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ACCESS

ATN Compliant Communications
European Strategy Study

Accommodation of FANS-1/A

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The present report is the result of one specific task of the project, but it must be noted that ACCESS is still in progress and this report should therefore not be regarded as the final deliverable of the ACCESS consortium.

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EXECUTIVE SUMMARY

This document is the deliverable for work package 225 'Accommodation of FANS-1/A'. A breakdown of the operational characteristics of FANS-1/A, both the applications and the communication media, is provided and a comparison with ATN based systems undertaken. In addition the document identifies any convergence planning activities in progress and any policy positions of European States with regards to FANS-1/A.

The requirement for this work package is driven by a need for some States and organisations to support both FANS-1/A and the ATN in the transition phase to a wholly ATN environment. In the context of this document the term "Accommodation" is used to refer to operating ATN and FANS-1/A equipped aircraft in the same airspace simultaneously.

ICAO developed a concept known as Communications, Navigation & Surveillance/Air Traffic Management (CNS/ATM), which is based on using the Aeronautical Telecommunications Network (ATN) and embraces a number of different technologies with a view to improving the process of ATM.

The ATN is an internetwork that will use existing and developing networks to support the end to end communication of ATS and AOC data between end systems. The protocols used by the ATN are ISO OSI bit oriented protocols. The ATN is a fully scaleable network offering prioritised end-to-end communications, routing procedures that are policy based and a high service availability to meet the stringent performance and safety requirements needed for ATC.

However, as the CNS/ATM package was being validated, prior to its incorporation in Annex 10, the aircraft manufacturers Boeing and Aerospatiale developed FANS-1/A. This product allowed aircraft operators to utilise a system known as the Aircraft Communications Addressing and Reporting System (ACARS). This is a communication data-link system which allows messages to be sent between suitably equipped aircraft and ground systems, e.g. airline host computers (for AOC messages), ATC host computers (for ATS messages) and other parties. The ACARS system uses a character-based protocol, with limited end-to-end integrity checking, routing and prioritisation and is not suitable for transfer of binary information, as required by ATS applications. The ACARS service is provided by service provider organisations rather than ATS providers. SITA and ARINC are the two largest such organisations.

ICAO realised the potential problems of accommodating FANS-1/A in an ATN environment, and tasked the ADS Panel (ADSP) to generate guidance material applicable to those States and organisations that have or are considering the implementation of FANS-1/A and ATN. The ADSP considered several accommodation scenarios and developed a list of assumptions and principles to scope the work. This allowed an extensive comparison between the FANS-1/A applications and the ATN applications to be undertaken. The goal of this work was to identify the differences and, where possible, to provide a set of solutions to overcome the differences.

The ADSP document proposes the '*Independent Approach*' scenario (to handle each type of aircraft independently) for the accommodation of FANS-1/A AFN and the '*ATN SARPs Approach'* scenario (maximise ATN capability and accommodate FANS-1/A as much as possible) for the accommodation of the FANS-1/A ADS and CPDLC. This is in line with the provision of a suitable transition path to global compliance with the CNS/ATM concept as defined by ICAO. In addition the document emphasises the need for States and organisations to assess the applicability of these assumptions in their airspace. In some cases, operational, technical and/or institutional issues in a State or region may preclude FANS-1/A accommodation in an ATN environment.

At the time of writing there is no generally accepted policy between States on FANS-1/A accommodation. However, in June 1997, the ICAO North Atlantic Systems Planning Group (NAT SPG) made the decision to support services to FANS 1/A equipped aircraft in the North Atlantic (NAT) Region. This service will be restricted to Way Point Reporting only. The UK is planning to support such a service for FANS-1/A aircraft in the North Atlantic (NAT) Region.

There are a number of additional activities being undertaken in the ACCESS Region which may provide

solutions towards the accommodation of FANS-1/A. For example the use of a common CPDLC message subset as adopted by the PETAL II trials, or the generation of technical solutions, as proposed by the AEEC, to ensure the plans for ACARS replacement incorporate a path to the introduction of the ICAO CNS/ATM. It will be important for States to monitor and assess the impact of any recommendations upon their planned data communications strategy.

There is currently no overall implementation strategy to integrate ATN and FANS-1/A within the ACCESS Region. The current trend is towards the 'co-habitation' of ATN and FANS-1/A activities within Europe. At a technical level there are two options available to implementors and selection of the most appropriate option will be dependent on many factors including the life expectancy of existing systems, e.g. FDPS, operational requirements for supporting FANS-1/A, and the transition strategy of the State.

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1. Introduction

1.1 Purpose of the Document

FANS-1/A already provides a data communication capability for air traffic services that provides primary means of controller-pilot communication in oceanic and remote airspace (typically in the Pacific area).

The operational safety, performance, security and interoperability requirements defined by some European states within their own airspace for specific operational objectives (e.g. optimal use of voice bandwidth) may also be met by systems which use FANS-1/A technology. This would result in the presence of a combination of both ATN and FANS-1/A aircraft in some parts of the ACCESS airspace in the 2000-2010 timeframe considered in the ACCESS project.

For those states involved in the control of a mixed fleet of aircraft, accommodation solutions should be agreed and co-ordinated by regional planning and implementation groups.

The purpose of ACCESS Work Package 225 is to initiate the discussion on the FANS-1/A accommodation in Europe. The tasks identified for this WP are:

1. A survey of the on-going international activities on this topic;
2. An overview of the national plans of any ACCESS States considering the support of FANS-1/A aircraft in their airspace for ATS purposes (e.g. UK);
3. Technical alternatives for accommodating FANS-1/A.

1.2 Scope

This document will provide an overview of the ADSP Guidance Manual on the accommodation of FANS-1/A Systems[ICA16], and address the planned accommodation of FANS-1/A in the ICAO North Atlantic (NAT) Region. Other published plans or initiatives which address FANS-1/A accommodation in an ATN SARPs environment will also be considered.

This document only considers the technical aspects of FANS-1/A accommodation; it does not consider the operational implications of this accommodation e.g. a potential need for changes to European airspace structure or procedures.

