INTERNATIONAL CIVIL AVIATION ORGANIZATION

**AFI PLANNING AND IMPLEMENTATION REGIONAL GROUP (APIRG)
COMMUNICATIONS, NAVIGATION AND SURVEILLANCE SUB-GROUP SECOND MEETING**

(CNS/SG/2)

(Dakar, Senegal 22 – 25 May 2007)

Agenda Item 4: Aeronautical Telecommunications

Agenda Item 7: AFI Implementation Strategy for Communication Systems

ATN Planning and Implementation Issues

(Presented by the Secretariat)

1. Introduction

1.1 This paper addresses the development of SARPs for the Aeronautical Telecommunication Network (ATN), based on the standards for the Internet Protocol Suite (IPS) (or TCP/IP).

2. Discussion

2.1 Work in the Aeronautical Communications Panel (ACP) on the introduction in Annex 10 of SARPs for the ATN based on the standards for the IPS from the Internet Engineering Task Force (IETF), has progressed to the extent that the ACP is in the process of finalizing the necessary amendments to Annex 10. At ACP/1 (10-18 May 2007) these draft SARPs have been recommended for incorporation in Annex 10 and, when the Commission agrees, relevant amendment proposals will be sent to States during the summer. It is expected that these SARPs will be approved by Council in February/March 2008 and become effective in November 2008.

2.2 Implementation of IPS in the ATN (ground-ground) is already ongoing in North America and Europe. The use of IETF standards IPS is offering solutions for introducing ATN which are expected to offer greater flexibility in implementing ATN on actual requirements (scalability) and growth potential.

2.3 The current draft version of the revised ATN SARPs and the new ATN/OSI Manual on detailed technical specifications[1] are attached herewith as **Appendices A** and **B**. The CNS Sub-group may wish to encourage States in the Region to consider implementing ATN/IPS Standards (even if they are not yet formally adopted by ICAO) to avoid, to the maximum extent possible, interoperability difficulties with an ATN/OSI system.

2.4 It is the Secretariat's view that, in any case, States need to be informed on these developments, should they wish to redirect their investments in implementing ATN towards the IPS based ATN.

3. Conclusion

3.1 The CNS Sub-group is invited to:

a) Encourage AFI States to consider implementing ATN/IPS Standards (even if they are not yet formally adopted by ICAO) to avoid, to the maximum extent possible, interoperability difficulties; and

b) Agree to accordingly amend the regional implementation strategy for ground-to-ground communications.

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[1] *It is anticipated that ACP/1 has developed minor amendments to be incorporated to the attached material.*

Report of ACP WG N/7 (29 January-2 February 2007),
Bangkok, Thailand

Attachment WWW

Draft Amendments to ATN-SARPs
Version 3.3; 2 February 2007

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME III - COMMUNICATION SYSTEMS

(PART I - DIGITAL DATA COMMUNICATION SYSTEMS;
PART II - VOICE COMMUNICATION SYSTEMS)

FIRST EDITION - JULY 1995

PART I - DIGITAL DATA COMMUNICATION SYSTEMS

STANDARDS AND RECOMMENDED PRACTICES FOR
THE AERONAUTICAL TELECOMMUNICATION NETWORK (ATN)

Including amendment 81 (23 November 2006)

THIS PAPER INCLUDES AMENDMENTS TO THE ATN SARPS AS CURRENTLY AGREED IN ACP WORKING GROUP N1.
THE AMENDMENTS INTRODUCE IPS (TCP/IP) IN THE ATN AND ARE RESTRUCTURED IN ACCORDANCE WITH THE CURRENT GUIDELINES FROM THE AIR NAVIGATION COMMISSIONS

VERSION 3.3 "CLEAN VERSION"

THESE AMENDMENTS ARE SUBJECT TO FURTHER CHANGES.
THIS VERSION 3.3 INCORPORATES ALL CHANGES AGREED UP TO AND INCLUDING WG N7 (JANUARY 2007)
FINALIZATION OF THE AMENDMENTS IS FORESEEN AT ACP/1 IN MAY 2007.
THE NEW MATERIAL IS EXPECTED TO BECOME APPLICABLE IN NOVEMEBR 2008

The first edition of Annex 10, Volume III was adopted by the Council on 20 March 1995 and becomes applicable on 9 November 1995.

