CEC TEN-T ATM Task UK/96/94

ACCESS

ATN Compliant Communications

European Strategy Study

Interim Deliverable 2

Network Implementation Issues

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EXECUTIVE SUMMARY

This document is an Interim Deliverable of the ACCESS Project, making partial results of the study available before the final report has been completed. It is concerned with Phase 2, Part 1 of the project, i.e. the ATN implementation in Europe and, in particular, with those ACCESS tasks in Part 1 under the heading of "Network Implementation Issues". A previous Interim Deliverable summarised the results of "Network Architecture".

There are nine tasks and deliverables classified as "Network Implementation Issues". Their goals are:

Third Party Service Provision: taking into account related studies, trials and operational services, to identify and provide guidance to ATSOs on issues surrounding the use of Third Party Communications Service Providers for providing an ATN service or elements thereof.

Deployment Scenarios for A/G Subnetworks: propose an air/ground subnetworks' architecture for the ACCESS area.

Operational Scenarios: illustrate from a high-level, non-technical perspective by means of an example use case how the ATN will operate.

Security Issues: outline the general security precautions for the target ATN European network. The proposed precautions aim at protecting the network from the threats whose occurrence and/or potential damages are thought to justify specific countermeasures.

Safety Assessment / Certification: address the issues associated with the safety assessment and certification of implementing and operating the ATN in the ACCESS Region of Europe. The deliverable is, however, not a Safety Case for the 'Target European ATN', that is the responsibility of the relevant States and Organisations.

Institutional Issues: analyse the non-technical obstacles which could affect the implementation of the ATN and to develop organisational, regulatory and institutional configurations capable of facilitating the implementation of the ATN.

Accommodation of FANS-1/A: reviews the ADSP report guidelines on the operational accommodation of FANS-1/A systems in an ATN SARPs environment. The ADSP document provides useful guidance to States and organisations that are considering implementation of both FANS-1/A and ATN. In addition, the WP identifies any convergence planning activities in progress and any policy positions of European States with regards to FANS-1/A accommodation.

Life Cycle Costs: explains how the various cost elements have been identified, drawing on other European Commission funded projects (COPICAT and EOLIA) and Eurocontrol output, and captured in a user friendly Microsoft Excel spreadsheet model.

Systems Management: provide realistic and acceptable guidelines on the way European ATSOs can co-ordinate and cooperate in providing the essential network management needed for operating the European ATN.

Each of the nine tasks is relatively independent from the other "Network Implementation Issues" and is summarised as such in this document.

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1. Introduction

1.1 Background of ACCESS

As part of the new CNS/ATM concept, the Aeronautical Telecommunication Network (ATN) has a strategic role to play in providing the internetworking connectivity required for supporting the ATS and AOC data exchanges between the various end systems involved. This connectivity is to be provided across the evolving variety of data networking technologies of the deployed subnetworks. This is required for supporting aeronautical data exchanges between ground based end systems, and between ground based end systems and aircraft based end systems.

With the level of internetworking connectivity that the ATN will provide, it will become much easier to introduce new end systems. This will facilitate the evolution of operations from voice based data exchanges to data link based data exchanges with the resulting improvements in operational efficiency.

In 1997, the ICAO Air Navigation Commission approved the publication of the ATN SARPs in Annex 10. In parallel large projects have been initiated for the development of ground and airborne pre-operational ATN systems (ProATN, EOLIA), and operational ATN software (ATNSI/RRI) as well as for ATN Conformance Tests Suites (RAF and ATNSI/CTS now grouped into the CAERAF Project). These projects are expected to result in the provision of operational and pre-operational CNS/ATM-1 software and/or systems from 98-99 onwards.

A specific Task Force has been created under the aegis of the Eurocontrol EATCHIP programme to prepare the implementation of ATN in Europe, and work has started on the definition of implementation plans for the deployment of the initial European ATN network within all administrations, organisations, airlines and industries involved in the ATN and aiming at using it in the coming years.

It is to complement and coordinate all this work that NATS, DFS and STNA decided to launch the 'ATN Compliant Communications European Strategy Study' (ACCESS). The ACCESS Project is a European Commission co-funded project formally titled "ATN Implementation Feasibility Studies". It is ATM Task UK/96/94 under the Trans-European Networks - Transport (TEN-T) programme, managed by DG VII within the Commission.

1.2 Objectives and Organisation of ACCESS

1.2.1 General Objectives

ACCESS aims at defining the initial architecture of the ATN in the European Core Area (e.g. selection of the initial applications, definitions of the initial network topology, definition of the routing organisation and of the addressing plan), proposing initial solutions as regards the security, safety/certification, network management, institutional, and other issues as well as a transition plan from the current European aeronautical telecommunications infrastructure towards an European ATN network.

