



International Civil Aviation Organization

**AERONAUTICAL TELECOMMUNICATION  
NETWORK IMPLEMENTATION  
COORDINATION GROUP – EIGHTH  
WORKING GROUP MEETING (ATNICG WG/8)**

**AIRWAYS**  
NEW ZEALAND

Christchurch New Zealand  
28 September – 1 October 2010

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**Agenda Item: 17:      Review documentation tree and status on each of the documents**

**MANUAL ON THE  
AERONAUTICAL TELECOMMUNICATION NETWORK (ATN)  
USING INTERNET PROTOCOL SUITE (IPS)  
STANDARDS AND PROTOCOLS (Doc 9896)**

(Presented by the Secretariat)

**SUMMARY**

ATN over IPS has been adopted in ICAO Annex 10, Volume III through Amendment 75 to the Annex. Standards and Guidance on Implementation have been provided in ICAO Doc 9896. This paper provides information on Edition 1 of the Document and brings out some significant information from the Document

**1.                    Introduction**

1.1                    First Aeronautical Communication Panel (ACP) Working of the Whole Meeting held in Montreal from 21 to 29 June 2005 agreed that the use of IPS in ATN was feasible and recommended to ICAO development of SARPs for the introduction of TCP/IP elements of Internet Protocol Suite (IPS) in the Aeronautical Telecommunication Network (ATN).

1.2                    Based on the recommendations, amendment incorporating inclusion of IPS over ATN into ICAO Annex 10, Volume III, Part I and II became operative from 20 November 2008.

1.3                    Manual on *The Aeronautical Telecommunication Network (ATN) using Internet Protocol Suite (IPS) Standards and Protocols* (Doc 9896) has been developed to provide guidance on the matters relating to the implementation of ATN over IPS. First Edition of the document was published in June 2010.

## 2. Discussion

2.1 ATN/IPS has been established with the specific objective of providing global ATM services based on commercial off-the-shelf technologies. First edition of *Manual on the Aeronautical Telecommunication Network (ATN) using Internet Protocol Suite (IPS)* (Doc 9869) providing implementation guidance on ATN over IPS was published in June 2010. The manual is divided into three parts:

### Part I – Detailed Technical Specifications

This part contains general description of ATN over IPS and covers the network, transport and security requirements for the ATN over IPS

### Part II – Internet Protocol Suite (IPS) Applications:

This part contains a description of applications supported by ATN over IPS and includes convergence mechanism and application services that will allow legacy ATN over OSI applications to operate over the ATN over IPS transport layer.

### Part III – Guidance Material

This part contains guidance material on ATN over IPS communications including information on architecture, as well as general information to support the implementation of ATN over IPS.

## Part I

The ATN over IPS has adopted the same four-layer model as defined in the Internet Society (ISOC) internet standard STD003. Model described ( Figure 1) in these RFCs has four layers called the link layer, the Internet or Internet Protocol (IP) layer, the transport layer and the application layer (at the top). Manual prescribes IPv6 for internet layer interoperability and Border Gateway Protocol – 4 (BGP-4) with extensions for inter-domain routing. Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) have been adopted for connection-oriented and connectionless services at the transport layer.

