AERONAUTICAL TELECOMMUNICATIONS NETWORK PANEL

WORKING GROUP 3 MEETING

Munich, 24-28 June 1996

Agenda Item 6:   **Air-Ground Applications SARPs**

PROPOSED ATNP/2 WP -

'OVERVIEW OF ADS APPLICATION SARPS AND GUIDANCE MATERIAL'

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SUMMARY
This paper briefly outlines the development of the ADS SARPs since ATNP/1. It recommends that the attached SARPs be baselined as Version N.0

1.   INTRODUCTION

1.1   The concept of using data link as a major medium for ATS communications arose from the deliberations of the two phases of the ICAO Special Committee for Future Air Navigation Systems which met between 1985 and 1992. Automatic Dependent Surveillance (ADS) the oldest of the four early applications of an air/ground Air Traffic Management (ATM) data link system envisaged by the Automatic Dependent Surveillance Panel (ADSP), the others being Context Management (CM), Controller Pilot Data Link Communications (CPDLC), and Flight Information Services (FIS).

1.2   The ADSP is one of the ICAO operational Panels. It is charged with developing Operational Requirements for ATM data link applications, both air/ground and ground/ground, but it is not required to develop the necessary technical Standards and Recommended Practices (SARPS) - this responsibility has been delegated by ICAO to the Aeronautical Telecommunications Network Panel (ATNP).

1.3   The ATNP established a number of Working Groups, of which Working Group 3 was responsible for developing, inter alia, SARPS and Guidance Material (GM) for the four air/ground applications noted in paragraph 1.1 above. WG 3 convened a Subgroup specifically for the purpose of developing SARPS material for the four air/ground applications, taking into account a limited set of the funtionalities identified by the ADSP, constrained by the need to achieve early implementation of the applications by 1998, this timescale being established by the requirements of the Industry.

1.4   The proposed ADS Standards and Recommended Practices are attached at Appendix A to this paper.

2.   OPERATIONAL CONCEPT

2.1   Automatic Dependent Surveillance (ADS) is a surveillance technique in which aircraft automatically provide, via a data link, data derived from on-board navigation and position-fixing systems, including aircraft identification, four-dimensional position, and additional data as appropriate.

2.2   The implementation of ADS, through reliable data link communications and accurate aircraft navigation systems, will provide surveillance services in oceanic airspace and other areas where non-radar air traffic control services are currently provided. The implementation of ADS will also provide benefits in en-route continental, terminal areas and on the airport surface. The automatic transmission of the aircraft position through ADS will replace present pilot position reports.

2.3   The ADS application allows the implementation of reporting agreements, which, with the exception of an aircraft in an emergency situation, are established exclusively by the ground. An ADS agreement is an ADS reporting plan which establishes the conditions of ADS data reporting (i.e., data required by the ATC system and the frequency of the ADS reports which have to be agreed prior to the provision of the ADS services). The terms of an ADS agreement will allow for information to be exchanged between the ground system and the aircraft by means of a contract, or a series of contracts.

2.4   An ADS contract specifies under what conditions an ADS report would be initiated, and what data groups will be included in the reports. There are three types of contract - 'demand', which provides a single report, 'periodic', which provides a report at a regular periodic interval determined by the ground system, and 'event', which provides a report when or if a specified event or events take place.

3.   DEVELOPMENT OF THE ADS SARPS.

3.1   The root document from which the SARPs has been developed is the Draft ICAO Manual of ATS Data Link Applications, submitted to the 2nd Meeting of the ADS Panel in September 1996. ICAO has specified that ADS should conform to the ATN protocols for its data link operations.

3.2   The development of the SARPs was based on the general premise that ADS is a system to system based operation, with minimal human involvement.

3.3   The complexity of the SARPs arises from the fact that are many options within the system, both in what information the aircraft may be called upon to report, and the way it can report.

3.4   There has always been an explicit requirement in ADS operational requirements that an Air Traffic Services Unit (ATSU) in receipt of information from an aircraft should be able to pass this information to other ATSUs. ATNP WG 3 considered that, within the timecale available, it would be unable to develop a suitable set of Inter Centre Communications SARPs to enable this functionality. It therefore decided to include an element of ground/ground message forwarding in the ADS functionality.

3.5   This ground/ground functionality is so different in operating concept from the air/ground application that to facilitate comprehension, validation and implementation, that it has been given its own section within the SARPs document.

3.6   The ground/ground functionality were seen by some WG 3 members as having a limited applicability. Therefore, the WG agreed to separate out the functionalities to enable part implementation and part validation, whilst still retaining the interoperability required by the ICAO Standards. This has led to the development of subsetting rules, and the identification of conformant configurations.

