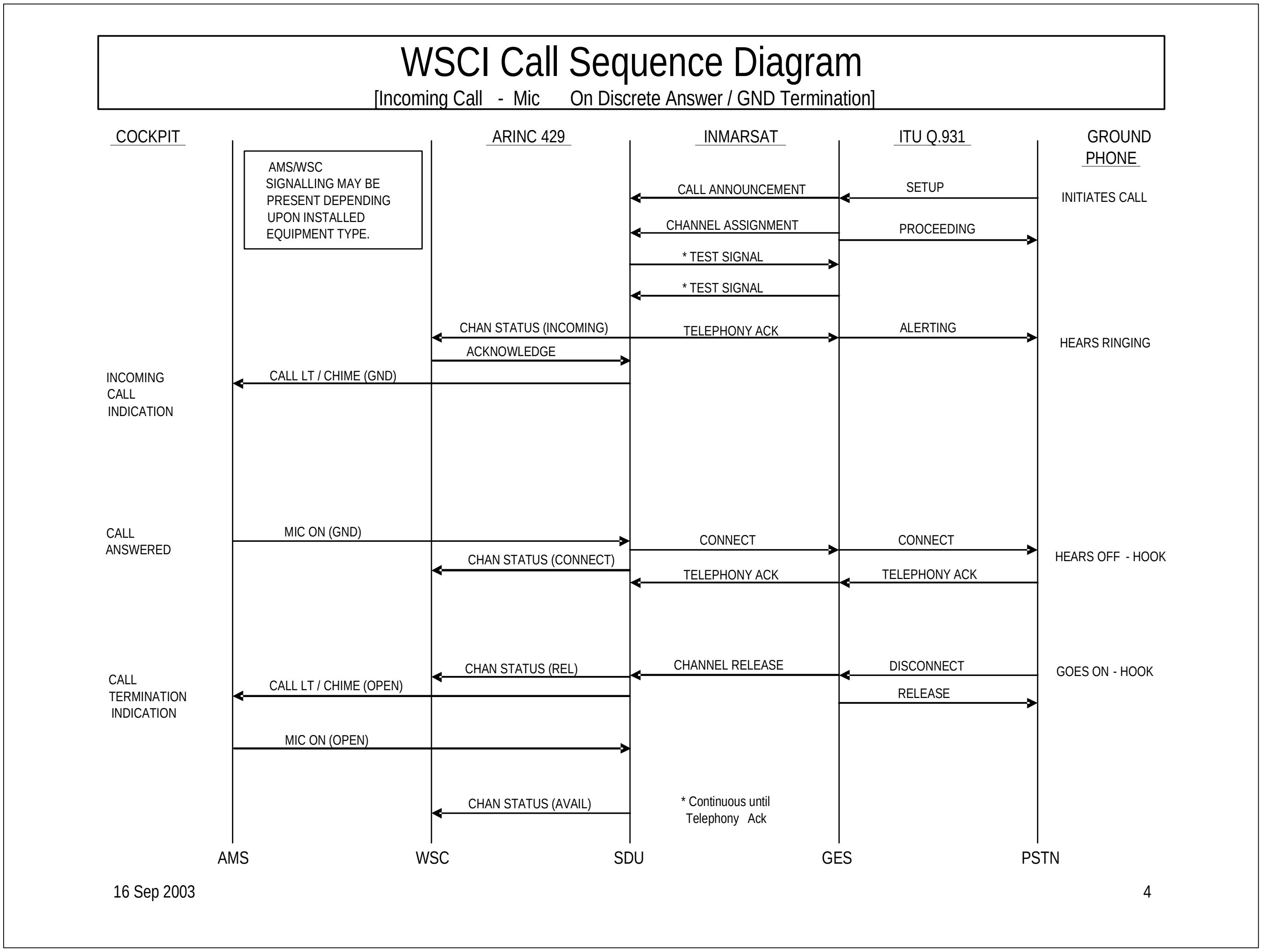


Figure 2F-42.1-3D – WSCI Call Sequence Diagram
[Incoming Call: Mic On Discrete Answer/GND termination]

ATTACHMENT 2F-42.1
WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

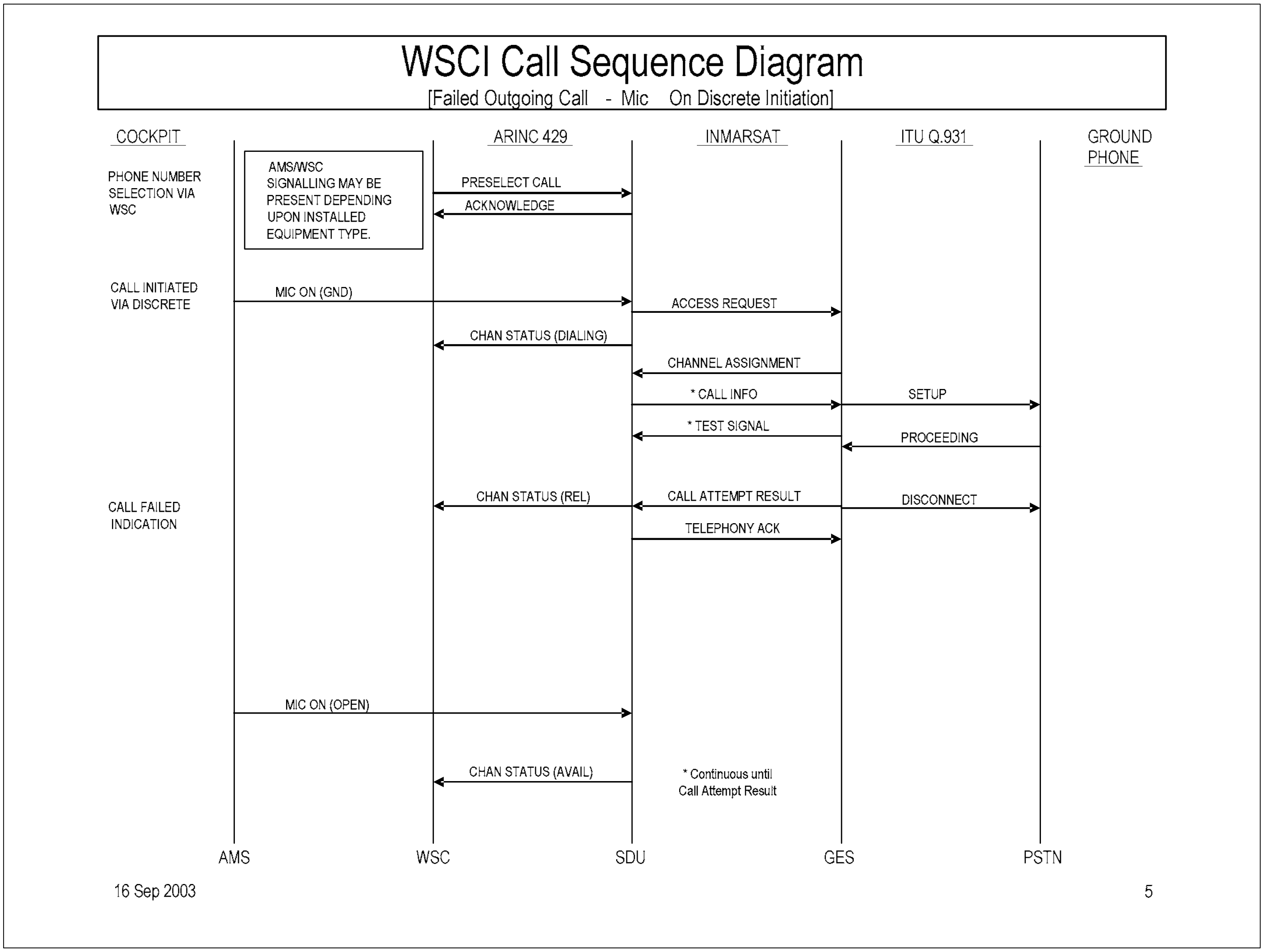


Figure 2F-42.1-3E – WSCI Call Sequence Diagram
[Failed Outgoing Call-Mic On Discrete Initiation]

ATTACHMENT 2F-43
AERONAUTICAL DATA NETWORK ADDRESSING PLAN

ABSTRACT

This attachment describes syntax and semantics for the construction of Aeronautical Telecommunication Network (ATN) Network Service Access Point (NSAP) addresses. This addressing plan is applicable to both Air Traffic Service (ATS) and Airline Operational Control (AOC) user groups, and facilitates the internetworking of these users through aircraft, air/ground and ground-based aeronautical data subnetworks. The ATN NSAP plan is consistent with ISO Network Layer service specifications, and with ISO Network Layer interface and routing protocols. This attachment begins with an overview of the objectives and key attributes of the addressing plan, including a description of the addressing plan scope and applicability.

1 Network Addressing Plan Overview

The *Aeronautical Telecommunication Network* (ATN) *Network Service Access Point* (NSAP) addressing plan provides a common network address syntax for end-users and service providers participating in the international aeronautical data communication environment. This plan defines the Network Layer addressing information to be utilized by ATN end-systems, and by ATN intermediate-systems located at the boundaries of aircraft, air/ground and ground-based subnetworks. This plan serves the needs of a variety of aeronautical data communication user groups; these groups include *Air Traffic Service* (ATS), *Airline Operational Control* (AOC) and *General Aviation* (GA).

The ATN NSAP addressing plan specifies a hierarchical, name-based address format, and is applicable for the identification of either fixed or mobile end-systems. This approach allows the unique identification of a destination end-system with an address composed directly by the originating end-system, thus avoiding dependence on directory services in limited-bandwidth subnetwork environments. The ATN NSAP addressing plan also avoids dependence on a particular subnetwork address format, as the ATN end-systems and intermediate-systems perform translation between the ATN NSAP address format and the format used on the next-hop subnetwork. This facilitates *data transport interoperability* among various end-users and service providers within the aeronautical domain, while allowing these end-users and service providers to retain local control of local end-system and subnetwork operations.

Section 2 describes the key attributes of the plan, and Section 3 covers selected topics which enhance the understanding of the ATN NSAP addressing plan. Section 4 provides a syntactic and semantic definition of the ATN NSAP addressing plan.

2 Network Addressing Plan Attributes

Key attributes of the ATN NSAP addressing plan may be summarized as follows:

1. The ATN NSAP address is utilized by ATN intermediate-systems and end-systems operated by ATS and AOC organizations, and can be used by both airborne and ground-based applications. The ATN NSAP addressing information may be carried over existing subnetworks utilized by these authorities.
2. The plan makes use of existing aeronautical addressing standards in order to facilitate its phased introduction within the aviation community.

   a. Existing *International Civil Aviation Organization* (ICAO) standards are used for identification of ATS locations (Reference [1]) and fixed (i.e., ground based) host-groups (Reference [2]). Existing *International Organization for Standardization* (ISO) standards are used for identification of ATS organizations.
   b. Existing *International Air Transport Association* (IATA) standards are used for identification of AOC organizations and locations (Reference [3]), and for identification of AOC fixed host-groups (Reference [4]).
   c. The ICAO 24-bit aircraft identifier (i.e., 24-bit address, as described in Reference [6]) is used for identification of mobile (i.e., aircraft-based) host-groups.
3. This plan offers conformance with the ISO OSI Network Layer Addressing Plan (Reference [10]). The ATN plan defines an address format consisting of fields which map into the ISO NSAP address *Domain Specific Part* (DSP) selected by an ICAO *International Code Designator* (ICD) value.
4. The address format supports the operation of routing protocols in conformance with the ISO Routing Framework (Reference [15]), and may be utilized by the ISO End-System to Intermediate System Routing Protocols (Reference [16] and Reference [17]) and the ISO Intra-Domain Routing Protocol (Reference [18]).
5. The address format allows selective or combined encoding of address fields for subnetwork transfer, in order to minimize transferred address header overhead. This encoding process may be individually optimized for each participating subnetwork.

The ATN NSAP Addressing Plan synthesizes existing addressing standards and addressing administrations into a global aeronautical addressing plan which may be used in support of aeronautical data network relaying and routing.

3 Selected Network Layer Concepts

The ATN NSAP addressing plan is designed to satisfy the technical and organizational constraints of the international aeronautical environment, while maintaining conformance with certain ISO *Open Systems Interconnection* (OSI) Network Layer concepts and specifications. This section summarizes key Network Layer concepts which influence the design of an ISO NSAP address format.

3.1 Aeronautical Data Communication Domain

The collection of interconnected aeronautical *end-system* (ES), *intermediate-system* (IS) and *subnetwork* (SN) elements administered by international authorities for aeronautical data communication is denoted the *Aeronautical Telecommunication Network*. The ATN environment, or *domain*, encompasses all data communication service end-users associated with the international airspace, including *Air Traffic Service* (ATS) and *Airline Operational Control* (AOC) end-users, as well as *General Aviation* (GA) end users. The ATN administrative domain is, thus, inherently international and inter-organizational, since aeronautical data communication spans both national and organizational boundaries.

