Government/Industry Operational Concept for the Evolution of Free Flight

Addendum 1:

FREE FLIGHT PHASE 1

Limited Deployment of Select Capabilities

(URET, TMA (SC), pFAST, CPDLC, CDM, SMA)

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Foreword

This report was approved by the RTCA Free Flight Steering Committee on August 19, 1998.

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- analyzing and recommending solutions to the system technical issues that aviation faces as it continues to pursue increased safety, system capacity and efficiency;

- developing consensus on the application of pertinent technology to fulfill user and provider requirements, including development of minimum operational performance standards for electronic systems and equipment that support aviation; and

- assisting in developing the appropriate technical material upon which positions for the International Civil Aviation Organization and the International Telecommunication Union and other appropriate international organizations can be based.

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Section 1

Introduction

This document supplements the government and industry consensus on the operational concept for National Airspace System (NAS) modernization reflected in *Government/Industry Operational Concept for the Evolution of Free Flight* by focusing on Free Flight Phase 1 (FFP1) capabilities. It reflects the perspectives of NAS users and service providers. This supplement to the operational concept covers the near-term period 1998 to 2002, during which the FFP1 capabilities will be implemented at specified locations. While focusing on FFP1 capabilities, this document also covers related concepts and capabilities of other NAS modernization efforts occurring during this time period. This document is the basis for both the Federal Aviation Administration (FAA) and the user community plans for procedural, investment and architectural decisions that will make FFP1 a reality.

1.1 Background

The goal of FFP1 is to provide near-term air traffic management (ATM) capabilities that can provide early benefits to service providers and NAS users, leveraging proven technologies with needed procedural enhancements and appropriate standards. From the outset, RTCA Task Force 3 recognized the need to evolve to a mature Free Flight concept[1] through safe, benefits-driven incremental steps. RTCA Task Force 3 also recognized the notion of implementation risk: "Significant benefit to airspace users and service providers is achievable from near-term actions. Emphasis needs to be placed on what can be done now that will provide significant benefits at low cost and low implementation risk."

In this context, recent events associated with NAS modernization activities and decisions are a reaffirmation of the guiding principles and the foundation initially set by the RTCA Task Force 3 in 1995. The RTCA Task Force 3 report, *The Final Report of RTCA Task Force 3: Free Flight Implementation* defined the Free Flight concept, evaluated the Free Flight architecture and technology needs, and identified an incremental transition to Free Flight. The Free Flight Steering Committee was established in 1996 to oversee the implementation of the recommendations of Task Force 3. During the same year, the RTCA Select Committee on Free Flight Implementation was established as the working arm and a

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1 Free flight is "...a safe and efficient flight operating capability under instrument flight rules (IFR) in which the operators have the freedom to select their path and speed in real time. Air traffic restrictions are only imposed to ensure separation, to preclude exceeding airport capacity, to prevent unauthorized flight through Special Use Airspace (SUA), and to ensure safety of flight. Restrictions are limited in extent and duration to correct the identified problem. Any activity which removes restrictions represents a move toward free flight."

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consensus-building entity to work the detailed plans and activities within the aviation community. As its first product, the Select Committee developed the *Free Flight Action Plan* that outlined the specific FAA and industry program activities needed to implement the concepts and capabilities defined in the RTCA Task Force 3 report. The Action Plan was subsequently approved by the RTCA Free Flight Steering Committee in the summer of 1996.

During 1996 and 1997, the Select Committee made several key recommendations to move forward with specific programs and activities. Responsive to and working with the user community, the FAA undertook a monumental effort to develop a NAS architecture plan to reflect the aviation community needs and recommendations. In late 1997, this effort was manifested in the FAA's NAS Architecture Version 3.0 Draft. Driving the architecture was a companion operational perspective embodied in the FAA Air Traffic Service's (ATS) *Concept of Operations for the NAS in 2005.* In yet another parallel, but coordinated effort, the aviation community reached consensus through RTCA on an evolutionary operational concept to modernizing the NAS, reflected in *Government/Industry Operational Concept for the Evolution of Free Flight.* These operational documents together with NAS Architecture 3.0 plan constituted the framework to modernize the NAS by 2005. The need to take concrete and near-term steps to modernize the NAS was subsequently reconfirmed through independent assessments by segments of the aviation community which projected severe NAS capacity and delay problems, leading to a degraded air transportation system.

However, budget constraints and the identification of risks that could prevent the successful implementation of NAS Architecture 3.0 resulted in the FAA Administrator establishing a NAS Modernization Task Force to identify the critical issues associated with the NAS Architecture 3.0 as it existed and to recommend realistic strategies to achieve the goals of Free Flight.

