CEC TEN-T ATM Task UK/96/94

ACCESS

ATN Compliant Communications

European Strategy Study

Transition Planning Transition planning and future evolution of the European ATN

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Draft 0.3	17/09/1998	STNA and DFS input in chapters 2 and 3.2
Draft 0.4	30/10/1998	Chapter 3 consolidated DFS, NATS and STNA comments incorporated
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EXECUTIVE SUMMARY

The initial objective of ACCESS WP240 was to define a transition plan[1] to the target European ATN network applicable to the ACCESS geographical area, as defined in prior ACCESS work packages. However, due to the many uncertainties currently affecting long term ATN implementation objectives and in the absence of any expressed commitment of ATN stakeholders to launch ATN-based data link applications and infrastructures, the study has been pragmatically refocused on the transition towards an *initial ACCESS ATN*, based on facts or transition steps that can be reasonably assessed.

That initial ACCESS ATN can be defined as a coherent ATN infrastructure based on the evolution of initially local ATN initiatives, that evolution resulting from the decision to implement a (limited) set of data link services across the ACCESS area, for which true operational benefits are expected in the short term.

The document therefore presents ATN evolution in three successive steps[2]:

- the *local ATN initiatives* that should demonstrate the true benefits of operational ATN-based data link services and consequently ease the evolution to the initial ACCESS ATN make up a first phase made of asserted programmes,

- the successive step is defined as the transition period allowing to progressively build the initial ACCESS ATN in order to implement a *regional ATN service implementation plan* (and compatible national implementation plans), made of a limited set of ATN ATSC services and supported by all ATN stakeholders (essentially, ATSOs and Airlines),

- the last step is defined as the transition from the initial ACCESS ATN to the target one: this section is not developed as any attempt to produce a scenario for that transition is not retained realistic due to the many uncertainties already affecting the prior steps.

The main part of the document (section 3) deals with the initial ACCESS ATN deployment, which is the first step, and consequently the most important one, to a wide-scale European ATN. The initiation of that deployment is critical as it requires a prior high-level commitment of ATSOs to implement the regional implementation plan and an adequate pan-European organisation in order to carry out the full co-ordination required to get an operational European ATN.

Section 3 first proposes a list of candidate ATSC services (data link air/ground and AMHS services) that could trigger the transition to the initial ACCESS ATN and then successively sketches out transition scenarios for the deployment of the various ATN infrastructure components required by the operation of those services (e.g., ground and air/ground VDL Mode 2 subnetworks, ATN routers, ATN routing architecture, location of end systems, network management solutions, etc.). The proposed scenarios are generally based on reasonable assumptions about short term evolutions of aeronautical communications and/or ATN implementation.

This document has also permitted to identify a set of actions that are necessary to the successful deployment of the initial ACCESS ATN infrastructure and services: the resulting action list

[1]That transition plan focuses on the technical aspects of ATN deployments in Europe: other important issues (such as institutional or economical issues) are not specifically covered by that study (other European studies such as the CEC sponsored ATNI2 study deal with those aspects).

[2]The study will generally make reference to phases rather than to mere dates as most results presented in the document are thought to remain valid, no matter when those phases will precisely occur.

(summarised in section 5) outlines the need for a *initial high-level commitment from ATN stakeholders* (mainly, ATSOs and Airlines) to develop data link services in Europe and calls for an adequate implementation programme (the LINK 2000+ initiative that should be launched by Eurocontrol could provide the required programme and overall structures).

Finally, it has to be noted that, although the scope of the ACCESS study is limited to ATSC services, it is likely that *AOC services* are likely to be an important driver for ATN deployments in the ACCESS area, if Airlines push the development of AOC applications on top of an ATN / VDL Mode 2 network infrastructure, which will allow to deploy part of the infrastructure required by the operational use of ATN-based ATSC services.

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1. Introduction

1.1 The ACCESS Project

1.1.1 General Objectives

The 'ATN Compliant Communications European Strategy Study' (ACCESS) project is being run under the European Commission’s programme for financial aid in the field of Trans-European Transport Network (TEN-T), ATM Task UK/96/94. This project aims at defining the initial architecture of the ATN in EUROPE (i.e. selection of the initial applications, definitions of the initial network topology, definition of the routing organisations and of the addressing plan, etc.), at proposing initial solutions as regards to the security, safety/certification, network management, institutional, and other issues, and finally at defining a transition plan from the current European aeronautical environment towards the initial architecture defined by the project.

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

1.1.2 Project Organisation

ACCESS has been broken down into three successive phases:

- Phase 1 - Project Scoping (January-March 1997),
- Phase 2 - Study Tasks (April 1997 - December 1998), and
- Phase 3 - Final Report Preparation (November 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 only related to Phase 2, Part 1 of the project, i.e. ATN implementation.

1.1.3 Description of ACCESS Part 1: ATN Implementation

1.1.3.1 Time Frame and Geographical Area Considered by ACCESS

The time frame considered in the ACCESS project is 2000-2010. The initial ACCESS ATN is expected to be deployed by around 2005. This initial ACCESS ATN must however be considered in the time as the first brick to a global and mature target ACCESS ATN that would meet most of ground-ground and air-ground ATN communication requirements currently identified. The target ACCESS ATN is assumed to be deployed in years 2005-2010 where new data link services and new communication networks will be set in operation and additional ground facilities will be equipped. These two steps are identified in this document as the **Initial ACCESS ATN** and the **Target ACCESS ATN.**

Note that the dates envisioned for the deployment phases (i.e., mainly 2005 and 2010) are based on information available in late 1998: they should not be given excessive importance because even if the ATN deployment process was delayed for whatever reason, it is thought that the content of the document would still largely remain valid with respect to the identified transition phases. That is why reference will preferably be made to the phases rather than to specific dates when applicable in the rest of the document.

The initial ACCESS ATN must consist of the first elements of an expandable ATN infrastructure that will actually allow, in some further implementation steps, the deployment of the target ACCESS ATN. The initial ACCESS ATN is therefore viewed as a transition step toward the target ATN infrastructure.

The geographical area considered in ACCESS consists of the following countries as illustrated in Figure 1: UK, Ireland, Benelux, Germany, France, Italy, Spain and Portugal. These States were chosen for the following reasons:

- **They have a direct connection to the CFMU and/or are involved in the control of North Atlantic traffic.** States connected directly to the CFMU - in 1997 - were selected because this enables the major ground/ground data flows in Europe to be included in the study. North Atlantic Region States were selected, as this Region is likely to provide the first operational implementation of ATN services.

- **The study is representative of both Oceanic and Continental ATC**. Including the NAT Region and European States allows routing and architecture issues between boundary Regions to be studied.

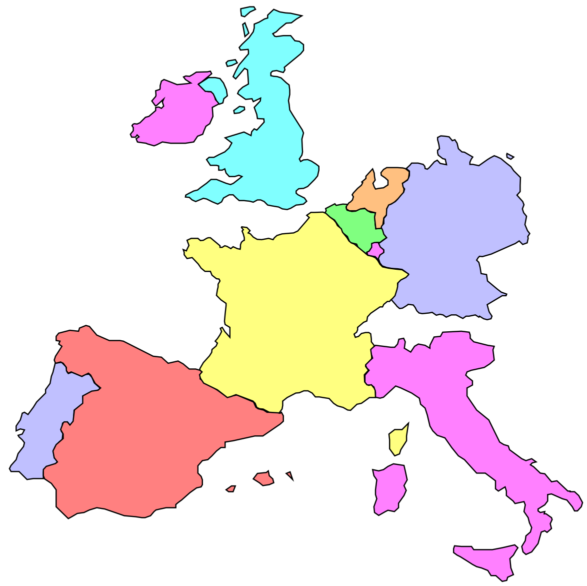

Figure 1: the ACCESS Geographical Area

Because of the limited amount of resources and time available to perform the project, the choice of a larger geographical area, such as the entire ECAC area, would have compromised the overall quality of the results. However, it must be noted that the recommendations resulting from the ACCESS study will be scaleable, i.e. can be extended to the rest of Europe outside the defined ACCESS geographical area.

1.1.3.2 Work Breakdown Structure

The ACCESS Phase 2 - Part 1 was divided into three sequential sub-parts:

- The first sub-phase (April 1997 - April 1998) defined the proposed **Network Architecture**, i.e. the main elements of the Target ACCESS ATN. It resulted in Interim Deliverable 1.
- The second sub-phase (March - December 1998) proposed solutions for **Network Implementation Issues** related to the Target ACCESS ATN but not studied or not completed during the first sub-phase (e.g. security, certification, etc.). It resulted in Interim Deliverable 2.
- The actual sub-phase (September - December 1998) proposes a **Transition Plan** from the existing network infrastructure to the Target ACCESS ATN infrastructure, and defines the Initial ACCESS ATN. It results in Interim Deliverable 3 (this document).

1.2 About this Document

1.2.1 Scope

This document is the ACCESS Interim Deliverable 3.

1.2.2 Purpose

The **initial purpose** of this document was to define a transition plan from the current European aeronautical telecommunication environment towards the “Target ACCESS ATN”. However, because the “Target ACCESS ATN” can only be implemented if the “Initial ACCESS ATN” is implemented first, the focus of the document was shifted to concentrate on the transition plan towards this “Initial ACCESS ATN”. The objectives of this plan are to clearly indicate the various actions to be taken by each state, organisation, or third party involved in the deployment of the ATN in the considered ACCESS Region and to produce an associated schedule.

However this purpose, defined as the proposition of a transition plan to the “Initial ACCESS ATN” and an associated schedule, has been reconsidered in the course of the drafting of this document, for reasons explained in the next section.

The **new purpose** of this document is kept focused on the “Initial ACCESS ATN” but it has been reduced to the **identification of initial ATSC data link services, the description of the supporting initial ATN network** and the **description of the actions required** to propose a realistic transition plan to that “Initial ACCESS ATN”.

Note that although AOC services and traffic are out of the scope of the study and therefore are not specifically developed in the remaining part of the document (AOC is mentioned only when of particular relevance for a related ATSC issue, e.g. in section 3.3.3.2), it is commonly recognised that AOC will certainly be a prime driver for early ATN deployments.

1.2.3 Approach

The ATN is the internationally agreed networking environment for the future aeronautical data communication and is the expected solution for overcoming the shortfalls of the present ATM system and for meeting the ambitious objectives set up by current forecasts of air traffic movements, changing user needs, and prevailing aviation and ATM related trends. However, today the ATN consists only in an ICAO standard, in pre-operational implementations of this standard and in experimental ATN networks that have been used to validate the ATN concepts.

The transition process that will lead the aeronautical community from the current situation to an operational context where the ATN is widely deployed and used as the primary networking solution will be driven by many factors. The main drivers are technical, economical, operational and political.

However, due to the numerous uncertainties associated with long term ATN implementation objectives and to the size of the required analysis, which is not feasible within the ACCESS project timeframe, it was considered reasonable to focus this analysis of the transition process on the evolution to the “Initial ACCESS ATN”. The “Initial ACCESS ATN” can be defined as the set of services necessary to trigger the evolution of the local ATN deployment into the coherent ATN infrastructure in the ACCESS target area necessary to support these services. This is seen as the critical stage of ATN transition and the further evolution towards the “Target ATN” introduced in section 1.1.3.1 will be dependent on the success of establishing this “Initial ACCESS ATN”.

Therefore this document is primarily focused on **technical issues** for a **transition to the “Initial ACCESS ATN”**, while (as far as possible) leaving aside economical, operational and political considerations.

An initial drafting of the document was realised based on the assumption that operational requirements for data link services will drive the deployment to the initial ACCESS ATN. That initial draft was written with the purpose of proposing a high level ATN implementation project plan, proposing an arrangement and a scheduling of the required ATN implementation activities and presenting an assessment of the most critical aspects identified for the successful realisation of the proposed implementation plan. This was totally in line with the initial expression of the purpose of this work package.

However, even if several studies, experiments or trials have been accomplished or planned for ATN-based data link services in Europe, it is clear that, to date, **there is no apparent overall implementation plan for operational ATN-based services in the ACCESS area**, coming either from ATSOs or AOs. Whatever reasons may justify such a situation, at the moment the current study is performed (fall 1998), there is no clearly expressed objective in terms of deployment of operational ATN-based applications throughout Europe; the only reliable elements in that area are those experimental or pre-operational data link projects such as PETAL II, EuroVDL, etc.

In the absence of any concrete political decision towards an ATN deployment in Europe, it was therefore concluded that it is difficult to produce realistic implementation plans and resulting schedules for the transition to the initial ACCESS ATN. As a consequence, this document will focus on the only elements of a transition plan that can be justified by **facts or reasonable prospects.**

This transition study is therefore structured as follows:

- the study will first identify and review the existing initiatives that can be considered as valid starting points for a deployment of operational ATN-based services (e.g., pre-operational data link experiments and resulting pre-operational ATN infrastructures),

- secondly, the initial ACCESS ATN will be described as far as possible. This step should lead firstly to the proposition of initial operational services[3]and then to:

  1. the identification of the ATN infrastructure and the organisational aspects required to support the operation of the selected services,

  2. the description of a (as far as possible) realistic transition plan to the so defined "initial ACCESS ATN".

The structure of the document, which is described in more details in the next section, reflects this general approach.

1.2.4 Structure of the Document

The document is structured as follows:

- Chapter 2 presents the current, initial landscape in terms of ATN deployments in the ACCESS area: this stage corresponds to the deployment by ATSOs of embryonic ATN infrastructures developed in the context of local national initiatives or European pre-operational ATN projects. This chapter therefore presents those various initiatives and projects, their schedules and the resulting ATN infrastructures and services candidate for further operational use. Note that this chapter 2 only describes initiatives already launched by the time this report was written (fall 1998).

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[3] Because it is believed that only a political / strategic decision to deploy a limited set of initial operational data link services will be the event that will trigger the deployment of a European ATN network. Consequently an ATN implementation plan can only start by the selection of that limited set of data link services.

- Chapter 3 presents *the subsequent ATN deployment step*, which culminates in the establishment of the “Initial ACCESS ATN”. This chapter proposes a list of the initial operational ATN services that should be supported by this initial ATN. It also sketches out the elements of a likely ATN infrastructure at that stage of ATN deployments, while raising the prior actions to be carried out for the definition and the completion of a successful transition to the initial ACCESS ATN.

- Chapter 4 summarises the reasons that prevent from proposing today any solidly established transition plan to the “Target ATN”.

- Chapter 5 is a summary of all previously identified actions.

- Chapter 6 is the conclusion of ACCESS WP 240.

1.3 References

ACCESS Reference	Title
[A201]	ACCESS WP 201 – Current Communications Infrastructure.
[A202]	ACCESS WP 202 – Define Geographic Area and Services: ATN Data Link Services in the ACCESS Area.
[A203]	ACCESS WP 203 – Define Network Topology and Routine Architecture: Definition of the European ATN routing Architecture.
[A204]	ACCESS WP 204 – Ground/Ground Subnetworks.
[A209]	ACCESS WP 209 – Selection of Routing Architecture
[A220A]	ACCESS WP 220A – Deployment Scenarios for Air/Ground Subnetworks
[A222]	ACCESS WP222 – Security Mechanisms in the European ATN Network

2. Current ATN Initiatives

2.1 Introduction

The initial ATN deployments in the ACCESS area are considered to be made of the set of embryonic ATN infrastructures which are developed in the context of local/national initiatives or European pre-operational ATN projects **and which will result in the deployment of components of an ATN network (e.g., ATN routers, VDL stations, etc.) on future operational sites**.

Although those first initiatives or projects have started in an overall context with no strictly defined and co-ordinated ATN deployment programme at the European level – the ACCESS project should help pave the way for that programme -, their essential characteristic having to do with the ACCESS transition study is that they are already started or to be started, no matter what ATN deployment occurs in the next years. Additionally they are not thought to be “one-shot” experiments: they conversely should become the first operational ATN expandable nuclei, around which a co-ordinated deployment programme could be set up in a second stage.

This chapter therefore presents those various initiatives and projects, their schedules and the resulting ATN infrastructures and services candidate for further operational use, which are essentially derived from the **Petal II**, **EuroVDL** and the ongoing **ATSMHS** projects. Although it will not support any operational traffic, **ATIF** is presented as well because it will provide the first elements of the test/integration ATN infrastructure associated to the future operational ATN network.

ProATN/Eolia is not presented in that report because this project will not a priori result in the deployment of ATN components in future operational sites. ProATN/Eolia is a fundamental initiative for the European ATN deployment process as well but its results are rather expected to:

- help define/study the implementation of data link services,
- develop ground-based and airborne systems with the capability to become operational systems.

The networking infrastructure made of the interconnection of ProATN systems will rather be integrated into the ATIF infrastructure.

Finally note that an additional project is being set up to provide a European test facility to test operational ATN systems prior to deployment in the operational environment. Testing is required in the context of recognised safety assessment, certification and operational approval processes. The CAERAF project (Common American European Reference ATN Facility) is a joint project between the FAA and ATN Systems, INC. on one side and EUROCONTROL on the other side. ATN Systems, INC, an 11 airline owned and FAA supported company, is developing a Conformance Test Suite that will be integrated in the CAERAF in the context of a EUROCONTROL sponsored contract. The CAERAF approach is based on the principle that all systems are to be tested against the same reference implementation, i.e. the CAERAF platform. The scope of these tests includes interoperability, stress, robustness, conformance and performance capabilities. The CAERAF is planned to be available in 2000.

2.2 PETAL-II

2.2.1 General

PETAL-II is a continuation of PETAL, the Preliminary EUROCONTROL Test of Air/ground data Link. PETAL created a platform for joint air and ground user development of air/ground data link operational requirements and functions and allowed to gain operational and system experience with this data link technology to be gained.

PETAL-II data link services will be conducted using commercial aircraft on routine operations in controlled airspace. In most cases, PETAL-II data link services will be used by air traffic controllers conducting routine duties at existing operational air traffic control stations.

During its initial phases, PETAL-II will involve only the airspace controlled by its core ATC service provider, the Maastricht UAC. PETAL-II aircraft will be controlled via data link during routine operations, as and when they transit all Maastricht UAC sectors. Other airspace could be incorporated in the PETAL-II trials depending of the involvement in the project of European CAAs.

A part of the project is dedicated to experiment data link services over the ATN using the DERA trial aircraft (BAC1-11). An extension to this phase (PETAL-IIe) has been set up to organise operational trials with 4 American Airlines B-767-ERs equipped with Collins and ATNSI ATN-compliant systems. The first transatlantic flights are currently scheduled from March 2001 in co-ordination with the FAA ATN Implementation Plan (CPDLC Build 2). Jointly agreed End-to-End Trials Specifications are being produced under the responsibility of the PETAL-II Integration Team (PIT).

Note: the first of the other on-going PETAL-II parts is dedicated to STDMA ADS-Broadcast experiments with 20 equipped aircraft. Trials are in progress (over 130 flights using CPDLC with Maastricht in September 98). The ADS-B flights are expected to continue to end 1999. The second part is dedicated to FANS-1/A experiments with 25 FANS/1-A equipped aircraft. The Work was performed in November 98 to test the FANS-1/A Front End Processor and subsequent testing has included United Airlines and Continental Airlines.

The main partners involved in PETAL-II are the following: Eurocontrol (as Project Leader), the Maastricht UAC (ATCC), France (Mode-S ATCC, ESCAPADE), Aérospatiale (FANS-A aircraft) and aircraft operators (SAS – DC-9 and F-28, SwissAir – 16 FANS-1 MD-11, Air New Zealand - 4 FANS-1 Boeing, Lufthansa – STDMA and FANS/1 Boeing). The FAA, American Airlines, ATNSI, ARINC, Boeing and Rockwell Collins, IATA and IFATCA are providing support to the PETAL-II extension for ATN.

2.2.2 Overview of the ATN Data Link Services Supported in PETAL-II

PETAL-II objectives are to implement the following data link services on ATN: **DLIC** for ATN data link initiation, **FLIPCY** for flight plan conformance checking, **ACM** for ATC communication management, **CIC** for ATC clearances and ATC Microphone Check and **CAP** for presentation of aircraft parameters to the controllers.

Note: most of these services will also be supported by FANS-1/A and ADS-B technologies. In addition, the broadcast downlink of airborne parameters service will be provided by the ADS-B application.

PETAL-II services are based on the ODIAC-TF data link services definitions (with some deviations due to infrastructure-specific needs or capabilities or trials environment) and on EOLIA specifications. PETAL-II uses a subset of ICAO ATN Doc 9705, Edition 1 SARPs (V2.3).

2.2.3 PETAL II Ground Architecture

PETAL-II ground system functional architecture - based on the existing Maastricht UAC architecture – is illustrated in Figure 2:

- The **MADAP** system is the Flight Data Processing System (FDPS) upgraded to cope with the 3 communication infrastructures (NEAN, FANS-1/A and ATN).

- The **P2FEP** system supports the communications-specific functions (PETAL-II Front End Processor). The P2FEP provides the FDPS with a single source and destination for all data link messages, regardless of the underlying technology: ADS-Broadcast, FANS-1/A or ATN.

    - The **NFEP** (NEAN Front End Processor) interfaces PETAL-II with the ADS-Broadcast

    - The **FaFEP** (FANS-1/A Front End Processor) interfaces PETAL-II with the FANS aircraft

- The **ALLA** system provides a direct access to the ATN services.

- The **ProATN/EOLIA** systems interfaces PETAL-II with the ATN subnetworks. It contains an ATN router and an ATN End System supporting CM, CPDLC and ADS.

Note: the current data link airborne infrastructure is based on an unchanged FMS on board. This currently jeopardises the support of ADS in the aircraft, and hence of the data link services CAP and FLIPCY. Another open issue is the ability by aircraft ATN systems to not support IDRP.

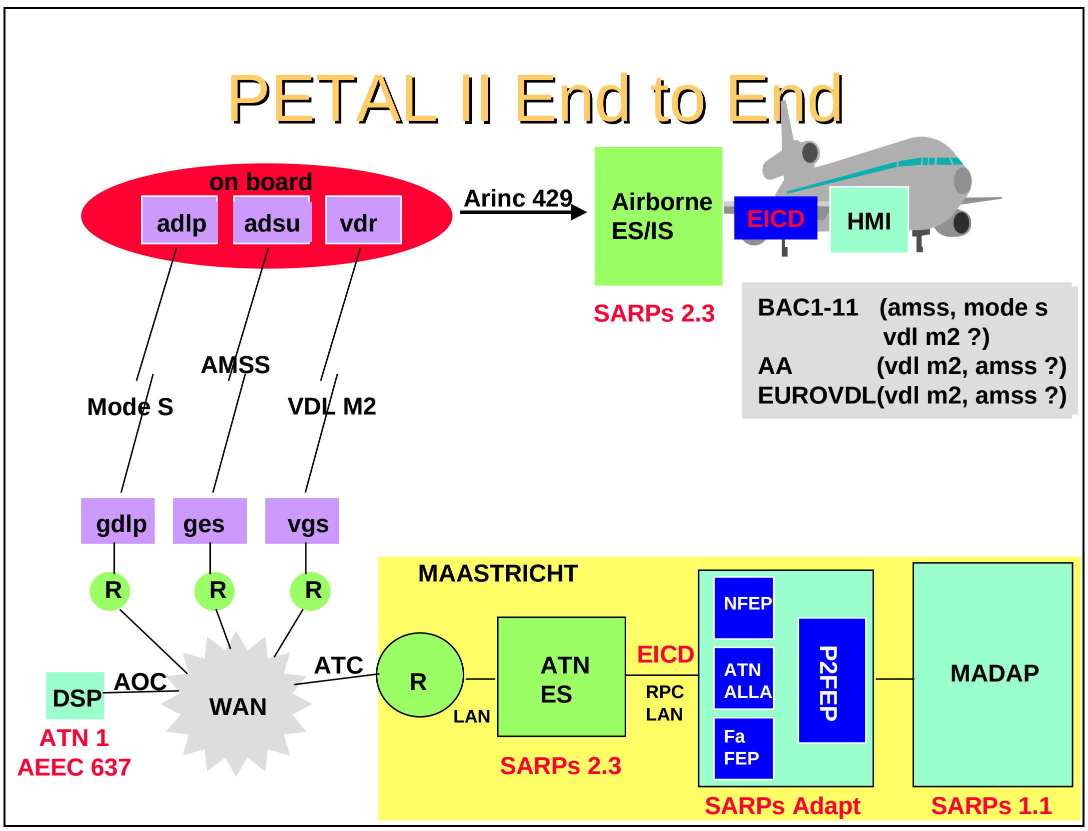


Figure 2: PETAL-II Architecture

The communication infrastructure to support the ATN operations will consist in:

- The **ATN Trials Infrastructure** (ATIF), migrated later to ProATN/EOLIA systems, will provide the appropriate ATN equipment to the Maastricht UAC to allow data communications (via

SatCom and VDL-2) with ATN-equipped aircraft.

- **ARINC** will provide by mid 2001 the VDL-2 ATN infrastructure for the trials. 6 VDL stations will be deployed (Paris, London, Amsterdam, Frankfurt, Copenhagen and Berlin) as shown in Figure 3.

During Phase 1, controller HMI will be based on the old Operational input and Display System (ODS), using the existing Touch Input Device (TID) for input, and the primary screen for display of air/ground data link interactions and data. In Phase 2, controller HMI may be based on new ODS, using the primary screen for data link inputs as well.

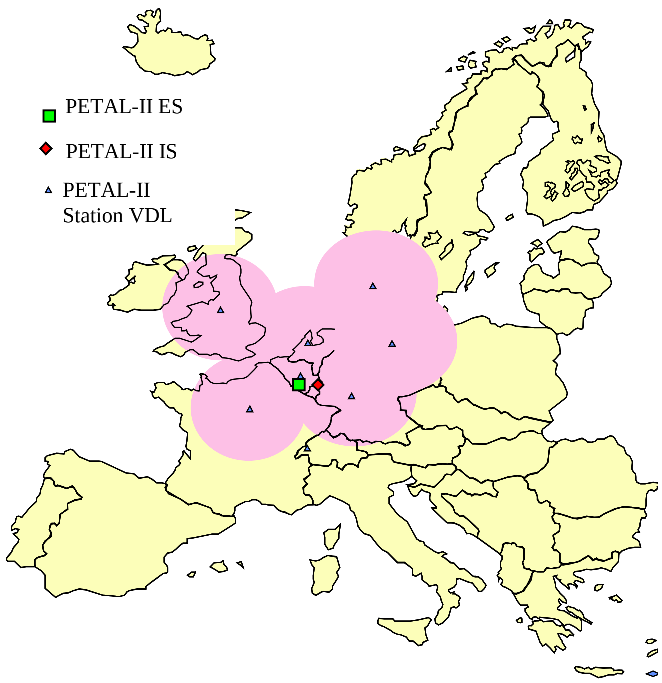


Figure 3: PETAL-II VDL Mode 2 Coverage and Ground ATN Systems

2.3 EuroVDL

2.3.1 General

VDL Mode 2 is recognised as the primary subnetwork technology for fulfilling the increasing data link needs for both ATS and AOC applications. This technology has been standardised and endorsed by the aeronautical community for a rapid deployment across Europe.

Eurocontrol has been tasked by the European CAAs to co-ordinate a European VDL Mode 2 Implementation Programme. An important element of that programme is the pilot implementation project called *EuroVDL*. This project aims at creating a momentum to implement the VDL Mode 2 by including all stakeholders involved in the data link implementation or operation and reducing the cost of each side impacted by the VDL Mode 2.

EuroVDL participants are Eurocontrol, CAAs (ENAV, NATS, STNA and DFS as an observer only in phase 1), Airlines - to be confirmed in the light of business case figures (Air France, Alitalia, British Airways and soon Lufthansa) -, as well as SITA and Airbus/Aérospatiale.

The project schedule is organised around three successive phases:

- Phase 1 (1998-1999): definition and development phase,
- Phase 2 (1999-2000): implementation and deployment phase,
- Phase 3 (2001): validation and analysis phase.

This project should address the following main issues:

- introduction of VDL Mode 2 capability in production avionics,
- frequency allocation & spectrum aspects,
- smooth transition for AOC applications to use VDL Mode 2,
- evaluation of the impact on flight operations using commercial A319/320/321 Airbus aircraft in operational conditions,
- support of all the current AOC applications over VDL Mode 2 (transparent switching between VDL Mode 2 coverage and ACARS coverage).

