EUROCONTROL

ATNP/WG3 __

WP 8-14 Rev 1

11th October 1996

AERONAUTICAL TELECOMMUNICATION NETWORK PANEL

WORKING GROUP 3 (APPLICATIONS AND UPPER LAYERS)

Alexandria USA, 7 - 18 October 1996

ADS draft SARPs Validation Report

Prepared by: T I Maude

Presented by: M Asbury

SUMMARY

This document examines the results of the validation programmes that have been undertaken by various states and organisations, which include validation of the ADS draft SARPs. It summarises the ADS-related results, and analyses them against a set of high level validation objectives, drawing conclusions on the level of validation achieved so far.

TABLE OF CONTENTS

1 Introduction........1
1.1 Scope........1
1.2 Background........1
1.3 References........1

2 High Level Validation Objectives........2

3 Validation Means........3

4 Application Functionality Validation Achieved by States and Organisations........4

5 Summary of Validation methods and tools........5
5.1 ATNP/WG3/SG2........5
5.2 Eurocontrol........5
5.2.1 Requirements Analysis........5
5.2.2 API Specification........5
5.2.3 Prototype Implementation........6
5.2.4 Interworking Testing........6
5.2.5 Inspection and desk checking.........6
5.2.6 Simulation and Modelling........6
5.3 FAA........6

6 Defect Report Summary........7

7 Analysis and Conclusions........9
7.1 SVO 1........9
7.2 SVO 2........9
7.3 FVO 1........9
7.4 FVO 2........9
7.5 FVO 3........9
7.6 FVO 4........9
7.7 FVO 5........9
7.8 FVO 6........10
7.9 FVO 7........10
7.10 TVO 1........10

7.11 TVO 2 10
7.12 TVO 3 10
7.13 TVO 4 10
7.14 TVO 5 10
7.15 TVO 6 11
7.16 TVO 7 11
7.17 TVO 8 11
7.18 TVO 9 11
7.19 TVO 10 11
7.20 TVO 11 11

8 Subset to Validation Functional Mapping 12
8.1 ADS-Air Subsets 12
8.2 ADS-Ground Subsets 12
8.3 ADS Report Forwarding Subsets 13

1 INTRODUCTION

1.1 Scope

Since the start of the development of the draft ADS SARPs, there have been a number of validation programmes that have been established due to the efforts of a number of organisations and states. The purpose of this document is to report on the results of those programmes that have reported their ADS-related results so far, and to draw conclusions on the level of validation of the ADS draft SARPs which has been achieved.

1.2 Background

The ADS SARPs were placed under configuration control at the 5th meeting of WG3 (Brisbane, February 1996), and since that time a detailed change record has been included in the configuration sheet which is part of the SARPs document. There was a major functional extension relating to ground forwarding of ADS reports which was included at the Brisbane meeting of WG3, in February 1996. The change history is shown in Table 1.

Version	Date	Comment
1.0	October 1995	Banff Proposed Draft SARPs.
1.1	February 1996	Input to ATNP/WG3 at Brisbane.
2.0	February 1996	Output Brisbane Draft SARPs. G-G report forwarding function included. Configuration control applied.
2.1	April 1996	Input to ATNP/WG3 at Brussels. New ASE for G-G report forwarding.
2.2	May 1996	Output Brussels/Toulouse Draft SARPs. A-G and G-G ASEs as separate sections.
2.3	June 1996	Output of Vancouver SG2/Input to Munich WG3. Subsetting rules defined.
3.0	June 1996	Output of ATNP/WG3 at Munich. Baseline version submitted to ICAO.
4.0	October 1996	Output from ATNP/WG3 at Alexandria. (Redlined 3.0 submitted to ICAO)

Table 1: Change History

1.3 References

[1] Validation Report For CNS/ATM-1 Package SARPs, Eurocontrol, Reference TC5/DEL/T03/D21v0_e

2 HIGH LEVEL VALIDATION OBJECTIVES

Table 2 shows the high level validation objectives for ADS.