1.3 Document Structure

Chapter 2 details the FANS-1/A system concept and the definition of associated terms.

Chapter 3 summarises the ADSP document - ‘Guidance on operational accommodation of FANS-1/A systems in an ATN SARPs environment [ICA16] on a chapter per chapter basis.

Chapter 4 details the plans for the North Atlantic Region.

Chapter 5 identifies the technical alternatives for accommodating FANS-1/A in an ATN environment.

Chapter 6 details the conclusions.

1.4 Background

The ADS Panel primarily dealing with the development of ATM data link applications provided guidance applicable to those states and organisations that have been or are considering the implementation of FANS-1/A and ATN.

ADSP considered several accommodation scenarios. A list of assumptions and principles was also defined to scope the work. The main ones were:

– in a given airspace were disparate data link systems co-exist, operational events and procedures must be identical except in situations where an operational advantage could be gained by dissimilar implementations and where safety and controller/pilot workload are not adversely affected;

– the accommodation would take place in the ground system only;

– ICAO SARPs would not change in order to accommodate FANS-1/A.

ADSP produced extensive comparison work between the FANS-1/A applications and the SARPs ones. This work covered two aspects: the comparison itself and a set of solutions to overcome the differences when possible.

In order to disseminate the result of this work to States, a document entitled "Guidance on operational accommodation of FANS-1/A systems in an ATN SARPs environment" and referenced [ICA16] was produced.

The ADSP document [ICA16] includes information on the impact of the differences between the FANS-1/A and the SARPs messaging capability so as to assist States in making decisions on accommodating multiple data link systems, and how to go about planning a structured strategy towards CNS/ATM end-state. Regarding the strategy the document highlights some areas which States would need to consider (e.g. cost, certification or performances) in addition.

ATNP addresses the transition issue in parts I and II of the ICAO Comprehensive ATN Manual (CAMAL) referenced in [ICA17] and [ICA18]. The need for world-wide co-ordination on a bilateral and multilateral basis was emphasised taking into account the national plans defined for the transition from the current infrastructure and procedures to those required for the operation of the ATN. Concerning the interface with FANS-1/A aircraft, ATNP proposes the same accommodation scenario as ADSP:

All accommodation will be done on the ground, both ATN and FANS-1/A downlink messages will be processed without restriction, and uplink messages will arrive at aircraft in the native protocols and message sets expected by the aircraft (i.e. FANS-1/A to FANS-1/A aircraft, and ATN to ATN aircraft). The FANS-1/A only aircraft will not be able to obtain the same operational services which will be offered to an ATN aircraft.

The ATNP recognises the need for further guidance on accommodation. Operational accommodation solutions have been provided in ADSP in [ICA16].

1.5 References

[ICA16] ADSP - Guidance on operational accommodation of FANS-1/A systems in an ATN SARPs environment - Attachment to ICAO State Letter SP 52/4-98/78 - 16/10/98

[ICA17] ATNP - Comprehensive ATN Manual (CAMAL) - Part I - Introduction and Overview Version 1.0

[ICA18] ATNP - Comprehensive ATN Manual (CAMAL) - Part II - System Level Planning and Implementation - Version 1.0

[GEN1] UK Requirement Specification for a FANS Front End Communications Processor [Restricted]

[EUR11] Proposed ACARS Replacement Solutions - Issue 1.2 - 24/03/98 - Ref: DED6/ATNCT/ProATN_Sup/DCI/AW_22

[SIT1] SITA - ACARS use of ICAO Data Links - Version 1.0 14/4/98 Ref::

ACARS/ICAO/SD/1

[EUR12] PETAL-II Feasibility Report & Preliminary Trials Description - Version 1.0 - 19/8/96

2. Definitions

2.1 Introduction

This section introduces the main concepts used when addressing the accommodation of FANS-1/A systems in the ATN environment. This includes a description of ACARS and the standards developed that enable it to support ATS applications. In addition, for comparison purposes a brief description of the ATN is provided.

2.2 ACARS

The Aircraft Communications Addressing and Reporting System (ACARS) is a communication data-link system which sends messages between an aircraft and ground system including airline host computers (for AOC messages), ATC host computers (for ATS messages) and other parties. ACARS is available as an option on most commercial aircraft currently in production or as a retrofit.

The ACARS system uses a character-based protocol, with limited routing and end-to-end integrity checking. There is limited message prioritisation for uplinked messages and none for downlinked messages. ACARS messages contain a maximum of 220 characters of text; this is adequate for routine messages. Longer messages need to be sent as a series of separate ACARS messages which are later regrouped by the ground system. ACARS is not suitable for transfer of binary information, as required by ATS applications.

The ACARS service is provided by service provider organisations rather than ATC authorities. SITA and ARINC are the two largest such organisations.

Initially the ACARS system was designed to support airline operational communications (AOC). The scope of AOC includes accurate recording of block times (times the aircraft left the gate, lift-off time, touchdown time and time of arrival at the gate), engine monitoring and pre-flight time saving.

2.3 Standards - ARINC 622/623

ARINC 622 is aimed at enabling ACARS to support ATS applications and allow bit-oriented applications to be used. An emulated ISO 8702 Transport Service is provided by the ACARS convergence function through the addition of a Cyclic Redundancy Check (CRC) to the bit-oriented application messages and the conversion to a character message of the resulting string. A specific application was specified to handle exchange of addressing information (ATS Facilities Notification -AFN) between airborne and ground ACARS systems. The performances characteristics of ARINC 622 systems are similar to those of ACARS.

Since the data networks are currently in place and available there has been a growth in interest in the potential use of ACARS for ATS applications. Initially this was limited to non-time critical ATS applications. ARINC 623 specifies ATIS (Automatic Terminal Information Service), DCL (Departure Clearance Service) and OCM (Oceanic Clearance Message).

In the meantime, international industrial standards were released covering the controller pilot data link applications: RTCA DO-219 (Two way Data Link - TWDL). The ADS application was specified in ARINC 745-2 and the MOPS (DO-212). Both these standards have been used in the FANS-1/A systems.

