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**A Comparison of the Functionality described in ARINC
Characteristic 745 and the ADS Draft SARPs**

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SUMMARY

This document has been developed to compare the functionality now specified in the ADS draft SARPs with that described in ARINC Characteristic 745 (June 1993). The objectives are:

- to verify there has been no regression in the ADS Draft SARPs
- to identify the new services that have been introduced
- to assist in recognising what validation carry-through is possible based on trials carried out using ARINC 745 implementations.

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1. INTRODUCTION

1.1 Scope

The work of the ATNP WG3 to develop SARPs for CNS/ATM-1 package (end 1996) has now resulted in draft SARPs for the identified functional areas (ADS, CPDLC, CMA, ATIS, ULs). Many of these have evolved from earlier specifications (ARINC, RTCA etc.) which have been used as the basis for experimentation and pre-operational trials. This document has been developed to compare the functionality now specified in the ADS draft SARPs with that described in ARINC Characteristic 745 (June 1993). There are two purposes for this comparison:

- to recognise the degree of change that has been introduced into the ADS SARPs over the earlier ARINC specification
- to identify the extent to which trials carried out with ARINC 745 implementations can be considered to support the validation of the ADS SARPs.

1.2 References

1. ICAO ATNP Draft SARPs for the ATN CNS/ATM-1 Package. Part 2: ADS Application SARPs, Version 2.0, 15th February 1996 (*ADS Draft SARPs*)
2. ARINC Characteristic 745-2, Automatic Dependent Surveillance (ADS), June 30, 1993 (*ARINC 745*)

2. NATURE OF THE SPECIFICATIONS

Although both the ADS draft SARPs and ARINC 745 address the same functionality, that of providing aircraft positional, directional and other information over data link to ground ATC centres, the presentation of information is quite different. ARINC 745 is written as an avionics equipment specification, and thus provides information on implementation and compatibility of the ADS Unit (ADSU), which is not addressed at all by the ICAO draft SARPs. The draft SARPs are written based on the Opens Systems Interconnection (OSI) conventions, describing in abstract terms an end-to-end service provided by a pair of co-operating peer entities.

However, both approaches need to describe the (technical) operational behaviour of Automatic Dependent Surveillance, in terms of what an ATC centre can expect or request of an Aircraft, what an Aircraft can expect or request of an ATC centre, and what information exchanges take place to achieve that expectation. It is this part of the specifications which have to be compared so as to measure the similarities and differences, and to determine where pre-existing trials results can be meaningfully applied to the validation of the ADS draft SARPs.

Both specifications describe the encoding of data to be exchanged over the data link, and how the data link is used. It is recognised that there are changes at the technical level that affect the encoding and use of the data link, but such changes are not the subject of this comparison.

3. COMPARISON OF FUNCTIONALITY

3.1 Approach

The means used in this report by which similar specifications can be compared for functionality is based on work of the Standards Promotion and Application Group (SPAG) in Europe in the late 80's. In this approach, the functionality is decomposed into a number of tables, each of which contain entries for a subset of the abstract services defined in the specifications. By comparing the degree to which the different specifications address each of the entries in the table, it is possible to make statements on the compatibility, or divergence of the specifications.

3.2 Conventions

In the tables that follow, the following conventions are used.

Column 1	A sequential number used only for identification purposes within the table.
Column 2	The service as identified in the ADS draft SARPs.
Column 3	ADS draft SARPs Support
Column 4	Reference in ADS draft SARPs
Column 5	ARINC 745 Support
Column 6	ARINC 745 Description (often different from ADS terminology) and comments

The support columns can contain any of the following.

Y = Yes, the service is defined in the specification

N = No, the service is not described, and therefore not available

M = Mandatory, the service is described and MUST BE USED

O = Optional, the service is described but it is a user choice whether it is used

C = Conditional, and usage depends on some defined condition being fulfilled

A numeric value indicates the bounds on usage, e.g. "up to 10 instances"

4. THE COMPARISON TABLES

4.1 Top Level Functionality

ADS information is exchanged between aircraft and ground in ADS Reports, which are issued by the aircraft as the result of a "Contract" between aircraft and one or more ground ATC centres. The table below shows the support of different types of contract, and other top level parameters, in the referenced specifications.

