DRAFT

Research Management Plan for Integrating the Flight Object into the National Airspace System (NAS)

Version 1.0 DRAFT

September 2000

MITRE/CAASD for the

FAA Office of System Architecture and Investment Analysis (ASD)

LIST OF FIGURES

LIST OF TABLES

1.0 Introduction

1.1 Purpose

The flight object, which is a collection of information elements describing an individual flight, is being proposed to provide a common view of that flight in the National Airspace System (NAS). Flight object research will examine how the flight object can provide useful information for NAS users and Air Traffic Management (ATM) service providers, as well as determine the information elements that each organization is responsible for updating. The purpose of this Research Management Plan (RMP) is to establish the approach by which the Federal Aviation Administration (FAA) can most effectively manage the research and development (R&D) needed for integrating the flight object into the NAS. This RMP will also facilitate deployment of the capability enhancements required for implementing the flight object.

1.2 Background

The flight object concept was described at a high-level in the *ATS Concept of Operations for the NAS in 2005* and referred to as shared flight information in the *Government/Industry Operational Concept for the Evolution of Free Flight*. For fiscal year (FY) 2000, the FAA Office of System Architecture and Investment Analysis (ASD-130) tasked MITRE's Center for Advanced Aviation System Development (CAASD) with developing an overview of a concept describing how the flight object would be defined and used in the Free Flight Phase 1 (FFP1) and Free Flight Phase 2 (FFP2) time frames, as well as in the beyond FFP2 time frame that is described in the ATS (Air Traffic Services) document.[1] This concept overview completed in FY 2000 [*An Overview of a Flight Object Concept for the NAS* and the Flight Object Concept Web Site] serves as the basis for exploration of the flight object beginning in FY 2001.

The FAA/NASA (National Aeronautics and Space Administration) Interagency ATM Integrated Product Team (IAIPT) was established in September 1995 to coordinate and manage the ATM R&D efforts of the two agencies. The IAIPT consists of an Interagency Integrated Management Team (IAIMT) responsible for providing executive leadership in the planning and performance of a relevant and dynamic national ATM R&D program, and six Area Work Teams (AWTs) tasked with planning and performing specific research activities in each of six areas (surface, terminal, en route, traffic flow management, oceanic, and system/cross-cutting). At some point (possibly during initial flight object research activities or after the initial research activities are completed), it is expected that the flight object will be placed under the purview of the system/cross-cutting AWT.

A critical aspect of conducting a responsive ATM R&D improvement program is the ability to transition new capabilities and capability enhancements out of the research arena into the operational environment of the NAS. The *Integrated Plan for ATM Research and Technology Development* defines an ATM R&D program that reflects the system life-cycle realities. As identified in that plan, the FAA/NASA IAIPT plans and manages the concept exploration and concept development phases of the life cycle. The IAIPT also is responsible for deployment transfer (i.e., technical transfer) from the IAIPT to the FAA's appropriate domain Integrated Product Team (IPT) as the research effort matures. The *Research Management Process for Developing New Concepts and Capabilities for the NAS*, established by the Program Director for R&D (ARX-20), provides overall guidance for the activities associated with the early life cycle phases. In addition, the *System Prototypes in Operational Air Traffic Control Facilities: Development and Evaluation Process Guidelines*, developed by the Program Director for ASD, provides additional guidance for the field installation and evaluation of research prototypes. This RMP includes a description of the guidelines established in both of these documents with a focus on the R&D activities associated with the flight object.

[1] This work also supported the FAA Offices of Operations Planning (ATP) and Air Traffic Systems Development (AUA).

1.3 Scope

This RMP describes the process for exploring and developing capability enhancements to implement the flight object through the concept exploration and concept development research phases. At the completion of the concept development phase, the FAA's Air Traffic organization will determine whether the capability enhancements are operationally suitable and acceptable to warrant the development and installation of prototype enhancements at field sites (i.e., the prototype development research phase). Upon such a decision, the flight object capability enhancements will be transitioned to the appropriate IPT and a Facilities and Equipment (F&E) program will be established. During the prototype development phase, organizations developing the capability enhancements and the appropriate IAIPT working team will continue to provide support to the designated IPT, as necessary.

Because flight object R&D has just begun, this first version of the RMP is not yet complete. This version of the RMP serves as a starting point to assist in organizing future plans for flight object R&D. It is expected that as plans for flight object R&D are developed, they will be coordinated with ASD-100 and then incorporated into future versions of this RMP.

1.4 Document Organization

Section 2 describes the proposed flight object capabilities, including their operational concept of use, functional/interface components, linkage to FAA planning documents, and expected outcomes and outputs. Section 3 provides a summary of the research project, including the research phases and exit criteria, the roles and responsibilities of the participating organizations, a work breakdown structure, and a summary of the current research issues and status. When the plans for flight object R&D become more developed, Section 4 (TBD) will be included to provide a plan for transitioning each capability enhancement to the appropriate FAA systems development organization (AUA) for implementation.