End-user application services, as well as the data subnetworks serving those end-users, may be operated by governmental authorities or by vendors of services for profit. The ATN domain is divided along these organizational boundaries into sub domains, or *areas*, in order to optimize routing of data communication traffic. ATN

Areas are administered by governmental and public/private aeronautical service providers, and are defined to be consistent with organizational boundaries. This allows retention of local control within existing administrations; additionally, this tends to recognize the likely boundaries of dense communication traffic patterns.

3.2 Routing with the ATN Domain

An ATN intermediate-system (referred to as an *ATN Router*, or ATNR) makes use of known subnetwork connectivity to perform routing of message traffic among aeronautical end-systems, possible involving one or more cooperating ATN routers. Routing decisions are based on connectivity information exchanged among routers and end-systems, used in conjunction with NSAP address and *quality of service* (QOS) information supplied by the originating end-user.

ATN intra-domain routing is organized as a two-level hierarchy, in conformance with the ISO Network Layer routing architecture (see References [15] and [18]). The upper level of the hierarchy performs inter-Area routing, and is denoted *Level 2*. The lower level of the hierarchy performs routing between intermediate-systems within an Area, and is denoted *Level 1*. ATN Network Layer routing is thus performed as a two-phase process:

1. Route the addressed message to the destination Area based on evaluation of the inter-Area portion of the NSAP address. This completes delivery of the message to a known point-of-entry into the destination Area.
2. Route the addressed message to the destination host equipment, based on evaluation of the intra-Area portion of the NSAP address. This completes delivery of the message to the intended recipient host.

The ATN NSAP address format is organized to support this two level routing architecture.

The essential benefit of the *area routing* approach is that routing information transfer between Areas is minimized, thus reducing the amount of management overhead traffic carried by interconnecting subnetworks, and reducing the amount of routing information stored within each ATN router. A secondary benefit of this approach is that the Areas share less topology information, and thus preserve an additional degree of privacy. Since the Area boundaries observe natural organizational boundaries, this second benefit is often of equal importance to the first.

3.3 Routing through Non-Aeronautical Subnetworks

Many communication paths between ATN ES and IS elements utilize subnetworks operated by aeronautical authorities; however, certain ATN ES and IS elements may be interconnected through one or more non-aeronautical subnetworks, such as those operated by *Post, Telephone and Telegraph* (PTT) or *Public Data Network* (PDN) authorities. Although the internal operations of the PTT or PDN subnetworks are outside the administrative domain of the aeronautical authorities, the Network Layer operations occur within ATN-administered routers located at the boundaries of these subnetworks. These Network Layer operations are thus regarded as part of the ATN domain.

ATTACHMENT 2F-43
AERONAUTICAL DATA NETWORK ADDRESSING PLAN

REFERENCES

1. Location Indicators, Doc 7910/38, ICAO.
2. Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services, Doc 8585/64, ICAO.
3. Airline Coding Directory, 16th Edition, 1 April 1988, IATA.
4. ATA IATA Interline Communications Manual, DOC.GEN/1840, Revision 8, 1 October 1987, IATA.
5. AERONAUTICAL TELECOMMUNICATION: Annex 10 to the Convention on International Civil Aviation, Volume II, Fourth Edition, April 1989, ICAO.
6. Appendix A to the Report on Agenda Item 3, SICASP/2-WP/73, ICAO.
7. Data Country Codes, ISO.
8. Network Service Definition, ISO 8348, ISO.
9. Addendum to the Network Service Definition Covering Connectionless Data Transmission, ISO 8348/AD1, ISO.
10. ISO Network Service Definition - Addendum 2: Network Layer Addressing, ISO 8348/AD2, ISO.
11. Internal Organization of the Network Layer, ISO 8648, ISO.
12. X.25 Packet Level Protocol for Data Terminal Equipment, ISO 8208, ISO.
13. Use of the X.25 Packet Level Protocol to Provide the OSI Connection-Oriented Network Service, ISO 8878, ISO.
14. Protocol for Providing the Connectionless-Mode Network Service, ISO 8473, ISO.
15. Draft Routing Framework, ISO/IEC JTC 1/SC 6/N 4494, ISO.
16. End System to Intermediate System Routing Exchange Protocol for use in conjunction with ISO 8208 (X.25/PLP), ISO/IEC JTC 1/SC 6/N 5006, ISO.
17. End System to Intermediate System Routing Exchange Protocol for use in conjunction with the Protocol for the Provision of the Connectionless-mode Network Service (ISO 8475), ISO 9542, ISO.
18. Intermediate System to Intermediate System Intra-Domain Routing Exchange Protocol, X 353.3/87-150, ANSL.
19. Operation of an X.25 Interworking Unit, ISO/IEC JTC 1/SC6/N4937, ISO.

ATTACHMENT 2F-43.1
AERONAUTICAL DATA NETWORK ADDRESSING PLAN

Abstract Syntax for Global (NSAP) Addressing in the Proposed ATN Plan

The proposal follows ISO Network Service Definition-Addendum 2: Network Layer Addressing (ISO 8348/AD2) and is documented in Appendix A of the draft MOPS for the ATCRBS/Mode Select ADLP.

Initial Domain Part (IDP)		Domain Specific Part (DSP)
1 octet	(AFI indicates length)	(AFI indicates length)
AFI	IDI	DSP format is defined by the Authority identified in the IDI field

Initial Domain Part (IDP) as Administered by ISO:

Authority and Format Identifier

Specifies the format of the IDI, the responsible addressing authority, and the abstract syntax for the DSP. The following AFT values (decimal) have been defined; 47 is selected for NSAP addressing in the ATN plan.

AFI or AFI+1

Indicates whether the abstract syntax is written in decimal or binary notation.

36 or 37	Packet Switched Data Network (PSDN) address per ITU-T X.121
42 or 43	Public Switched Telephone Network (PSTN) address per ITU-T X.163
44 or 45	Integrated Services Data Network (ISDN) address per ITU-T X.164
40 or 41	Telex address per ITU-T X.69
38 or 39	Data Country Code (DCC) address per a registration with ISO
46 or 47	International Code Designator (IDC) address per a registration with ISO (ISO 6523)
48 or 49	Local domain address using decimal or binary digits
50 or 51	Local domain address using ISO 646 characters or other national characters (all other AFI values are reserved)

IDI = Initial Domain Identifier

Specifies the addressing domain from which the DSP values are allocated and the addressing authority responsible. Pending actual registration with ISO, the assumption made in the proposed ATN plan is that:

ICAO IDI = 1001 decimal for all ATN addresses used for ATC and Flight Information facilities and services.

IATA IDI = 1002 decimal for all ATN addresses used by AOC or AAC facilities and services.

Maximum permitted length for the entire NSAP address is 20 binary octets or 40 decimal digits.

Maximum length of the DSP is 13 binary octets when the AFI = 47 (IDI = ISO-assigned ICD and DSP syntax is binary)

ATTACHMENT 2F-43.1
AERONAUTICAL DATA NETWORK ADDRESSING PLAN

IDP and DSP as proposed for the ATN Addressing Domain to be administered by ICAO:

IDP		DSP							
1 octet	2	2	1	1	3	3	1	1	1
AFI	IDI	ADM	ARS	IDF	LOC	GRP	HST	EQS	TPS
Area Code for the NSAP				Equipment ID Code for the NSAP					

AFI = 47 (2 decimal)
IDI = 1001 or 1002 (4 decimal)
ADM = Administration Identifier:
if IDI = 1001, ADM is 3 decimal
if IDI = 1002, ADM is 3 alpha (A-Z, @)
ARS = Area Selector (2 hex)

All fields are right-justified and are filled with leading zeros in numeric fields and leading @s in alphabetic fields. Null fields contain only fill characters.

Plan as of June 1988

IDF = Equipment ID Format (2 hex)
LOC = Location Identifier (3 or 4 A-Z, @ characters)
if IDF = 01 (ATS Fixed) or 41 (ATS Mobile), LOC is 4 characters
if IDF = 81 (Airline Fixed) or c1 (Airline Mobile), LOC is 3 characters
GRP = Group Identifier
if IDF = 41 or c1 (Mobile), GRP is 6 hex (24 bit ICAO aircraft ID)
if IDF = 01 and IDI = 1001, GRP is 3 alpha (ICAO Agency Designator)
if IDF = 81 and IDI = 1002, GRP is 2 alpha (IATA Function Designator)
HST = Host Identifier (2 hex; IDI and IDF select list of unique values)
EQS = Equipment Selector (2 hex; IDI and IDF select list of unique values)
TPS = Transport Protocol Selector (2 hex; designates the end user protocol, or Higher Layer Entity associated with this NSAP. A standard Transport Protocol (ISO, ICAO, AEEC, etc.) would normally be this HLE.

ATTACHMENT 2F-44
DATA-2 PROTOCOL DATA UNIT

Link Service Data Unit Header		**First Octet of Message**	**Remainder of Message**
Octet 1	Octet 2		
1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 1	

Initial Protocol
Identifier (IPI)
01_h(SOH) = ACARS

ATTACHMENT 2X

The Tables Figures, Annexes, and Appendices referenced to this Attachment are as presented in the Inmarsat Aeronautical System Definition Manual (SDM) Module 1, Version 1.44.

ATTACHMENT 2Y

The Figures referenced to this Attachment are as presented in the Inmarsat Aeronautical System Definition Manual (SDM) Module 2, Version 1.18.

ATTACHMENT 2Z

The 9.6 kbps Voice Encoder Standards, Data Interface Unit (DIU), and Terminal Interface Functional Unit (TIFU) descriptions and associated Figures, Tables etc., referenced to this Attachment are as presented in the Inmarsat Aeronautical System Definition Manual (SDM) Module 5, Part 1, Version 3.1.

The 4.8 kbps Voice Encoder Standards, Data Interface Unit (DIU), and Terminal Interface Functional Unit (TIFU) descriptions and associated Figures, Tables, etc., referenced to this Attachment are as presented in the Inmarsat Aeronautical System Definition Manual (SDM) Module 5, Part 2, Version 1.1.

APPENDIX 1
APPLICATION OF THE OPEN SYSTEM INTERCONNECT (OSI) MODEL TO THE AVIATION SATELLITE SYSTEM

Each communication in the aviation satellite system represents a series of functions which is 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 that make the transition from the user's application process to the transmission medium; e.g., the L-band transmitter. These seven layers are depicted in Figure 1 and briefly described as follows:

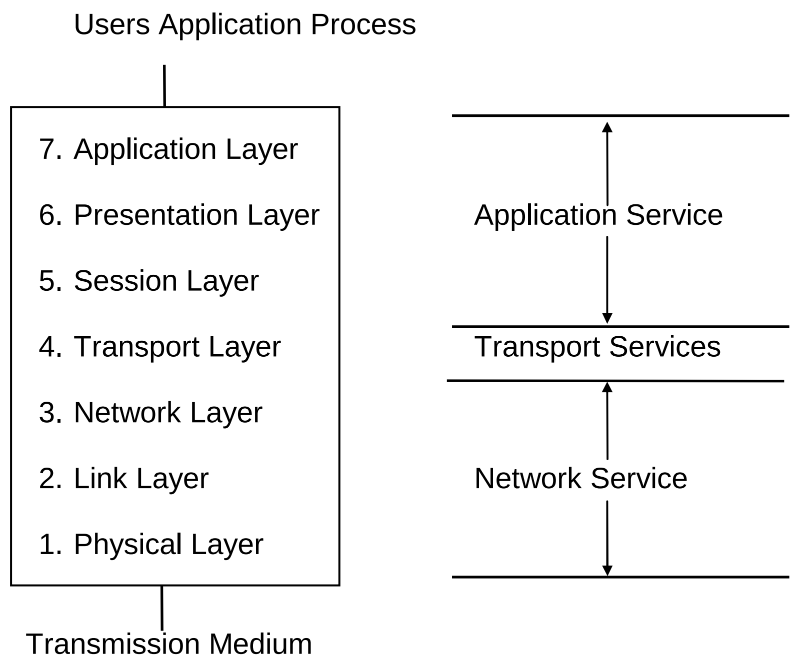


Figure 1 - Layers of the OSI Model

Layer	Function	Definition
7	Application Layer	Provides access to the open system interconnection environment and manages the communication.
6	Presentation Layer	Provides those services necessary to interpret the syntax of the information being transferred.
5	Session Layer	Establishes, maintains and tears down connections between specific pairs of processes, called sessions.
4	Transport Layer	Provides end-to-end control of the communication process with the reliability expected by the user.
3	Network Layer	Provides the switching and routing functions used to establish, maintain and terminate the connections that are used to transfer data between the end systems.
2	Link Layer	Sometimes referred to as the data link layer, it provides the timing and control functions used to transfer data over the physical link.
1	Physical Layer	Provides the functions used to activate, maintain and release the physical link which carries the bit stream of the communication.

APPENDIX 1
APPLICATION OF THE OPEN SYSTEM INTERCONNECT (OSI)
MODEL TO THE AVIATION SATELLITE SYSTEM

The three upper layers provide direct support of the application process while the lower three layers 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. Since the signal from the Enhanced ACARS Management Unit is already formatted with OSI protocol, the Satellite Data Unit (SDU) and the RF Unit (RFU) need only exchange or add prefixes and suffices as needed to effect reliable data transfer over the satellite link.

