

International Standards
and Recommended Practices



Annex 10
to the Convention on
International Civil Aviation

Aeronautical Telecommunications

Volume III
Communication Systems
(Part I — Digital Data Communication Systems
Part II — Voice Communication Systems)

This edition incorporates all amendments
adopted by the Council prior to 27 February 2007
and supersedes, on 22 November 2007, all
previous editions of Annex 10, Volume III.

For information regarding the applicability
of the Standards and Recommended
Practices, see Foreword.

Second Edition
July 2007

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**International Standards
and Recommended Practices and
Procedures for Air Navigation Services**



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International Civil Aviation**

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AMENDMENTS

Amendments are announced in the supplements to the *Catalogue of ICAO Publications*; the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

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FOREWORD

Historical background

Standards and Recommended Practices for Aeronautical Telecommunications were first adopted by the Council on 30 May 1949 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago 1944) and designated as Annex 10 to the Convention. They became effective on 1 March 1950. The Standards and Recommended Practices were based on recommendations of the Communications Division at its Third Session in January 1949.

Up to and including the Seventh Edition, Annex 10 was published in one volume containing four Parts together with associated attachments: Part I — Equipment and Systems, Part II — Radio Frequencies, Part III — Procedures, and Part IV — Codes and Abbreviations.

By Amendment 42, Part IV was deleted from the Annex; the codes and abbreviations contained in that Part were transferred to a new document, Doc 8400.

As a result of the adoption of Amendment 44 on 31 May 1965, the Seventh Edition of Annex 10 was replaced by two volumes: Volume I (First Edition) containing Part I — Equipment and Systems, and Part II — Radio Frequencies, and Volume II (First Edition) containing Communication Procedures.

As a result of the adoption of Amendment 70 on 20 March 1995, Annex 10 was restructured to include five volumes: Volume I — Radio Navigation Aids; Volume II — Communication Procedures; Volume III — Communication Systems; Volume IV — Surveillance Radar and Collision Avoidance Systems; and Volume V — Aeronautical Radio Frequency Spectrum Utilization. By Amendment 70, Volumes III and IV were published in 1995 and Volume V was planned for publication with Amendment 71.

Table A shows the origin of Annex 10, Volume III subsequent to Amendment 70, together with a summary of the principal subjects involved and the dates on which the Annex and the amendments were adopted by Council, when they became effective and when they became applicable.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards, Recommended Practices and Procedures specified in Annex 10 should be notified and take effect in accordance with the provisions of Annex 15.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of air navigation. Wherever possible, the provisions of this Annex have been deliberately written in such a way as would facilitate incorporation, without major textual changes, into national legislation.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

- a) *Standards and Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

- b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.
- c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.
- d) *Tables and Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

- a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption;
- b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text;

- c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices;
- d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Disclaimer regarding patents

Attention is drawn to the possibility that certain elements of Standards and Recommended Practices in this Annex may be the subject of patents or other intellectual property rights. ICAO shall not be responsible or liable for not identifying any or all such rights. ICAO takes no position regarding the existence, validity, scope or applicability of any claimed patents or other intellectual property rights, and accepts no responsibility or liability therefore or relating thereto.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix Recommendation; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb “shall” is used, and for Recommended Practices the operative verb “should” is used.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A. Amendments to Annex 10, Volume III

<i>Amendment</i>	<i>Source(s)</i>	<i>Subject(s)</i>	<i>Adopted Effective Applicable</i>
70	Air Navigation Commission, Third Meeting of the Aeronautical Mobile Communications Panel (AMCP)	Introduction of new Volume III and SARPs related to the Aeronautical Mobile-Satellite Service (AMSS)	20 March 1995 24 July 1995 9 November 1995
71	Air Navigation Commission; SP COM/OPS/95 Divisional Meeting (1995); fifth meeting of the Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel (SICASP); third meeting of the Aeronautical Mobile Communications Panel (AMCP)	Addition of specifications for the Mode S subnetwork of ATN; addition of material relating to the introduction of 8.33 kHz channel spacing; changes to material related to the protection of air-ground communications in the VHF band; addition of technical specifications relating to the RF characteristics for the VHF digital link (VDL).	12 March 1996 15 July 1996 7 November 1996
72	Air Navigation Commission; fourth meeting of the Aeronautical Mobile Communications Panel (AMCP)	Introduction of SARPs and guidance material for VHF digital link (VDL); definition for VDL and deletion of obsolete material on air/ground data interchange.	12 March 1997 21 July 1997 6 November 1997
73	Air Navigation Commission; second meeting of the Aeronautical Telecommunication Network Panel (ATNP); sixth meeting of the Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel (SICASP)	Introduction of material relating to the ATN; changes to specifications of the Mode S subnetwork.	19 March 1998 20 July 1998 5 November 1998
74	Fifth meeting of the Aeronautical Mobile Communications Panel (AMCP); Air Navigation Commission	Introduction of: a) specifications for HF data link; and b) changes to the specifications for emergency locator transmitters.	18 March 1999 19 July 1999 4 November 1999
75	Sixth meeting of the Aeronautical Mobile Communications Panel (AMCP); Air Navigation Commission	Changes to the AMSS SARPs introducing a new antenna type, a new voice channel type and enhanced provisions for interoperability among AMSS systems; changes to the VDL SARPs to reduce potential interference to current VHF voice communication systems caused by VDL transmitters; changes to the VHF voice communication SARPs to enhance immunity to interference from VDL transmitters on board the same aircraft.	13 March 2000 17 July 2000 2 November 2000
76	Third meeting of the Aeronautical Telecommunication Network Panel (ATNP); seventh meeting of the Aeronautical Mobile Communications Panel (AMCP); the Secretariat assisted by the ATS Voice Switching and Signalling Study Group (AVSSSG)	Aeronautical telecommunication network (ATN) system management, security and directory services; removal of detailed material relating to CIDIN; integrated voice and data link system (VDL Mode 3); data link satisfying surveillance applications (VDL Mode 4); deletion of all the provisions for VDL Mode 1; removal of the detailed technical specifications for VDL Mode 2; aeronautical speech circuits; update of references to the ITU Radio Regulations.	12 March 2001 16 July 2001 1 November 2001

<i>Amendment</i>	<i>Source(s)</i>	<i>Subject(s)</i>	<i>Adopted Effective Applicable</i>
77	Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel (SICASP)	Mode S subnetwork (Part I), aircraft addressing system (Part I).	27 February 2002 15 July 2002 28 November 2002
78	Air Navigation Commission	Changes to technical specifications relating to radio frequency channels; introduction of registration requirement for ELTs; incorporation of VDL Modes 3 and 4 in the table of ATN subnetwork priorities (Table 3-3); editorial amendments.	5 March 2003 14 July 2003 27 November 2003
79	Eighth meeting of the Aeronautical Mobile Communications Panel (AMCP)	Changes to technical specifications relating to high frequency data link (HFDL) to align them with relevant provisions of ITU RR; introduction of FM immunity characteristics for VDL Mode 4; deletion of the note indicating that VDL Mode 4 SARPs apply to surveillance applications.	23 February 2004 12 July 2004 25 November 2004
80	Air Navigation Commission	Provisions for the location protocols for use in emergency locator transmitters (ELTs) operating on the 406 MHz frequency.	25 February 2005 11 July 2005 24 November 2005
81	—	No change.	—
82 (2nd edition)	Aeronautical Communications Panel (ACP); Surveillance and Conflict Resolution Systems Panel (SCRSP); Operational Data Link Panel (OPLINKP)	Updating ATN provisions on AMHS; revision of AMS(R)S SARPs; introduction of UAT; updating of material on SSR Mode S data link and use of Mode S extended squitter for ADS-B; relocation of Mode S and extended squitter ADS-B data formats to separate manuals.	26 February 2007 16 July 2007 22 November 2007
83	Aeronautical Communications Panel (ACP)	The introduction of Internet Protocol Suite (IPS) technology to the aeronautical telecommunication network (ATN) and introduction of provisions for 8.33 kHz offset carrier systems in the very high frequency (VHF) double sideband-amplitude modulation (DSB-AM).	10 March 2008 20 July 2008 20 November 2008
84	—	No change.	—
85	Aeronautical Surveillance Panel (ASP)	Improvement of the procedure for the allocation of 24-bit addresses to States and updating the table of allocations.	26 February 2010 12 July 2010 18 November 2010
86	—	No change.	—
87	—	No change.	—
88-A	Aeronautical Communications Panel (ACP)	a) Alignment of VDL SARPs, mainly to reflect recent updates to the ITU Radio Regulations; b) Provisions added to encourage implementation of ATN/IPS, while indicating that ATN/OSI remains a supported Standard.	26 February 2013 15 July 2013 14 November 2013
88-B	—	No change.	—
89	—	No change.	—

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INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

PART I — DIGITAL DATA COMMUNICATION SYSTEMS

CHAPTER 1. DEFINITIONS

Note 1.— All references to “Radio Regulations” are to the Radio Regulations published by the International Telecommunication Union (ITU). Radio Regulations are amended from time to time by the decisions embodied in the Final Acts of World Radiocommunication Conferences held normally every two to three years. Further information on the ITU processes as they relate to aeronautical radio system frequency use is contained in the Handbook on Radio Frequency Spectrum Requirements for Civil Aviation including statement of approved ICAO policies (Doc 9718).

Note 2.— This Part of Annex 10 includes Standards and Recommended Practices for certain forms of equipment for communication systems. While the Contracting State will determine the necessity for specific installations in accordance with the conditions prescribed in the relevant Standard or Recommended Practice, review of the need for specific installation and the formulation of ICAO opinion and recommendations to Contracting States concerned, is carried out periodically by Council, ordinarily on the basis of recommendations of Regional Air Navigation Meetings (Doc 8144, Directives to Regional Air Navigation Meetings and Rules of Procedure for their Conduct).

Note 3.— This chapter contains general definitions relevant to communication systems. Definitions specific to each of the systems included in this volume are contained in the relevant chapters.

Note 4.— Material on secondary power supply and guidance material concerning reliability and availability for communication systems is contained in Annex 10, Volume I, 2.9 and Volume I, Attachment F, respectively.

Aeronautical administrative communications (AAC). Communications necessary for the exchange of aeronautical administrative messages.

Aeronautical operational control (AOC). Communication required for the exercise of authority over the initiation, continuation, diversion or termination of flight for safety, regularity and efficiency reasons.