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

INTERNATIONAL CIVIL AVIATION ORGANIZATION

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 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.

Aeronautical administrative communications (AAC) - Communications necessary for the exchange of aeronautical administrative messages (Re. Annex 10, Volume II, paragraph 4.4.1.1.7).

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 (Re. Annex 6, Part I, Chapter 1 – Definitions).

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.

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) (Re. Annex 11, Chapter 1 – Definitions).

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

Automatic Dependent Surveillance- Contract (ADS-C) – A means by which the terms of an ADS agreement will be exchanged between the ground system and the aircraft, via a data link, specifying under

what condition ADS-C reports would be initiated and what data would be contained in the report. (Re. Annex 11, Chapter 1 – Definitions).

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. (Re. Annex 11, Chapter 1 – Definitions).

Data link-automatic terminal information service (D-ATIS). The provision of ATIS via data link. (Re. Annex 11, Chapter 1 – Definitions).

Voice-automatic terminal information service (Voice-ATIS). The provision of ATIS by means of continuous and repetitive voice broadcasts. (Re. Annex 11, Chapter 1 – Definitions).

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/No). 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 106 implies the maximum allowed error in the clock is ±1.2 x 10 - 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 communication (CPDLC). A means of communication between controller and pilot, using data link for ATC communications. (Re. Annex 11, Chapter 1 – Definitions).

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,IN0). The ratio of the average energy transmitted per channel symbol to the average noise power in a I 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.rp). 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. (Re. Annex 11, Chapter 1 – Definitions).

Data link flight information service (D-FIS) - The provision of FIS via data link(Re. Annex 11, Chapter 1 – Definitions).

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 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.

Packet. The basic unit of data transfer among communications devices within the network layer.

Packet layer protocol (PLP). A protocol to establish and maintain a connection between peer level entities at the network layer, and to transfer data packets between them. In the context of this standard, the term refers to the protocol defined by the ISO 8208 standard used in this document.

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 co-ordination between the users.

Switched virtual circuit (SVC). The primary circuit management technique provided within the ISO 8208 protocol. The network resources are dynamically allocated when needed and released when no longer required.

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.

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.

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.

CHAPTER 3. AERONAUTICAL TELECOMMUNICATION NETWORK

Note: Detailed technical specifications for the ATN are contained in Doc 9705/Doc. 9880 and Doc. XXX [in preparation] respectively. These documents also contain a detailed description of the ATN, including details on the Standards and Recommended Practices below

3.1 DEFINITIONS

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

Directory services (DIR). Services provided by the Directory, through an access point, to its users by means of a number of Directory operations. (Re. ITU-T X.511)

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.

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

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 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 nother 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 that the administrator(s) of the routing domain(s) has pre-defined as suitable for a given traffic type and 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. (Re. Doc. 4444)

Inter-centre communications (ICC). ICC is data communication between ATS units to support ATS, such as notification, coordination, transfer of control, flight planning, airspace management and air traffic flow management. ICC is a functional super-set of AIDC

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3.2 INTRODUCTION

3.2.2 . 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:

1) air traffic services communication (ATSC) with aircraft;

2) air traffic services communications between ATS units;

2) aeronautical operational control communications (AOC); and

3) aeronautical administrative communication (AAC);

3.3 GENERAL

Note: The Standards and Recommended Practices in sections 3.4 – 3.9 below define the minimum required protocols and services that will enable the global implementation of the ICAO Aeronautical Telecommunication Network (ATN)

3.3.1 ATN communication services shall support ATN applications.
Note 1.- Detailed technical specifications for ATN/OSI applications are contained in the "Manual of Detailed Technical Specifications for the ATN using ISO/OSI standards and protocols" (Doc 9880).

Note 2.- Detailed technical specifications for ATN/IPS applications are contained in the "Manual of Detailed Technical Specifications for the ATN using IPS standards and protocols" (Doc xxxx). [Insert correct title]

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

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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: Interoperability between interconnecting OSI/IPS networks shall be arranged prior to implementation.