Top Level ADS Functionality					
No.	Service Name and Parameters	ADS Draft SARPs		ARINC 745	
		Support	Ref	Support	Description / comment
1	Demand Contract Request	Y	1.3.2	Y	Variant of Periodic Contract Request, with zero reporting interval
2	Event Contract Request	Y	1.3.3	Y	
3	Periodic Contract Request	Y	1.3.4	Y	
4	Cancellation of Contracts	Y	1.3.5	Y	
5	Emergency Mode	Y	1.3.6	Y	
6	Modify Emergency Contract Request	Y	1.3.7	Y	
7	Cancellation of Emergency Mode	Y	1.3.8	Y	
8	Ground Forwarding Facility	Y	1.3.9	N	
9	Max. number of ATC ground systems simultaneously	4		4	
10	Max. number of simultaneous contracts per ATC ground system	3		3	

4.2 Demand Contract Request Service

A Demand Contract is initiated by a ground ATC and requests a single ADS report to be sent from the aircraft to the ground. The table below shows the functionality involved in setting up a demand contract.

Demand Contract Request Service					
No.	Service Name and Parameters	ADS Draft SARPs		ARINC 745	
		Support	Ref	Support	Description / Comment
1	"Request" specifies optional Fields as below:	Y	1.3.2.1.3	Y	
2	- Flight Id	Y	1.3.2.2.3	Y	Flight ID Group (12)
3	- Projected profile for next 2 way points	Y	"	Y	Predicted Route group (13)
4	- Ground vector - track, ground speed, vertical rate	Y	"	Y	Earth Reference Group (14)
5	- Air Vector - heading, air speed, vertical rate	Y	"	Y	Air Reference Group (15)
6	- Weather Information - wind speed, wind direction, temperature, turbulence	Y	"	Y	Meteorological Group (16)
7	- Airframe Id	Y	"	Y	Airframe ID Group (17)
8	- Navigational Intent	Y	"	Y	Aircraft Intent Group (21, 22, 23)
9	- Extended Projected Profile	Y	"	N	
10	Positive Acknowledgement in report	Y	1.3.2.2.4	Y	(Implicit)
11	Free standing positive acknowledgement	Y	1.3.2.2.5	Y	Acknowledgement Message (3)
12	Negative Acknowledgement (refusal) of contract	Y	1.3.2.2.6	Y	Negative Acknowledgement Message (4)
13	Non-compliance Notification	Y	1.3.2.2.7	Y	Non-compliance Notification (5)

4.3 Event Contract Request Service

An event contract can be requested by the ground ATC system if it requires to receive ADS reports in response to any of a set of agreed events arising. The table below shows the functionality involved in setting up an event contract.

Event Contract Request Service					
No.	Service Name and Parameters	ADS Draft SARPs		ARINC 745	
		Support	Ref	Support	Description / Comment
1	Max. No. Of simultaneous event contracts to one ATC centre	1	1.3.3.1.2.		
2	Multiple event types can be specified	Y	1.3.3.1.3	Y	ADS Event Contract Request (8)
3	Vertical rate change (60 sec)	Y	"	Y	Vertical Rate Change (18)
4	Way point change	Y	"	Y	Way point Change (20)
5	Lateral deviation change (60 sec)	Y	"	Y	Lateral Deviation (10)
6	Altitude range deviation (60 sec)	Y	"	Y	Altitude Range (19)
7	Airspeed change	Y	"	N	
8	Ground speed change	Y	"	N	
9	Heading change	Y	"	N	
10	Extended Projected Profile change	Y	"	N	
11	Figure of Merit change	Y	"	N	
12	Track angle change	Y	"	N	
13	Altitude change	Y	"	N	
14	Partial compliance notification	Y	1.3.3.1.7	Y	Acknowledgement (3)
15	Contract Acknowledgement	Y	1.3.3.1.5	Y	Non-compliance Notification (5)
16	Contract refusal	Y	1.3.3.1.6	Y	Negative Acknowledgement (4)

4.4 Periodic Contract Request Service

A periodic contract can be requested by the ground ATC system if it requires to receive ADS reports at a regular periodic rate from an aircraft. The table below shows the functionality involved in setting up a periodic contract.