A second part of the ACCESS project addresses the ATSMHS Interoperability/Validation testing.

1.2.2 Project Organisation

ACCESS has been broken down into three successive phases:

- Phase 1 - Project Scoping (January-March 1997)
- Phase 2 - Study Tasks and Trials (April 1997 - November 1998)
- Phase 3 - Final Report Preparation (December 1998 - March 1999)

Phase 1, i.e. the Project Scoping phase, ended as planned in March 1997. This phase served to define the scope and aims of the project, defining in detail the work packages to be undertaken and allocating responsibility for their completion. The phase resulted in the production of the project plan, the Quality plan, the Consortium agreement, and a synthesis report which describes the outcomes of former ATN related European studies and projects.

Phase 2 (the report development phase) is split into two independent parts :

- Part 1 focuses on ATN Implementation with the objectives of proposing a network architecture, solutions for network implementation issues and a plan for transition from the existing network infrastructure to the proposed ATN infrastructure. It addresses topics related to both network and application infrastructure.
- Part 2 covers the AMHS Interoperability/Validation testing.

Phase 3 is the final phase and will produce the final report and present the project results to the CEC.

The present document is related only to Phase 2, Part 1 of the project, i.e. ATN implementation and, in particular, to those tasks in Part 1 under the heading of "Network Implementation Issues".

1.3 ACCESS Phase 2, Part 1: ATN Implementation

1.3.1 Structure

The following table shows the structure of ACCESS Phase 2, Part 1, by listing in a hierarchical fashion the production tasks, i.e. those tasks leading to published reports.

Phase 2, Part 1: ATN Implementation Report Preparation

- **Network Architecture**
  - Current Communications Infrastructure
  - Define geographic area & services
  - **Define Network Topology**
    - Routing Architecture - Option 1
    - Routing Architecture - Option 2
    - Ground / Ground Subnetworks
    - Air / Ground Subnetworks
  - Addressing Plan
  - Performance Analysis and Dimensioning
  - Selection of Routing Architecture
- **Network Implementation Issues**
  - Third Party Service Provision
  - Deployment Scenarios for A/G Subnetworks
  - Operational Scenarios
  - Security Issues
  - Safety Assessment / Certification
  - Institutional Issues
  - Accommodation of FANS-1/A
  - Life Cycle Costs
  - Systems Management
- **Transition Planning**

A summary report of the tasks under the heading "Network Architecture" has been provided in [A208], Interim Deliverable 1. Transition planning is the topic discussed in its own dedicated report.

1.3.2 The "Network Implementation Issues"

The tasks under "Define Network Topology" can be considered to be the "core" of the ACCESS design activity. They address basic issues which must be defined before follow-on work can be performed because the latter is dependent on the decisions made there. ACCESS is basically an engineering design project and the logic of the ensuing decisions taken follow on from the fundamental decisions made under "Define Network Topology".

The "Network Implementation Issues" are also of great importance to the implementation of the ATN in Europe and, in particular, to the implementation of the network topology defined in the preceding tasks. Although these tasks are highly dependent on the tasks under "Define Network Topology", they are not very dependent on each other and have been produced in parallel within the ACCESS project.

1.3.3 Status of the Tasks

This document gives a snapshot view of the work produced for the "Network Implementation Issues" phase. The nine work packages completed in this phase are detailed in the following table.

Title	WP number	Version	Date	Status
Third Party Service Provision	220	2.0	22/01/99	Agreed
Deployment Scenarios for A/G Subnetworks	220A	1.0	2/11/98	Agreed
Operational Scenarios	221	2.0	11/03/99	Agreed
Security Issues	222	1.0	23/10/98	Agreed
Safety Assessment / Certification	223	2.0	14/01/99	Agreed
Institutional Issues	224	1.0	05/03/99	Agreed
Accommodation of FANS-1/A	225	1.0	22/01/99	Agreed
Life Cycle Costs	226	2.0	09/02/99	Agreed
Systems Management	227	1.0	3/11/98	Agreed

1.4 Purpose and Structure of this Document

1.4.1 Purpose

In a fashion similar to Interim Deliverable 1 for the "Network Architecture" tasks, this document, Interim Deliverable 2, summarises the results of the tasks under the heading "Network Implementation Issues". It is intended to give very brief overviews of the "Network Implementation Issues". Complete results of the individual tasks are available in the reports on the corresponding tasks.

1.4.2 Structure

The "Network Implementation Issues" are largely independent from each other. They are summarised in an independent fashion in the following 9 sections of this document. Each summary is on the level of detail of the "Executive Summary" of each task.