VO	Description
SVO 1	To determine which System Level Requirements are satisfied by the functional descriptions in combination with the user requirements and recommended practices of the SARPs.
SVO 2	To determine if the CNS/ATM-1 Package applications specifications are mutually consistent.
FVO 1	To determine if the functional descriptions in the SARPs are compatible with the technical requirements.
FVO 2	To determine if the user requirements and recommended practices are compatible with the technical requirements.
FVO 3	To determine if the SARPs are complete.
FVO 4	To determine if the SARPs are unambiguous.
FVO 5	To determine if the SARPs are consistent.
FVO 6	To determine if there are requirements in the SARPs which would have no effect if removed.
FVO 7	To determine if provision has been made to ensure that the SARPs are implementation independent.
TVO 1	To determine if the protocol description supports the end to end services.
TVO 2	To determine if the protocol description has any unacceptable behaviour
TVO 3	To determine if the abstract service interface parameters are mapped appropriately to PDU fields and/or communication service interface parameters, and vice versa.
TVO 4	To determine if protocol errors in the peer application entity are correctly handled.
TVO 5	To determine if the SARPs are consistent with the upper layer architecture to the extent that this is a requirement, e.g. use of the Dialogue service, application of the control function. (this applies to application SARPs only)
TVO 6	To determine if the APDUs are correctly specified.
TVO 7	To determine if provision for QOS management has been addressed.
TVO 8	To determine if provision for future migration has been addressed.
TVO 9	To determine if efficiency requirements have been addressed, e.g. minimising size of data transfer, appropriate maintenance of dialogue.
TVO 10	To determine that the functionality described in the SARPs is implementable.
TVO 11	To determine that independent implementations built in accordance with the SARPs will be able to interoperate.

Table 2: Validation Objectives

3 VALIDATION MEANS

The following generic means of validation have been identified, and are used in Table 3.

a) Two or more independently developing interoperating implementations validated by two or more states/organisations.

b) Two or more independently developing interoperating implementations validated by one state/organisation.

c) One implementation validated by more than one state/organisation.

d) One implementation validated by one state/organisation.

e) Partial implementation validated by one or more state/organisation.

f) Simulation, analysis using tools e.g. ASN.1 compiler, modelling tools.

g) Analysis and inspection.

4 APPLICATION FUNCTIONALITY VALIDATION ACHIEVED BY STATES AND ORGANISATIONS

Table 3 summaries the validation activities that have completed to date. The letters in the table correspond to the validation means given in section 3. Each table entry contains all validation means that apply. Expected validation levels and dates are indicated where applicable in parentheses.

Groups of “shall” statements	ATNP/WG3/SG2	Eurocontrol	FAA	Summary
Demand contract - ground	g	f, g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	f, g, (d Feb 1997, a Mar 1997)
Demand contract - air	g	f, g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	f, g, (d Feb 1997, a Mar 1997)
Event contract - ground	g	f, g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	f, g, (d Feb 1997, a Mar 1997)
Event contract - air	g	f, g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	f, g, (d Feb 1997, a Mar 1997)
Periodic contract - ground	g	f, g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	f, g, (d Feb 1997, a Mar 1997)
Periodic contract - air	g	f, g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	f, g, (d Feb 1997, a Mar 1997)
Emergency contract - ground	g	f, g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	f, g, (d Feb 1997, a Mar 1997)
Emergency contract - air	g	f, g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	f, g, (d Feb 1997, a Mar 1997)
Abort - ground	g	f, g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	f, g, (d Feb 1997, a Mar 1997)
Abort - air	g	f, g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	f, g, (d Feb 1997, a Mar 1997)
Cancel-all-contracts - ground	g	f, g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	f, g, (d Feb 1997, a Mar 1997)
Cancel-all-contracts - air	g	f, g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	f, g, (d Feb 1997, a Mar 1997)
Forward - initiator	g	-	g, (d Feb 1997)	g, (d Feb 1997)
Forward - responder	g	-	g, (d Feb 1997)	g, (d Feb 1997)
Miscellaneous	g	g, (d Feb 1997, a Mar 1997)	g, (a Mar 1997)	g, (d Feb 1997, a Mar 1997)

Table 3: Validation Activities Summary

5 SUMMARY OF VALIDATION METHODS AND TOOLS

5.1 ATNP/WG3/SG2

In its work in developing the ADS draft SARPs, members of ATNP/WG3/SG2 have reviewed every line of the draft SARPs on numerous occasions. The sub-group has also reviewed the document on a page-by-page basis when working in session.

5.2 Eurocontrol

5.2.1 Requirements Analysis

Eurocontrol developed a set of tools to support the analysis of "requirements" ("shalls" and "shoulds") in the draft SARPs. These were used to extract the requirements of the ADS draft SARPs into a tabular format for further manual investigation.