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

3.4.5 The ATN shall accommodate routing based on a pre-defined routing policy.

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

3.4.6 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.

3.4.7 The ATN shall provide communication in accordance with the prescribed required communication performance (REC) (Re. Manual on Required Communication Performance (Doc. 9896))3.4.8 The ATN shall operate in accordance with the communication priorities defined in Table 3-2 and Table 3-3.

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

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

3.4.14 The ATN shall support data communications to fixed and mobile systems.

3.4.15 The ATN shall accommodate ATN mobile subnetworks as defined in this Annex.

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

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

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

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

3.4.27 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

3.5.1.1.1 The ATN shall support the Data Link Initiation Capability (DLIC) applications as contained in Doc. 9694 (Manual on ATS Data link applications Part I) when air-ground data links are implemented

Note: Detailed technical specifications for DLIC application for the ATN[OSI (Context Management (CM)) are contained in Doc. 9880, Part 1 For ATN/IPS detailed technical specification for DLIC capabilities are contained in Doc. Xxxx)

3.5.1.2.1 The ATN/OSI end systems shall support the following 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

3.5.2.1.1 The ATN shall be capable of supporting on or more of the following applications, in accordance with the provisions of Doc. 9694:

ADS-C; CPDLC;FIS (including ATIS and METAR); and

METAR.

3.5.3 Ground-ground applications

3.5.3.1.1.1 The ATN shall be capable of supporting:

AIDC applications as contained in Doc. 9694.

ATS message handling service application (ATSMHS).

3.6 ATN COMMUNICATION SERVICE REQUIREMENTS

3.6.1 ATN IPS upper layer communication 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.
Note: the detailed technical specifications for OSI ULCS are defined in Doc 9705.

3.6.2 ATN IPS Internet Communication Service

3.6.2.1 An ATN host shall be capable of supporting the ATN IPS Internet including the:

Transport layer in accordance with RFC 793 (TCP) and RFC 768 (UDP); and

Network layer in accordance with RFC 2460 (IPv6)

3.6.2.2. An IPS Router shall support the ATN network layer in accordance with RFC 2460 (IPv6) and RFC 2543 (BGP)

3.6.3 ATN OSI Internet communications service

3.6.3.1 An ATN/OSI end system shall be capable of supporting the ATN Internet including the:

a) transport layer in accordance with ISO/IEC 8073 (TP4) and ISO/IEC …(CTLP) ; and

b) network layer in accordance with ISO/IEC 8473 (CLNP).

3.6.2.2 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.

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

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

3.9 ATN SECURITY REQUIREMENTS

3.4.4 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 entity.

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

3.4.29 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.

3.9.2.2 A request for protection of ATS messages shall be honoured.

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

Table 3-2. Mapping of ATN communication priorities

Message categories	ATN application	Corresponding protocol priority	
		Transport layer priority	Network layer priority
Network/systems management	SM	0	14
Distress communications		1	13
Urgent communications		2	12
High-priority flight safety messages	CPDLC, ADS	3	11
Normal-priority flight safety messages	AIDC, ATIS	4	10
Meteorological communications	METAR	5	9
Flight regularity communications	CM, ATSMHS	6	8
Aeronautical information service messages		7	7
Network/systems administration	SM, 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

Note.— The network layer priorities shown in the table apply only to connectionless network priority and do not apply to subnetwork priority.

Table 3-3. 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 (see Note 5)	SSR Mode S	HFDL
Network/systems management	14	14	see Note 1	3	high	high	14
Distress communications	13	14	see Note 1	2	high	high	14
Urgent communications	12	14	see Note 1	2	high	high	14
High-priority flight safety messages	11	11	see Note 1	2	high	high	11
Normal-priority flight safety messages	10	11	see Note 1	2	high	high	11
Meteorological communications	9	8	see Note I	I	medium	low	8
Flight regularity communications	8	7	see Note 1	1	medium	low	7
Aeronautical information service messages	7	6	see Note 1	0	medium	low	6
Network/systems administration	6	5	see Note 1	0	medium	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	I	I	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

Note 1.- VDL Mode 2 has no specific subnetwork priority mechanisms.