2.4 Procedures - ATS Facilities Notification (AFN)

The ATS Facilities Notification (AFN) procedure enables an ATS facility to become aware of aircraft's data link capabilities and provides an exchange of address information.

The aircraft AFN application sends a connection request message to the ground-based AFN application. This message contains details of the applications that the aircraft is capable of using and a flag indicating that the connection to the ATS facility is active. The ATS facility will return an acknowledgement message with details of the equivalent ground applications. Having exchanged this information the aircraft is then able to commence use of data link applications, for example setting up an ADS contract.

When the aircraft reaches a FIR boundary, the active ATS facility will cancel the connection and return the active flag to the aircraft. The aircraft will then request connection to the next ATS facility with the active flag. Possession of the active flag prevents control being accidentally passed to more than one ATS facility.

2.5 FANS-1 and FANS-A

FANS-1 is a Boeing-developed package with ADS and CPDLC communications via SATCOM or VHF. It has mainly been installed on 747-400 and 777 aircraft although it is available for 757,767 and MD-11 aircraft.

FANS-A is the equivalent Airbus package providing ADS and CPDLC via SATCOM or VHF for A340 aircraft (it is understood that this will become available in Q1 2000).

Trials have been conducted in the South Pacific leading to operational introduction of ADS and CPDLC. The ground system used by the Tahiti ACC is based around VIVO, an oceanic data link system, developed on behalf of STNA, which provides communications to FANS-1/A equipped aircraft.

2.6 Accommodation

The term "Accommodation" is used in this document to refer to operating ATN and FANS-1/A equipped aircraft in the same airspace simultaneously.

2.7 ATN

The Aeronautical Telecommunications Network (ATN) is the future ICAO specified data communications network. The ATN is an internetwork that will use existing and developing networks to support the end to end communication of ATS and AOC data between end systems. The connectivity between the ‘individual’ networks is provided by ATN routers. The protocols used by the ATN are ISO OSI bit oriented protocols, unlike ACARS which is character based. The ATN is a fully scaleable network offering prioritised end-to-end communications, routing procedures that are policy based and a high service availability to meet the stringent performance and safety requirements needed for ATC.

3. ADSP Guidance on accommodation of FANS-1/A systems in an ATN environment

Note. This chapter summarising the report issued by ADSP [ICA16] on the accommodation issue follows the structure of the ADSP report.

3.1 Historical Background

During the process of standardisation for the ATN, questions were asked about how existing systems can be accommodated in the future ATN environment. A substantial installed base of FANS-1/A-equipped aircraft is anticipated by the time ATN becomes operational. For the airspace where FANS-1/A is proven to be operationally acceptable, the approach for handling accommodation for mixed fleet equipage needs to be defined.

In 1997, ICAO was tasked to identify and address all aspects of transition to the ATN. It was recognised that guidance would be necessary to assist States and organisations to develop a well co-ordinated, structured approach to both the transition and the accommodation issues.

3.2 General

The objective of the ADSP document [ICA16] is to provide information on the operational differences between the FANS-1/A and the ATN environments which should be addressed when defining a transition strategy that incorporates ground accommodation. The different approaches considered for ground accommodation should be analysed by the States and organisations in the light of the operational requirements in effect in their airspace.

The technical impact of using ACARS and ATN in the same airspace is not addressed in the ADSP report [ICA16].

3.2.1 Assumptions

The following assumptions are made on how the ground accommodation should be performed:

- the goal is to migrate to uniform ATN SARPs compliance,
- the accommodation takes place in the ground systems,

Note. If the ability to change between FANS-1/A and ATN, while in flight, is available from the airborne system architecture, then accommodation is not necessary.

- the ground system handles both FANS-1/A and ATN aircraft,
- ATN SARPs are not changed in order to accommodate FANS-1/A,
- the outline approach mitigates against aircraft equipage changes,
- An ATN aircraft is considered as fully ATN SARPs compliant,
- mixed fleet equipage (i.e. FANS-1/A and ATN) could exist for a period of time,
- a given operational environment may require a different minimum capability for data link services.

Assuming that the accommodation takes place in the ground systems leads to another set of assumptions:

- the ground system is capable of processing all downlink messages from either FANS-1/A or ATN aircraft (the minimum capability is to be able to decode the message and reply

SERVICE UNAVAILABLE if the message processing is not supported).

- the accommodation restrictions apply only to ground-initiated uplink messages,
- when the ground system creates a response message, it is capable of using the same message capability as that of the incoming message,
- all uplink message leave the ground as either a FANS-1/A message or an ATN message.

3.2.2 Operational requirements considerations

The following operational requirement considerations must be taken into account when considering a particular technology as a suitable step on the migratory path:

1. in a given airspace where controllers utilise disparate data link services, operational events and procedures should be identical except in situations where an operational advantage could be gained by dissimilar implementations and where controller/pilot workload are not adversely affected.
2. where the same data link service is to be provided by several ATS units, operational events and procedures should be identical except in situations where an operational advantage could be gained by dissimilar implementations and where controller/pilot workload are not adversely affected.
3. when considering whether FANS-1/A can support a given phase, attention should be paid to the restrictions which arise from ranges, resolution and accuracy of message parameters, operational events related to context Management and Logon, error events and the inability to use a Logical Acknowledgement.
4. regarding Regions that choose to apply data link in a phased manner, regional co-ordination groups should reach agreement on what specific phases can be supported by FANS-1/A in order to ensure that the requirements in 2. and 3. above can be satisfied.
5. data link service procedures should be published in the appropriate documents and clearly state the units and resolutions to be used in data link exchanges.
6. in addition to restrictions arising from FANS-1/A applications differences vis-à-vis ATN SARPs, there will be restriction arising from data communication mode alternatives, such as ACARS. These restrictions should be considered during co-ordination of phased implementation.