2.0 Description of Proposed Capability

As the NAS evolves, new capabilities in the form of automation and procedures will be introduced to support the ATM service providers in the different domains of the NAS. In addition to assisting the service providers in better managing their workload, these capabilities will support collaboration with the NAS users. Many of these capabilities will use various types of information associated with flights in the NAS, and as a result, they are likely to operate using some of the same information elements. A ***flight object***, defined as a collection of common information elements describing an individual flight, can be implemented through capability enhancements to facilitate the sharing of common flight information elements among the various capabilities. The following sections describe: a proposed operational concept of use for the flight object; the major NAS interfaces required; how the flight object relates to the *ATS Concept of Operations for the NAS in 2005* and the *NAS Architecture Version 4.0*; and the expected outcomes, outputs, and benefits.

2.1 Operational Concept of Use

The current operational concept for the flight object [*An Overview of a Flight Object Concept for the NAS* and the Flight Object Concept Web Site] describes a structure for organizing the flight object information elements and identifies the information elements common to capabilities expected to be available during three different time frames (FFP1, FFP2, and beyond FFP2). These common information elements are ***candidates*** for including in the flight object and sharing with other capabilities; the information elements that could actually be implemented as part of the flight object in the specified time frames are yet to be determined. In the FFP1 and FFP2 time frames, it is expected that the Host Computer System's (HCS's, or Host's) flight information will be available outside of the flight object, through a direct connection with the ATM capabilities. It is not until beyond the FFP2 time frame that the Host's flight information is expected to be available through an implementation of the flight object. A brief description of the flight object structure and the planned capabilities for the different time frames is provided below.

As shown in Figure 1, the flight object has the following three major components:

- The ***flight as filed*** portion of the flight object contains information from NAS user personnel and capabilities. This portion of the flight object could extend beyond today's filed flight plan to include flight intent and user preferences.
- The ***flight as cleared*** portion of the flight object contains information from ATM service providers and capabilities, such as clearances and possible flight plan amendments.
- The ***flight as flown*** portion of the flight object contains information from sensors and pilot reports, including position reports and reported flight conditions.

The types of information elements within each of these major components of the flight object can be categorized as historical information, current information, or planned or projected information. In this document, the nomenclature used to denote one of these categories within a major component of the flight object structure is denoted as *component:category* (for example, *flight as flown:current*). Because the flight-specific information elements associated with the capabilities fit well into this structure, it is the nomenclature used to discuss the concept for sharing flight information among current and future ATM capabilities.

The information described by the flight object is dynamic and varies depending on the status of the flight. For any particular flight, the scheduled flight plan information (like that available in bulk store) is available in the *flight as filed:planned or projected* portion of the flight object. When the user files the flight plan for a flight, the flight plan becomes current and is available in the *flight as filed:current* portion of the flight object. When the system accepts the filed flight plan, it becomes available in the *flight as cleared:planned or projected* portion of the flight object. When the flight departs as cleared, the flight plan is activated and becomes available in the *flight as cleared:current* portion of the flight plan. This flight plan is then archived to the *flight as cleared:history* portion of the flight object when it has been amended or when the flight lands.

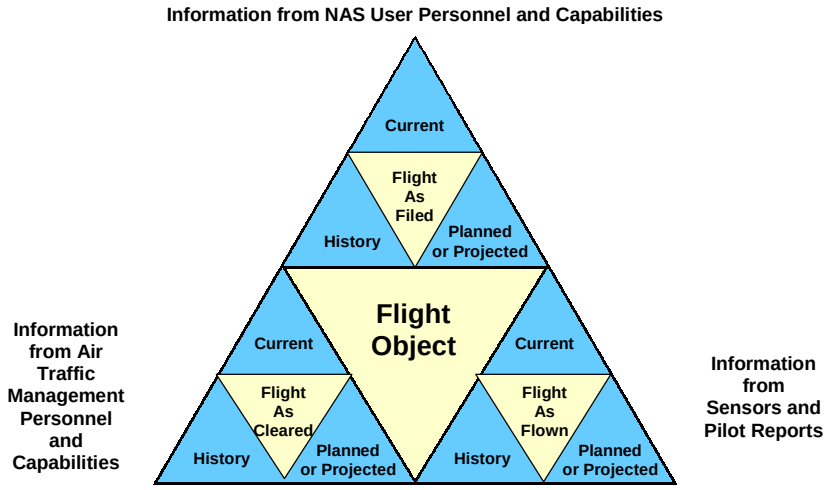


Figure 1. Flight Object Organization

The capabilities planned for implementation in the ***FFP1 time frame*** [*Government/Industry Operational Concept for the Evolution of Free Flight, Addendum 1: Free Flight Phase 1 Limited Deployment of Select Capabilities*] are listed below:

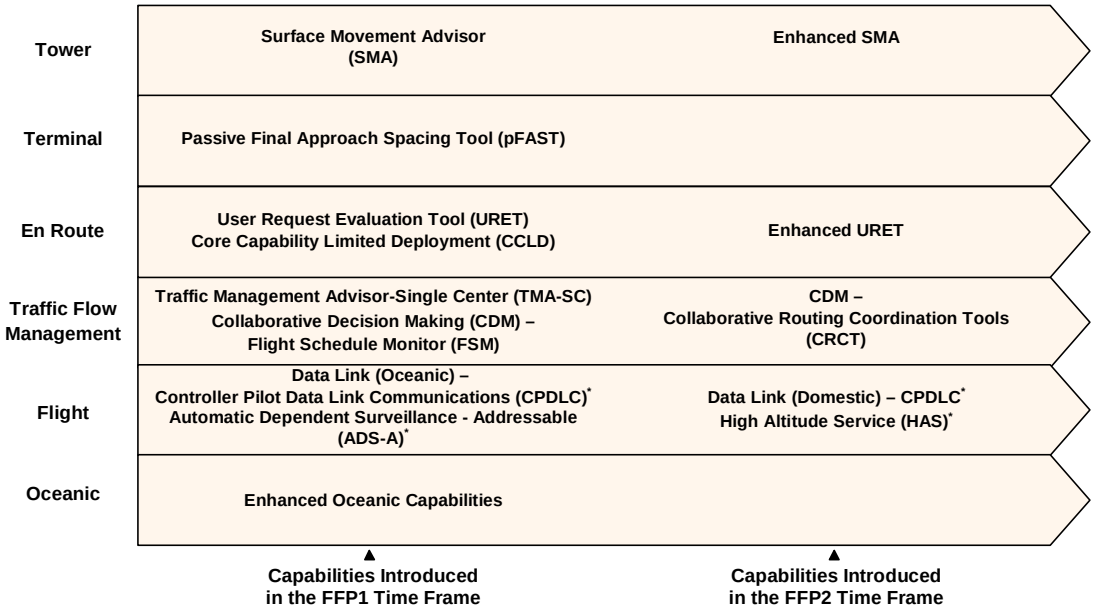
- Surface Movement Advisor (SMA)
- Passive Final Approach Spacing Tool (pFAST)
- User Request Evaluation Tool (URET) Core Capability Limited Deployment (CCLD)
- Traffic Management Advisor-Single Center (TMA-SC)
- Collaborative Decision Making (CDM) – Flight Schedule Monitor (FSM)
- Data Link (oceanic) –
  - Controller Pilot Data Link Communications (CPDLC)
  - Automatic Dependent Surveillance - Addressable (ADS-A)
- Enhanced oceanic capabilities

Because many of these capabilities are being implemented using a spiral development process (first introducing core capabilities with limited deployment and then enhancing those capabilities in a wider deployment), they are likely to be available at only a few facilities when they are first introduced.

In the ***FFP2 time frame***, increased availability of the FFP1 capabilities is expected [*Documentation of 2003 - 2005 Capabilities Working Group Deliberations and Recommendations*], along with the introduction of the following new and enhanced capabilities:

- Enhanced SMA
- Enhanced URET
- CDM – Collaborative Routing Coordination Tools (CRCT)
- Data Link (domestic) – CPDLC
- High Altitude Services (HAS)

A summary of the planned capabilities to be introduced in the FFP1 and FFP2 time frames is shown in Figure 2, as allocated to the different ATM domains within the NAS (the "flight" domain contains cross-cutting capabilities such as air-ground communications, or data link).



* Flight object work in progress.

Figure 2. Planned Capabilities to be Introduced in the FFP1 and FFP2 Time Frames

In addition to the capabilities introduced in the FFP1 and FFP2 time frames, the following capabilities are planned for the ***beyond FFP2 time frame***:

- Surface Management System (SMS) in the tower domain, which may include SMA enhancements and Datalink Delivery of Taxi Clearance (DDTC)
- Expansion of flight data processing capabilities beyond the en route domain into other ATM domains within the NAS
- Additional URET enhancements to include automatically initiated problem resolution in the en route domain (manually initiated problem resolution may be available in the FFP2 time frame)
- Enhancements to Traffic Flow Management (TFM) capabilities, including Multi-Center Traffic Management Advisor (McTMA), as well as additional collaborative decision making and post-analysis capabilities, such as the following:
  - Integrated Impact Tool (IIT) – integrates one-dimensional impact results from CRCT, FSM, and other capabilities
  - Post Operative Evaluation Tool (POET) – compares filed or planned flight information to actual flight information based on Enhanced Traffic Management System (ETMS) data and carrier-supplied information
- Data Link – Automatic Dependent Surveillance - Broadcast (ADS-B) in the flight domain

It is expected that the flight object will eventually interface with all capabilities that can take advantage of shared flight information. In addition to the ATM capabilities listed above, capabilities that may benefit from shared flight information include the following:

- User flight planning and performance analysis capabilities
- Search and rescue capabilities

- Accident investigation capabilities
- Flight Service Stations (FSSs)
- ETMS
- Sector suite staffing and scheduling capabilities
- Air Traffic Control System Command Center (ATCSCC, or Command Center) capabilities
- All en route Air Route Traffic Control Center (ARTCC, or Center) capabilities
- Terminal Radar Approach Control Facility (TRACON) capabilities

It is possible that these additional capabilities will be available in the beyond FFP2 time frame, but because they are not yet well defined, they have not been fully incorporated into this concept.