4.   OVERVIEW OF THE CONTENTS OF THE MATERIAL

General

4.1   Due to the complexities of the documentation, and the repetitive nature of some of the material, none of the Air-Ground Applications SARPs are stand-alone documents. For example, there are no formal list of acronyms, definitions or references - these are all in Part 1. Likewise, conventions for expressing requirements, system performance parameters common to all air-ground applications, and the whole description of the Application Layer structure, with its finite and abstract concepts and its basis within ISO specifications, is also outwith this material.

4.2   Also, to the extent possible, the ADS SARPs are a Controlled Document. This means that, once they were initially baselined (at the WG 3/4 meeting in October 1995) all changes have been documented through defect reporting and a configuration control procedure. All defect reports are reviewed by Subgroup 2, acting as a Configuration Control Board , the necessary remedial action put in place, and the results presented to WG 3 for acceptance and approval. Traceability of actions is provided by means of the Configuration Sheet at the front of the SARPs.

4.3   All the Air-Ground SARPs are produced to a standard format of eight chapters, and all chapter headings are the same. This has greatly helped the maintenance of document stability, commonality and presentation. Although ADS SARPs are effectively two sets of SARPs in one volume, both sections in their own way are no different in the eight chapter basic layout from all other air-ground applications SARPs.

Section 1 - ADS Air-Ground Communication

<u>Chapter 1 - Application overview</u>

4.4   This introductory chapter gives a very brief, high level description of ADS as an application allowing users to obtain positional and other information from suitably equipped aircraft in a timely manner in accordance with their requirements.

4.5   This chapter also contains an outline description of the functions which the application provides, namely:

a.   **General Functionality**

        The avionics are capable of supporting contracts with at least four ATC ground systems simultaneously; they are also capable of supporting one demand, one event and one periodic contract with each ground system simultaneously.

        In addition if the pilot or avionics elects, the avionics will suspend any existing periodic contract, and establishes an emergency contract with each ground system with which it has an ADS contract.

b.   **Establishment and Operation of a Demand Contract**

        This function allows the ground system to establish a demand contract with an aircraft.. Realisation of the contract involves the sending of a single report from an aircraft to the ground system.

c.   **Establishment and Operation of an Event Contract**

        This function allows the ground system to establish an event contract with the aircraft.. Realisation of the contract involves the sending of reports from the aircraft to the ground system when certain agreed events occur..

d.   **Establishment and Operation of a Periodic Contract**

        This function allows the ground system to establish a periodic contract with the aircraft. Realisation of the contract involves the sending of reports from the aircraft to the ground system at regular intervals (the reporting rate).

e.   **Cancellation of Contracts**

        This function allows the ground system explicitly to cancel a contract that is in operation.

f.   **Establishment and Operation of Emergency Contracts**

This function allows the avionics to initiate an emergency contracts (either on instruction from the pilot or on its own initiative), between the avionics and all ground systems with which it has existing contracts. Realisation of the contract involves the sending of ADS emergency reports from the avionics to the ground system at regular intervals

g.   **Modifying an Emergency Contract**

This function allows the reporting rate of an emergency contract to be modified.

h.   **Cancellation of Emergency Contracts**

This function allows the aircraft to cancel an emergency contract.

Chapter 2 - General requirements

4.6   This chapter contains information and high level requirements for the maintenance of Backward Compatibility and Error Processing. Throughout these SARPs great emphasis is placed on the end users being kept informed of the state of the system.

Chapter 3 - The Abstract Service

4.7   This chapter defines the abstract service interface for the ADS application. The ADS-Application Service Element (ADS-ASE) abstract service is described from the viewpoint of the ADS-air-user, the ADS-ground-user and the CPDLC-service-provider.

4.8   In this chapter the static behaviour, (i.e. the format) of the CPDLC abstract service is described. Its dynamic behaviour (i.e. how it is used) is described in chapter 7. In order to clarify some of the concepts inherent in the abstract service, an outline diagram and informative notes are provided as an introduction.

4.9   The ADS-ASE abstract service shall consist of a subset of the following services (permissible subsets are described in chapter 8), the rules and requirements of which are described in detail:

a.   ADS-demand-contract service

b.   ADS-event-contract service

c.   ADS-periodic-contract service

d.   ADS-report service

e.   ADS-cancel service

f.   ADS-cancel-all-contracts service

g.   ADS-emergency-report service

h.   ADS-modify-emergency-contract service

i.   ADS-cancel-emergency service

j.   ADS-user-abort service

k.   ADS-provider-abort service

4.10   Each service contains a number of primitives and parameters - parameter values, where required, conforming to the Abstract Syntax Notation .One (ASN.1) syntax as given in Chapter 4.