3.3 Potential Accommodation Approaches, Comparative Analysis of Applications and their Operational Impact

3.3.1 Background

The ADSP report [ICA16] provides explanations on why FANS-1/A and ATN applications are not compatible. Actually, most differences between FANS-1/A and ATN applications can be explained by the following reasons:

- different underlying communication services with different capabilities,
- ATN ATS application expected to be globally applicable to terminal, en-route and oceanic airspace whilst FANS-1/A primarily attended to be used in oceanic airspace (this was the original need in Pacific and remote areas), and
- ATN SARPs attempt to address known limitation of FANS-1/A standards and products.

3.3.2 Accommodation approaches

Five different approaches have been considered when determining how an operational application can be handled when both FANS-1/A and ATN aircraft are flying in the same airspace:

- the **independent approach** is to handle each type of aircraft totally independently.
- the **common denominator approach** is to restrict the use of the application to the capability common to both types of aircraft.
- the **merged approach** is to restrict the use of the application to a subset from both type types of aircraft capabilities. This approach differs from the common denominator approach in that it includes additional, specific ATN SARPs functionality regarded as essential to meet operational requirements.
- The **ATN SARPs approach** is to maximise ATN capability and accommodate FANS-1/A as much as possible.
- The **FANS-1/A approach** is to provide full FANS/1-A capability and accommodate ATN aircraft as much as possible.

Table 3-1 provides the characteristics of each of these approaches.

Approach	Characteristics
Independent approach	• input capability have to accommodate differences between FANS-1/A and ATN aircraft. • implies the most significant controller interface differences. • the controller is aware of the differences. • the HMI for both ATN and FANS-1/A is required. • when FANS-1/A is no longer supported, the FANS-1/A HMI is eliminated. • full ATN capabilities are available to ATN aircraft and full FANS-1/A capabilities are available to FANS-1/A aircraft.
Common Denominator approach	• input capability are restricted to what is common to FANS-1/A and ATN capability. • controller interface differences are minimised. • the existing full compliant FANS-1/A HMI is modified to support the common capability only. • when FANS-1/A is no longer supported, the HMI is modified again. • the additional ATN compliant capability is eliminated.
Merged approach	• any additional ATN messages (i.e. not defined in FANS-1/A) could not be sent to FANS-1/A aircraft • any FANS-1/A message not in compliance with the ATN SARPs cannot be sent to ATN aircraft. • the automation is tailored for handling differences between FANS-1/A and ATN messages. • the controller is aware of the differences. • the existing FANS-1/A HMI is modified to support the merged capability only. • when FANS-1/A is no longer supported, the HMI is modified again.
ATN SARPs approach	• the input capability makes maximum use of the ATN capability. • the HMI for ATN SARPs is used. • the automation is tailored for FANS-1/A specific messages. • the controller is aware of the differences.

	• the existing FANS-1/A HMI is modified to support the ATN capability. • when FANS-1/A is no longer supported, the HMI does not need to be modified.
FANS-1/A approach	• the input capability limits services that can be provided to ATN aircraft. • the HMI for FANS-1/A messages would be used. • the automation is tailored for ATN specific messages. • the controller is aware of the differences. • the existing FANS-1/A HMI does not need to be modified. • when FANS-1/A is no longer supported, the HMI is modified to support the ATN capability.

Table 3-1: Accommodation Approaches

The approach preferred by each State will certainly depend on the availability (or not) of the FANS-1/A service. For those States having already implemented FANS-1/A, the FANS-1/A approach may be preferred. States going straight to the ATN would prefer the ATN SARPs approach.

Comparative analysis and operational impact

A first category of differences contains those differences that could be absorbed by automated systems. These differences are completely transparent to the controller and pilot and have therefore no operational impact. Examples of such differences are a difference of range and resolution or ATN functions or messages emulated by FANS-1/A functions or messages.

The second category of differences contains those which may not be absorbed by an automated system and could therefore have an impact on pilot or controller procedure and workload. Examples of such differences are appearance of new functions or messages introduced in the ATN SARPs which could not be emulated by FANS-1/A functions or messages or similar functions in FANS-1/A and ATN presenting drastic technical differences.

3.3.3 ATN Context Management (CM) and FANS-1/A ATS Facilities Notification (AFN)

The main operational difference between CM and AFN is related to the flight plan correlation. For the current FANS/1-A implementation, participating airlines must file a flight plan with ATS, containing the aircraft registration in field 18 of the ICAO flight plan message. This was mandated so that when a FANS/1-A aircraft logs on to an ATS facility, the logon can be correlated with the flight plan. However, the AFN logon does not provide any additional information that would allow the resolution of duplicate or multiple flight plans for a single aircraft. This problem is addressed by the CM application through the optional provision of departure point, destination, and Estimated Off-Block Time (EOBT).

Note: the detailed analysis of the differences between AFN and CM is provided in chapter B2 of the ADSP document [ICA16].

Two independent applications, each resident in the ground end system, appeared the most logical approach. The differences in both content and format are such that two separate applications are needed to ensure that the messages are delivered correctly to the proper addresses as the transition proceeds. The Independent Approach is preferred from handling the accommodation of CM and AFN in the same airspace.

Since AFN and CM are systems applications mainly invisible to end users, both can be operationally accommodated with little or no impact on these users. The user interfaces can be built to operate in exactly the same way.

3.3.4 ATN compliant CPDLC and FANS-1/A CPDLC (DO-212)

In the intent of providing a globally applicable accommodation guidance and taking into account that the overall goal was to migrate to uniform SARPs compliance, the ATN is adopted.

The main problem identified is the lack of Logical Acknowledgement in the FAN-1/A implementations and the inability to emulate it simply. Work-around solutions with extensive use of free text messages shall be evaluated in terms of frequency and workload on controller and aircrew.

Table 3-2 lists the differences identified between the FANS-1/A and ATN CPDLC applications. Guidelines on how the differences should be handled in given in the last column.

Note. the detailed analysis is provided in chapter G1 of the ADSP document.