Figure 2 depicts ISO definitions which apply in this document and one briefly described at the (N) layer.

Term	Meaning
Protocol Control Information	The (N)-PCI is exchanged between peer entities to coordinate their joint operation.
User Data	The (N)-User Data may also be transferred between peer entities as needed. In the (N-1)-layer the UD becomes the (N-1)-Service Data Unit (N-SDU), including then the (N)-PCL.
Protocol Data Unit	The (N)-PDU is a combination of the (N)-PCI and the (N)-UD or (N)-SDU. The (N)-PDU is the total information that is transferred between peer entities as a unit.
Interface Control Information	The (N)-ICI provides the interaction between the adjacent layer entities. These are referred to as Primitives in a layer service definitions that are under development.
Interface Data Unit	The (N)-IDU is the total unit of information transferred across the service access point.
Service Data Unit	The (N)-SDU is the part of the (N)-IDU, whose identity is preserved between the ends of the connection.
(N)-Layer	(N)- is set for any layer names (such as Link, Network, Transport, etc.), or for their initial (e.g., (N)-SDU means TSDU at the transport layer.

Figure 2 - ISO Definitions

APPENDIX 1
APPLICATION OF THE OPEN SYSTEM INTERCONNECT (OSI) MODEL TO THE AVIATION SATELLITE SYSTEM

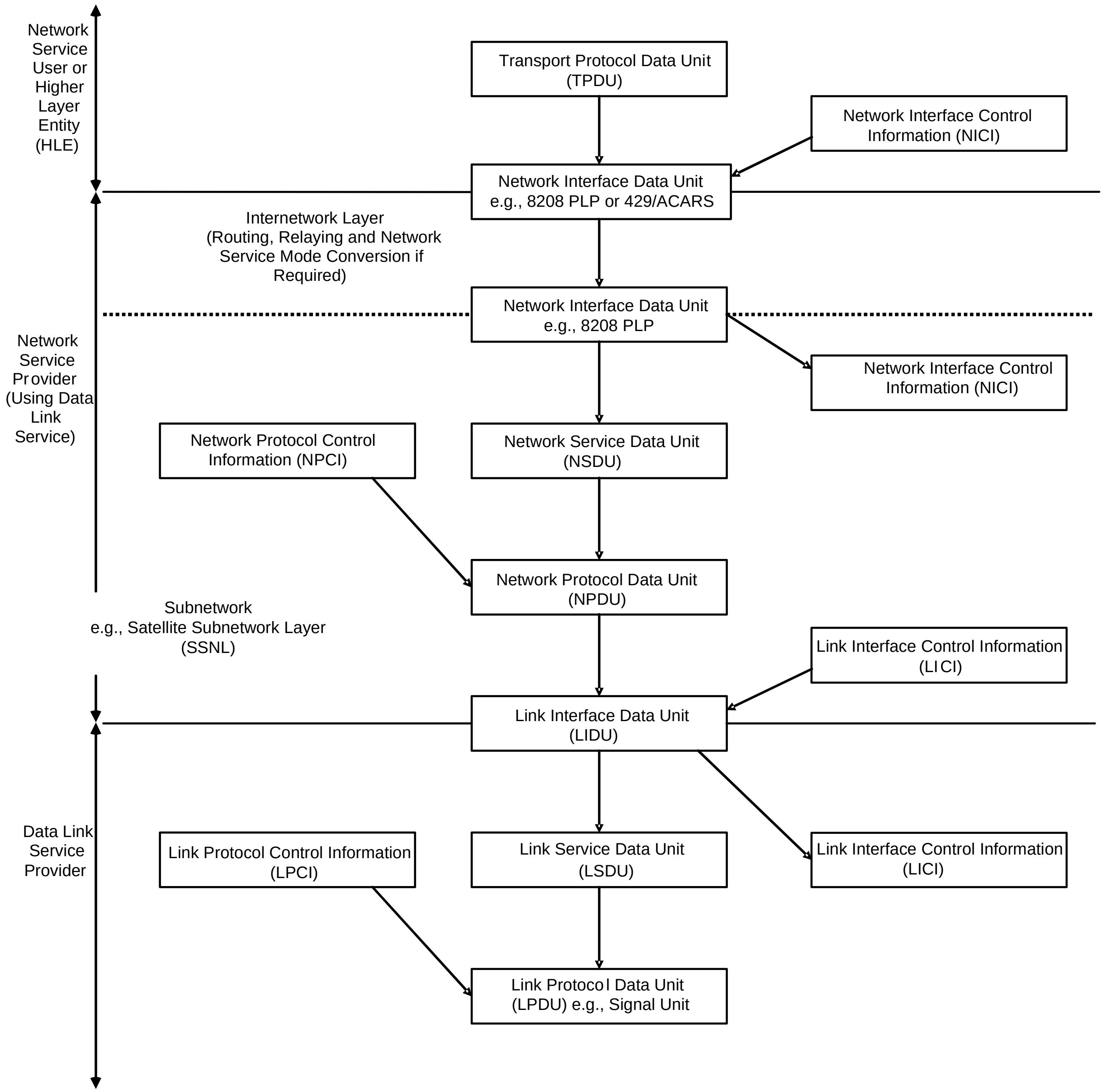
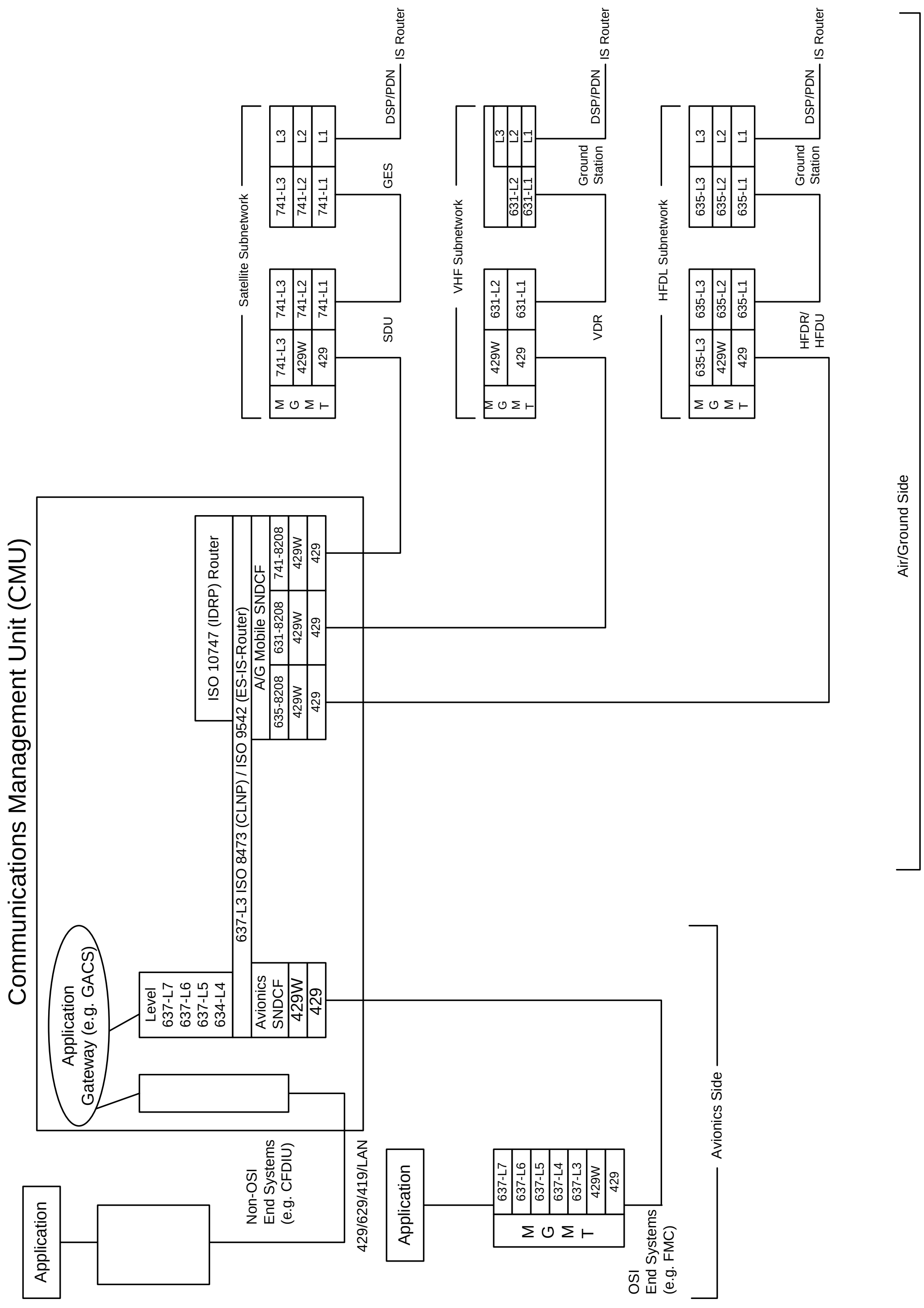


Figure 3 - Data Unit Terminology - ISO Convention

APPENDIX 1
APPLICATION OF THE OPEN SYSTEM INTERCONNECT (OSI) MODEL TO THE AVIATION SATELLITE SYSTEM



NOTES:

1. This figure appears in the following ARINC standards: 631, 635, 637, 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.

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APPENDIX 2
ACRONYMS AND ABBREVIATIONS

AAC	Aeronautical Administrative Communications
ABPSK	Aviation Binary Phase Shift Keying
ACARS	Aircraft Communications Addressing and Reporting System
ACI	Adjacent Channel Interference
Ack	Acknowledge (message)
ACK	Acknowledge Signal
ACKCTL	Acknowledge Control
ACP	Audio Control Panel
ACSE	Access Control and Signaling Equipment
ADM	Administration Identifier
ADS	Automatic Dependent Surveillance
AEEC	Airlines Electronic Engineering Committee
AES	Aircraft Earth Station
AFC	Automatic Frequency Compensation
AFC	Automatic Frequency Control
AFI	Authority and Format Identifier
AGC	Automatic Gain Control
ALLOC'D	Allocated
ALLOC'N	Allocation
ALO	AES Log-On
ALO-ALR	Aloha-Aloha Response (as used in the ARINC 429 Williamsburg FTP)
AM/PM	Amplitude Modulation-to-Phase Modulation
AMP	Audio Management Panel
AMS	Audio Management System
AMSS	Aeronautical Mobile Satellite Services
AMU	Audio management unit
ANCP	Alternate Network Control Point
ANCT	Aircraft Network Control Terminal
Ant	Antenna
AOC	Aeronautical Operational Control
AOR	Atlantic Ocean Region
APC	Adaptive Predictive Coding (Voice Coding Algorithm)
APC	Aeronautical Public Correspondence
AQPSK	Aviation Quadrature Phase Shift Keying
ARINC	Aeronautical Radio Inc.
ARQ	Automatic Repeat Request

APPENDIX 2
ACRONYMS AND ABBREVIATIONS

ARS	Area Selector
ASCII	American standard code for information interchange; based on ITA-5 of the ITU-T and ISO, and similar to ISO-5 and IA5.
ASORRF	Start of Aircraft Receive Reporting Frame
ASORTCF	Start of Aircraft Receive Terminal Control Frame
ASSOC'D	Associated
ATA	Air Transport Association
ATC	Air Traffic Control
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Services
Auto	Automatic
Az	Azimuth (a component of the satcom antenna steering angle relative to the aircraft)
BAVAIL	Flag indicating if a TDMA channel reservation is available in the next 8 seconds
BCD	Binary Coded Decimal
BCS	Block Check Sequence
BER	Bit Error Rate
BI	Burst Interval
BILL	Billing Subsystem
BITE	Backward Interworking Telephony Event
BL	Burst Length
BOP	Bit Oriented Protocol
BOS	Beginning of Slot
B-party	From the point of view of a telephone user, the far-end party that either called the user or was called by the user.
BPS	Bits per Second
BPSK	Binary Phase Shift Keying
BTP	Burst Time Plan
BUFFER(Q)	Temporary Buffer assigned to messages for a given precedence value (i.e. Q value)
C/M	Carrier-to-Multipath Ratio
C/No	Carrier-to-noise-density ratio
CAA	Civil Aviation Authority

APPENDIX 2
ACRONYMS AND ABBREVIATIONS

Camp-On	A condition that occurs when a cockpit call is initiated when all necessary call resources (codec, modem and RF transmitter power) are presently consumed by other users, such that the cockpit call will be automatically attempted as soon as the needed resources are released by another caller.
C-band	4/6 GHz
CC	Connection Confirmation
CCC	Communications Control Circuit
CCIR	International Radio Consultative Committee; a predecessor organization of the ITU-T.
CCITT	International Telegraph and Telephone Consultative Committee; a predecessor organization of the ITU-T.
CCS	Cabin Communications System
CDU	Control Display Unit
CEPT	European Conference of Postal and Telecommunications Administrations
CFNO	Current Frame Number
CFS	Cabin File Server
Ch or Chan	Channel
Circuit-mode	A mode of AES operation involving a bi-directional pair of channels between the AES and the GES involving a continuous connection, as required for a telephone call; as contrasted to packet-mode operation, wherein a data packet can be transmitted and routed to the intended recipient at some indeterminate later time per the addressing information attached to it.
Class	Log-on mode of an Inmarsat AES (classes 1-4 apply). Only Classes 2 and 3 are capable of circuit-mode operation.
Cmd	Command
CMU	Communications Management Unit
CODEC	Coder-Decoder
CONS	Connector-Oriented Network Service
CONV	Conversion
CP	Reference number for a telephone call
CPDF	Cabin Packet-Mode Data Function
CR	Connection Request
CRC	Cyclic Redundancy Check
CRF	Connection ReFused
C-to-L	C-band to L-band
CTU	Cabin Telecommunications Unit
D	Delivery Confirmation Bit
dB	Decibel
dBHz	Decibel Hertz