Aeronautical telecommunication network (ATN). A global internetwork architecture that allows ground, air-ground and avionic data subnetworks to exchange digital data for the safety of air navigation and for the regular, efficient and economic operation of air traffic services.

Aircraft address. A unique combination of twenty-four bits available for assignment to an aircraft for the purpose of air-ground communications, navigation and surveillance.

Aircraft earth station (AES). A mobile earth station in the aeronautical mobile-satellite service located on board an aircraft (see also “GES”).

Air traffic service. A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).

Automatic dependent surveillance — contract (ADS-C). A means by which the terms of an ADS-C agreement will be exchanged between the ground system and the aircraft, via a data link, specifying under what conditions ADS-C reports would be initiated, and what data would be contained in the reports.

Automatic terminal information service (ATIS). The automatic provision of current, routine information to arriving and departing aircraft throughout 24 hours or a specified portion thereof.

Data link-automatic terminal information service (D-ATIS). The provision of ATIS via data link.

Voice-automatic terminal information service (Voice-ATIS). The provision of ATIS by means of continuous and repetitive voice broadcasts.

Bit error rate (BER). The number of bit errors in a sample divided by the total number of bits in the sample, generally averaged over many such samples.

Carrier-to-multipath ratio (C/M). The ratio of the carrier power received directly, i.e. without reflection, to the multipath power, i.e. carrier power received via reflection.

Carrier-to-noise density ratio (C/N_0). The ratio of the total carrier power to the average noise power in a 1 Hz bandwidth, usually expressed in dBHz.

Channel rate. The rate at which bits are transmitted over the RF channel. These bits include those bits used for framing and error correction, as well as the information bits. For burst transmission, the channel rate refers to the instantaneous burst rate over the period of the burst.

Channel rate accuracy. This is relative accuracy of the clock to which the transmitted channel bits are synchronized. For example, at a channel rate of 1.2 kbits/s, maximum error of one part in 10^6 implies the maximum allowed error in the clock is $\pm 1.2 \times 10^{-3}$ Hz.

Circuit mode. A configuration of the communications network which gives the appearance to the application of a dedicated transmission path.

Controller pilot data link communications (CPDLC). A means of communication between controller and pilot, using data link for ATC communications.

Data link flight information services (D-FIS). The provision of FIS via data link.

Doppler shift. The frequency shift observed at a receiver due to any relative motion between transmitter and receiver.

End-to-end. Pertaining or relating to an entire communication path, typically from (1) the interface between the information source and the communication system at the transmitting end to (2) the interface between the communication system and the information user or processor or application at the receiving end.

End-user. An ultimate source and/or consumer of information.

Energy per symbol to noise density ratio (E_s/N_0). The ratio of the average energy transmitted per channel symbol to the average noise power in a 1 Hz bandwidth, usually expressed in dB. For A-BPSK and A-QPSK, one channel symbol refers to one channel bit.

Equivalent isotropically radiated power (e.i.r.p.). The product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (*absolute or isotropic gain*).

Flight information service (FIS). A service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights.

Forward error correction (FEC). The process of adding redundant information to the transmitted signal in a manner which allows correction, at the receiver, of errors incurred in the transmission.

Gain-to-noise temperature ratio. The ratio, usually expressed in dB/K, of the antenna gain to the noise at the receiver output of the antenna subsystem. The noise is expressed as the temperature that a 1 ohm resistor must be raised to produce the same noise power density.

Ground earth station (GES). An earth station in the fixed satellite service, or, in some cases, in the aeronautical mobile-satellite service, located at a specified fixed point on land to provide a feeder link for the aeronautical mobile-satellite service.

Note.— This definition is used in the ITU's Radio Regulations under the term "aeronautical earth station". The definition herein as "GES" for use in the SARPs is to clearly distinguish it from an aircraft earth station (AES), which is a mobile station on an aircraft.

Mode S subnetwork. A means of performing an interchange of digital data through the use of secondary surveillance radar (SSR) Mode S interrogators and transponders in accordance with defined protocols.

Point-to-point. Pertaining or relating to the interconnection of two devices, particularly end-user instruments. A communication path of service intended to connect two discrete end-users; as distinguished from broadcast or multipoint service.

Slotted aloha. A random access strategy whereby multiple users access the same communications channel independently, but each communication must be confined to a fixed time slot. The same timing slot structure is known to all users, but there is no other coordination between the users.

Time division multiple access (TDMA). A multiple access scheme based on time-shared use of an RF channel employing: (1) discrete contiguous time slots as the fundamental shared resource; and (2) a set of operating protocols that allows users to interact with a master control station to mediate access to the channel.

Time division multiplex (TDM). A channel sharing strategy in which packets of information from the same source but with different destinations are sequenced in time on the same channel.

Transit delay. In packet data systems, the elapsed time between a request to transmit an assembled data packet and an indication at the receiving end that the corresponding packet has been received and is ready to be used or forwarded.

VHF digital link (VDL). A constituent mobile subnetwork of the aeronautical telecommunication network (ATN), operating in the aeronautical mobile VHF frequency band. In addition, the VDL may provide non-ATN functions such as, for instance, digitized voice.

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CHAPTER 2. GENERAL

[to be developed]

ANNEX 10 — VOLUME III

I-2-1





CHAPTER 3. AERONAUTICAL TELECOMMUNICATION NETWORK

Note 1.— Detailed technical specifications for ATN/OSI applications are contained in the Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI Standards and Protocols (Doc 9880) and in the Manual of Technical Provisions for the Aeronautical Telecommunication Network (ATN) (Doc 9705).

Note 2.— Detailed technical specifications for ATN/IPS applications are contained in the Manual for the Aeronautical Telecommunication Network (ATN) using Internet Protocol Suite (IPS) Standards and Protocols (Doc 9896) (available electronically on the ICAO-Net).

3.1 DEFINITIONS

Application entity (AE). An AE represents a set of ISO/OSI communication capabilities of a particular application process (see ISO/IEC 9545 for further details).

ATN security services. A set of information security provisions allowing the receiving end system or intermediate system to unambiguously identify (i.e. authenticate) the source of the received information and to verify the integrity of that information.

ATS interfacility data communication (AIDC). Automated data exchange between air traffic services units in support of flight notification, flight coordination, transfer of control and transfer of communication.

ATS message handling service (ATSMHS). An ATN application consisting of procedures used to exchange ATS messages in store-and-forward mode over the ATN such that the conveyance of an ATS message is in general not correlated with the conveyance of another ATS message by the service provider.

ATS message handling system (AMHS). The set of computing and communication resources implemented by ATS organizations to provide the ATS message handling service.

Authorized path. A communication path suitable for a given message category.

Data link initiation capability (DLIC). A data link application that provides the ability to exchange addresses, names and version numbers necessary to initiate data link applications (see Doc 4444).

Directory service (DIR). A service, based on the ITU-T X.500 series of recommendations, providing access to and management of structured information relevant to the operation of the ATN and its users.

Required communication performance (RCP). A statement of the performance requirements for operational communication in support of specific ATM functions (see *Manual on Required Communication Performance (RCP)* (Doc 9869)).

3.2 INTRODUCTION

3.2.1 The ATN is specifically and exclusively intended to provide digital data communications services to air traffic service provider organizations and aircraft operating agencies in support of:

- a) air traffic services communications (ATSC) with aircraft;
- b) air traffic services communications between ATS units;
- c) aeronautical operational control communications (AOC); and
- d) aeronautical administrative communications (AAC).

3.3 GENERAL

Note — The Standards and Recommended Practices in sections 3.4 to 3.8 define the minimum required protocols and services that will enable the global implementation of the aeronautical telecommunication network (ATN).

3.3.1 ATN communication services shall support ATN applications.

3.3.2 Requirements for implementation of the ATN shall be made on the basis of regional air navigation agreements. These agreements shall specify the area in which the communication standards for the ATN/OSI or the ATN/IPS are applicable.

3.4 GENERAL REQUIREMENTS

3.4.1 The ATN shall either use International Organization for Standardization (ISO) communication standards for open systems interconnection (OSI) or use the Internet Society (ISOC) communications standards for the Internet Protocol Suite (IPS).

Note 1.— ATN/IPS implementation is preferred for ground-ground networks. While ATN/OSI continues to be supported in air-ground networks, particularly when using VDL Mode 2, it is expected that future air-ground implementations will use the ATN/IPS.

Note 2.— Interoperability between interconnecting OSI/IPS networks is expected to be arranged prior to implementation.

Note 3.— Guidance material on interoperability between ATN/OSI and ATN/IPS is contained in Doc 9896.

3.4.2 The AFTN/AMHS gateway shall ensure the interoperability of AFTN and CIDIN stations and networks with the ATN.

3.4.3 An authorized path(s) shall be defined on the basis of a predefined routing policy.

3.4.4 The ATN shall transmit, relay and deliver messages in accordance with the priority classifications and without discrimination or undue delay.

3.4.5 The ATN shall provide means to define data communications that can be carried only over authorized paths for the traffic type and category specified by the user.

3.4.6 The ATN shall provide communication in accordance with the prescribed required communication performance (RCP).

Note.— The Manual on Required Communication Performance (RCP) (Doc 9869) contains the necessary information on RCP.

3.4.7 The ATN shall operate in accordance with the communication priorities defined in Table 3-1* and Table 3-2.

3.4.8 The ATN shall enable exchange of application information when one or more authorized paths exist.

3.4.9 The ATN shall notify the appropriate application processes when no authorized path exists.

3.4.10 The ATN shall make provisions for the efficient use of limited bandwidth subnetworks.

3.4.11 **Recommendation.**— *The ATN should enable an aircraft intermediate system (router) to connect to a ground intermediate system (router) via different subnetworks.*

3.4.12 **Recommendation.**— *The ATN should enable an aircraft intermediate system (router) to connect to different ground intermediate systems (routers).*

3.4.13 The ATN shall enable the exchange of address information between applications.

3.4.14 Where the absolute time of day is used within the ATN, it shall be accurate to within 1 second of coordinated universal time (UTC).

Note.— *The time accuracy value results in synchronization errors of up to two seconds.*

3.5 ATN APPLICATIONS REQUIREMENTS

3.5.1 System applications

Note.— *System applications provide services that are necessary for operation of the ATN.*

3.5.1.1 The ATN shall support the data link initiation capability (DLIC) applications when air-ground data links are implemented.