The expected EuroVDL coverage is represented in Figure 4. In addition this figure depicts ProATN VDL Mode 2 ground stations, as they could be used by the EuroVDL project although they are not intended to become operational in further stages of the ATN deployment (except the Amsterdam ProATN GES, maybe).

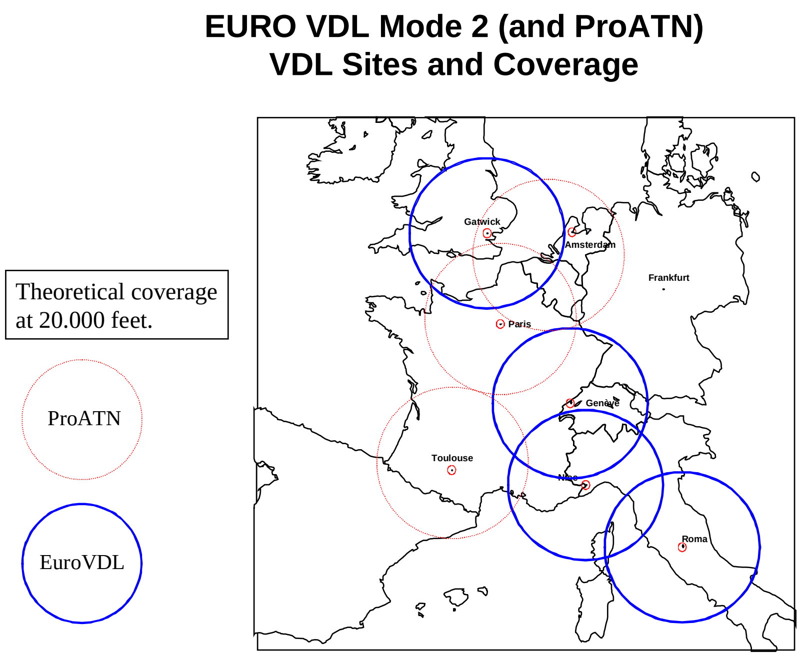


Figure 4: EuroVDL Mode 2 Coverage

2.3.2 EuroVDL and the European ATN

The EuroVDL project is essentially driven by the validation of a solution allowing AOC applications to use a VDL Mode 2 a/g infrastructure. Three options were envisioned for the migration of "ACARS applications" as exposed in [A220A]:

1. ACARS/X.25 solution (SITA proposal),
2. ACARS over CLTP (ARINC proposal),
3. ACARS over full ATN.

EuroVDL project members decided to go for an ATN-based architecture (solution 3). The project objectives were then accordingly refined: EuroVDL aims at defining and validating all the elements required for a VDL Mode 2 subnetwork as part of the European ATN, supporting the existing AOC applications of the Airlines and one ATN-compliant ATS service (ADS) to aircraft on operational flights.

EuroVDL should therefore allow for an early ATN deployment paving the way for the introduction of CNS/ATM applications.

EuroVDL is considered important in this ACCESS ATN transition plan because it will result in a set of deployed operational VDL Mode 2 ground stations and, hopefully, operational certified airborne VDRs.

Figure 5 depicts the proposed ATN architecture used by the EuroVDL project.

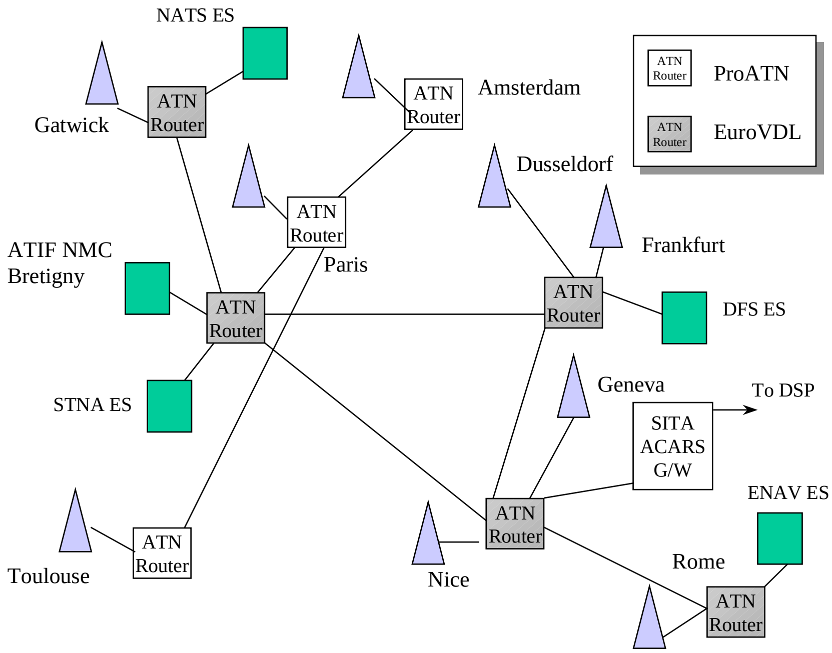


Figure 5: EuroVDL ATN proposed architecture

2.4 ATIF

The European ATN Trials Infrastructure (ATIF) is a region-wide ATN project being conducted in a joint effort by European national aviation administrations, Eurocontrol, the European Commission and industry. Its aims are to validate ATN standards to ensure that they are complete and correct, and to test them in operational environments.

Complementary ATN components such as the Trials End system (TES), the Trial ATN router and Transport Server (TAR-TTS), and the Mode S Ground Data Link Processor have been integrated into a distributed ATIF with connections to other regions such as Japan, the U.S. and Australia. In addition, experimental airborne ATN compliant systems were developed on PC platforms. Integration of the ProATN/EOLIA systems into ATIF is expected mid-1999. ProATN is the program which developed pre-operational and pre-industrial prototype ATN systems (ISs and ESs), and EOLIA developed and evaluated a set of user-oriented ATN-compliant, pre-operational ATC data link services in the European environment.

The ATIF systems have been distributed as widely as possible to Eurocontrol member states.

The key ATIF components are described below:

– **TAR-TTS**

  The TAR-TTS comprises the ATN Internet functionality providing configurable mobile and ground ATN routers.

  TAR-TTS currently has a large installed user community, including the Eurocontrol UACC at Maastricht, the ADS Europe project, NATS, the Irish Aviation authority, SICTA in Italy, LVB in the Netherlands, DFS in Germany, TELNOR in Norway, AENA in Spain and CENA in France, all administrated from the Eurocontrol Experimental Centre at Brétigny in France.

  In the ATIF context, TAR-TTS will be progressively replaced by the ProATN air/ground BIS in 1999, which is itself an upgrade of the TAR-TTS system.

– **Airborne TAR-TTS**

  Airborne TAR-TTS supports an interface to ARINC 429 and the aircraft standard bus and is portable in a PC UNIX environment. It will support the use of mobile subnetworks – Mode S, VHF, Satcom – on experimental aircraft.

– **Trials End Systems (TES)**

  The TES comprises the ATN Upper Layers plus ADS, CPDLC and CM applications. These upper layers, integrated with TAR-TTS, provide a complete end-to-end seven-layer ICAO-compliant implementation on the ground and in the air.

– **Network Management Centre (NMC)**

  The NMC is a tool set that configures and controls distributed ATIF systems to create an integrated and flexible network for trials and demonstration purposes. It is being designed to be platform-independent so that it can be adapted to all major Unix platforms, and is available now.

– **Mobile Subnetworks**

  The TAR-TTS router connects to the Mode-S T-GDLP (Trials Ground Datalink Processor) developed by Eurocontrol. The ADLP (Airborne Datalink Processor) is now available and flight trials are under way.

The TAR-TTS interface to the satellite subnetwork on the ground is operational. The airborne router interface to the satellite was ported to the PC environment intended for avionics use. It is available now and is being used in the ADS Europe and FITAMS trials.

The TAR-TTS does not currently interface to VDL-2 subnetwork equipment, but this is planned for mid-1999.

- **Local and Wide-Area Subnetwork**

The TAR-TTS can operate over Ethernet and FDDI LANs and also offers X25 WAN access. A specification for the integration of ATM to ATIF is ready and will be incorporated in TAR-TTS.

- **FITAMS**

FITAMS (Flight Trials of ATN and Multiple Subnetworks) is an ATIF internal sub-project. Successful flight trials, using the BAC1-11 trials aircraft operated by UK's DERA have demonstrated ADS and CPDLC over the ATN Internet (Satcom and Mode-S). In the future, VDL Mode 2 and LEO satellite subnetworks will be added to the trials.

Figure 6 depicts the target ATIF Infrastructure in Europe.

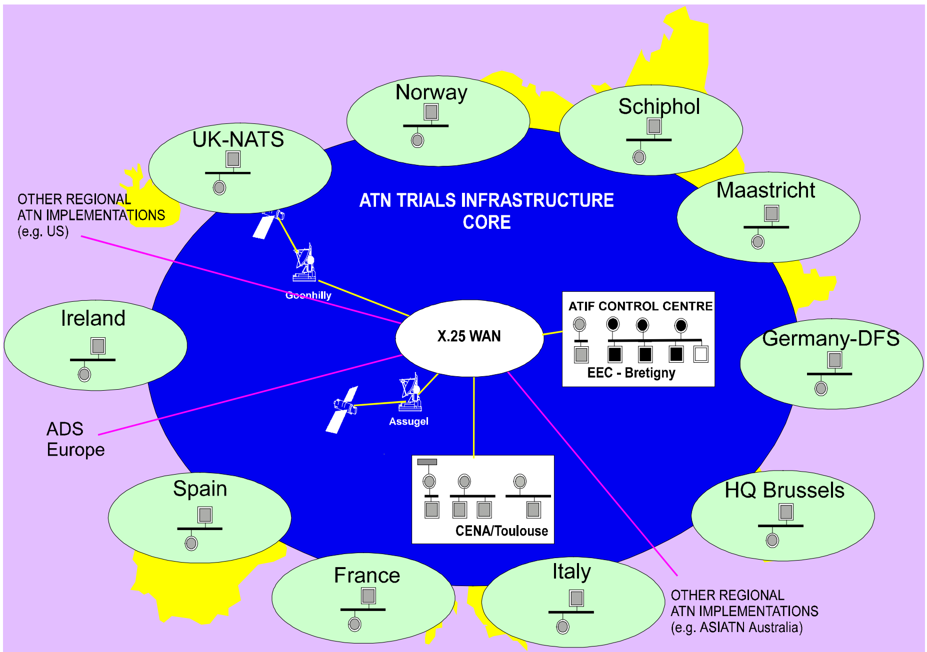


Figure 6: ATIF ground infrastructure

2.5 AMHS

2.5.1 Introduction

This section presents European ATSMHS projects that are already (even partially) operational or that are near completion for an operational use.

2.5.2 Spanish ATSMHS Project

The ATSMHS project in Spain consisted in the development and the deployment over the AENA sites of ATN MHS compliant systems.

2.5.2.1 The AFTN/AMHS Gateway

The Madrid COM Centre which operated so far an AFTN component and a CIDIN component has been installed with an AFTN/AMHS Gateway mock-up. This platform was used first (1997-1998) to validate the ICAO specifications of the gateway (Doc 9705 - SARPs). The following step was to run in the mock-up a "Transition Phase" with duplicated traffic from the current AFTN/CIDIN COM Centre in Torrejón (CRAMI) towards the mock-up of the future Centre. For that purpose, there was defined a set of AMHS users that received messages that were a copy of those sent to AFTN active users; this was aimed at testing the behaviour of the Gateway as well as the future COM Centre in an environment with traffic copy from the real one, checking the switching possibilities among the different available networks. This phase run between end of March and mid June 1998.

The AFTN/AMHS Gateway was successfully put in operation the 17th June, 1998. Since then the COM Centre supports the interchange of all AFTN, CIDIN and AMHS communications and provides access to Telex, Fax and AFTN over X.25, as illustrated in Figure 7.

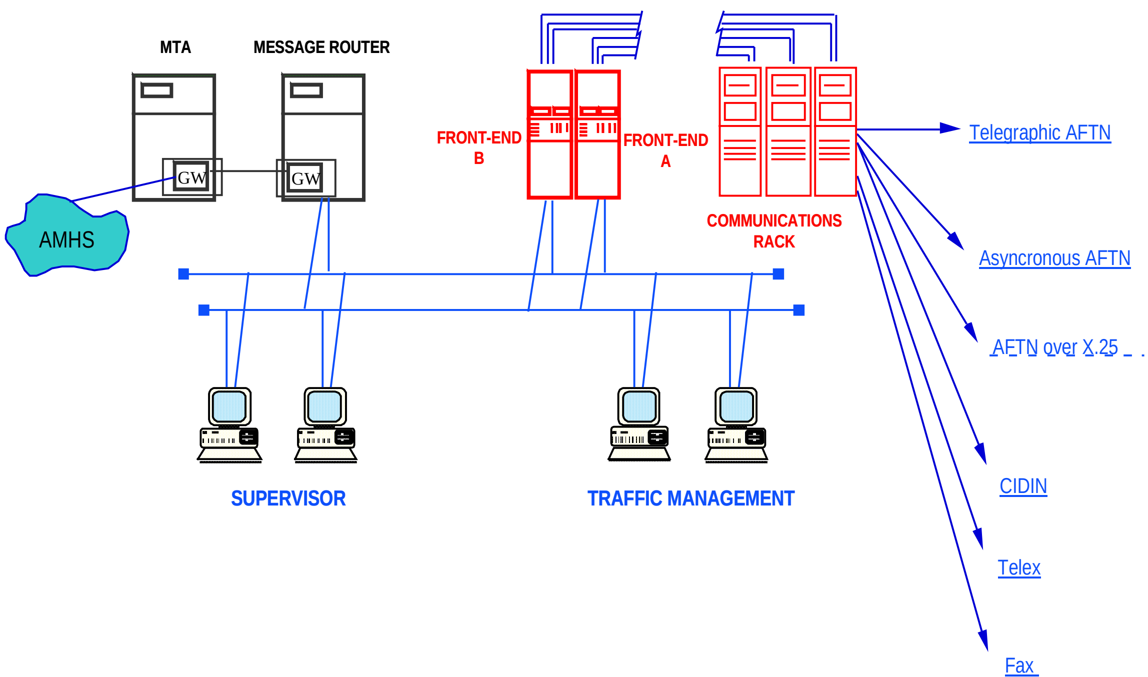


Figure 7: Current COM Centre Topology in Madrid

The AFTN HMIs are being replaced by native AMHS user agents. The philosophy of the migration of the current AFTN users and applications to the AMHS environment is to start the integration of users belonging to ACC's in Spain, followed by those of the sector heading airports, to end with those of the smallest airports and air bases.

The installation and configuration of AMHS equipment to the Madrid ACC's users was performed in October 1998. The migration of the users of the remaining Spanish ACCs is in progress, with a complete set of operations of the Spanish AMHS network foreseen to be finished by mid 1999.

2.5.2.2 AMHS Network

A complete network of ATSMHS servers has been installed and set up. This network is composed of 17 Message Transfer Agents (MTA) located in the five Spanish ACCs (Madrid, Barcelona, Sevilla, Palma de Mallorca and Gran Canaria) and in the main Sector Heading Airports. These servers shall provide service to the different users and applications in the current AFTN network in Spain, when they will migrate to AMHS procedures.

The AMHS network is supported by the resources offered by the current data network of Air Navigation of REDAN.

Figure 8 shows the topology and structured hierarchy of servers and users conforming the AMHS network. In a first level there can be found the servers to be installed in the different ACC’s, called ESVAS (Value Added Service Elements). These servers use fault tolerant equipment and constitute the “Backbone” of the network. Associated to these servers there are STU 1 (Terminal User System 1) formed by a set of users (UA user agents) of the ACC. The equipment of these users is a PC with AMHS user software.

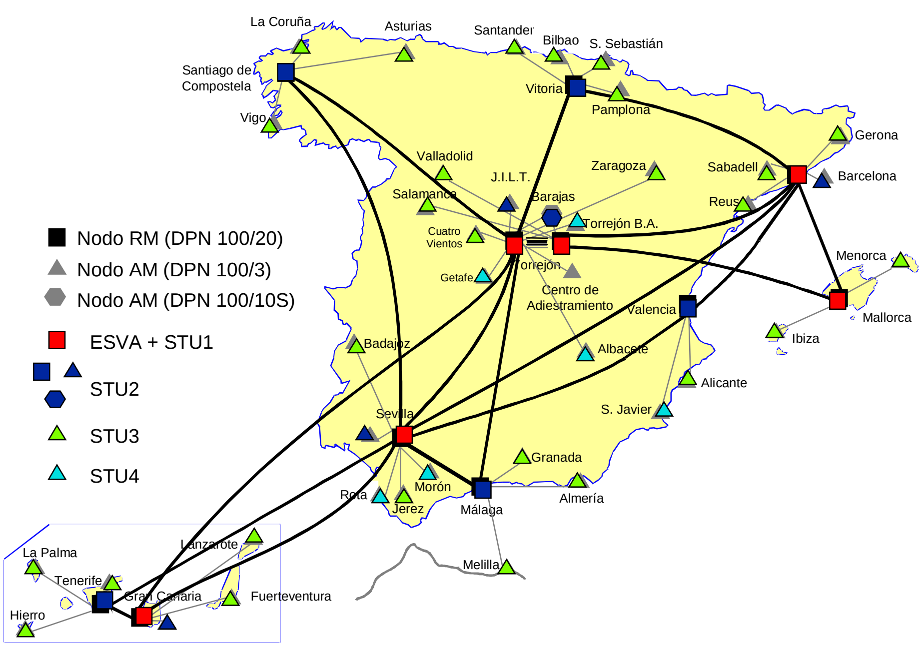


Figure 8: Operational AMHS Topology in Spain (mid-1999)

In a second hierarchical level STU 2 (Terminal User System 2) are found, which are formed by a set of servers (built on a Workstation) with an AMHS server (MTA) resident software, and a set of users built on a PC with AMHS user agent (UA) software. This equipment is associated to sector heading airports and big volume of traffic airports.

In a third level there are found the STU 3 (Terminal User System 3) formed by a set of users built on a PC with AMHS user agent (UA) software, with remote access, via TCP/IP over X.25, to an AMHS server of STU 2 or ESVA type. They are associated to low volume of traffic airports.

At last, there are the STU 4 (Terminal User System 4) formed by a set of users built on a PC with AMHS user agent (UA) software, and that remotely access via X.25, to an AMHS server of STU 2 or ESVA type. They are associated to air bases and remote sites.

As an added value, the Spanish AMHS network makes use of the Directory Service based on the X.500 standard of ITU-T for the users address resolution of AMHS.

2.5.3 ANDRA Project

ANDRA (Advanced Node for Data Relay in the ATN) is an ongoing ATSMHS project which will result in a new COM-Center of DFS, becoming operational in the first quarter of 2000. ANDRA shall serve as a message switch and gateway, providing the functionality of an AFTN/CIDIN and an AFTN/AMHS gateway to guarantee utmost connectivity between various messaging formats and protocols.

The ANDRA system will provide functionalities of an ATN End System, so it will be configurable to operate as an ATS Message Server, ATS Message User Agent and an AFTN/AMHS Gateway as well. The different protocols and message formats are implemented in a flexible way so it is easily possible to operate ANDRA in a multi-protocol environment. The implemented network management facility will be based on SNMP MIB2 amended with an ANDRA specific application MIB.

Integrated in the operational environment of the DFS and connected to the packet switched network PSN of the DFS, ANDRA will have direct communication relations with the national Value Added Network (distribution of ATS-messages to all end-users), with the national Flightplan Processing Systems, with the German Military COM-Center and with all surrounding international COM-centers and the CFMU/IFPS using initially the CIDIN protocol over network links (PVC and SVC). Two dedicated AFTN-links remain for communication with SITA.

2.6 Conclusion

On one hand, Petal II and EuroVDL should be decisive drivers for the ATN deployment in Europe as they should demonstrate in operational conditions the true benefit brought by data link applications based on ATN infrastructures and services. It is assumed that the ATN infrastructure elements deployed in operational sites for those projects (VDL Mode 2 ground stations, attached ATN BISs, data link servers, etc.) will serve as the first elements of the future ACCESS ATN.

On the other hand, the Spanish ATSMHS and the ANDRA projects have already resulted (or are due to result) in the deployment of the first operational ground-based ATN ESs that will use the future ACCESS ATN internet.

The network infrastructures and services resulting from those pre-operational projects are thought to be the first expandable elements of the future operational European ATN network (see next section). Nonetheless the effective expansion of those various elements into a structured ATN network (like the initial ACCESS ATN described in the next section) will be conditioned by the creation of a necessary European ATN deployment programme and the subsequent commitment of the ATN stakeholders (ATSOs, AOs, etc.) to support that programme.

3. Initial ATN Deployment

3.1 Introduction

The starting of the "initial ATN" deployment should be motivated by the expressed will of ATSOs to provide a limited number of operational data link services in Europe. Those services should be derived from ODIAC studies and, more generally, from the evolution of the European data link needs within that timeframe.

That deployment phase should therefore lead to the provision of a set of ATN ATSC services in the ACCESS area, which will be obviously accompanied by the deployment of a supporting ATN infrastructure.

Considering that the induced deployments will end up with *the initial ACCESS ATN*, it is assumed that this initial ACCESS ATN will be **progressively** deployed, based on the operational ATN infrastructure and services resulting from current ATN initiatives (see section 2) and on a specific deployment co-ordination programme (possibly under the responsibility of a central European ATN entity), at least for the common (inter-domain) infrastructure (e.g., the initial ACCESS ATN backbone).

More specifically, it is thought that the initial stages of a wide scale ATN deployment in Europe (i.e., the initial stages of the transition path to the initial ACCESS ATN) will be based on the incremental expansion of the “local” data link services that have demonstrated their operational benefit to their users in the context of the current ATN initiatives. It can be envisioned that further stages of the transition path to the initial ACCESS ATN will be driven by a European ATN deployment programme integrating the prior deployments, once ATN stakeholders (and more particularly ATSOs) will have committed themselves at the highest level to such a programme for answering the increasing data link communication needs.

Consequently the first objective of chapter 3 is to sketch out the likely ATN network infrastructure and services that should be available with the initial ACCESS ATN (around 2005). Deployment scenarios for that initial ATN will be proposed whenever possible (i.e., when based on reasonable prospects or tangible elements).

Another important objective of chapter 3 is to raise the actions that must be carried out prior to or during that deployment phase for ensuring a successful transition to the *initial ACCESS ATN*. Those actions are summarised in chapter 5.

The first part of this chapter presents the likely *initial ACCESS ATN* services. The second part describes the *initial ACCESS ATN* infrastructure that should support these services. Finally, a third part gathers the elements that are additionally required to get a truly operational *initial ACCESS ATN*, either in the organisational or in the technical fields (e.g., system management, security, certification).

Note that, although it is recognised that AOC needs will be fundamental for the ATN deployments, the scope of the document covers ATSC services only and the ATN infrastructure required to support them.

3.2 Initial ATN Services

3.2.1 Initial Air/Ground ATN Services

This section contains recommendations on the air/ground services that can be assumed to be supported by the initial ACCESS ATN.

[A202] proposed an initial list of ATN-compliant data link ATSC services which should be provided by ATSOs to ATN-equipped aircraft in the ACCESS area in the 2000-2005 timeframe. The main criteria driving the selection of the initial data link services was to select the services which would provide the better operational benefits to the ATC actors, in priority ATSOs and airlines.

As far ATSOs are concerned, the selected services should allow to increase significantly the current ATC capacity. The usual means – such as the automation of ground co-ordination and the sectorisation of the airspace -, which have taken away various phone exchanges from the controllers and have reduced the number of aircraft to be controlled by each controller, have reached their limits of efficiency and can not be applied anymore. As a very significant part of the controller's and pilot's work is to exchange information by VHF voice, it is clear that if some of these exchanges could be automated, extra time could be allocated to the controller to perform other tasks or control more aircraft. Data-link services provide by nature a very good support to automate air-ground communications.

For airlines, the economic benefit is obviously the main factor that will push them to equip their fleet with ATN systems. The services providing a better flexibility in the route assignment and allowing the controllers to better take into account the pilot's preferences appear to be the most promising from the airline's perspective.

3.2.1.1 ATSC Services to be supported by the Initial ACCESS ATN

The list provided in [A202] has been refined, having in mind the benefits identified above and taking as baseline the list of services specified by the ODIAC Task Force (and therefore recognised as the most relevant for the European airspace) and those selected for the EOLIA et PETAL-II projects. The EOLIA services were identified by a joint ProATN/EOLIA User Forum were all actors involved in the data link were present: CAAs, airlines and communication service providers. The PETAL-II project has then confirmed this selection with some differences (DSC and D-OTIS not selected, CAP added). The air-ground services proposed for the initial ACCESS ATN are briefly presented below. [A202] provides details on each service.

CPDLC-based services minimise the use of the VHF between pilots and controllers and relieve them of repetitive voice communication exchanges. The basic principle is to allow exchanges of text-formatted messages compliant with the current voice syntax. Lack of understanding between controllers and pilots due to the bad quality of the VHF or the misuse of English would decrease significantly. CPDLC is the generic ATN application allowing the exchange of pilot-controller messages. Each of the following data link services, based on the CPDLC application, meet a specific operational requirement.

- The **ATC Communications Management** service (ACM) deals with the voice and data-link channels switches. The introduction of this service in the ACCESS area where FIRs and sectors are small is expected to reduce the use of the VHF by about 20%. In the Target ACCESS ATN, the transfer of communications by data link will be performed between en-route controllers, between en-route and approach controllers, between approach and tower controllers and between tower and ground controllers. This assumes that both en-route and approach ATCCs be fully ATN-equipped. In 2005, such an assumption will certainly not be met. It is likely that first the en-route ATSUs will be provided with data link tools and then the capability will be extended to approach ATSUs. This is why it is proposed in the Initial ACCESS ATN in 2005 to deploy the ACM service in most possible en-route ATSUs and to leave the ATSOs to decide locally in which approach ATSU the service will also be made available.

- The **Clearances and Information Communications** service (CIC) allows for reliable exchanges of usual ATC messages via data-link between the cockpit and the controlling ATC. Only a subset of the defined CPDLC messages will be authorised in the ACCESS area (in such a dense area, clearances for route, level, speed will continue to be exchanged by voice). As for the ACM, it is proposed to provide the CIC service in all en-route ATSUs only, leaving the ATSO to decide the availability of the CIC service in the approach ATSUs.

- The **Down Stream Clearance** service (DSC) provides assistance to aircrew for requesting and obtaining clearances or information from an ATSU that will provide air traffic services to the aircraft at some later time in its flight but which does not yet have executive authority over the flight.

  Several operational use of DSC could be considered in the ACCESS airspace:

  - The oceanic clearance (OCM) service is the classical example of a DSC service. The oceanic clearance procedure occurs once per oceanic flight. This service involves the planning controller at the ACCESS oceanic en-route ATSUs (e.g. in U.K.). The oceanic clearance is the only DSC service proposed in the Initial ACCESS ATN.

  - The current processing of a diversion request issued by a pilot implies the co-operation of several controllers. The DSC service would remove the need for intermediate sectors to be involved in the forwarding of the request.

  - The aircrew could use the DSC service along the aircraft intended routing to interrogate ATSUs about the availability of conditional routes due to military inactivity.

- The **Departure Clearance** service (DCL) provides an automatic way for the pilot to obtain the departure clearance before the take-off.

Few **Automated Downlink Aircraft Parameter services** (ADAP) supported by the ATN are selected in the first instance. The CAP (Controller Access Parameter) service providing in real time the approach or en-route controller with some aircraft parameters (heading, speed, etc…) is also selected but it will be based on other data link technology than the ATN (Mode-S specific services). These services rely on the ADS ATN Application specified in the ICAO SARPs.

- The **Aircraft Parameter Reporting** service (APR) will enhance the ATC surveillance capability on the ACCESS oceanic area,

- The **Flight Plan Consistency** service (FLIPCY) will allow to detect inconsistencies between the data stored in the ground FDPS and data stored in the FMS as soon as the aircraft is entering the ATC region. This service will reduce the amount of information exchanged when the pilot contact the controller for the first time and provide a better level of security since the complete flight plan is checked (presently, only the first beacon is checked by the controller).