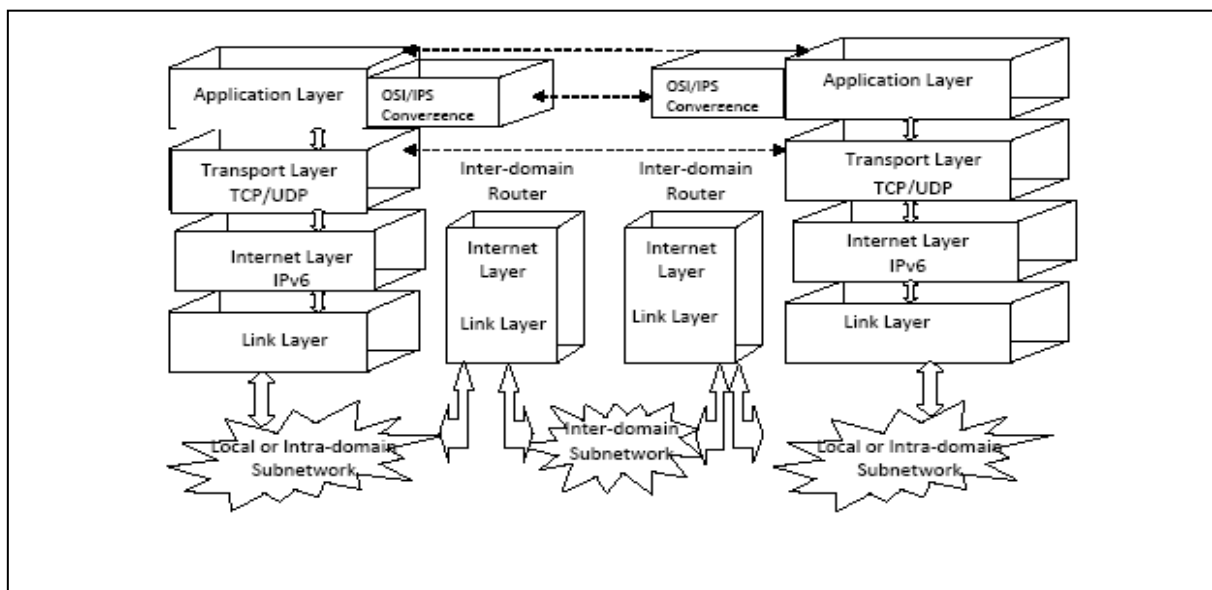


Figure 1. ATN/IPS Structure

Requirements

ATN network will consist of IPS nodes (device that hosts IPv6) and networks operating in a multinational environment in support of air traffic services communication as well as an aeronautical industry service communication, such as aeronautical administrative communications and aeronautical operational communications.

There are two types of nodes, first is an IPS router that forwards internet protocol (IP) packets not explicitly addressed to itself and second is an IPS host (node that provides service to end user) that is not a router .

From administrative perspective, network consists of a number of interconnected administrative domains, which can be an individual State, a group of States (like ICAO region), a communication service provider (CSP) or an air navigation service provider (ANSP), or any other organizational entity. Each administrative domain will operate one or more IPS routers which execute inter domain routing protocol specified in the manual.

From routing perspective, inter-domain routing protocols are used to exchange routing information between autonomous systems (AS), where an AS is a connected group of one or more IP address prefixes.

Globally scoped IPv6 addressing architecture as specified in RFC 4291 is required to be implemented for IPS nodes. The document recommends that Administrative domains should obtain IPv6 address prefix assignments from their local internet registry (LIR) or regional internet registry (RIR). Mobile Service Providers (MSPs) have been advised to obtain a /32 IPv6 address prefix assignment for exclusive use of IPS mobile nodes or mobile networks. Address structure recommended for aircraft address is as follow:

Mobility Service Provider:	32 bits
ICAO aircraft address:	24 bits (aircraft address /56)
Subnet ID:	8 bits (for ATS, AOC, AAC etc.)
Interface ID:	64 bits
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Total	128 bits

Chapter also mentions about the references to the guidance available to improve the performance of the system and the Appendix to the chapter provides Autonomous System (AS) Numbering Plan covering ICAO Contracting States, non-Contracting States and other Territories.

**Part II**  
**Internet Protocol Suite (IPS) Applications**

To operate ATSMHS (an application defined for ATN/OSI) IPS hosts are required to make use of RFC 2126 to provide TCP/IPv6 or make use of RFC 1006 to provide TCP/IPv4 combined with IPv4/IPv6 protocol translation device(s). AIDC (another application), as defined in Doc 9880 Part IIA, is currently not planned for implementation in the ATN/IPS environ, though some provisions have been mentioned about supporting Online Data Interchange (OLDI).