The efforts of the Modernization Task Force resulted in a top level assessment of the issues and risks associated with the NAS Architecture 3.0. A initial matrix was developed which highlighted the challenges and opportunities associated with the elements of the Architecture toward evolving to Free Flight. The Modernization Task Force requested that an aviation community consensus be reached on the matrix. Subsequent to the Select Committee deliberations in early 1998, the Modernization Task Force Risk Reduction Matrix emerged as the focal point for risk mitigation strategies needed in order to realize the goals of the NAS modernization plans in a timely manner.

The Risk Reduction Matrix provides a representation of the operational capabilities of NAS modernization mapped against the challenges or principal sources of risk which stand as potential barriers to timely implementation of the essential elements of Free Flight. These challenges, barriers, or risk factors generally fall into technical, institutional, funding and operational categories. The matrix represents an initial assessment and consensus by the

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aviation community with regard to the status of NAS modernization efforts and the need to develop new implementation strategies.

The Modernization Task Force recommended two new strategies to implement the goals of NAS modernization. The first strategy was to deliver early benefits to users by 2002 through the fielding of low-risk capabilities at specified locations throughout the NAS. This activity was dubbed *Free Flight Phase 1* (FFP1). The second strategy addressed the risks associated with major new communications, navigation, and surveillance (CNS) programs. The CNS risk reduction strategy was formalized into the *Flight 2000* activity to mitigate the remaining risks that exist in the CNS area.

1.1.1 Free Flight Phase 1 Capabilities

FFP1 is the limited deployment of the following core Air Traffic Management (ATM) capabilities:

- Conflict Probe as represented by the User Request Evaluation Tool (URET)
- Traffic Management Advisor (TMA), Single Center Operations (SC)
- Passive Final Approach Spacing Tool (pFAST)
- Controller-Pilot Data Link Communications (CPDLC)
- Collaborative Decision Making (CDM) with Airline Operations Centers (AOCs)
- Surface Movement Advisor (SMA)

The intent is to deploy these capabilities, currently in development status or in limited operational use at some FAA facilities, to other facilities or locations through a process known as Core Capability Limited Deployment (CCLD). CCLD is an emerging strategy for NAS modernization as a means to manage risk exposure while incrementally providing early benefits to users. The intent of FFP1 is to deploy the above capabilities as quickly as possible (to allow for evaluation by 2002) in order to provide early benefits to NAS users. Deployment of these capabilities will require necessary support infrastructure (e.g., Display System Replacement (DSR), Standard Terminal Automation Replacement System (STARS), and Host Replacement, or their equivalents).

Table 1-1 provides the candidate locations for implementation of FFP1 capabilities. The sites shown in Table 1-1 were agreed to by the aviation community, representing government, industry, users, and other stakeholders, and adopted by the Free Flight Steering Committee in April 1998.

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Table 1-1 Candidate Sites for FFP1 Implementation[2]

Centers	FREE FLIGHT PHASE 1 CAPABILITIES 1, 2, 3					
	TMA (SC)	pFAST	URET CCLD	CDM with/AOCs	SMA	CPDLC
ZAU: Chicago		(ORD) 6	✓		✓(ORD) 7	
ZFW: Fort Worth	✓	✓(DFW)			✓(DFW) 7	
ZLA: Los Angeles	✓	✓(LAX)				
ZTL: Atlanta	✓	✓(ATL)	✓		✓(ATL)	
ZID: Indianapolis			✓			
ZME: Memphis			✓			
ZDC: Washington			✓			
ZOB: Cleveland			✓		✓(DTW) 7	
ZMP: Minneapolis	✓	✓(MSP)				
ZKC: Kansas City		✓(STL) 8	✓			
ZNY: New York	4	(JFK), (EWR), 5 (LGA), (PHL)			✓(EWR) 7 (PHL) 7, (TEB) 7	
ZOA: Oakland	✓					
ZMA: Miami	✓					✓9
ZDV: Denver	✓					
ATCSCC				✓		
AOCs				✓		

Legend: ✓ - Part of FFP1 | Feasibility Study | Planned Capability | (xxx) - Location

Notes:

1 Operational by 1998-2002

2 Assumes no impact on other programs

3 Risks need to be identified and a risk mitigation plan established and implemented in coordination with RTCA

4 In 1998, launch R&D program to develop tools to expedite arrivals in complex airspace - at PHL (outside funding scope of FFP1)

5 By June 1998, determine feasibility of implementing stand-alone pFAST without multi-center TMA, and implement accordingly (outside funding scope of FFP1)

6 Begin development after completion of current airspace review and design

7 Functionality different from SMA at Atlanta

8 Stand-alone pFAST without single-center TMA

9 CPDLC path change to VDL-2 and site change to ZMA (from ZMP) approved 20 Aug 98 by Steering Committee,

2 The candidate sites shown in this table represent the RTCA recommended FFP1 implementation locations as approved by the RTCA Free Flight Steering Committee, April 16, 1998 and amended August 20, 1998.