Note 2.- The AMSS SARPs specify mapping of message categories to subnetwork priority without explicitly referencing ATN network layer priority.

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.

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.

Note 5.- The VDL Mode 4 subnetwork provides support for surveillance applications (e.g. ADS).

International Civil Aviation Organization

ACP-SWGN1-13/WP-03
13 April 2007

WORKING PAPER

ICAO

Aeronautical Telecommunication Network (ATN)

Manual of Detailed Technical Specification for Internet Protocol Suite (IPS)

Communication Service

Prepared by: ICAO ACP WG-N (N1)

April 2, 2007

Version 10b

FOREWORD

This document defines the requisite data communications protocols and services to be used for implementing the International Civil Aviation Organization (ICAO) Aeronautical Telecommunications Network (ATN) using the Internet Protocol Suite (IPS). The material in this document is to be considered in conjunction with the relevant Standards and Recommended Practices (SARPs) as contained in Annex 10, Volume III, Part I Chapter 3.

Editorial practices in this document.

The detailed technical specifications in this document that include the operative verb "shall" are essential to be implemented to secure proper operation of the ATN.

The detailed technical specifications in this document that include the operative verb "should" are recommended for implementation in the ATN. However, particular implementations may not require this specification to be implemented.

The detailed technical specifications in this document that include the operative verb "may" are optional. When implementing these optional specifications, interoperability with systems having not implemented these optional specifications needs to be secured.

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1 INTRODUCTION

1.1 GENERAL OVERVIEW

This manual contains the minimum communication protocols and services that will enable implementation of an ICAO Aeronautical Telecommunication Network (ATN) based on the Internet Protocol Suite (IPS) utilizing Internet Protocol version 6 (IPv6).

Implementation of IPv4 for transition to IPv6 (or as a permanent subnetwork) is a regional or local issue, and is not be addressed in this manual. The scope of the manual is on inter-domain routing, although the material in this manual can also be used for intra-domain routing (e.g. within a country).

The IPS in the ATN architecture is illustrated in Figure 1.