Note.— *The Manual of Air Traffic Services Data Link Applications (Doc 9694, Part I) defines the data link initiation capability (DLIC) application.*

3.5.1.2 The ATN/OSI end-system shall support the following directory services (DIR) application functions when AMHS and/or security protocols are implemented:

- a) directory information retrieval; and
- b) directory information modification.

3.5.2 Air-ground applications

3.5.2.1 The ATN shall be capable of supporting one or more of the following applications:

- a) ADS-C;

* Tables 3-1 and 3-2 are located at the end of this chapter.

- b) CPDLC; and
- c) FIS (including ATIS and METAR).

Note.— See the Manual of Air Traffic Services Data Link Applications (Doc 9694).

3.5.3 Ground-ground applications

3.5.3.1 The ATN shall be capable of supporting the following applications:

- a) ATS interfacility data communication (AIDC); and
- b) ATS message handling services applications (ATSMHS).

Note.— See the Manual of Air Traffic Services Data Link Applications (Doc 9694).

3.6 ATN COMMUNICATIONS SERVICE REQUIREMENTS

3.6.1 ATN/IPS upper layer communications service

3.6.1.1 An ATN host* shall be capable of supporting the ATN/IPS upper layers including an application layer.

3.6.2 ATN/OSI upper layer communications service

3.6.2.1 An ATN/OSI end-system (ES)* shall be capable of supporting the OSI upper layer communications service (ULCS) including session, presentation and application layers.

3.6.3 ATN/IPS communications service

3.6.3.1 An ATN host shall be capable of supporting the ATN/IPS including the:

- a) transport layer in accordance with RFC 793 (TCP) and RFC 768 (UDP); and
- b) network layer in accordance with RFC 2460 (IPv6).

3.6.3.2 An IPS router shall support the ATN network layer in accordance with RFC 2460 (IPv6) and RFC 4271 (BGP), and RFC 2858 (BGP multiprotocol extensions).

3.6.4 ATN/OSI communications service

3.6.4.1 An ATN/OSI end-system shall be capable of supporting the ATN including the:

- a) transport layer in accordance with ISO/IEC 8073 (TP4) and optionally ISO/IEC 8602 (CLTP); and
- b) network layer in accordance with ISO/IEC 8473 (CLNP).

* An ATN host is an ATN end-system in OSI terminology; an ATN end-system is an ATN host in IPS terminology.

3.6.4.2 An ATN intermediate system (IS) shall support the ATN network layer in accordance with ISO/IEC 8473 (CLNP) and ISO/IEC 10747 (IDRP).

3.7 ATN NAMING AND ADDRESSING REQUIREMENTS

Note.— The ATN naming and addressing scheme supports the principles of unambiguous identification of intermediate systems (routers) and end-systems (hosts) and provides global address standardization.

3.7.1 The ATN shall provide provisions for unambiguous application identification.

3.7.2 The ATN shall provide provisions for unambiguous addressing.

3.7.3 The ATN shall provide means to unambiguously address all ATN end-systems (hosts) and intermediate systems (routers).

3.7.4 The ATN addressing and naming plans shall allow States and organizations to assign addresses and names within their own administrative domains.

3.8 ATN SECURITY REQUIREMENTS

3.8.1 The ATN shall make provisions whereby only the controlling ATS unit may provide ATC instructions to aircraft operating in its airspace.

Note.— This is achieved through the current and next data authority aspects of the controller-pilot data link communications (CPDLC) application.

3.8.2 The ATN shall enable the recipient of a message to identify the originator of that message.

3.8.3 ATN end-systems supporting ATN security services shall be capable of authenticating the identity of peer end-systems, authenticating the source of messages and ensuring the data integrity of the messages.

Note.— The use of security is the default; however, its implementation is based on local policy.

3.8.4 The ATN services shall be protected against service attacks to a level consistent with the application service requirements.

TABLES FOR CHAPTER 3

Table 3-1. Mapping of ATN communication priorities

Message categories	ATN application	Corresponding protocol priority	
		Transport layer priority	Network layer priority
Network/systems management		0	14
Distress communications		1	13
Urgent communications		2	12
High-priority flight safety messages	CPDLC, ADS-C	3	11
Normal-priority flight safety messages	AIDC, ATIS	4	10
Meteorological communications	METAR	5	9
Flight regularity communications	DLIC, ATSMHS	6	8
Aeronautical information service messages		7	7
Network/systems administration	DIR	8	6
Aeronautical administrative messages		9	5
<unassigned>		10	4
Urgent-priority administrative and U.N. Charter communications		11	3
High-priority administrative and State/Government communications		12	2
Normal-priority administrative communications		13	1
Low-priority administrative communications and aeronautical passenger communications		14	0
<i>Note.</i> — The network layer priorities shown in the table apply only to connectionless network priority and do not apply to subnetwork priority.			

Table 3-2. Mapping of ATN network priority to mobile subnetwork priority

Message categories	ATN network layer priority	Corresponding mobile subnetwork priority (see Note 4)					
		AMSS	VDL Mode 2	VDL Mode 3	VDL Mode 4	SSR Mode S	HFDL
Network/systems management	14	14	see Note 1	3	14	high	14
Distress communications	13	14	see Note 1	2	13	high	14
Urgent communications	12	14	see Note 1	2	12	high	14
High-priority flight safety messages	11	11	see Note 1	2	11	high	11
Normal-priority flight safety messages	10	11	see Note 1	2	10	high	11
Meteorological communications	9	8	see Note 1	1	9	low	8
Flight regularity communications	8	7	see Note 1	1	8	low	7
Aeronautical information service messages	7	6	see Note 1	0	7	low	6
Network/systems administration	6	5	see Note 1	0	6	low	5
Aeronautical administrative messages	5	5	not allowed	not allowed	not allowed	not allowed	not allowed
<unassigned>	4	unassigned	unassigned	unassigned	unassigned	unassigned	unassigned
Urgent-priority administrative and U.N. Charter communications	3	3	not allowed	not allowed	not allowed	not allowed	not allowed
High-priority administrative and State/Government communications	2	2	not allowed	not allowed	not allowed	not allowed	not allowed
Normal-priority administrative communications	1	1	not allowed	not allowed	not allowed	not allowed	not allowed
Low-priority administrative communications and aeronautical passenger communications	0	0	not allowed	not allowed	not allowed	not allowed	not allowed
<p><i>Note 1.— VDL Mode 2 has no specific subnetwork priority mechanisms.</i></p> <p><i>Note 2.— The AMSS SARPs specify mapping of message categories to subnetwork priority without explicitly referencing ATN network layer priority.</i></p> <p><i>Note 3.— The term “not allowed” means that only communications related to safety and regularity of flight are authorized to pass over this subnetwork as defined in the subnetwork SARPs.</i></p> <p><i>Note 4.— Only those mobile subnetworks are listed for which subnetwork SARPs exist and for which explicit support is provided by the ATN boundary intermediate system (BIS) technical provisions.</i></p>							

FIGURE FOR CHAPTER 3

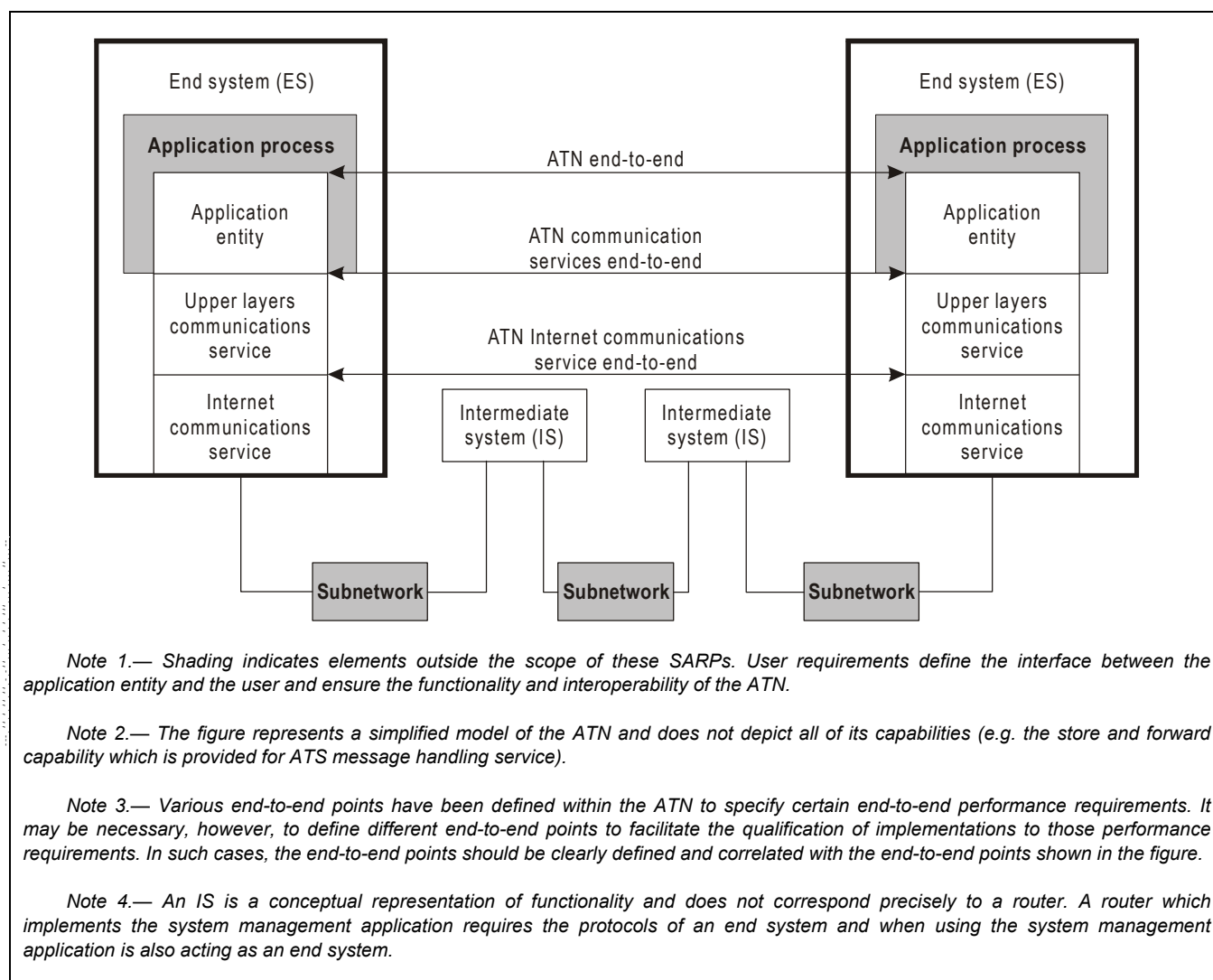


Figure 3-1. Conceptual model of the ATN

CHAPTER 4. AERONAUTICAL MOBILE-SATELLITE (ROUTE) SERVICE (AMS(R)S)

Note 1.— This chapter contains Standards and Recommended Practices applicable to the use of Aeronautical Mobile-Satellite (R) Service communications technologies. The Standards and Recommended Practices in this chapter are service- and performance-oriented and are not tied to a specific technology or technique.