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FFP1 is a subset of the NAS modernization activities planned for the mid-term period 1998-2002. It must be understood that FFP1 capability deployment will occur simultaneously with other modernization activities planned for this time period. Further, many FFP1 capabilities are dependent on other modernization activities for critical prerequisite functions and architectural support. Without the successful deployment and implementation of these supporting activities, FFP1 capabilities and desired benefits will not be achieved. The appendix provides more detail on the dependent NAS modernization activities necessary to support FFP1 implementation.

It is important to note that FFP1 is more than a collection of core capabilities; it is the *joint deployment* of those capabilities – government, industry, and labor working together – that ultimately defines the program.

Although the above capabilities represent low-risk approaches to realizing early benefits, they are not entirely risk free, particularly at locations where they do not currently exist and where interaction between the capabilities is not well understood. In addition, the potential for reduced FAA funding profiles could result in a re-assessment of the effort, resulting in a loss of capability and subsequent benefits. Consequently, FFP1 is not a program with *no* risk, but rather a program that seeks to *mitigate* the risks that do exist by employing an evolutionary approach to system development and deployment that results in a continued high level of system safety while providing much-needed user efficiencies and benefits. As noted earlier, CCLD is an evolutionary approach and strategy for FFP1 implementation and risk mitigation. Through CCLD, the aviation community will be able to deliver on its goal of early benefits while managing risk with the highest concern for system safety.

1.1.2 Overview of FFP1 Technical and Operational Issues and Risks

With any modernization activity, the absolute highest priority is that of safety. The level of aviation safety in the NAS must not be compromised at any time by any implementation plan or risk mitigation strategy and must be maintained at a level equal to or exceeding current standards.

While representing a low-risk approach to delivering early benefits, FFP1 capabilities do incur some risk that needs to be fully understood and properly mitigated. These initial assessments were addressed by the NAS Modernization Task Force and summarized in the Risk Reduction Matrix. As a necessary next step, technical and operational issues must be evaluated in detail so future expansion of the capabilities can occur on schedule. This step should be addressed by appropriate program managers and is discussed in more detail in Section 1.2.

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Risks associated with FFP1 activities should be mitigated through the application of appropriate strategies that further reduce uncertainties for future deployments. This is the core philosophy of the CCLD evolutionary development approach: mitigate risk in smaller sets, learn from the experience, and apply it in the next round of development and deployment.

In addition to the successful implementation of FFP1 capabilities during this time, it is also important to remember that these efforts will form the cornerstone of future NAS modernization improvements. FFP1 will effectively transition several core technology programs from concepts to operational reality. To ensure that a viable and credible NAS results from this implementation, two very critical overarching risk areas will receive special attention in this process, human factors and safety. Issue and risk analyses must emphasize these areas and risk mitigation strategies must incorporate carefully constructed test and validation plans for all human factors and safety related issues. It is essential that end-users (service providers and pilots) be involved in both the design and the validation process. Issues and risks in these two critical areas cannot be addressed *after* the FFP1 capabilities are operationally deployed. This process will require industry-wide, non-partisan support to ensure NAS safety throughout this period.

There are three principal areas where the issues and risks associated with FFP1 implementation are thought to occur:

- **Operational and procedural issues** associated with FFP1 capabilities
- **Architectural and support issues** that result from the deployment of FFP1 capabilities
- **Programmatic issues** associated with each capability

The following further describes some of the concerns identified by the NAS Modernization Task Force:

- ***Certification:*** The formal certification process is lengthy and the many regulations governing the process are complex. This could impact deployment schedules. Also, as in the case of CPDLC, a non-FAA certified communications system is an integral component of the deployed capability, creating many unique issues and risks.
- ***Deployment Rate Limitations:*** This area concerns the ability of users and service providers to accept and implement new systems in a timely manner. Of concern are training schedules, system integration to existing infrastructure, availability of technical staff to perform the installation, and safety aspects of the potential disruption of routine operations at a deployment site.
- ***Information Security:*** Many of the new systems employ "open" architectures and modern networking techniques to distribute and collect information. The

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vulnerability of these systems to attack, spoofing, and interference from intentional or unintentional sources is of great concern. Resolution requires thorough understanding in the earliest stages of deployment so that risk and cost are both minimized.