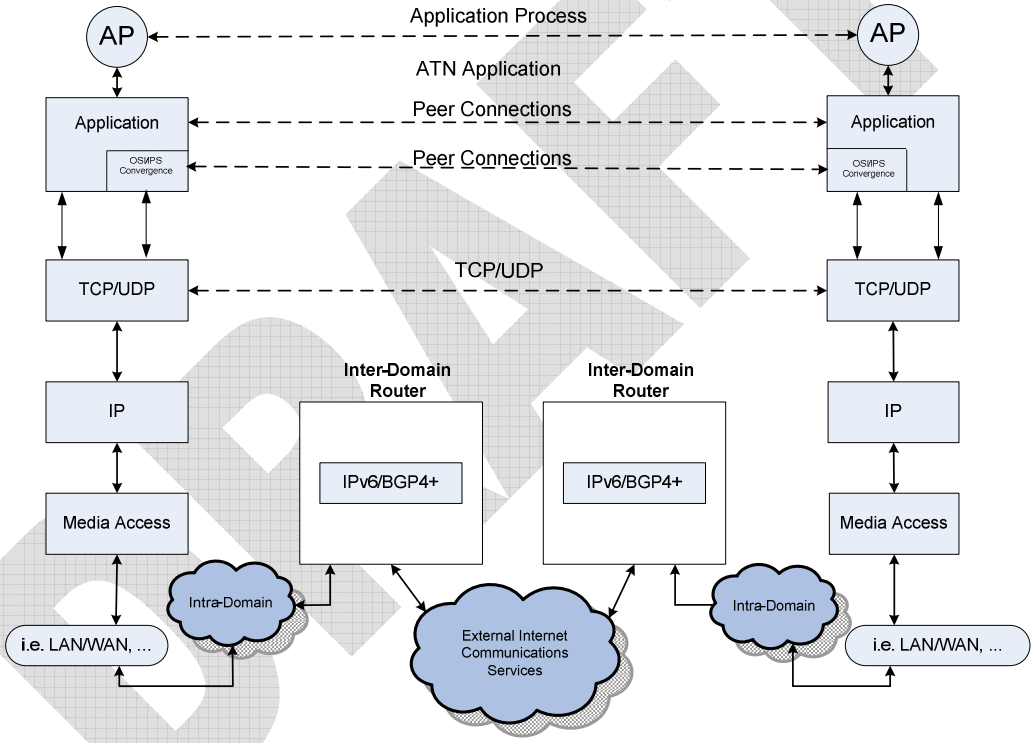

Figure 1 – IPS Architecture in the ATN

In accordance with Annex 10, Volume III, Part I, paragraph [3.3.3] implementation of the ATN/IPS, including the protocols and services included in this manual, shall take place on the basis of regional air navigation agreements between ICAO contracting states. Regional planning and implementation groups (PIRG's) are coordinating such agreements.

2 REFERENCE DOCUMENTS

2.1 IETF STANDARDS

The following documents form part of this manual to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this manual, the provisions of this manual shall take precedence.

Request for Comments (RFCs)

RFC-768	User Datagram Protocol, August 1980
RFC-793	Transmission Control Protocol, September 1981
RFC-1323	TCP Extensions for High Performance May 1992
RFC-1981	Path MTU Discovery for IP Version 6, August 1996
RFC-2401	Security Architecture for the Internet Protocol, November 1998
RFC-4302	IP Authentication Header, December 2005
RFC-4303	IP Encapsulating Security Payload (ESP), December 2005
RFC-2410	The NULL Encryption Algorithm and Its Use with IPsec, November 1998
RFC-2460	Internet Protocol, Version 6 (IPv6) Specification, December 1998
RFC-2474	Differential Services Field, December 1998
RFC-2488	Enhancing TCP over Satellite Channels, January 1999
RFC-2858	Border Gateway Protocol (BGP4) Multiprotocol Extensions June 2000
RFC-4271	A Border Gateway Protocol 4 (BGP-4), January 2006
RFC-4305	Cryptographic Algorithm Implementation Requirements for Encapsulating Security Payload (ESP) and Authentication Header (AH) – (NB proposed standard, obsoletes RFC2402, RFC2406), December 2005
RFC-4306	Internet Key Exchange (IKEv2) Protocol, December 2005
RFC-4307	Cryptographic Algorithms for Use in the Internet Key Exchange Version 2 (IKEv2), December 2005
RFC-4443	Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification, March 2006

2.2 RELEVANT ICAO PUBLICATIONS

In the event of a conflict between the manual and the provisions in Annex 10, the provisions of Annex 10 shall take precedence.

ICAO Annex 2 Rules of the Air
ICAO Annex 3 Meteorological Service for International Air Navigation
ICAO Annex 10 Aeronautical Telecommunications – Volume III, Part I – Digital Data Communication Systems
ICAO Annex 11 Air Traffic Services
ICAO Doc. 9705-AN/956 Edition 3, Manual of Technical Provisions for the ATN, 2002
ICAO Doc. 9739 Edition 1, Comprehensive ATN Manual (CAMAL), 2000

ICAO Doc. 4444 Procedures for Air Navigation Services – Air Traffic Management 14th Edition, 2001
ICAO Doc. 9694 Manual of Air Traffic Services Data Link Applications

ICAO Doc. 9880 Detailed technical specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI protocols *(Doc. 9880 replaces Doc. 9705)*

3 ABBREVIATIONS

The acronyms used in this manual are defined as follows:

AAC	Aeronautical Administrative Communications
AOC	Aeronautical Operational Communications
AS	Autonomous System
AD	Administrative Domain
AH	Authentication Header
AINSC	Aeronautical Industry Service Communication
ATN	Aeronautical Telecommunication Network
ATSC	Air Traffic Services Communication
BGP	Border Gateway Protocol
CL	Connection-less
CO	Connection-oriented
ECP	Encryption Control Protocol
ESP	Encapsulating Security Protocol
G-G	Ground- to- Ground
IANA	Internet Assigned Numbers Authority
ICAO	International Civil Aviation Organization
ICMP	Internet Control Message Protocol
IETF	Internet Engineering Task Force
IKEv2	Internet Key Exchange (version2)
IP	Internet Protocol
IPS	Internet Protocol Suite
IPv6	Internet Protocol version 6
ISO	International Organization for Standardization
LAN	Local Area Network
MTU	Maximum Transmission Unit
OSI	Open System Interconnection
QoS	Quality of Service
RFC	Request for Comments
TCP	Transmission Control Protocol
SARPs	Standards and Recommended Practices
SPI	Security Parameter Index
UDP	User Datagram Protocol
WAN	Wide Area Network