Note 2.— Detailed Technical Specifications of AMS(R)S Systems are contained in the manual on AMS(R)S. This document also provides a detailed description of the AMS(R)S, including details on the Standards and Recommended Practices below.

4.1 DEFINITIONS

Connection establishment delay. Connection establishment delay, as defined in ISO 8348, includes a component, attributable to the called subnetwork (SN) service user, which is the time between the SN-CONNECT indication and the SN-CONNECT response. This user component is due to actions outside the boundaries of the satellite subnetwork and is therefore excluded from the AMS(R)S specifications.

Data transfer delay (95th percentile). The 95th percentile of the statistical distribution of delays for which transit delay is the average.

Data transit delay. In accordance with ISO 8348, the average value of the statistical distribution of data delays. This delay represents the subnetwork delay and does not include the connection establishment delay.

Network (N). The word “network” and its abbreviation “N” in ISO 8348 are replaced by the word “subnetwork” and its abbreviation “SN”, respectively, wherever they appear in relation to the subnetwork layer packet data performance.

Residual error rate. The ratio of incorrect, lost and duplicate subnetwork service data units (SNSDUs) to the total number of SNSDUs that were sent.

Spot beam. Satellite antenna directivity whose main lobe encompasses significantly less than the earth’s surface that is within line-of-sight view of the satellite. May be designed so as to improve system resource efficiency with respect to geographical distribution of user earth stations.

Subnetwork (SN). See *Network (N)*.

Subnetwork service data unit (SNSDU). An amount of subnetwork user data, the identity of which is preserved from one end of a subnetwork connection to the other.

Total voice transfer delay. The elapsed time commencing at the instant that speech is presented to the AES or GES and concluding at the instant that the speech enters the interconnecting network of the counterpart GES or AES. This delay includes vocoder processing time, physical layer delay, RF propagation delay and any other delays within an AMS(R)S subnetwork.

Note.— The following terms used in this chapter are defined in Annex 10 as follows:

- *Aeronautical telecommunication network (ATN): Volume III, Chapter 1.*
- *Aeronautical mobile-satellite (route) service (AMS(R)S): Volume II, Chapter 1.1.*
- *Aircraft earth station (AES): Volume III, Chapter 1.*
- *Ground earth station (GES): Volume III, Chapter 1.*
- *Subnetwork layer: Volume III, Chapter 6.1.*

4.2 GENERAL

4.2.1 Any mobile-satellite system intended to provide AMS(R)S shall conform to the requirements of this chapter.

4.2.1.1 An AMS(R)S system shall support packet data service, or voice service, or both.

4.2.2 Requirements for mandatory carriage of AMS(R)S system equipment including the level of system capability shall be made on the basis of regional air navigation agreements which specify the airspace of operation and the implementation timescales for the carriage of equipment. A level of system capability shall include the performance of the AES, the satellite and the GES.

4.2.3 The agreements indicated in 4.2.2 shall provide at least two years' notice of mandatory carriage of airborne systems.

4.2.4 **Recommendation.**— *Civil aviation authorities should coordinate with national authorities and service providers those implementation aspects of an AMS(R)S system that will permit its worldwide interoperability and optimum use, as appropriate.*

4.3 RF CHARACTERISTICS

4.3.1 Frequency bands

Note.— *ITU Radio Regulations permit systems providing mobile-satellite service to use the same spectrum as AMS(R)S without requiring such systems to offer safety services. This situation has the potential to reduce the spectrum available for AMS(R)S. It is critical that States consider this issue in frequency planning and in the establishment of national or regional spectrum requirements.*

4.3.1.1 When providing AMS(R)S communications, an AMS(R)S system shall operate only in frequency bands which are appropriately allocated to AMS(R)S and protected by the ITU Radio Regulations.

4.3.2 Emissions

4.3.2.1 The total emissions of the AES necessary to meet designed system performance shall be controlled to avoid harmful interference to other systems necessary to support safety and regularity of air navigation, installed on the same or other aircraft.

Note 1.— *Harmful interference can result from radiated and/or conducted emissions that include harmonics, discrete spurious, intermodulation product and noise emissions, and are not necessarily limited to the "transmitter on" state.*

Note 2.— Protection requirements for GNSS are contained in Annex 10, Volume I.

4.3.2.2 INTERFERENCE TO OTHER AMS(R)S EQUIPMENT

4.3.2.2.1 Emissions from an AMS(R)S system AES shall not cause harmful interference to an AES providing AMS(R)S on a different aircraft.

Note.— One method of complying with 4.3.2.2.1 is by limiting emissions in the operating band of other AMS(R)S equipment to a level consistent with the intersystem interference requirements such as contained in RTCA document DO-215. RTCA and EUROCAE may establish new performance standards for future AMS(R)S which may describe methods of compliance with this requirement.

4.3.3 Susceptibility

4.3.3.1 The AES equipment shall operate properly in an interference environment causing a cumulative relative change in its receiver noise temperature ($\Delta T/T$) of 25 per cent.

4.4 PRIORITY AND PRE-EMPTIVE ACCESS

4.4.1 Every aircraft earth station and ground earth station shall be designed to ensure that messages transmitted in accordance with Annex 10, Volume II, 5.1.8, including their order of priority, are not delayed by the transmission and/or reception of other types of messages. If necessary, as a means to comply with the above requirement, message types not defined in Annex 10, Volume II, 5.1.8 shall be terminated even without warning, to allow Annex 10, Volume II, 5.1.8 type messages to be transmitted and received.

4.4.2 All AMS(R)S data packets and all AMS(R)S voice calls shall be identified as to their associated priority.

4.4.3 Within the same message category, the system shall provide voice communications priority over data communications.

4.5 SIGNAL ACQUISITION AND TRACKING

4.5.1 The AES, GES and satellites shall properly acquire and track service link signals when the aircraft is moving at a ground speed of up to 1 500 km/h (800 knots) along any heading.

4.5.1.1 **Recommendation.**— *The AES, GES and satellites should properly acquire and track service link signals when the aircraft is moving at a ground speed of up to 2 800 km/h (1 500 knots) along any heading.*

4.5.2 The AES, GES and satellites shall properly acquire and track service link signals when the component of the aircraft acceleration vector in the plane of the satellite orbit is up to 0.6 g.

4.5.2.1 **Recommendation.**— *The AES, GES and satellites should properly acquire and track service link signals when the component of the aircraft acceleration vector in the plane of the satellite orbit is up to 1.2 g.*

4.6 PERFORMANCE REQUIREMENTS

4.6.1 Designated operational coverage

4.6.1.1 An AMS(R)S system shall provide AMS(R)S throughout its designated operational coverage (DOC).

4.6.2 Failure notification

4.6.2.1 In the event of a service failure, an AMS(R)S system shall provide timely predictions of the time, location and duration of any resultant outages until full service is restored.

Note.— Service outages may, for example, be caused by the failure of a satellite, satellite spot beam, or GES. The geographic areas affected by such outages may be a function of the satellite orbit and system design, and may vary with time.

4.6.2.2 The system shall annunciate a loss of communications capability within 30 seconds of the time when it detects such a loss.

4.6.3 AES requirements

4.6.3.1 The AES shall meet the relevant performance requirements contained in 4.6.4 and 4.6.5 for aircraft in straight and level flight throughout the designated operational coverage of the satellite system.

4.6.3.1.1 **Recommendation.**— *The AES should meet the relevant performance requirements contained in 4.6.4 and 4.6.5 for aircraft attitudes of +20/-5 degrees of pitch and +/-25 degrees of roll throughout the DOC of the satellite system.*

4.6.4 Packet data service performance

4.6.4.1 If the system provides AMS(R)S packet data service, it shall meet the standards of the following subparagraphs.

Note.— System performance standards for packet data service may also be found in RTCA Document DO-270.

4.6.4.1.1 An AMS(R)S system providing a packet data service shall be capable of operating as a constituent mobile subnetwork of the ATN.

Note.— In addition, an AMS(R)S may provide non-ATN data functions.

4.6.4.1.2 DELAY PARAMETERS

Note.— The term “highest priority service” denotes the priority which is reserved for distress, urgency and certain infrequent network system management messages. The term “lowest priority service” denotes the priority used for regularity of flight messages. All delay parameters are under peak-hour traffic loading conditions.

4.6.4.1.2.1 *Connection establishment delay.* Connection establishment delay shall not be greater than 70 seconds.

4.6.4.1.2.1.1 **Recommendation.**— *Connection establishment delay should not be greater than 50 seconds.*

4.6.4.1.2.2 In accordance with ISO 8348, data transit delay values shall be based on a fixed subnetwork service data unit (SNSDU) length of 128 octets. Data transit delays shall be defined as average values.

4.6.4.1.2.3 *Data transit delay, from-aircraft, highest priority.* From-aircraft data transit delay shall not be greater than 40 seconds for the highest priority data service.

4.6.4.1.2.3.1 **Recommendation.**— *Data transit delay, from-aircraft, highest priority. From-aircraft data transit delay should not be greater than 23 seconds for the highest priority data service.*

4.6.4.1.2.3.2 **Recommendation.**— *Data transit delay, from-aircraft, lowest priority. From-aircraft data transit delay should not be greater than 28 seconds for the lowest priority data service.*

4.6.4.1.2.4 *Data transit delay, to-aircraft, highest priority.* To-aircraft data transit delay shall not be greater than 12 seconds for the highest priority data service.

4.6.4.1.2.4.1 **Recommendation.**— *Data transit delay, to-aircraft, lowest priority. To-aircraft data transit delay should not be greater than 28 seconds for the lowest priority data service.*

4.6.4.1.2.5 *Data transfer delay (95th percentile), from-aircraft, highest priority.* From-aircraft data transfer delay (95th percentile), shall not be greater than 80 seconds for the highest priority data service.

