National Aeronautics and Space Administration

Airspace Systems Program

Next Generation Air Transportation System Concepts and Technology Development

FY2010 Project Plan

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Airspace Systems Program

NextGen CTD Project

FY 2010 Project Plan

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1. NEXTGEN-CONCEPTS AND TECHNOLOGY DEVELOPMENT PROJECT PLAN INTRODUCTION

1.1 Document Purpose

This document describes the FY2010 plan for the management and execution of the Next Generation Air Transportation System (NextGen) Concepts and Technology Development (CTD) Project. The document was developed in response to guidance from the Airspace Systems Program (ASP), as approved by the Associate Administrator of the Aeronautics Research Mission Directorate (ARMD), and from guidelines in the *Airspace Systems Program Plan*.

This document, titled *NextGen CTD FY2010 Project Plan* (hereafter referred to as "FY2010 Project Plan" or "the Project Plan") satisfies NASA research and technology development management requirements, as described in NPR 7120.8, specifically, "Chapter 5, R & T Portfolio Project Requirements."

The document reflects Airspace Systems Program adjustments for FY2010, which resulted in a different project structure and is discussed in section **1.2 Background**, which follows.

1.2 Background

Congress established the multi-agency Joint Planning and Development Office (JPDO) in 2003 to develop a vision for the 2025 Next Generation Air Transportation System (NextGen) and to define the research required to enable it. NASA is one of seven agency partners contributing to the effort.[1] Accordingly, NASA's ARMD realigned the Airspace Systems Program in 2007 to "directly address the fundamental research needs of the Next Generation Air Transportation System… in partnership with the member agencies of the JPDO."[2] The Program subsequently established two new projects to meet this objective: the NextGen-Airspace Project and the NextGen-Airportal Project. Most recently, in FY2010, the Program restructured its research portfolio:

- Fundamental Research Focus Areas (RFAs) from the NextGen-Airspace Project and NextGen-Airportal Project were consolidated into the NextGen CTD Project. The Project develops and explores fundamental concepts, algorithms, and technologies to increase throughput of the National Airspace System (NAS) and achieve high efficiency in the use of resources such as airports, en route and terminal airspace. In pursuit of that aim, researchers will develop algorithms, conduct analyses and simulations, identify and define infrastructure requirements, identify and define field test requirements, and conduct field tests.

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[1] JPDO partners include Department of Commerce, Department of Defense, Department of Homeland Security, Department of Transportation, the Federal Aviation Administration, NASA, and the White House Office of Science and Technology Policy.

[2] NASA's New Aeronautics Research Program, 45th AIAA Aerospace Sciences Meeting & Exhibit, Dr. Lisa Porter, Associate Administrator for Aeronautics, 11 January 2007.

- Cross-cutting RFAs from the NextGen-Airspace and NextGen-Airportal were consolidated into the NextGen Systems Analysis, Integration and Evaluation (SAIE) Project. The NextGen Systems Analysis, Integration, and Evaluation (SAIE) Project is responsible for characterizing airspace system problem spaces, defining innovative approaches, assessing the potential system impacts and design ramifications of the program's portfolio, providing integrated solutions, and facilitating the research and development maturation of these integrated concepts through evaluation in relevant environments. Other research will focus on system-level, collective impact assessments; safety assessments; and cost-benefit analyses.

Together, the projects will also focus NASA's technical expertise and world-class facilities to address the question of where, when, how and the extent to which automation can be applied to moving aircraft safely and efficiently through the NAS and technologies that address optimal allocation of ground and air technologies necessary for NextGen. Additionally, the roles and responsibilities of humans and automation influence in the NAS will be addressed by both projects. Foundational concept and technology research and development begun under the NextGen-Airspace and NextGen-Airportal projects will continue. There will be no change in NASA Research Announcement (NRA) strategy, nor will there be any change to NASA interfaces with the JPDO, Federal Aviation Administration (FAA), Research Transition Teams (RTTs), or other stakeholders.

2. Objectives

Key objectives of NASA Airspace Systems (AS) Program are to:

- Improve mobility, capacity efficiency and access of the airspace system;
- Improve collaboration, predictability, and flexibility for the airspace users;
- Enable accurate modeling and simulation of air transportation systems;
- Accommodate operations of all classes of aircraft; and
- Maintain system safety and environmental protection.

NASA's NextGen CTD Project supports these program objectives by developing gate-to-gate concepts and technologies intended to enable significant increases in the capacity and efficiency of the NextGen, as defined by the JPDO.

The CTD Project Goal is to develop and explore gate-to-gate concepts, algorithms and technologies. This is accomplished along three thrusts:

- Innovative research and new directions
- JPDO NextGen related research and development (within the scope of NASA's core competencies and where NASA is responsible)
- Advance concepts and technologies for stakeholder benefits (with SAIE)

The Airspace Systems Program Director (PD) approved the Project restructure as developed by the Principal Investigators (PIs), Project Managers (PMs) and Project Scientists (PSs) of both projects and presented by the PI to the PD.