1.5 References

Reference	Title
[CEC16]	ATNII Study Interim Deliverable
[AXXX]	ACCESS Report WPxxx

2. Third Party Service Provision

This WP investigates a trend apparent in many areas of modern business in that parts of a corporation's "non-core" business are contracted out and supplied by a provider whose business it is to deliver such services. In the case of a supplier delivering ATN services to an ATSO, AO etc., this would be a "Third Party Communications Service Provider", TPCSP.

The main objective of the report is to, take into account related studies, trials and operational services, to identify and provide guidance to ATSOs on issues surrounding the use of TPCSP for providing an ATN service or elements thereof. Specifically:

- identify those elements of the end-to-end ATN service which are suitable to be contracted to be provided by a Third Party Communications Service Provider;
- to provide guidance on the nature and content of a service level agreement.

When planning to provide an operational ATS service based on an ATN infrastructure an ATSO needs to consider the optimal means for the provision of this infrastructure. The options ranging from building and operating its own infrastructure versus contracting a third party communications service provider to provide the required service. This service may be provided at different levels within the ATN architecture, these levels being referred to as "Service" levels. For each Service Level there are a number of factors that need to be considered to determine which way to proceed.

Three "Service" levels at which elements of an ATN service may be **realistically** contracted to a TPCSP are:

- "Application Service";
- "Internet Service";
- "Subnetwork Service".

The **Application Service** would provide a communications service at the application service interface and below. This would most likely involve the provision of a "server" by the TPCSP to be co-located with the host system (e.g. FDPS) to which it will be required to provide a data link service. EUROCONTROL and STNA, within the context of ATNP and the CEC EUR AGDL projects, proposed the concept of a Data Link Server (DLS). Such a server is being proposed as the "focal point for the provision of all the functionality associated with handling the communications aspects of datalinks, and would present a process oriented interface to other centre components such as the Flight Data Processing System and/or the Human/Machine interface."

The **Internet Service** would be provided to the ATSO by means of local or remote access to a BIS of the TPCSP. The service, subject to physical realisation of the avionics, would extend from the ground interface to the BIS up to the BIS interface provided to the airborne End System. The Internet Service will be required to ensure, in a transparent manner, the available ground/ground and air/ground networks to satisfy the performance/QoS requirements as defined in the SLA.

For the mobile **Subnetwork Service**, based on the WP220A report, the only realistic means by which an ATSO may use a VDL or AMSS service is to contract a TPCSP, there is unlikely to be an alternative option possible in the short term.

A Service Level Agreement, SLA is the contract basis controlling the provisioning of the service by a TPCSP. Based on the relevant contents of the related ACCESS Work Packages, and as a result of the experiences gained in the ADS Europe trial and FANS 1/A operations

it is possible to develop a comprehensive list of issues that require to be addressed in a SLA. Guidance on specific details to be addressed has been provided.

The SLA needs to address the following aspects:

- Performance/Quality of Service Requirements such as availability, reliability, integrity, continuity, throughput, transit delay, maximum service outage and geographical / volume coverage;
- SLA performance indicators used as parameters to measure whether the SLA is being adhered to or not;
- Minimum Performance Requirements for AMSS Service Providers which might be contracted by airlines;
- Service Communications Profile which ties down all options and recommendations defined in the applicable ATN and industry standards;
- Physical Service Access/Interconnection Requirements;
- Certification and re-certification requirements on the supplied communication service,
- Means for Performance/QoS Monitoring;
- Provisions for the TPCSP Quality Plan,
- the Right of an ATSO to Audit its TPCSP;
- Procedures for Problem Reporting and Resolution, TPCSP Infrastructure Enhancements, Configuration Management and Maintenance;
- Participation in the ATN Service User Forum[1];
- Liability of the TPCSP in the case that it can be demonstrated that the organisation has not fulfilled its obligations;
- Charging Mechanism and means of calculating charges;
- Billing: including frequency, breakdown of costs, information to be provided etc.;
- Procedures and services of the Help Desk.

Though the SLA concept is in theory a means to specify requirements, it must be understood that even the TPCSPs have limited experience with ATS based data link. Consequently it is recommended that ATSOs and TPCSPs work together in validating the SLA requirements in terms of whether they are really required and, if so, whether they can be practically realised. Furthermore, it is recommended that, for initial operations that the ATSO establish the means for itself to monitor the performance of the contracted communications service until such time that the ATSO has developed sufficient confidence in the ability of the TPCSP.

[1] Based on experiences in the FANS 1/A environment it is expected, and recommended, that a User Forum of ATN service users will be established. The SLA should include requirements on the TPCSP to support such a forum in order to (1) present data related to the performance of its service and (2) to receive collective feedback from its customers so that it may improve elements of its service.

3. Deployment Scenarios for A/G Subnetworks

The deployment scenarios for the ATN air/ground subnetworks in Europe (namely, VDL Mode 2 and AMSS) are not known at the present time. This ACCESS work package (WP220A) is dedicated to the identification and the description of the most probable deployment scenarios for VDL Mode 2 and AMSS in terms of location of ground stations and connectivity of these ground stations to ATN routers.