	FANS-1/A	ATN	Operational impact
Message header	inability to request a LACK		An evaluation should be made concerning the operational impact of not utilising LACK with some or all aircraft.
Message attributes			
• Upl #127-130	R (ROGER)	W (WILCO) / U (UNABLE)	not significant, Roger means Wilco in these cases.
• set of Upl messages	NE (Not Enabled)	Y (Yes)	May impact on Upl #137-140-142-147
• Upl #157	R (ROGER)	N (No)	no impact
• set of Upl messages	NE (Not Enabled)	N (No)	no impact, NE and N are functionally equivalent.
Message elements			
• Level/Altitude	range and resolution	range and resolution	use of free text message when mismatch recommendation to use the FANS-1/A range and resolution
• Block level	only one level is specified	a block of 2 levels may be specified	use of two concatenated FANS-1/A fixed format messages
• Position	resolution = 0.1 minute	resolution < 0.1	not sure the requirement of less than 0.1 exists.
• Distance	range and resolution	range and resolution	recommendation to use the FANS-1/A range and resolution
• Speed type	non existing variable		message Upl 134 + free text is equivalent
• Traffic type	non existing variable		message Upl 166 + free text is equivalent
• Procedure name	< 6 characters	< 20 characters	free text is used but the response attributes are different (W/U < 6 and R > 6)
• LegType	does not allow 0	allows 0	0 not used. no impact.
• PDC/DCL		some fields not supported (aircraft type, aircraft equipment, etc.)	fields not used. no impact.
• Frequency	range and resolution	range and resolution	free text is used but the response attributes are different (W/U for not 8.33 and R for 8.33)
• Facility Designation	4 characters	8 characters	Potential problems with system generated messages 160 (NDA) and 163 (Facility Designation). 4 characters are sufficient during the accommodation period.
• Error information			no impact
• Additional message elements		additional message elements	combination of existing FANS msgs or/and free text msgs Impact to be assessed Potential pb with Upl 192 which may have 2 FANS

			msgs
• Miscellaneous	• Msgs must be responded to before any subsequent message is sent. • the use of free text messages to emulate ATN intent may have certification, safety and workload impact.	• the use of free text message to emulate FANS-1/A intent reduced the number of operational msg element	

Table 3-2: Differences between FANS-1/A and ATN CPDLC Applications

Note. Number (e.g. Upl #127) refers to message numbers (Uplink Message 172 is CLIMB AT [verticalRate] MAXIMUM).

3.3.5 ATN compliant ADS and FANS-1/A ADS (DO-219)

The ATN is adopted. The merged approach and the common denominator approach are not suitable due to the nature of the differences between the two applications.

FANS-1/A was primarily designed for use in oceanic and low-density domestic airspace. ATN has taken into account the possible use of ADS for all types of airspace.

Most of the operational differences have little impact on the controller, as indicated in Table 3-3. ADS is not seen as HMI intensive as CPDLC because of its automatic nature.

Note: the detailed analysis of the differences between FANS-1/A and ATN ADS is provided in chapter D1 of the ADSP document.

	FANS-1/A	**ATN**	**Operational impact**
Demand contract Event contract Periodic contract Cancel contract Modify emergency contract Number of connections Ranges and Resolutions Timers Miscellaneous	ADS message elements differ between the two applications		potential accommodation strategies foreseen to mitigate the differences
Event contract	the event contract is automatically cancelled when the event occurs	• the event contract shall be cancelled by the ground • some events (lateral deviation, altitude range and vertical rate) trigger 60 second interval reports for the duration of the event.	The ADS-ground system will need to deal with this functional difference
Periodic contract reporting rate	limited to a maximum of 64 seconds		This limit may affect the applicability of FANS-1/A ADS within certain airspaces
Aircraft address	24bit address not present in the ADS reports.		
Extended projected profile	EPP not provided		
Range and Resolution • time stamp	seconds count converted by the ground automation in		

	HHMMSS		
• aircraft intent projection time	4 hours 33 minutes	24 hours	
• vertical rate change threshold	64 feet/min	10 feet/min	no impact. it is recommended not to use more than 64 feet/min

Table 3-3: Differences between FANS-1/A and ATN ADS Applications

3.4 Operational Impacts Associated with Implementation of ATS Data Link Applications

A number of operational impacts not specifically related to accommodation have been identified by the ADS Panel. It should be noted that ADSP identify these issues but does not fix them. These side issues are briefly introduced below.

Time stamping

Requirements for message time stamping are not precisely defined. It was recognised that every message of each application need to be time stamped, but the way to do it (who and when should be added the time stamp to the message, is the time stamp exchanged between air and ground peers, etc.)

Security

There are no provision for security in the existing FANS-1/A implementations. Although there are technical provisions for security in the ATN, none have yet been specified for use by the ATN data link application SARPs. States should consider security as a real requirement.

Accuracy

There is a confusion between the accuracy of data contained in messages and the resolution of that data. The accuracy of the data is dependent on its source and the sensors used to collect the data.

Resolution

The need to exceed the resolution available in FANS-1/A in the near term is seen as unlikely. The FANS-1/A resolution values seems sufficient during the accommodation period.

Recording facilities

Although Annex 6 requires the recording of all digital communications with ATS, existing FANS-1/A equipped aircraft do not record any FANS-1/A application messages received or sent by the avionics.

3.5 Other Issues

The accommodation analysis has mainly been carried out from an operational perspective. The ADSP Report indicates that other types of analyses should also be performed, as the one listed below.

Cost benefit

The costs associated with allowing for accommodation of FANS-1/A applications in an ATN environment would need to be weighed against the benefits expected from such accommodation. Further, would the accommodation of differing capabilities and integrity levels in a given environment have a negative impact on those ATN-equipped aircraft expecting an appropriate rate of return. What price would be paid by the ATS users and providers to permit accommodation?

These matters would have to be considered by any State or Region contemplating the accommodation issue.

Certification

The analysis for certification of the accommodated system will have to consider two aspects:

1. at the application level: a system that allowed for more than one application with subtle but operationally significant differences would cause additional strain on the process of certification.
2. at the communication service level: the ability to certify varying levels and means of ensuring integrity would need to be considered in parallel with costs and feasibility associated with the certification and regulatory criteria.

Communications performance

The capabilities of the communication network would need to be addressed to ensure that the applicable communication performance requirements, including end-to-end integrity, reliability and continuity, etc. could be met to allow for an agreed messaging performance in a given airspace.