APPENDIX 2
ACRONYMS AND ABBREVIATIONS

dBi	Decibel relative to isotropic
dBK	Decibel Kelvin
dBW	Decibel Watts
DCC	Data Country Code
DCD	Data Carrier Detect
DCE	Data Circuit-Terminating Equipment
DDI	Direct Dialing In
DEA	Delayed Echo Application
DEAP	Delayed Echo Application Protocol
DEAPDU	Delayed Echo Application Protocol Data Unit
DEL	Delete
DIU	Data Interface Unit
DLS	Direct Link Service
Dn	Time Control Correction
DRT	Diagnostic Rhyme Test
DSP	Domain Specific Part
DTE	Data Terminal Equipment
DTMF	Dual Tone Multi-Frequency
ECAM	Electronic Centralized Aircraft Monitoring
EIA	Electronic Industries Association
EICAS	Engine Instrument and Crew Alerting System
EIRP	Effective Isotropic Radiated Power
El	Elevation (a component of the satcom antenna steering angle relative to the aircraft).
EOS	End of Slot
EQS	Equipment Selector
ES	End-System
FANS	Future Air Navigation System
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction
FID	Format Identifier Field
FIFO	First In First Out
FMC	Flight Management Computer
FP	Frequency Plan
FSN	Frame Sequence Number
FTP	File Transfer Protocol

APPENDIX 2
ACRONYMS AND ABBREVIATIONS

G/T	Gain/Temperature
GA	General Aviation
GES	Ground Earth Station
GFI	General Format Identifier
GLONASS	Global Orbiting Navigation Satellite System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRP	Host-Group Identifier
GSDB	GES Specific Data Broadcast
Hex	Hexadecimal (base 16)
HF	High Frequency
HGA	High Gain Antenna
HIC	Highest Incoming Channel
HLE	Higher Layer Entity
HMI	Human-machine interface
HOC	Highest Outgoing Channel
HPA	High Power Amplifier
HST	Host Identifier
HTC	Highest Two-Way Channel
I/F or i/f	Interface
I/O	Input/output
IA5	International alphabet number 5; similar to ITA-5, ISO-5 and ASCII.
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICD	International Code Designator
ID	Identification
IDF	Equipment ID Format
IDI	Initial Domain Identifier
IEEE	Institute of Electrical and Electronic Engineers
IFR	Instrument Flight Rules
IM	Intermodulation
INIT	Initial
Inmarsat	(Formerly) International maritime satellite [organization]
Inop	Inoperative
INSTANCE	Each time a process is invoked, it is called an instance of that process. The same process may have many simultaneous, independent instances.

APPENDIX 2
ACRONYMS AND ABBREVIATIONS

IOR	Indian Ocean Region
IPI	Initial Protocol Identifier
IS	Intermediate-System
ISDN	Integrated Services Data Network
ISO	International Organization for Standardization
ISO-5	ISO alphabet number 5; similar to ITA-5, IA5 and ASCII.
ISU	Initial Signal Unit
ITA-5	International telegraph alphabet number 5; similar to ISO-5, IA5 and ASCII.
ITU	International Telecommunication Union
ITU-R	Radio-communications sector of the ITU (from the predecessor organization CCIR).
ITU-T	Telecommunication standardization bureau of the ITU (combined from the former predecessor organizations CCITT and CCIR).
IVN	Interface version number
kbps	kilobit per second
LCN	Logical Channel Number
LDU	[Data] Link [protocol] data unit
LGA	Low Gain Antenna
LI	Location Identifier
LIC	Lowest Incoming Channel
LICI	Link Interface Control Information
LIDU	Link Interface Data Unit
LNA	Low Noise Amplifier
LOC	Lowest Outgoing Channel
Log-on	The process of an AES requesting and being granted access to the Inmarsat system through a specific satellite and GES, granting it the ability to receive and transmit data packets and to request circuit-mode (e.g., telephone call) channels.
LPDU	Link Protocol Data Unit
LRU	Line Replaceable Unit
LSB	Least Significant Bit
LSDU	Link Service Data Unit
LSU	Lone Signal Unit
LTC	Lowest Two-Way Channel
M	More Data Bit
MBS	M-bit Sequence
MC	Multiple Carrier
MCCP	Message Connection Control Part

APPENDIX 2
ACRONYMS AND ABBREVIATIONS

MCDU	Multifunction Control Display Unit
MCS	Maritime Communications Sub-System (on INTELSAT-V)
MESS	Message
MESS(Q,AES)	Message with that Q value from that AES
MESSQ	Message with that Q value
MHz	Megahertz
Mic	Microphone
ML	Message Length
Modem	Modulator/demodulator
MOS	Mean Opinion Score
MP	Middle plug insert section on an ARINC 600 connector.
MP	Reference Number for a message sent on P-Channel
MP(Q)	MP for that Q value
MR	Reference number for a message sent on R-Channel
MR(Q)	MR for that Q value
MRT	Modified Rhyme Test
ms	milliseconds
µs	micro second
MSB	Most Significant Bit
Msg	Message
MSK	Minimum Shift Keyed
MT	Reference Number for a message sent on a TDMA channel
MTCN	Minimum Throughput Class Negotiation
MU	Management Unit
MUX	Multiplexer
N	Number of SUs in burst
NA	Not Available
NAK	Negative Acknowledgement
NAKRES (ISU)	T-Channel acknowledge signal indicating error and the corresponding reservation
NAKRES	Negative Acknowledge signal with Reservation
NAKRES(SSU)	T-Channel acknowledge signal indicating specific SUs in error
NAKRFC	T-Channel acknowledge signal indicating specific SUs in error and the delay before the associated RES (NAKRES) should arrive
NATS	North American Terrestrial Systems
NC	Network Connection
NCC	Network Control Circuit

APPENDIX 2
ACRONYMS AND ABBREVIATIONS

NCS	Network Coordination Station
NCT	Network Control Terminals
Net	Network
Ng	Number of GESs in a table of GES names.
NICI	Network Interface Control Information
NOTAM	Notice to Airmen
NPCI	Network Protocol Control Information
NPDU	Network Protocol Data Unit
NS	Network Service
NSAP	Network Service Access Point
NSDU	Network Service Data Units
OALP	Outgoing Aeronautical Logic Procedures
OAPSP	Outgoing Aeronautical Physical Signalling Procedures
OCC	Operations Control Center
Octet	A not-necessarily-related group of eight bits, e.g., eight discrete status and/or control bits grouped together into a field that can be processed as an eight-bit byte.
Off-hook	The condition of a telephone circuit where it is in use. The transition from on-hook to off-hook signals that an annunciated call has been answered.
On-hook	The condition of a telephone circuit where it is not in use, or where the previous call has just been terminated.
OQPSK	Offset Quadrature Phase Shift Keying
ORT	Owner (or owner's) requirements table; a data base in the SDU, which can be partitioned, to set various options relevant to different owner/operator/user preferences and aircraft configurations.
OSI	Open Systems Interconnection
PA	Power Amplifier
PABX	Automatic PBX
PACK	P-Channel Acknowledge Signal
$PACK_e$	PACK indicating Specific SUs in error
$PACK_o$	PACK indicating no Error (Figure S16B, Attachment 2X)
$PACK_r$	PACK indicating Message Retransmission (Figure S16B, Attachment 2X)
PAK	P-channel Acknowledgement block
PBX	Private branch exchange (i.e., automatic or manual on-site telephone switching system).
PCI	Protocol Control Information
PCM	Pulse Code Modulation
Pd	P-Channel used for data

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ACRONYMS AND ABBREVIATIONS

PDN	Public Data Network
PDU	Protocol Data Unit
PFD	Power Flex Density
PLO	Phase Locked Oscillator
PLP	Packet Layer Protocol
PM	Phase Modulation
PMA	P-channel Message Assembler
PN	Pseudo Noise
POLREQ	Poll Request
POP	Retrieve a value from a stack
POR	Pacific Ocean Region
Preempt	The process of immediately and ruthlessly seizing needed telephone call resources from a lower-priority call in order to support a higher-priority call (which is typically cockpit-initiated). Contrast with camp-on.
Preselect	The ability to select a phone number from a data base list of numbers/mnemonics but not placing the call until a subsequent action.
Priority	One of four levels of circuit-mode call relative importance used in the Inmarsat satcom system for making preemption and other decisions. The priority codes are assigned as follows: 1: Distress/urgency 2: Flight safety, direction finding 3: Other safety & regularity of flight 4: Non-safety (private and public communications)
PSK	Phase Shift Keying
Psmc	P-Channel used for SMC functions
PSTN	Public Switched Telephone Network
PTCPROC	P-Channel Transmit Process (Part of PQU Block)
PTP	P-Channel Transmit Process (Process in PT block)
PTT	Post, Telephone and Telegraph
PTT	Press-to-Test
PTT	Push-to-Talk
PUSH	Store a value on a Stack
PVC	Permanent Virtual Circuit
Q	Precedence value indicating the number of the queue used for transmission
Q_{ISU}	Q value in Received Initial Signal Unit
QOS	Quality of Service
QPSK	Quadrature Phase Shift Keying
Q_{SSU}	Q value at the top of a stack of Q values

APPENDIX 2
ACRONYMS AND ABBREVIATIONS

QU	Queuing Unit
QUEUE	Holding Buffer for Signal Units awaiting transmission
RACK	R-Channel Acknowledge Signal
$RACK_e$	RACK indicating Error
$RACK_o$	RACK indicating No Error
$RACK_r$	RACK indicating Message Retransmission
RAK	R-Channel Acknowledgement block
RB	Reference Burst
RBA	Reference Burst A
RCORRECTION	
(Q,AES)	Process in block RAK for sending signals to request retransmission of a message
Rd	R-Channel used for data
Ref	Reference
REPEATREQ(Q)	Process in Block PAK for sending signals to request a repeat of a complete message, of that
REQ	Access Request Signal (Figures S4A and S4B, Attachment 2X)
REQPROC	Request Process (Block TRG)
RES	Reservation TDMA Channel Assignment Signal (Figure S13, Attachment 2X)
RET	Return
Rev	Revision
RF	Radio Frequency
RFC	Reservation Forthcoming Signal
RFC	Reservation Forthcoming Signal (Attachment 2X, Figure S13)
RFCPROC	Reservation Forthcoming Process (Block TRG)
RFM	RF Monitor
RFU	Radio Frequency Unit
RFU	Radio Frequency Unit
RHCP	Right Hand Circular Polarization
RLS	Reliable Link Service
RMP	Radio Management Panel
RND(0, x)	Random integer in the range 0 to x
RQA	Request for Acknowledge signal
RQA(Q)	RQA for that Q value
RQU	R-Channel Queuing Unit (Figure 41A, Attachment 4X)
RR	Repeat Request
RREQPROC	R-Channel Request Process (Block TRG)

APPENDIX 2
ACRONYMS AND ABBREVIATIONS

RS	Reed Solomon
RSCMA	Return Sub-band C-Channel Message Assembler (Figure 45B, Attachment 2X)
RSCT	Return Sub-band C-Channel Transmit (Block) (Figure 45A, Attachment 2X)
Rsmc	R-Channel used for SMC functions
RSS	Root-Sum-Square
RTP	R-channel Transit Process
RTX EXPECTED	Flag
RTX	Retransmission message, comprising the retransmission header ISU (Figure S16, Attachment 2X) followed by a sequence of one or more SSUs
RTX(Q)	RTX for a given precedence value (i.e., Q)
RTXPROX	
(Q,GES)	R-Channel Transmit Process (Part of RQU Block)
SAL	System Address Label
SARPs	Standards and Recommended Practices
SAT	Satellite or satcom
SATCOM	Satellite Communications
SBA	Stand-by Burst Allocation
SCC	Satellite Control Center
SCDU	Satcom control/display unit; typically an MCDU.
SCPC	Single Channel per Carrier
SDL	Specification and description language
SDM	Inmarsat Aeronautical System Definition Manual
SDU	Satellite Data Unit
sec	second(s)
SELCAL	Selective Calling
SF	Super Frame
SFN	Starting Frame Number
SFPROC	Stored Reservation Synchronization Process (Block TRS)
SICASP	SSR Improvements and Collision Avoidance Panel
SIG	(Telephony) Signaling Process
SLCV	Source/location/class/value; a code used within the satcom call signaling to indicate the specific state of a call attempt for reason for a call failure or termination.
SLOT SYNCHRO	Timing pulse/signal indicating the start of a TDMA channel slot (about 8 milliseconds)
SMC	System Management and Communication
SN	Subnetwork

