NORTH ATLANTIC (NAT) REGION

AIR TRAFFIC MANAGEMENT (ATM)

CONCEPT OF OPERATIONS

Prepared on behalf of the North Atlantic Systems Planning Group April 1999

FOREWORD

The *North Atlantic (NAT) Region Air Traffic Management (ATM) Concept of Operations* is published by the North Atlantic Systems Planning Group. It describes the current and anticipated future operations for the North Atlantic Region.

The NAT SPG will issue revised editions of the Document as required to reflect any changes that occur.

Copies of the *North Atlantic (NAT) Region Air Traffic Management (ATM) Concept of Operations* can be obtained by contacting:

EUROPEAN AND NORTH ATLANTIC OFFICE OF ICAO

e-mail	:	icaoeurnat@paris.icao.int
Internet	:	
Fax	:	+33 1 46 41 85 00
Mail	:	3 bis Villa Emile Bergerat 92522, Neuilly-sur-Seine CEDEX FRANCE
PCO e-mail	:	natpco@btconnect.com
PCO web site		www.nat-pco.org

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1. PART I – GENERAL

1.1 SCOPE OF THE NAT REGION ATM CONCEPT OF OPERATIONS

1.1.1 The intent of this concept of operations is to be requirements-led, rather than technology-driven. Technology changes must enable a system requirement and be either cost-beneficial or meet a direct user requirement.

1.1.2 This document is structured in three parts, with the first part explaining the basic operating principles of the NAT region, the basic operation of the current system and the inherent shortcomings. The second part of the document explains the future demands which will be placed on the system, essentially growth in traffic demand and changing user requirements. The final part explains the technology changes that will be required to overcome the existing system deficiencies and to meet future system requirements.

1.1.3 As cost-benefit analyses are still in progress for some of the longer-term system changes, the third part of the document only details those service improvements that are feasible before 2005. It is intended that once the cost benefit analyses are complete, a longer-term view can be taken and Part 3 updated accordingly.

1.2 BASIC PRINCIPLES USED IN THE DEVELOPMENT OF THIS DOCUMENT

Introduction

1.2.1 The NAT Region ATM Concept of Operations takes account of the principles given below in the development and operation of the future NAT ATM System. These principles were endorsed by the Limited (COM/MET/RAC) NAT Regional Air Navigation (LIM NAT RAN) (1992) Meeting and subsequently approved by the ICAO Council. It is intended that the concept is given in sufficient detail to provide the necessary guidance for further work in planning for and implementation of facilities and services in the NAT Region to the year 2005.

General principles

1.2.2 The future NAT ATM System should provide for improved regularity and efficiency of air traffic with the same or higher level of safety as that of the present system. ATM in the NAT Region must function as a single system. Any differences between the ground systems must be transparent to the user.

1.2.3 The future NAT ATM System should be developed on a system basis and in balance with other parts of the overall air navigation infrastructure. Orderly transition from the present system to the future concept, including adequate lead times, is of primary importance. However, the concept should allow for flexibility in implementation under the guidance of the North Atlantic Systems Planning Group (NAT SPG) and changes in user requirements.

1.2.4 The concept should be adaptable to the particular requirements in the various parts of the NAT Region and there should be no disparity in the level of service to a degree, which is detrimental to the expeditious flow of air traffic. System development must be harmonised to enable future technologies to be accommodated in a consistent fashion throughout the NAT Region. The system must also be compatible at the interfaces with the ATM systems in adjacent Regions.

1.2.5 All proposals, including transition from High Frequency (HF) voice to data communications, should be considered in the light of likely financial implications for users and providers and due regard should be given to possible alternative solutions and operational cost/benefit considerations. Safety considerations may also drive certain technical improvements.

1.2.6 The future NAT ATM system should take into account the need to achieve maximum economy of flight operations and the need for compatibility between the airborne and ground systems. It should also permit the optimum exploitation of the capabilities of advanced airborne equipment.

1.2.7 All foreseeable airspace user requirements should be taken into account when the system is defined.

1.2.8 Due account should be taken of the new technology foreseeable in the air navigation field in the time-scale under consideration.

Specific principles

Use of existing technology

1.2.9 Existing technology should be utilised wherever it offers benefits.

ATM System Capacity/Efficiency

1.2.10 The aim of the future ATM system should be to efficiently satisfy the demand of all users of the airspace. It must be recognised, however, that it may not be practicable to provide for excessive peak levels of air traffic without adverse effects on efficiency. The system must also be designed so as to be easily expandable to meet anticipated future growth.