Aircraft equipage

In any specific airspace, the ratio of FANS-1/A equipped aircraft to non-FANS-1/A equipped aircraft, and any anticipated change to this ratio over a period of time may be determining factors in the decision to accommodate FANS-1/A operations.

3.6 Conclusion of the Report

The ADSP document [ICA16] provides useful guidance to States and organisations that are considering implementation of both FANS-1/A and ATN.

Based on a series of specified assumptions, operational requirements considerations and the need to provide a suitable transition path to global compliance with the CNS/ATM concept defined by ICAO, the document proposes to follow the *Independent Approach* for the accommodation of FANS-1/A AFN and the *ATN SARPs Approach* for the accommodation of the FANS-1/A ADS and CPDLC.

The document [ICA16] emphasises the need for States and organisations to assess the applicability of these assumptions in their airspace. In some cases, operational, technical and/or institutional issues in a State or region may preclude FANS-1/A accommodation in an ATN environment.

4. FANS-1/A Accommodation Activities in the ACCESS Region

4.1 Introduction

This section will provide an overview of national plans of the ACCESS States who are considering the use of services to aircraft based on FANS-1/A technology. The work will describe the environment, accommodation, implementation and future plans. In addition, a summary of any activities which address FANS-1/A accommodation will be provided.

At the time of writing there is no generally accepted policy between States on FANS-1/A accommodation. One State in the ACCESS area , the UK, is planning to support a Way Point Reporting (WPR) Service using ADS for FANS-1/A aircraft in the North Atlantic (NAT) Region. This is a possible alternative for the existing reporting via HF voice. The WPR service will be based upon an operational requirement to support FANS-1/A equipped aircraft and would include the generation of an operational concept.

4.2 The North Atlantic (NAT) Environment

4.2.1 Background

By international agreement the North Atlantic Region is divided into a number of different control areas known as CTAs. Control of aircraft in the Shanwick CTA is the responsibility of the Oceanic Area Control Centre (OACC) at Prestwick. They are supported in this role by HF radio operators at the communications centre in Ballygirreen, on the west coast of Ireland. Air Traffic Controllers use Flight Data Processing Systems (FDPS) to assist them in the monitoring and controlling of aircraft. The FDPS systems provide aircraft conflict prediction and resolution, automatic data exchange with other ATC agencies and checking and processing of aircraft information. Flight data is displayed and updated electronically at dedicated controller positions.

At present aircraft over the Atlantic Ocean region are required to make regular position reports using HF radio voice communications. Position reports are received at the HF stations by radio operators who generate a data message and forward it by ground/ground data communications link to the FDPS. After checking the message the FDPS updates the responsible controllers electronic display.

Some aircraft are required to provide weather information which is also communicated using HF voice communications. After reception by the radio operator, a message is generated and forwarded via ground AFTN datalink to the MET office.

Sometimes due to ionospheric conditions, time of day, sun spot activity etc. it becomes difficult to establish communications between the aircraft and the ground based radio operators. This can lead to long delays between the actual time that the aircraft reaches a reporting point and that event being reported to the responsible Air Traffic Controller.

As the Oceanic Region is a non radar environment procedural control is used to maintain separation between aircraft. To allow for possible communications problems, the separation minima between aircraft in the oceanic regions is much greater than those used in domestic airspace, where radar coverage is available and communications more reliable.

4.2.2 The ADS Way Point Reporting Service

For a number of years now the International Civil Aviation Organisation (ICAO) have been looking at ways of improving Air Traffic Management (ATM). With the development of new

technologies such as satellite communications, global positioning and ground based internetworking new methods of controlling aircraft are being sought. ICAO have developed a concept known as Communications, Navigation & Surveillance/Air Traffic Management (CNS/ATM) which is based on using the Aeronautical Telecommunications Network (ATN) and embraces a number of different technologies with a view to improving the process of ATM.

One of these technologies is Automatic Dependent Surveillance (ADS) which among other functions can provide ground based systems with a timestamped three dimensional fix of the current aircraft position together with information on its future intent.

The NAT SPG Implementation Plan states that the use of ATN based systems complying with the ICAO CNS/ATM standards remains the end goal for the NAT Region. However, manufacturers such as Boeing and Airbus have developed proprietary systems for aircraft such as the 747-400 and Airbus A340 using existing data communications networks which are known as FANS-1 and FANS-A respectively (see section 2). Operators have been installing these avionics to obtain benefits in ICAO regions other than the NAT and while it is recognised that they may not obtain any significant operational benefits in the NAT Region they may still wish to use the equipment in this area.

At a meeting of the ICAO North Atlantic Systems Planning Group (NAT SPG), in June 1997, the decision was taken to accommodate FANS 1/A equipped aircraft in the North Atlantic (NAT) Region. Although FANS 1/A systems have a broad range of functionality the Implementation Management Group (IMG, a NAT SPG sub-group) have decided that its initial use in the NAT region will be limited to an ADS Waypoint Reporting (ADS WPR) trial.

The present FDPS at Prestwick is unable to receive messages in the ADS format. The establishing of data link communications between an aircraft and the ground and the requesting of ADS contracts is also outside the capabilities of the present FDPS. In order to meet the objectives of the NAT SPG, a system will have to be installed which is capable of interfacing the two environments.

The system that will provide such an interface will be known as the FANS Front End (FFE). Broadly, the FFE is a stand alone system that will contain functionality to set up ADS contracts with participating aircraft and convert the resulting ADS reports into position reports (POS) that are compatible with the current HF voice originated reports and can be input directly into the existing FDPS at ScOACC via AFTN.

4.2.3 Implementation Approach

Those States that intend to deploy FFEs will do so at their own pace. The ADS WPR trials will commence in an FIR when the relevant FFE becomes available. It is expected that Gander and Shanwick FIRs will have FFEs in place by late 1999. In the interim, some NAT ATS providers (e.g. Canada and Ireland) may arrange for a centralised ADS service to be available from one of the communications service providers such as ARINC or SITA. However, this will not be a generally adopted approach as some States (e.g. Iceland and Portugal) have stated that they do not intend to follow that path.