The flight object will make common information accessible to the appropriate capabilities within a reasonable response time, as illustrated by the examples in Table 1 and Table 2 for the beyond FFP2 time frame.

2.1.1 Problem Statement

Capabilities currently planned for introduction into the NAS in the FFP1 time frame require trajectory and other types of flight information. Capabilities such as URET CCLD and TMA-SC require more detail and accuracy in their trajectories than can be provided by the Host's converted route [*An Overview of a Flight Object Concept for the NAS* and the Flight Object Concept Web Site], and as a result, each capability creates its own separate trajectory. Additional capabilities under research for the FFP2 and beyond FFP2 time frames require trajectory and other flight information as well. Because it is not feasible or fiscally practical for each capability to create and store a separate version of the flight information, the FAA and the user community must examine ways to share flight information efficiently.

2.1.2 Opportunities

The flight object provides an opportunity for achieving increased operational efficiency by sharing common flight information elements among many different ATM capabilities. Sharing common information elements using the flight object has a number of potential advantages:

- Improved accuracy and availability of flight information updates
- Improved consistency of flight planning in different domains and a smoother transition of flights between domains
- Enhanced availability of user preferences for real-time planning and recorded history information for post-analysis processing
- Improved effectiveness of on-going traffic management initiatives and the associated collaborative decision-making process
- Enhanced ability of service provider to issue traffic advisories to controlled aircraft about uncontrolled aircraft and to provide flight following services for aircraft flying Visual Flight Rules (VFR)

Both the users and the ATM service providers can benefit from the increased efficiency of well-coordinated capabilities that share common flight information elements.

Table 1. Flight Object Information Element Accessibility Examples – Prior to Departure

Accessibility of Flight Object Information Elements	Sample Capabilities Using or Providing Flight Object Information Elements	Sample Flight Object Information Elements
Within hours less than 90 days prior to departure	User flight planning capabilities ETMS Sector suite staffing and scheduling capabilities	Information identifying flight Date/time stamp for each update Current flight plan and intent (preferred trajectory without constraint) information Previous flight plan and intent information (retain all changes)
Within minutes less than 24 hours prior to departure	User flight planning capabilities ETMS CDM – CRCT Sector suite staffing and scheduling capabilities	Information identifying flight Date/time stamp for each update Current flight plan and intent information Previous flight plan and intent information
Within seconds less than 24 hours prior to departure	User flight planning capabilities FSSs ETMS CDM – CRCT Departure Sequencing Program (DSP) Sector suite staffing and scheduling capabilities Host URET SMS DDTC Traffic Management Advisor (TMA)/Expedite Departure Path (EDP)	Information identifying flight Date/time stamp for each update Current flight plan and intent information Previous flight plan and intent information Control information

Table 2. Flight Object Information Element Accessibility Examples – After Departure

Accessibility of Flight Object Information Elements	Sample Capabilities Using or Providing Flight Object Information Elements	Sample Flight Object Information Elements
Within seconds while flight is active	Host DDTC pFAST URET TMA-SC and McTMA CDM – FSM and CRCT Data link – CPDLC and ADS-A HAS Enhanced oceanic capabilities	Information identifying flight Date/time stamp for each update Current flight plan and intent information Out, Off, On, and In (OOOI) times Last known position information Current trajectory information Control information[2]
Within minutes while flight is active	User flight planning capabilities ETMS CDM – CRCT Search and rescue capability	Information identifying flight Date/time stamp for each update Current user preferences (preferred trajectory given known constraints) Recent user preference information Recent flight plan and intent information OOOI times Recent history trail information Recent trajectory history information Recent control history information Other search and rescue information
Within hours after flight is terminated	User flight performance analysis ETMS System performance analysis Flow analysis Accident investigation capability	Information identifying flight Date/time stamp for each update Complete user preference information Complete flight plan and intent history information OOOI times Complete history trail information Complete trajectory history information Complete control history information Other post-analysis information

[2] Control information available to ATM capabilities is not available to NAS user capabilities.

2.2 Functional/Interface Components

Evaluation and implementation of the flight object requires that ATM capabilities that can benefit from the flight object (such as those capabilities listed above) interface with each other to share flight object information. This can be accomplished several different ways, such as through a *centralized depository,* or through a *decentralized subscription service* in which the "owners" of specific information elements maintain those elements and transmit updates to subscribers as they are available. In either case, the ATM capabilities that use or provide specific flight object information elements interface with other ATM capabilities to use and provide those information elements.

2.3 Linkage to NAS 2005 Ops Con/NAS Architecture Version 4.0

Both the *ATS Concept of Operations for the NAS in 2005* and the *NAS Architecture Version 4.0* describe the need to provide Decision Support Tools (DSTs) to facilitate efficient use of flight information and enable the implementation of future operational concepts. The *NAS Architecture Version 4.0* describes the need for replacing the flight plan with the flight object as called for by the *ATS Concept of Operations*. The flight object can provide the dynamic update capabilities that will help integrate operational and business decisions to gain efficiency, predictability, and flexibility in flight operations. Key capabilities envisioned by these concepts are summarized below.