Based on the authorization to proceed with the restructure in FY2010, the Project is now focusing on completion and implementation of the NextGen CTD Project restructure, which had begun in 2009. The new project description can be found in Section 1.2 Background.

In 2010, ARMD revised the Governance model that will be put in place in FY2011 and will be addressed in the FY2011-2015 Project Plan Update and milestone records.

2.1 Key Stakeholders and JPDO Alignment

As in previous years under the NextGen-Airspace project, the NextGen CTD Project research and technology agenda is aligned with the NextGen research needs, commitments, efforts, and resources as defined by the JPDO in the *Next Generation Air Transportation System Integrated Work Plan: A Functional Outline, Version 1.0.* The Project will conduct research activities in FY2010 according to that agenda. [3]

3. Technical Approach

This chapter describes 1) NextGen CTD Project approach to planning and conducting research and technology, 2) research focus areas, and 3) interfaces with the NextGen SAIE Project and projects in other ARMD programs.

3.1 Technical Approach

The NextGen CTD Project conducts foundational research and technology development to extend the state-of-the-art in the computer science, software engineering, applied physics, mathematics, and human factors/automation design. NextGen CTD Project research is tightly coupled with research in the NextGen SAIE Project, and both projects are aligned with NextGen goals and objectives, as defined by the JPDO.

FY2010 is a transitional year as the CTD/SAIE restructure is completed. The legacy four level approach to milestones was maintained for continuity and project tracking. Originally the four levels were to differentiate foundational research from three levels of increasing multi-disciplinary work. See Section 3.3.1 for a description of how the CTD/SAIE Projects will interface.

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[3] NASA's Aeronautics Research in Support of NextGen, Akbar Sultan, Technical Integration Manager, CTD Systems Program, April 10, 2008.

3.2 Research Focus Areas (RFAs)

The NextGen CTD Project is conducting research and development on the efficient utilization of emerging ground, airborne, and space-based technologies to enable NextGen. Accordingly, researchers at NASA Ames Research Center (ARC), NASA Langley Research Center (LaRC) and researchers in the external community at universities and in industry are developing, testing, simulating, and (where appropriate) demonstrating advanced concepts, capabilities, and technologies. The work is organized into the following Research Focus Areas (RFAs):

- **Dynamic Airspace Configuration (DAC)** research is focused on a new operational paradigm in ATM that seeks to modify static airspace resources (controllers/structure) by temporally increasing capacity based on the movement of resources. DAC works with TFM to address the demand/capacity imbalance problem in the safest, most equitable and efficient manner possible.

- **Traffic Flow Management (TFM)** research is focused on the planning (e.g., scheduling and routing) of air traffic flows subject to airport and airspace capacity constraints while accommodating user preferences in the presence of system uncertainties.

- **Separation Assurance (SA)** research is addressing airspace capacity barriers arising from human workload issues related to responsibility for maintaining separation assurance by utilizing sequential processing of sequence and merging with separation for transition and cruise airspace.

- **Super Density Operations (SDO)** research is addressing airspace capacity barriers due to human workload/responsibility for separation assurance by utilizing simultaneous sequencing, spacing, merging, and de-confliction for terminal airspace with nearby runway thresholds and arrival/departures runway balancing.

- **Safe and Efficient Surface Operations (SESO)** research is focused on managing traffic on the airport surface (gates, taxiways, and runways) safely and efficiently to enable maximum throughput in the airport environment with consideration of environmental impacts.

3.2.1 Dynamic Airspace Configuration (DAC)

ATM employs capacity and demand management techniques to predict and mitigate air traffic demand/capacity mismatches and balance capacity with demand. In NextGen, as defined by the JPDO, demand management will be allocated to the TFM function; in contrast, capacity management will be allocated, in part, to the DAC function. Effectively functioning in a complementary fashion, DAC and TFM thus represent a new operational paradigm in ATM.

Unlike today’s NAS, which is characterized by limited user access to information about airspace status and routine imposition of flow restrictions and/or route amendments on users, NextGen is expected to improve customer service with open access to ATM information and fewer restrictions on, and amendments to, user requests. The primary goal of DAC is to better serve users’ needs by tailoring the availability and capacity of the airspace and promptly communicating its status to users. The fundamental objective of DAC is to provide *1) flexibility where possible* and *2) structure where necessary* via strategic airspace organization and dynamic airspace adjustments in response to changing demand. The DAC input is a set of regularly updated trajectory projections and demand equipage characteristics. DAC is expected to include the following capabilities:

- Temporarily instantiate high-density airspace corridors, low-density general-use zones and/or any other class of airspace to best service aggregate user demand.
- "Flex" airspace boundaries to balance projected airspace complexity.
- Temporarily restrict airspace access based upon performance standards to more effectively ration oversubscribed resources.
- Provide flexibility to users where possible.