4.6.4.1.2.5.1 **Recommendation.**— *Data transfer delay (95th percentile), from-aircraft, highest priority. From-aircraft data transfer delay (95th percentile), should not be greater than 40 seconds for the highest priority data service.*

4.6.4.1.2.5.2 **Recommendation.**— *Data transfer delay (95th percentile), from-aircraft, lowest priority. From-aircraft data transfer delay (95th percentile), should not be greater than 60 seconds for the lowest priority data service.*

4.6.4.1.2.6 *Data transfer delay (95th percentile), to-aircraft, highest priority.* To-aircraft data transfer delay (95th percentile), shall not be greater than 15 seconds for the highest priority data service.

4.6.4.1.2.6.1 **Recommendation.**— *Data transfer delay (95th percentile), to-aircraft, lowest priority. To-aircraft data transfer delay (95th percentile), should not be greater than 30 seconds for the lowest priority data service.*

4.6.4.1.2.7 *Connection release delay (95th percentile).* The connection release delay (95th percentile) shall not be greater than 30 seconds in either direction.

4.6.4.1.2.7.1 **Recommendation.**— *The connection release delay (95th percentile) should not be greater than 25 seconds in either direction.*

4.6.4.1.3 INTEGRITY

4.6.4.1.3.1 *Residual error rate, from-aircraft.* The residual error rate in the from-aircraft direction shall not be greater than 10^{-4} per SNSDU.

4.6.4.1.3.1.1 **Recommendation.**— *The residual error rate in the from-aircraft direction should not be greater than 10^{-6} per SNSDU.*

4.6.4.1.3.2 *Residual error rate, to-aircraft.* The residual error rate in the to-aircraft direction shall not be greater than 10^{-6} per SNSDU.

4.6.4.1.3.3 *Connection resilience.* The probability of a subnetwork connection (SNC) provider-invoked SNC release shall not be greater than 10^{-4} over any one-hour interval.

Note.— *Connection releases resulting from GES-to-GES handover, AES log-off or virtual circuit pre-emption are excluded from this specification.*

4.6.4.1.3.4 The probability of an SNC provider-invoked reset shall not be greater than 10^{-1} over any one-hour interval.

4.6.5 Voice service performance

4.6.5.1 If the system provides AMS(R)S voice service, it shall meet the requirements of the following subparagraphs.

Note.— ICAO is currently considering these provisions in the light of the introduction of new technologies.

4.6.5.1.1 CALL PROCESSING DELAY

4.6.5.1.1.1 *AES origination.* The 95th percentile of the time delay for a GES to present a call origination event to the terrestrial network interworking interface after a call origination event has arrived at the AES interface shall not be greater than 20 seconds.

4.6.5.1.1.2 *GES origination.* The 95th percentile of the time delay for an AES to present a call origination event at its aircraft interface after a call origination event has arrived at the terrestrial network interworking interface shall not be greater than 20 seconds.

4.6.5.1.2 VOICE QUALITY

4.6.5.1.2.1 The voice transmission shall provide overall intelligibility performance suitable for the intended operational and ambient noise environment.

4.6.5.1.2.2 The total allowable transfer delay within an AMS(R)S subnetwork shall not be greater than 0.485 seconds.

4.6.5.1.2.3 **Recommendation.**— *Due account should be taken of the effects of tandem vocoders and/or other analog/digital conversions.*

4.6.5.1.3 VOICE CAPACITY

4.6.5.1.3.1 The system shall have sufficient available voice traffic channel resources such that an AES- or GES-originated AMS(R)S voice call presented to the system shall experience a probability of blockage of no more than 10^{-2} .

Note.— Available voice traffic channel resources include all pre-emptable resources, including those in use by non-AMS(R)S communications.

4.6.6 Security

4.6.6.1 The system shall provide features for the protection of messages in transit from tampering.

4.6.6.2 The system shall provide features for protection against denial of service, degraded performance characteristics, or reduction of system capacity when subjected to external attacks.

Note.— Possible methods of such attack include intentional flooding with spurious messages, intentional corruption of system software or databases, or physical destruction of the support infrastructure.

4.6.6.3 The system shall provide features for protection against unauthorized entry.

Note.— These features are intended to provide protection against spoofing and “phantom controllers”.

4.7 SYSTEM INTERFACES

4.7.1 An AMS(R)S system shall allow subnetwork users to address AMS(R)S communications to specific aircraft by means of the ICAO 24-bit aircraft address.

Note.— Provisions on the allocation and assignment of ICAO 24-bit addresses are contained in the Appendix to Chapter 9.

4.7.2 Packet data service interfaces

4.7.2.1 If the system provides AMS(R)S packet data service, it shall provide an interface to the ATN.

Note.— The detailed technical specifications related to provisions of the ATN-compliant subnetwork service are contained in Section 5.2.5 and Section 5.7.2 of Doc 9880 — Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) (in preparation).

4.7.2.2 If the system provides AMS(R)S packet data service, it shall provide a connectivity notification (CN) function.



CHAPTER 5. SSR MODE S AIR-GROUND DATA LINK

Note.— The SSR Mode S air-ground data link is also referred to as the Mode S subnetwork in the context of the aeronautical telecommunication network (ATN).

5.1 DEFINITIONS RELATING TO THE MODE S SUBNETWORK

Aircraft. The term aircraft may be used to refer to Mode S emitters (e.g. aircraft/vehicles), where appropriate.

Aircraft address. A unique combination of 24 bits available for assignment to an aircraft for the purpose of air-ground communications, navigation and surveillance.

Aircraft data circuit-terminating equipment (ADCE). An aircraft specific data circuit-terminating equipment that is associated with an airborne data link processor (ADLP). It operates a protocol unique to Mode S data link for data transfer between air and ground.

Aircraft data link processor (ADLP). An aircraft-resident processor that is specific to a particular air-ground data link (e.g. Mode S) and which provides channel management, and segments and/or reassembles messages for transfer. It is connected to one side of aircraft elements common to all data link systems and on the other side to the air-ground link itself.

Aircraft/vehicle. May be used to describe either a machine or device capable of atmospheric flight, or a vehicle on the airport surface movement area (i.e. runways and taxiways).

Air-initiated protocol. A procedure initiated by a Mode S aircraft installation for delivering a standard length or extended length downlink message to the ground.

BDS Comm-B Data Selector. The 8-bit BDS code determines the register whose contents are to be transferred in the MB field of a Comm-B reply. It is expressed in two groups of 4 bits each, BDS1 (most significant 4 bits) and BDS2 (least significant 4 bits).

Broadcast. The protocol within the Mode S system that permits uplink messages to be sent to all aircraft in coverage area, and downlink messages to be made available to all interrogators that have the aircraft wishing to send the message under surveillance.

Capability report. Information identifying whether the transponder has a data link capability as reported in the capability (CA) field of an all-call reply or squitter transmission (see “data link capability report”).

Close-out. A command from a Mode S interrogator that terminates a Mode S link layer communication transaction.

Cluster of interrogators. Two or more interrogators with the same interrogator identifier (II) code, operating cooperatively to ensure that there is no interference to the required surveillance and data link performance of each of the interrogators, in areas of common coverage.

Comm-A. A 112-bit interrogation containing the 56-bit MA message field. This field is used by the uplink standard length message (SLM) and broadcast protocols.

Comm-B. A 112-bit reply containing the 56-bit MB message field. This field is used by the downlink SLM, ground-initiated and broadcast protocols.

Comm-C. A 112-bit interrogation containing the 80-bit MC message field. This field is used by the uplink extended length message (ELM) protocol.

Comm-D. A 112-bit reply containing the 80-bit MD message field. This field is used by the downlink ELM protocol.

Connection. A logical association between peer-level entities in a communication system.

Data link capability report. Information in a Comm-B reply identifying the complete Mode S communications capabilities of the aircraft installation.

Downlink. A term referring to the transmission of data from an aircraft to the ground. Mode S air-to-ground signals are transmitted on the 1 090 MHz reply frequency channel.

Extended length message (ELM). A series of Comm-C interrogations (uplink ELM) transmitted without the requirement for intervening replies, or a series of Comm-D replies (downlink ELM) transmitted without intervening interrogations.

Uplink ELM (UELM). A term referring to extended length uplink communication by means of 112-bit Mode S Comm-C interrogations, each containing the 80-bit Comm-C message field (MC).

Downlink ELM (DELM). A term referring to extended length downlink communication by means of 112-bit Mode S Comm-D replies, each containing the 80-bit Comm-D message field (MD).

Frame. The basic unit of transfer at the link level. In the context of Mode S subnetwork, a frame can include from one to four Comm-A or Comm-B segments, from two to sixteen Comm-C segments, or from one to sixteen Comm-D segments.

General formatter/manager (GFM). The aircraft function responsible for formatting messages to be inserted in the transponder registers. It is also responsible for detecting and handling error conditions such as the loss of input data.

Ground data circuit-terminating equipment (GDCE). A ground specific data circuit-terminating equipment associated with a ground data link processor (GDLP). It operates a protocol unique to Mode S data link for data transfer between air and ground.

Ground data link processor (GDLP). A ground-resident processor that is specific to a particular air-ground data link (e.g. Mode S), and which provides channel management, and segments and/or reassembles messages for transfer. It is connected on one side (by means of its DCE) to ground elements common to all data link systems, and on the other side to the air-ground link itself.

Ground-initiated Comm-B (GICB). The ground-initiated Comm-B protocol allows the interrogator to extract Comm-B replies containing data from a defined source in the MB field.

Ground-initiated protocol. A procedure initiated by a Mode S interrogator for delivering standard length or extended length messages to a Mode S aircraft installation.

Mode S air-initiated Comm-B (AICB) protocol. A procedure initiated by a Mode S transponder for transmitting a single Comm-B segment from the aircraft installation.

Mode S broadcast protocols. Procedures allowing standard length uplink or downlink messages to be received by more than one transponder or ground interrogator respectively.

Mode S ground-initiated Comm-B (GICB) protocol. A procedure initiated by a Mode S interrogator for eliciting a single Comm-B segment from a Mode S aircraft installation, incorporating the contents of one of 255 Comm-B registers within the Mode S transponder.