- ***Procedures and Operational Concepts:*** Without proper adaptation of procedures and policies to use new capabilities, the overriding concepts of operations will not be fulfilled. The proper use of capabilities, detailed in their procedures, is an important element in ensuring that the benefits are delivered to the appropriate NAS participants. Data availability and the policies directing proper implementation and maintenance of data in support of new applications will present coordination challenges. Like certification, procedures development is a controlled process with specific lead-time requirements. The procedures and policies area also captures most of the significant discussion pertaining to changes in roles and responsibilities of the NAS participants resulting from a new capability.
- ***Technical and Information Interdependencies:*** This area is critical to the evolutionary development process because it highlights the arrangements, interactions, and interdependencies of the FFP1 capabilities as a common set of systems and services. This requirement is judged to present the greatest challenge for FFP1 implementation. The technical and information architectures of the independent systems will be brought together into a cohesive array of features delivering increased enhancements and performance to the NAS.
- ***Adaptation:*** This area is concerned with site-specific adaptation of FFP1 capabilities. Much of the new functionality delivered in the FFP1 capabilities is complex and very data dependent. Some of the site-specific airspace data are inconsistent across centers and across systems. During this period, an airspace review process will be on-going, potentially altering some site data. Adaptation across centers for a single system and across systems installed at the same site are concerns for FFP1 implementation.
- ***System Acceptance:*** With all FFP1 capabilities, acceptance by the NAS participants that will use or provide the services is critical to ensuring success. In all areas of FFP1 implementation, human factors issues will require special emphasis and consideration. ATM personnel and system users must provide clear system acceptance criteria and must be aware of the benefits and risks of the new capabilities. Each NAS participant becomes integral to overall implementation success.
- ***Infrastructure Management:*** A prerequisite to all activity for this time frame is the integration of FFP1 capabilities with NAS Infrastructure Management (NIM), the FAA Airways Facilities (AF) maintenance management program. NIM establishes maintenance management capabilities and strategies for NAS systems to ensure effective and efficient delivery of services. It is essential that NIM issues be

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understood and methods to bring FFP1 capabilities under the NIM "umbrella" be initiated in conjunction with implementation plans.

1.2 Purpose and Scope

This document focuses on FFP1 CCLD capabilities, but other NAS modernization activities and procedures that coincide with FFP1 are included. The operational concept for FFP1 CCLD and an overview of the operational enhancements that will be provided by the FFP1 core capabilities are also provided.

Specifically, this document details the concept of operations for FFP1 CCLD, provides a brief summary of the functions and enhancements that are part of the FFP1 core capabilities being implemented, and provides operational scenarios that illustrate NAS functionality and FFP1 capabilities. This document provides an operational overview of FFP1 CCLD for use by all stakeholders and offers and records an initial common understanding of the capabilities with respect to expected enhancements, operational concepts, and operational use. It is meant to assist the aviation community in reaching further consensus on the direction of FFP1 CCLD activities and provides a benchmark reference for use in discussions pertinent to FFP1 CCLD matters.

FFP1 CCLD is a program to provide early benefits to NAS users and service providers while mitigating risks in order to ensure that the core capabilities can be more extensively deployed (beyond the initial set of sites) after 2002. In this light, assessment of the benefits becomes an important consideration. Deployment of a capability to a site and successfully integrating it into the unique traffic management capabilities of that site may fulfill many technical and architectural issues and risks, but not necessarily produce the user benefits desired or expected from FFP1. These benefits will be achieved only when the capabilities are widely used within that facility (i.e., in a large number of sectors) on a daily basis. Benefits assessment will require that each capability be evaluated to determine what the critical level of expansion of that capability is within any FFP1 site. Ultimate benefits from FFP1 capabilities will be achieved when they are expanded to all appropriate sites.

1.3 Organization

The document is organized into four sections and two appendices.

- **Section 1** provides introductory comments detailing the government/industry involvement in NAS modernization planning and implementation as well as an overview to follow-on efforts needed to support FFP1 CCLD implementation
- **Section 2** provides an overview of the FFP1 CCLD operational concept
- **Section 3** provides an overview of the FFP1 core capabilities and enhancements
- **Section 4** provides FFP1 CCLD operational scenarios
- **Appendix** provides top level FFP1 CCLD architectural dependencies

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