2.3.1 Flight Object Concepts

- Including additional flight information, such as the user's route and altitude preferences, the aircraft's weight, gate assignments, departure/arrival runway preferences, and location while in flight
- Dynamically updating flight object information elements for improved planning

2.3.2 Decision Support Tool Concepts

- Providing common flight information in standard formats to be used by ATM service provider and NAS user capabilities
- Improving Air Traffic Control (ATC) efficiency (in communicating flight information) through the implementation of capability enhancements that facilitate collaborative management of flight operations between ATM service providers and NAS users

2.4 Expected Outcomes/Outputs

2.4.1 Outcomes

Two of the performance goals defined in the *1998 FAA Strategic Plan* are improved system flexibility and reduced system delays. The use of flight object capability enhancements can contribute to achieving these goals through increased collaboration among ATM service providers and NAS users, which improves the flexibility of the NAS and reduces system delays. In addition to these FAA-defined goals, the flight object capability enhancements can lead to other improvements in system efficiency by: 1) increasing overall system predictability through the use of common flight information, and 2) enhancing service delivery through improved coordination among ATM facilities and the NAS users.

2.4.2 Outputs/Expected Benefits

It is expected that the deployment of the flight object capability enhancements will provide benefits to both the ATM service providers and the NAS users through the increased efficiency of well-coordinated capabilities that share common flight information elements.

3.0 Research Project Summary

3.1 Research Phases/Exit Criteria

A typical project life cycle consists of five phases: concept exploration, concept development, prototype development, full-scale development, and deployment/operations. As stated in Section 1.3, this RMP discusses the activities associated with the flight object for the first three phases.

3.1.1 Concept Exploration

During this phase, the flight object capability enhancements will be examined for their feasibility and potential to improve the efficiency of NAS operations. Based on this evaluation, the IAIPT may approve the transition of the flight object from concept exploration to concept development. Exit criteria for this decision include:

- Development of a Description of Proposed Capability (DPC), describing how operational personnel will use the flight object capability enhancements to provide a desirable beneficial service for the airspace user
- Identification of technical and operational issues
- Identification of the nature and extent of expected benefits
- Definition of supporting methodologies for addressing safety, human factors, procedures and performance

3.1.2 Concept Development

During this phase, functional demonstrations and operational evaluations will be conducted in laboratories, such as at MITRE/CAASD and the William J. Hughes Technical Center (WJHTC) that operates the TFM laboratory and the Integration and Interoperability Facility (I^2F). Functional demonstrations and operational evaluations may also be conducted in a "shadow mode" (simulation of operational use) at several facilities (for example, the Command Center, one or more Centers, and an airline's Aeronautical Operational Control, or AOC facility).

The laboratory activities will evaluate the functionality of the capability enhancements associated with the flight object and verify the non-interference of these enhancements with the required capabilities (systems) of the NAS. The activities in the WJHTC TFM laboratory will include verifying that the installation and use of TFM and AOC capability enhancements (and the associated equipment) will have no adverse effects on a future field site. During the I^2F evaluation, the emphasis will be on the assessment of the operational suitability and usability of the flight object capability enhancements, the resolution of operational and technical issues (see Section 3.4), and the identification of any necessary modifications.

The "shadow mode" phase of concept development will have ATM service providers and NAS users at the different facilities participate in periodic (for example, once a week) exercises (off the operational floor). During these exercises, the participants will use the flight object capability enhancements to communicate flight information and collaborate on flight planning. The impact of using the flight object capability enhancements will be evaluated "off-line" by using flight object analysis tools and by debriefing the participants. The "shadow mode" phase will provide additional opportunities to resolve the identified operational issues (see Section 3.4.1).

After the concept is developed and evaluated in the laboratory and in "shadow mode," Operations Planning (ATP-400) and System Research (ARX-20) will determine whether the flight object capability enhancements are operationally suitable and acceptable to warrant the development and installation of prototypes at field sites. Upon such a decision, the flight object capability enhancements will be transitioned to the appropriate IPT (AUA-X00) and an F&E program will be established. Exit criteria for this phase include:

- Development of Operational Concept document
- Resolution of operational and technical issues
- Estimate of benefit/cost
- Development of Transition/Technology Transfer Plan
- Decision to proceed to prototype development/installation at field site(s)

3.1.3 Prototype Development and Validation

At the commencement of this phase, an F&E program will be established for flight object capability enhancements. The appropriate IPT (AUA-X00) will be responsible for managing this program. During this phase, a test NAS Change Proposal (NCP) will be developed to allow integration of the flight object capability enhancements with the field site capabilities, and functional, full-featured flight object capability enhancement prototypes will be developed and installed. The appropriate IAIPT working team and the capability developers will continue to provide support and resources during this phase, as required, including development and documentation of the relevant configuration management process.

3.2 Roles and Responsibilities

Each participating organization contributes to the overall flight object research program through the roles and responsibilities described below.