Two main strategies are identified for the provision of VDL Mode 2 subnetworks in Europe**:**

- **A Communications Service Provider (CSP) driven deployment**: This will require CSPs to expand their air/ground data link systems to meet the requirements of the airlines, specifically to support AOC traffic (ATSC would be an additional source of revenue in this scenario). This strategy would be driven by economic factors;
- **An ATSO driven deployment**: ATSOs develop and keep control of the VDL Mode 2 deployment and operation for ATSC traffic. This strategy would be justified by long term concerns, e.g. related to safety or institutional issues.

A deployment scenario for each strategy is presented, taking account of the specific requirements and constraints of the VDL Mode 2 service (e.g., scarcely available VHF frequencies). However, current trends suggest the first strategy is the more realistic for VDL Mode 2 deployment. This will probably lead competing CSPs (SITA and ARINC) to provide a similar coverage of the European core area by 2002, initially for AOC ACARS traffic only, while a later parallel implementation based on the second strategy will allow the support of more and more ATSC traffic.

In conclusion, AOC requirements and institutional issues will play a major role in the future deployment of VDL Mode 2 subnetworks in Europe.

Concerning AMSS subnetworks, it should be recognised that AMSS is unlikely to be the preferred air/ground subnetwork in the core European area since other subnetworks (e.g. VDL, Mode S) will be supported in the region and are likely to provide a more cost effective capability. The use of AMSS may be restricted to fringe areas where existing infrastructure is limited such as the Mediterranean or Eastern Europe. It may also provide a backup capability to support the preferred air/ground subnetworks under failure conditions.

There are three possible interconnection scenarios for AMSS (based on the Inmarsat system), each with their corresponding advantages and disadvantages:

- **Complete Interconnectivity**: Each State would provide their own ATN air/ground BIS and access to the AMSS subnetwork;
- **Air/ground BIS per Ground Earth Station (GES)**: Those States within which a GES is operated would provide an ATN air/ground BIS to service all the connections via that GES;
- **Air/ground BIS per AMSS Operator**: Those States within which an AMSS Operator is based would provide an ATN air/ground BIS to service all the connections via that company

No selection of a preferred interconnection scenario has been made in the ACCESS study.

In future, it is likely that various competing LEO/MEO satellite systems, which are currently under development, will become available and these may be proposed for aeronautical use. The common factor between all these Next Generation Satellite Systems (NGSS) is that none of them will be a system dedicated only to ATS; in every case ATS will just be one user and will generate a relatively small proportion of the total system traffic. All of these

individual systems will be proprietary and it will be necessary for the ICAO standardisation process to operate at a very high, generic level.

In conclusion, new competing satellite systems will emerge, designed to provide global services and not dedicated to ATS services. ATS services using NGSS will need to have a defined service level agreement in place to meet the strict quality of service requirements.

4. Operational Scenarios

The objective of the operational scenario work package is to illustrate from a high-level, non-technical perspective how the Aeronautical Telecommunication Network (ATN) will operate. This is done in the form of a guided tour through the interior of the ATN along a typical use case. The use case describes an example flight scenario in a European ATN environment including flight planning and preparation and involves different user groups including ATS providers, airline operators and pilots. Along this use case the fundamental mechanisms, procedures and principles of ATN-internal operation in response to user requests and in support of user activities are presented.

An event-driven presentation has been selected which demonstrates the operation of the ATN along the actual sequence of key events occurring in the defined use case. These key events are triggering ATN operations which are presented in a descriptive and intuitive manner without diving into the technical details of each individual operation. The ultimate objective of this presentation is to give a basic understanding of the principles and mechanisms of ATN operation.

The operation of the ATN applications and the ATN network is demonstrated along the route of a transatlantic flight. The Lufthansa flight selected for illustrating the ATN operation starts from the international airport of Frankfurt am Main (Germany) and is destined to the international JFK airport in the U.S. As many of the ATN related events and operations experienced during the earlier flight phases repeat during later phases of flight, the report focuses on the portion of the flight within the European ATC-environment only. The relevant events that are triggered by the aircrew, the controller or another human user, or by an ATN application are called flight-related events, the network events are those which do not require any human input. Figure 1 illustrates the generation of ATN operations by these events, originated in the flight and network scenarios.