Allocation of Responsibility

1.2.11 ATM functions will remain the responsibility of the Air Traffic Services (ATS) provider, while the responsibility for navigation will remain with the pilot in command. ATM consists of a ground and an air part, where both parts are integrated through defined procedures and interfaces, to ensure the safe and efficient movement of aircraft. ATM comprises ATS (which includes Air Traffic Control (ATC), Flight Information, and Alerting Services), Air Traffic Flow Management (ATFM), and Airspace Management (ASM).

Air Traffic Services

1.2.12 The ATC service maintains a safe, orderly and expeditious flow of air traffic by applying separation between aircraft and by issuing clearances to individual flights as close as possible to their preferred profiles, taking into account the actual state of airspace utilization and within the general framework of ATFM measures when applicable.

1.2.13 The objective of the Flight Information Service is to provide advice and information useful for the safe and efficient conduct of flights.

1.2.14 The purpose of the Alerting Service is to notify appropriate organizations regarding aircraft in need of search and rescue aid and assist such organizations as required.

Air Traffic Flow Management

1.2.15 ATFM is needed to support ATC as a planning tool by providing for an optimum flow of air traffic to or through areas during times when demand exceeds or is expected to exceed, the available capacity of the ATC system. Oceanic ATFM service should be interfaced with domestic ATFM organizations/units to provide maximum harmonization and unified ATC application

Airspace Management

1.2.16 The main objective of ASM is the avoidance of permanent reservation of parts of the airspace for one particular user. This applies to all airspace, but the objective is of special importance in airspace where the ATM system is based on a floating track structure rather than on a fixed network of tracks.

Level of Automation and Associated Human Factors

1.2.17 Further advancement of automation or computer assistance will be required for the future development of the system. The development of automation must be balanced against the need for operational flexibility.

Compatibility in Data Exchanges

1.2.18 The data exchanges required within the future system must be *Standards and Recommended Practices* (SARPS) -compliant.

1.3 OVERVIEW OF THE CURRENT NAT SYSTEM

1.3.1 The NAT airspace is divided into seven Flight Information Regions (FIRs) or Control Areas (CTA) for the implementation of the Communications Navigation Surveillance/Air Traffic Management (CNS/ATM) systems. The NAT Region comprises the followingFIRs/CTAs:

- Bodø Oceanic
- Gander Oceanic
- New York Oceanic
- Reykjavik
- Santa Maria
- Shanwick
- Søndrestrøm

1.3.2 There are few international aerodromes within the Region and international traffic operating to and from these aerodromes represents only a small proportion of the total. NAT traffic is predominantly commercial. International General Aviation (IGA) Business aircraft comprise a high proportion of the higher altitude airspace operations, and due consideration should be given to their operational requirements.

Airborne Collision Avoidance Systems (ACAS)

1.3.3 Although the design and intended application of ACAS equipment is still in the evolutionary stage, it is expected that the vast majority of aircraft transiting the NAT Region will, during the period planned for, be ACAS equipped.

Traffic flows

1.3.4 The traffic is dominated by three major axes. First, there is the axis linking Europe (and the Middle East) to North America (excluding Alaska). Second, there is the axis linking the Eastern seaboard of North America with the Caribbean, South America and Bermuda. Third, there is the axis linking Europe to the Caribbean and South America. A substantial proportion of NAT traffic, namely that operating between cities in Europe and those in North America operate on the first axis.

1.3.5 The major traffic flow between Europe and North America takes place in two distinct traffic flows during each 24-hour period due to passenger preference, time zone differences and the imposition of night-time noise curfews at the major airports. The majority of the Westbound flow leaves European airports in the late morning to early afternoon and arrives at Eastern North American coastal airports typically some 2 hours later - local time - given the time difference. The majority of the Eastbound flow leaves North American airports in mid/late evening and arriving in Europe early to mid morning - local time. Consequently, the diurnal distribution of this traffic, has a distinctive tidal pattern characterised by two peaks passing 30° W - the Eastbound centred on 0400 Universal Co-ordinated Time (UTC) and the Westbound centred on 1500 UTC.

Organised Track System (OTS)

1.3.6 Although a number of fixed trans-Atlantic tracks exist, the bulk of traffic operates on tracks which vary from day to day dependent on meteorological conditions. The variability of the wind patterns would make a fixed track system unnecessarily penalising in terms of flight time and consequent fuel usage. Nevertheless, the volume of traffic along the core routes is such that a complete absence of any designated tracks (i.e. a free flow system) would currently be unworkable given the need to maintain procedural separation standards in airspace largely without radar surveillance.

1.3.7 As a result, an OTS is set up on a diurnal basis for each of the Westbound and Eastbound flows. Each core OTS is comprised of a set, typically 4 to 7, of parallel or nearly parallel tracks, positioned in the light of the prevailing winds to suit the traffic flying between Europe and North America.