Mode S multisite-directed protocol. A procedure to ensure that extraction and close-out of a downlink standard length or extended length message is affected only by the particular Mode S interrogator selected by the aircraft.

Mode S packet. A packet conforming to the Mode S subnetwork standard, designed to minimize the bandwidth required from the air-ground link. ISO 8208 packets may be transformed into Mode S packets and vice-versa.

Mode S specific protocol (MSP). A protocol that provides restricted datagram service within the Mode S subnetwork.

Mode S specific services. A set of communication services provided by the Mode S system which are not available from other air-ground subnetworks, and therefore not interoperable.

Mode S specific services entity (SSE). An entity resident within an XDLP to provide access to the Mode S specific services.

Packet. The basic unit of data transfer among communication devices within the network layer (e.g. an ISO 8208 packet or a Mode S packet).

Segment. A portion of a message that can be accommodated within a single MA/MB field in the case of a standard length message, or MC/MD field in the case of an extended length message. This term is also applied to the Mode S transmissions containing these fields.

Standard length message (SLM). An exchange of digital data using selectively addressed Comm-A interrogations and/or Comm-B replies (see “Comm-A” and “Comm-B”).

Subnetwork. An actual implementation of a data network that employs a homogeneous protocol and addressing plan, and is under the control of a single authority.

Subnetwork management entity (SNME). An entity resident within a GDLP that performs subnetwork management and communicates with peer entities in intermediate or end-systems.

Timeout. The cancellation of a transaction after one of the participating entities has failed to provide a required response within a pre-defined period of time.

Uplink. A term referring to the transmission of data from the ground to an aircraft. Mode S ground-to-air signals are transmitted on the 1 030 MHz interrogation frequency channel.

XDCE. A general term referring to both the ADCE and the GDCE.

XDLP. A general term referring to both the ADLP and the GDLP.

5.2 MODE S CHARACTERISTICS

5.2.1 General provisions

Note 1.— Reference ISO document. When the term “ISO 8208” is referred to in this standard, it means the ISO Standard “Information technology — Data communications — X.25 Packet Layer Protocol for Data Terminal Equipment, Reference Number ISO/IEC 8208: 1990(E)”.

Note 2.— The overall architecture of the Mode S subnetwork is presented in the diagram on the following page.

Note 3.— The processing splits into three different paths. The first consists of the processing of switched virtual circuits (SVCs), the second consists of the processing of Mode S specific services, and the third consists of the processing of subnetwork management information. SVCs utilize the reformatting process and the ADCE or GDCE function. Mode S specific services utilize the Mode S specific services entity (SSE) function.

5.2.1.1 *Message categories.* The Mode S subnetwork shall only carry aeronautical communications classified under categories of flight safety and flight regularity as specified in Annex 10, Volume II, Chapter 5, 5.1.8.4 and 5.1.8.6.

5.2.1.2 *Signals in space.* The signal-in-space characteristics of the Mode S subnetwork shall conform to the provisions contained in Annex 10, Volume IV, Chapter 3, 3.1.2.

5.2.1.3 *Code and byte independency.* The Mode S subnetwork shall be capable of code and byte independent transmission of digital data.

5.2.1.4 *Data transfer.* Data shall be conveyed over the Mode S data link in segments using either standard length message (SLM) protocols or extended length message (ELM) protocols as defined in 3.1.2.6.11 and 3.1.2.7 of Annex 10, Volume IV.

Note 1.— An SLM segment is the contents of one 56-bit MA or MB field. An ELM segment is the contents of one 80-bit MC or MD field.

Note 2.— An SLM frame is the contents of up to four linked MA or MB fields. An ELM frame is the contents of 2 to 16 MC or 1 to 16 MD fields.

5.2.1.5 *Bit numbering.* In the description of the data exchange fields, the bits shall be numbered in the order of their transmission, beginning with bit 1. Bit numbers shall continue through the second and higher segments of multi-segment frames. Unless otherwise stated, numerical values encoded by groups (fields) of bits shall be encoded using positive binary notation and the first bit transmitted shall be the most significant bit (MSB) (3.1.2.3.1.3 of Annex 10, Volume IV).

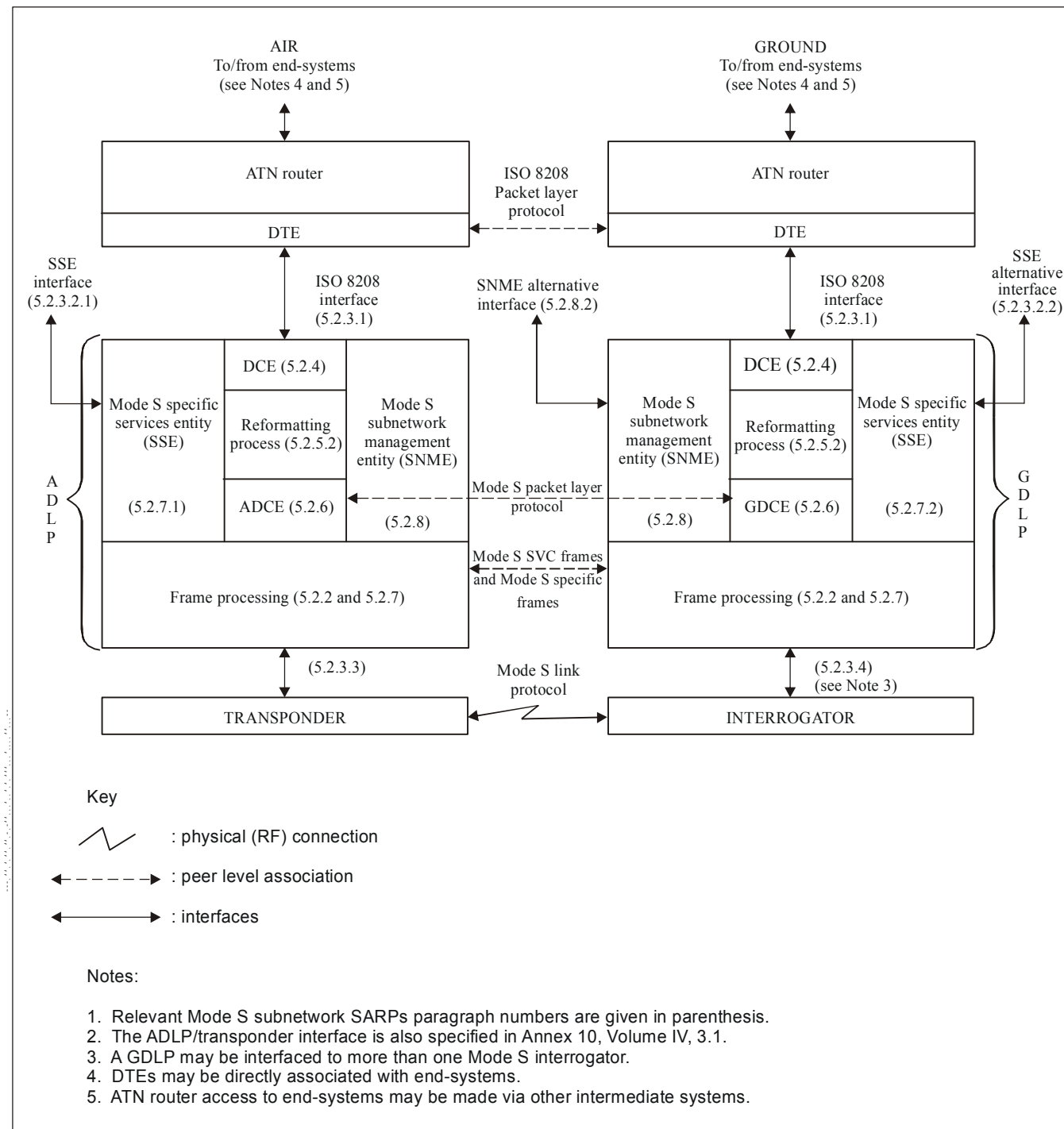
5.2.1.6 *Unassigned bits.* When the length of the data is not sufficient to occupy all bit positions within a message field or subfield, the unassigned bit positions shall be set to 0.

5.2.2 Frames

5.2.2.1 UPLINK FRAMES

5.2.2.1.1 *SLM frame.* An uplink SLM frame shall be composed of up to four selectively addressed Comm-A segments.

Functional elements of the Mode S subnetwork



Note.— Each Comm-A segment (MA field) received by the ADLP is accompanied by the first 32 bits of the interrogation that delivered the segment (3.1.2.10.5.2.1.1 of Annex 10, Volume IV). Within these 32 bits is the 16-bit special designator (SD) field (3.1.2.6.1.4 of Annex 10, Volume IV).

5.2.2.1.1.1 *SD field.* When the designator identification (DI) field (bits 14-16) has a code value of 1 or 7, the special designator (SD) field (bits 17-32) of each Comm-A interrogation shall be used to obtain the interrogator identifier subfield (IIS, bits 17-20) and the linked Comm-A subfield (*LAS*, bits 30-32). The action to be taken shall depend on the value of *LAS*. The contents of *LAS* and IIS shall be retained and shall be associated with the Comm-A message segment for use in assembling the frame as indicated below. All fields other than the *LAS* field shall be as defined in 3.1.2 of Annex 10, Volume IV.

Note.— The SD field structure is shown in Figure 5-1*.

5.2.2.1.1.2 *LAS coding.* The 3-bit *LAS* subfield shall be coded as follows:

LAS *MEANING*

0	single segment
1	linked, 1st segment
2	linked, 2nd but not final segment
3	linked, 3rd but not final segment
4	linked, 4th and final segment
5	linked, 2nd and final segment
6	linked, 3rd and final segment
7	unassigned

5.2.2.1.1.3 *Single segment SLM frame.* If *LAS* = 0, the data in the MA field shall be considered a complete frame and shall be made available for further processing.

5.2.2.1.1.4 *Multiple segment SLM frame.* The ADLP shall accept and assemble linked 56-bit Comm-A segments associated with all sixteen possible interrogator identifier (II) codes. Correct linking of Comm-A segments shall be achieved by requiring that all Comm-A segments have the same value of IIS. If *LAS* = 1 through 6, the frame shall consist of two to four Comm-A segments as specified in the following paragraphs.

5.2.2.1.1.4.1 *Initial segment.* If *LAS* = 1, the MA field shall be assembled as the initial segment of an SLM frame. The initial segment shall be stored until all segments of the frame have been received or the frame is cancelled.