3.2.1 AAR-230 FAA/NASA Integrated NAS Research

As the FAA co-lead of the IAIPT, AAR-230 is responsible for overall oversight and management of the joint research projects defined in the *Integrated Plan for ATM Research and Technology Development.*

3.2.2 ASD-100 Architecture and System Engineering

In addition to developing the flight object Operational Concept, ASD-100 is responsible for developing and maintaining the flight object RMP and coordinating with appropriate organizations to identify and resolve associated issues. ASD-100 is also responsible for defining the associated NAS information architecture and developing the requirements associated with the flight object.

3.2.3 ATP-400 Operations Planning

ATP-400 will participate in the identification and resolution of operational issues and questions associated with flight object capability enhancements, including the definition of supporting methodologies needed to address human factors and procedural issues. ATP-400 is also responsible for reviewing an Operational Concept for the use of the flight object capability enhancements and for getting a consensus within Air Traffic. After the Operational Concept is developed and evaluated in the laboratory and in "shadow mode," ATP-400 will work with ARX-20 to determine whether the flight object capability enhancements are operationally suitable and acceptable, so that they warrant developing and installing prototypes at field sites.

3.2.4 ARX-20 System Research

ARX-20 has overall responsibility for ATS management and coordination of the flight object RMP. After the "shadow mode" evaluation of the Operational Concept has been completed, ARX-20 will work with ATP-400 to determine whether the flight object capability enhancements are operationally suitable and acceptable, so that they warrant developing and installing prototypes at field sites.

3.2.5 NAS Information Architecture Committee (NIAC) of the Configuration Control Board (CCB)

The NAS Information Architecture Committee (NIAC) of the Configuration Control Board (CCB) is responsible for identifying common flight object information elements, and for developing and enforcing the design standards for those information elements.

3.2.6 Object Management Group (OMG)

The Flight Planning Working Group of the Object Management Group (OMG) is responsible for developing the implementation standards for flight object information elements.

3.2.7 AUA-200, -300, -400, -600, -700 En Route ATC/Terminal ATC/Weather and Flight Service/Oceanic and Offshore ATC/Traffic Flow Management Systems Development

AUA-200, AUA-300, AUA-400, AUA-600, and AUA-700 will participate in the identification and resolution of technical issues associated with the flight object capability enhancements from the perspectives of en route ATC, terminal ATC, weather and flight service, oceanic and offshore ATC, and traffic flow management, respectively. In addition, AUA will assist in defining the architecture in which the flight object capability enhancements will be expected to operate, as well as in defining the target operational environment. The appropriate IPT (AUA-X00) will be responsible for managing the F&E program established for flight object capability enhancements, including the development and installation of functional, full-featured flight object capability enhancement prototypes.

3.2.8 AND-500 Advanced Technology

The Advanced Technology IPTs in AND-500 are responsible for the management and acquisition of specific airborne systems in the NAS. To the extent that the flight object will affect the design and implementation of certain avionics systems, AND-500 will be responsible for ensuring that the certification, software, and interface standards related to the information needs of the flight object and the appropriate avionics are developed and met.

3.2.9 MITRE/Center for Advanced Aviation System Development (CAASD)

MITRE/CAASD will use its knowledge of ATM capability research (including Automated En Route Air Traffic Control, or AERA, URET CCLD, and CDM-CRCT), Host modernization research, the operational application of shared flight object information, operational analyses/evaluation, human factors analyses, and requirements definition to support the flight object research. MITRE/CAASD will be responsible for developing the flight object operational concept of use and identifying data items for standardization.

MITRE/CAASD contributes expertise in ATM concept and prototype development, extensive field site experience, algorithm development, system architecture and engineering, and human factors. MITRE/CAASD will work with the FAA, NASA Ames Research Center (ARC), and other cognizant organizations to understand how to share trajectory and other flight object information.

3.2.10 NASA Ames Research Center (ARC)

NASA ARC is co-lead of the IAIPT and is responsible for overall oversight and management of the joint research projects defined in the *Integrated Plan for ATM Research and Technology Development.* NASA ARC contributes expertise in Center-TRACON Automation System (CTAS) software development, extensive field site experience, algorithm development, and human factors to the development and evaluation of CTAS. NASA ARC will work with MITRE/CAASD and the FAA to understand how to share trajectory and other flight object information.

3.2.11 NAS Users

The airlines (dispatchers and other personnel), military, general aviation, and flight planning groups are responsible for assisting in the definition and implementation of the flight object.

3.2.12 Massachusetts Institute of Technology (MIT) International Center for Air Transportation

The Department of Aeronautics and Astronautics in the Massachusetts Institute of Technology (MIT) International Center for Air Transportation is responsible for assisting in identifying the types of intent information that NAS users provide for ATM service providers, the types of intent information that service providers need to resolve potential separation problems and traffic flow situations, and then the useful types of intent information that are not yet available to the service providers. The Department of Aeronautics and Astronautics is responsible for determining the steps that are necessary to make the needed types of information available to service providers and for examining the usefulness of including service provider intent, environment, and weather information as part of a shared flight object.