1.3.8 The main difference between the North American-Caribbean traffic axis and that between Europe and North America is that the former is constrained by the fixed track structure. Some of these fixed tracks are tied to Non Directional Beacon (NDB) and Very High Frequency Omnidirectional Range/Distance Measuring Equipment (VOR/DME) radio navigation aids and, where this is the case, appropriate separation standards apply. Where tracks are beyond the range of such aids, long-range navigation systems are required. However, this part of the NAT Region is not yet designated an Minimum Navigation Performance Specifications (MNPS) Airspace, and 60 NM lateral separation minima does not apply (see paragraph 1.3.10 below).

1.3.9 The designation of an OTS facilitates a high throughput of traffic by ensuring that aircraft on adjacent tracks are separated for the entire oceanic crossing - at the expense of some restriction in the operator's choice of track. In effect, where the preferred track lies within the geographical limits of the OTS, the operator is obliged to choose an OTS track - unless he flies above or below the system. Where the preferred track lies clear of the OTS, the operator is free to fly it by nominating a random track. Trans-Atlantic tracks, therefore, fall into three categories: OTS, Random or Fixed.

Minimum Navigation Performance Specification

1.3.10 MNPS airspace has been established between FL285 and FL420. Longitudinal separation between in-trail aircraft using the Mach Number Technique is 10 minutes and aircraft which satisfy MNPS are separated laterally by a minimum of 60 NM. To ensure the safe application of the reduced separation minima, only MNPS certified aircraft are permitted to operate within the MNPS airspace. The current MNPS was established to ensure that the risk of collision as a consequence of a loss of horizontal separation would be contained within an agreed Target Level of Safety (TLS).

Reduced Vertical Separation Minimum (RVSM)

1.3.11 RVSM airspace has been established within the confines of MNPS airspace and associated transition areas. In RVSM airspace, 1000 ft vertical separation is applied between approved aircraft. Currently, RVSM is only applied between FL 310 and FL 390 inclusive. To ensure the safe application of the separation minimum, only RVSM approved aircraft are allowed to operate within RVSM airspace. Aircraft are monitored to ensure that the TLS is being met.

1.4 EXISTING SYSTEM SHORTCOMINGS

General

1.4.1 The system shortcomings given below are structural, that is, inherent to the system itself.

Air/ground Communications

1.4.2 Air/Ground voice communications in the NAT region are mainly conducted on HF. The quality of HF is largely dependent on propagation factors. Because of high noise levels and other difficulties, HF communications are conducted through a third party to relay communications for controllers. The absence of direct controller-pilot communications remains a major limitation in the provision of ATS in the NAT Region.

1.4.3 Pressure on the NAT HF systems continues to grow in line with the ever-increasing traffic levels.

1.4.4 While some increases in voice exchanges have been experienced since the introduction of RVSM, earlier predictions about the impact on HF systems have not as yet been seen. However, some stations are reporting HF exchanges approaching 60 messages per hour on each of three frequencies over a 2.5 to 3 hour period. It is expected that pilots will begin to make more use of the increased airspace capacity created by RVSM by making requests for step climbs and therefore increasing the load on HF communications.

Ground/Ground Communication

1.4.5 The Aeronautical Fixed Services (AFS) encompass voice and data communications. Telephone connections between ATS units provide for voice communications whereas the dissemination of flight plan data is normally accomplished through the Aeronautical Fixed Telecommunications Network (AFTN). While an Interface Control Document (ICD) has been developed for the exchange of data between ATS units, data is currently exchanged using a character-based protocol with limited message length and requires specifically designed equipment, which in turn limits flexibility and increases costs.

Navigation

1.4.6 The MNPS airspace requires continuous monitoring of aircraft navigational performance to support the lateral separation minima. A major deficiency to be overcome is the lack of early detection of Gross Navigational Errors (GNEs), which impact the TLS.

1.4.7 Lack of an international standard for avionics time handling (i.e., rounding vs. truncating) adds considerably to navigation uncertainty in longitudinal separation.

Surveillance

1.4.8 Radar coverage is subject to line-of-sight constraints and is not, for most parts, available in the NAT Region. Available radar is not used to the extent possible throughout the NAT Region. Outside areas of radar coverage ATC units monitor the progress of flights on the basis of pilot position reports. The average interval between position reports for most transatlantic flights is between 30 and 50 minutes. This surveillance system limits the efficiency of ATC in the Region.

1.4.9 Manual waypoint insertion errors are the main cause of GNEs and the current surveillance system provides only a limited ability to detect errors and to contain them by ATC intervention.