**Part III**  
**Guidance Material**

This part contains information to assist the States in the deployment of an ATN/IPS network to support ATM services.

Following table depicts the relationship with reference to Open System Interconnection (OSI) reference model between ATN/OSI and ATN/IPS:

OSI Reference Model	ATN/OSI Protocols	ATN/IPS Protocols
Application Layer 7	ATN Applications (e.g. CMIP, X.400)	Consolidated application services (e.g. SMTP, SNMPv3, FTP, X.400 and Telnet)
Presentation Layer 6	Fast-byte	
Session Layer 5	Fast-byte	
Transport Layer 4	Transport Layer Class 4	TCP/UDP
Network Layer 3	CLNP ----- SNDCF ----- X.25	IPv6 and ICMPv6
Link Layer 2	LAP B (HDLC)	LLC/MAC
Physical Layer 1	Physical Layer (e.g. EIA-232, V.35, X.21)	Physical Layer (e.g. FDDI, 802.X)

As required by ICAO SARPs, ATN/IPS internetwork is specifically and exclusively intended to provide following types of services

- a) ATS Communication (ATSC) related to air traffic services including air traffic control, aeronautical and meteorological information, position reporting, and services related to safety and regularity of flight.

- b) Aeronautical operation control (AOC) required for exercise of authority over the initiation, continuation, diversion or termination of flight for safety, regularity and efficiency
- c) Aeronautical administration communication (AAC) used by operating agencies in relation to business aspects and transport services. Used for variety of services like flight and ground transportation, bookings, deployment of crew and aircraft or any other logistical purposes

It is required that each administrative domain participating in the ATN/IPS internetwork must operate one or more IPS routers which execute an inter-domain routing protocol called the border gateway protocol (BGP) to make sure that any IPS host can reach any other IPS host in the ATN/IPS internetwork.

Mobile IPv6 permits mobile nodes (MN) (i.e. aircraft in the ATN/IPS) to communicate transparently with correspondent node (CN) while moving within or across air-ground networks. An administrative domain in the ATN/IPS which offers mobile IPv6 service is called a mobility service provider (MSP) which operates one or more home agents playing a key role in location management to keep track of movement of a mobile node.

### **Part III** **Guidance Material**

Third part of the manual contains information to assist States in deploying an ATN/IPS network to support air traffic management (ATM) services. The core services enable ATM applications to provide voice and data services using appropriate priorities and security over the ATN/IPS network. Coordination policies amongst the administrative domains are prescribed to ensure exchange of data between different domains. Possible configurations to provide mobile service through the use of Mobile IPv6 are discussed.

#### Transition Arrangements

Three transition mechanisms that can assist organizations deploying ATN/IPS in a heterogeneous environment have been discussed in the document:

-- *tunneling*: one protocol being encapsulated into other

IPv6 has been specified to operate over a variety of lower layer interfaces such as Frame Relay etc. Tunneling implies that a given protocol is encapsulated into another, meaning that IPv6 would be encapsulated into another functionally equivalent network protocol. The key benefit of this mechanism will be for those aeronautical organizations that already operate IPv4 networks to allow the IPv6 ATN/IPS hosts and routers to communicate between each other. It may be mentioned that IPv6 cannot operate over X.25 network. Under such circumstances, an IPv6 tunnel over IPv4 can be tunneled over an X.25 network. A specific tunneling mechanism term IP SNDCEF is defined for ATN/OSI applications which enables interoperability between ATN/OSI applications over an IP network but does not enable interoperability with ATN/IPS applications. Tunneling leads to an increase of protocol overhead and segregation of the two routed domains creating additional work for network management. This mechanism is best suited to resolve lower layer communication issues between ATN/IPS IPv6 hosts and routers.