3.3 Work Breakdown Structure

3.3.1 Schedule

Table 3 provides an initial schedule for flight object exploration.

Table 3. Flight Object Schedule

Milestone	Location	Date
Concept Overview Documentation	MITRE/CAASD	09/00
Common Trajectory Research	MITRE/CAASD and NASA ARC	09/01

3.3.2 Costs/Funding

Table 4 provides a summary of the general cost categories for the flight object research and the organizations responsible for covering those costs:

Table 4. Summary of the General Cost Categories

Description	Responsible Party
NASA ARC Research	NASA ARC
MITRE/CAASD Research	FAA
MIT International Center for Air Transportation	NASA ARC

When the plans for flight object R&D become more developed, the costs associated with flight object research (by organization and fiscal year) will be shown in Table 5 (TBD).

Table 5. Cost Associated with Flight Object Research (TBD)

	FISCAL YEAR					
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
FAA($M)						
MITRE CAASD($M)						
NASA($M)						
TOTAL($M)						
FAA(SY)						
MITRE CAASD(SY)						
NASA(SY)						
TOTAL(SY)						
Included in FAA($M):						
FAA-to-NASA($M)						
FAA-to-Program($M)						

3.4 Research Issues

The following paragraphs identify operational and technical issues and questions associated with flight object research. Appropriate resolution of these issues will be required prior to the approval of an operational field site evaluation of any proposed flight object capability enhancements.

3.4.1 Operational Issues

Collaboration Issues

- How can the ATM service providers collaborate with the NAS users to share flight object information?
- What are the roles and responsibilities for the ATM services providers and the NAS users in sharing flight object information?
- What types of information elements are needed to support collaboration among ATM service providers and NAS users?
- What types of performance metrics are needed to evaluate collaboration among ATM service providers and NAS users?

Planned Capability Issue

- Some of the FFP2 capabilities identified in this paper have not yet been well defined (such as HAS). How will these capabilities change as they become more defined, and how will the entire set of planned capabilities evolve for the FFP1 and FFP2 time frames? Which capabilities are planned for the beyond FFP2 time frame? How will new capabilities, as well as existing capabilities that evolve over time, interact with the flight object?

General Information Element Issues

- The information elements identified as initial flight object information elements available from the Host are applicable to the planned capabilities that have been identified for the FFP1 and FFP2 time frames. How will these Host information elements change as the planned capabilities for the FFP1, FFP2, and beyond FFP2 time frames evolve?
- What level(s) of accuracy should be available through the flight object for an information element that is used with different levels of accuracy by different capabilities (such as current speed or heading)?
- How should an advisory (such as a TMA metering assignment or a pFAST landing assignment) be incorporated into the flight object? How do these advisories differ from constraints?
- What other types of information (besides *descriptive* information such as the aircraft identifier and the origin and destination airports, and *control-related* information such as the computer identifier and the controlling and receiving sectors) should be shared as part of the flight object?
- How will the set of information elements that could be shared for the capabilities expected to become available in the FFP1 and FFP2 time frames change as the planned capabilities for these time frames evolve and become more defined? Which new information elements could be shared for the capabilities expected to become available in the beyond FFP2 time frame?

Trajectory Issues

- What types of information are considered part of a trajectory?
- Which flight activation event should initiate that flight's representation in the *flight as cleared:current* portion of the flight object?
- Given the future plan for the Host to integrate its current representation of past track with a four-dimensional trajectory for the flight path projection, how will the ATM capabilities be affected?
- Would the individual capabilities (such as URET CCLD and TMA-SC) and the system as a whole benefit from sharing a common trajectory? If so, which elements of a trajectory should be shared among the capabilities accessing the flight object?

3.4.2 Technical Issues

- When can the Host's flight information become available through an implementation of the flight object?
- What is the most efficient network, hardware, and software architecture for sharing flight object information elements?
- What is the best alternative for providing flight object information to multiple locations (hardware and software alternatives)?
- What is the best strategy for transitioning to the new flight object concept, e.g., are there interim steps that make sense?

3.4.3 Certification

TBD

3.5 Current Status of Research

3.5.1 Present Readiness Level

TBD

3.5.2 Funding Profile

TBD

3.5.3 Locations of Present Prototypes

None.

3.5.4 Proposed Next Steps

An important next step is to make the flight object concept and the common information elements identified by NIAC available throughout the FAA and supporting organizations, as well as to the NAS users, for facilitating further discussion of candidate flight object information elements. As the flight object discussion continues, revisions to this RMP and the flight object concept are planned. The plans for and the results of ongoing research will be documented (such as the development and application of a common trajectory), as well as any additional issues that require analysis and evaluation before information elements can actually be shared within the NAS. Examination of the issues associated with the flight object will provide more information to support the development of Host and ATM capability requirements.

3.5.5 List of Required Documents

Description of Proposed Capability (DPC) RMP Section 3.1.1

Responsible party: TBD

Required for decision in transition from concept exploration to concept development.