AIR TRAFFIC MANAGEMENT

Track Structure Penalties

1.4.10 The establishment of a track structure, whether by daily promulgation of an OTS or the permanent establishment of fixed tracks, may impose some constraints on aircraft profiles. Operators may choose to flight plan random routes. However, random traffic competes for routes and flight levels on a first-come, first- served basis and aircraft flying random routes conflicting with the OTS are likely to be subject to flight level or routing restrictions.

1.4.11 Aircraft electing to fly random tracks are required to flight plan on great circle tracks joining successive significant points defined by whole degrees of latitude intersecting meridians spaced by 10 degrees of longitude (20 degrees North of 70 degrees N). This procedure, which is dictated by the present air traffic control methods, restricts freedom of operation.

Level Cruise Penalty

1.4.12 This penalty is associated with flying at fixed levels as opposed to cruise-climbing and the requirement to choose a flight level based on a predetermined Flight Level Allocation Scheme (FLAS).

Meteorological Forecast Penalty

1.4.13 Although not directly attributable toATM, this penalty plays an important part in flight economics. Inaccuracies in the meteorological forecast may cause the operator to choose a track which does not make optimum use of prevailing conditions; whilst not directly attributable to ATM, this penalty plays an important part in flight economics. In addition, the limitations of turbulence forecasting may operationally impact upon the application of RVSM levels for OTS and random flights resulting in reduced capacity and efficiency.

Airspace Capacity

1.4.14 While the NAT Region as a whole is not saturated, a capacity shortfall can occur in the busiest part of the Europe/North America axis where aircraft may not obtain the desired route or flight level and therefore must be re-cleared on a less optimal flight profile.

Separation standards

1.4.15 The safety of the system is measured against an agreed TLS which identifies the risk of a mid-air collision caused by a breakdown in operating procedures and is expressed in terms of an agreed mathematical formula. This ensures that, if errors occur which have a direct impact on the continuation of safe operations, there is an agreed fall-back plan to increase separation minima for a period needed to bring the operation back within the TLS. Any implementation of such a fall-back plan would have an adverse impact on the capacity and efficiency of the system.

Horizontal separation

1.4.16 The system currently in use dictates the need for horizontal separation minima which limits exploitation of the airspace capacity. It is unlikely that significant reductions of lateral separation will be possible in the present CNS environment.

Vertical separation

1.4.17 The inability in certain areas of the NAT Region to apply RVSM reduces system capacity and efficiency.

Control Methods

1.4.18 Control throughout the NAT is largely strategic and uses procedural methods. These are based on flight plan information, updated by pilot (voice) position reports. This limits tactical flexibility, especially in the OTS, where re-clearances are normally limited to the provision of some step climbs and/or reroutes.

1.4.19 In areas outside the OTS, some tactical flexibility is achieved, particularly where traffic operates on random routes. An efficient use of such tactical control is limited by present communication and surveillance systems.

2. PART II – FUTURE REQUIREMENTS

2.1 OBJECTIVES

2.1.1 The NAT Concept of Operation must take into account the service delivery objectives for the NAT Region. These are listed below:

Safety	1) To satisfy the required TLS in the NAT airspace.
Cost	2) To reduce service costs relative to the current level and quality of service. 3) To maintain any increases in service cost due to developments to less than the exacted benefits of the development.
Quality	4) To reduce flight crew workload, particularly in pre-entry clearance regions. 5) To improve management of domestic/oceanic interface and facilitate flow management where required. 6) To reduce to the minimum cost-effective level the penalties, e.g, fuel, currently suffered by the service users as a result of system design constraints.

2.2 AIR TRAFFIC DEMAND

General

2.2.1 The North Atlantic Traffic Forecasting Group (NAT TFG) produces forecasts in response to the needs of various users, in particular the NAT SPG, for which detailed forecasts for peak and off-peak movements are produced. To this end, flight data are collected from all the NAT Air Traffic Control Centres.

Short Term Forecast Of Aircraft Movements In The North Atlantic Region (Thousands)

	Forecasts											
Scenario	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Optimistic		221.8	244.6	256.6	269.1	279.9	296.8	312.3	327.9	343.3	358.7	372.8
Baseline		220.3	238.0	249.5	267.1	279.9	296.8	312.3	322.5	333.3	345.3	357.3
Pessimistic		215.4	234.3	242.0	263.2	272.4	292.0	302.0	308.2	314.6	322.0	329.1
Actual	213.0	228.2	247.5	251.4	261.0	279.0						

Long-Term Forecast Of Aircraft Movements In The North Atlantic Region (Thousands)

	Forecast					
Scenario	1996	1997	2002	2005	2010	2015
Optimistic		296.8	372.8	407.2	468.8	545.7
Baseline		296.8	357.3	389.2	437.0	477.2
Pessimistic		292.0	329.1	341.5	357.3	369.4
Actual	279.0					

2.2.2 From the work of the NAT TFG, it can be seen that the actual rise in traffic has consistently been closer to the optimistic rather than the baseline forecast. This NAT ATM Concept of Operations is based on the assumption that traffic in the NAT Region in 2015 will be at least double that of 1992.