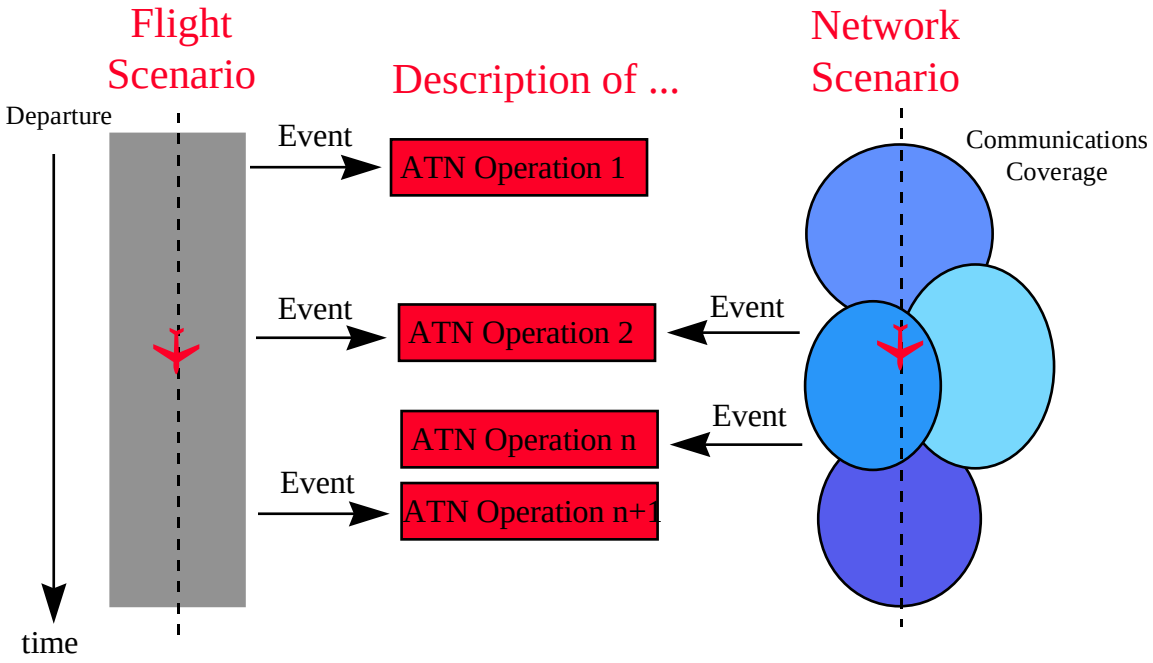

Figure 1: Generic Illustration of Proposed Approach

5. Security Issues

Security precautions are required to protect the ATN European network from threats whose occurrence is thought to justify specific countermeasures. These potential threats induce general security requirements which fall into two categories:

- system security (e.g., protection of the ATN resources themselves);
- telecommunications (e.g., protection of the information exchanged on the network).

A review of existing ATNP material and existing practices in the area of network security has identified potential threats and led to the development of high-level security requirements. These requirements have led to the derivation of general precautions appropriate to a security policy applicable to the European ATN. These precautions range from purely physical protection measures to procedural provisions or technical mechanisms implemented in ATN systems.

Most technical countermeasures use cryptographic techniques (mainly based on a public key cryptosystem). These public key systems are not fully standardised in the current draft ATNP material. The ATN security mechanisms are still being specified by the ATNP for integration in future CNS/ATM-2 SARPs. Once the relevant ATNP recommendations are finalised and the consequent implementations are available, it should be possible to use cryptographic techniques and operate the complete set of security precautions. These include ATN upper layers security mechanisms, IDRP authentication and system management security functions and essentially deal with the protection of ATN communications

As a consequence, it is expected that the CNS/ATM-1 products will not integrate any of the ATN standardised security mechanisms. Hence the protection of the communications will not be achieved in the initial European ATN with CNS/ATM 1 implementations. However, the available security measures will still include aspects such as physical protection, access control and system security.

In addition, there is a necessity to develop an ATN public key infrastructure (PKI). This infrastructure is required for the correct operation of the ATN security mechanisms that are aimed at ensuring the integrity and the authentication of the messages exchanged on the network. The implementation of an ATN PKI raises important technical and institutional issues which have not been clearly addressed by the ATN community so far (e.g., availability of an ATN X.500 repository, establishment of ATN Certification Authorities, etc.).

6. Safety Assessment / Certification

The document addresses the issues associated with the safety assessment and certification of implementing and operating the ATN in the ACCESS Region of Europe. The document is not a Safety Case for the Target European ATN, that is the responsibility of the relevant States and Organisations.

The document details the current work being undertaken on Safety Assessment & Certification for data link applications and the associated infrastructure. It includes a review of state procedures regarding the safety certification of systems, and identifies common trends and key issues related to the safety assessment and certification of the ATN infrastructure. Finally, there are recommendations on the practical approaches necessary to fulfil the requirements of Safety Assessment & Certification for the proposed ATN topology in the ACCESS region.