5.2.2.1.1.4.2 *Intermediate segment.* If *LAS* = 2 or 3, the MA field shall be assembled in numerical order as an intermediate segment of the SLM frame. It shall be associated with previous segments containing the same value of IIS.

5.2.2.1.1.4.3 *Final segment.* If *LAS* = 4, 5 or 6, the MA field shall be assembled as the final segment of the SLM frame. It shall be associated with previous segments containing the same value of IIS.

5.2.2.1.1.4.4 *Frame completion.* The frame shall be considered complete and shall be made available for further processing as soon as all segments of the frame have been received.

5.2.2.1.1.4.5 *Frame cancellation.* An incomplete SLM frame shall be cancelled if one or more of the following conditions apply:

* All figures and tables are located at the end of this chapter.

- a) a new initial segment ($LAS = 1$) is received with the same value of IIS. In this case, the new initial segment shall be retained as the initial segment of a new SLM frame;
- b) the sequence of received LAS codes (after the elimination of duplicates) is not contained in the following list:
 - 1) $LAS = 0$
 - 2) $LAS = 1,5$
 - 3) $LAS = 1,2,6$
 - 4) $LAS = 1,6,2$
 - 5) $LAS = 1,2,3,4$
 - 6) $LAS = 1,3,2,4$
 - 7) $LAS = 1,2,4,3$
 - 8) $LAS = 1,3,4,2$
 - 9) $LAS = 1,4,2,3$
 - 10) $LAS = 1,4,3,2$
- c) T_c seconds have elapsed since the last Comm-A segment with the same value of IIS was received (Table 5-1).

5.2.2.1.1.4.6 *Segment cancellation.* A received segment for an SLM frame shall be discarded if it is an intermediate or final segment and no initial segment has been received with the same value of IIS.

5.2.2.1.1.4.7 *Segment duplication.* If a received segment duplicates a currently received segment number with the same value of IIS, the new segment shall replace the currently received segment.

Note.— The action of the Mode S subnetwork protocols may result in the duplicate delivery of Comm-A segments.

5.2.2.1.2 *ELM frame.* An uplink ELM frame shall consist of from 20 to 160 bytes and shall be transferred from the interrogator to the transponder using the protocol defined in 3.1.2.7 of Annex 10, Volume IV. The first 4 bits of each uplink ELM segment (MC field) shall contain the interrogator identifier (II) code of the Mode S interrogator transmitting the ELM. The ADLP shall check the II code of each segment of a completed uplink ELM. If all of the segments contain the same II code, the II code in each segment shall be deleted and the remaining message bits retained as user data for further processing. If all of the segments do not contain the same II code, the entire uplink ELM shall be discarded.

Note.— An uplink ELM frame consists of two to sixteen associated Comm-C segments, each of which contains the 4-bit II code. Therefore, the capacity for packet transfer is 19 to 152 bytes per uplink ELM frame.

5.2.2.2 DOWNLINK FRAMES

5.2.2.2.1 *SLM frame.* A downlink SLM frame shall be composed of up to 4 Comm-B segments. The MB field of the first Comm-B segment of the frame shall contain a 2-bit linked Comm-B subfield (LBS, bits 1 and 2 of the MB field). This subfield shall be used to control linking of up to four Comm-B segments.

Note.— The LBS uses the first 2-bit positions in the first segment of a multi or single segment downlink SLM frame. Hence, 54 bits are available for Mode S packet data in the first segment of a downlink SLM frame. The remaining segments of the downlink SLM frame, if any, have 56 bits available.

5.2.2.2.1.1 *LBS coding.* Linking shall be indicated by the coding of the LBS subfield of the MB field of the initial Comm-B segment of the SLM frame.

The coding of LBS shall be as follows:

LBS	MEANING
-----	---------

0	single segment
1	initial segment of a two-segment SLM frame
2	initial segment of a three-segment SLM frame
3	initial segment of a four-segment SLM frame

5.2.2.2.1.2 *Linking protocol*

5.2.2.2.1.2.1 In the Comm-B protocol, the initial segment shall be transmitted using the air-initiated or multisite-directed protocols. The LBS field of the initial segment shall indicate to the ground the number of additional segments to be transferred (if any). Before the transmission of the initial segment to the transponder, the remaining segments of the SLM frame (if any) shall be transferred to the transponder for transmission to the interrogator using the ground-initiated Comm-B protocol. These segments shall be accompanied by control codes that cause the segments to be inserted in ground-initiated Comm-B registers 2, 3 or 4, associated respectively with the second, third, or fourth segment of the frame.

5.2.2.2.1.2.2 Close-out of the air-initiated segment that initiated the protocol shall not be performed until all segments have been successfully transferred.

Note.— The linking procedure including the use of the ground-initiated Comm-B protocol is performed by the ADLP.

5.2.2.2.1.3 *Directing SLM frames.* If the SLM frame is to be multisite-directed, the ADLP shall determine the II code of the Mode S interrogator or cluster of interrogators (5.2.8.1.3) that shall receive the SLM frame.

5.2.2.2.2 *ELM FRAME*

Note.— A downlink ELM consists of one to sixteen associated Comm-D segments.

5.2.2.2.2.1 *Procedure.* Downlink ELM frames shall be used to deliver messages greater than or equal to 28 bytes and shall be formed using the protocol defined in 3.1.2.7 of Annex 10, Volume IV.

5.2.2.2.2.2 *Directing ELM frames.* If the ELM frame is to be multisite-directed, the ADLP shall determine the II code of the Mode S interrogator or cluster of interrogators (5.2.8.1.3) that shall receive the ELM frame.

5.2.2.3 *XDLP frame processing.* Frame processing shall be performed on all Mode S packets (except for the MSP packet) as specified in 5.2.2.3 to 5.2.2.5. Frame processing for Mode S specific services shall be performed as specified in 5.2.7.

5.2.2.3.1 *Packet length.* All packets (including a group of packets multiplexed into a single frame) shall be transferred in a frame consisting of the smallest number of segments needed to accommodate the packet. The user data field shall be an integral multiple of bytes in length. A 4-bit parameter (LV) shall be provided in the Mode S DATA, CALL REQUEST, CALL ACCEPT, CLEAR REQUEST and INTERRUPT packet headers so that during unpacking no additional bytes are added to the user data field. The LV field shall define the number of full bytes used in the last segment of a frame. During LV calculations, the 4-bit II code in the last segment of an uplink ELM message shall be (1) ignored for uplink ELM frames with an odd number of Comm-C segments and (2) counted for uplink ELM frames with an even number of Comm-C segments. The value contained in the LV field shall be ignored if the packet is multiplexed.

Note.— A specific length field is used to define the length of each element of a multiplexed packet. Therefore the LV field value is not used. LV field error handling is described in Tables 5-16 and 5-19.

5.2.2.3.2 *Multiplexing.* When multiplexing multiple Mode S packets into single SLM on ELM frame, the following procedures shall be used. Multiplexing of the packets within the ADLP shall not be applied to packets associated with SVCs of different priorities.

Note.— Multiplexing is not performed on MSP packets.

5.2.2.3.2.1 Multiplexing optimization

Recommendation.— When multiple packets are awaiting transfer to the same XDLP, they should be multiplexed into a single frame in order to optimize throughput, provided that packets associated with SVCs of different priorities are not multiplexed together.

5.2.2.3.2.2 *Structure.* The structure of the multiplexed packets shall be as follows:

HEADER:6 or 8	LENGTH:8	1ST PACKET:v	LENGTH:8	2ND PACKET:v
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Note.— A number in the field signifies the field length in bits; “v” signifies that the field is of variable length.

5.2.2.3.2.2.1 *Multiplexing header.* The header for the multiplexed packets shall be as follows:

DP:1	MP:1	SP:2	ST:2	FILL2:0 or 2
------	------	------	------	--------------

Where,

Data packet type (DP) = 0

MSP packet type (MP) = 1

Supervisory packet (SP) = 3

Supervisory type (ST) = 2

Note.— See Figure 5-23 for a definition for the field structure used in the multiplexing header.

5.2.2.3.2.2.2 *Length.* This field shall contain the length of the following packet in bytes. Any error detected in a multiplexed DATA packet, such as inconsistency between length as indicated in the LENGTH field and the length of the frame hosting that packet, shall result in the discarding of the packet unless the error can be determined to be limited to the LENGTH field, in which case a REJECT packet with the expected PS value can be sent.

5.2.2.3.2.2.2.1 **Recommendation.**— For multiplex packets, if the entire packet cannot be de-multiplexed, then the first constituent packet should be treated as a format error, and the remainder should be discarded.

5.2.2.3.2.3 *Termination.* The end of a frame containing a sequence of multiplexed packets shall be determined by one of the following events:

- a) a length field of all zeros; or
- b) less than eight bits left in the frame.

5.2.2.3.3 MODE S CHANNEL SEQUENCE PRESERVATION

5.2.2.3.3.1 *Application.* In the event that multiple Mode S frames from the same SVC are awaiting transfer to the same XDLP, the following procedure shall be used.

5.2.2.3.3.2 Procedure

Note 1.— SLM and ELM transactions can occur independently.

Note 2.— Uplink and downlink transactions can occur independently.

5.2.2.3.3.2.1 SLM frames. SLM frames awaiting transfer shall be transmitted in the order received.

5.2.2.3.3.2.2 ELM frames. ELM frames awaiting transfer shall be transmitted in the order received.

5.2.2.4 GDLP FRAME PROCESSING

5.2.2.4.1 GENERAL PROVISIONS

5.2.2.4.1.1 The GDLP shall determine the data link capability of the ADLP/transponder installation from the data link capability report (5.2.9) before performing any data link activity with that ADLP.

5.2.2.4.1.2 GDLP frame processing shall provide to the interrogator all data for the uplink transmission that are not provided directly by the interrogator.

5.2.2.4.2 *Delivery status.* GDLP frame processing shall accept an indication from the interrogator function that a specified uplink frame that was previously transferred to the interrogator has been successfully delivered over the ground-to-air link.

5.2.2.4.3 *Aircraft address.* GDLP frame processing shall receive from the interrogator along with the data in each downlink SLM or ELM frame, the 24-bit address of the aircraft that transmitted the frame. GDLP frame processing shall be capable of transferring to the interrogator the 24-bit address of the aircraft that is to receive an uplink SLM or ELM frame.