Types of Aircraft and Operating Characteristics

2.2.3 The current saturation of major aerodromes and expanding markets has led operators to exploit secondary aerodromes, offering surplus capacity, to supplement their hub to hub operations. This has lead to a significant increase in the number of routes flown (city pairs), a tendency which is expected to continue.

2.2.4 These lower density routes will be served by aircraft with medium seating capacity such as present day Extended Range Operations of twin-engined aeroplanes (ETOPS) or future narrow body multi-engine aircraft. Operating characteristics of these aircraft types will be similar to those of present types. A tendency for higher cruising levels (above FL 400) is assumed as well as a larger spread of preferred cruising speeds.

Military Operations

2.2.5 The percentage of military operations in the NAT Region has decreased in recent years. There is no indication that this figure will increase, however military reservations in lower airspace may increase.

IGA Operations

2.2.6 Airspace planning for future change needs to give due consideration to the continuing growth of IGA Business Aviation and its operational requirements.

2.3 FUTURE REQUIREMENTS

General

2.3.1 The NAT airspace infrastructure must evolve to meet the changing demands of the aviation community. The current NAT airspace divisions form the foundation of an airspace structure whose design must evolve to ensure an efficient flow of air traffic throughout the Region. Provider States must therefore co-ordinate their airspace planning to balance the conflicting but legitimate requirements of all users, to efficiently provide sufficient capacity to meet traffic demands, to ensure optimum utilisation, to ensure compatibility with their neighbours and to guarantee the safety of flight. In developing time lines for implementation of new standards and procedures, consideration must be given to the time required for product development and certification for all airspace users.

2.3.2 The airspace structure of the future NAT ATM System must be designed to support the ultimate goal of allowing each aircraft to fly its own optimised flight path with conflict resolution by tactical intervention. This would include the possibility for flight planned cruise climbs and variable Mach number schedules. If necessitated by density of traffic, a limited number of predetermined tracks could be established on a temporary basis.

2.3.3 While a long term aim is the elimination of the OTS, an evolutionary approach demands that a high priority must be given to reducing both horizontal and vertical separation minima, thereby reducing the extent of the OTS.

2.3.4 The fundamental requirements of the three major groups of airspace users, commercial air transport, general, and military aviation, have to be met in the future airspace structure. All users should enjoy maximum economy in their operations with minimum restrictions. Any future ATM System must be capable of interfacing with other systems, both oceanic and domestic. Until free flight is introduced, the following requirements apply.

User Requirements

2.3.5 The aircraft operator will wish to operate in an environment where, having filed a flight plan for the preferred track/vertical profile, the response to the initial request for an oceanic clearance, via datalink, is "cleared as filed". Where the track being requested lies within the most densely loaded part of the NAT Region it may be necessary, in the interests of maintaining an orderly flow of traffic, and making the most efficient use of the airspace, to retain a reduced Organised Track System.

2.3.6 Throughout the Atlantic crossing the operator will expect ATC to monitor the progress of the flight using Automatic Dependent Surveillance (ADS) with an appropriate update rate and little or no flight crew involvement. Should the aircraft wish to change its profile (including route of flight) while in flight, such requests would be originated from the aircraft, transmitted via datalink, and should be expeditiously processed by ATC.

2.3.7 While all routine air/ground communications will be conducted via datalink, it will be necessary to have direct controller/pilot voice for emergency and safety related non-routine use. Datalink will also be used to obtain information, such as destination weather conditions, from ground based databases at the initiation of the flight crew.

2.3.8 The passage of aircraft across Oceanic Control Area (OCA) boundaries must be transparent to the flight crew and there should be no specific requirement for crew action to initiate contact with subsequent Oceanic Are Control Centres (OACs).

2.3.9 Direct interaction between ATC computers and operators' computers should be available to forward requests and aid in the evaluation of traffic conflict resolutions.

2.3.10 The system must provide for variable cruise parameters to optimize efficiency. Cruise climbs and variable cruise speeds should be readily available.