The enabler of DAC is a new NAS infrastructure that supports 1) flexible staffing of the NAS, and 2) accurate projections of demand trajectories and equipage. The primary output of DAC will be a reconfigured airspace structure tuned, to the extent feasible, to accommodate aggregate user demand. The time horizon within which traffic managers could be expected to reconfigure airspace will range from months, to days, to hours, as needed.

3.2.2 Traffic Flow Management (TFM)

The primary function of Traffic Flow Management (TFM) is to identify and resolve any imbalance(s) in the demand and supply of NAS resources, such as airspace and runways. The TFM function in NextGen has to be designed to accommodate future traffic growth, while accounting for system uncertainties, and accommodating user preferences. To accomplish this goal, the TFM effort is organized into three focus areas: (a) Traffic Flow Optimization, (b) Collaborative Traffic Flow Management (CTFM), and (c) Weather Impact Assessment.

The traffic flow optimization area focuses on developing linear and nonlinear optimization techniques, as well as, heuristic-based approaches and decomposition methods for effectively developing aircraft-level or aggregate flow control strategies in response to actual and predictive demand and capacity imbalances at the local, regional, and national levels. These optimization techniques contribute to the goal of increasing NAS capacity by leveraging key features of NextGen such as 4D trajectory-based operations, performance-based operations, automated separation assurance, and super-density operations.

Collaborative Traffic Flow Management in TFM focuses on the development of methodologies for incorporating user preferences into traffic flow management. The outputs of this focus area are algorithms, procedures, and protocols for fully integrating CTFM into the TFM process.

The weather impact assessment component of TFM develops metrics to predict and analyze the performance of the NAS with respect to observed or predictive weather; develops models to translate meteorological observations and forecasts into time-varying deterministic and probabilistic estimates of the available airspace and airport capacities; and defines requirements for NextGen ATM weather products.

The output of the TFM focus area is a set of modeling, simulation, and optimization techniques that are designed to minimize or maximize a system performance measure, such as total delay, subject to airspace and airport capacity constraints while accommodating weather uncertainty, user preferences, and predicted growth in demand.

3.2.3 Separation Assurance (SA)

In today's NAS operations, air traffic controllers provide separation assurance by visual and cognitive analysis of a traffic display and by issuing control clearances to pilots using voice communication. Decision support tools (DST) deployed in recent years provide trajectory-based advisory information to assist controllers with conflict detection and resolution, arrival metering, and other tasks. Although DSTs have reduced delays, a human controller's cognitive ability limits his/her ability to handle more than approximately 15 aircraft. Consequently, a fundamental transformation of the way separation assurance is provided is necessary in order to achieve NextGen 2025 performance objectives. Emerging aircraft performance capabilities are expected to play a key role in NextGen operations. The objective of SA research in the NextGen CTD Project is to identify trajectory-based technologies and human/machine operating concepts capable of safely supporting a substantial increase in capacity (e.g., 2-3X) under nominal and failure recovery operations, while accommodating airspace user preferences and favorable cost/benefit ratios. SA research in the NextGen CTD Project is focusing on three areas:

- **Automated separation assurance technology development.** Researchers are focusing on automatic conflict detection and resolution algorithms, trajectory analysis methods, and system architectural characteristics that together result in automated resolution trajectories that are safe, efficient, and robust under the huge variety of traffic conditions in the NAS.

- **Functional allocation research.** Researchers are developing human/machine air/ground allocations to provide integrated solutions for traffic conflicts, metering and weather (Wx) avoidance. This will include a series of human-in-the-loop simulations (HITLs) of increasing complexity with higher traffic densities, mixed equipage/operations in nominal and off-nominal conditions.

- **Human/automation operating concepts research.** Researchers are addressing the need to conduct analyses of cognitive workload, situational awareness, performance under different service-provider-based concepts of operations, roles, and responsibilities of controllers and pilots and include a series of human-in-the-loop simulations of increasing complexity and fidelity.

- **System safety and failure recovery analysis research.** Researchers are addressing the need to identify component failure and recovery modes for automated SA methods, including missed conflict alerts, datalink failure, primary trajectory server failure, false read-back, human operator mistakes, and other factors.