Document must describe how operational personnel will use the tool to provide a desirable beneficial service for the airspace user.

Operational Concept RMP Section 3.1.2

Responsible party: ASD-100

Required for completion of concept development phase and transition to prototype development and validation.

Transition/Technology Transfer Plan RMP Section 3.1.2

Responsible party: TBD

Required for completion of concept development phase and transition to prototype development and validation.

NAS Change Proposal (NCP) RMP Section 3.1.3

Responsible party: TBD

Required as part of the prototype development and validation phase; required to allow integration of flight object capability enhancements with the field site capabilities.

4.0 Transition Plan

TBD

REFERENCE DOCUMENTS

ATS Concept of Operations for the National Airspace System in 2005, Federal Aviation Administration (FAA), September 1997, available online: http://www.nas-architecture.faa.gov/CATS/Documents/Opscon.pdf

Government/Industry Operational Concept for the Evolution of Free Flight, RTCA, Inc., December 1, 1997, available for ordering online: http://www.rtca.org/

Viets, K. and N. Taber, *An Overview of a Flight Object Concept for the National Airspace System (NAS),* The MITRE Corporation, September 2000 (MTR 00W0000085), available online: http://www.caasd.org/flight_object_concept/related/concept.pdf

The Flight Object Concept Web Site [Online], The MITRE Corporation, September 2000. Available: http://www.caasd.org/flight_object_concept/index.htm

Integrated Plan for Air Traffic Management Research and Technology Development, Version 3.0, FAA/NASA IAIPT, January 1999.

Research Management Process for Developing New Concepts and Capabilities for the NAS, FAA/ARX-20, 1999.

System Prototypes in Operational Air Traffic Control Facilities: Development and Evaluation Process Guidelines, FAA Acquisition Management System, January 2000, available online: http://www.nas-architecture.faa.gov/CATS/Documents/AMSPrototype_jan00.PDF

NAS Architecture Version 4.0, FAA, January 1999, available online: http://www.nas-architecture.faa.gov/CATS/Tutorials/NASArch.htm

Government/Industry Operational Concept for the Evolution of Free Flight, Addendum 1: Free Flight Phase 1 Limited Deployment of Select Capabilities, RTCA, Inc., Select Committee on Free Flight Implementation, August 1998, available for ordering online: http://www.rtca.org/

Documentation of 2003 - 2005 Capabilities Working Group Deliberations and Recommendations, RTCA, Inc., Select Committee on Free Flight Implementation, expected for publication in December 2000.

1998 FAA Strategic Plan, Federal Aviation Administration (FAA), May 1998, available online: http://www.nas-architecture.faa.gov/CATS/Documents/98sp-fin.pdf

ACRONYMS

ADS-A	Automatic Dependent Surveillance - Addressable
ADS-B	Automatic Dependent Surveillance - Broadcast
AERA	Automated En Route Air Traffic Control
AOC	Aeronautical Operational Control
ARC	Ames Research Center
ARTCC	Air Route Traffic Control Center
ATC	Air Traffic Control
ATCSCC	Air Traffic Control System Command Center
ATM	Air Traffic Management
ATS	Air Traffic Services
AWT	Area Work Team
CAASD	Center for Advanced Aviation Systems Development
CCB	Configuration Control Board
CCLD	Core Capability Limited Development
CDM	Collaborative Decision Making
CPDLC	Controller Pilot Data Link Communications
CRCT	Collaborative Routing Coordination Tools
CTAS	Center-TRACON Automation System
DDTC	Datalink Delivery of Taxi Clearance
DPC	Description of Proposed Capability
DSP	Departure Sequencing Program
DST	Decision Support Tool
EDP	Expedite Departure Path
ETMS	Enhanced Traffic Management System
FAA	Federal Aviation Administration
F&E	Facilities and Equipment
FFP1	Free Flight Phase 1
FFP2	Free Flight Phase 2
FSM	Flight Schedule Monitor
FSS	Flight Service Station
FY	Fiscal Year
HAS	High Altitude Service
HCS	Host Computer System
I^2F	Integration and Interoperability Facility

IAIMT	Interagency Integrated Management Team
IAIPT	Interagency ATM Integrated Product Team
IIT	Integrated Impact Tool
IPT	Integrated Product Team
McTMA	Multi-Center Traffic Management Advisor
MIT	Massachusetts Institute of Technology
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NIAC	NAS Information Architecture Committee
NCP	NAS Change Proposal
OMG	Object Management Group
OOOI	Off, Out, On, and In (*aka* ASQP data)
pFAST	Passive Final Approach Spacing Tool
POET	Post Operative Evaluation Tool
R&D	Research and Development
RMP	Research Management Plan
SMA	Surface Movement Advisor
SMS	Surface Management System
TBD	To Be Done
TFM	Traffic Flow Management
TMA	Traffic Management Advisor
TMA-SC	Traffic Management Advisor - Single Center
TRACON	Terminal Radar Approach Control Facility
URET	User Request Evaluation Tool
VFR	Visual Flight Rules
WJHTC	FAA William J. Hughes Technical Center