ATC Requirements

2.3.11 Air traffic control will expect the system to present relevant flight information at an appropriate time before the flight enters the sector and to indicate immediately whether the initial portion of the requested profile will be conflict free. Where conflicts are indicated the system should present sufficient information to enable the conflict to be resolved. Controller selection of a proposed alternative could enable automatic delivery of that clearance and indicate to the controller its acceptance.

2.3.12 When ADS is being used, the system will continuously monitor the progress of the flight using a system determined update rate, the controller having the capability of temporarily varying that rate within defined parameters. It will identify any discrepancies in position, forward way points, flight levels, Figure of Merit (FOM), etc. and initiate an alert to the controller with details of such discrepancies. The system should be capable of presenting the controller with information on proximate traffic, in an easily assimilated manner.

2.3.13 Most Controller/Pilot communications will be via datalink; however the controller will expect to be able to use direct voice for non-routine safety related matters. When it is necessary to discuss an emergency or non-routine situation the controller/pilot voice channel(s) must be available.

2.3.14 While most inter-centre communications will be via datalinks, the controller will have to have access to ATS direct speech connections.

Planning Requirements

2.3.15 The design of the system must ensure that the overall system is developed in an evolutionary manner, to agreed regional planning timescales, taking advantage of expected airborne capabilities such as ADS, improved navigation, datalink, etc, and of improved ATC automation and display capabilities in order to:

a) maintain or improve safety at increasing levels of traffic density;
b) reduce the OTS laterally, vertically, and/or in the hours of operation;
c) reduce the need to ensure a conflict-free path to landfall;
d) increase tactical control, both in the resolution of conflicts and the issuance of a timely and flexible ATC response to requests for en-route re-clearances;
e) take full advantage of reduced separation minima;
f) improve the co-ordination between adjacent centres by maximum use of automated facilities; and
g) improve the co-ordination and reduce the interface problems between Oceanic and Domestic ATS units.

System Safety Requirements

2.3.16 It is a requirement that ATC service be maintained to an acceptable level of safety in the event of partial or total failure of automated systems. Procedures must be established and promulgated to cater for any failure of the ground, space, and airborne elements of Aeronautical Mobile Satellite Service (AMSS).

2.3.17 Failure of any element of an aircraft's avionics should not cause major problems - it may however require the issue of a new clearance and involve extra co-ordination between OACs.

2.3.18 Failure of an OAC may be resolved by an adjacent OAC providing a limited service in the affected airspace until the failure is rectified.

2.3.19 As shown below, changes to the NAT system will introduced in defined phases. It is necessary that each phased change to the system should not degrade the overall system safety.

2.3.20 In order to demonstrate that the system safety is not degraded, a safety assessment needs to be made for each change prior to its operational introduction. One method of safety assessment is a four-part safety case, where

- **Part 1** defines the safety requirements to be met;
- **Part 2** explains how the design of the system change meets those safety requirements;
- **Part 3** explains any compromises made during the introduction to service that may affect Part 2; and
- **Part 4** is a statement from the operating authority that the system can be operated and maintained in the designed manner.

2.4 PROGRAMME OBJECTIVES

Planning Horizon

2.4.1 Planning is currently being undertaken up to 2005. The results of the NAT Implementation Management Group (NAT IMG) Cost Effectiveness (NICE) programme will provide indications of which service improvements are cost beneficial post 2005. Once those results are published, a further planning round will extend the phased service improvements beyond 2005.

Phased Service Improvements

2.4.2 A series of service improvements have been planned to address the future system requirements described above.

Service Improvement	Purpose
Support ADS Waypoint Position Reports (WPR) via Future Air Navigation System (FANS-1/A) avionics Reduced Longitudinal Separation Minima (15 to 10 minutes)	In response to customer requests Increase longitudinal track capacity
Reduced Same Direction Longitudinal Separation Minima (10 to 7 minutes)	Increase longitudinal track capacity
Phase 3 RVSM (FL290-FL410)	Increase track capacity

3. PART III – TECHNICAL MEANS

3.1 TECHNICAL MEANS

Introduction

3.1.1 The following sections briefly examine the technical systems that will be used to support future ATM requirements. The technical solutions presented below are only those necessary to deliver the scheduled service improvements to 2005.

3.2 AIRBORNE SYSTEM CAPABILITIES

3.2.1 Capabilities of aircraft operating in the NAT MNPS airspace through 2005 will continue to advance in airborne CNS technologies primarily due to replacement of older aircraft with newer generation models. Although current planned service improvements in the NAT region (paragraph 2.4.2 refers) only mandate standardized time keeping for the airborne side, various CNS capabilities will become increasingly available providing opportunities for improvements to the system.

Communication

3.2.2 HF Voice - with the exception of some aircraft operating on the "Blue Spruce" and other specifically designated routes, all aircraft will have HF voice capability.