3.1 DEFINITIONS

Definitions are consistent with IETF terminology**.**

Autonomous System
A connected group of one or more IP prefixes, run by one or more network operators, which has a single, clearly defined routing policy.

Host A host is a computer connected to the ATN that provides end users with services; in addition, a host can function as a router. *(Note: In OSI terminology, a host is and end system and a router is an intermediate system).*

Internet A worldwide computer communications network that interconnects WANs, LANs, and computers by adopting common interface services and protocols based on the TCP/IP technology.

LAN A network that interconnects hosts over short distances.

Network Collection of computers, printers, routers, switches, and other devices that communicate with each other over a common transmission medium.

Protocol A set of rules and formats (semantic and syntactic) which determine the communication behavior between peer entities in the performance of functions at that layer.

Router The communication element that manages the relaying and routing of data while in transit from an originating end system to a destination end system.

Inter-Domain Routing (Exterior Routing Protocol)
Protocols for exchanging routing information between ASes. They may in some cases be used between routers within an AS, but they primarily deal with exchanging information between ASes.

Intra-Domain Routing (Interior Routing Protocol)
Protocols for exchanging routing information between routers within an AS.

WAN A computer network that spans a large geographical area.

4 REQUIREMENTS

4.1 ATN IPS ADMINISTRATION

4.1.1 The ATN IPS Internet

4.1.1.1 The ATN IPS Internet consists of IPS Nodes and networks operating in a multinational environment. The ATN IPS Internet is capable of supporting Air Traffic Service Communication (ATSC) as well as Aeronautical Industry Service Communication (AINSC), such as Aeronautical Administrative Communications (AAC) and Aeronautical Operational Communications (AOC).

4.1.1.2 There are two types of IPS Nodes in the ATN. An IPS Router is an IPS Node that forwards Internet Protocol (IP) packets not explicitly addressed to itself. An IPS Host is an IPS Node that is not a router.

4.1.1.3 The ATN IPS Internet consists of a set of interconnected Administrative Domains (AD). From a management perspective, an Administrative Domain can be an individual State, a group of States or a region. From a Physical perspective, an Administrative Domain is a group of hosts, routers, and networks operated and managed by a single organization. An Administrative Domain is viewed from the outside, for purposes of routing, as a cohesive entity.

4.1.2 Administrative Domains

4.1.2.1 Each State participating in the IPS Internet shall operate one or more Administrative Domains or form part of an Administrative Domain containing one or more Inter-domain Routers as required to interconnect with Inter-domain Routers in other ground-based Administrative Domains.

Note 1.— An Administrative Domain constitutes one or more Autonomous Systems.

Note 2.— The routing protocol within an Administrative Domain is local matter determined by the managing organization.

4.2 PHYSICAL LAYER & LINK LAYER REQUIREMENTS

4.2.1 The specification of the physical and link layer characteristics for a node is local to the interfacing nodes.

4.3 NETWORK LAYER REQUIREMENTS

4.3.1 IPv6 Networking

4.3.1.1 IPS Nodes in the ATN shall implement IPv6 as specified in RFC-2460.

4.3.1.2 IPS Hosts should implement IPv6 Maximum Transition Unit (MTU) path discovery as specified in RFC-1981. .

4.3.1.3 Path MTU discovery shall be supported for IPv6 packets greater than 1280 bytes.

4.3.1.4 An IPS Host Flow Label field shall be set to zero. (Flow Label Field is not supported in the ATN.)

4.3.2 Network Addressing

4.3.2.1 Administrative Domains shall be responsible to obtain globally scoped IPv6 address assignments for IPS nodes.

4.3.3 **Inter-Domain Routing**

4.3.3.1 IPS routers in the ATN IPS which support inter-domain dynamic routing shall implement version 4 of the Border Gateway Protocol (BGP4) as specified in RFC-4271.