APPENDIX 2
ACRONYMS AND ABBREVIATIONS

SNC	SubNetwork Connection
SNPCI	SubNetwork Protocol Control Information
SNPDU	SubNetwork Protocol Data Unit
SNR	Signal-to-Noise Ratio
SNRES	Short-term Next Reservation Process (Block TRH)
SNS	SubNetwork Service
SNSDU	SubNetwork Service Data Unit
SOATRF	Start of Aircraft Transmit Reporting Frame
SOATTCF	Start of Aircraft Transmit Terminal Control Frame
SOH	Start of Header
SOITDF	Start of Inbound Transmit Data Frame
SOITMF	Start of Inbound Transmit Master Frame
SORDF	Start of Receive Data Frame
SORMF	Start of Receive Master Frame
SORSF	Start of the Receive Super Frame
SOTSF	Start of Transmit Super Frame
SPITE	Switching Processing Interface Telephony Event
Spot (beam)	A beam of a satellite focussed on a particular area of the earth in order to increase the gain and decrease the amount of RF power required to complete the communications link. Most Inmarsat spot beams cover an area about the size of the North American continent. Contrast with a global beam, which for the Inmarsat satellites (in geosynchronous orbit) covers approximately 1/3 of the earth.
SQI	Signal quality index (a measure of received signal quality).
SSM	Sign Status Matrix
SSND	Satellite Sub-Network Dependent
SSNL	Satellite Sub-Network Layer
SSR	Secondary Surveillance Radar
SSU	Subsequent Signal Unit
STACK	Last-in, First-out holding buffer
SU	Signal Unit
SUT	System Under Test
SVC	Switched Virtual Circuit
T1, T2, T3	Timers used in the WSCI protocol.
TA1, TA2, etc.	Timers used in the protocol between the AES and a GES.
TACK	T-Channel acknowledge signal indicating no errors (Figure S16C, Attachment 2X)
$TACK_e$	TACK indicating Error

APPENDIX 2
ACRONYMS AND ABBREVIATIONS

$TACK_o$	TACK indicating No Error
$TACK_r$	TACK indicating Message Retransmission
TBD	To be determined
TCC	Terminal Control Circuit
TCN	Throughput Class Negotiation
TCORRECTIONQ	Process for RLS message supervision (Block TAK)
TDM	Time Division Multiplex
TDMA	Time Division Multiple Access
TDSAI	Transit Delay Selection and Indication
TFTS	Terrestrial Flight Telephone System
TIFU	Terminal Interface Functional Unit
TP	Top plug insert section on an ARINC 600 connector.
TP	Transport Protocol
TPDU	Transport Protocol Data Unit
TPS	Transport Protocol Selector
Transit (call)	The ability to place a phone call through a GES other than the log-on GES. Can be useful in minimizing additional satellite hops and their resultant additional propagation delay that result in more difficult voice communication.
TREQPROC	T-Channel Request Process (Block TRG)
TRS	TDMA Reservation Synchronizer (Block and Process)
TSDU	Transport Service Data Unit
TT&C	Tracking Telemetry and Command
TTL	Transistor-Transistor Logic
TTP	T-Channel Transmit Process
TTXPROC	TDMA Channel Transmission Process (Block TQU)
TUP	Telephone User Part of CCITT Signaling System No. 7
TXMESSAGE	Temporary Buffer for a Message to be Transmitted or a Signal containing the Contents of the TXMESSAGE Buffer
TXSU(N)	Process for transmission of a burst of N SUs (Block TTP)
UD	User Data
UP	User Data Process (Network layer)
UW	Unique Word
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio
W	Watts
W/	With
Williamsburg	Name for the file transfer protocol specified in ARINC 429 Part 3.

APPENDIX 2
ACRONYMS AND ABBREVIATIONS

WSC	Williamsburg SDU Controller
WSCI	Williamsburg SDU Controller interface
XTB	Cross-talk bus (two-way high speed ARINC 429 buses between both SDUs in a dual satcom system).
Zk	Randomization index for the K^{th} repeat attempt
Zo	Initial value of Zk

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SUPPLEMENT 1
TO
ARINC CHARACTERISTIC 741

AVIATION SATELLITE COMMUNICATION SYSTEM
PART 2
SYSTEM DESIGN AND EQUIPMENT FUNTIONAL DESCRIPTION

Published: July 31, 1992

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: October 8-10, 1991

A. PURPOSE OF THIS DOCUMENT

This supplement introduces major revisions to ARINC Characteristic 741 Part 2 to reflect an evolving satellite system. The normal practice of publishing a separate supplement to update an existing document has not been followed.

B. ORGANIZATION OF THIS SUPPLEMENT

Due to the extensive nature of the changes incorporated into this supplement, ARINC Characteristic 741 Part 2 has been produced in its entirety. The typical c-1 markings identifying Supplement 1 changes have not been included in this document.

Copies of the Characteristic bearing the number 741P2-1 already contain this supplement and thus do not require revisions by the reader. Copies of ARINC Characteristic 741 Part 2, adopted by the AEEC October 21, 1988, and published March 15, 1989, should be considered obsolete.

C. CHANGES TO ARINC CHARACTERISTIC 741 INTRODUCED BY THIS SUPPLEMENT

ARINC Characteristic 741 Part 2 has undergone major revisions both in format and technical content. The original document described avionics capable of operating in two different systems environments. These were identified as the Frequency Division Multiple Access (FDMA) environment, in which the use of FDMA techniques predominated and the Time Division Multiple Access (TDMA) environment in which the TDMA techniques predominated.

The format of the text of the original Part 2 was unique. When the material in the document applied equally to operations in both environments, it was located on the pages centrally between the left- and right-hand margins. When it applied only to operations in the FDMA environment, it was located in the left-hand column on each page and each paragraph number carried the postscript F. When it applied only to operations in the TDMA environment, it was located in the right-hand column on each page and each paragraph number carried the postscript T. The above format is no longer used.

The FDMA and common material contained in the original document was used as a basis for this document. It was then extensively edited to be consistent with the RTCA Minimum Operational Performance Standards (MOPS), International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPS), and INMARSAT System Definition Manual (SDM).

The TDMA material has not been included in this document. Part 5 has been reserved for this purpose and has been archived for future development.

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SUPPLEMENT 2
TO
ARINC CHARACTERISTIC 741

AVIATION SATELLITE COMMUNICATION SYSTEM
PART 2
SYSTEM DESIGN AND EQUIPMENT FUNCTIONAL DESCRIPTION

Published: February 28, 1994

Prepared by the Airlines Electronic Engineering Committee

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

A. PURPOSE OF THIS DOCUMENT

This supplement introduces new material on Data-2 services and an AES Frequency Check Algorithm. Updates were made to the Owner Requirements Table and all references to the Facsimile Interface Unit (FIU) have been deleted and/or replaced with Terminal Interface Function Unit (TIFU).

B. ORGANIZATION OF THIS SUPPLEMENT

The first part of this document, printed on buff-colored paper contains descriptions of changes introduced into this Characteristic by this supplement. The second part consists of replacement white pages for the Characteristic, modified to reflect the changes. The modified and added material on each page is identified by a c-2 in the margins. Existing copies of ARINC Characteristic 741-1 Part 2 may be updated by simply inserting the replacement white pages where necessary and destroying the pages they replace. The buff-colored pages are inserted inside the rear cover of the Characteristic.

C. CHANGES TO ARINC CHARACTERISTIC 741 INTRODUCED BY THIS SUPPLEMENT

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

3.0 System Design

Section updated briefly to describe other parts of ARINC Characteristic 741.

3.0.1 Overview

New text was added to the fifth paragraph indicating that Data-2 and Data-3 modes are permitted. The Data-2 definition was also clarified.

3.3 Data-3 Packet-Mode SubNetwork Services

Data-3 was added to the section title.

3.3.4 Satellite SubNetwork Access Protocol

A Data-3 reference was added.

3.5.4.1.1 AES Frequency Check Algorithm

This section added.

3.6 Data-2 Packet-Mode Data Service

This section added.

3.6.1 Link Layer Features

This section added.

3.6.2 Data-2 Packet-Mode Services

This section added.

3.6.3 Data-2 Service Features

This section added.

3.6.4 Data-2 Access Protocol

This section added.

3.6.5 Data-2 Message Format

This section added.

4.2.3.4.1 Aircraft Earth Station Address (AES)

The 24-bit ICAO Technical Address was changed to 24-bit ICAO SSR Mode S Address.

4.3.2.1.1 ISO 8208 Protocol Implementation Conformance Statement

Item 11, Extended Packet Sequence Numbering, was deleted and the remaining items were renumbered.

4.3.2.1.2 AES Specific Service Interface Requirements

Since the D-bit procedure is not supported the non standard default window size of 12 packets for each direction was deleted.

4.3.2.2 Satellite SubNetwork Sublayer

SNSDUs was changed to SNPDUs on the third line of the first paragraph.

4.3.3.3.1 Data Transfer Procedure

The sixth paragraph was deleted because the requirement had the adverse effect of reducing throughput and increasing delays. For proper operation of networks, flow control in various subnetworks should not be directly linked to each other.

4.3.3.3.2 Flow Control Procedure

SNPU was changed to SNPDU on the third line of the second paragraph.

4.4.3.1 General

References to FIU deleted from this section.

4.4.3.2.1 Call Setup Procedure

References to FIU deleted from this section. New paragraph added for TIFU option. Reference to DIU option added.

4.4.3.2.2 Data Mode Activation Procedure (DIU)

References to FIU deleted from this section. Reference note to Attachment 3X added.

4.4.3.2.3 Data Mode Deactivation Procedure DIU)

References to FIU deleted from this section. Reference note to Attachment 3X added.

4.4.3.3 Analog-Interconnect Services

Reference to activation and deactivation of data mode by AES deleted from first paragraph. TIFU circuit-mode option added to first paragraph. Reference to TIFU and DIU added to second paragraph; FIU deleted. Reference to Attachment 3X added.

4.4.3.3.1 Circuit-Mode Data Channel Format (DIU Option)

DIU option added to section title.

4.4.3.3.2 Forward C-channel Burst Mode Operation (DIU Option)

DIU option added to section title. The second sentence of the first paragraph was deleted. The third paragraph was deleted.

4.4.4.2 SubNetwork Access Protocol

The second and third paragraphs were deleted and a reference was made to ARINC Characteristic 746, Attachment 11.

4.4.4.3 Protocol Interworking Scheme

This Section and Sections 4.4.4.3.1, 4.4.4.3.1.1, 4.4.4.3.1.2 and 4.4.4.3.1.3 were deleted. However, Section number 4.4.4.3. and 4.4.4.3.1 have been retained in order not renumber the sections that follow.

4.4.4.3.1 Cabin Services

This section was deleted.

4.4.4.3.1.1 Connection Establishment: Air-to-Ground (Inbound) Call

This section was deleted.

4.4.4.3.1.2 Connection Establishment: Ground-to-Air (Outbound) Call

This section was deleted.

4.4.4.3.1.3 Connection Termination: Air-to-Ground Initiated

This section was deleted.

4.4.4.3.2.1 Connection Establishment: Air-to-Ground Call

This section was edited to allow the call lamp indication to be made at the same time as the chime and to clarify how the chime reset functions.

4.4.4.3.2.2 Connection Establishment: Ground-to-Air Call

This section was edited to expand the definition of the Owner Requirements Table option to include routing APC calls to the cockpit as well as to the analog and digital cabin phones.

4.4.4.3.2.3 Connection Termination: Air/Ground Initiated

A new sentence was added at the end of the second paragraph.

4.4.4.3.2.4 Other Call Signaling Requirements

The second paragraph was deleted.

4.4.5.2 Ground-to-Air Call Procedures

Changes and additions were made to update the Ground-to-Air call routing procedures in accordance with INMARSAT and ICAO standards.

4.5.2.3 Owner Requirements Table

New text was added preceding the optional and default tables. Certain items in the optional table were marked as the minimum set that should be accommodated. This section was edited to expand the definition of the Owner Requirements Table option to include routing APC calls to the cockpit as well as to the analog and digital cabin phones. Items (l) and (m) were added to the optional and default settings.

4.6 Data-2 Packet-Mode Data Service

This section added.

4.6.1 Link Layer Functions

This section added.

4.6.2 Data-2 Structure

This section added.

4.6.3 Internetworking Functions

This section added.

4.6.3.1 Data-2 Transmit

This section added.

4.6.3.2 Data-2 Receive

This section added.

4.6.3.3 Logged On Status

This section added.

4.7 ACARS MU/CMU - SATCOM Interface

This section added.

4.7.1 Overview

This section added.

4.7.2 Physical Interface

This section added.

4.7.3 Link Layer - Broadcast

This section added.

4.7.3.1 SDU to ACARS MU/CMU Status Word

This section added.

4.7.3.2 ACARS MU/CMU to SDU Status Word

This section added.

4.7.4 Link Layer - Bit Oriented FTP

This section added.

4.7.4.1 File Formats

This section added.

4.7.4.2 Data-2 Enveloped Messages

This section added.