-- *dual stack*: an environment in which multiple protocols operate simultaneously;

Dual stack implies handling of two communication protocols for a given application or function. A number of communication applications (like HTTP, FTP, SMTP etc.) have been dual stacked by supporting both IPv4 and IPv6 protocols. This concept is ideally suited for systems that need to support ATN applications for both OSI and IPS. In such environment, the applications are designed in an abstract fashion to be independent of the lower layers, e.g. they are unaware of the lower level protocols (OSI or IP). Dual stack mechanism provides maximum level of interoperability with peers

while reducing complexity of lower layer communication protocol gateways and additional single points of failures. It is ideally suited for applications such as the ATS message handling system (AMHS) where in some systems have already been implement on OSI and others on TCP/IP. A dual stack approach can be valid for air-ground data link ground systems to support CPDLC over multiple datalink services, such as ATN/OSI and ATN/IPS

-- *translation*: the conversion from one protocol to another

Translation mechanism implies conversion from one protocol to another. This mechanism can be interpreted as a lower layer communication gateway between two protocols that share a high degree of commonality. Several translators such as RFC 2766 – Network Address Translation – Protocol Translation (NAT-PT) have been developed in the context of the transition from IPv4 to IPv6 as both versions share a number of common features. Considering global internet scalability issues and the fact that most internet applications and systems have become dual stacked, the need for translators has declined. But there may be a role for translators in some specific environment. For example, although existing AMHS systems operate on dual stack, none of them have upgraded their application code to make use of IPv6. In other words RFC 1006 is supported but not RFC 2126. In such cases and in view of the limited number of systems, the deployment of translators provide a short-term measure for such systems to comply with the ATN/IPS and interwork with RFC 2126. IPv4/IPv6 translators increase the complexity of the IP infrastructure and its management. A dual stack approach is to be preferred but in specific cases translators may be the only short-term measure to provide compliance with the ATN/IPS

As ATN/IPS implementation will be gradual, it is understandable that a combination of the above three mechanisms will be applied simultaneously.

### **Transport Layer**

There are two mandatory transport layer protocols; TCP and UDP. TCP is used to provide reliable transport service and UDP is used to provide the best effort services.

#### *Transport Control Protocol (TCP)*

Internet protocol (IP) works by exchanging groups of information called the packets. Packets are short sequence of bytes consisting of a header and a body. Header describes the packet's routing information, which routers on the internet to pass the packet along in the right direction until it arrives at its final destination. The body contains the application information. TCP is optimized for accurate delivery rather than timely delivery and sometimes incurs long delays while waiting for out-of-order messages or retransmission of lost messages; it is not particularly suitable for real time applications like VoIP. It is a connection-oriented reliable stream delivery service that guarantees to deliver a stream of data sent from one host to another without duplication or losing data. Since packet transfer is not reliable, a technique known as positive acknowledgement with retransmission is used to guarantee reliability of packet transfers, while the sender keeps record of each packet it sends and waits for acknowledgement before sending the next packet. A timer is kept by the sender to retransmit the packet after the timer expires. Consecutive packets may take different routes to maintain efficiency. TCP is a connection oriented service

Real time applications require real time protocols like the real time transport protocol (RTP) running over the user datagram protocol (UDP). UDP provides connectionless service with limited error detection and no recovery and no congestion management mechanism.

### **Application Layer**

Document encourages IPv6 migration, however provision has been kept to accommodate requirement of maintaining IPv4 address scheme by using IPv4 mapping procedure, in which first 80 bits are set to zero, the next 16 bits are set to 1 and the last 32 bits are used for IPv4 addresses. Also the option of 'port' element is included to allow specifying a particular application. The port number is not needed if the implementation uses the standard IANA port numbers assigned to IPS applications.