The **Data Link Flight Information Services** (D-FIS) services provide aircrew with up-to-date ground-generated data. The FIS ATN application implements the communication functions required to provide operational users with the D-FIS services.

- The **Data Link Operational Terminal Information service** (D-OTIS) service is triggered by the pilot to obtain by data link **Automatic Terminal Information Service** (ATIS) information.

In the category "other services":

¬ The **Data Link Initiation Capability** (DLIC) is operated when the aircraft enters a new data-link region to exchange the addressing information required to establish application connectivity and to allow the ground ATC to identify unambiguously the aircraft. This service is mandatory. DLIC relies on the CM ATN Application.

In order to be able to specify an ATN Implementation Plan in Europe, a formal commitment to support these ATSC services by 2005 must be first expressed by the ACCESS states and organisations. A European program must be launched to identify all the areas where a co-ordination is needed and define precisely the terms of this co-ordination. Co-ordination is needed in various areas, such as the operational procedures between ATSOs when supporting a given service, the organisational and institutional issues, etc.

3.2.1.2 The ACCESS Implementation Plans for Air-Ground Services

The services identified above as proposed to be implemented in the initial ACCESS ATN will not be all implemented in the ACCESS area and on the same way and at the same time by all ATSOs. In order to cope with the required co-ordination to implement distributed services on one hand and the flexibility demanded by each ATSO to implement data link equipment, two levels of implementation plans are proposed.

The **Regional ACCESS Implementation Plan** defines the overall "air/ground service profile" required to be implemented in the ACCESS area based on the service requirements relevant for European ATCs. Recommended services and service options that should be supported by 2005 by most ACCESS ATSOs would be defined in such a regional implementation plan. The terms of co-ordination between ATSOs would be defined in this plan. The regional profile indicates also where the ATN End Systems needed to support the regional services should be located.

In terms of services, the Regional ACCESS Implementation Plan proposed for year 2005 would contain the following requirements:

– **CPDLC-based services**. Most ACCESS en-route ATSUs would support the ACM and CIC services. The DCL service should be available in all major ACCESS airports. The oceanic ACCESS en-route ATSUs should support the DSC service.

– **ADAP-services**. The oceanic ACCESS en–route ATSUs should support the APR and FLIPCY services. The ADS ground forward service will not be supported in the initial ACCESS ATN.

– **D-FIS services**. A national or international ATIS server should be identified for each ATSO. Both types of contracts (demand and update) should be supported by the FIS servers. Even if other D-FIS services are being standardised at ICAO (e.g. METAR), it is unlikely that other services than ATIS will be provided in the initial ACCESS ATN.

– **DLIC**: The DLIC service must be available everywhere an a/g service is provided. All ACCESS en-route ATSUs must support the CM-logon and CM-contact services. The "limited CM server capability" will be supported by all ground CM systems. This capability – as described later – is for a ground CM system contacted by an aircraft which is not under the control of the local ATSU to instruct the aircraft to log-on to the appropriate CM. This implies that the ground CM servers maintain an addressing database with the addresses of all ACCESS CM systems and that the aircraft in the CM-logon explicitly indicates which ATSU it wants to logon to.

Action S1	**To support the development of a Regional ATN Service Implementation Plan.**	**All ATSOs & Airlines together (e.g., in the frame of LINK2000+)**

Action S2	**To specify the Regional ATN Service Implementation Plan, based on the services proposed in this document:** **CPDLC services: ACM and CIC (in en-route ATSUs), DCL (in major airports) and DSC (in oceanic en-route ATSUs),** **ADAP services: APR and FLIPCY (in oceanic en-route ATSUs),** **D-FIS services: one ATIS server per ATSO** **DLIC service (in all en-route ATSUs providing a/g services).**	**ATSOs & Airlines together (e.g., in the frame of LINK2000+)**
Action S3	**To commit to support the ATN Service Regional Implementation Plan (as a result of action S2).**	**All ATSOs & Airlines together (e.g., LINK2000+)**

In addition, each ATSO will define a **National ACCESS Implementation Plan** identifying which of the optional services or service options will be supported and defining a time schedule for the implementation of these services in the course of the inital ACCESS ATN deployment. The national implementation plan indicates also where additional ATN End Systems will be installed.

- **CPDLC-based services**. The national plan states which approach/tower/ground controllers have access to the CIC and ACM services. The regional plan defines the set of CPDLC messages operationally supported by the ground ATC systems in the initial ACCESS ATN. The location of the CPDLC End Systems (either in the en-route or in the approach ATSU) is defined in the national service profile.

- **ADAP-services**. The decision to have the ACCESS non oceanic ATSUs supporting these ground-initiated services (APR and FLIPCY) is left to each ATSO.

- **D-FIS services**. Each ATSO is responsible for selecting which airports are covered by the national ATIS server. The way the ATIS information is sent to the national/international FIS server must be defined (there is no FIS ground protocol defined so far).

- **DLIC**: the national plan contains the list of the adjacent ATSOs with which the ground CM-forward service is operated. It also identifies the approach ATSUs where a CM ATN ES must be installed.

The national implementation plan will also describe how the ATSO will accommodate or migrate its current operational non-ATN systems (e.g. the Gatwick Pre-Departure Clearance System or the French CLAIRE system) to the ATN environment.

Efforts to define national ATN service implementation plans may precede the formal elaboration of the European ATN Service Implementation Plan, e.g. based on local constraints or requirements. In all cases, a compatibility between the European implementation plan and its national versions must be targeted for obvious efficiency reasons: that calls for interested ATSOs to directly constribute to the European ATN Service Implementation Plan definition from the very beginning of the elaboration process.

Action S4	**To develop a National ATN Service Implementation Plan consistent with the Regional ATN Service Implementation Plan.**	**Each ATSO individually**

3.2.1.3 Overview of the Implementation Schedule

This present report does not attempt to build a detailed deployment schedule of the initial ATN data link services because such a schedule depends too much on political decisions from individual CAAs which we cannot predict today. It would be extremely hazardous to build a detailed planning for transition to ATN in Europe when many CAAs have not yet declared their position on ATN operational deployments.

It is believed that operational ATN-based services will be first deployed in each ATSO domain during the period 2000-2005, each ATSO following the implementation rhythm and priorities as defined in its national implementation plan. In turn, each ACCESS ATSO will enhance its ATC environment to eventually provide within the national coverage, possibly in the 2003-2008 period, the services described in the regional ACCESS implementation plan.

Based on a minimum co-ordination between interested ATSOs in the early stages of the initial ATN deployment (e.g., through bi- or multi-lateral agreements) and then (once defined and approved) on the necessary Regional Implementation Plan and its implied full co-ordination, the region-wide services requiring inter-ATSO communications will be gradually put in operation. For this purpose, a regional operational group must be identified to specify the operational procedures specific to the ACCESS area. Examples of such procedures are provided later in this document (refer to section 3.5.3.2). The objective is that the co-ordination between ATSOs be fully effective as soon as possible after the Regional Implementation Plan endorsement [4].

Action S5	**To define the Region-wide operational procedures consistent with the ICAO procedures, in order to operate the services defined in the Regional Plan.**	**A European operational group (e.g. ODIAC, EUROCAE, ICAO Regional Group)**

Once the national ATN air/ground implementations are co-ordinated to form a regional air/ground implementation in a seamless fashion and profile the full ACCESS service profile, the deployment of additional data link services can take place.

[4] The future LINK2000+ programme proposed by Eurocontrol will possibly provide an appropriate structure to handle that function.

3.2.2 Initial Ground/Ground ATN Services

This section contains recommendations on the ground/ground services which can be assumed to be supported by the initial ACCESS ATN.

3.2.2.1 Services to be Supported by the Target ACCESS ATN

Section 2.2 of [A202] contains a complete list of possible ground/ground services that could be considered as candidates to be supported by the ACCESS target ATN design in the time frame 2010. These are:

- ATS Message Service, supported by the ATS Message Handling System, AMHS, as basic message handling service providing service to operational ATS services (it is not considered realistic that conventional message handling services, AFTN and CIDIN, be supported directly by the ATN),

and the following ATS operational services:

- radar data transfer service,
- meteorological data transfer service,
- aeronautical information service,
- flight plan data transfer service,
- airspace management and air traffic flow management data transfer service and
- ATCC co-ordination data transfer service.

An overview of these services is given in Section 2.2 of [A202] and the way in which they are supported by networks in the current ATS environment is described in detail in Chapter 5 of [A201]. In Section 2.2.4 of [A202] a wide-ranging proposal is formulated and justified to the effect that *all of these services* should be supported by the target ATN in the ACCESS time frame. For the transition planning, object of this WP, it is necessary to assume a *subset of these services* to be supported by the initial ACCESS ATN.

3.2.2.2 The Services as Candidates for the Initial ACCESS ATN

In this section the services listed in the previous section are considered individually as candidates to be supported by the initial ACCESS ATN.

The **AMHS** has been specifically designed in the ATN SARPs to be the common system supporting all ATS message oriented services, giving it a wide area of potential application. The importance of message oriented services in the aeronautical context is beyond question. The existing aeronautical messaging service (AFTN, CIDIN) would be significantly improved through the introduction of AMHS during the initial ACCESS timeframe. AMHS presents a suitable long-term migration goal. For these reasons, **it is recommended** that the AMHS be supported by the Initial ACCESS ATN.

Radar Data Transfer is a well-established, volume intensive use of data networks which has central importance in the ATC environment. The transfer of non-standardised formats would not profit significantly from ATN support at the internet level due to the limited connectivity involved. The transfer of standardised formats among RMCDEs, however, could profit from ATN support at the internet level because of the high degree of connectivity and because the locations of RMCDEs are those which will be served by the ATN anyway. In this way, economies of scale could come about due to the intensive use of common infrastructure, and thus benefit all users of the ATN. This would be the case in spite of the additional protocol overheads with respect to current implementation techniques. However this is not a sufficient argument for this service to drive the development of the ATN and conversion from the current network situation to the ATN could be costly. Further, it is not likely that ATN SARPs will be defined for this service. For these reasons, **it is not recommended** that radar data transfer be assumed to be supported by the Initial ACCESS ATN.

The **Meteorological Services** are currently implemented as users of the message handling services AFTN/CIDIN ("OPMET applications") and would therefore indirectly be users of AMHS via AFTN/AMHS Gateways. The WMO networking environment is very extensive and its applications are not candidates for migration to the ATN. It is possible that a native use of the ATN by meteorological services might be defined in the future, e.g. using AIDC, but this is not likely within the migration time frame considered here. For these reasons, **it is not recommended** that meteorological services be assumed to be supported by the Initial ACCESS ATN, otherwise than through the use of AMHS. The detailed support of Meteorological Services by the AMHS is under study in the context of the SPACE Project, which is currently in progress as CEC TEN-T ATM Task FR/98/228, under the auspices of CEC DG VII.

The **Aeronautical Information Service** is currently implemented as a user of the message handling services AFTN/CIDIN and would therefore indirectly be a user of AMHS via AFTN/AMHS Gateways. Compared with other services, its data transfer requirements are not particularly demanding. The European AIS Database project, EAD, is currently in the call-for-proposals stage and its operation is planned for the year 2002. It is unlikely that common ATSO networking infrastructure will be used in its implementation, making it unclear whether a migration to the ATN internet might be attractive in the long-term or not. For these reasons, **it is not recommended** that the Aeronautical Information Service be assumed to be supported by the Initial ACCESS ATN, otherwise than through the use of AMHS. The detailed support of the Aeronautical Information Service by the AMHS is under study in the context of the SPACE Project.

The **Flight Plan Data Service** is currently implemented as a user of the message handling services AFTN/CIDIN and would therefore indirectly be a user of AMHS via AFTN/AMHS Gateways. A major source/sink of flight plans is CFMU. A migration of this service to be a native user of the ATN, e.g. using AIDC, would require a major implementation effort which does not appear feasible within the migration period being considered here. For these reasons, **it is not recommended** that the Flight Plan Data Service be assumed to be supported by the Initial ACCESS ATN, otherwise than through the use of AMHS. The detailed support of the Flight Plan Data Service by the AMHS is under study in the context of the SPACE Project.

Air Space Management and **Air Traffic Flow Management** Services are currently implemented on dedicated networks and could therefore lead to considerable cost savings through a migration to the ATN. However such a migration could only be justified if the ATN infrastructure already existed and it appears unrealistic to use these applications as "drivers" to establish the infrastructure itself. For these reasons, **it is not recommended** that Air Space Management and Air Traffic Flow Management Services be assumed to be supported by the Initial ACCESS ATN, otherwise than through the use of AMHS. The potential support of the Air Space Management and Air Traffic Flow Management Services by the AMHS is under study in the context of the SPACE Project.

ATCC co-ordination is currently implemented with OLDI/SYSCO protocols over point-to-point and subnetwork connections. It is planned to migrate the service to implementations of the AIDC SARPs over the ATN. However the possible benefits with respect to the current implementation to be gained through such a rapid migration are not highly significant and it would be difficult to justify the cost of taking this service to be one of the initial ATN applications in Europe. This would, of course, be much easier once the ATN infrastructure existed and only in this case, are advantages apparent. For these reasons, **it is not recommended** that ATCC co-ordination be assumed to be supported by the Initial ACCESS ATN.

It is possible that other ground services may come into being within the time frame up to the implementation of the Initial ACCESS ATN. However such services can be included in the categories discussed above, and the same arguments concerning their inclusion in or exclusion from the ATN environment would apply.

3.2.2.3 Summary of Services Selected for the Initial ACCESS ATN

The situation of ground services as "drivers" which stimulate and deliver requirements for the development of the ATN is quite different from that of air/ground services. Whereas the latter are dependent on the existence of mobile subnetworks and an appropriate ground ATN infrastructure for their proper implementation, this is not the case for ground services. These can be supported by a wide range of different types of ground network infrastructures, not necessarily ATN, as can be seen from their current implementations using non-ATN network infrastructures.

It is not simple to find arguments which might convince those responsible for designing and developing the individual ground services to migrate to the ATN: the advantages for each implementation, seen by itself, gained from a migration are not obvious. Whereas most would agree that, for reasons of cost and service quality, a situation in which a wide range of ground services and applications use a common European ATN infrastructure for data transmission is desirable, this is not necessarily true in the migration steps towards this goal: the benefits attainable in the long-term situation may not be available during migration. Migration can only by compelled by means of enforcing a long-term policy which has as its goal the widespread use of the ATN by different applications. Due to the independence of the organisations involved and the lack of a policy-enforcement organisation, this is not feasible in the current institutional ATN context.

The results of the analysis in the previous section is in keeping with this state of affairs. It is recommended that AMHS be the *only* ground service assumed to be supported directly by the initial ACCESS ATN. Although the other services could profit, in principle, from a migration to the ATN, the advantages to be gained may not be sufficient and may be attainable only if *all services* migrate. This is not considered to be realistic within the time frame up to the implementation of the initial ACCESS ATN, except by indirect use through the AMHS.

The situation with respect to the AMHS however is different from that of other existing services. This message handling service has been designed specifically with the ATN internet as the underlying network infrastructure in mind and AMHS Message Servers fit well into the category of ATN End Systems. In addition, it is obvious to those involved in engineering the Aeronautical Fixed Service that the existing networks, AFTN and CIDIN, are urgently in need of an upgrade and a long-term development path. Interfacing between the AMHS and these networks has been defined in SARPs and is making progress in a number of implementations.

On the other hand, from a technical point of view and in possible contradiction with the SARPs, it is not absolutely necessary that the AMHS be implemented "on top of" the ATN internet. Other (inter-) networks could also be used as transport infrastructures. Consider, for example, the existing implementation in Spain of an extensive message handling system according to the same base standards as AMHS for national ATS messaging. This system will be interfaced on the message handling level with the European AMHS. In fact, this independence of AMHS from the ATN internet could be considered as one of its strengths. However it can be assumed that the AMHS will be implemented concurrently with the ATN internet. If the connections among ATS Message Servers are implemented by means of the complete ATN protocol stack, even if the degree of meshing is low to begin with, migration to the initial and target ATN will be simple.

For the reasons discussed in this section, AMHS is considered in the ACCESS migration planning to be the only ground service being directly supported by the Initial ACCESS ATN. A Regional AMHS Implementation Plan will be therefore required. Each National AMHS Implementation Plan will decide whether the AMHS infrastructure deployed in each ATSO will be used by native users through ATS Message Servers, consistently with the Regional AMHS Implementation Plan.

Action S6	**To support the development of a Regional AMHS Implementation Plan.**	**ATSOs together (e.g., SPACE)**

Action S7	**To develop a National AMHS Implementation Plan with an optional direct use by "native users" through ATS Message Servers.**	**Each ATSO individually, or together (e.g., SPACE)**
Action S8	**To launch the deployment of the national AMHS infrastructure (as a result of action S7).**	**Each ATSO individually**
Action S9	**To deploy a national AMHS infrastructure with an optional direct use by "native users" through ATS Message Servers.**	**Each ATSO individually**
Action S10	**To interconnect national AMHS infrastructures in accordance with the Regional AMHS Implementation Plan.**	**ATSOs**
Action S11	**To deploy an AMHS interface with the AFTN network of non-European regions.**	**Some ATSOs**

3.3 Initial ACCESS ATN Infrastructure

3.3.1 Introduction

The initial ACCESS ATN infrastructure will result from the following elements:

- the requirements raised by the provision of the initial ACCESS ATN **services**, as described in the previous section,

- the constraints inherent to the overall ATS **context** (technical, economical, organisational) that will anyway impact the initial ACCESS ATN (i.e., no matter how or when the ATN will be deployed). An example is constituted by the current trends affecting the a/g aeronautical communication market (i.e., migration from ACARS to VDL Mode 2 for AOC purposes, ARINC offensive in Europe), which is not directly bound to the ATN development (although a synergy will certainly be beneficial to all parties implied by both the ATN and the a/g telecommunication deployments).

The objective of section 3.3 is therefore to describe a likely ATN infrastructure aimed at supporting the ATSC services identified in section 3.2 and to identify the actions required by the successful deployment of that infrastructure.

Section 3.3 is divided into several sub-sections, each sub-section presenting a specific part of the infrastructure:

1. ATN ground subnetworks (availability and coverage),

2. ATN air/ground subnetworks (availability and coverage, a/g router siting),

3. ATN routers (availability),

4. ATN internetwork: this sub-section aims at giving a comprehensive view of the initial ACCESS ATN internet, based on the elements developed in the previous sub-sections (ATN subnetworks) and on the proposition of a likely routing organisation and ATN routers siting.

5. ATN end systems or data link servers (availability and data link server siting),

6. ATC systems (i.e., FDPS, RDPS, CWPs, etc.): this sub-section presents the constraints raised by the necessary evolution of ATC systems in order to support the new operational ATN-based services,

7. Airborne systems (availability of airborne ATN systems, equipped fleet),

8. AMHS,

9. System management,

10. Security.

3.3.2 Ground Subnetworks

3.3.2.1 Scope of the Section

The strategy for the deployment of ground subnetworks is based on the inventory of existing infrastructure in [A201] and a judgement of its future development, together with the discussion of ACCESS subnetworks in [A204]. The strategy is subject to the constraints and requirements of the ACCESS target architecture as laid down in [A203] and [A209]. A brief overview of available network technologies is given together with a summary of current network integration among ATSOs.

This is followed by the presentation of a likely deployment scenario of ATN ground subnetworks for the initial ACCESS ATN and the identification of the actions that are required so that the existing or planned ATSO subnetwork infrastructure will be ready to support the initial ACCESS ATN ground subnetworks.

3.3.2.2 Network Technologies

The analysis of current infrastructure in [A201] and the discussion in [A204] have shown a current predominance of packet switching technologies in use and have demonstrated their suitability in support of ATN communications in the ACCESS area.

In modern implementations of the packet switching service, this service is usually just one of several services, such as frame relay and even ATM, which are made available in an integrated fashion by the same network access nodes. The protocols used internally in a closed network are not visible to its users and could involve frame relay, ATM and other proprietary protocols.

This means that the implementations of the packet switching service in individual networks does not, in itself, restrict the data transmission service to be packet switching. However this comes from the constraints of interworking.

The essential characteristic of frame relay which differentiates it from packet switching technologies is its simpler protocol structure which allows higher data rates above 64 kbps, typically 2 mbps and higher. For the interconnection of a pair or more of frame relay networks, interfaces standardised by industry forums are available. For example, the frame relay network-network-interface is similar to X.75 in the packet switching environment and can be considered to be equivalent to a pair of User-Network-Interfaces back-to-back. Interworking between frame relay and packet switching is also defined, making the implementation of a packet switching "shell" around a frame relay "core" possible.

For higher data rates and the integration of data streams with different characteristics, ATM is finding increasing acceptance. The integration of speech and data however is not a topic which should be discussed within the ATN context because the latter is a pure data network. The implementation of ATM networks is currently restricted to individual ATSOs and this is likely to remain so within the time frame of the Initial ACCESS ATN (exception: EGNOS, see below). Their interworking is possible by means of standardised network-to-network interfaces. An interface between ATM and frame relay is also defined. It is unlikely that a European-wide ATM service will be available for the implementation of the Initial ACCESS ATN.

An ATM network is foreseen for the connection of satellite ground stations within the scope of the EGNOS project (European Geostationary Navigation Overlay Service, a network adding value within the European Region to existing navigation satellite systems). However this will only serve the small number of ground station locations and, because of the safety requirements placed on the network, will not be available for the transport of other traffic such as ATN.

3.3.2.3 ATSO Integration Activities

The NSM-TF within EATCHIP has made considerable progress in defining and implementing a common network infrastructure based on nationally operated networks. This progress is likely to continue within the time frame up to the implementation of the Initial ACCESS ATN. The work is highly relevant to considerations of ground subnetwork deployment for the Initial ACCESS ATN.

This work (see also [A201] and [A204]) began because of the successful use made of a unified packet switching network in Germany and the Benelux countries. It is now the intention to agree on procedures and to implement a service connectivity (the EAN) across 7 European countries in a first phase.

The documents being produced by the NSM-TF consist of a formal Interconnection Agreement and a number of technical appendices describing the various transmission services to be provided, their realisation with interworking interfaces, organisational procedures, accounting and security procedures etc. The executive body managing the networks and services for the NSM-TF is a “Network Office”, the day-to-day activities being performed by a central help desk. The latter co-ordinates the network management activities which continue to be performed in a decentralised fashion in the individual States which are owners of the national networks being integrated. Associated with the central help desk is a central network management centre duplicated at two independent sites (Gatwick and Vienna). It is to be a central clearing facility, implemented on HP OpenView, for network information passed in both directions between the national management centres and the central management centre. Currently, no active management functions are planned for the central management centre. It is not intended that the help desk functions as a legal body for negotiations and other dealings with (potential) users (such as an ATN planning group) of the integrated services.

The work of the NSM-TF is well advanced and the migration of a number of applications on the EAN (currently planned: CIDIN, OLDI and CRCO using X.25 service) is foreseen for 1999. The services to be provided or in the planning stage are X.25 and its PAD derivatives, frame relay and ATM cell relay.

The following EAN implementation plan is foreseen:

- EAN target topology: 25 countries in Europe should be interconnected. The EAN architecture, which should define the various interconnections and the way they are used for inter-ATSOs traffic, is still to be finalised,
- EAN access technology: network access is accomplished using X.25 interfaces with access line speeds around 64kps. Further evolutions may include other access types and/or line speeds (e.g., frame relay, 2 mbps access line speed, etc.),
- EAN deployment schedule:
  - 1999: initial EAN encompassing 7 ATSOs (Austria, Czech Republic, Eurocontrol, France, Germany, Spain, UK), providing X.25 connectivity to experimental user applications. Network management, operational procedures, organisational issues should be refined based on the experience gained in that period,
  - 2000 onwards: the initial network is operational. EAN services are provided to new user applications. Progressive extension of the network to other European countries.

3.3.2.4 Initial ACCESS ATN Ground Subnetworks

3.3.2.4.1 ATN Ground Subnetworks Used for Transnational Communications

It is not realistic for cost, organisational and political reasons to assume that a *new* and *dedicated* network infrastructure will be implemented in Europe to support the ATN transnational communications. It is conversely expected that ATN ground subnetworks will be mainly supported by *existing* infrastructures (either for national or transnational communications).

The availability of a European-wide connectivity such as the one offered by the EAN will therefore be particularly beneficial for the initial ATN deployment. The packet switching service being defined and implemented within that scope is sufficient in geographical extent and other service parameters to be used as the base subnetwork supporting the transnational ATN communications on the ground. It is already partly available and will most likely be available in the time frame of the Initial ACCESS ATN. The ATN will be one of the users of the integrated network: other non-ATN applications will use the integrated network, and, in particular, the packet switching service in parallel. In general, nodes of the integrated network will be at the same locations as the ATN Routers and End Systems.

The usage of the packet switching service does not mean that the service is implemented within the common subnetwork only with packet switching technologies. Other technologies such as frame relay and ATM could be employed there, for example in the core of the network. The requirement for the packet switching interface comes from the constraints introduced by the need to interconnect different national subnetworks.

One principal limitation of packet switching techniques is the restriction of the data rates to the order of 64 kbps. This restriction is not due to the throughput capabilities of the networks themselves but to the packet switching user interface. In general, this data rate will be sufficient for the use made of it by the Initial ATN under the assumption of the services to be provided by the Initial ATN. Should this not be true in isolated cases, additional physical access connections could be established between network nodes and ATN Routers / End Systems.

In conclusion, it is expected that the WAN infrastructure used by the initial ACCESS ATN ground subnetworks for transnational communications will be based on the European ATSO switching Network (the EAN) as defined by the Network Integration Group (i.e. made of the interconnection of the different national ATSOs' packet switching networks).

Moreover it is likely that, around 2005, most ATSOs of the ACCESS area will be part of the EAN and will provide at least one EAN entry point per ATSO (several entry points may be provided, e.g. one per ACC), backbone BISs being physically attached to EAN entry points for the realisation of the initial ACCESS ATN backbone[5].

The deployment of the ATN backbone connections in Europe is therefore related to the EAN deployment, as ideally that network shall offer the required X.25-level connectivity between any pair of backbone BISs of the ACCESS area (no matter how that connectivity is physically achieved or how the network is internally architectured). However, there is no requirement for a strict co-ordination of the deployment of EAN access or switching nodes and the deployment of ATN systems, assuming a subset of the European network already provides the required connectivity.[6]

3.3.2.4.2 ATN Ground Subnetworks Used for National Communications

As for ATN transnational ground subnetworks, ATN ground subnetworks supporting national communications in the ACCESS area will rather be supported by the existing networking infrastructures of each individual ATSO rather than new, dedicated infrastructures. They will be deployed based on national requirements using ground network infrastructures under the responsibility of individual ATSOs (they can be operated by the ATSOs themselves or supplied by telecomm providers). These infrastructures will be made of:

- LANs for local or metropolitan connectivity,
- WAN links supported by the various national packet switching networks (e.g., RENAR, REDAN,

[5] As presented in [A209], specific (temporary) solutions can be envisioned for the connection of ATN BISs located in countries not covered by the EAN, should that case be raised (e.g., for Italy, Portugal or Ireland). Distant access to an entry point located in another country could be set up to that purpose.

[6] Economic and administration reasons may however justify a co-ordinated deployment scenario where ATN nodes and EAN access nodes are adequately located.

CAPSIN, etc.).

Since national planning is performed by each individual ATSO, no recommendation can be made here on this issue.

3.3.2.5 Proposed Actions

The effective implementation of the ATN ground subnetworks will be conditioned by the result of the actions or tasks presented hereafter.

Action G1	**To define the common ground subnetwork X.25 interconnection scheme and the related technical requirements (throughput, transit time, etc.).**	**All ATSOs directly connected to the EAN**
Action G2	**To ensure the ATN deployment is compatible with the EAN deployment (geographic coverage in the ACCESS area, schedules, access requirements, etc.).**	**All ATSOs**

3.3.3 Air-Ground Subnetworks

3.3.3.1 General

Two types of a/g subnetworks are envisioned for the initial ACCESS ATN: VDL Mode 2 and AMSS subnetworks (other possible a/g subnetworks like Mode S or STDMA are not considered for the initial ACCESS ATN).