Periodic Contract Request Service					
No.	Service Name and Parameters	ADS Draft SARPs		ARINC 745	
		Support	Ref	Support	Description / Comment
1	Max. No. Of simultaneous periodic contracts with one ATC centre	1	1.3.4.1.1	1	In ARINC 745, Periodic Contract Request is the same message as Demand Contract Request
2	reporting rate	Y	1.3.4.1.1	Y	1 ~ 4000 seconds
3	“Request” specifies optional Fields as below		1.3.4.2.1	Y	
4	- flight id modulus	Y	“	Y	Flight ID Group (12)
5	- projected profile modulus	Y	“	Y	Predicted Route group (13)
6	- ground vector modulus	Y	“	Y	Earth Reference Group (14)
7	- air vector modulus	Y	“	Y	Air Reference Group (15)
8	- weather modulus	Y	“	Y	Meteorological Group (16)
9	- airframe id modulus	Y	“	Y	Airframe ID Group (17)
10	- navigational intent modulus and projection time	Y	“	Y	Aircraft Intent Group (21, 22, 23)
11	- extended projected profile modulus	Y	“	N	
12	Positive Acknowledgement in report	Y	1.3.4.1.3	Y	(Implicit)
13	Free standing positive acknowledgement	Y	“	Y	Acknowledgement Message (3)
14	Negative Acknowledgement	Y	1.3.4.1.5	Y	Negative Acknowledgement Message (4)
15	Non-compliance notification	Y	1.3.4.2.7	Y	Non-compliance Notification (5)

4.5 ADS Report

An ADS report can be sent by an aircraft to an ATC ground centre as a result of any of the contract types described earlier. The table below shows the main functionality of the ADS report.

ADS Report main components					
No.	Service Name and Parameters	ADS Draft SARPs		ARINC 745	
		Support	Ref	Support	Description / Comment
1	3-D position of aircraft	M	1.3.2.2.2	Y	Basic ADS Group
2	Time (UTC z)	M	"	Y	Basic ADS Group
3	Figure of Merit	M	"	Y	Basic ADS Group
4	Flight Id	O	1.3.2.2.3	Y	Flight ID Group (12)
5	Projected profile for next 2 way points	O	"	Y	Predicted Route group (13)
6	Ground vector - track, ground speed, vertical rate	O	"	Y	Earth Reference Group (14)
7	Air Vector - heading, air speed, vertical rate	O	"	Y	Air Reference Group (15)
8	Weather Information - wind speed, wind direction, temperature, turbulence	O	"	Y	Meteorological Group (16)
9	Airframe Id	O	"	Y	Airframe ID Group (17)
10	Navigational Intent:	O	"	Y	Aircraft Intent Group (21, 22, 23)
11	- Short Term Intent	C (If 10)	"	Y	" " " (23)
12	- Intermediate Intent (up to 7 instances)	O	"	Y	" " " (22)
13	Extended Projected Profile	O	"	N	

Other Data Elements in an ADS Report					
No.	Service Name and Parameters	ADS Draft SARPs		ARINC 745	
		Support	Ref	Support	Description / Comment
1	Air Speed - Mach	Y	ASN.1	Y	Air Reference Group
2	Air speed - IAS	Y	ASN.1	N	
3	Extended Project Profile way-points	128	ASN.1	N	Identical to ADS draft SARPs " " " "
4	Figure of Merit	Y	ASN.1	Y	
5	Positional Accuracy	Y	ASN.1	Y	