4.7.4.3 8208 Packets

This section added.

4.7.4.4 Command/Control File

This section added.

4.7.5 Command/Control Interface

This section added.

4.7.5.1 Command/Control Overview

This section added.

4.7.5.2 Command/Control Format

This section added.

4.7.6 ACARS Peripheral Functionality

This section added.

4.8 Provisions for Dual SATCOM

This section added.

4.8.1 SDU #1/SDU #2 Programming Pins

This section added.

4.8.2 Master/Slave Definition

This section added.

4.8.3 System Select and Disable Discretes

This section added.

4.8.4 Manual System Selection Criteria

This section added.

4.8.5 Automatic System Selection Criteria

This section added.

4.8.6 Recovery Criteria

This section added.

4.8.7 Interface Operation in a Dual System

This section added.

4.8.7.1 CMU Interface Operation

This section added.

4.8.7.2 CFDS Interface Operation

This section added.

4.8.7.3 SCDU Interface Operation

This section added.

4.8.7.4 Cockpit Voice Interface Operation

This section added.

4.8.7.5 Cabin Telephone Interface Operation

This section added.

ATTACHMENT 2F-40.1 - AVIONICS INTERCONNECTION DIAGRAM VOICE SERVICES

STIU was changed to CTU.

ATTACHMENTS 2F-40.2 THROUGH 2F-40.5 INCLUSIVE.

The contents of these attachments were deleted. However, the attachment numbers were retained so as not to renumber the remaining attachments. This was done for the convenience of industry which reference ARINC Characteristic 741 attachment numbers.

ATTACHMENT 2F-40.6 - COCKPIT - SATELLITE NETWORK PROTOCOL INTERWORKING AIR-TO-GROUND CALL ESTABLISHMENT

This attachment was modified to provide Lamp-On Steady visual and Chime-On Once aural call indications from the SDU to the AMP/ACP. In addition, Telephony_Ack was added from the SDU to the Satellite Network.

ATTACHMENT 2F-40.7 - COCKPIT - SATELLITE NETWORK PROTOCOL INTERWORKING GROUND-TO-AIR CALL ESTABLISHMENT

Telephony_Ack was added from the Satellite Network to the SDU.

ATTACHMENT 2F-40.9

Note added to bottom of page indicating that Attachments 2F-40.10 through 2F-40.14, pages 75 through 79, were deleted.

ATTACHMENTS 2F-40.10 THROUGH 2F-40.14 INCLUSIVE.

These attachments, pages 75 through 79, were deleted. However, the attachment numbers were retained so as not to renumber the remaining attachments. This was done for the convenience of industry which reference ARINC Characteristic 741 attachment numbers.

ATTACHMENT 2F-40.16 - MAPPING OF Q.931 MESSAGES TO SSND MESSAGES

The Voice Channel Characteristics bullets were deleted from the Q.931 SETUP to SSND ACCESS REQUEST and the SETUP to CALL ANNOUNCEMENT blocks. The reference to Attachment 2F-40.17 was changed to reference ARINC Characteristic 746.

ATTACHMENT 2F-40.16b - MAPPING OF Q.931 MESSAGES TO SSND MESSAGES

The FACILITY to CALL PROGRESS block was deleted as well as two notes.

ATTACHMENT 2F-40.16c - MAPPING OF Q.931 MESSAGES TO SSND MESSAGES

The reference to Attachment 2F-40.18 was changed to reference ARINC Characteristic 746.

ATTACHMENT 2F-40.17 - CODING OF Q.931 NETWORK SPECIFIC FACILITIES INFORMATION ELEMENT

This Attachment was deleted.

ATTACHMENT 2F-40.18 - CODING OF THE FACILITY INFORMATION ELEMENT COMPONENTS AS PER CCITT RECOMMENDATION Q.932

This Attachment was deleted.

ATTACHMENT 2F-42 - OPERATIONAL DESCRIPTION OF AVIATION SATELLITE AUDIO CHANNELS

The Pilot Procedures and Pilot System Interfaces areas were edited for clarity. Activation of Call Cancel discretes associated with SATCOM Call lights was added as a way to terminate a call.

ATTACHMENT 2F-44 - DATA-2 PROTOCOL DATA UNIT

This Attachment was added.

ATTACHMENT 2X - ANNEX 1 - SIGNAL INFORMATION ELEMENT CODING

Reference to DIU option added to Item 14a; change made to last two entries in first table. Reference to DIU option added to Item 14b.

APPENDIX 2 - SATCOM FREQUENCY CHECK ALGORITHM IMPLEMENTATION EXAMPLES

This Appendix was added. The old Appendix 2 has been renumbered to Appendix 3.

Appendix 3 - GLOSSARY OF TERMS AND ABBREVIATIONS

This Appendix was formerly in Appendix 2.

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SUPPLEMENT 3
TO
ARINC CHARACTERISTIC 741

AVIATION SATELLITE COMMUNICATION SYSTEM
PART 2
SYSTEM DESIGN AND EQUIPMENT FUNCTIONAL DESCRIPTION

Published: December 30, 1994

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: October 20, 1994

A. PURPOSE OF THIS DOCUMENT

This supplement introduces new material on Data-2 services and an AES Frequency Check Algorithm. Updates were made to the Owner Requirements Table and all references to the Facsimile Interface Unit (FIU) have been deleted and/or replaced with Terminal Interface Function Unit (TIFU).

B. ORGANIZATION OF THIS SUPPLEMENT

The first part of this document, printed on buff-colored paper contains descriptions of changes introduced into this characteristic by this supplement. The second part consists of replacement white pages for the characteristic, modified to reflect the changes. The modified and added material on each page is identified by a c-2 in the margins. Existing copies of ARINC Characteristic 741-1 Part 2 may be updated by simply inserting the replacement white pages where necessary and destroying the pages they replace. The buff-colored pages are inserted inside the rear cover of the characteristic.

C. CHANGES TO ARINC CHARACTERISTIC 741 INTRODUCED BY THIS SUPPLEMENT

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

PAGE xiii - LIST OF CHANGE NOTICES FOR THE TABLES IN ATTACHMENT 2X

List of change notices deleted.

PAGES xiv through xx - LIST OF CHANGE NOTICES FOR THE FIGURES IN ATTACHMENT 2X

List of change notices deleted.

PAGE xxi - LIST OF CHANGE NOTICES FOR THE ANNEXES IN ATTACHMENT 2X

List of change notices deleted.

3.5.4.1.1 AES Frequency Check Algorithm

The AES Frequency Check Algorithm was revised.

4.3.4.3.1 DTE Address Format & Characteristics

The optional on-board terminal number D digit definition was added.

4.4.4.3 Protocol Interworking Scheme

STAFF NOTE was deleted.

4.4.4.3.2.2 Connection Establishment: Ground-to-Air Call

This section was edited to expand the definition of the SDU routing calls according to priority.

4.5.2.3 Owner Requirements Table

Item (n) concerning bit 14 of label 270, SDU to ACARS, was added to the optional and default settings.

4.7 ACARS MU/CMU - SATCOM Interface

Text added to indicate this section applies for the case of the DTE address D digit being absent or equal to zero.

4.7.3.1 SDU to ACARS MU/CMU Status Word

The titles and/or definitions of Bits 11, 18, 19, 20, 21, 22, 23, 24, and 25 were edited. The definition of Bit 13, Voice Resources, was replaced with a definition for SATCOM Voice Unavailable. The definition of Bit 14, SELCAL, was expanded to include ground initiated and air initiated calls. The second labeled Bit 26 was changed to Bit 27. Bit 28, SATCOM LGA Subsystem Failure, and Bit 29, SATCOM Data were added.

4.7.4 Link Layer - Bit Oriented FTP

The first sentence was updated to indicate that the Bit-oriented Communications Protocol is also known as the Williamsburg protocol. A reference to ARINC Specification 429 Table 10-5 was added for High Speed applications. A reference to ARINC Specification 618 was deleted as it only covers the case of the MU and not the CMU. The BOP Table of options was updated to be consistent with ARINC Specification 618 and ARINC Specification 748 for both the MU and CMU. Note 1 was added.

4.7.4.1 File Format

Williamsburg was added before General Format Identifier in the first sentence and before GFI in the last sentence. SOH was changed to SOT in the second sentence. The table was updated to provide missing information and the 8208 Packets row GFI code was changed from 0001b(1h) to 0100b(4h).

4.7.4.2 Data-2 Enveloped Messages

Williamsburg was added to the first sentence.

4.7.4.3 8208 Packets

Text was added to indicate that the first octet of the NPDU is an initial protocol identifier (IPI) coded per ISO 9577. Additional information about the IPI is included.

4.7.4.4 Command/Control File

Williamsburg was added to the first sentence.

4.9 CPDF - SATCOM Interface

New section added.

4.9.1 Overview

New section added.

4.9.2 Physical Interface

New section added.

4.9.3 Link Layer - Broadcast

New section added.

4.9.3.1 SDU to CPDF Status Word

New section added.

4.9.3.2 CPDF to SDU Status Word

New section added.

4.9.4 Link Layer - Bit Oriented File Transfer Protocol

New section added.

4.10 CTU - SATCOM Interface for Packet-Mode Data

New section added.

4.10.1 Overview

New section added.

4.11 HGA With LGA Backup

New section added.

4.12 Use of HGA Below 7 dBi Reported Antenna Gain

New section added.

ATTACHMENT 2F-38.2 - TRANSIT DELAY FACILITY FORMATS

Attachment with Figures F3 and F4 deleted.

ATTACHMENT 2F-38.3 - THROUGHPUT CLASS FACILITY FORMATS

Attachment with Figures F5 and F6 deleted.

ATTACHMENT 2F-38.5 - FAST SELECT AND EXPEDITED DATA FACILITY FORMATS

Attachment with Figures F9 and F10 deleted.

ATTACHMENT 2F-40.16a - MAPPING OF Q.931 MESSAGES TO SEND MESSAGES

Channel Rise changed to Channel Release on Disconnect - Call Progress block.

ATTACHMENT 2F-40.16b - MAPPING OF Q.931 MESSAGES TO SEND MESSAGES

Channel Rise changed to Channel Release on Release Complete - Call Progress block.

ATTACHMENT 2F-40.16c - MAPPING OF Q.931 MESSAGES TO SEND MESSAGES

Direction of arrowheads corrected on Facility - Call Progress and Information - Supplementary Signal blocks.

ATTACHMENT 2F-42 - OPERATIONAL DESCRIPTION OF AVIATION SATELLITE AUDIO CHANNELS

RMS added after milliwatts in Pilot System Interfaces section. Corrections made to Figures 1 and 2.

ATTACHMENT 2X

Attachment 2X has been replaced with a reference to the Inmarsat Aeronautical System Definition Manual (SDM) Module 1, Version 1.39.

ATTACHMENT 2Y

Attachment 2Y has been replaced with a reference to the Inmarsat Aeronautical System Definition Manual (SDM) Module 2, Version 1.15.

APPENDIX 1 - APPLICATION OF THE OPEN SYSTEM INTERCONNECT (OSI) MODEL TO THE AVIATION SATELLITE SYSTEM

Network Interface Control Information (NICI) changed to Network Protocol Control Information (NPCI).

APPENDIX 2 - SATCOM FREQUENCY CHECK ALGORITHM IMPLEMENTATION EXAMPLES

Examples A and B as well as the illustration showing the relationship between two transmit channels and the associated intermodulation products have been replaced.

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SUPPLEMENT 4
TO
ARINC CHARACTERISTIC 741

AVIATION SATELLITE COMMUNICATION SYSTEM
PART 2
SYSTEM DESIGN AND EQUIPMENT FUNCTIONAL DESCRIPTION

Published: December 8, 1995

Prepared by the Airlines Electronic Engineering Committee

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

A. PURPOSE OF THIS DOCUMENT

This supplement introduces changes to the Ground-to-Air Call Procedures, Owner Requirements Table, Link Layer-Broadcast, Master/Slave Definition, System Select and Disable Discretes, Manual System Selection Criteria, and Interface Operation in a Dual System. A new ATC Call Management Section was added.

B. ORGANIZATION OF THIS SUPPLEMENT

The first part of this document, printed on buff-colored paper contains descriptions of changes introduced into Characteristic 741, Part 2, by Supplement 4. The second part consists of replacement white pages for Characteristic 741, Part 2, modified to reflect the changes. The modified and added material on each page is identified by a c-4 in the margins. Existing copies of ARINC Characteristic 741, Part 2, may be updated by simply inserting the replacement white pages where necessary and discarding the pages they replace. The buff-colored pages are inserted inside the rear cover of the characteristic.

C. CHANGES TO ARINC CHARACTERISTIC 741 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete tabulation of the changes and additions to Characteristic 741, Part 2, introduced by Supplement 4. Each change or addition is defined by the section number and the title currently employed in Characteristic 741, Part 2. In each case a brief description of the change or addition is included.

4.4.4.3.2.1 Connection Establishment: Air-to-Ground Call

A hookswitch signaling change was made to provide a Place ATC Call capability from the ACP.

4.4.4.3.2.3 Connection Termination: Air/Ground Initiated

Call Cancel was changed to Place/End Call.