5.2.2.4.4 *Mode S protocol type identification.* GDLP frame processing shall indicate to the interrogator the protocol to be used to transfer the frame: standard length message protocol, extended length message protocol or broadcast protocol.

5.2.2.4.5 *Frame determination.* A Mode S packet (including multiplexed packets but excluding MSP packets) intended for uplink and less than or equal to 28 bytes shall be sent as an SLM frame. A Mode S packet greater than 28 bytes shall be sent as an uplink ELM frame for transponders with ELM capability, using M-bit processing as necessary (5.2.5.1.4.1). If the transponder does not have ELM capability, packets greater than 28 bytes shall be sent using the M-bit or S-bit (5.2.5.1.4.2) assembly procedures as necessary and multiple SLM frames.

Note.— The Mode S DATA, CALL REQUEST, CALL ACCEPT, CLEAR REQUEST and INTERRUPT packets are the only Mode S packets that use M-bit or S-bit sequencing.

5.2.2.5 ADLP FRAME PROCESSING

5.2.2.5.1 *General provisions.* With the possible exception of the last 24 bits (address/parity), ADLP frame processing shall accept from the transponder the entire content of both 56-bit and 112-bit received uplink transmissions, excluding all-call and ACAS interrogations. ADLP frame processing shall provide to the transponder all data for the downlink transmission that is not provided directly by the transponder (5.2.3.3).

5.2.2.5.2 *Delivery status.* ADLP frame processing shall accept an indication from the transponder that a specified downlink frame that was previously transferred to the transponder has been closed out.

5.2.2.5.3 *Interrogator identifier.* ADLP frame processing shall accept from the transponder, along with the data in each uplink SLM and ELM, the interrogator identifier (II) code of the interrogator that transmitted the frame. ADLP frame processing shall transfer to the transponder the II code of the interrogator or cluster of interrogators that shall receive a multisite-directed frame.

5.2.2.5.4 *Mode S protocol type identification.* ADLP frame processing shall indicate to the transponder the protocol to be used to transfer the frame: ground-initiated, air-initiated, broadcast, multisite-directed, standard length or extended length.

5.2.2.5.5 *Frame cancellation.* ADLP frame processing shall be capable of cancelling downlink frames previously transferred to the transponder for transmission but for which a close-out has not been indicated. If more than one frame is stored within the transponder, the cancellation procedure shall be capable of cancelling the stored frames selectively.

5.2.2.5.6 *Frame determination.* A Mode S packet (including multiplexed packets but excluding MSP packets) intended for downlink and less than or equal to 222 bits shall be sent as an SLM frame. A Mode S packet greater than 222 bits shall be sent as a downlink ELM frame for transponders with ELM capability using M-bit processing as necessary (5.2.5.1.4.1). When M-bit processing is used, all ELM frames containing $M = 1$ shall contain the maximum number of ELM segments that the transponder is capable of transmitting in response to one requesting interrogation ($UF = 24$) (5.2.9.1). If the transponder does not have ELM capability, packets greater than 222 bits shall be sent using the M-bit or S-bit (5.2.5.1.4.2) assembly procedures and multiple SLM frames.

Note.— The maximum length of a downlink SLM frame is 222 bits. This is equal to 28 bytes (7 bytes for 4 Comm-B segments) minus the 2-bit linked Comm-B subfield (5.2.2.1.1).

5.2.2.6 PRIORITY MANAGEMENT

5.2.2.6.1 *ADLP priority management.* Frames shall be transferred from the ADLP to the transponder in the following order of priority (highest first):

- a) Mode S specific services;
- b) search requests (5.2.8.1);
- c) frames containing only high priority SVC packets; and
- d) frames containing only low priority SVC packets.

5.2.2.6.2 GDLP PRIORITY MANAGEMENT

Recommendation.— *Uplink frames should be transferred in the following order of priority (highest first):*

- a) *Mode S specific services;*
- b) *frames containing at least one Mode S ROUTE packet (5.2.8.1);*
- c) *frames containing at least one high priority SVC packet; and*
- d) *frames containing only low priority SVC packets.*

5.2.3 Data exchange interfaces

5.2.3.1 THE DTE ISO 8208 INTERFACE

5.2.3.1.1 *General provisions.* The interface between the XDLP and the DTE(s) shall conform to ISO 8208 packet layer protocol (PLP). The XDLP shall support the procedures of the DTE as specified in ISO 8208. As such, the XDLP shall contain a DCE (5.2.4).

5.2.3.1.2 *Physical and link layer requirements for the DTE/DCE interface.* The requirements are:

- a) the interface shall be code and byte independent and shall not impose restrictions on the sequence, order, or pattern of the bits transferred within a packet; and
- b) the interface shall support the transfer of variable length network layer packets.

5.2.3.1.3 DTE ADDRESS

5.2.3.1.3.1 *Ground DTE address.* The ground DTE address shall have a total length of 3 binary coded decimal (BCD) digits, as follows:

$$X_0X_1X_2$$

X_0 shall be the most significant digit. Ground DTE addresses shall be decimal numbers in the range of 0 through 255 coded in BCD. Assignment of the DTE address shall be a local issue. All DTEs connected to GDLPs having overlapping coverage shall have unique addresses. GDLPs which have a flying time less than T_r (Table 5-1) between their coverage areas shall be regarded as having overlapping coverage.

5.2.3.1.3.2 *Mobile DTE address.* The mobile DTE address shall have a total length of 10 BCD digits, as follows:

$$X_0X_1X_2X_3X_4X_5X_6X_7X_8X_9$$

X_0 shall be the most significant digit. The digits X_0 to X_7 shall contain the octal representation of the aircraft address coded in BCD. The digits X_8X_9 shall identify a sub-address for specific DTEs on board an aircraft. This sub-address shall be a decimal number in the range of 0 and 15 coded in BCD. The following sub-address assignments shall be used:

00 ATN router

01 to 15 Unassigned

5.2.3.1.3.3 *Illegal DTE addresses.* DTE addresses outside of the defined ranges or not conforming to the formats for the ground and mobile DTE addresses specified in 5.2.3.1.3.1 and 5.2.3.1.3.2 shall be defined to be illegal DTE addresses. The detection of an illegal DTE address in a CALL REQUEST packet shall lead to a rejection of the call as specified in 5.2.5.1.5.

5.2.3.1.4 PACKET LAYER PROTOCOL REQUIREMENTS OF THE DTE/DCE INTERFACE

5.2.3.1.4.1 *Capabilities.* The interface between the DTE and the DCE shall conform to ISO 8208 with the following capabilities:

- a) expedited data delivery, i.e. the use of INTERRUPT packets with a user data field of up to 32 bytes;

- b) priority facility (with two levels, 5.2.5.2.1.1.6);
- c) fast select (5.2.5.2.1.1.13, 5.2.5.2.1.1.16); and
- d) called/calling address extension facility, if required by local conditions (i.e. the XDLP is connected to the DTE via a network protocol that is unable to contain the Mode S address as defined).

Other ISO 8208 facilities and the D-bit and the Q-bit shall not be invoked for transfer over the Mode S packet layer protocol.

5.2.3.1.4.2 *Parameter values.* The timer and counter parameters for the DTE/DCE interface shall conform to the default ISO 8208 values.

5.2.3.2 MODE S SPECIFIC SERVICES INTERFACE

Note.— Mode S specific services consist of the broadcast Comm-A and Comm-B, GICB and MSP.

5.2.3.2.1 ADLP

5.2.3.2.1.1 *General provisions.* The ADLP shall support the accessing of Mode S specific services through the provision of one or more separate ADLP interfaces for this purpose.

5.2.3.2.1.2 *Functional capability.* Message and control coding via this interface shall support all of the capabilities specified in 5.2.7.1.

5.2.3.2.2 GDLP

5.2.3.2.2.1 *General provisions.* The GDLP shall support the accessing of Mode S specific services through the provision of a separate GDLP interface for this purpose and/or by providing access to these services through the DTE/DCE interface.

5.2.3.2.2.2 *Functional capability.* Message and control coding via this interface shall support all of the capabilities specified in 5.2.7.2.

5.2.3.3 ADLP/TRANSPONDER INTERFACE

5.2.3.3.1 TRANSPONDER TO ADLP

5.2.3.3.1.1 The ADLP shall accept an indication of protocol type from the transponder in connection with data transferred from the transponder to the ADLP. This shall include the following types of protocols:

- a) surveillance interrogation;
- b) Comm-A interrogation;
- c) Comm-A broadcast interrogation; and
- d) uplink ELM.

The ADLP shall also accept the II code of the interrogator used to transmit the surveillance, Comm-A or uplink ELM.

Note.— Transponders will not output all-call and ACAS information on this interface.

5.2.3.3.1.2 The ADLP shall accept control information from the transponder indicating the status of downlink transfers. This shall include:

- a) Comm-B close-out;
- b) Comm-B broadcast timeout; and
- c) downlink ELM close-out.

5.2.3.3.1.3 The ADLP shall have access to current information defining the communication capability of the Mode S transponder with which it is operating. This information shall be used to generate the data link capability report (5.2.9).

5.2.3.3.2 ADLP TO TRANSPONDER

5.2.3.3.2.1 The ADLP shall provide an indication of protocol type to the transponder in connection with data transferred from the ADLP to the transponder. This shall include the following types of protocols:

- a) ground-initiated Comm-B;
- b) air-initiated Comm-B;
- c) multisite-directed Comm-B;
- d) Comm-B broadcast;
- e) downlink ELM; and
- f) multisite-directed downlink ELM.

The ADLP shall also provide the II code for transfer of a multisite-directed Comm-B or downlink ELM and the Comm-B data selector (BDS) code (3.1.2.6.11.2 of Annex 10, Volume IV) for a ground-initiated Comm-B.

5.2.3.3.2.2 The ADLP shall be able to perform frame cancellation as specified in 5.2.2.5.5.

5.2.3.4 GDLP/MODE S INTERROGATOR INTERFACE

5.2.3.4.1 INTERROGATOR TO GDLP

5.2.3.4.1.1 The GDLP shall accept an indication of protocol type from the interrogator in connection with data transferred from the interrogator to the GDLP. This shall include the following types of protocols:

- a) ground-initiated Comm-B;
- b) air-initiated Comm-B;
- c) air-initiated Comm-B broadcast; and
- d) downlink ELM.

The GDLP shall also accept the BDS code used to identify the ground-initiated Comm-B segment.