The advent of end to end data link technology and services in the ATC environment requires that the users of the technology and services provide the necessary safety assurances to the regulatory bodies prior to their certification and approval for operational use. This has resulted in a range of projects being initiated, projects whose specific aim is to provide guidance and develop tools to support the approval of such systems into operational service. The EOLIA and ProATN projects have both undertaken preliminary safety assessment work to assist in the development of practical recommendations for assessing and certifying data link services and the associated infrastructure. The objective of this work will be to allow the implementor to develop specific implementations of the data link system components, e.g. routers, and verify and approve them using agreed standards and methodologies. The components, providing they gain certification approval, can then be introduced into the end to end system without the need to re-certify the existing components. All the work reviewed detailed the importance of considering the institutional issues and to account for the scale of the CNS/ATM operations, i.e. it will encompass many States and Organisations.

The current procedures adopted by the majority of States rely on the ATS provider to adopt a formal Safety Management System with individual States applying their own adaptations of Safety Management. Safety Management allows organisations to implement an effective safety policy and to achieve high standards of safety thus minimising the risks as far as is reasonably practicable. The majority of States will adopt to use the Safety Case methodology as the focus of their Safety Management System. The Joint Aviation Authority (JAA) is an integral part of the certification process for avionics manufacturers. It is important that any new standards and guidance material developed to address the safety implications of data link services are recognised by the regulating authorities and organisations such as the JAA.

Third Party Service Providers (TPSP) who offer ATS distribution services will also need to demonstrate the safety of their systems, via documented evidence, to the relevant aviation safety regulatory authority in support of their application to obtain certification for the operational use of their system.

The techniques and reference systems currently being developed by international bodies such as EUROCAE are considering an approach whereby ATN data link services can be assessed and certified as separate entities to the ATN Communications Infrastructure[2] (ACI). This approach would ensure that new data link services can be developed and certified without the need to re-certify the underlying infrastructure. The technique requires

2 ACI is the ATN communications stack up to and including the application entity; it does not include the application process.

the safety requirements for ATN data link services to be translated into QoS requirements for the ATN Communications Infrastructure. These QoS requirements can then be distributed to the sub-systems, e.g. routers and subnetworks, which form the underlying infrastructure. Existing sub-systems such as communications subnetworks may need to rely on in-service history and safety cases to provide the required safety assurance. Where new sub-systems, such as routers, are developed they will need to be designed using best practice, recognised standards and incorporate rigorous testing to include a reference facility to ensure interoperability. In all cases adequate levels of redundancy and 'fall-back' procedures will need to be demonstrated as part of the safety assurance process.

The safety assessment process will need to demonstrate that the QoS figures for the ATN Communications Infrastructure are achievable and maintainable. This can be achieved by utilising network and system management techniques to ensure that operational changes can be implemented in a controlled and timely manner and a safe service maintained.

A data link system is highly integrated and any changes no matter how minor have the potential to adversely affect the end to end performance. It is important that any Service Level Agreement (SLA) with a TPSP should allow for the testing and assessing of modifications, prior to implementation, to minimise the impact upon the operational ATS service.

The ACCESS study has defined two distinct ATN transitional implementations. The first consists of local implementation initiatives of datalink services and these can be introduced relatively independently by individual States. The second is a coherent infrastructure offering a range of datalink services covering multiple Flight Information Regions (FIR) and States. Local implementations can use existing procedures adopted for other safety critical systems to provide the necessary safety assurance to the regulating authority. The coherent infrastructure will require coordination of safety activities with States needing to coordinate and adopt consistent system acceptance criteria. This may require the development of an internationally agreed standard to cover specific implementations and metrics defined to ensure that consistent system acceptance criteria are employed across the institutional boundaries.

The Target European ATN describes a routing architecture centred around a European ATN Island. The datalink services offered will be an expansion of those identified in the initial ATN and may include more safety critical datalink services. The approval of new services will, in principle, follow existing approval procedures, albeit requiring greater levels of coordination where more States are involved.

7. Institutional Issues

In order to avoid duplication of effort and to make best use of available expertise in related study areas, the ACCESS Project has used the first deliverable of the ATN Implementation Issues (ATNII) Study as a baseline document for its work on Institutional Issues. Whereas ACCESS is primarily an engineering/system design study, the terms of reference of ATNII specifically address non-technical issues and deal mainly with the institutional environment in which the ATN is expected to come into being in Europe. Using this approach, the ACCESS study was able to consider the correlation between the initial findings documented in Deliverable 1 [CEC16] of the ATNII Study and to identify any aspects of the ACCESS technical recommendations which might constrain potential future institutional scenarios for ATN and vice versa.

In general the efforts of the ATSOs supporting the ATN are being devoted to the elaboration of a technical architecture and its implementation plan. This is a necessary task that will prove to be unsuccessful unless it is complemented by the proposition of adequate solutions for the organisational, institutional and economical aspects which are tightly coupled. The feasibility of the ATN implementation plan proposed by ACCESS is likely to be undermined unless the essential institutional and/or non-technical enabling activities can also be accomplished in a timely way.