The requirements analysis and extraction processes revealed:

- layout / structural errors in the SARPs document
- spurious “shalls” and “shoulds”
- requirements dependent on some condition
- duplicated requirements
- redundant requirements
- badly formed requirements

A number of structural and editorial improvements were made to the SARPs text as a direct result of these activities. For example, SARPs clauses containing more than one requirement were identified and split into separate clauses, redundant “shall” statements were identified and eliminated, and context-free shall clauses (e.g. “The ASE shall...”) were given context (e.g. “When event X happens, the ASE shall...”).

In some cases a “hanging requirement” was identified, indicating that at some level in the hierarchy there is an unstated or implied requirement that needs to be stated. These observations were fed through to the SARPs editor.

A number of technical and editorial deficiencies were found, and a Defect Report was sent to the SARPs editor for corrections to be applied.

5.2.2 API Specification

Eurocontrol developed an Application Programming Interface (API) specification for the ADS draft SARPs. This API was defined in the "C" programming language in a format compatible with that adopted by the X/Open organisation for the Transport Service Interface (XTI). As part of this specification work, a number of defects in the draft SARPs were detected and notified to the SARPs editor for corrections to be applied.

The interface definitions were then test-compiled. From this exercise, errors were detected in the original SARPs, which resulted in a number of defect reports being generated.

5.2.3 Prototype Implementation

Eurocontrol is developing the Trials End System (TES) prototype applications to assist in the validation of draft SARPs for the CNS/ATM-1 Package. The objectives of the overall TES project are:

- the validation of the ATN draft SARPs for air-ground applications and supporting upper layers,
- the production of corresponding prototypes and simulation models,
- the free issue of the software to Eurocontrol member Administrations.

The TES prototypes are being developed by a European industry consortium led by Thomson, who will independently analyse the draft SARPs, produce functional and design specifications based on the draft SARPs and implement the software realisations. The TES prototype will then be used to test the functionality, interoperability and performance resulting from the draft SARPs.

5.2.4 Interworking Testing

When the TES prototypes are completed, Eurocontrol plan to use them for interoperability testing, to achieve further levels of validation. These interworking tests will be carried out between difference instances of the TES software, and also with other States and organisations who have SARPs conformant implementations available for interworking tests.

5.2.5 Inspection and desk checking.

Eurocontrol provided the editor for the ADS draft SARPs. In consequence, the text was subject to extensive internal review in order to meet quality assurance guidelines for document development and production.

5.2.6 Simulation and Modelling

The ADS protocol is described in the draft SARPs in textual form (the functionality is also represented in general as a set of state tables). Based on the text in the draft SARPs, Eurocontrol has transcribed the functionality into the formal definition language SDL (Specification and Design Language - defined by ITU-T Z.100), which was then read and processed by the modelling tool GEODE.

Having developed the model, simulation activities were performed. Each of the valid sequences of events was simulated individually, to ensure that they are all possible. Then random simulation was performed to ensure that no problems occurred when the valid sequences of events are mixed. Exhaustive simulation can ensure that all possible scenarios are tested.

Modelling the application protocol using SDL and the GEODE tool allows the sections in the draft SARPs that describe the protocol machine to be validated.

5.3 FAA

The FAA has tasked Open Network Solutions, Inc. (ONS) to develop an implementation for each of the air - ground applications. The implementations will include the complete functionality and will be used for validation of the SARPs through interoperability testing. The implementation will be based on Version 3.0 of the SARPs including changes based on published defect reports.

The scheduled date of completion of the separate implementations is first quarter 1997. The schedule is set to allow interoperability testing with other organisations' implementations in the February time frame.

6 DEFECT REPORT SUMMARY

Table 4 gives a summary of the defect reports raised against version 3.0 during the validation programme.