Concerning VDL Mode 2 subnetworks, two strategies[7] were envisioned in [A220A] with respect to their deployment in the ACCESS area:

1. the first one is CSP-driven, assuming airlines will require from their CSPs an upgrade of their data link system to meet their increasing AOC needs, specifically in the core area where ACARS capacity limitations are most felt.

2. the second one is ATSO-driven, resulting from a commitment of ATSOs to deploy VDL Mode 2 with an appropriate European co-ordination, in order to support their ATSC applications and possibly some AOC flows.

According to the conclusion of [A220A], it is likely that the initial deployment of VDL Mode 2 in Europe will be driven by CSPs for meeting AOC requirements (CSP-driven strategy) where they are most critical, i.e. in the European core area. The general deployment of VDL Mode 2 by ATSOs does not look like realistic in the short term.

The dominant position of SITA and the possible extension of ARINC presence on the European market are two key factors for VDL Mode 2 deployment scenarios.

For AMSS, [A220A] assumes that AMSS is unlikely to be the preferred air/ground subnetwork in the core European area since other subnetworks (i.e., mainly VDL Mode 2) 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 oceanic regions (e.g., NAT), the Mediterranean or Eastern Europe. It may also provide a backup capability to support the preferred air/ground subnetworks under failure conditions.

3.3.3.2 Initial ACCESS ATN VDL Mode 2 Subnetworks

3.3.3.2.1 VDL Mode 2 Subnetworks Deployment

[A220A] proposes a likely deployment scenario for VDL Mode 2 in Europe. This section only summarises that scenario up to the Initial ACCESS ATN for the VDL Mode 2 coverage. It therefore focuses on the availability (and the deployment) of VDL ground stations, whereas it does not address the way that infrastructure will be used by the ACCESS ATN (this aspect is developed in the following section).

Note that the maps of that section only aim at providing a VDL coverage indication and are not intented to be geographically precise.

⌦ *first step (1999-2001):*

It is reasonable to assume that the *first step* (from 1999 to 2001) of the deployment will be for a CSP to use the 136.975 channel as a general purpose (base) frequency providing general coverage of both

[7] Another strategy would consist in a closer co-operation between ATSOs and CSPs, both technical and commercial, e.g. by setting up a non-profit body that would be owned and regulated equally by CSPs and ATSOs and that would operate a VDL Mode 2 subnetwork covering the ACCESS geographical area. However the likeliness of such a scenario is not ascertained to date.

airport, TMA and en-route service volume and to deploy the first VDL ground stations in those airports where the ACARS capacity limitations are most felt. This would imply the deployment of VDL ground stations in each of the main airports where SITA currently uses its new ACARS frequency (i.e. 136.900 MHz) to provide additional terminal traffic dedicated capacity.

Although the foreseen VDL Mode 2 coverage for that first step is built from the ACARS VHF situation in Europe where currently SITA has a dominant position, it can be assumed that an equivalent VDL Mode 2 coverage will be achieved by ARINC (using the same 136.975 channel), as that coverage (i.e., more or less the core area) is drawn by mere business considerations.

The initial VDL Mode 2 deployment will therefore results in the coverage of the core area around 2002 by two different CSPs competing for the same airspaces and using the same frequency. At this stage, VDL Mode 2 networks will be mainly used for AOC/ACARS traffic and some pre-operational ATSC traffic.

That coverage can be deduced from the following list of the airports:

Country	*First airports to be equipped with a VDL Mode 2 GRS*
United Kingdom	Manchester London Heathrow London Gatwick
France	Paris CDG Paris Orly Nice
Germany	Dusseldorf Frankfurt Hamburg Munich Berlin
Switzerland	Zurich Geneva
Netherlands	Amsterdam
Belgium	Brussels
Spain	Madrid
Italy	Rome

The resulting initial coverage, at an altitude of 20000 feet, is represented in Figure 9.

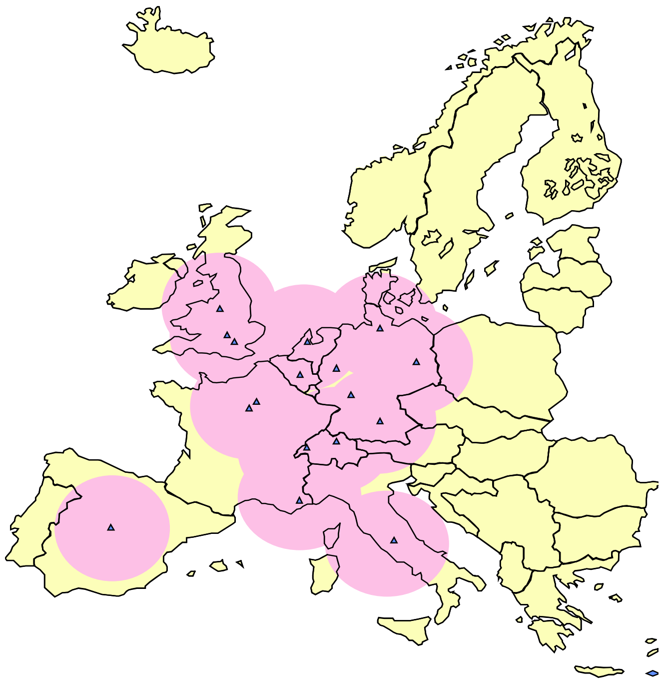


Figure 9: VDL Mode 2 Coverage in 2001

⌦ *second step (2001-2003):*

In a *second step* (2001-2003), while a second channel is not available for CSPs, it seems reasonable to assume that CSPs would extend the availability of their base VDL mode 2 coverage to cover other large airports and a larger European en-route airspace. It is assumed that this extended base coverage would not be very different from the coverage of the alternate en-route ACARS VHF infrastructure that has been deployed by SITA to circumvent the ACARS shortage experienced for en-route communications in the European Region.

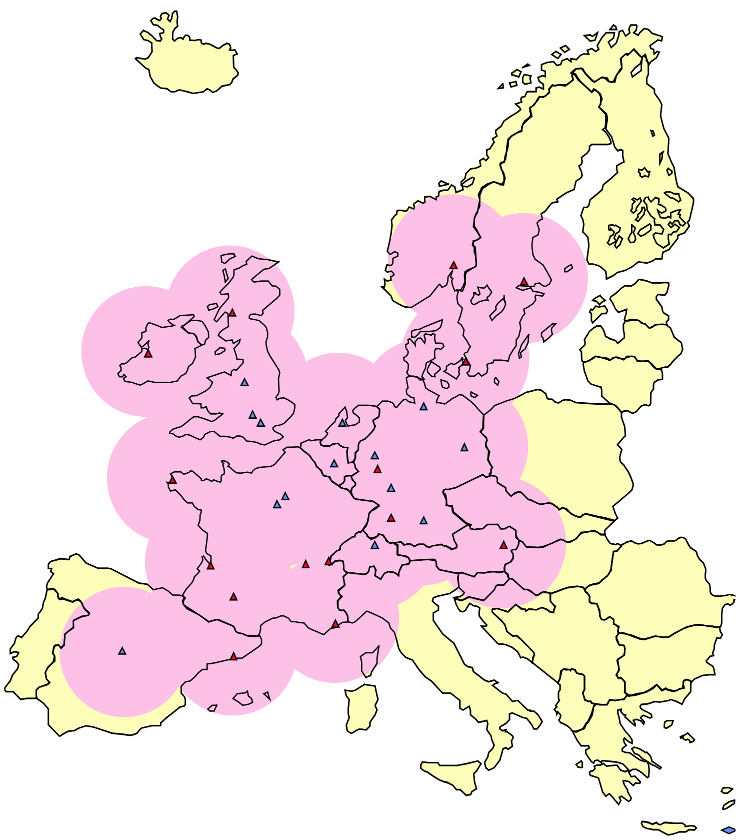
The same 136.975 MHz frequency will still be used by the CSPs in that period.

This would lead to the deployment of additional VDL Mode 2 VGS at the new locations presented in the next table.

In that period, VDL Mode 2 networks will continue to be mainly used for AOC/ACARS traffic, while some operational ATSC traffic will start to be carried over certain VDL Mode 2 subnetworks (due to the implementation of "local" ATC services).

Country	*Locations for the second step of the VDL Mode 2 deployment*
United Kingdom	Glasgow
France	Brest Bordeaux Toulouse Lyon
Germany	Stuttgart Cologne
Spain	Barcelona
Ireland	Shannon
Norway	Oslo
Sweden	Stockholm
Denmark	Copenhagen
Austria	Vienna

The resulting coverage, at an altitude of 20000 feet, is represented in Figure 10.



EMBED

Figure 10: VDL Mode 2 Coverage in 2003

⌦ *third step (2003-2005):*

The geographical extension of the CSP base VDL Mode 2 coverage may then continue with the coverage of other airports and of other European airspace depending on the VHF ACARS shortage and possibly on the airline requirements which may be willing to develop new binary-oriented AOC applications requiring a generalisation of the VDL Mode 2 coverage.

In that period, it is also likely that CSPs reuse one of their own previously ACARS frequencies for VDL Mode 2 in some locations, where this would help solve AOC/ACARS shortages (e.g., for SITA this would consist in replacing their VHF RGSs operating on the 136.900 MHz channel by VDL VGSs operating on the same frequency). This would result in the possible use of several VDL Mode 2 frequencies (up to 3) in Europe.

This *third step* (2003-2005) would then primarily be marked by the deployment of airport/TMA dedicated VDL Mode 2 VGS in the main airports, and operating on a new channel. The list of airport equipped with this new VGS is assumed to be the same as the list of airports that where first equipped with VDL Mode 2 in step 1.

From this period, operational ATSC traffic will start to represent an increasing part of the overall traffic carried over VDL Mode 2 networks.

The resulting coverage for the initial ACCESS ATN is depicted in Figure 11.

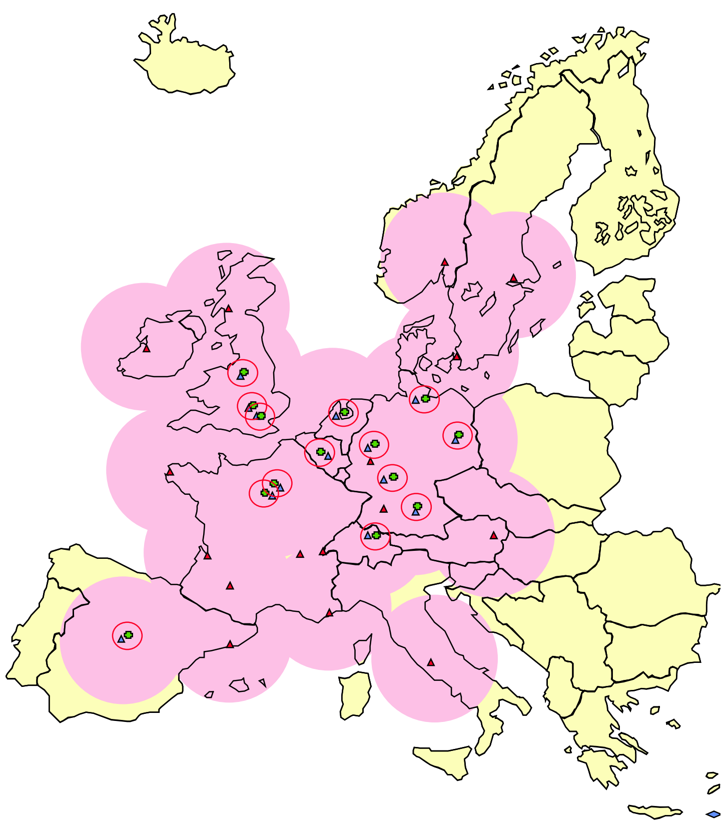


Figure 11: VDL Mode 2 Coverage of the Initial ACCESS ATN

3.3.3.2.2 VDL Mode 2 Access to the ATN Internet

Assuming the VDL Mode 2 infrastructure will be deployed as exposed in the previous section, this section addresses the way VDL Mode 2 infrastructures will be accessed by the ACCESS ATN internet[8].

This results in the proposition of a likely ATN BIS siting for handling VDL Mode 2 subnetworks. The technical elements that can impact that topology are essentially performance considerations, which are related to handoff management. The resulting topology for the initial ACCESS ATN will probably be based on a solution with a minimum of one central a/g BIS per ATSO (which would be then connected to all VDL Mode 2 VGSs of the country) and a few additional a/g BISs in some locations where ATN traffic will justify it (e.g., in main airports).

Assuming ATSOs will keep some control on the way VDL Mode 2 a/g BISs will be deployed and will be accessed by the ATN internet (see the related discussion in section 3.3.3.2.3), the following deployment scenario is foreseen:

1. 1999-2003: VDL Mode 2 BISs are used in the context of experimental or pre-operational data link projects such as Eolia/ProATN, Petal II or EuroVDL. As a limited ATN traffic is carried over VDL Mode 2 subnetworks, the topology in 2003 mainly results from those initial projects.

2. From 2003 onwards: the progressive development of the ATN traffic calls for a coherent deployment of the ATN internet. The resulting siting of operational VDL Mode 2 a/g BISs is initially based on one central a/g BIS per ATSO; additional a/g BISs are then deployed for handling congested areas first (i.e., in some main airports/TMAs initially). This evolution will proceed with the deployment of new a/g BISs in ACCs and in airports as dictated by the ATN traffic increase.

Figure 12 represents a possible VDL Mode 2 BIS siting for the initial ACCESS ATN.

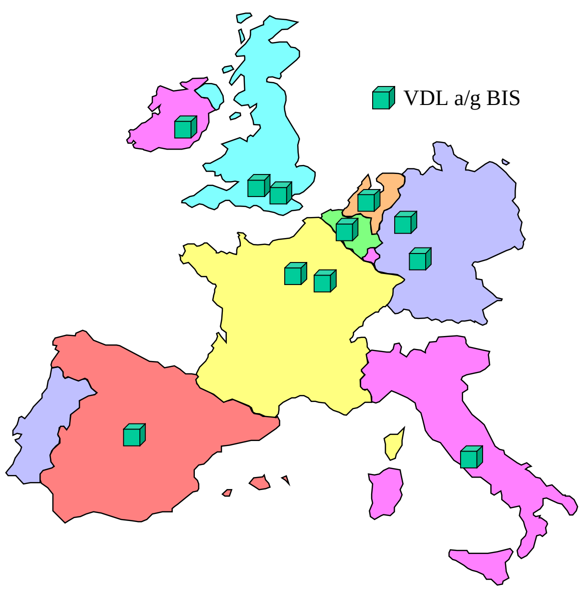


Figure 12: VDL Mode 2 a/g BISs in the Initial ACCESS ATN

[8] Note that this issue could also have been presented in the section of the document presenting the initial ACCESS internet.

3.3.3.2.3 VDL Mode 2 Subnetworks Deployment Issues

<u>ACCESS areas not covered by VDL Mode 2</u>

The envisioned VDL Mode 2 deployment scenario may leave apart some ACCESS areas which are not supposed to be covered in 2005 and maybe even after 2005 (e.g., Portugal, Spain, Italy). This situation would certainly result from mere business considerations (i.e., CSPs did not see the need to extend their coverage over those areas).

<u>VDL Mode 2 a/g BIS siting and operation</u>

The VDL Mode 2 subnetwork coverage for the initial ACCESS can be reasonably estimated. Conversely, the VDL Mode 2 BIS siting of the initial ACCESS ATN as presented in the previous figure is questionable because there are many possible architectures having different institutional and organisational characteristics. For example, the a/g BISs connected to VDL Mode 2 VGSs can be owned and/or operated by ATSOs or CSPs: the deployment of a/g BISs and the resulting architecture can vary depending on who owns and/or operates what.

The scenario by which ATSOs own and operate VDL Mode 2 a/g BISs is thought to be the most likely because it would certainly make it easier for ATSOs to control and ensure the strict QoS requirements of ATSC traffic.

However, assuming the VDL Mode 2 coverage will be provided by CSPs, diverse scenarios could be envisioned for the VDL Mode 2 topology of the initial ACCESS ATN:

- CSPs sell a “global ATN service” to ATSOs for ATSC, using their own ground networks: the VDL Mode 2 subnetworks are operated by the CSP, internals are not necessarily known and made visible to ATSOs (i.e., a single BIS per CSP could be connected to the backbone and service all connections to/from the VDL Mode 2 subnetworks of that CSP). ATN connectivity could therefore be provided at the European ATSO backbone level, although this scheme probably would not be optimal in technical terms (longer network paths).

- CSPs sell “individual VDL Mode 2 a/g segments including the a/g BISs”: VDL Mode 2 ground station and related a/g BISs are operated by the CSPs. Different technical architectures are possible (an ATN a/g BISs per ground station, ATN BISs servicing clusters of ground stations, etc.).

- CSPs sell “individual VDL Mode 2 a/g segments, a/g BISs are operated by ATSOs”: VDL Mode 2 ground stations are operated by the CSPs whereas VDL Mode 2 a/g BISs are operated by ATSOs. Different technical architectures are possible (an ATN a/g BISs per ground station, ATN BISs servicing clusters of ground stations, etc.).

If VDL Mode 2 a/g BISs handle clusters of ground stations, their siting for each ATSO is quite variable, making harder any attempt to specify now a likely topology for 2005.

<u>Institutional and economical aspects</u>

In addition to the technical issues surrounding the deployment of VDL Mode 2 subnetworks, many institutional and economical issues can impact such a deployment (e.g., SLAs with CSPs).

3.3.3.2.4 Proposed Actions

The main identified actions or tasks that may condition the VDL Mode 2 subnetworks deployment for the initial ACCESS ATN are summarised hereafter.

Action V1	**To define a VDL Mode 2 profile for ATN systems and to validate a VDL Mode 2 subnetworks' architecture (a/g BIS siting, interconnection scheme with CSPs, etc.)**	**ATSOs with CSPs**
Action V2	**To make VDL Mode 2 / ATN trials with aircraft**	**ATSOs with CSPs and Airlines**
Action V3	**To ensure that CSPs' VDL Mode 2 deployment strategy and activities are compliant with the ATN implementation plan**	**ATSOs**
Action V4	**To define and contract SLAs (both commercial and technical) for VDL Mode 2 connectivity provided by CSPs**	**ATSOs with CSPs (and Airlines with CSPs)**

3.3.3.3 Initial ACCESS ATN AMSS Subnetworks

3.3.3.3.1 AMSS Subnetworks Deployment

AMSS will not be the preferred a/g subnetwork in Europe for various reasons. However, its use is envisaged in fringe areas (especially in oceanic regions like the NAT area) and/or for backup purposes over the European core area.

It is therefore assumed that the initial ACCESS ATN may make use of AMSS subnetworks for the following possible needs:

- AMSS is required for AOC needs (e.g., in the NAT area),

- AMSS is required for ATSC needs, **on a local basis** (i.e., depending on individual ATSOs requirements). This would typically result in the use of the AMSS as a primary communication medium by ATSOs in charge of oceanic regions (e.g., for handling AMSS-equipped long haul aircraft in the NAT area).

- AMSS is used for backup purposes over the European core area: the ground ATN will therefore provide an AMSS connectivity, the effective use of this capability still depending on the equipment level of aircraft (which is another issue).

Hence the AMSS deployment resulting from such needs is thought to be based on one of the following scenarios:

1. CSPs provide the AMSS subnetworks with AMSS-connected a/g BISs: although this scenario is able to fulfil both AOC and ATSC needs, it is essentially driven, at least initially, by AOC needs.

2. ATSOs using AMSS as a primary communication medium for ATS applications (i.e., ATSOs controlling oceanic areas like UK, Portugal or Ireland) do not want to totally rely on CSPs for the provision of AMSS connectivity. They operate their own AMSS a/g BISs and they may provide that connectivity to other ATSOs according to specific bilateral agreements.

3. ATSOs are more “active” with respect to AMSS subnetworks. They intend to make use of AMSS

subnetworks either as a primary or a back-up medium and they do not want to totally rely on CSPs for the provision of AMSS services. A consortium entity made of ATSOs, AOs and CSPs is created and entrusted the provision of AMSS subnetworks in Europe. This scenario is adapted to both ATSC and AOC needs but its likeliness highly depends on commitments and co-ordinations that are not verified to date.

It is difficult to rate the likeliness of those scenarios at that stage of the study. However the second scenario appears to be a likely one because it is directly driven by local operational needs implying a limited number of actors (i.e., the directly interested ATSOs). This scenario could be realised for the NAT area and, more generally, for fringe areas with a limited VDL Mode 2 coverage.

The resulting AMSS subnetwork topology would certainly look like the complete interconnectivity scenario developed in [A220A]: each involved ATSO (namely, Portugal, UK and Ireland) would have an a/g BIS connected to the various satellite service providers' terrestrial networks[9] for getting the required connectivity to GESs supplying the AORE satellite coverage (i.e., North Atlantic East). Appropriate SLAs should be established between the involved ATSOs[10] and the various satellite providers. Figure 13 depicts such a scenario. It should be noted that airlines have contracts with CSPs to meet their own requirements (e.g., APC, cabin telephone, AOC data communications) and this will affect their preferences for the provision of ATS data.

[9]Those satellite service providers (Skyphone, Skyways, Satellite Aircom) are all telecommunication providers selling the satellite service provided by Inmarsat.

[10] These ATSOs could in turn provide their AMSS connectivity to other ATSOs via specific bilateral agreements.

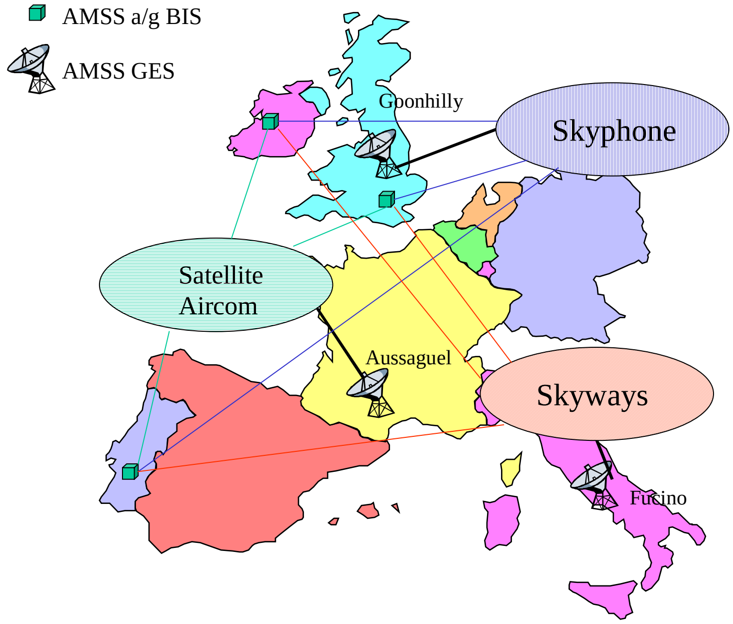


Figure 13: AMSS Subnetworks in the Initial ACCESS ATN

3.3.3.3.2 AMSS Subnetworks Deployment Issues

<u>Use of AMSS by the European ATN</u>

AMSS is by itself an open issue for the initial ACCESS ATN deployment, as there is no clearly established strategy regarding the way it will be used. Its use as a back-up communication means in the core area is an example of pending question.

<u>Institutional and economical aspects</u>

Assuming AMSS subnetworks will be effectively used, many institutional and economical issues can impact such a deployment (e.g., SLAs with AMSS providers).

<u>Possible use of future LEO/MEO offers</u>

The use of AMSS subnetworks is hindered by the relatively high charges currently invoiced for the use of Inmarsat-based satellite communications. 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. Although they aim at supporting a broad range of applications, especially in the public mobile telephony field, they could emerge as new competitive candidates for supporting satellite-based ATN subnetworks, provided their suitability for ATSC safety critical communications is verified.

3.3.3.3.3 Proposed Actions

The main identified actions or tasks that may condition the AMSS subnetworks deployment for the initial ACCESS ATN are summarised hereafter.

Action AMSS1	**To clarify whether AMSS will be used or not in Europe (and possibly to which purpose)**	**ATSOs & Airlines (together)**
Action AMSS2	**To define an AMSS profile for ATN systems and to validate an AMSS subnetworks' architecture (e.g., a/g BIS siting, interconnection scheme with providers)**	**Involved ATSOs**
Action AMSS3	**To make AMSS trials with aircraft**	**Involved ATSOs with CSPs** **(and Airlines with CSPs)**
Action AMSS4	**To define and contract SLAs (both commercial and technical) for AMSS connectivity provided by satellite service providers**	**Involved ATSOs with CSPs** **(and Airlines with CSPs)**
Action AMSS5	**To follow the satcom market evolutions (e.g., new LEO/MEO offers) in relation with ATSC needs**	**Some ATSOs**

3.3.4 ATN Air/Ground End Systems and Data Link Servers

3.3.4.1 What is an "ATN Data Link Server"

The introduction of the data link in the ATM environment assumes a totally new approach of ATC centres. The **concept** of a new system dedicated to support data link services (the "data link server") is being studied in Europe. A data link server is a ground communication management unit responsible for the air-ground data link communications with the aircraft. This system is configured by each ATSO to support one or several communication technologies appropriate for the provided operational services: ATN, Mode-S, ACARS, etc.

An ATN data link server is a ground system hosting an ATN a/g ES. The ATN ESs provide the ATN "communication" service at the application level, i.e. the CM, ADS, CPDLC and FIS communication services. In addition, the ATN data link server carries out the processing needed to provide the "operational" service, e.g. DLIC, CIC, ACM, etc… This processing is identified as the "Layer S" (Layer Service) in the EOLIA project.

In addition to support the ATN application protocols and services, the role of the data link server is to interface the ATN-equipped aircraft or remote ground ATC centres with the local ground ATC systems, namely the Flight Data Processing System (in en-route ATSUs), the Controller Working Positions (en-route and/or approach) and the Radar Data Processing System.

An ATN data link server is locally interconnected – through an Ethernet or FDDI LAN - with an ATN Router on which it relies for the message routing.

The EURO AG-DL project supported by EUROCONTROL, France, Germany and U.K. is currently conducting a feasibility assessment of a data link server and developing the common specifications of such a system. European ATSOs will then undertake the development of experimental data link servers integrated in their national ATC environment.

The assumption is made here that the architecture of the initial ACCESS ATN will be based on ATN data link servers for ATSC a/g services. This does not mean that a separate dedicated system must be developed. Some ATSOs could chose to develop a stand-alone ground data link server system, whereas other may prefer to integrate the functions of the server into existing ATC systems.

3.3.4.2 Functions of the ATN Data Link Server

Concrete examples of the functions required to be performed by the ATN data link server to provide the initial ACCESS services are exposed hereafter:

- **DLIC.** The ATN data link server operates the CM protocol with the aircraft. It stores and disseminates to the ground applications the addressing information (name, version number and ATN addresses of airborne applications) received from the aircraft. The server returns to the aircraft the addressing information of the ground applications supported by the local ATSU and of the national FIS server. Based on information sent by the FDPS, it takes the initiative to trigger a CM-contact with the next ATSUs either through air-ground or ground data link exchanges.

- **DCL**. Upon receipt of a Departure Clearance request from the pilot, the ATN data link server forwards the request to the Departure controller. The exchange is either local (LAN-based) to the ATSU when the server is installed in the approach ATSU or distributed (WAN-based) when the server is installed in the en-route ATSU. An exchange with the FDPS in the en-route ATSU for processing the departure clearance is also required.

- **CIC/ACM**. The data-link server need to know in real time which CWP is controlling each aircraft in order to forward the messages to the relevant controller. The complexity of this function depends on whether the server is co-located with the CWPs (i.e. the server is in the en-route ATSU or the approach ATSU) or not (the server in the en-route ATSU forwards the message to CWPs in the approach ATSU).

– **D-FIS/ATIS**. The ATN data link server operates the FIS protocol with the aircraft. It maintains the ATIS database updated with information transferred from the airport of one or several ATSOs. A dedicated national server per ATSO is currently envisioned for providing ATIS services. A sensitive issue will be the performance capability of the FIS server in terms of maximum number of aircraft supported.

3.3.4.3 Location of the ATN Data Link Servers

The location of the ATN data link servers in the ACCESS area is defined from the regional and national ACCESS implementation plans defined earlier.