4.4.5.2 Ground-to-Air Call Procedures

Updated the Terminal Identification handling to allow Ground-to-Air calls to be completed.

4.5.2.3 Owner Requirements Table

Updated ORT (item h) and added new ORT (item o) as part of the hookswitch signaling change to provide a Place ATC Call capability from the ACP. Added new ORT (item p) for mapping physical channels to logical channels for dual SATCOM systems.

4.7.3 Link Layer - Broadcast

Changed 270 to 27x to accommodate label 271, and possible future labels.

4.7.3.1 SDU to ACARS MU/CMU Status Word

Added first sentence and descriptions of SDI bits 9-10 and SSM bits 30-31. Added text for bit 14 to hold bit 14 in the set state nominally four seconds. Added text for bit 28 for dual-SDU systems. For bit 29 changed (C)MU to ACARS MU/CMU in several places. Added text after bit 31 indicating that for dual SATCOM systems, all general status bits should have either local or global significance. Identified dual system significance for bits 11 through 29.

4.7.3.2 ACARS MU/CMU to SDU Status Word Call

Edited first sentence. Added SDI bits 9-10 and SSM bits 30-31.

4.7.3.3 SDU to ACARS MU/CMU Join/Leave Message

New section was added.

4.7.3.4 SDU to EICAS/ECAM/EDU for Dual SATCOM Label 276

New section was added.

4.8.2 Master/Slave Definition

Edited last paragraph for consistency with changes to Sections 4.8.7.3 and 4.8.7.4.

4.8.3 System Select and Disable Discretes

Changes made to describe how dual system management is implemented.

4.8.4 Manual System Selection Criteria

Editorial changes. Added text to describe an optional external switching case of disabling both systems simultaneously.

4.8.7.3 SCDU Interface Operation

Updated first paragraph to be less restrictive in view of optionally having the Slave as well as the Master provide cockpit voice. Master/Slave distinction may not be necessary.

4.8.7.4 Cockpit Voice Interface Operation

Updated to be less restrictive in view of optionally having the Slave as well as the Master provide cockpit voice. Added reference to ORT (item p) in Section 4.5.2.3 for mapping AMS/ACP logical channels to dual system physical channels.

4.8.7.5 Cabin Telephone Interface Operation

Updated to maximize call setup probability on the first attempt and to minimize call setup time.

4.9.3 Link Layer - Broadcast

Changed 270 to 27x to accommodate label 271, and possible future labels.

4.9.3.1 SDU to CPDF Status Word

Added label 270 in first sentence. Changed (C)MU to ACARS MU/CMU.

4.9.3.2 CPDF to SDU Status Word

Edited first sentence. Added SDI bits 9-10 and SSM bits 30-31.

4.9.3.3 SDU to CPDF Join/Leave Message

New section added.

4.13 ATC Call Management

New section added.

ATTACHMENT 2F-42 OPERATIONAL DESCRIPTION OF AVIATION SATELLITE AUDIO CHANNELS

Changed Call Cancel to Place/End Call in three places. Reinstated Figure 2 title.

APPENDIX 3 - ACRONYMS

Changed title and updated.

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SUPPLEMENT 5
TO
ARINC CHARACTERISTIC 741

AVIATION SATELLITE COMMUNICATION SYSTEM
PART 2
SYSTEM DESIGN AND EQUIPMENT FUNCTIONAL DESCRIPTION

Published: November 15, 1996

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: October 22, 1996

A. PURPOSE OF THIS DOCUMENT

This supplement includes updates for the AES Specific Service Interface, Packet-Mode Data-3 operation, constructing the complete AES DTE address, SELCAL Bit 14 of the SDU to ACARS MU/CMU Status Word, and the Power Budget Management definition of available EIRP. A new Data Qualifier Section was added as well as a newly defined bit 13, No IRS Data, for SDU to EICAS/ECAM/EDU, and a new definition for use of HGA below 7 dBi reported antenna gain.

B. ORGANIZATION OF THIS SUPPLEMENT

This supplement introduces a rework of ARINC Characteristic 741, Part 2 to reflect an evolving Satellite Communication system. The normal practice of publishing a separate supplement to update the existing document has not been followed. The changes introduced by Supplement 5 has resulted in the impracticality of producing a separate set of replacement pages. Supplement 5 is therefore available only as an integral part of ARINC Characteristic 741-5, Part 2. The modified and added material on each page is identified by a c-5 in the margin.

C. CHANGES TO ARINC CHARACTERISTIC 741 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete tabulation of the changes and additions to Characteristic 741, Part 2, introduced by Supplement 5. Each change or addition is defined by the section number and the title currently employed in Characteristic 741, Part 2. In each case a brief description of the change or addition is included.

3.0.3.1 AES Service Levels

Deleted the word “draft” from the first sentence.

4.3.2.1.2 AES Specific Service Interface Requirements

A reference to Attachment 2F-39 was added. The type of circuits supported and the range of logic channel numbers were added.

4.3.2.2.2 Logical Channel Number

Text added to be consistent with Change Notice 70 for the Inmarsat Aeronautical System Definition Manual (SDM), Module 1, Appendix 10, Section 3.5 which redefined Data-3 operation.

4.3.3.3.2 Flow Control Procedure

Text added to be consistent with Change Notice 70 for the Inmarsat SDM Module 1, Section 7.3.3.3.

4.3.3.4 Reset Procedure

Text deleted from Item 2 and Item 6 rewritten to be consistent with Change Notice 70 for the Inmarsat SDM Module 1, Section 7.3.4.

4.3.3.5 Error Procedure

Text added to be consistent with Change Notice 70 for the Inmarsat SDM Module 1, Section 7.3.4.

4.3.3.5.1.1 Log-On Renewal/AES Log-off

Second paragraph was replaced and last paragraph was edited to be consistent with Change Notice 70 for the Inmarsat SDM Module 1, Section 7.3.5.1.1.

4.3.4.3.2 DTE Address Processing

Text added to be consistent with Change Notice 53 for the Inmarsat SDM Module 1, Section 7.3.6.2.2.

4.3.4.3.3 DTE Address Compression and Expansion

Text was added to show how the complete AES DTE address is reconstructed.

4.3.4.5.1 SNC Priority

Text added to be consistent with Change Notice 70 for the Inmarsat SDM Module 1, Section 7.3.6.6.

4.3.4.5.6 Data Qualifier (Optional)

New section was added to be compatible with Change Notice 70 for the Inmarsat Aeronautical SDM, Module 1 Section 7.3.6.11.

4.4.4.3.2.2 Connection Establishment: Ground-to-Air Call

In the third paragraph, deleted “with Service ID = 1” and “; For Priority 4 calls with Service ID not = 1, routing is TBD.”

4.5.4.1 Power Budget Management

Replaced the table with a new definition for available EIRP and added commentary.

4.7.3.1 SDU to ACARS MU/CMU Status Word

Bit 14 was rewritten to reflect hold time requirements that have evolved and to reference ORT item n.

4.7.3.4 SDU to EICAS/ECAM/EDU (Label 276)

Added new bit 13 definition for No IRS Data.

4.12 Use of HGA Below 7 dBi Reported Antenna Gain

Added definition for use of HGA below 7 dBi reported antenna gain.

ATTACHMENT 2X

Updated reference to Module 1, Version 1.44.

ATTACHMENT 2Y

Updated reference to Module 2 Version 1.18.

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SUPPLEMENT 6
TO
ARINC CHARACTERISTIC 741

AVIATION SATELLITE COMMUNICATION SYSTEM
PART 2
SYSTEM DESIGN AND EQUIPMENT FUNCTIONAL DESCRIPTION

Published: April 30, 1998

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: October 14, 1997

A. PURPOSE OF THIS DOCUMENT

This supplement introduces changes to the Physical Layer, AES Table Management, Log Status Management, and Channel Resource Management areas. References to Parts 3, 4, and 5 were deleted or changed.

B. ORGANIZATION OF THIS SUPPLEMENT

This supplement introduces a rework of ARINC Characteristic 741, Part 2 to reflect an evolving Satellite Communication system. The normal practice of publishing a separate supplement to update the existing document has not been followed. The changes introduced by Supplement 6 have resulted in the impracticality of producing a separate set of replacement pages. Supplement 6 is therefore available only as an integral part of ARINC Characteristic 741-6, Part 2. The modified and added material on each page is identified by a c-6 in the margin.

C. CHANGES TO ARINC CHARACTERISTIC 741 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete tabulation of the changes and additions to Characteristic 741, Part 2, introduced by Supplement 6. Each change or addition is defined by the section number and the title currently employed in Characteristic 741 Part 2. In each case a brief description of the change or addition is included.

3.0 System Design

Deleted the last paragraph with references to Parts 3 and 4. Deleted staff note referencing Part 5.

3.0.1 Overview

Changed CCITT to ITU-T to reflect change in the name of this organization. This editorial change is made throughout the document.

3.4.1 General

Changed reference to Part 3 in the first paragraph to be Attachment 2Z.

4.1 Physical Layer

Replaced the text of Section 4.1 and its Sub-Sections with a short definition of the Physical Layer components and a reference to the Inmarsat Aero SDM.

4.1.1 RF Channel Configuration

Section deleted.

4.1.2 Automatic Frequency Compensation

Section deleted.

4.1.3 Modulation Methods

Section deleted.

4.1.3.1 Modulator

Section deleted.

4.1.3.1.1 Modulator Model

Section deleted.

4.1.3.1.2 Tolerance on Modulator Output

Section deleted.

4.1.3.1.3 Carrier Suppression

Section deleted.

4.1.3.1.4 Amplitude Stability

Section deleted.

4.1.3.1.5 Frequency Stability

Section deleted.

4.1.3.1.6 AQPSK Quadrature Balance

Section deleted.

4.1.3.2 Demodulator

Section deleted.

4.1.3.2.1 Operating Conditions

Section deleted.

4.1.3.2.2 Demodulation Performance

Section deleted.

4.1.3.2.3 Channel Filtering

Section deleted.

4.1.4 Channel Formats

Section deleted.

4.1.4.1 Bit Scrambling

Section deleted.

4.1.4.2 Forward Error Correction (FEC)

Section deleted.

4.1.4.3 Interleaver

Section deleted.

4.1.4.4 Preamble and Postamble

Section deleted.

4.1.4.4.1 Preamble and Unique Word Definition

Section deleted.

4.1.4.4.2 Postamble Definition

Section deleted.

4.1.4.5 Channel Timing

Section deleted.

4.1.4.5.1 P-channel Frame Duration

Section deleted.

4.1.4.5.2 R- and T-channel Transmit Timing

Section deleted.

4.1.4.6 Frame Format

Section deleted.

4.1.4.6.1 P-channel

Section deleted.

4.1.4.6.2 T-channel

Section deleted.

4.1.4.6.3 R-channel

Section deleted.

4.1.4.6.4 R- and T-channel Transmit Operations

Section deleted.

4.1.4.6.5 C-channel Frame

Section deleted.

4.3.4.3.2 DTE Address Processing

Editorial changes in second paragraph.

4.3.4.4.2 NSAP Address Processing

Editorial change in first paragraph.

4.4.3.1 General

Changed reference to Part 3 in the last paragraph to be Attachment 2Z.

4.4.3.2.2 Data Mode Activation Procedure (DIU)

Changed reference to Attachment 3X in the first paragraph to be Attachment 2Z.

4.4.3.2.3 Data Mode Deactivation Procedure (DIU)

Changed reference to Attachment 3X in the first paragraph to be Attachment 2Z.

4.4.3.3 Analog-Interconnect Services

Changed reference to Attachment 3X in the last paragraph to be Attachment 2Z.

4.5.2.1 System Table

Replaced text of Section 4.5.2.1 and its Sub-Sections with a reference to the Inmarsat Aero SDM.

4.5.2.1.1 System Table Update

Section deleted.

4.5.2.1.1.1 System Table Broadcast

Section deleted.

4.5.2.1.1.1.1 Complete Sequence

Section deleted.

4.5.2.1.1.1.2 Partial Sequence

Section deleted.

4.5.2.2 Service Capability Dependent Table

Last paragraph and TBD deleted.

4.5.2.3 Owner Requirements Table

Added new ORT item q introduced by Inmarsat Aero SDM Change Note CN72.

4.5.3 Log Status Management

Replaced the old Sections 4.5.3.1 through 4.5.3.4.5 with the following new Sections 4.5.3.1 through 4.5.3.2.4.4.

4.5.3.1 AES Management

Section added. Former Section 4.5.3.1, AES Joining Network, deleted.

4.5.3.1.1 Selection of Satellite

Section deleted.

4.5.3.1.1.1 System Table Update Prior to Log-On

Section deleted.

4.5.3.1.2 Automatic Selection of Log-On GES

Section deleted.

4.5.3.1.2.1 Spot Beam Selection

Section deleted.

4.5.3.1.2.2 GES Selection

Section deleted.

4.5.3.1.3 Selection of Log-on GES by User Command

Section deleted.

4.5.3.1.4 Log-on Procedure

Section deleted.

4.5.3.1.4.1 Log-on Request

Section deleted.

4.5.3.1.4.2 Log-on Rejection

Section deleted.