DR Ref.	Status	Version	Summary
ADS-0032	CLOSED	V3.0	2.1.1.3.1.1 has the same meaning as 2.2.1.3.2.1; 2.1.2.3.1.1 has the same meaning as 2.2.2.3.2.1
ADS-0033	CLOSED	V3.0	Note 1 in 2.2.1.4.1.1 contains two "shoulds" - which are not permitted in notes.
ADS-0034	CLOSED	V3.0	Several comments in the ASN.1 contains "shoulds"
ADS-0035	CLOSED	V3.0	The word "must" appears in comments in ASN.1
ADS-0036	CLOSED	V3.0	Conditions C.1 and C.2 in 2.2.1.8.1.1 contain "shall" and "must".
ADS-0037	CLOSED	V3.0	Incorrect reference is given to section 2, instead of section 2.2.1
ADS-0038	REJECTED	V3.0	The following acronyms are not explained the first time they are used: ETA, PDU, PER, RER, FU, RF
ADS-0039	CLOSED	V3.0	There are references to "emergency mode" which no longer exists as a concept in ADS.
ADS-0040	OPEN	V3.0	The parameter ranges and resolutions differ from those in the draft ICAO Manual of ATS Data Link Applications
ADS-0041	CLOSED	V3.0	There are no Abort timer stop events in Table 2.2.1.5-1
ADS-0042	CLOSED	V3.0	Reference to Dialogue service is incorrect.
ADS-0043	CLOSED	V3.0	The reference to ASN.1 is incorrect.
ADS-0044	CLOSED	V3.0	The definition of AE-Qualifier serves no purpose.
ADS-0045	CLOSED	V3.0	The phrase "of functionally equivalent means to produce the same result" is superfluous.
ADS-0046	CLOSED	V3.0	Actions on unrecoverable system error should be recommendations - not requirements.
ADS-0047	CLOSED	V3.0	Incorrect reference.
ADS-0048	CLOSED	V3.0	The t-LI-1 timer is not set or tested.
ADS-0049	CLOSED	V3.0	The t-EM-4 timer on Figure 2.2.1.5-28 should be t-EM-3.
ADS-0050	CLOSED	V3.0	There is no figure to indicate a crossed ADS-cancel-emergency and ADS-modify-emergency-contract.
ADS-0051	CLOSED	V3.0	There is no stated requirement for the ASE to be able to encode and decode APDUs.
ADS-0052	CLOSED	V3.0	Reference to "user" instead of "ADS-user".
ADS-0053	CLOSED	V3.0	There is no definition of the term "Abstract Syntax".
ADS-0054	CLOSED	V3.0	The statement that the ASE will process primitives in the order in which they are received is superfluous, since the ULA requires this.
ADS-0055	CLOSED	V3.0	There are two stated requirements for the abstract service.
ADS-0056	CLOSED	V3.0	The definition of an Invalid PDU and Sequence error is not consistent with the other air-ground application SARPs.

Table 4: Defect Report Summary

7 ANALYSIS AND CONCLUSIONS

7.1 SVO 1

As far as can practicably be determined by inspection, all the system level requirements relevant to ADS are satisfied by version 3.0 of the draft SARPs.

7.2 SVO 2

All of the technical requirements arising from other draft SARPs have been checked for inclusion in these draft SARPs. Items of common text have been identified and checked for divergences.

Comparison of the tabulated requirements of ADS with the other air-ground applications reveals that a consistent approach has been adopted.

Study of the ASIs in each of the application SARPs ensured that they were specified in a consistent manner.

Examination of the draft SARPs shows that requirements placed on ADS by CM have been met, and that the use by ADS of the upper layer architecture is consistent with its definition.

7.3 FVO 1

The technical requirements have been examined to ensure that they provide the intended functionality. (The functional descriptions are mostly in non-normative notes).

7.4 FVO 2

All of the User requirements and recommendations in chapters 2.2.1.7 and 2.2.2.7 have been examined and have been determined to be compatible with the technical requirements.

The “User Requirements” correspond to the requirements at the ASI boundary, therefore specification of the API ensured that such requirements can be conveyed.

7.5 FVO 3

All statements in the air-ground section on protocols were modelled, and care was taken not to make any assumptions where there were no “shall” statements. Having built the model, it achieved the functions that were intended - there were no parts of the protocol that were “missing”. It can be concluded, therefore, that the “shall” statements describing the air-ground protocol are complete.

7.6 FVO 4

A number of ambiguities were detected in earlier inspections and have been rectified. No further ambiguities were detected in the final inspection.

Specification of the API ensured that the ASI parts of the SARPs are specified unambiguously.

7.7 FVO 5

A number of inconsistencies were detected in earlier inspections and have been rectified. No further inconsistencies were detected in the final inspection.

Specification of the API ensured that the various ASI primitives and their parameters are specified consistently in the SARPs.

The ADS model was built, taking care that all statements were modelled. No part of the model had to be removed in order to be replaced by other statements. Thus it can be concluded that the statements on protocol are consistent.

7.8 FVO 6

The tabulated requirements indicate that all stated requirements are necessary.

7.9 FVO 7

The SARPs are independent of any particular implementation constraints as far as can be determined. The abstract nature of the service “interfaces” is not always clear.

Specification of the C language API verified that nothing in the ASI specification required a particular implementation platform.

7.10 TVO 1

All air-ground end-to-end services were exercised within the modelling exercise. It was not possible to run exhaustive testing, due to memory limitations in the simulation machine, therefore end-to-end service were not exercised under all possible conditions. It can therefore be concluded that the air-ground protocol description meets the end-to-end services in all normal cases. No such conclusion can be drawn about ground forwarding.