In theory, ATN End Systems should be installed close to the end users (systems or controllers) in order to guarantee the service end-to-end integrity and availability provided by the ATN and to avoid to implement above the ATN applications a message routing function. Therefore, an ATN data link server should be installed in en-route ATSUs (en-route controllers), approach ATSUs (departure/arrival controllers) and airports (tower and ground controllers).

In practice, it is not clear that ATSOs will install ATN ISs and ESs in approach ATSUs and in airports in the Initial ACCESS ATN. The choice will be driven by the will of the ATSO to provide data link to the approach/tower/ground controllers, by the technical characteristics of the ATSO's ATC environment and of course by financial aspects.

The two possible implementations (illustrated in the Figure 14) are the following:

1. Several ATN servers are installed (one per en-route ATSU, one per approach ATSU and one per airport or one for both airport and approach),

2. A single ATN server installed in every en-route ATSU communicates with all en-route CWPs and the CWPs of the approach ATSUs/TMAs associated with the corresponding en-route ATSU.

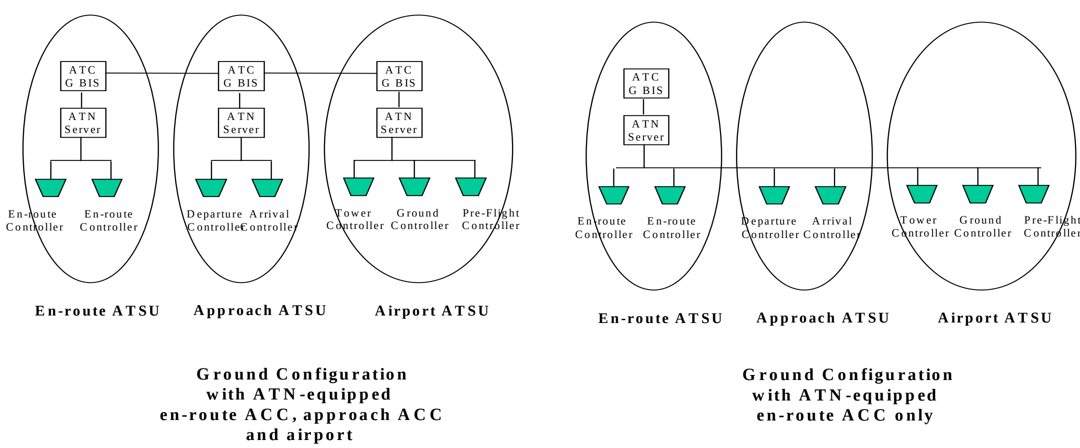


Figure 14: Alternatives for Implementing ATN Servers in ACCs

The regional ACCESS implementation plan recommends that ATN data link servers be located at least in the following en-route ATSUs:

– **A data link server in all ACCESS continental en-route ATSUs** (i.e. 25 ESs in the ACCESS area) including the CPDLC and ADS applications to support the ATN communication requirements of the CM, DLIC, ACM and CIC services and, optionally, the FLIPCY and DSC services.

- **A data link server in the ACCESS oceanic en-route ATSUs** (i.e. 3 ESs in the ACCESS area) including the CPDLC and ADS applications to support the ATN communication requirements of the DSC and APR services in addition to the services of a continental en-route ATSU.

- **A FIS/ATIS server per country or set of countries** (i.e. 8 ESs in the ACCESS area as maximum) to support the ATN communication requirements of the ATIS service. The DLIC service is not supported by this server: the CM application of any ATSU will return the address of the FIS application for the concerned country.

Each national ACCESS implementation plan will define – if required - the location of ATN data link servers in the approach ATSUs. In 2005, only the major TMAs in the ACCESS area could be ATN-equipped. For those TMAs, the national ACCESS implementation plan indicates whether a data link server is installed in the approach ATSU or whether the en-route ATN servers also support ATN communications on behalf of the approach ATSU.

- **Optionally, a data link server in the ACCESS approach ATSUs covering the major airports** (i.e. 10 ESs in the ACCESS area) including the CM and CPDLC applications to support the ATN communication requirements of the DLIC, ACM, CIC or/and DCL services.

Figure 15 represents a siting of ATN data link servers envisaged for the initial ACCESS ATN.

The en-route ATSUs of the ACCESS area are the following:

- Belgium: Brussels,
- Eurocontrol: Maastricht,
- France: Bordeaux, Brest, Reims, Aix, Athis-Mons,
- Germany: Berlin, Bremen, Dusseldorf, Frankfort, Karlsruhe, Munich,
- Ireland: Shannon,
- Italy: Brindisi, Milan, Rome, Padua,
- Netherlands: Amsterdam, Nieuw Milligen,
- Portugal: Lisbon,
- Spain: Barcelona, Canarias, Madrid, Seville,
- United Kingdom: London, Manchester, Scottish.

The list of approach ATSUs where a data link server could be implemented corresponds:

- to the airports of the ACCESS area with more than 700 aircraft movements per day : London-Heathrow, Frankfurt am Main, Paris-Orly, Paris-CDG, Amsterdam-Schipol, Madrid, Brussels, and
- those with more than 500 aircraft movements per day: Munich, Palma de Mallorca, London-Gatwick, Rome-Fiumicino, Dusseldorf, Manchester, Barcelona, Bonn and Milan-Linate).

Approach ATSUs are not all represented in the figure.

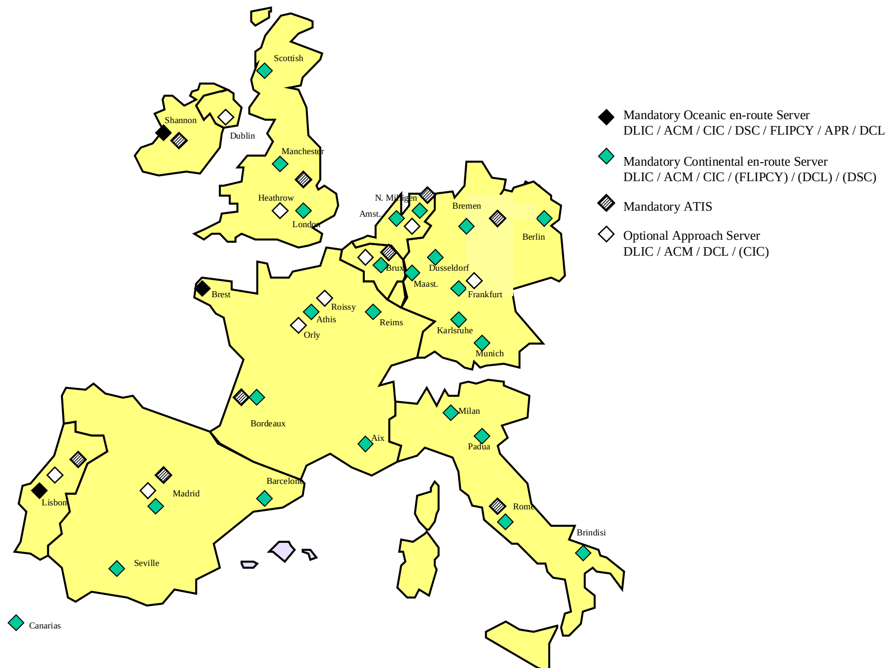


Figure 15: Location of ATN servers in the Initial ACCESS ATN

3.3.4.4 ATN Data Link Server Availability

An ATN data link server is a system providing the communication services of the ATN End Systems and the operational services of the "Layer S". Such a system is supposed to be certified as part of the air-ground segment to be allowed to be used operationally. However, the nature of the certification required for the ground systems still need to be specified.

So far, in Europe, only experimental ATN ESs are operated through European programs (ES ProATN) or programs launched by states or organisation (ES CHARME in France, TES in Eurocontol). TES is being used by Italy (SICTA), Germany (DFS), UK (NATS), Eurocontrol (Brétigny) and the FITAMS project (Flight Trials of ATN / Mode S Subnetwork). However, these ESs need to be upgraded to have the chance to be integrated in an operational ATC centre.

EOLIA is the only known program having developed a Layer S compatible with the ODIAC specifications. The EOLIA platform will be used for the PETAL-II trials. France is being developing a pre-operational ATN data link server integrated in the CAUTRA ATC system. In the scope of the EURO-AGDL project, other ATN servers will very likely be developed in Europe.

ATNSI, via the ACI consortium, is announcing a SARPs-compliant certified End System for 1999. ATNSI has no plan to develop software for data link services (Layer S).

In any case, ATN data link servers will have to be integrated in the systems management scheme of each organisation. On-line fault reporting, remote configuration and performance monitoring are examples of usual system management functions that ATSOs might want to use in order to manage their ATN data link servers. The choice of both protocols and tools supporting these functions is left to each ATSO since the involved system management exchanges are limited to the ATSO's organisation domain. In addition, some management information related to the ATN ESs will have to be made available by ATSOs to other ATSOs or airlines. ICAO SARPs provide to that purpose recommendations for the choice of inter-domain system management protocols as well as for the definition of managed objects made available externally. As a consequence, any ATSO program to develop and integrate data link servers in the operational ATC environment must include a dedicated task pertaining to system management.

Hence a likely deployment scenario is as follows:

- From 1998 to 2001: use of the experimental data link servers (e.g.EOLIA/ProATN),
- In 2001, experimentation in a real ATC environment of the PETAL-II server in the Maastricht UAC Centre with the American Airline aircraft,
- 2001-2005, deployment of national ATN data link servers in the ACCESS area based on commercial products (e.g., ATNSI and ACI software, upgraded ATN/EOLIA or Euro-AGDL systems, etc.).

3.3.4.5 Proposed Actions

Action DLS1	**To validate the concept of ATN data link server and enable further evaluation at the ACCESS area scale through European data link programmes**	**All ATSOs (in close coordination with EuroAGDL)**
Action DLS2	**To define and integrate ATN data link servers' system management capabilities for both intra- and inter-domain management**	**Each ATSO**
Action DLS3	**To follow ATN ES product (e.g., ProATN, ATNSI/ACI) development to ensure their availability for use in data link servers**	**ATSOs**
Action DLS4	**To harmonise the developments of ATN data link servers throughout Europe and plan their operational integration**	**All ATSOs (together)**
Action DLS5	**To deploy data link servers**	**Each ATSO individually**
Action DLS6	**To decide on the implementation of additional ATN data link servers (e.g., in approach ATSUs) in the frameof the National Implementation Plan**	**Each ATSO individually**

3.3.5 ATC Systems

3.3.5.1 General

The provision of ATN data link services is not limited to the deployment of ATN End Systems and routers. The deployment demands also that some of the current ATC systems in the ATN-equipped ATSU be customised for data-link.

The functional model of a typical ACCESS ATSU is illustrated in Figure 16. It assumes that the following ATC systems are at least implemented in the ATSU:

- the **Flight Data Processing System** (FDPS) provides in real-time the en-route and approach controllers with the information related to the aircraft they may be interested in. The FDPS is also involved in the aircraft/flight plan association processing, the processing of clearances and the air flight plan validation.

- the **Controller Working Positions** (CWPs) are the HMI of the controllers. En-route and approach CWP may be different, some CWPs are dedicated for a special purpose (e.g. interface to the departure controller). New generations of CWPs are emerging based on the European ODS concept in which European standards have been defined (COPS – Common Operational Specifications, ASTERIX, ADEXP, OLDI, SYSCO, etc…). The data-link is one of numerous new features to be integrated in the new CWPs. Although experimental data-link CWPs are being developed and validated by controllers through European projects (e.g. EOLIA, EOLIA-2, PETAL-2), the time scale for the provision of data link functions to the controllers is very dependent of the time scale of the replacement of the current ATC equipment. It is likely that in the ACCESS area each ATSO will define its own planning and it is therefore impossible to determine a global date at which data link CWPs will be available.

- the **Radar Data Processing System** (RDPS) displays the aeronautical situation based on information received in real-time by the radar stations and the information of the FDPS identifying the aircraft,

- the **ATN Data Link Server** as described above is responsible for the ATN communications with the aircraft and the interface with the existing ATC systems.

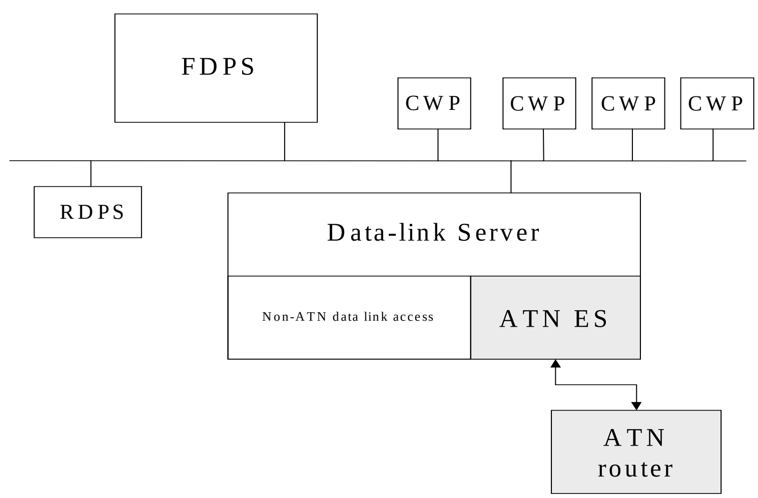


Figure 16: Functional Model of an En-route ATSU

The list below (summarised in Table 1) provides an overview of the impact of the data link on the current ATC systems.

– **DLIC**

The FDPS is modified to perform the aircraft/flight plan association. The FDPS processes the downlink information (24 bit aircraft address, departure and arrival airport, estimated departure time) to associate the aircraft with the flight plan. It must identify and provide the next data authority in charge of the aircraft and the date where the aircraft is leaving the current FIR in order to trigger a CM-contact with that centre. The CWPs are not impacted by the DLIC service.

– **DCL**

The FDPS produces the Departure Clearance for transmission to the pilot on his request. The communication interface FDPS – Departure Clearance CWP must be developed. The Departure Clearance CWP shall be customised to process data link clearance requests. The Departure CWP already in operation over ACARS (A623) could be adapted to the ATN.

– **ACM**

The FDPS is responsible for triggering the transfer of communications (uplink of the NDA message and release of the active CPDLC link). The CWP shall be able to display downlink CPDLC messages and Logical Acknowledgements indicating that an uplink message has been correctly received by the avionics and to generate the uplink messages MONITOR and CONTACT.

– **CIC**

The CWP shall be able to display downlink CPDLC messages and Logical Acknowledgement indicating that an uplink message has been correctly received by the avionics. The CWPs must provide controller with the capability to respond to a pilot query and to validate any controller input, etc. The CWP shall check that the aircraft is effectively controlled by the position before sending any data. The CWP is responsible to generate back to the aircraft the Logical Acknowledgements to downlink messages or the SERVICE NOT AVAILABLE message when the processing of the received message is not supported. The FDPS is not impacted by the introduction of the CIC service.

– **FIS/ATIS**

The FIS server acts as a gateway between the aircraft and the airport platforms where the ATIS reports are generated. The current ATIS generators require to be modified to be able to send ATIS reports on real-time to the (inter-) national FIS server via ground exchanges.

– **FLIPCY**

The FDPS require major modifications to support the FLIPCY service. The FDPS shall identify the part of the flight plan relevant for the comparison, shall request the data-link system to retrieve the flight plan stored in the aircraft's FMS and shall check the consistency between the returned dowlinked flight plan and the ground based data. A message shall be built and sent to the controller and the pilot when an inconsistency has been detected. The error message must indicate the seriousness of the discrepancy. In case the airborne flight plan is different but acceptable the FDPS is authorised to upgrade the ground flight plan with issuing a warning to the controllers when they are already aware of the flight. The FDPS may be also modified in such a way the FLIPCY service is initiated automatically after the DCL service.

The CWP is modified in order to inform the controller whether FLIPCY has been performed for a particular ATN-equipped aircraft and whether an inconsistency has been detected. The controller must have the possibility to manually request the airborne flight plan for an unexpected check in case of doubt about the progress of a flight.

	CWP	FDPS	Data-link Server	Other Systems
General	Interface with the d/l server	Interface with the d/l server		
DLIC	-	Aircraft/flight plan correlation Identification next CM and date of contact	Run the CM application. Dissemination of aircraft addresses Addressing data base management	
DCL	Interface with the departure controller	Departure clearance composition.	Run the CPDLC application Message routing to departure CWP	
ACM	Interface with transferring and receiving en-route controller.	-	Run the CPDLC application	
CIC	Interface with the en-route controller controlling the aircraft.	Processing of some tactical messages.	Run the CPDLC application. Message routing to active CWP	
DSC	Interface with an en-route controller not controlling the aircraft.	Downstream clearance composition.	Run the CPDLC application	
FLIPCY	Alarm sent to the controller	Flight Plan comparison	Run the ADS application	
ATIS	-		Run the FIS application.	ATIS Server presents a new interface to the Data-link server.
APR	Selection of the ADS contract type.	-	Run the ADS application	Surveillance Processing System

Table 1: Assignment of Data Link Functions to ATC Systems

Very likely, a phased approach for the upgrade of the current ATC systems to support the data link feature will be taken by the ATSOs, depending on the priorities defined for ATC by each ATSO. For instance, in France, the major milestones for the provision of an operational ATN-based data-link ATC environment have been roughly defined as follows:

- a pre-operational environment should be installed in a French en-route ATSU for experimental and validation purposes likely in 2001. It includes a data-link CWP based on ODS-France, an option of the operational FDPS integrating the data link-related functions to support an initial set of services and an ATN data link server providing access to the ATN.

- the integration of these data link ATC components as operational systems and the deployment in other ATSUs will begin once the validation is completed.

- the first data-link version of ATC systems supporting a limited set of data-link services and operating in the operational CAUTRA environment is therefore not expected before year 2003 . This planning would allow to match the initial ACCESS ATN rendez-vous.

3.3.5.2 Proposed Actions

Action ATC1	**To launch study and development programs aiming at integrating the data link capability in the existing operational ATC systems (CWPs, FDPS, etc.)**	**Each ATSO**

3.3.6 AMHS Systems

This section outlines a strategy for the implementation of the AMHS in Europe as a service being supported by the Initial ACCESS ATN in the time frame to 2005.

3.3.6.1 AMHS as an Intermediate Service

In order to develop a strategy for the implementation of AMHS as a service being supported by the Initial ATN, it is necessary to investigate the way in which it is used and, from this, the demands it places on the ATN.

The AMHS is different from other services considered in this context to the extent that it does not directly provide an "end user" service. In order for services such as Flight Plan or ATFM Transfer to be made available, there need to be additional formats and protocols defined. The exchange of messages within the context of these services remain separate from each other, e.g. by means of disjoint address spaces or O/R Names. Even the simple exchange of messages among human users, e.g. terminal operators, may need to be well defined as a separate service.

This characteristic of AMHS has influence on the recommendations made below on its implementation in the Initial ATN. For example, when AMHS components are set up as ATN End Systems, no restrictions can be made on the set of end user services which they will handle, except by artificial means such as address screening. The message traffic is therefore a mixture of traffic from different end user services. This is true of the three different types of End Systems in the AMHS, ATS Message Servers, ATS Message User Agents and AFTN/AMHS Gateways.

The planning of the future European AMHS is a major task which can hardly be done justice here in the context of ATN planning. The project SPACE, dedicated to AMHS planning in Europe, has been set up for this purpose. This section merely formulates some principles which should be of assistance to those planning the ATN internet and to show what will be necessary in the Initial ACCESS ATN in order to support AMHS.

3.3.6.2 Native use of AMHS via ATS Message Servers

Current ATS services using message handling are supported by AFTN/CIDIN at AFTN terminals and CIDIN Stations. It is the goal of the AMHS to migrate these user interfaces, whether operated by humans or by machines, to those at ATS Message Servers through the use of ATS Message User Agents, and possibly of Message Stores, thus, allowing the AFTN/CIDIN to be phased out in the long-term.

In order for this "native use" of the AMHS to be possible, end user AMHS services such as Flight Data Transfer and ATFM Data Transfer need to be defined. For this purpose, of course, use can be made of the formats and protocols of the corresponding services in the AFTN/CIDIN. Experience gained in national environments in which modern message handling techniques are already in operation, e.g. Spain, can be taken advantage of.

For the planning of the use of the ATN internet by AMHS, assumptions about which end user services are in operation and about the way in which they use AMHS represent considerable uncertainty. This means, for example, that assumptions on traffic volumes and other service requirements for the time frame of the implementation of the Initial ACCESS ATN are necessarily vague.

3.3.6.3 Transmission of AFTN/CIDIN Traffic via AMHS

The other main type of ATN End System in the AMHS is the AFTN/AMHS Gateway. This system is designed to convert message traffic between AFTN and the AMHS in both directions. A similar system for conversion of message traffic between CIDIN and the AMHS in both directions is also being specified by the ICAO ATN Panel for future inclusion in the SARPs. Within the AMHS, no distinction is made between traffic which has originated at ATS Message Servers and that which has originated in the AFTN. Because of the extensive use made of the AFTN in aeronautical applications, its long history and the corresponding wealth of experience in its operation, the Gateway will be very important for the migration of the AFTN to the AMHS. A Gateway is already present in a system operated by AENA (although the gateway functions themselves are not yet all in operation), a system is under development by DFS and one is planned by STNA.

The AFTN/AMHS Gateway is different from the ATS Message Server in many respects, in particular, it is not intended to be a source or sink of message traffic in its own right. Of course, a Gateway and a Message Server can be present as functional entities together in the same physical system.

3.3.6.4 AMHS Implementation Principles for the Initial ATN

Based on the background information provided in the previous subsections, three principles for the implementation of the AMHS as a service using the Initial ATN are developed below. These recommendations will, of course, have to be revisited using additional knowledge and experience gained from the SPACE project when these become available.

In the previous two subsections, the distinction between "native" AMHS traffic originating or terminating in the European AMHS and traffic originating and terminating in the AFTN/CIDIN has been made. Considering the facts that:

- AFTN/ATN Gateways in conjunction with ATS Message Servers for transit purposes and limited user access will certainly be present in the Initial,
- the large amount of AFTN transit traffic in the European Region has long been a problem together with the fact that messages take too many hops within the Region,
- there should be minimal impact on host computers and their applications when introducing the AMHS,

the following design principle is formulated:

Design the initial Regional AMHS around the interconnection of transit ATS Message Servers co-located with peripheral AFTN/AMHS Gateways, making the initial AMHS configuration consist of a core which can be used right from the start for AFTN transit traffic does not originating or terminating in Europe.

This principle is considered to set up the ideal initial conditions for the development of the European AMHS and to assist in the migration path enabling its progression. It needs no assumptions to be made about the end user environment and it is in keeping with the planning principle of implementing long-distance trunks where possible since long-distance traffic will transit Europe in one hop. In the initial stages of implementation, it can be operated in parallel with the conventional AFTN/CIDIN, traffic being split by means of routing tables. In this way, the amount of traffic traversing the AMHS can be increased gradually.

Assuming the application of this principle, the question arises as to how native message traffic will access the European AMHS. Considering the facts that:

- the establishment of national message handling systems based on AMHS is a cost effective and technically attractive strategy for ATSOs,
- the approach is currently being considered by a number of ATSOs and has already been implemented by AENA,
- if the country involved maintains one of the AFTN/AMHS Gateways, access to the international AMHS is assured,

the following design principle is formulated:

Assume the development of national messaging networks based on AMHS which are interconnected e internationally to the Regional AMHS at transit ATS Message Servers.

This principle delegates the native AMHS access to the national planning domain and thus simplifies the overall planning by de-coupling it from overall European planning. No constraints are placed on national AMHS implementation as long as they satisfy the SARPs when viewed from outside. It can be expected that the national AMHS implementations will use national parts of the ATN internet for data transport but this is not essential.

The network design principle according to which all national traffic enters and leaves the international domain at one COM centre for each country is well known from the AFTN/CIDIN techniques. However, considering the facts that:

- AMHS routing is independent from ATN internet routing,
- there is no basic need for an MTA in a COM Centre to be involved when the national/international boundary is traversed by a message (this was different with older messaging technologies because there were fewer independent protocol levels),
- a higher communication efficiency possible if an MTA in a COM Centre is not involved, thus avoiding possible bottlenecks in network,

the following design principle is formulated:

Migrate towards a fully meshed European AMHS with no restrictions, in principle, on the connections between MTAs in different countries.

This principle diverges from current AFTN/CIDIN practice but makes sense in an AMHS environment. However it is unlikely to impact planning for the Initial ACCESS ATN in its early stages.

3.3.6.5 Configuration of the AMHS for the Initial ACCESS ATN

In this section the configuration of the AMHS using the Initial ACCESS ATN is derived from the planning principles of the previous section and made more concrete.

The following considerations need to be made when configuring the co-located ATS Message Servers and AFTN/AMHS Gateways interfacing between the European Region and other Regions:

- The major transit traffic flows need to be taken account of.
- Because of the high availability requirements and importance of the European AMHS as a transit network, sufficient redundancy among the AFTN/AMHS Gateways needs to be provided as well as alternative routes across the European Region for transit message traffic. This means that, in general, non-European Regions are connected to two Gateways.
- A sufficient number of Gateways needs to be implemented so that the second principle can be applied and their responsibilities distributed appropriately.

In the light of these considerations, a possible configuration results, which is very similar to that contained in [A202] which was based on preliminary ideas. It consists of 7 Gateways with the following responsibilities for other Regions, as illustrated in Figure 17:

- EG for NAT/CAM/CAR and ASIA/PAC
- LP for NAM/CAR and AFI
- LE for SAM and AFI

- LI for AFI, EUR/MID and ASIA/PAC
- LF for AFI
- ED for EUR/ASIA
- EH for EUR/ASIA

On the basis of this configuration, the core of an European AMHS would be established and the other two principles could be applied. It might be possible to reduce the number of Gateways by 2 by deleting EH and LP and shifting links to other Gateways.

Little can be said about the capacity necessary in each of the Gateways, however the throughput requirements are not critical. A figure of a few (<5) messages, each of a few kilobytes average per message, would appear to be sufficient throughput. The overall strategy benefits from the fact that message traffic can be migrated gradually from conventional networks to the European AMHS.

No remarks on the planning of national domains are made here because this is essentially de-coupled from the overall planning process. In general the co-located ATS Message Servers and Gateways will be implemented together with ATN routers.

Figure 17: Possible location of AFTN/AMHS Gateways in the Initial ACCESS ATN

3.3.7 Initial ACCESS ATN Internet

3.3.7.1 General

On the basis of the assumed scenarios for the deployment of the ATN ESs, and for the availability of ground and air-ground subnetworks in the initial ACCESS timeframe, an outline of the initial ACCESS ATN internet topology in terms of ATN router siting and routing organisation can be given.

This section aims at describing the possible routing architecture of the initial ACCESS ATN and the possible number, role and location of ATN routers.

The elements allowing to sketch out this topology are developed in [A203], [A203A] and [A209].

The elements exposed in this section (e.g., the evolution of national RDs) are particularly "volatile" as they mainly depend on local factors and decisions (at ATSO level), in the absence of a clearly established ATN deployment plan supported by firm commitments from European ATSOs.

3.3.7.2 ATN Routers Deployment Scenario

3.3.7.2.1 General

ATN routers will generally be deployed on the sites where ATN applications are run[11]. Their primary function will be to relay data packets between the Local Area Network to which the local ATN ESs are connected, and the attached mobile or ground-ground subnetworks providing connectivity with external domains. In these sites, ATN routers will be either intra-domain ISs, ground BISs or a/g BISs depending on the adopted routing organisation and on the a/g connectivity requirements.

According to sections 3.3.4.3 and 3.3.6.5, ATN ATS applications will be run in the following sites:

- the en-route ACCs,
- optionally, the approach ACCs covering the major airports,
- optionally, the major airports,
- the AFTN/AMHS switching centres.

This section discusses the deployment of ATN systems in each of these sites.

3.3.7.2.2 ATN Deployment in Airports

According to section 3.3.4.3, the airports will not be the primary location for the deployment of ATN ATS applications; only the largest ones may possibly be equipped with a data link server in the initial ACCESS time frame. On the other hand, airports will remain the physical location where many pre-tactical and tactical AOC applications are run. This makes large airports a first choice target for AOC-related ATN resources integration effort.

It is therefore assumed that, in the initial ACCESS timeframe, the large European airports will be equipped with at least **a general purpose** Air/Ground BIS.