### **Mobility Guidance**

Mobility solution specified in RFC 3775 for Mobile IPv6 has been adopted in the document. It prescribes two addresses; a home address (the permanent address) and a dynamic care-of address (which changes with mobile node changing its point of attachment to the network) to the mobile node. The fundamental technique in mobile IP is forwarding. A correspondent node (CN), which is any peer node with which a mobile node is communicating, sends packets to the home agent (HA) of the mobile node. Upon receipt of a packet from CN the HA forwards them to the MN at its current care-of address. The HA simply tunnels the original packet in another packet with its own source address and a destination address. This is possible because of the mobile IP protocol whereby the MN sends "binding updates" messages to the HA whenever its point of attachment changes. In reverse direction, the mobile node can send packets directly to the corresponding nodes using normal IP routing, but Mobile IPv6 allows the mobile node to follow the same path back to the correspondent node via home agent using bidirectional tunneling whereby, in addition to the home agent tunneling packets to the mobile node, the mobile node reverses tunnel packets to home agent. The home agent decapsulates the tunneled IP packet and forwards it to the correspondent node. With the bidirectional tunneling the correspondent node is not required to support mobile IP. It may happen that the mobile node and the correspondent nodes are close to each other but the home agent is far off in some other domain, that may create a longer path, in such cases route optimization has been recommended wherein mobile node sends binding updates to both the home agent and the corresponding nodes and communicate with the correspondent node directly if that route is shorter. Processes used in 'Hierarchical Mobile IPv6' to address the issues of delay or loss of packets during transition from one point of attachment to the second point of attachment are discussed in detail.

### **Security Guidance**

ATN/IPS nodes are required to implement IPS Security (IPsec) and the Internet Key Exchange 2 (IKEv2) protocol. Baseline for ground-ground security is the network layer security implemented using IPsec. IPsec creates a boundary between unprotected and protected interfaces. It forms a virtual private network (VPN) among gateways, which could be a router or another security device such as firewall. To achieve interoperability across the ATN/IPS internetwork, manual specifies support for the IPsec security architecture, the encapsulating payload protocol and a common set of cryptographic algorithms. Manual also specifies that ATN/IPS nodes in the ground-ground environment may implement the IP authentication header (AH) protocol. For air-ground, specific default algorithms are identified for authentication and for encryption, because of bandwidth limitation in air-ground links.

### **Voice over Internet Protocol**

The key advantages associated with the use of a packet network for the transmission of digitized voice

- Bandwidth allocation efficiency
- Ability to use modern voice compression methods
- Economic advantages associated with shared network use
- Reduced cost
- Enhanced reliability of packet networks; and
- Ability to use multiple logical connections over a single physical circuit

There are two standardized frameworks for implementing VoIP: ITU-T H.323 and IETF SIP. The focus of H.323 is to handle voice and multimedia calls, while SIP was designed as a generic transaction protocol for session initiation not bound to any specific media (e.g. audio or video). H.323 operates in the application layer to support multimedia, data and signaling protocol.

SIP is an application layer control protocol that provides advanced signaling and control functionality for large range multimedia communications.

Document provides details of the services provided and various protocols used for them.

### **IPS Implementations**

#### *Online data interchange (OLDI)*

Online data interchange (OLDI) combined with the flight message transfer protocol (FMTP) is a means to enable AIDC operational requirements for the coordination and transfer of aircraft information between adjacent air traffic control units. Relationship between AIDC and OLDI messages is described in the *Manual of Air Traffic Service Data Link Applications* (Doc 9694), Part VI, Chapter I, Appendix.

#### *Flight message transfer protocol (FMTP)*

The flight message transfer protocol (FMTP) is a communications stack based on TCP/IPv6 to support the transmission of OLDI messages. It is a machine that handles connection establishment and session management.

#### *AMHS*

AMHS has already achieved operational status over TCP/IP in the European and North American regions. European deployments make use of IPv6 for network interconnections in line with Part II of this document.

Manual provide a list of the documents referred in the end. Most of the documents referred are the *Request for Comments* (RFC) documents, ICAO Annexes, Manuals and some EUROCONTROL specifications.

**3. Action Required**

3.1 The meeting is invited to:

- a) Review the document; and
- b) Consider using the guidance and standards provided in the document for planning implementation of ATN over IPS

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