3.2.3 Satellite Communication (SATCOM) Voice - a rapidly increasing number of aircraft have SATCOM Voice capability. It is anticipated that a majority percentage of aircraft will be so equipped well before 2005. This could lead to its use for safety-related non-routine or emergency communications allowing the elimination of any requirement for dual aircraft HF transceivers.

3.2.4 Controller Pilot Data Link Communications (CPDLC) - a number of FANS-1/A equipped aircraft operate in the NAT are capable of CPDLC. The number will increase in this timeframe. By 2001, it is anticipated that SARPs compliant CNS/ATM-1 aircraft capable of CPDLC will also be operating in the NAT region. Avionics suites with other datalink capabilities (e.g. – Flight Management System (FMS) Product Improvement Package-(PIP)) will also be available. These CPDLC technologies will provide the opportunity for usage in routine communications allowing the elimination of any requirement for dual aircraft HF transceivers as well. CPDLC functionality will be enhanced by either HF Datalink or SATCOM Datalink. Over regions of ground-based VHF coverage, VHF Data Link (VDL) or ACARS may also be utilized.

Navigation

3.2.5 Global Navigation Satellite Systems (GNSS) - the use of satellite-based navigation will increase during the period either with airborne installations that use GNSS navigation directly or through its use as a primary input to an FMS installation. Accuracy's are very high which may affect the computed level of safety in the region, especially vs. Inertial Reference Unit/Inertial Navigation System (IRU/INS) based installations with their inherent drift without updates utilizing other navigational aids. Although these systems would allow transition towards an Required Navigation Performance (RNP) standard, it is not anticipated to be necessary prior to at least 2005.

3.2.6 FMS - an increasing number of aircraft are equipped with FMS; therefore, by 2005, it is anticipated that the majority percentage will have installations. Navigation capabilities with FMS's allow for such flexibility as precise directs and lateral offset courses as well as increased safety due to the use of installed navigation databases.

Surveillance

3.2.7 ADS - a number of FANS-1/A equipped aircraft operate in the NAT capable of sending ADS messages. The number will increase over this timeframe. Sometime after 2001, it is anticipated that SARPs compliant CNS/ATM-1 aircraft with ADS will be operating in the NAT. Avionics suites with other datalink capabilities (e.g. -FMS Product Improvement Package-PIP) will also be available. These ADS technologies will provide the opportunity for usage in routine ATS messages that presently utilize HF voice. ADS message capabilities will be enhanced by either HF Datalink or SATCOM Datalink. Over regions of ground-based VHF coverage, VDL or ACARS may also be utilized.

3.3 GROUND SYSTEMS

AIR/GROUND COMMUNICATIONS

3.3.1 While current ground-based communications links, such as HF and VHF voice, would continue to be used where necessary and appropriate, CPDLC will start to provide high quality near-real-time information interchange in the major part of the NAT Region using satellite data link. VHF, HF or Mode-S data links will also be used where appropriate. Satellite voice is expected to be used to meet the requirements for direct Pilot/Controller communications.

FANS 1/A

3.3.2 FANS-1/A are avionics packages providing for certain aircraft type ADS and CPDLC capabilities over a character-oriented network. These capabilities are a sub-set of the ICAO SARPs. Although the Aeronautical Telecommunications Network (ATN) system remains the end state, FANS 1/A equipped aircraft will operate in the NAT Region for a number of years. Accommodation of FANS 1/A aircraft is therefore required. The level of accommodation will be determined by the airspace requirements.

GROUND COMMUNICATIONS

Data communications

3.3.3 The AFTN/Common ICAO Data Interchange Network (CIDIN) will continue to be used as the primary ground/ground transmission network until the ATN is deployed. The use of X.25 and implementation of the AFTN header with optional data fields 2-5 will serve as the foundation for transition the ATN. On-line ground/ground data interchange messages will initially be character orientated. The ICAO standard for ATS Inter-Facility Data Communications (AIDC) will eventually be introduced, nonetheless, planned NAT ground/ground communications systems must be capable of handling either format.

Voice communications

3.3.4 The need for ATS direct speech circuits will remain, however the requirement for dedicated circuits should be re-evaluated when updated SARPs for voice switching networks are available.

NAVIGATION

3.3.5 No significant developments in ground based navigation aids are expected in the NAT in the period addressed by this document. However, it should be noted that the availability of SARPs compliant GNSS is playing an increasingly significant role in the airborne navigation capabilities of the NAT airspace users.

SURVEILLANCE

General

3.3.6 Pilot voice reports will be progressively replaced by a predominately satellite-based ADS system, integrated with ground-based radar systems where available.