7.11 TVO 2

The air-ground protocol was modelled completely. No unacceptable behaviour was detected, although it was not possible to run exhaustive testing, due to memory limitations in the simulation machine. It can be concluded that there is a high probability that there is no unacceptable behaviour in the air-ground protocol. No such conclusion can be drawn about ground forwarding.

7.12 TVO 3

Inspection of the text shows that the abstract service interface parameters (sections 2.2.1.3, 2.2.2.3) are mapped appropriately to PDU fields and/or Dialogue Service primitives.

7.13 TVO 4

All aspects of the air-ground protocol were implemented in the modelling exercise, including error handling. Error handling was not tested against a model which produced incorrect protocol, and therefore cannot claim that this objective has been fully met. It can be concluded that it is probable that sequence errors in the peer ADS application are correctly handled. No such conclusion can be drawn about ground forwarding.

7.14 TVO 5

The draft SARPs appear to cross refer to, and invoke the ULCS in a manner correct and consistent with the ULCS SARPs. An outstanding defect report relates to AE Qualifier syntax.

7.15 TVO 6

The APDU definitions have been inspected and appear correct. An ASN.1 compiler is required to verify the syntax.

7.16 TVO 7

QOS management is not a function of the ADS SARPs. Priority and requested RER have fixed values. Routing class (which maps to CLNP security label) is specified by the ADS-User, and can take any of the permitted ATSC values - it is not dynamically managed.

The provision for QOS management was reflected in the “pass-through” Class of Communication parameter.

7.17 TVO 8

A version number and ASN.1 extensibility markers have been included as an aid to future migration. The ADS Report Forwarding function has been specified as a separate ASE. This appears to be sufficient to meet the requirement for future migration.

7.18 TVO 9

PER is invoked, and PER-visible constraints have been specified for optimal encoding efficiency. Some further optimisations are possible.

7.19 TVO 10

Engineering judgement suggests that the functionality is implementable.

7.20 TVO 11

Engineering judgement suggests that independent implementations will interoperate.

8 SUBSET TO VALIDATION FUNCTIONAL MAPPING

8.1 ADS-Air Subsets

Table 5 maps the valid ADS-air subsets to the groups of "shall" statements identified in section 4, indicating the extent of validation achieved when working with each subset.

Subset	Predicates	Validation Functions
I	ADS/air + DC-FU + EC-FU + PC-FU + EM-FU	Demand contract - air Event contract - air Periodic contract - air Emergency contract - air Abort - air Cancel-all-contracts - air Miscellaneous

Table 5: ADS-air Subsets

8.2 ADS-Ground Subsets

Table 6 maps the valid ADS-ground subsets to the groups of "shall" statements identified in section 4, indicating the extent of validation achieved when working with each subset.

Subset	Predicates	Validation Functions
I	ADS/ground + DC-FU	Demand contract - ground Abort - ground Miscellaneous
II	ADS/ground + EC-FU + EM-FU	Event contract - ground Abort - ground Cancel-all-contracts - ground Miscellaneous
III	ADS/ground + PC-FU + EM-FU	Periodic contract - ground Abort - ground Cancel-all-contracts - ground Miscellaneous
IV	ADS/ground + DC-FU + EC-FU + EM-FU	Demand contract - ground Event contract - ground Abort - ground Cancel-all-contracts - ground Miscellaneous

Subset	Predicates	Validation Functions
V	ADS/ground + DC-FU + PC-FU + EM-FU	Demand contract - ground Periodic contract - ground Abort - ground Cancel-all-contracts - ground Miscellaneous
VI	ADS/ground + EC-FU + PC-FU + EM-FU	Event contract - ground Periodic contract - ground Abort - ground Cancel-all-contracts - ground Miscellaneous
VII	ADS/ground + DC-FU + EC-FU + PC-FU + EM-FU	Demand contract - ground Event contract - ground Periodic contract - ground Abort - ground Cancel-all-contracts - ground Miscellaneous

Table 6: ADS ground Subsets

8.3 ADS Report Forwarding Subsets

Table 7 maps the valid ADS Report Forwarding subsets to the groups of "shall" statements identified in section 4, indicating the extent of validation achieved when working with each subset.

Subset	Predicates	Validation Functions
I	INIT	Forward - initiator Forward - responder
II	none	Forward - responder

Table 7: ADS Report Forwarding Subsets