Suitably equipped aircraft will participate in the trial as they wish. There is no compulsion to equip; the purpose of the trial is to allow those aircraft that are already equipped to make use of their FANS-1/A equipment for ATC purposes. The only potential benefits are a reduced air crew workload as a result of not having to make HF voice reports and the resultant reduction in demand for HF voice frequency allocations. Furthermore, the use of ADS may assist in the identification and subsequent correction of Gross Navigational Errors.

The HF Voice system will continue to operate without change during the open-ended trial period and will be the fallback system for those aircraft that are using ADS WPR should the FANS-1/A infrastructure fail.

It is accepted that there is no cost benefit from this trial, it is being undertaken by the provider States in response to airline requests.

The provider States will use this operational trial to gather performance data on the FANS-1/A system and then determine if other FANS-1/A services could be supported in the NAT Region.

4.2.4 Future Accommodation Plans

In the interim period, it is likely that ATN equipped aircraft will start becoming available on the NAT from 2000/2001 onwards. Initially, these aircraft will be equipped to support ATN based trials such as those being sponsored by Eurocontrol (PETAL-II) and the FAA CPDLC trials. Currently the feasibility of providing equivalent ATN based services on a trials basis is being studied and a possible arrangement is outlined in Figure 1. This would enable the establishment of the ATN infrastructure (e.g. routers) required to support the full ATN based service that is the eventual 'end goal' for the NAT region. Furthermore, it will enable the 'ATN infrastructure' to be tested thoroughly in an operational environment before it is used to support a full ATN based service. In addition the airlines are being driven by a need for increased data capacity to support their own Airline Operational Communications (AOC) and this may dictate the speed at which aircraft are ATN equipped. .

Any future replacement FDPSs for the NAT Region are currently being specified to have full FANS-1/A and ATN functionality to enable the support of both environments and to facilitate a transition from FANS-1/A usage to the long term goal of full ATN usage. The need for, and specific approach to, a particular accomodation approach (e.g. ATN SARPs, Common Denominator, Independent) has not been determined.

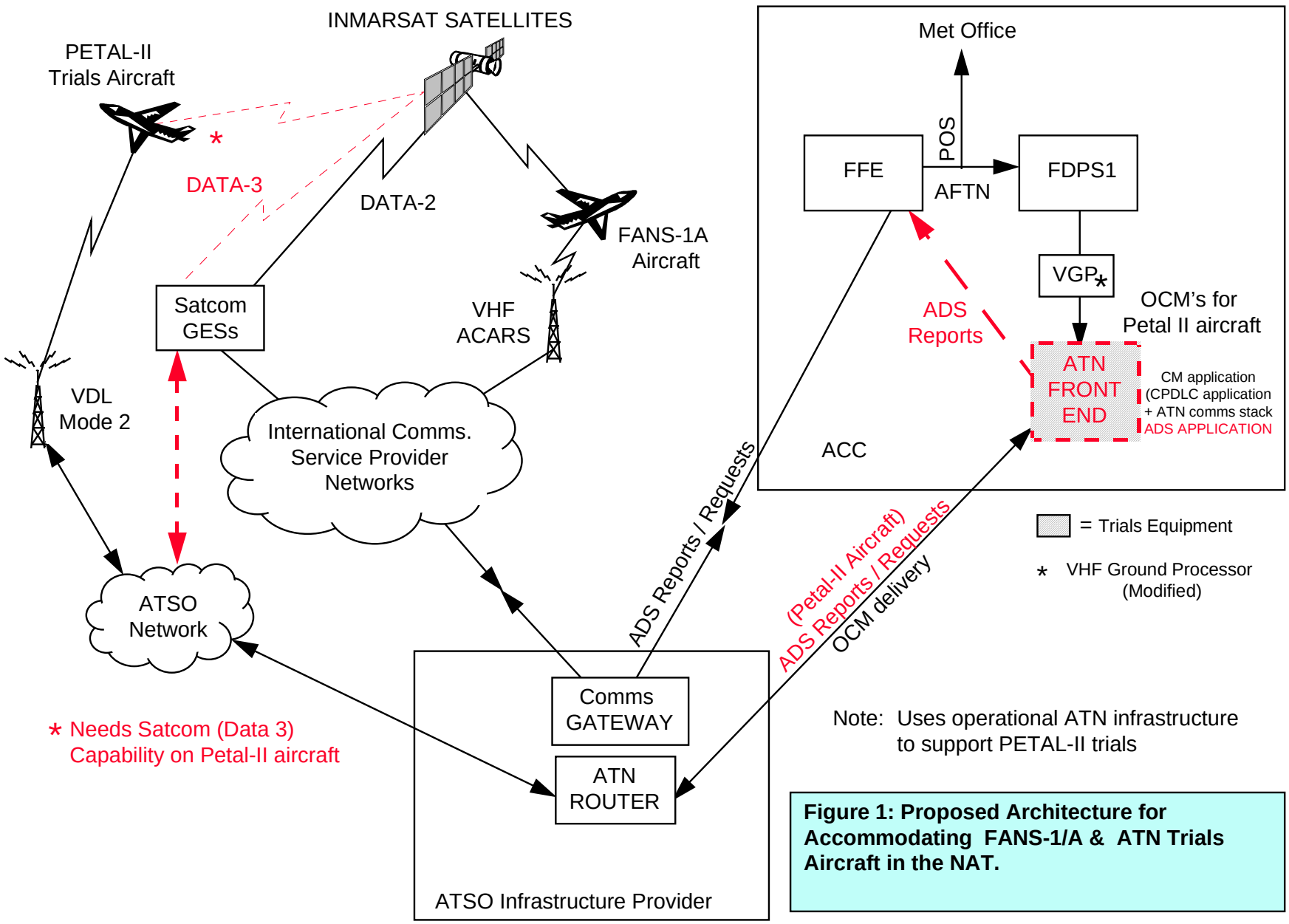

Figure 1: Proposed Architecture for Accommodating FANS-1/A & ATN Trials Aircraft in the NAT.