4.3.3.2 IPS routers in the ATN which support inter-domain dynamic routing shall implement the BGP-4 Multiprotocol Extensions as specified in RFC-2858.

4.3.3.3 Administrative Domains shall be responsible to obtain AS numbers for ATN IPS routers that implement BGP-4.

4.3.4 Error Detection and Reporting

4.3.4.1 IPS nodes shall implement Internet Control Message Protocol (ICMPv6) as specified in RFC-4443.

4.3.5 Quality of Service (QoS)

4.3.5.1 The IPS shall provide the required class of service to support the operational requirements.

4.3.5.2 IPS Routers, which support traffic class, shall implement Differential Services Field as specified in RFC-2474.

4.4 TRANSPORT LAYER REQUIREMENTS

4.4.1 End to End Services

4.4.1.1 The transport layer provides end-to-end service between hosts over the ATN.

4.4.2 Support Services

4.4.2.1 The transport layer supports the following types of services:

- Connection-Oriented (CO), invoking TCP
- Connection-Less (CL), invoking UDP

4.4.3 Transmission Control Protocol (TCP)

4.4.3.1 IPS Host shall implement Transmission Control Protocol (TCP) as specified in RFC-793.

4.4.3.2 IPS Host may implement TCP Extensions for High Performance as specified in RFC-1323.

4.4.3.3 IPS Host may implement RFC 2488 when operating over satellite links.

4.4.4 User Datagram Protocol (UDP)

4.4.4.1 IPS Host shall implement User Datagram Protocol as specified in RFC-768.

5 NETWORK LAYER SECURITY

Note1. - Implementation of, s*upport for security is to be based on a system threat and vulnerability analysis.*

Note 2. – Network layer security in the ATN IPS Internet is implemented using IPsec.

5.1 BASIC ARCHITECTURE

5.1.1 IPS nodes in the ATN which support network layer security shall implement the Security Architecture for the Internet Protocol as specified in RFC-2401.

5.2 SECURITY PROTOCOLS

5.2.1 IPS nodes in the ATN which support network layer security shall implement the IP Encapsulating Security Protocol (ESP) as specified in RFC-4303.

5.2.2 IPS nodes in the ATN which support network layer security shall implement the IP Authentication Header (AH) protocol as specified in RFC-4302.

5.3 KEY MANAGEMENT METHODS

5.3.1 IPS nodes in the ATN which support network layer security shall implement manual configuration of the security key and Security Parameters Index (SPI).

5.3.2 IPS nodes in the ATN which support network layer security should implement The Internet Key Exchange (IKEv2) Protocol. as specified in RFC-4306.

5.4 TRANSFORMS AND ALGORITHMS

5.4.1 IPS nodes in the ATN which support network layer security shall implement the Cryptographic Algorithm Implementation Requirements for the Encapsulating Security Payload (ESP) and Authentication Header (AH) as specified in RFC 4305.

5.4.2 IPS nodes in the ATN which support network layer security shall implement The Null Encryption Algorithm and Its Use With IPsec as specified in RFC-2410.

5.4.3 IPS nodes in the ATN which support network layer security shall implement the IP Encapsulating Security Protocol NULL authentication algorithm as specified in RFC-4303.

5.4.4 IPS nodes in the ATN which support network layer security shall operate either the NULL Encryption Algorithm or the NULL Authentication Algorithm.

Note - Since ESP encryption and authentication are both optional, support for the NULL encryption algorithm [RFC-2410] and the NULL authentication algorithm [RFC-4303] is to be provided to maintain consistency with the way these services are negotiated. When ESP is used, at least one of these optional services is invoked (i.e. is non-NULL).

5.4.5 IPS nodes in the ATN which support network layer security shall implement the Cryptographic Algorithms for Use in the Internet Key Exchange Version 2 (IKEv2) required algorithms for key exchange as specified in RFC-4307.

Note. – Algorithms of equivalent or greater strength than those identified in RFC-4307 are implemented as a local matter on a bi-lateral basis.