Chapter 4 - Formal Definition of Messages

4.11   This chapter describes the contents of all permissible ADS air-ground messages through definition of the ADS ASN.1 abstract syntax. All possible combinations of message parameters and their range of values are detailed.

4.12   Parameter ranges and resolutions, where applicable, have been obtained from the ADSP documentation - any changes in these will be reflected in this chapter through the means of defect notes.

Chapter 5 - Protocol Definition

4.13   This chapter is effective split up into three parts - sequence diagrams for the services given in chapter 3, protocol descriptions and error handling for the ADS-Air- and Ground-ASEs, and State Tables.

4.14.   The sequence diagrams define the valid sequence of primitives that are possible to be invoked during the operation of the ADS application. They show the relationship in time between the service request and the resulting indication, and, if applicable, the subsequent response and resulting confirmation. With the exception of the abort primitives, only the sequence of primitives described in the diagrams shall be permitted. (Abort primitives may interrupt and terminate any of the normal message sequences.)

4.15   In order to guarantee message sequencing in normal operations, the ADS-air-ASE and the ADS-ground-ASE shall process primitives in the order in which they are received.

4.16   The protocol descriptions and error handling part of the chapter presents requirements for the ADS-air and ground-ASEs in specific states. If no actions are described for a ADS service primitive when the ASE is in a specific state, then the invocation of that primitive shall be prohibited while the ASE is in that state. Likewise, should the unexpected happen when an ASE is in a specific state, then exception handling procedures shall apply.

4.17   The state tables are a tabular description of the protocol rules earlier in the chapter. However, if the state tables conflict with any textual statements made elsewhere in the SARPs, the textual statements take precedence.

4.18   In the state tables, the statement 'cannot occur' means that if the implementation conforms to the SARPs, it is impossible for this event to occur. If the event does occur, this implies that there is an error in the implementation. If such a situation is detected, it is suggested that the ASE aborts , giving an indication of an unrecoverable system error. The statement 'not permitted' means that the implementation must prevent this event from occurring through some local means. If the event does occur, this implies that there is likewise an error in the implementation. However, if such a situation is detected in this case, it is suggested that the ASE performs a local rejection of the request, rather than aborting the dialogue.

Chapter 6 - Communication Requirements

4.19   This short chapter specifies the use of Packed Encoding Rules (PER) to encode/decode the ASN.1 message structure, Dialogue Service requirements, including Quality of Service (QOS), and stipulates the IA5 character string used as the Application Entity qualifier for the ADS application.

4.20   In this initial version of the ADS application, there are only limited QOS requirements - these will be expected to become more strongly defined in later versions.

Chapter 7 - User Requirements

4.21   This chapter contains requirements imposed on the ADS-user concerning ADS reports and interfacing with the ADS-ASEs.

Chapter 8 - Subsetting Rules

4.22   This chapter specifies conformance requirements which all implementations of the ADS protocol obey. The protocol options are tabulated, and indication is given as to whether mandatory, optional or conditional support is required to ensure conformance to the SARPs.

4.23   There are seven ADS-ground-ASE conformant configurations, (for the air-ground operations) supporting various combinations of functions. These are technical subsets - the ADSP may indicate a minimum set of functionalities to ensure an operational system. There is only one ADS-air-ASE conformant configuration.

4.24   These subsetting rules will permit applications to be tailored to suit individual ground implementations, commensurate with the underlying task, while still maintaining an acceptable level of interoperability.

Section 2 - ADS Report Forwarding

4.25   The ADS report forwarding application will allow users to obtain positional and other information from suitably equipped aircraft in a timely manner in accordance with their requirements. Significant differences in Section 2 chapters are outlined below.

Chapter 1

a.   **Establishment and Operation of Forward Contract**

This function provides a method for a ground system to establish a forward contract with another ground system and to forward ADS reports.

b.   **Cancellation of the Forward Contract**

This function allows the sending ground system to cancel the Forward Contract.

Chapter 3

4.26   The ADS-RF-ASE abstract service shall consist of a set of the following services as allowed by the subsetting rules defined in chapter 8:

a.   ADS-start-forward service

b.   ADS-forward-report service

c.   ADS-end-forward service

d.   ADS- user-abort service

e.   ADS-provider-abort service

5.   RECOMMENDATION

5.1   The Panel is recommended to approve the attached CPDLC Standards and Recommended Practices for review by the Air Navigation Commission for inclusion into the relevant ICAO documentation.