Optionally, the major airports will additionally be equipped with an ATS-dedicated ground BIS, managed by the Terminal Air Traffic Authority, (or by another party operating by delegation from the

[11]Note that where an a/g BIS serves more than one ACC, it may be sited away from the locations where the applications are run (i.e., in a separate communication centre).

Civil Aviation Authority of the concerned Member State).

This provision would allow to establish an ATS-only internetworking subset, so as to alleviate responsibility and liability concerns with respect to ATS applications

The resulting possible routing organisation for a major airport is illustrated in Figure 18. The figure depicts:

- the Routing Domain of the Airport Operator (APO's RD) which contains the APO's A/G-BIS and the CWP of the ground controller,
- **optionally**, the part of the local ATSO Routing Domain (RD) which is located at the airport and contains a data link server and an ATS-dedicated Ground BIS.
- possibly, the Headquarters RD of one (or several) Aircraft Operator(s),
- the RD formed by an aircraft (with the ATN ESs of the aircrew), and
- the RD of an IACSP.

The APO's A/G-BIS is interconnected with the adjacent G-BISs over ground links (e.g. an Airport Local Area Network), and with the airborne BISs (when powered-on) of all ground-located aircraft over a local VDL Mode 2 subnetwork. Possibly Gatelink will be available in 2005 in major Airports and used for interconnection of the APO’s A/G BIS with Gatelink-equipped Aircraft.

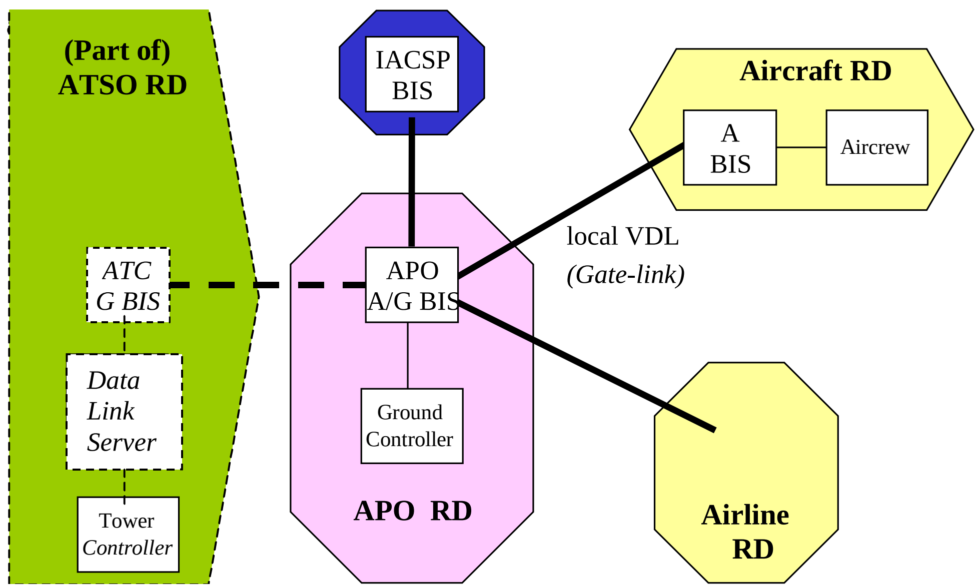


Figure 18: ATN Routing Organisation - ATN Deployment in Airports

3.3.7.2.3 ATN Deployment in ACCs

Each ACC will likely be equipped with at least one ATN IS for interconnecting the ACC LAN(s) (to which the ATN ES(s) are assumed to be attached) to the national ATS WAN.

In ACCs with A/G connectivity, this IS will be an A/G BIS, thus being additionally connected to Air/Ground subnetworks. Furthermore, if one of the attached mobile subnetworks is authorised for AOC traffic, this Air/Ground BIS must be connected to an IACSP network and/or to other private or public WANs, for allowing AOC ATN communication between remote Airline Centre of Operations and the Aircraft.

In ACCs without A/G connectivity, this IS may be either an Intra-Domain IS or a ground BIS depending on whether the IS is at the boundary of a routing Domain or not.

3.3.7.2.4 AFTN/AMHS switching centres

AFTN/AMHS switching centres will be equipped with at least one IS for interconnecting the LAN(s) to the national ATS WAN and possibly to other private and/or public WANs if connectivity is required with non-ATS actors.

Assuming that these ATS Sites have no A/G connectivity, the IS may be either an Intra-Domain IS or a ground BIS depending on whether the IS is at the boundary of a routing Domain or not.

3.3.7.2.5 ATN Routing Organisation of the ATSO ATN Domains

The ATN Administrative Domain of an ATSO may consist or one single RD or may be divided in several local RDs. It is difficult, to say more on the internal ATN routing organisations of the ATSOs in the ACCESS area in 2005 as they are very dependent on local requirements and constraints.

Considering the limited number of A/G BISs that will be deployed, the limited number of ATN-equipped sites, and the relatively limited number of ATN-equipped aircraft in 2005, it can be assumed that very simple routing organisations will be sufficient and suitable for the support of the routing traffic. For most ATSOs in the ACCESS area, one single Routing Domain will be an appropriate initial routing architecture. In large countries comprising several large airports, it could be necessary to split the local ATN domain in 2 or 3 Routing Domains so as to divide and distribute the amount of routing information to be processed by the ATN routers.

In the remainder of this document, it will be simply assumed that each ATSO will form one single Routing Domains Confederation (RDC) which hides the detail of its internal routing organisation to the adjacent ATSOs.

3.3.7.3 Routing Organisation for the Initial ACCESS ATN

The assumed ATN overall Routing Organisation of the initial European ATN internetwork is based on the Routing Organisations defined in [A203], [A203A] and [A209].

The European ATN is divided into two major entities:

- an European Region ATN Island RDC and
- an independent separate European Homes RDC.

The European Region ATN Island RDC comprises the RDCs of the national ATC authorities and the European Region Island's Backbone RD; it is primarily dedicated to ATSC traffic.

The European Homes RDC comprises the other European ATN ground systems. It is structured into the Home Routing Domains of the different European Airline Operators (AOs), the RDs of the airport operators (APOs), the RDs of the international aeronautical communications service providers (IACSPs), and the European Homes' Backbone RD.

The aircraft are neither contained in the European Region ATN Island or in the European Homes RDC, but form their own independent RDs.

As concerns the interconnection of the European ATN with non-European Islands, the following assumptions are made:

- the European "Region" ATN Island will be directly interconnected with non-European Islands. These interconnections will primarily be used for the exchange of ground-ground ATSC traffic. The European "Region" ATN Island will be interconnected with the European "Homes" RDC. Interconnection between Islands will be established between backbones.

- the European "Homes" RDC will be interconnected with the European "Region" ATN Island and with other Islands on other continents. These interconnections will primarily be used for the exchange of ground/ground and air/ground AOC traffic.

This overall architecture is represented in Figure 19.

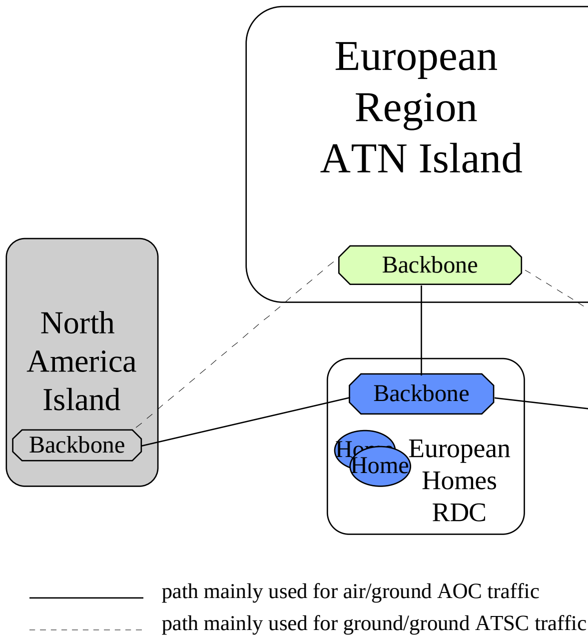


Figure 19: Proposed Overall Architecture of the Initial ACCESS ATN

For the initial ATN, the European Region ATN Island will not be divided into multiple sub-regions (as this is proposed in [A203] for the target European ATN).

As far as the ATN backbone is concerned, it can be reasonably assumed that:

- a single backbone architecture will be sufficient to meet the performance and connectivity requirements,

- the requirement of route servers (as proposed in [A203] for the backbone of the target European ATN) will not exist at this stage of the ATN deployment in Europe.

Figure 20 describes a possible topology for the initial ACCESS ATN backbone:

- the lines represent the IDRP BIS-BIS connections supported by the underlying EAN infrastructure and used for cross-domain traffic, i.e. the backbone links and the connections of the various RDCs to the backbone,

- the following assumptions are made regarding that topology:

  - 1 to 3 fault-tolerant backbone BISs realise the initial backbone at that stage of the ATN deployment. They are interconnected using meshed EAN links. Their location is not specified; it will depend on the interest of ATSOs in the participation to the European ATN backbone infrastructure (this is considered as an institutional issue),

  - there is at least one national fault-tolerant BIS per ATSO directly connecting the corresponding ATSO RDC to one of the backbone BISs (or indirectly, via a national BIS of a neighbouring ATSO RDC, e.g. Ireland and Portugal). Additionally, it is possible that some

RDCs get connected to the backbone by more links (e.g., UK, Germany, France, Spain, Italy),

- the figure does not aim at representing the other national BISs or links that make up the diverse ATSO RDCs.

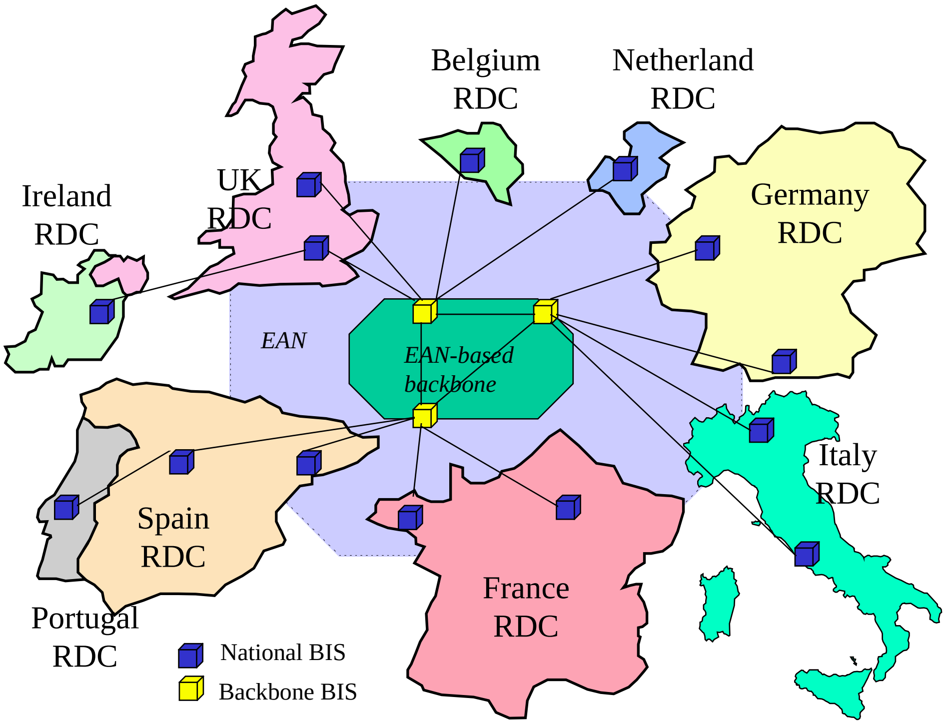


Figure 20: Initial ACCESS ATN Backbone

3.3.7.4 Proposed Actions

The following actions are proposed to facilitate the deployment of the initial ACCESS ATN internet.

Action INT1	**To define the European backbone router architecture**	**ATSOs with CSPs**
Action INT2	**To define the various national parts of the initial ACCESS ATN internet (a/g BIS siting, connection to the backbone, internal topology, etc.)**	**Each ATSO**
Action INT3	**In the field of network planning and consequent implementation activities, to investigate network modelling and simulation tools and to develop experience in the modelling of ATN networks**	**ATSOs**
Action INT4	**To deploy the ATN internet**	**ATSOs & CSPs**

3.3.8 ATN Routers

3.3.8.1 General

The initial deployment of the European ATN Internet is dependent on the availability of the core ATN internet building blocks: ATN routers.

The availability of ATN ground and air/ground routers is therefore an obvious prerequisite for the initial deployment of the ATN ground network infrastructure. This availability is meant to be both technical (availability of operational ATN-conformant routers with appropriate administrative and/or management tools) and economical (availability of distribution channels with appropriate maintenance and support services, availability of a licensing policy, etc.).

This section aims at presenting a likely scenario for the availability of ATN routers for the initial ACCESS ATN. It then summarises the main issues raised by that scenario which require specific actions.

3.3.8.2 Product Availability

Given the specific requirements and constraints of the aeronautical community (e.g., certification, quality of service requirements, etc.) and of the ATN itself, it is generally assumed that ATN systems will be developed by a rather limited number of manufacturers and consequently be distributed by a reduced set of suppliers.

Those manufacturers and/or suppliers will be companies that are traditional business partners of aeronautical organisations in the “not-so-open” market of aeronautical systems (this is especially true for airborne systems). In other words, it is unlikely that ATN-specific routers will be supplied by network equipment vendors (e.g., router vendors such as Cisco, 3Com, Bay, etc.), as there seems to be no potential interesting benefit in the development of ATN-specific features which would be required for that limited market.

Therefore it is assumed that ATN-specific routing products (ATN BISs or route servers) can only be expected from the following two channels[12]:

1. Evolution of existing experimental and/or pre-operational ATN BISs (i.e., TAR-TTS or ProATN)

2. ATNSI (RRI project).

Although the requirement for intra-domain routers is not ascertained in the proposed deployment scenario proposed as the intra-domain routing architecture of ATSO RDs is left as a local issue, there is a potential need for ATN intra-domain routers. The following possibilities may be envisioned for the provision of ATN-compliant intra-domain routers:

1. Evolution of existing experimental and/or pre-operational ATN BISs (i.e., TAR-TTS or ProATN)

2. ATNSI (RRI project) (tbc)

3. COTS IS-IS routers.

3.3.8.2.1 Pre-Operational ATN BISs

Candidate pre-operational ground-based router products that shall be conformant to the current SARPs

[12] The question of the availability of other suppliers has to be investigated as recent information showed the evidence of another ATN BIS implementation (apparently developed by or on behalf of Raytheon).

(package 1) are TAR-TTS and ProATN BISs. However the most qualified implementation for pre-operational use is probably the ProATN one. This is because:

1. the ProATN BIS development is an on-going project and the product is due to be available with a complete, documented and tested implementation by early 1999. Conversely the TAR-TTS product, whose software implementation has been used as a building block of the ProATN BIS implementation, is an older generation product that was designed for experimental rather than pre-operational use (e.g., scarce documentation, limited user interface, etc.).

2. Owners of the TAR-TTS IPRs have similar rights on the ProATN BIS and will probably prefer to develop a single product line for business optimisation reasons (rather than maintaining two routers in parallel).

It is therefore retained that the ProATN BIS is the most technically complete and acceptable product for an operational use amongst the existing pre-operational ATN BISs products. In any case, the ProATN BIS has already been selected for some major experimental or pre-operational data link projects (such as ATIF, Petal II or EuroVDL).

The current status of the ProATN ground-based BIS implementation is summarised as follows:

1. Version 1 available from March 1998 (running on SUN Solaris platform), current version is 1.2.

2. Availability of version 2 (fully compliant to CNS/ATM 1 SARPs and ProATN specifications) planned in January 1999 (on SUN Solaris platform).

3. ProATN BISs version 2 should be ported on HP and DEC platforms in 1999 and available by early 2000.

4. Further evolution to CNS/ATM 2 ProATN version not planned so far.

Further developments are expected following version 2 completion. They should essentially aim at turning the pre-operational product into a fully operational ATN BIS. The main expected enhancements to that purpose are described below:

1. Extensive testing of CNS/ATM 1 implementation in pre-operational conditions (e.g., a/g subnetworks interfacing, interoperability with airborne BIS implementations, etc.).

2. Enhancement of the user/administrator interface.

3. Integration of network management capabilities (development of a system management agent and adequate management objects).

It is not currently envisioned that the ProATN BIS will be ported on industrial-type rack-fitted hardware, e.g. for external connectivity extensions, performance or maintenance enhancements (hot swapping capabilities), etc. It is rather expected that ProATN routers will only be supported by dedicated Unix platforms.

3.3.8.2.2 RRI Routers

ATNSI is a consortium of air carriers formed in 1995 whose purpose is to co-operate with the U.S. FAA in a joint venture to develop critical ATN products for both avionics and ground systems. The Router Reference Implementation (RRI) Project, which is a part of the ATN Project led by ATNSI, aims at developing a set of portable ATN router and end-system products. ATNSI has subcontracted the ACI consortium for the actual development of those ATN products that are intended to be certified for operational use in avionics systems.

The RRI project has been effectively started in 1997. According to the RRI Project schedule, the first version of the portable RRI software should be fully compliant to CNS/ATM 1 SARPS and available in early 2000. It is not ascertained today if ATNSI (or ACI) will provide CNS/ATM 2 compliant products when the related SARPs are finalised.

The RRI product licensing policy and the possible commercial agreements for its distribution to ATS users are not known yet.

It has to be noted that the RRI router product is defined as a portable software package implementing the ATN BIS functions. Hence the RRI product is not a ready-to-use ATN BIS, it must be ported on a hardware platform to be usable as an operational router. It is not clear to date whether ATNSI (or ACI) will provide ready-to-use ATN BISs (i.e., hardware platforms running the RRI routing software) in addition to the RRI software package itself.

Although the RRI product appears to be a commonly accepted target ATN BIS implementation in the ATN community, a lot of issues surrounding its precise technical and commercial availability are still unknown today.

3.3.8.2.3 ATN Route Servers

The target routing architecture proposed in [A203] makes use of route servers for the European ATN backbone. An ATN route server is a BIS dedicated to the processing of routes: route servers fully participate in IDRP but they do not forward any CLNP packet. The concept of router server has been introduced quite recently in the ATN architecture. Although no specific ATN route server development is scheduled to date, it is reasonable to assume that an ATN route server product could be built rather rapidly from existing ATN BIS implementations (e.g., from the ProATN BIS implementation).

In any case, the use of route servers in the ACCESS area will not be required before the European ATN backbone has at least 3 backbone BISs and is deployed over a fully meshed pan-European subnetwork (such as one based on the EAN).

Therefore the initial ATN deployments will not require ATN route servers.

3.3.8.2.4 ATN IS-IS Routers

The target routing architecture as described in [A203] does not mandate the use of intra-domain IS-IS routers within RDs of the ACCESS area: it is rather left as a local issue. Nevertheless it is probable that some ground-based RDs will actually use such routers.

IS-IS routers can be available from the following sources:

1. COTS IS-IS routers. The use of COTS routers faces two distinct problems:

    - limited availability: the use of OSI protocols is more and more confined to “niche” markets so that router vendors do not plan any investment in OSI developments and support. Router vendors currently provide multi-protocol routers that can be configured as CLNP routers running the IS-IS protocol but it is expected that their next generation products will not support CLNP nor IS-IS as standard features.

    - ATN incompatibility: the ATN makes use of a few specific CLNP protocol-level features that generally make COTS CLNP routers not usable within ATN RDs unless specific ATN configurations can be set up (which is not the case with existing products).

2. ATN BIS with IS-IS capability (e.g., ProATN router configured as a pure intra-domain IS-IS router).

3.3.8.2.5 ATN Router Industrialisation Issue

The question of the transition from workstation-based to industrial ATN routers (i.e., rack-fitted hardware with modular and high capacity attachment capabilities, built-in redundancy provisions, etc.) is not clearly answered so far, for both ProATN or RRI products.

Assuming no COTS ATN router will ever be available on the market from usual router manufacturers, the main reasons that could call for such a transition would be linked to increased needs in terms of:

1. CLNP forwarding performance: increased ATN flows that would not be coped with existing workstation-based routers would require improved CLNP forwarding performance. That improvement could be brought by industrialised routers based on specialised hardware platforms, ASICs, etc., similarly to what happened to COTS routers.

2. Attachment capacity: industrialised ATN routers would be able to handle more subnetwork attachments with additional functions such as ISDN back-up, automatic switchover, etc.

3. Built-in redundancy capabilities: the use of a modular hardware platform would allow for redundancy provisions such as hot-swap of certain hardware modules, dual power supply or CPU modules, etc.

The lack of high attachment capacity or redundancy capabilities can be worked around by appropriate architectural decisions (e.g., doubled ATN routers for redundancy). Therefore the only problem that could justify the need for an industrialised router is the performance one. That problem will eventually occur only if ATN forwarding requirements increase above the capacities of workstation-based products.

However, ATN performance requirements are mainly driven by air-ground applications which do not induce massive CLNP packet forwarding. Hence it is likely that ATN traffic will not require such an evolution in the ACCESS timeframe, assuming there is no fundamental increase of ATN use (e.g., by new bandwidth consuming ground applications).

3.3.8.3 Availability of ATN Routers by 2005

In the light of the current situation and trends of the ATN router market, the following deployment scenario is proposed for the *ATN BISs* up to the initial ACCESS ATN deployment:

1. From 1998 to 2001: deployment of several ProATN BISs in Europe in the context of ATN or data link experimental or pre-operational projects (use of CNS/ATM 1-compliant products).

2. From 2001 to 2005: the ProATN BISs used in pre-operational projects will be used as fully operational routers, since they are already used and managed and there is no other source of ready-to-use ATN BISs, at least in the first two years (2001 to 2002). In that same timeframe (from 2001 onwards), it is likely that the first operational RRI-based ATN BISs will appear on the market, so that a situation mixing ProATN and RRI routers may appear in Europe from 2002 to 2005. Moreover it is possible that RRI routers will progressively substitute ProATN routers simultaneously to a CNS/ATM 1 to CNS/ATM 2 transition.

As for *route servers*, the initial ACCESS ATN infrastructure that will be deployed until 2005 does not require the optimisations brought by the route server concept: route servers will not be required by the initial ACCESS ATN. However development actions will be necessary in that timeframe to prepare a future transition to a European ATN internet using route servers.

The question of *intra-domain IS-IS rout*ers is a local issue to each ACCESS RD. If required, it is likely that they will be based on the same products as those used for ATN BISs (i.e., ProATN or RRI), even if in the first steps of the ATN deployment some COTS IS-IS routers will be used with a limited scope (e.g., in cases where only ATN General Communications[13] flows are routed).

3.3.8.4 Proposed Actions

This section summarises the main actions or tasks required for ensuring the availability of operational ATN routers as previously developed.

- ProATN products

Action Pro1	**To integrate network management capabilities in ProATN routers**	**ProATN a/g BIS suppliers**
Action Pro2	**To validate ProATN routers in operational environments**	**ProATN a/g BIS users**
Action Pro3	**To define maintenance & support policy for ProATN routers**	**ProATN a/g BIS suppliers**

- RRI products

Action RRI1	**To follow ATNSI/RRI project & resulting ground-based router product availability**	**ATSOs & Airlines**
Action RRI2	**To define ATNSI/RRI marketing & licensing policy (product distribution, portable software vs. industrialised product, etc.)**	**ATNSI/RRI suppliers**
Action RRI3	**To define ATNSI/RRI maintenance & support policy**	**ATNSI/RRI suppliers**

- Other

Action R1	**To investigate requirements for route server project**	**ATSOs**
Action R2	**To investigate the existence of other ATN BIS products (e.g., Raytheon)**	**ATSOs**

[13]The ATN traffic is broken down into different categories identified as "traffic types", each traffic type resulting at the CLNP level in an ATN Security Label being conveyed in the security parameter field of CLNP packets: "ATN General Communications" is the specific ATN traffic type which does not use any ATN Security Label (i.e., CLNP packets carrying data pertaining to that traffic type do not contain any security parameter). As COTS IS-IS routers usually do not support the optional CLNP security function, their standard behaviour is to simply discard CLNP packets containing a security parameter field. That is why COTS IS-IS routers are not able to route ATN packets except those packets carrying ATN General Communications data flows.

3.3.9 Airborne Systems

3.3.9.1 Introduction

In addition to the necessary deployment of ATN ESs and ISs on the ground (see previous sections of Chapter 3), ATN-based data link services obviously require the installation of ATN airborne systems on the aircraft using those services.

In this section, an "ATN airborne system" is intended to include the communication layers required by both ATN ES and IS functions as well as the ATN ASEs required by the data link services.

The question of the deployment of ATN airborne systems is two-fold:

- availability: as for ground-based ATN equipment, such a deployment is conditioned by the availability of certified ATN airborne systems,
- equipped fleet: the availability of ATN airborne systems must be accompanied by the will of AOs to equip their fleet (or part of it) with those systems. This aspect is clearly linked to the Airlines' strategy in terms of data link applications and aeronautical communications and their position vis-à-vis ATN development programmes.

3.3.9.2 Availability

No operational ATN airborne system is available to date. The only product that is currently targeting to be used as an operational ATN airborne system is the RRI software of ATNSI/ACI as presented in section 3.3.8.2.2.

The RRI software is intended to be a set of ATN router and end system products portable into both avionics and ground system. In addition to the RRI router and end system development, ACI supports the development of ASE software that should be available in the same timeframe.

ATNSI products are CNS/ATM 1-compliant and developed according to RTCA DO178 B level C requirements so that avionics systems including those products will be certified.

As for ground systems, a lot of issues surrounding the technical and commercial availability of airborne RRI-based ATN systems are still unknown today: it is possible that the first ATNSI software products to be ported into avionics systems will be available in 2000. However, onboard integration and ensuing testing and certification of the airborne products will certainly delay the availability of operational ready-to-use airborne systems up to 2002 or 2003 at a minimum.

3.3.9.3 Equipped Fleet

The ATN equipment of aircraft is the most critical aspect of the ATN deployment:

- the potential number of aircraft that can be equipped is large, which can represent huge financial investments for the AOs, especially if the ATN equipment is accompanied by the simultaneous installation of new onboard communication equipment (e.g., VDR),
- the process of integrating new equipment onboard is made more difficult due to the specific constraints affecting airborne systems (e.g., certification, establishment of new operational procedures, etc.).

The many uncertainties affecting the ATN deployment process and the ATSC data link applications in general are largely due to the technical and financial impacts of such deployments in aircraft.

The few initiatives in terms of operational equipped fleet are only those known to be started in the context of the projects described in section 2: thus American Airlines has decided to equip 4 B-767-ERs in the context of the Petal-II project. Incentives pushing AOs to install ATN equipment onboard could maybe result from the recent decision of the U.S. FAA to launch the CPDLC Build 1 and 1/A programme: the momentum thus created for ATN deployments in the U.S. could in turn be propagated to Europe, especially for the support of increasing AOC traffic.

However, it is difficult to assess today the evolution of Airlines fleets in the initial ACCCES timeframe.

3.3.9.4 Proposed Actions

Action AS1	**To follow ATNSI/ACI airborne product development process (router & ASEs)**	**ATSOs & Airlines**
Action AS2	**To follow Airlines' strategy and programmes with respect to ATN equipment** **To follow avionics vendors strategy and activities with respect to ATN airborne systems**	**All ATSOs**

3.3.10 System Management

3.3.10.1 General

System management is a critical factor for the successful deployment of the ATN in Europe, as any deployment of ATN resources must be accompanied by adequate system management solutions allowing the ATN infrastructure to reach the high quality of service objectives of ATN users.

Unfortunately, the ATN implementation effort was up to now busy on the numerous other aspects of the ATN implementation, and the ATN system management issues were somewhat neglected. The effective implementation of an efficient system management solution for the European ATN is not available today. The current situation in terms of ATN system management can be summarised as follows:

- The existing ATN systems support only local basic configuration and supervision tools allowing a local operator to configure the system and perform some basic maintenance activities. The ATIF/NMC architecture is the only centralised system management solution available today. However, this solution was not implemented with the objective to be used in an operational context, and hence does not implement all the features required to manage an operational network.