It is acknowledged that these difficulties arise because the main players involved in the ATN have not made clear operational choices and because there is a lack of a clear CNS/ATM operational framework and associated business case. It can be reasonably assumed that a solid business case would enable and encourage the construction of the required organisational and institutional solutions.

The range of institutional issues raised is significant in scope, including the need for an ATN regulatory framework ("ATN Convention"), a separate operational entity for the European ATN co-ordination and the possible evolution towards a network built around commercial alliances and contracts instead of the usual multi-lateral co-operation between public administrations (ATSOs or CAAs). This evolution implies a new policy for aeronautical charges (e.g. differentiated services and charges) which could represent an incentive for the introduction of the ATN but whose feasibility can be questioned, at least in the ACCESS timeframe.

The interim work completed by the ATNII study identifies the potential need for fundamental changes to the institutional structures to exploit the full potential of enabling technologies such as ATN on the European ATM services. There is a commonality of these issues across the CNS/ATM concept, and the implementation period to bring about some of these changes would extend beyond the timeframe of the ACCESS study. However the impact of institutional issues when planning the development of the ATN is an important consideration.

It is beyond the scope of the ACCESS project to resolve institutional issues such as the need for ATN regulation. However, by taking a more pragmatic approach, ACCESS has examined the mechanisms required to put the technical building blocks in place to enable an initial ATN to be implemented. For example, the use of third party communications service providers and the development of detailed service level agreements to control and manage this relationship; the development of techniques to enable the end-to-end “certification” issue to be addressed through a modular approach to the construction and maintenance of system safety cases. Where the possible evolution of institutional arrangements, as foreseen by the ATNII Study, introduces a potential impact on the technical approach taken by ACCESS, no conflicts or constraints have thus far been identified and vice versa.

8. Accommodation of 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 the FANS-1/A AFN application 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 applications. 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.

9. Life Cycle Costs

One of the key issues associated with ATN implementation is forecasting the likely costs (and benefits) to all involved stakeholders. ACCESS has devised a mechanism to identify and capture the main parameters which could impact on the ATN Life Cycle Costs, concentrating on the capital and running/ownership costs to the air traffic service organisations (ATSOs) but also considering the cost to airline operators of equipping and maintaining aircraft.

The various cost elements required for ATN deployment have been identified (e.g. communication charges), drawing on other European Commission funded projects (COPICAT and EOLIA) and Eurocontrol output, and captured in a user friendly Microsoft Excel spreadsheet model. Of particular significance is the deployment of the ground infrastructure which is addressed on a per country basis in some detail. The ultimate objective is to identify where and when every main component needs to be deployed and the spreadsheet model supports this level of detail.

The air/ground subnetworks considered are VDL Mode 2, the Inmarsat based Aeronautical Mobile Satellite Service (AMSS) and Mode S, where the first two are considered to be supplied and administered by a third party. The impact of different usage charges can be observed, e.g. AMSS has a significant ongoing charge for communication costs but Mode S has a high capital cost to the ATSOs but no communications charges are currently attributed.

Total airline fleet sizes and growth rates are estimated together with a profile for equipping aircraft for ATN. The cost of adaptation and the subsequent maintenance costs are included.

Some analysis has been performed with the model by postulating, realistic and optimistic scenarios where the latter envisages that the full ATN infrastructure[3] is in place at 20 area control centres, 14 approach control centres and 27 airports in the ACCESS region by 2010. It is recommended that further analysis be undertaken in order to refine the data set, in particular for the costs of end systems, Mode S and Gatelink sub-networks and ATN avionics. Third party sub-network providers' charges can be significantly affected by commercial issues and need to be regularly reviewed.

The overall analysis demonstrates the potential impact of individual systems on the cost of ATN deployment based upon current understanding. It is anticipated that where more accurate figures, both prices and system developments, become available they can be easily incorporated into the model to produce better cost estimates.

The use of a spreadsheet model can play an important part in the investment analysis process. It can provide a convenient, flexible means of capturing and calculating the approximate costs associated with ATN deployment and, should be of use to individual ATSOs in the planning of their transition strategies.

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3 An operational Mode S subnetwork is only considered in the optimistic scenario

10. Systems Management

The solutions developed for the system management of the European ATN have been developed with consideration to the current ICAO/ATNP activities on Systems Management, and take into account current European network management practices and European specific requirements.