Co-operative Independent Surveillance

3.3.7 Secondary Surveillance Radar (SSR) is the only representative of this category currently in use. SSR systems are primarily deployed along the coastal fringes of the region. In the Reykjavík CTA, considerable SSR coverage is provided.

Manual Dependent Surveillance

3.3.8 This form of surveillance, using pilot voice reports, predominates in the Region today. For this purpose, several communication facilities are maintained. These facilities rely mostly on HF, although some also have access to the so-called General Purpose VHF frequencies. Some OACs also has the ability to communicate directly with aircraft on VHF.

Automatic Dependent Surveillance

3.3.9 Automatic Dependent Surveillance (ADS) is based on the aircraft automatically transmitting, via a datalink, data derived from on-board navigation systems. As a minimum, the data includes aircraft identification and three-dimensional position. Additional data may be provided as appropriate. ADS SARPS have been published by ICAO and their implementation will be the end state. Meanwhile the ADS capability of FANS 1/A will initially be used for automatic WPR plus emergency and MET reporting.

AUTOMATION

3.3.10 NAT provider States already have, or are procuring, automation systems to assist the provision of the ATS in the NAT Region. Some States are upgrading existing systems to take advantage of technology developments.

Display Technology

3.3.11 Developments in display technology will support the integrated presentation of various sources of surveillance data (ADS, RADAR). This integration will provide controllers with an increased situational awareness, which will benefit the determination of more optimal flight profiles.

Communications Technology

3.3.12 Systems will be enhanced to support FANS 1/A, ARINC 623 and, later, ATN compliant datalink applications. Systems will be harmonised to support NAT On-Line Data Interchange Group (OLDI) standards for ground/ground data exchange. In conjunction with the development of co-ordination agreements this will improve and progressively automate the co-ordination of flights between OACs.

Flight Data Processing

3.3.13 Systems will be capable of integrating datalink contracting and reporting with flight plan and flight data processing. In conjunction with improvements in display technology, the creation and consideration of more complex flight profiles will be possible, providing the capability to reflect customers optimum requirements more accurately.

Human Factors

3.3.14 Human factors expertise will be utilised in the design of ATC displays, including guidance material for the presentation of ADS and CPDLC data.

Safety Management

3.3.15 Development of automation systems, as outlined above, will be subjected to systematic safety analysis to identify and ameliorate any hazards and risks associated with such developments.

LIST OF ACRONYMS

ACAS	Airborne Collision Avoidance System
ADS	Automatic Dependent Surveillance
AFS	Aeronautical Fixed Services
AFTN	Aeronautical Fixed Telecommunications Network
AIDC	Air Traffic Services (ATS) Inter-facility Data Communications
AMSS	Aeronautical Mobile-Satellite Service
ASM	Airspace Management
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Services
CIDIN	Common ICAO Data Interchange Network
CNS/ATM	Communications, Navigation and Surveillance/Air Traffic Management
CPDLC	Controller Pilot Data Link Communications
CTA	Control Area
ETOPS	Extended Range Operations of Twin-Engined Aeroplanes
FANS-1/A	Future Air Navigation Systems Avionics
FIR	Flight Information Region
FLAS	Flight Level Allocation Scheme
FMS	Flight Management System
GNE	Gross Navigation Error
GNSS	Global Navigation Satellite System
HF	High Frequency
ICD	Interface Control Document
IGA	International General Aviation
IRU/INS	Inertial Reference Unit/Inertial Navigation System
LIM NAT RAN	Limited (COM/MET/RAC) North Atlantic Regional Air Navigation (1992) Meeting
MNPS	Minimum Navigation Performance Specifications
NAT	North Atlantic
NAT IMG	North Atlantic Implementation Management Group
NAT SPG	North Atlantic Systems Planning Group
NAT TFG	North Atlantic Traffic Forecasting Group
NDB	Non Directional Beacon
NICE	NAT Implementation Management Group Cost Effectiveness
OAC	Oceanic Area Control Centre
OCA	Oceanic Control Area
OLDI	On Line Data Interchange
OTS	Organized Track System
PIP	Product Improvement Package
RNP	Required Navigation Performance
RVSM	Reduced Vertical Separation Minimum
SARPS	Standards and Recommended Practices (ICAO)
SATCOM	Satellite Communications
SSR	Secondary Surveillance Radar
TLS	Target Level of Safety
UTC	Universal Co-ordinated Time
VHF	Very High Frequency
VDL	VHF Data Link
VOR/DME	Very High Frequency Omnidirectional Range/Distance Measuring Equipment
WPR	Waypoint Position Report

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