4.5.3.1.4.3 Log-on Confirm

Section deleted.

4.5.3.2 Log-on and Handover Procedures

Section added. Former Section, 4.5.3.2 AES Leaving Network, deleted.

4.5.3.2.1 System Log-on/Log-off

Section added.

4.5.3.2.1.1 System Log-on Procedure

Section added.

4.5.3.2.1.2 Log-off Procedure

Section added.

4.5.3.2.1.3 Log-on Verification Procedure

Section added.

4.5.3.2.2 Data Channel Re-assignment Procedure

Section added.

4.5.3.2.3 Handover Procedures

Section added.

4.5.3.2.3.1 Automatic Handover

Section added.

4.5.3.2.3.2 User Commanded GES-to-GES Handover

Section added.

4.5.3.2.3.3 User Commanded Satellite-to-Satellite Handover

Section added.

4.5.3.2.3.4 Spot Beam Handover

Section added.

4.5.3.3 AES Log Status Verification

Section deleted.

4.5.3.3.1 AES Continued Presence

Section deleted.

4.5.3.3.1.1 Direct Log-on Verification

Section deleted.

4.5.3.3.1.2 Log-on Prompt

Section deleted.

4.5.3.3.1.3 Log-on Renewal

Section deleted.

4.5.3.4 Handover

Section deleted.

4.5.3.4.1 Automatic Handover

Section deleted.

4.5.3.4.2 Handover Initiated by User Command

Section deleted.

4.5.3.4.3 GES-GES Handover

Section deleted.

4.5.3.4.4 Spot Beam-Spot Beam Handover

Section deleted.

4.5.3.4.5 Satellite-Satellite Handover

Section deleted.

4.5.4 Channel Resource Management

Replaced the old Sections 4.5.4.1 through 4.5.4.1.2.3 with the following new Sections 4.5.4.1 through 4.5.4.2.5.

4.5.4.1 Data Channel Power Control

Section added. Former Section 4.5.4.1, Power Budget Management, deleted.

4.5.4.1.1 Data Channel Power Control

Section deleted.

4.5.4.1.2 C-Channel Power Control

Section deleted.

4.5.4.1.2.1 Initial EIRP

Section deleted.

4.5.4.1.2.2 Monitoring and Reporting

Section deleted.

4.5.4.1.2.3 Power Adjustment

Section deleted.

4.5.4.2 C-Channel Power Control

Section added. Former Section 4.5.4.2, Transmitter Inhibit, changed to Section 4.5.4.3.

4.5.4.2.1 Power Control Management

Section added.

4.5.4.2.2 AES and GES Requirements for Measuring Bit Error Rate (BER)

Section added.

4.5.4.2.3 Power Control Decision Table

Section added.

4.5.4.2.4 Power Control Operation - Forward Link

Section added.

4.5.4.2.5 Power Control Operation Return Link

Section added.

4.5.4.3 Transmitter Inhibit

Section renumbered. Formerly Section 4.5.4.2.

ATTACHMENT 2C-4 DESIGNATED CHANNEL CHARACTERISTICS

Attachment deleted.

ATTACHMENT 2Z

Attachment added.

APPENDIX 1 - APPLICATION OF THE OPEN SYSTEM INTERCONNECT (OSI) MODEL TO THE AVIATION SATELLITE SYSTEM

Replaced Figure 4 - Aeronautical Data Protocol Reference Model with updated diagram.

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SUPPLEMENT 7
TO
ARINC CHARACTERISTIC 741

AVIATION SATELLITE COMMUNICATION SYSTEM
PART 2
SYSTEM DESIGN AND EQUIPMENT FUNCTIONAL DESCRIPTION

Published: December 24, 2003

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: June 6, 2003

A. PURPOSE OF THIS DOCUMENT

This supplement adds the SDU to EICAS/ECAM/EDU for Dual SATCOM (Label 276) bit 13 dual system significance as Local.

B. ORGANIZATION OF THIS SUPPLEMENT

This Document, printed on goldenrod paper, contains descriptions of changes introduced into Characteristic 741, Part 2 by this supplement. The material in Supplement 7 is integrated into ARINC Characteristic 741, Part 2 to form an updated version of the standard.

Changes introduced by Supplement 7 are identified using change bars and are labeled by a c-7 symbol in the margin.

C. CHANGES TO ARINC CHARACTERISTIC 741 INTRODUCED BY THIS SUPPLEMENT

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

4.7.3.1 SDU to ACARS MU/CMU Status Word

Correction and restored to its previous wording.

4.7.3.3 SDU to ACARS MU/CMU Join/Leave Message

Added bit 25-23 aero service type description.

The last sentence of the Commentary was changed to be as follows:

The Aero Service Type field may be used by the CMU to make routing decisions. e.g., if cost per bit is a routing criterion.

4.7.3.4 SDU to EICAS/ECAM/EDU for Dual SATCOM (Label 276)

Added bit 13 description as Local.

APPENDIX 1 – APPLICATION OF THE OPEN SYSTEM INTERCONNECT (OSI) MODEL TO THE AVIATION SATELLITE SYSTEM

Replaced Figure 4 – Aeronautical Data Protocol Reference Model with updated diagram.

APPENDIX 2 – SATCOM FREQUENCY CHECK ALGORITHM IMPLEMENTATION EXAMPLE

Correction and restored to previous capital Greek letter delta.

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SUPPLEMENT 8
TO
ARINC CHARACTERISTIC 741

AVIATION SATELLITE COMMUNICATION SYSTEM
PART 2
SYSTEM DESIGN AND EQUIPMENT FUNCTIONAL DESCRIPTION

Published: May 31, 2006

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: October 4, 2005

A. PURPOSE OF THIS DOCUMENT

This supplement provides a new Attachment 2F-42.1 for the Williamsburg Satellite Data Unit (SDU) Controller Interface (WSCI) Protocol Definition and revises other areas of the standard to refer to the new attachment. The AES Frequency Check Algorithm and Implementation Example was updated to address frequency management that is appropriate to the type of diplexer/LNA installed and to address the Type D diplexer and SwiftBroadband and high-speed data provisions. The Acronym list in Appendix 3 has been updated.

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 CHARACTERISTIC 741 PART 2 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete tabulation of the changes and additions to the characteristic introduced by this supplement. In each case a brief description of the change or addition is included.

3.4.5 Subnetwork Access Interface

In the second paragraph, changed ARINC 739 compatible SCDUs to SCDUs/WSCs

3.5.4.1.1 AES Frequency Check Algorithm

Section was updated to address frequency management that is appropriate to the type of diplexer/LNA installed and to address the Type D diplexer and SwiftBroadband and high-speed data provisions.

4.4.4.1 Physical Interconnection Scheme

In the second paragraph, changed SCDUs to SCDUs/WSCs. Deleted the last paragraph.

4.4.4.2 Subnetwork Access Protocol

In the second paragraph, changed ARINC 739 compatible SCDUs to SCDUs/WSCs.

4.4.4.3.2.1 Connection Establishment: Air-to-Ground Call

Changed SCDU to SCDU/WSC in five places. In the first paragraph, deleted or Radio Management Panel (RMP). Deleted (or RMP) from two places.

4.4.4.3.2.2 Connection Establishment: Ground-to-Air Call

Changed SCDU to SCDU/WSC in three places. Deleted (or RMP) from two places.

4.4.4.3.2.3 Connection Termination: Air/Ground Initiated

Changed SCDU to SCDU/WSC.

4.7.3.1 SDU to ACARS MU/CMU Status Word

For Bits 15 and 16 descriptions, changed MCDU to MCDU/WSC.

4.8.7.3 SCDU/WSC Interface Operation

Changed the title from SCDU Interface Operation to SCDU/WSC Interface Operation. Changed SCDU to SCDU/WSC in four places.

ATTACHMENT 2F-40.1 - AVIONICS INTERCONNECTION DIAGRAM VOICE SERVICES

Revised attachment to refer to SCDU/WSC and ARINC 741P2 Attachment 2F-42.1 Editorial revisions were added.

ATTACHMENT 2F-40.6 - COCKPIT - SATELLITE NETWORK PROTOCOL INTERWORKING AIR-TO-GROUND CALL ESTABLISHMENT (FOR MCDU/SCDU, NOT WSCI)

Revised title by adding (FOR MCDU/SCDU, NOT WSCI). Added note For WSCI, refer to Attachment 2F-42.1. Changed RMP to SCDU.

ATTACHMENT 2F-40.7 - COCKPIT - SATELLITE NETWORK PROTOCOL INTERWORKING GROUND-TO-AIR CALL ESTABLISHMENT (FOR MCDU/SCDU, NOT WSCI)

Revised title by adding (FOR MCDU/SCDU, NOT WSCI). Added note For WSCI, refer to Attachment 2F-42.1. Deleted or RMP from Setup.

ATTACHMENT 2F-40.8 - COCKPIT - SATELLITE NETWORK PROTOCOL INTERWORKING AIR INITIATED CALL CLEARING (FOR MCDU/SCDU, NOT WSCI)

Revised title by adding (FOR MCDU/SCDU, NOT WSCI). Added note For WSCI, refer to Attachment 2F-42.1.

ATTACHMENT 2F-40.9 - COCKPIT - SATELLITE NETWORK PROTOCOL INTERWORKING GROUND INITATED CALL CLEARING (FOR MCDU/SCDU, NOT WSCI)

Revised title by adding (FOR MCDU/SCDU, NOT WSCI). Added note For WSCI, refer to Attachment 2F-42.1. Changed RMP to SCDU.

ATTACHMENT 2F-42 - OPERATIONAL DESCRIPTION OF AVIATION SATELLITE AUDIO CHANNELS

In the sixth paragraph, changed or Radio Management Panel (RMP) to or ARINC 429 Williamsburg SDU Controller (WSC--refer to Attachment 2F-42.1 for specifics regarding the WSC interface [WSCI]). Deleted all references to the term RMP or similar phrases. Changed all instances of SCDU to SCDU/WSC. Updated Figure 1 and its pin numbers to reflect a configuration of three SCDUs/WSCs.

ATTACHMENT 2F-42.1 - WILLIAMSBURG SDU CONTROLLER INTERFACE (WSCI) PROTOCOL DEFINITION

Added new attachment.

APPENDIX 2 - SATCOM FREQUENCY CHECK ALGORITHM IMPLEMENTATION EXAMPLE

Changed 1616 MHz to 1610 MHz in several places. Revisions made to address the channel type and diplexer type as described in Section 3.5.4.1.1.

APPENDIX 3 - ACRONYMS

Updated acronym list.

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SUPPLEMENT 9
TO
ARINC CHARACTERISTIC 741

AVIATION SATELLITE COMMUNICATION SYSTEM
PART 2
SYSTEM DESIGN AND EQUIPMENT FUNCTIONAL DESCRIPTION

Published: November 22, 2006

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: October 11, 2006

A. PURPOSE OF THIS DOCUMENT

This supplement updates the GNSS Interference Protection (formerly AES Frequency Check Algorithm) and the Link Layer - Bit Oriented FTP sections and deletes Appendix 2 Satcom Frequency Check Algorithm Implementation Example. Appendix 2 now contains the former Appendix 3 Acronyms and Abbreviation.

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 CHARACTERISTIC 741, PART 2, 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.

3.5.4.1.1 GNSS Interference Protection

The Section title was changed from “AES Frequency Check Algorithm”. The body of text was re-written to refer to ARINC 781 on how this should be accomplished and the factors that must be taken into consideration.

4.7.4 Link Layer - Bit Oriented FTP

Changed a reference to ARINC Specification 429, Table 10-3a and added option 12.

APPENDIX 2 - SATCOM FREQUENCY CHECK ALGORITHM IMPLEMENTATION EXAMPLE

Deleted example.

APPENDIX 2 – ACRONYMS AND ABBREVIATIONS

Formerly Appendix 3. The former Appendix 2 – Satcom Frequency Check Algorithm Implementation Example was deleted by Supplement 9.

ARINC Standard – Errata Report

1. Document Title

ARINC Characteristic 741P2-9: *Aviation Satellite Communication System Part 2, System Design and Equipment Functional Description*
Published: November 22, 2006

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.)

2.0 Subcommittee Assignment and Project Support

2.1 Identify AEEC Group

(Identify an existing or new AEEC group.)

2.2 Support for the activity

Airlines: *(Identify each company by name.)*

Airframe Manufacturers:

Suppliers:

Others:

2.3 Commitment for resources *(Identify each company by name.)*

Airlines:

Airframe Manufacturers:

Suppliers:

Others:

2.4 Chairman: (Recommended name of Chairman.)

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

3.2 Planned usage of the envisioned specification

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 softwareware 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

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.)

For IA Staff use

Date Received: _____________ IA Staff Assigned: ___________

Estimated Cost: _____________

Potential impact: ______

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

Forward to committee(s) (AEEC, AMC, FSEMC): _____________ Date Forwarded:_____________

Committee resolution: _______

*(**0** Withdrawn **1** Authorized **2** Deferred **3** More detail needed **4** Rejected)*

Assigned Priority:______ Date of Resolution:_________________

*(**A** High - execute first **B** Normal - may be deferred.)*

Assigned to SC/WG:_________________