- System management solutions are not yet standardised. The ICAO SARPs on ATN system management are being developed, but they will not be completed before January 2000 (it is likely that further delays will be required for these SARPs to reach a mature state, since a concrete implementation of these SARPs will be needed to validate the concepts, and since it is unlikely that such an implementation exists by 2000).

- The ICAO SARPs on ATN System Management will focus on cross-domain System Management issues (i.e. specification of the management information to be exchanged across domain boundaries, and of the cross-domain management information exchange protocols). Guidance Materials will be developed on solutions and good practices for ATN System Management within an ATN Administrative Domain; however, no solution for system management functions to be used within an administrative domain is going to be standardised; the choice of the local system management architecture and technology will be left to the consideration of each organisation. The negative point of this level of freedom left to the organisations is that ATN Routers and ESs developers will not have System Management standards upon which they can refer for the implementation of local management agent capabilities on their systems. This may delay the availability, and limit the number of interoperable system management products.

- Beside the technical aspects of ATN System Management, there are many other related non-technical issues which are not answered today. The European ATN will be made by numerous distinct organisations, which makes the required co-ordination and co-operation for the European ATN system management more complex and raises many institutional and organisational problems. In addition, the ATN infrastructure will only be a part of the overall communication infrastructure managed by these organisations, and ATN System Management will hence have to be integrated within the system management environments currently in place for the supervision and administration of existing operational networks and systems.

The ATN community is aware that ATN System Management is an important issue and initiatives are currently being taken to enhance the current situation:

- Co-ordination between the ProATN and RRI projects is taking place for the implementation of common system management agents portable both on the ProATN and RRI routers. The current plans include: the development of a Full CMIP agent with limited capability for mid 99, the development of a FastMIP agent (DO178 Level E) with complete capability some time later, and the development of a FastMIP agent (DO178 Level C) for avionics ATN systems.

- A Network Management System interoperable with the Full CMIP agent mentioned above is going to be developed in the ProATN context.

- STNA is investigating the possible solutions for integrating ATN Systems Management within the environment already in place in French ACCs and other French ATC sites for the supervision and administration of the equipment. This may possibly result in the development of SNMP Agents for the ProATN routers and of an SNMP-based ATN Network Management System

As a result of these initiatives, it can be expected that SNMP agent-equipped and CMIP-agent equipped ProATN(/RRI) Routers and End Systems, and ATN System Management Stations are available by mid 2000

These System Management tools will constitute basic components from which ATSOs and other organisations could build their operational solutions for the management of the ATN. The organisations will be in a position to evaluate the applicability of the powerful CMIP-based architecture for their local ATN System Management versus a simpler SNMP-based one, more in-line with their current practice, and select the most appropriate one.

Further work will be required to reach the objective of an operational solution for the management of the ATN. The missing part relates to the integration of the ATN System Management within the current communication and supervisory environment of each individual organisation. It includes aspects such as:

- The customisation of the available System Management Station mentioned above, in order to meet local operator requirements (e.g. a specific "look and feel" of the application, translation into local language, specific additional functionalities) or to adapt the system to the local ATN topology.

- Possibly, the development of additional specific Network Management applications and Systems suitable to the local organisation for the sharing of the work and responsibilities.

- Possibly also, the integration of the ATN System Management applications, within existing local Network Management Systems.

- The test and validation of the resulting local ATN System Management architecture.

- The production of operator handbooks, the production of procedure guides, the formation of the operators, etc.

It is assumed that a number of European ATSOs in the ACCESS area, could launch their local ATN System Management implementation program in 2000, and hence that fully operational solutions could be implemented around 2003.

As far as the cross-domain System Management is concerned, the solutions being specified by ATNP are not yet mature. Time and effort will be needed for achieving the implementation of an operational European ATN system management solution compliant to the end-state architecture being standardised in the ATN SARPs. It is therefore assumed that the initial co-ordination requirements in the management of the European ATN, will be met using non-standard, European-specific procedures, similar to those in place for the management of the existing operational international networks such as the CIDIN and the EAN.

3.3.10.2 System Management of the Initial ACCESS ATN

As a conclusion of the previous section, it is considered that ATN system management can be split into two separate parts which undergo different development and deployment constraints (e.g., system management ICAO SARPs only focus the inter-domain part):

- inter-domain system management: the specific requirements and constraints applicable to inter-domain system management are largely described in [A227]. They encompass technical as well as organisational aspects (e.g., centralised co-ordination model).

- national system management: solutions in that area are aimed at managing national infrastructures under the responsibility of a single organisation (i.e., the ATSO). Both technical and organisational solutions may differ from the solutions selected for inter-domain system management.

The following scenario for the deployment of system management solutions is presented below:

1. From 2000 to 2003: in a first step ATSOs develop and deploy national system management solutions for managing their own infrastructure, which will be limited to embryonic sets of ATN systems and interconnections. The inter-domain system management functions that will be effectively required in that timeframe will be addressed by means of basic procedures specified by bilateral or multilateral agreements. In this period, however, regional agreement between the ATSOs must be reached on the European ATN management institutional and organisational issues and action plans should be launched to progressively enhance the System Management co-operation and co-ordination procedures, with the ultimate goal to reach an operational implementation of the ICAO standards at some further date. The preparation of this next stage will likely require the establishment of a co-ordination entity (e.g. the European ATN Co-ordination Entity (EACE) as described in the ATNI-TF documents).

   The solutions selected by ATSOs for national system management may not be unique, both in technical, procedural or organisational terms. However the following assumptions are made regarding those solutions:

   - accounting, configuration, fault and performance management will be the first areas addressed by those solutions (accounting will be particularly required in the case of national infrastructures provided by third parties).

   - the national system management architecture is likely to be based on a co-operative hierarchical model, where a centralised entity will be in charge of the administration and supervision of the overall infrastructure whereas some functions regarding the day-to-day management of local systems will be delegated to local maintenance personnel (e.g., in ACCs),

   - the technical solution will therefore allow for the use of dedicated ATN management stations and applications (e.g., used by the centralised system management entity) and for the integration of some ATN system supervision functions within the existing local system management applications (e.g., in ACCs),

   - CMIP and/or SNMP will be used. The protocol selection will depend on the success of the agent development projects and on the constraints for the integration of the ATN System Management in the existing environment.

2. In the period 2003-2005: Initial co-ordination requirements will need to be fulfilled. The first priority in the implementation of cross-domain system management functions is likely to be related to real-time exchanges of trouble tickets and performance data for co-ordinating fault and performance management activities, and to basic off-line exchanges of configuration and accounting information.

   In this period, it is unlikely that an ICAO SARPs compliant solution for the cross-domain exchange of management information (e.g. Cross-domain Network Management Systems implementing the Boundary MIB) be available for operational implementation.

   It is therefore assumed that temporary solutions will be used.

3.3.10.3 Proposed Actions

The main actions that are necessary to have a manageable initial ACCESS ATN are summarised below.

Action NM1	**To further progress in the required general studies on the institutional, organisational and other non-technical issues germane to the System Management of the European ATN**	**ATSOs, CSPs, Airlines**
Action NM2	**To study the minimum requirements for the overall European ATN management in terms of network monitoring and reporting functions (definition of service indicators, service alarm thresholds, procedures for the report and the tracking of troubles etc.)**	**ATSOs with CSPs and Airlines**
Action NM3	**To define bi- or multi-lateral agreements for system management exchanges and procedures between organisations (for initial deployments)**	**ATSOs, CSPs, Airlines**
Action NM4	**To endorse the creation of an organisational structure for the management of the European ATN**	**ATSOs, CSPs, Airlines**
Action NM5	**To provide for the appropriate products required to manage the European ATN within national administrations (e.g. Agents, National NMS, Boundary NMS, Network Viewer Tool)**	**ATSOs**
Action NM6	**To complete and validate ATN SARPs to allow the development and integration of the related NM products**	**ATNP**

3.3.11 Security

3.3.11.1 General

Security requirements and precautions applicable to the target European ATN network are developed in [A222].

ATN security needs mandate the use of interoperable mechanisms because of the very nature of the ATN communications taking place between application entities pertaining to different organisations or countries. Unfortunately, similarly to what happened to system management, ATN implementation efforts have not actually been devoted to ATN security issues so far, as ATN security mechanisms are only in the course of being specified by the ATNP for an integration in future CNS/ATM 2 SARPs. Additionally, a number of issues related to the use of those mechanisms within the ATN (such as security-related certification aspects or the need for an ATN repository) have not been addressed yet.

As a consequence, the first major constraint to be taken into consideration for the security of the initial ATN is that CNS/ATM 1 products will not integrate any of the ATN standardised security mechanisms that should be available with CNS/ATM 2 products (i.e., ATN upper layers' security mechanisms, IDRP authentication, system management security functions, etc.).

However, the set of security measures proposed in [A222] is not limited to the implementation of the CNS/ATM 2 security mechanisms, which essentially deal with the protection of ATN communications. It also includes measures in other areas such as physical protection, access control, system security, etc. In the light of this situation, [A222] proposes a two-step implementation strategy for the security of the ACCESS ATN. The first step corresponds to the initially deployed ATN network (based on CNS/ATM 1 products), for which a subset of the target security precautions that are deemed applicable will be proposed.

3.3.11.2 Security Measures for the Initial ACCESS ATN

3.3.11.2.1 Deployment Scenario

The utilisation of the target CNS/ATM 2 security mechanisms is conditioned by the availability of the following elements:

- availability of CNS/ATM 2 products (ATN ESs and ISs),
- establishment of a European ATN public key infrastructure (ATN PKI), including a European repository and probably a certification authority per organisation (CAA, Airline),
- implementation of system management security functions and/or procedures,
- resolution of institutional and organisational issues raised by the security mechanisms used in the European ATN.

It is likely that mature and validated CNS/ATM 2 SARPs will not be available before 2002. In addition further delays will certainly be necessary to get operational CNS/ATM 2 products integrating the required security mechanisms, to set up the necessary European PKI and the security-related system management functions and to complete the required co-ordination between ATN organisations.

For all those reasons, it is assumed that the initial ACCESS ATN will not be able to take benefit of the target security mechanisms as proposed in [A222] for the target European ATN, even if the first CNS/ATM 2 products start to be shipped between 2003 and 2005.

3.3.11.2.2 Initial ACCESS ATN Security Measures

The next table presents examples of measures that can be implemented in the initial ACCESS ATN. They are essentially extracted from [A222] (only those measures that are deemed applicable in the early stages of the ATN deployment are proposed).

Note that one of the most important sets of measures should be focused on dependability issues, as safety is a critical requirement for ATS applications: equipment redundancy, appropriate architectural design, adequate routing organisation, etc. are examples of such measures (although they are presented in this section because they do participate to the overall ATN security framework, those measures are often handled separately with respect to other security measures, because they have a particular importance in the day-to-day operation of mission-critical networks such as the ATN).

The only measure that does not come from [A222] is the “NET validation function”[14].

The use of this function raises the problem of the management of a list of authorised airborne addresses in the a/g BISs. A likely scenario is simply that network administrators will periodically receive announcements of the existence of new ATN-equipped aircraft with information on their configuration (addresses, support or non-support of IDRP, etc..). The network administrators will then plan the reconfiguration of a/g BISs and the network operators will later on perform this reconfiguration using their local ATN system configuration mechanisms. This scenario would require the prior definition of procedures for the announcement to a/g BIS operators (ATSOs, ACSPs) of new airborne router addresses by or on behalf of Airlines and for the management of a reference list of valid airborne addresses on a world basis.

The NET validation function is therefore proposed in the list of measures applicable to the initial ACCESS ATN. However its effective use is conditioned by the previously exposed elements and can be questioned by individual organisations based on cost/benefit analysis (i.e., induced management burden vs. the efficiency of the mechanism).

Most measures exposed in the next table can generally be implemented on a local basis, according to local security practices (typically at ATSO level). The only exceptions are those measures that are explicitly applied to common resources (e.g., the backbone) or that require a specific co-ordination of different organisations (e.g., NET validation function).

Security measure	Applicability	Comments
Physical protection of ATN resources	ATN ESs ATN ISs	ATN subnetworks are assumed to be physically protected by already existing (non ATN-specific) measures ATN systems shall benefit from the existing environmental protections offered by the deployment sites (ACCs, airports, etc.). ATN systems shall be located in rooms accessible by authorised personnel only (using the existing physical access control procedures and/or devices of the site) ATN systems shall benefit from the existing backed-up power supply system (when offered by the deployment sites, e.g. in ACCs).
User/administrator access control to	ATN ESs	End-user access control is out of the scope of ATN security (e.g., authentication of pilots, controllers, etc.)

[14] This CNS/ATM 1 function is implemented in a/g BISs and allows them at the establishment of the BIS-BIS connection to check whether an adjacency may be established with the peer airborne BIS based on the airborne BIS NET. The ATN SARPs do not specify exactly how the NET validation function must determine the acceptability of the airborne router address but the most likely procedure will be the comparison of the address received from the airborne BIS with a list of authorised addresses configured at the level of each ATN a/g BIS.

ATN systems	ATN ISs	Only users/administrators with appropriate credentials will be able to alterate the ATN system behaviour (e.g., changing its configuration, uploading its log files, etc.). These access control mechanisms will be at a minimum based on the login & file protection mechanisms of the hosting operating systems (e.g., Unix-based for ProATN BISs)
ATN system administration procedures & training	Maintenance personnel	Appropriate training programs are set for ATN system maintenance personnel Appropriate procedures are applied for ATN system administration
No single point of failure & alternative routing	ATN network architecture	Redundancy provisions applicable to ATN ISs (a/g BISs or ground BISs), to their connectivity to ATN subnetworks (e.g., one a/g BIS can be connected to several VDL 2 VGSs), to the ATN subnetworks themselves (e.g., redundancy provided by the competing CSPs overlapping VDL 2 coverage), etc. Because of their importance (which goes beyond security concerns), this subject is generally handled in a separate way with respect to the other security measures.
Forwarding control	ATN ISs	Not available with currently available products (except for COTS IS-IS routers, which can generally use access lists)
Subnetwork-level security provisions	ATN ground subnetworks	Use of Closed User Groups (CUGs) or equivalent mechanisms within national packet switching networks and within the EAN Use of VLANs in local area networks
NET validation function	ATN a/g BISs	Co-ordination required (with Airlines)

3.3.11.3 Proposed Actions

The main actions that are necessary to have a secured initial ACCESS ATN are summarised below. Some actions are really focused on the deployment of security measures applicable to the initial ACCESS ATN, while others are already required in the initial ACCESS ATN timeframe for the future introduction of new security mechanisms applicable to the target ACCESS ATN.

Action SEC1	**To decide on the use (or the non-use) of the NET validation function for security purposes in the early stages of the ATN deployment**	**ATSOs, CSPs and Airlines**
Action SEC2	**To co-ordinate and agree on the security measures to be applied to the initial ACCESS ATN common resources (e.g., the backbone BISs): subnetwork-level measures (based on EAN facilities), user/administrator access control policy and configuration, etc.**	**All ATSOs (together)**
Action SEC3	**To define the security measures to be applied to the initially deployed national ATN infrastructures**	**Each ATSO individually**

Action SEC4	**To investigate the way dependability issues for the ATN network have to be coped with**	**ATSOs**
Action SEC5	**To complete and validate ATN SARPs to prepare security solutions that will allow to make the initial ATN network evolve to the secured target ATN**	**ATNP**

3.4 Certification Aspects

3.4.1 General

[A223] addresses the safety assessment and certification issues for the ACCESS area.

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 current works undertaken on certification aspects in the context of data link applications aim at allowing implementers to develop specific implementations of the data link system components (e.g., ATN 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. Those works stress 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 techniques and reference systems currently being developed by international bodies such as EUROCAE include that ATN data link services be assessed and certified as a separate entity to the ATN Communications Infrastructure (ACI). This ensures that new data link services can be developed and certified without the need to re-certify the underlying infrastructure. The safety requirements for ATN data link services can 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. New sub-systems such as routers 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 fallback procedures will need to be demonstrated as part of the safety assurance process.

3.4.2 Certification in the Initial ACCESS Timeframe

The operational implementations of data link services in the first stages of the transition to the initial ACCESS ATN are likely to be achieved on a local basis, generally under the authority of a single ATSO: thus, it may be possible to provide the necessary safety assurance to the regulating authority using existing procedures adopted for other safety critical systems (in the event of a particular data link service being introduced by many organisations, it would be beneficial for the later transition phases to co-ordinate and adopt consistent system acceptance criteria).

Subsequent ATN deployments will certainly be realised to expand the existing services to adjacent areas (e.g., encompassing new FIRs) or to start new data link services that make sense only if implemented on a regional basis. The co-ordination required by such a deployment is also necessary for the certification activities: the regulatory authorities will need to co-operate as to the role standards and tools such as CAERAF will take in the approval and certification of data link systems and services. 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.

In conclusion, the certification aspects are a critical aspect of the ATN deployment due to its very nature and, more specifically, to the new requirements raised by its distributed architecture made of both airborne and ground systems. The ongoing works about the certification of data link applications should help define the methodologies and standards that will be required for an operational use of the European ATN network.

3.4.3 Proposed Actions

Action CER1	**In the context of data link activities, to progress through the identification of the certification requirements applicable to the ATN components (both airborne and ground-based) and the definition of consequent methodologies and standards**	**ATSOs and Airlines**

3.5 Organisational Aspects

3.5.1 Introduction

The ACCESS project is essentially focused on technical issues; however, organisational aspects are of the greatest importance for the successful deployment of the ATN in Europe. This section outlines the main elements to be addressed in the organisational field to get an operational initial ACCESS ATN.

Elements of a likely organisation scheme for the operation of the initial ACCESS ATN network and its supported services are presented first.

In a second part, this section summarizes the operational procedures required by the initial ACCESS ATN for the provision of operational services.

Note that the co-ordination required by the transition to the initial ACCESS ATN and the derived organisational model should ideally result from a European programme set up for the deployment of operational data link applications and of the supporting ATN infrastructure across Europe - this programme would directly result from the expected high-level commitments of ATSOs to develop the data link and ATN activities (see section 3.1)-. The future LINK 2000+ programme proposed by Eurocontrol may provide the appropriate structures to meet the organisational requirements of the initial European ATN as proposed in this document.

3.5.2 European ATN Organisation

3.5.2.1 General

The overall deployment scenario is based on the assumption that the first ATN deployments are driven by local initiatives and/or pre-operational data link projects. Those deployments should therefore result in small nuclei of ATN infrastructures providing data link services on a relatively local basis and they should therefore not require extensive co-ordination efforts. Hence, organisational requirements for the support of the current ATN initiatives should be satisfied by ad-hoc project management structures, possibly on a multi-lateral basis depending on the project participants.

The initial ACCESS ATN deployment phase conversely raises questions about the organisational requirements to be taken into consideration and the consequent organisation to be adopted to meet those requirements. It is expected that the “reduced” organisational model used for the previous "local" ATN deployments will not be able to cope with the following deployments, once they will effectively go past local initiatives an/or projects. As soon as ATN services will be required on a distributed basis (even for pre-operational use) involving different organisations (ATSOs, AOs, etc.), a structured ATN will have to be built (possibly re-using the existing initial "local" infrastructures) and will consequently require specific co-ordination efforts and associated organisational schemes.

The organisational requirements of the initial ACCESS ATN deployment are assumed to be driven by the following needs:

- overall management
- deployment co-ordination
- operational co-ordination (maintenance and support)

3.5.2.2 Overall Management

The implementation of a pan-European ATN communication service based on existing national infrastructures must address a significant number of institutional issues if it is to become a reality.

The significant institutional issues which the managed pan-European ATN communication services raise are:

- Organisation
- Control and performance (SLA)
- Liability
- Security
- Start up financing
- Operating cost recovery
- Evolution and growth
- Roles and responsibilities
- Incorporation of new ATSO/Application Owner
- Exit of existing ATSO/Application Owner

There is a series of activities which will be necessary to put in place to facilitate the start up of the network. The activities need to define and agree control mechanisms for:

- Terms of reference
- Constitution
- Powers
- Operating agreements
- Business plans
- Marketing plan
- Charging policy
- Definition and recovery of operating costs

During the transition to the initial ACCESS ATN, there is a need for European ATN management structures allowing these activities to be performed with each participating organisation, clearly understanding its obligations responsibilities and commitments when agreeing to participate in the European ATN implementation venture.

3.5.2.3 Deployment Co-ordination

As for any network, individual ATSOs involved in the initial ACCESS ATN will likely consider the evolution/extension to their ATN network infrastructure in the context of strategic network planning activities, the goal of which is to keep the ATN infrastructure in line with the committed Quality of Service (QoS) and prepare it to support future user requirements in an efficient manner.

Typical strategic network planning activities include:

1. Trend analysis and identification of potential future bottlenecks

2. Evaluation of new user or application requirements

3. Design of the network topology extensions to meet the new service requirements or to keep the performance and QoS in line with the service objectives

4. Assessment of return on investment and cost prediction

5. Decision on the resulting investments

6. Planning of all investments both in operating staff and network upgrades/extensions.

7. Establishment of contracts, agreements and policies for interconnection and communication with other administrative domains.

8. Prospective work to support time to market for new services or technologies

The co-ordination for the deployment of the initial ACCESS ATN can be considered as the co-ordination of individual ATSOs network planning activities. However this is considering the deployment co-ordination process according to a bottom-up logic which may not become satisfactory as the European ATN grows, and is increasingly used by critical ATM applications: co-ordinating the individual network planning activities may allow to detect potential conflicts in the modifications planned by the individual ATSOs, but may not allow to implement a coherent common strategy for the evolution of the overall European ATN.

This approach will certainly be sufficient for the ATN deployments required by the current ATN initiatives as described in section 2. On the other hand, a top down approach may be more appropriate to the subsequent deployments leading to the initial ACCESS ATN: it would rely on the creation of a regional ATN Network Planning group in charge of defining the phased new objectives for the overall evolution of the European ATN. The new overall objectives would then be declined at the level of each individual ATSOs and taken into account into national ATN implementation plans

3.5.2.4 Operational Co-ordination

Organisational aspects for the co-ordination of the System Management activities in the European ATN, are discussed in [A227]. Three possible organisational approaches are identified for the supervision and administration of the overall European ATN:

1. A centralised approach, as proposed by the COPICAT study, with a central regional body responsible for the supervision and administration of the whole European ATN.

2. A distributed co-ordination approach, with total distribution of the responsibilities for the supervision and administration of the European ATN to the organisations owning the ATN components.

3. A combination of the 2 above options (referred as the centralised co-ordination approach) with distribution of the responsibilities for the supervision and administration of the ATN to the organisations owning the ATN components but delegations from these organisations of certain responsibilities for the overall co-ordination of inter-domain system management activities to a central European co-ordination body

In its review of current system management practices in Europe, [A207] shows that ATSOs are reluctant to transfer responsibilities on the network management of their own infrastructure onto another central organisation. [A207] also demonstrates that a centralised approach is not required and that system management co-ordination mechanisms can be implemented for achieving management of the global European ATN to maintain quality while holding individual organisations accountable for their network management roles and responsibilities. It appears therefore unlikely that a purely centralised approach will be acceptable to the European ATSOs for the system management of the European ATN.

On the other hand, the distributed co-ordination principles that have been followed up to now for the management of the international ATC networks such as the CIDIN or the national PSN interconnection in Europe, have been proven ineffective for the management of highly international infrastructure, involving a lot of organisations. The current trend for the management of the CIDIN as well as for the management of the ATSO interconnected networks is in the centralisation of certain co-ordination activities and responsibilities

In the deployment phase corresponding to the initial European ATN implementation, it is therefore assumed that the suitable approach for the system management of the European ATN will be the one referred as the centralised co-ordination model, where responsibilities for the supervision and administration of the national ATN is left in the hand 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 agency

In practice, it is assumed that a combination of the centralised co-ordination and distributed co-ordination approaches will be followed; it is indeed considered that even if an agreement can be reached for the centralisation of the main system management co-ordination activities, direct bi-lateral co-ordinations are indeed likely to go on, on certain aspects.

Implementing the centralised co-ordination model for the system management of the European ATN requires the establishment of a central system co-ordination entity in charge of the overall co-ordination for the administration and supervision of the European ATN.

3.5.2.5 European ATN Management Organisation

It results from the above considerations that an appropriate approach for the management of the overall European ATN is to initiate the creation of a centralised co-ordination entity. This entity could be structured in a way similar to the one which has been proposed for the administration and management of the EAN. The ATN central co-ordination body would then consist of the following three groups:

1. The European ATN Management Group

   Set up with membership drawn from all participating ATSOs and airlines, this group is proposed to be responsible for defining, maintaining and reviewing the agreed standards, agreements, terms of operation, charging policy, cost recovery, terms and conditions etc. The group will have the responsibility of the strategic control and development of the infrastructure.

2. Network Administration and Engineering Group

   The Network Administration and Engineering Group would consist of a small permanent core staff, responsible to the European ATN Management Group for managing the administrative activities of the group and preparing the engineering changes to the overall European ATN network including maintenance and review of Service Level Agreements and Interconnection Agreements. Any changes which have policy or investment implications would have to be endorsed by the European Management Group. This group would monitor the evolution of the European ATN, consider changes undertaken by the organisations in the region, perform analysis of the consequence and simulation studies, propose solutions for potential regional routing, performance or other problems, process accounting information, generate the bills, collects and then dispatch the revenue, etc. To summarise, this group would be in charge of the off-line fault, performance, configuration, security, and accounting management co-ordination activities for the overall European ATN.

   This function would require a permanent group working normal office hours. It could be delegated as a specific responsibility to one or several of the participating organisations.

3. Tactical Operations and Help Desk

   This group would operate on a 24-hour per day basis, providing real time support for network activities. Problems that are unable to be resolved by this group would be referred to the Network Administration and Engineering group and ultimately to the steering group.

This function could also be delegated as a specific responsibility to one or several of the participating organisations.

This organisational model for the operation of the ACCESS ATN should be compatible with the organisational and institutional solution proposed by the ATNI-TF ATNII study, which suggests to split regulatory functions, operational management functions (EACE) and administrative management functions (EATNA) and to affect them to distinct adequate entities.

3.5.2.6 Proposed Actions

Action ORG1	**To specify and approve an organisational model and the ensuing structures required for the operation of the initial European ATN**	**ATSOs and Airlines**
Action ORG2	**To study the central help desk assignments so as to clearly define its boundaries with the involved ATSOs' network management structures**	**ATSOs**
Action ORG3	**To study further the most adequate and acceptable organisation to back up help desk functions, taking into account on the one hand the various languages that may need be handled, and on the other the possible systems or procedures that would be placed at users' disposal for request or claim purposes (telephone, fax, electronic mail, etc.)**	**ATSOs**

3.5.3 Operational Procedures in ACCESS

3.5.3.1 Introduction

Section 3.5.3 summarizes the operational procedures that are required to get operational ATN services.

The description of the related actions can be found in the previous sections of the document, where they are applicable.

3.5.3.2 Procedures Related to ATSC Air/Ground Services

Operational procedures need to be specified concerning the use of the data link services in operation in the ACCESS. Without these procedures the data link will not be correctly implemented. The ICAO SARPs guarantee a full technical interoperability between air and ground ATN systems but leave a lot of flexibility on the use of the provided application service. Rules to guarantee the operational interoperability need to be defined at the regional level.

These regional procedures must be uniform and standardised in the ACCESS region in compliance with the applicable ICAO procedures.

- **General Procedures**
  - Administrative mechanisms must be defined to indicate data link capability for a given facility which provides air traffic services. Examples would include Jeppesen charts,

Advisory Circulars, Aeronautical Information Publication (AIP), Notices to Airmen (NOTAMs) or Systems Management exchanges to inform potential users of the services available from a specific facility or facility type.

- Other mechanisms must be defined to advise aircrew and controllers of any scheduled data link communications services' unavailability.

- **DLIC Procedures**

  - Procedures must be established to support the initiation of the CM process. Back-up voice procedures among users must be established to support the abnormal initiation of the CM process (for instance in case of CM version incompatibility).

  - Pilot procedures must specify how the optional fields in the air-initiated CM-logon messages must be input. For instance, the facility information must be included in a Logon request for the specific facility with which data link communication is intended.

  - Administrative mechanisms must be defined to provide aircraft with and maintain CM ground addresses required by the aircraft to initiate the CM process.