Currently, the majority of system management exchanges (and the associated technical, operational and organisational issues) have been arranged on a bilateral basis between interconnected States. However, recent developments in network management for two of the main ATC data networks in Europe (European CIDIN network and the interconnection of European ATSO Packet Switched Networks) have highlighted the need for co-ordinated and dynamic network management between European ATSO data network facilities. It is accepted that overall network management solutions with centralisation of functions are required for efficient co-ordination. A progressive approach is currently taken for the introduction of these co-ordination functions in the management of the CIDIN and of the ATSO Networks Interconnection.

There are many options for developing an organisation for managing a multi-national ATN network. This could be vested in a central organisation, distributed across all States and organisations, or a combination of the two. The ACCESS Study assumed that States and organisations will wish to keep supervisory and administrative control of their ATN infrastructure, but it is still necessary that management coordination occurs. In a Region such as Europe, constituted by many inter-adjacent organisations, a centralised co-ordination approach is considered to be more appropriate than a distributed co-ordination approach.

The ACCESS Study considered performance management, troubleshooting, configuration changes and accounting and concluded that a co-ordinated system management approach with the distribution of system management responsibilities among organisations can be achieved with minimum changes to the traditional network management approach. The responsibility for the management of the national ATN is left in the hands of the ATSOs, (and other ATN organisations) while responsibilities for the co-ordination of some inter-domain system management activities (e.g. accounting management) are vested in a central co-ordination entity.

It should be noted that there are a number of issues to be resolved, and activities to be undertaken before a satisfactory European system management co-ordination model can be completely specified and implemented. Further activities on the ATN system management subject are detailed below.

1. Completion of ATN SARPs on System Management: the development of SARPs on ATN System Management is underway and the SARPs are expected to be completed by ATNP/3 in February 2000. However, since CNS/ATM Package 1 SARPs were completed, many ATSO have directed their resources to ATN in preference to the development of Package 2 SARPs. This may delay the completion of the SARPs and this situation is a cause for concern. The provision of a full ATN System Management capability is an essential pre-requisite to the longer term development of the ATN.

2. Resolution of institutional issues on the creation of a central co-ordination body, and production and endorsement by the States of a document specifying the roles and responsibilities of each organisations.

3. Validation of SARPs with implementation and test of SARPs compliant Network Management Systems.

4. Integration of the SARPs compliant Network Management System within the Network Operation Centres of the European organisations

Acronyms

A/G	Air / Ground
AAC	Aeronautical Administrative Communications
ACARS	Aircraft Communications and Reporting System
ACCESS	ATN Compliant Communications European Strategy Study
ACM	ATC Communication Management
ADAP	Automated Downlink of Aircraft Parameters
ADS	Automatic Dependent Surveillance
AFN	ATS Facilities Notification
AIDC	ATS Inter-facility Data Communications
AINC	Aeronautical Industry Communications
AIS	Aeronautical Information Service
AMHS	ATS Message Handling System
AMSS	Aeronautical Mobile Satellite Service
AO	Airline Operator
AOC	Aeronautical Operational Communications
APO	Airport Operator
APR	Automatic Position Reporting
ARINC	Aeronautical Radio Inc
ATFM	Air Traffic Flow Management
ATIS	Automatic Terminal Information Services
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATNII	Scenarios for the ATN, Non-technical Implementation Issues
ATNP	ATN Panel
ATS	Air Traffic Services
ATSC	Air Traffic Service Communications
ATSMHS	ATS Message Handling Services
ATSO	Air Traffic Services Organisation
BIS	Boundary Intermediate System
CAERAF	Common American European Reference ATN Facility
CAP	Controller Access Parameter
CFMU	Central Flow Management Unit
CIDIN	Common ICAO Data Interchange Network
CNS/ATM	Communications, Navigation, Surveillance / Air Traffic Management
CPDLC	Controller-Pilot Data Link Communications
CSP	Communication Service Provider
D-FIS	Datalink Flight Information System
DLIC	Data Link Initiation Capability
DLS	Data Link Server
EC	European Commission
EOLIA	European Pre-Operational Data Link Applications
EUROCAE	European Organisation for Civil Aviation Equipment
FANS	Future Air Navigation System
FDPS	Flight Data Processing System
FIR	Flight Information Region

GES	Ground Earth Station
G/G	Ground / Ground
IDRP	Inter Domain Routing Protocol
ISO	International Standards Organisation
JAA	Joint Aviation Authority
LEO	Low Earth Orbit
MEO	Medium Earth Orbit
METAR	Meteorological Reports
MIB	Management Information Base
OACC	Oceanic Area Control Centre
OSI	Open System Interconnection
PKI	Public Key Infrastructure
ProATN	Prototype ATN
QoS	Quality of Service
SITA	SociÈtÈ Internationale TÈlÈcommunications AÈronautique
SLA	Service Level Agreement
SARPs	Standards and Recommended Practices
TPCSP	Third Party Communications Service Provider
TPSP	Third Party Service Provider
VDL	VHF Data Link
VHF	Very High Frequency