4.3 AEEC

4.3.1 Summary of Activities

The AEEC (Airlines Electronic Engineering Committee) is mainly responsible for developing characteristics which define standard 'form and fit' requirements for avionic equipment to be fitted to airline aircraft. The AEEC operates like many international committees by creating working groups to develop standards to meet specific avionics requirements.

The AEEC data link sub-committee has as its major objective the development of ACARS replacement solutions. This is an urgent requirement given that an upgrade to VDL Mode 2 is required to provide much needed additional ACARS capacity by increasing the data rate from 300bits/s (worst case) to 10kbits/s [EUR11]. An additional consideration is the transitioning from ACARS based to ATN based communications whilst still providing backwards compatibility with existing ACARs users and equipment.

The sub-committee members include representatives from SITA and ARINC, the two main AOC communication service providers. There are proposals by both SITA and ARINC (with input from Eurocontrol) to provide a solution to the ACARS congestion problem and a clear transition path to the ATN. A detailed description of these proposals is provided in [EUR1] and [SIT1], however, they are still under review. Further discussions are planned within the AEEC forum to determine the best way forward and to ensure the benefits of increased ACARS capacity and a clear transition path to the ATN can be offered.

4.4 PETAL II

4.4.1 Introduction

The Preliminary Eurocontrol Test of Air/Ground Data Link (PETAL) II is a continuation of the PETAL project. The objective of PETAL II is to "conduct multi-aircraft data link operational trials during routine ATC operations"[EUR12]. This will enable the validation of the operational concept and requirements for air/ground data link in EATCHIP III and provide the required support during the transition period from EATCHIP III to EATMS.

The PETAL II data link services identified in [EUR12] will be supported by the Maastricht UAC (Upper Area Control Centre) for use by suitably equipped commercial aircraft. The aircrew and controllers have ultimate control and can terminate the data link service at any time. It is hoped that other UAC will become involved in the trials.

4.4.2 Extent of FANS-1/A Accommodation

The PETAL II trials use a common subset of CPDLC messages to allow accommodation of both the ATN and FANS-1/A communications architectures to prototype ATM services in a datalink environment. The use of a common message set is a form of FANS-1/A accommodation since these trials are effectively using a "Common Denominator" approach. This is unlikely to be suitable for the provision of a full CNS/ATM operational service in high density airspace where the complete ATN application functionality would be required.

5. Technical Alternatives

5.1 Introduction

This section considers what options are available to States for the technical integration of FANS-1/A and ATN systems. This should address, where possible, the current strategies of the ACCESS States.

5.2 Available Options

There is currently no overall implementation strategy to integrate ATN and FANS-1/A within the ACCESS Region. The current trend is towards the 'co-habitation' of ATN and FANS-1/A activities within Europe. At an operational level this should not impact upon the procedures for aircrew and controllers which should be identical for ATN and FANS-1/A based services. Only in circumstances where an operational benefit can be achieved without adversely affecting the aircrew/controller workload should procedural changes be considered. At a technical level the two different 'architectures' and the associated aircraft are treated separately. The aim is to align with the ATN architecture.

There are two options available for implementors to integrate ATN and FANS-1/A systems and these are listed below. The options assume that FANS-1/A is accommodated.

1. Development of separate systems to accommodate the two different data communication architectures.
2. The integration of the two different data communication architectures in one system.

The selection of the most appropriate option will be dependent on many factors including the life expectancy of existing systems, e.g. FDPSs, any operational requirement for supporting FANS-1/A, e.g. State provides ATC service in a remote or oceanic region, and the transition strategy of the State. Any State wishing to support FANS-1/A in the short term may need to develop a 'FANS Front End' as proposed in figure 1. This Front End would provide all the required functionality without impacting upon the existing systems.

6. Conclusion

The ADSP document [ICA16] provides useful guidance to States and organisations that are considering the implementation of both FANS-1/A and ATN. The ultimate aim for the ADSP in providing the guidance material is to provide a suitable transition path to global compliance with CNS/ATM. The document proposes that States and organisations follow:

- The *Independent Approach* (i.e. handle each type of aircraft totally independently) for the accommodation of the FANS-1/A AFN application;
- The *ATN SARPs Approach* (i.e. to maximise ATN capability and accommodate FANS-1/A as much as possible) for the accommodation of the FANS-1/A ADS and CPDLC applications.

However the document also emphasises the need for States and organisations to assess the applicability of these assumptions in their airspace. In some cases, operational, technical and/or institutional issues in a State or region may preclude FANS-1/A accommodation in an ATN environment.

The decision by the NAT SPG to support ADS Waypoint Reporting for FANS 1/A equipped aircraft in the North Atlantic (NAT) Region, has required NAT States to assess the impact of FANS-1/A upon their ATC systems. The UK has developed plans to implement a FANS Front End (FFE) to provide an interface between the existing FDPS and FANS-1/A aircraft. The PETAL II trials offer participating States the opportunity to put in place an initial ATN infrastructure required to support these trials. It is the ideal time for States and organisations to considera coordinated approach to the FANS-1/A accommodation issue and plan the necessary systems development activities to facilitate any resulting requirements for accommodation.

There are a number of additional activities being undertaken in the ACCESS Region which are addressing the co-existence of the two different datalink environments. For example the use of a common CPDLC message subset as adopted by the PETAL II trials, or the generation of technical solutions, as proposed by the AEEC, to ensure the plans for ACARS replacement incorporate a path to the introduction of the ICAO CNS/ATM. It will be important for States to monitor and assess the impact of any recommendations upon their planned data communications strategy.

In practical terms the particular technical approach to accomodation taken by different States will be strongly driven by the user service requirements and systems capabilities, rather than ‘ideal’ solutions. This is not unusual in transitional situations where individual States are at different levels of datalink service implementation.

Based on current technology capabilities it is unlikely that any accomodation of FANS1/A in the high traffic level environment of the ACCESS study area will be of significant benefit to the provision of Regional ATM services. Pragmatic, localised accommodations may however appear in response to specific user service requirements.