  - Administrative mechanisms must be defined for ATSOs to get the ATN addresses of the adjacent CM ground systems required to initiate the CM-contact and CM-forward services. Examples would include Aeronautical Information Publications (AIP) or System Management exchanges. Other mechanisms are needed to disseminate in real time any update of this addressing information.

  - Operational procedures must define the time slot before the entry in the airspace in which the logon must be initiated by the aircraft (e.g. 25 minutes) or the contact must be triggered by the ground (e.g. 10 minutes after sending the NDA).

- **ACM Procedures**

  - Procedures must indicate the option selected in Europe when the ICAO procedures / SARPs are open. For instance: who is the initiator of the CPDLC links (ground or aircraft) during a transfer of communications.

  - Procedures must be established concerning the initiation and re-initiation of the CPDLC link (e.g. who takes the initiative to re-establish a link, number of retries, etc…). Back-up voice procedures must be defined.

  - Procedures must be defined when ATSUs elect to implement and use ground-ground exchange in support of the ACM service. Bilateral agreements and local procedures need to be set up.

- **CIC Procedures**

  - The set of the allowed messages must be defined, as well as requirement to use the Logical Acknowledgement, definition of mixed data/voice environment procedures (clear and unambiguous procedures for reversion to voice in abnormal situations must be published in relevant documentation, condition of use of the voice channel, precedence of voice messages over data link messages, etc…).

  - Procedures must indicate the option selected in Europe when the ICAO procedures / SARPs are open. For instance: number of message elements allowed in a CPDLC message (1 to 5).

  - Procedure must indicate how and under which circumstance pre-formatted free text messages can be used in the ACCESS area.

- **DSC Procedures**

  - The set of allowed DSC messages and the use of these messages must be defined through regional operational procedures and published in AIPs, condition of reversion to voice.

  - Conditions of closure of the DSC link by the aircraft must be specified.

- **DCL Procedures**

  - Local procedures must define the time period prior the departure from which the DCL service is available and if the DCL service is still available during taxiing.

- **FLIPCY Procedures**

  - Procedures between adjacent ATSUs must be defined to disseminate and/or co-ordinate the flight plan modifications in case of discrepancy.

3.5.3.3 Procedures Related to the ATN Network Operation

In order to ensure a high service level, the day-to-day activities mostly relate to network supervision. This refers to the five famous Systems Management Functional areas as defined by ISO, that are configuration management, fault management, performance management, security management and accounting management. It is not intended to describe further all functions in those domains, but only the most obvious and undeniable ones (operational scenarios for the co-ordination of systems management activities are discussed in [A227]).

ATN supervision co-ordination activities will cover:

- Monitoring of the overall European ATN, problem tracking, expertise and resolution;

- Monitoring of the overall European ATN performance (resource utilisation rates, trunk and Routers utilisation rates, transit delays);

- Monitoring of the overall European ATN behaviour as regards security and contingency aspects;

- Reporting on the overall European ATN operations (resource utilisation and availability, outages, intrusion attempts, etc.) in order to either prove that the expected QoS has been delivered or determine areas which need improvements;

- Reporting on the overall European ATN utilisation (traffic loads, peak traffic, utilisation times, spare capacities, etc.) in order to provide material for network consolidation or billing purposes.

To perform the tasks listed above in an consistent and efficient manner, participating ATSOs have to harmonise network service indicators, that is to obtain at least the same perception of QoS, priority scheme, safety and security levels for instances. Additionally the participating ATSOs have to implement common mechanisms for the real time and/or off-line exchange of management information across administrative domain boundaries.

In the long term, it may be assumed that these activities will rely on the use of solutions standardised by the ICAO SARPs on ATN System Management (e.g. CMIP, Boundary MIB and Boundary Management Systems). However, the development of these SARPs is at a very early stage and it is unlikely that these standard solutions will be applicable in the time frame of the initial ACCESS ATN.

For the the initial ACCESS ATN implementation, it will be necessary to specify interim cross-domain system management co-ordination procedures. In this domain, it is recommended to go step by step taking advantage and gaining experience from the already started and ongoing activities on the management of the EAN infrastructure, but also moving forwards to a smooth implementation of the ICAO standard solutions.

It must furthermore be noted that although the ICAO SARPs on ATN system management will guarantee a full technical interoperability between management systems, they may not be explicit on the operational procedures governing the effective ways co-ordination will be achieved between the network operators. These procedures need to be defined at the regional level.

It is assumed that the first priority in the implementation of cross-domain systems management functions will be related to the real-time exchange of trouble tickets, and performance data for co-ordinating fault and performance management activities, and to basic off-line exchange of configuration and accounting information.

4. Target ATN Deployment

That step should lead to the deployment of the target European ATN network in the ACCESS area. It is likely to occur in the 2005-2010 timeframe.

However, as presented in section 1.2.2, the absence of any concrete political decision towards an ATN deployment in Europe makes it difficult to produce realistic implementation plans and resulting schedules for the transition to the initial ACCESS ATN. Consequently any attempt to sketch out a transition to the target ACCESS ATN is all the more difficult since realistic transition elements are really looked for.

That is why no transition scenario to the target is worth being proposed by the ACCESS project. It seems to be far more useful at this stage of the study to identify the necessary actions to make operational ATN deployments a reality for the initial ACCESS timeframe, as the first ATN "steps" will surely condition the whole ATN deployment scenario.

5. Actions Summary

The actions that have been identified in the previous sections of the document are reminded below in Table 3 REFMERGEFORMATTable 3(that table sequentially presents them in the order of their first appearance in the document).

<u>Note</u>: whereas the first column holds a sequential reference of each action allowing to identify the associated technical domain (see Table 2 *below), the second column classifies the actions according to their category as proposed hereafter:*

- *P = strategic / political decision*
- *M = management / co-ordination*

S = technical study / planification

- *T = development / test / validation*
- *D = operational deployment*

The last colum of the table presents the dependencies between the proposed actions (generally, actions that have to be completed prior to the referenced action initiation).

Action	*Associated "technical" domain*
S	*ATN services*
G	*ATN ground subnetworks*
V	*ATN VDL Mode 2 subnetworks*
AMSS	*ATN AMSS subnetworks*
DLS	*Data link server*
ATC	*ATC systems*
INT	*ATN internet*
Pro	*ProATN router product*
RRI	*ATNSI/RRI router product*
R	*ATN routers*
AS	*Airborne systems*
NM	*Network management*
SEC	*Security*
CER	*Certification*
ORG	*Organisational issues*

Table 2: Action References and Associated Domains

Action	Cat.	Description	Actionee	Dependency
S1	P	To support the development of a Regional ATN Service Implementation Plan.	All ATSOs & Airlines together (e.g., in the frame of LINK2000+)	none
S2	S	To specify the Regional ATN Service Implementation Plan, based on the services proposed in this document: CPDLC services: ACM and CIC (in en-route ATSUs), DCL (in major airports) and DSC (in oceanic en-route ATSUs), ADAP services: APR and FLIPCY (in oceanic en-route ATSUs), D-FIS services: one ATIS server per ATSO DLIC service (in all en-route ATSUs providing a/g services).	ATSOs & Airlines (e.g., in the frame of LINK2000+)	S1
S3	P	To commit to support the ATN Service Regional Implementation Plan (as a result of action S2).	All ATSOs & Airlines together	S2
S4	S	To develop a National ATN Service Implementation Plan consistent with the Regional ATN Service Implementation Plan	Each ATSO individually	none *(but in close co-ordination with S2)*
S5	S	To define the region-wide operational procedures consistent with the ICAO procedures in order to operate the services defined in Regional Plan	A European operational group (e.g. ODIAC, EUROCAE, ICAO Regional Group)	none *(but in close co-ordination with S2)*
S6	S	To support the development of a Regional AMHS Implementation Plan	ATSOs together (e.g., SPACE)	none
S7	S	To develop a National AMHS Implementation Plan with an optional direct use by "native users" through AMHS Message Servers	Each ATSO individually, or together (e.g., SPACE)	none
S8	P	To launch the deployment of the national AMHS infrastructure (as a result of action S7)	Each ATSO individually	S7
S9	D	To deploy a national AMHS infrastructure with an optional direct use by "native users" through ATS Message Servers	Each ATSO individually	S8
S10	D	To interconnect national AMHS infrastructures in accordance with the Regional AMHS Implementation Plan	ATSOs	S6 *(SPACE result)* S9
S11	D	To deploy an AMHS interface with the AFTN network of non-European regions.	Some ATSOs	S6 *(SPACE result)*
G1	S	To define the common ground subnetwork X.25 interconnection scheme and the related technical requirements (throughput, transit time, etc.).	All ATSOs directly connected to the	none

			EAN	
G2	D	To ensure the ATN deployment is compatible with the EAN deployment (geographic coverage in the ACCESS area, schedules, access requirements, etc.).	All ATSOs	G1
V1	S	To define a VDL Mode 2 profile for ATN systems and to validate a VDL Mode 2 subnetworks' architecture (a/g BIS siting, interconnection scheme with CSPs, etc.).	ATSOs with CSPs	none
V2	T	To make VDL Mode 2 / ATN trials with aircraft.	ATSOs with CSPs and Airlines	none
V3	D	To ensure that CSPs' VDL Mode 2 deployment strategy and activities are compliant with the ATN implementation plan.	ATSOs	V1
V4	M	To define and contract SLAs (both commercial and technical) for VDL Mode 2 connectivity provided by CSPs.	ATSOs with CSPs (and Airlines with CSPs)	V3
AMSS1	P	To clarify whether AMSS will be used or not in Europe (and possibly to which purpose).	ATSOs & Airlines (together)	none
AMSS2	S	To define an AMSS profile for ATN systems and to validate an AMSS subnetworks' architecture (e.g., a/g BIS siting, interconnection scheme with providers).	Involved ATSOs	AMSS1
AMSS3	T	To make AMSS trials with aircraft.	Involved ATSOs with CSPs (and Airlines with CSPs)	none
AMSS4	M	To define and contract SLAs (both commercial and technical) for AMSS connectivity provided by satellite service providers.	Involved ATSOs with CSPs (and Airlines with CSPs)	AMSS2
AMSS5	S	To follow the satcom market evolutions (e.g., new LEO/MEO offers) in relation with ATSC needs.	Some ATSOs	none
DLS1	S	To validate the concept of ATN data link server and enable further evaluation at the ACCESS area scale through European data link programmes.	All ATSOs (in close co-ordination with EuroAGDL)	none
DLS2	T	To define and integrate ATN data link servers' system management capabilities for both intra- and inter-domain management.	Each ATSO	DLS1
DLS3	S	To follow ATN ES products (e.g., ProATN, ATNSI/ACI) development to ensure their availability for use in data link servers.	ATSOs	DLS1
DLS4	T	To harmonise the developments of ATN data link servers throughout Europe and plan their operational integration.	All ATSOs together	DLS1
DLS5	D	To deploy data link servers.	Each ATSO	S3

			individually	S4 [15] DLS2 DLS3
DLS6	D	To decide on the implementation of additional ATN data link servers (e.g., in approach ATSUs) in the frame of the National Implementation Plan.	Each ATSO individually	DLS5
ATC1	P	To launch study and development programs aiming at integrating the data link capability in the existing operational ATC systems (CWPs, FDPS, etc.).	Each ATSO	S4
INT1	S	To define the European backbone router architecture.	ATSOs with CSPs	SEC4
INT2	S	To define the various national parts of the initial ACCESS ATN internet (a/g BIS siting, connection to the backbone, internal topology, etc.).	Each ATSO	S4 SEC4
INT3	S	In the field of network planning and consequent implementation activities, to investigate network modelling and simulation tools and to develop experience in the modelling of ATN networks.	ATSOs	none
INT4	D	To deploy the ATN internet.	ATSOs & CSPs	S3 INT1 INT2 INT3 G2 V3 Pro2 Pro3 RRI 1, 2 & 3 ORG3 NM3 NM4 NM5 SEC2 SEC3
Pro1	T	To integrate network management capabilities in ProATN routers.	ProATN a/g BIS suppliers	none
Pro2	T	To validate ProATN routers in operational environments.	ProATN a/g BIS users	Pro1
Pro3	M	To define maintenance & support policy for ProATN routers.	ProATN a/g BIS suppliers	none
RRI1	S	To follow ATNSI/RRI project & resulting ground-based router product availability.	ATSOs & Airlines	none
RRI2	M	To define ATNSI/RRI marketing & licensing policy (product distribution, portable software vs. industrialised product, etc.).	ATNSI/RRI suppliers	none
RRI3	M	To define ATNSI/RRI maintenance & support policy.	ATNSI/RRI suppliers	none
R1	S	To investigate requirements for route server project.	ATSOs	none
R2	S	To investigate the existence of other ATN BIS products (e.g., Raytheon).	ATSOs	none

[15]The effective deployment of data link servers by an ATSO assumes a prior (political) commitment to operate a/g services based on the national ATN service implementation plan (as specified as a result of action S4), that commitment being implicitly derived from the high-level commitment to support the European implementation plan (action S3).

AS1	S	To follow ATNSI/ACI airborne product development process (router & ASEs).	ATSOs & Airlines	none
AS2	S	To follow Airlines' strategy and programmes with respect to ATN equipment. To follow avionics vendors strategy and activities with respect to ATN airborne systems.	All ATSOs	none
NM1	S	To further progress in the required general studies onthe institutional, organisational and other non-technical issues germane to the System Management of the European ATN.	ATSOs, CSPs, Airlines	none
NM2	S	To study the minimum requirements for the overall European ATN management in terms of network monitoring and reporting functions (definition of service indicators, service alarm thresholds, procedures for the report and the tracking of troubles etc.).	ATSOs with CSPs and Airlines	none
NM3	M	To define bi- or multi-lateral agreements for system management exchanges and procedures between organisations (for initial deployments).	ATSOs, CSPs, Airlines	NM1 NM2
NM4	P	To endorse the creation of an organisational structure for the management of the European ATN.	ATSOs, CSPs, Airlines	NM1 ORG1
NM5	T	To provide for the appropriate products required to manage the European ATN within national administrations (e.g. Agents, National NMS, Boundary NMS, Network Viewer Tool).	ATSOs	none
NM6	S	To complete and validate ATN SARPs to allow then the development and integration of the related NM products, which will allow to ease the transition to target ATN network management solutions.	ATNP	none
SEC1	S	To decide on the use (or the non-use) of the NET validation function for security purposes in the early stages of the ATN deployment.	ATSOs, CSPs and Airlines	none
SEC2	S	To co-ordinate and agree on the security measures to be applied to the initial ACCESS ATN common resources (e.g., the backbone BISs): subnetwork-level measures (based on EAN facilities), user/administrator access control policy and configuration, etc.	All ATSOs (together)	none
SEC3	S	To define the security measures to be applied to the initially deployed national ATN infrastructures	Each ATSO individually	none
SEC4	S	To investigate the way dependability issues for the ATN network have to be coped with.	ATSOs	none
SEC5	S	To complete and validate ATN SARPs to prepare security solutions that will allow to make the initial ATN network evolve to the secured target ATN.	ATNP	none
CER1	S	In the context of data link activities, to progress through the identification of the certification requirements applicable to the ATN components (both airborne and ground-based) and the definition of consequent methodologies and standards.	ATSOs and Airlines	none
ORG1	P	To specify and approve an organisational model and the ensuing structures required for the operation of the initial European ATN.	ATSOs and Airlines	S3 S6

ORG2	S	To study the central help desk assignments so as to clearly define its boundaries with the involved ATSOs' network management structures	ATSOs	ORG1
ORG3	S	To study further the most adequate and acceptable organisation to back up help desk functions, taking into account on the one hand the various languages that may need be handled, and on the other hand the possible systems or procedures that would be placed at users' disposal for request or claim purposes (telephone, fax, electronic mail, etc.)	ATSOs	ORG2

Table 3: Proposed Actions

REFMERGEFORMATFigure 21Figure 21 below highlights the dependencies between the various actions (some actions are not represented in the figure - see further). That figure also allows to identify the main technical domains requiring specific actions (e.g., organisational issues, ATN products availability, ATN subnetworks availability, etc.), while particularly outlining the *ATN service-driven approach* of the study, whereby the operational deployment of the European ATN infrastructure (ATN internet, data link servers, etc.) results from a few initial high-level commitments to implement ATN-based services across the ACCESS area (data link a/g and AMHS services).

Although not particularly aiming at representing how actions can be relatively scheduled in time, the figure nevertheless allows to identify the general outlines of an implementation schedule. Basically:

- actions placed at the periphery of the figure can generally be started with no pre-requisite, thus suggesting they could be part of the first actions to be launched,
- the more an action is centrally placed, the more it is dependent on the completion of prior actions: hence such an action normally should not be started in the early times of the implementation process.

However, that "flat" interpretation of the figure cannot yield a realistic schedule of the actions, as no importance is given to the effective scope of each action and to the consequent time (or efforts) required to complete them. To that purpose, some actions are marked as *high priority actions* in the figure, which means that they should be started as soon as possible in the implementation process, either because their completion is likely to take some time and/or require many efforts or because they are of particular importance (e.g., political decisions) and can thus highly impact, directly or not, the way other actions will be effectively accomplished[16].

The proposed high priority actions are listed below:

- S1 obviously conditions the whole ATN implementation process in Europe,
- S4 and S7 are of particular importance for each country and can be started independently by each ATSO, provided the resulting national implementation plans will be conformant to the European implementation plan,
- ATC1 is to be started as soon as possible as ATC legacy systems usually require specific development processes,

[16]Note that, according to the figure, some of those high priority actions do depend on the completion of prior actions that are not similarly classified (ideally, those prior actions should be completed *before* the high priority one). This is due to the fact that the high priority action has a particular importance for the implementation process and/or that it can be started even if the prior actions are not fully completed.

- CER1, ORG1 and NM1 are thought to be decisive actions that can highly impact the whole ATN implementation process,

- Pro2, RRI1, DLS3 and V3 are the actions to be stressed in the area of ATN components for getting operational ATN network nuclei in Europe (assuming ProATN will be used before the availability of operational RRI routers for Pro2 action).

Note that DLS1 and S6 have not been classified as high priority actions because they are considered to be partially started through other projects (respectively, EuroAGDL and Space).

Actions not represented in the figure are actions which can be started with no pre-requisite and which do not *directly* affect ground-based ATN deployments: they are however necessary because they are related to airborne deployments (e.g., actions AS1, AS2, V2 and AMSS3), because they can change *the way* transition to the initial ACCESS ATN will occur (e.g., actions G3, AMSS5, R2, SEC1) or because they are necessary to prepare future extensions of the initial ACCESS ATN (e.g., actions R1, SEC5, NM6).

REFMERGEFORMATFigure 21Figure 21 also outlines that the operational deployment of the initial ACCESS ATN infrastructure (especially, the ATN internet and data link servers) can only be achieved as the result of various actions, ranging from technical studies (aimed at preparing strategic decisions concerning the Regional ATN Service Implementation Plan and at providing adequate technical and organisational solutions for the initial ATN deployments) to development and validation activities that shall ensure the availability of operational ATN components.

Note: some actions should be done in close co-ordination with other actions for obvious efficiency reasons, although there is no theoretical dependency between them (e.g., actions S2 and S4). Note also that the figure represents a likely but still uncompletely defined link between actions pertaining to certification aspects (CER1) and actions regarding some ATN infrastructure basic components such as routers, end systems and maybe subnetworks.

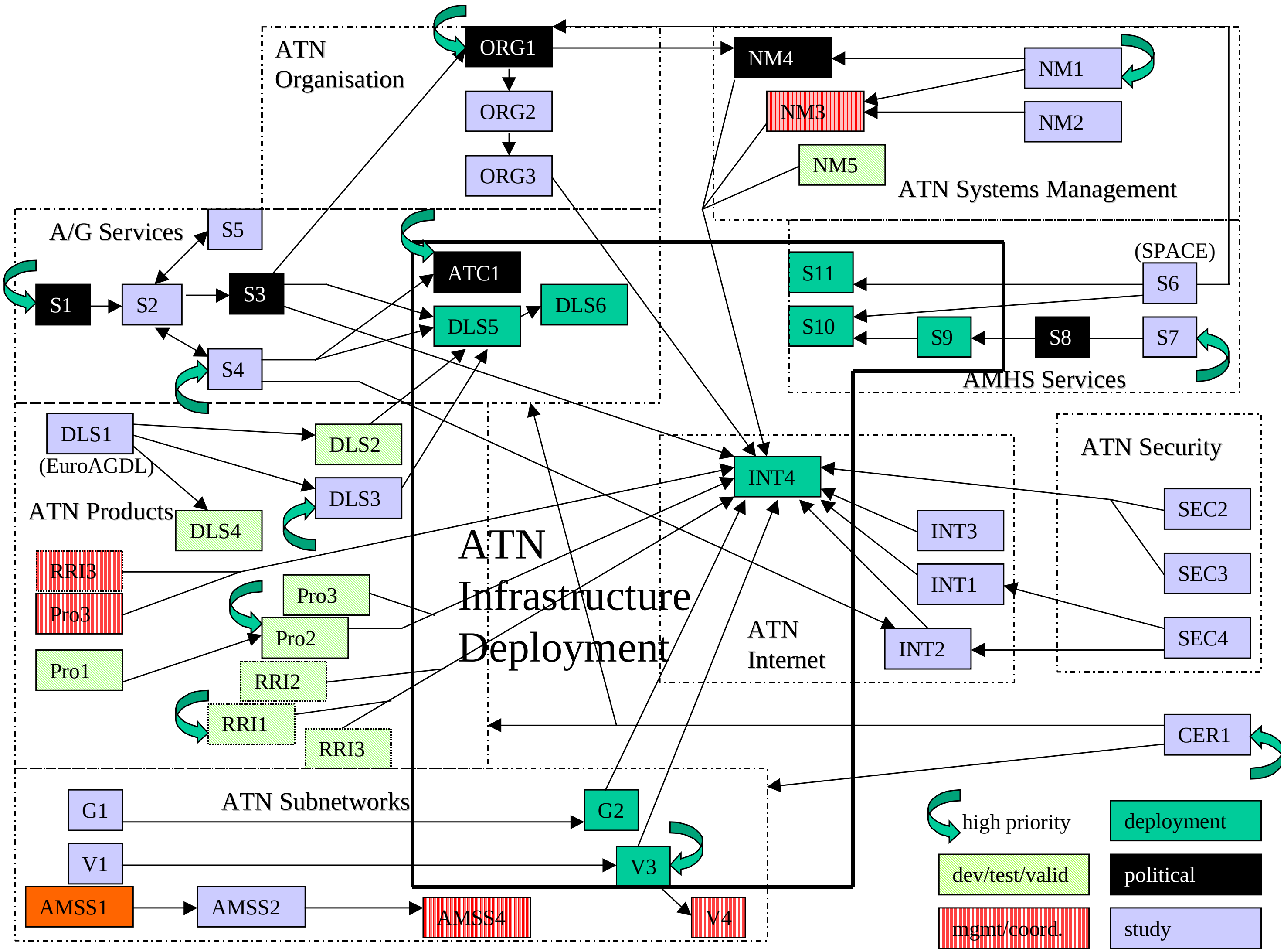


Figure 21: Dependencies between Actions

6. Conclusion

It is believed that only a political, strategic decision to deploy a set of operational ATN-based data link services in Europe (i.e., a subset of data link air/ground services and AMHS services, in a first step) can trigger the deployment of a European ATN network.

Unfortunately, in the absence of such a decision, many uncertainties still surround the ATN deployments in Europe: that is why no transition plan can be reasonably proposed to the target European ATN.

The study has consequently been refocused on the only transition elements that can be based on facts or reasonable prospectives. That approach allows to identify realistic transition steps towards an *initial European ATN*, initially based on the operational European ATN nuclei that will emerge from already started pre-operational and "local" ATN initiatives such as Petal II or EuroVDL, and then benefiting from the progressive expansion of operational ATN-based services to a regional scale, thanks to the application of an appropriate Regional ATN Implementation Plan.

Consequently, it is thought that the *initiation* of wide-scale European ATN deployments is the key factor for the deployment of an operational European ATN because that step requires a prior high-level commitment of ATSOs to develop operational ATN-based services in Europe (e.g., through a limited set of data link ATSC services). It is expected that the LINK2000+ programme that should be launched by Eurocontrol will provide the appropriate structures to create the conditions that will allow those deployments.

In any event, although AOC is not targeted by the ACCESS study, it is likely that the will to develop AOC applications on top of ATN/VDL Mode 2 subnetworks will allow to deploy (part of) the infrastructure required by the operational use of ATN-based ATSC services.

Finally, no matter how or when the expected momentum to develop an operational ATN will be available, the report has already allowed to identify a *set of actions* that are thought to be decisive for the transition to an initial European ATN network as specified in the deployment plan presented in the document.

Acronyms

ACARS	Aircraft Communications and Reporting System
ACC	Air Traffic Control Center
ACM	ATC Communication Management
ADAP	Automatic Dowlink Aircraft Parameter
ADS	Automatic Dependent Surveillance
AFTN	Aeronautical Fixed Telecommunication Network
A/G	Air/Ground
AMHS	ATN Message Handling System
AMSS	Aeronautical Mobile Satellite Service
AO	Airline Operator
AOC	Aeronautical Operational Communications
AORE	Atlantic Ocean Region (East)
AORW	Atlantic Ocean Region (West)
APO	Airport Operator
APR	Aircraft Parameter Reporting
ARINC	Aeronautical Radio Inc.
ASE	Application Service Element
ATC	Air Traffic Control
ATIF	ATN Trials Infrastructure
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATNI-TF	ATN Implementation Task Force
ATNP	ATN Panel
ATS	Air Traffic Services
ATSC	Air Traffic Service Communications
ATSMHS	Air Traffic Service Message Handling System
ATSO	Air Traffic Service Organisation
ATSP	Air Traffic Service Provider
ATSU	Air Traffic Service Unit
BIS	Boundary Intermediate System
CAA	Civil Aviation Authority
CAERAF	Common American European Reference ATN Facility
CIC	Clearances and Information Communications
CLNP	Connectionless Network Protocol
CLTP	Connectionless Transport Protocol
COTS	Common Off The Shelf
CM	Connection Management
CMIP	Common Management Information Protocol
CNS	Communications, Navigation and Surveillance
CPDLC	Controller-Pilot Data Link Communications
CSP	Communication Service Provider
CWP	Controller Working Position
DCL	Departure Clearance
DLIC	Data Link Initiation Capability
DSC	Down Stream Clearance
D-FIS	Data Link Flight Information Service
DFS	Deutsche Flugsicherung
D-OTIS	Data Link Operational Terminal Information Service
EACE	European ATN Co-ordination Entity
EAN	European Aeronautical Network

ES	End System
FANS	Future Air Navigation System
FDPS	Flight Data Processing System
FIS	Flight Information Service
FLIPCY	Flight Plan Consistency
GES	Ground Earth Station
GNS	Global Network Services
HFDL	High Frequency Data Link
IACSP	International Aeronautical CSP
ICAO	International Civil Aviation Organisation
IDRP	Inter-Domain Routing Protocol
IOR	Indian Ocean Region
IS	Intermediate System
IS-IS	Intra-Domain Routing Protocol
ISO	International Standard Organisation
LAN	Local Area Network
LEO	Low Earth Orbit
MEO	Medium Earth Orbit
MIB	Management Information Base
MTA	Message Transfer Agent
NAT	North Atlantic
NATS	National Air Traffic Services
NET	Network Entity Title
NGSS	Next Generation Satellite Systems
NSM-TF	Network & System Management Task Force
OSI	Open Systems Interconnection
PKI	Public Key Infrastructure
POR	Pacific Ocean Region
PSN	Public Switched Network
PTT	Public Telephone & Telegraph
QoS	Quality of Service
RD	Routing Domain
RDC	Routing Domain Confederation
RDPS	Radar Data Processing System
RGS	Radio Ground Station
SARPs	Standards and Recommended Practices
SITA	Société Internationale Télécommunications Aéronautique
SLA	Service Level Agreement
SNMP	Simple Network Management Protocol
SSP	Satellite Service Provider
STNA	Service Technique de la Navigation Aérienne
TMA	Terminal Manoeuvering Area
VDL	VHF Data Link
VDR	VHF Digital Radio
VGS	VDL Ground Station
VHF	Very High Frequency
WAN	Wide Area Network