3.2.4 Super-Density Operations (SDO)

SDO refers to highly efficient operations at the busiest airports and in the terminal airspace. Capacity at the busiest airports plays a key role in determining the efficiency and robustness of the NAS and ultimately defines the attainable growth in air traffic. Significant growth at the busiest airports as well as regional and smaller airports is needed to achieve NextGen capacity goals. The JPDO envisions a combination of new technologies enabling significant growth at large airports and increased operations at underutilized airports to absorb the expected increase. Increasing capacity in the current architecture is not scalable to meet future needs. A new operational paradigm is needed to increase terminal area capacity to meet NextGen demand. To support this goal, the NextGen CTD Project is conducting SDO research in the following areas:

- **Concept of operations development** is focused on employing rapid prototyping and fast-time simulation to assess and iteratively refine the concept of operations based on improved understanding of the fundamental challenges and development of enabling technologies to address those challenges.

- **Sequencing and deconfliction technologies development** is focused on advancing sequencing and deconfliction methods beyond the current practices of modified first-come-first-served scheduling and tactical separation service. Outputs of this research will be an understanding of the inherent uncertainty associated with execution of precision trajectories in SDO airspace together with improvements in multi-objective constraint optimization for air traffic systems.

- **Precision spacing and merging technologies development** is addressing the need to reduce the level of uncertainty inherent in aircraft operations in SDO airspace and enable many aspects of Equivalent Visual Operations, a key capability associated with NextGen, as defined by the JPDO. This research will produce procedures and technologies for airborne precision merging and spacing extended to meet multiple constraints and environmental considerations.

- **Regional SDO resource optimization research** is defining methods for regional resource optimization to enhance regional SDO capacity and robustness to a variety of disturbances. Outputs will include methods for managing precision and non-precision operations in the same airspace. Work will be coordinated with performance based systems research to incorporate precision performance-based concepts in SDO airspace.

- **Concepts and technologies for runway balancing and assignment for arrival/departures** will be developed. As appropriate these will be integrated with scheduling and surface management technologies. Limitations due to wake, location and strength will be particularly considered for dynamic wake spacing.

3.2.5 Safe and Efficient Surface Operations (SESO)

SESO research is investigating new technologies and concepts to increase airport capacity by enhancing the flexibility and efficiency of surface operations. The research will result in evaluations of integrated automation technologies and procedures designed to provide the following capabilities:

- Improved surface traffic planning through: 1) balanced runway usage; 2) optimized taxi planning of departures and arrivals; 3) departure scheduling satisfying environmental constraints, dynamic wake vortex separation criteria, and constraints driven by other NAS domains; and 4) balanced runway usage and efficient runway configuration management through coordination with SDO. Environmental impacts will be considered as concepts are investigated.

- Providing the capability of trajectory-based surface operations by modeling of aircraft surface trajectory prediction and synthesis, developing pilot display requirements and technologies for 4D taxi clearances compliance, and taxi clearance conformance monitoring algorithms and procedures.

- Maintaining safety in ground operations through the development of concepts and algorithms for both aircraft- and ground-based surface conflict detection and resolution (CD&R) and integration of the two approaches. This research will be done in coordination with the Integrated Intelligent Flight Deck (IIFD) Project in the Aviation Safety Program. The IIFD Project and NextGen CTD Project will work on flight deck technologies for surface CD&R and collaborate in the development of requirements for the display characteristics of these technologies for flight crews.

Researchers will develop surface traffic simulation capabilities (fast- and real-time simulation with human-in-the-loop) and a surface traffic data analysis too, then will use them to evaluate integrated technologies. A software interface will also be developed to integrate the real-time surface traffic simulation with flight deck simulation capabilities.

3.3 Interfacing With Other Projects

This section describes how the NextGen CTD Project interfaces with 1) the NextGen SAIE Project and with 2) projects in other ARMD programs.

3.3.1 NextGen SAIE Project Interface

The successful transition of concepts and technologies to stakeholders depends on SAIE and CTD projects working in a coordinated manner. To facilitate this transition, the two projects have identified roles based on Technology Readiness Levels (TRL), likely transition paths that concepts or technologies may find themselves on, Research Transition Teams to conduct transition activities, the actual coordination strategy that CTD and SAIE projects utilize, and a plan to evaluate pop up ideas or unexpected research opportunities.

TRL responsibilities between projects follow closely with the projects primary roles see table 1. At the lower TRLs (TRL 1-3), the CTD project is the lead project for these roles. At TRL 4, the opportunity and need for the projects to work together as co-leads are common. SAIE leads activities at TRL5-6. TRL 5-6 concepts and technologies that have work tasks at the TRL 1-3 level will have these tasks handled by CTD and TRL 4 work will be handled by the appropriate project based on the work documented in the milestone and milestone records.

At TRL 7, there are additional partners in prototype demonstration and again the projects work together with the designated stakeholders for best success. Activities beyond TRL7, include implementation into operational environments and neither project will have lead responsibilities for these activities. At this level of readiness, stakeholders take responsibilities for implementation and NASA projects serve as consulting subject matter experts depending on agreements between stakeholder and the program/projects.

Table 1. TRL Responsibilities between Projects

TRL (NASA SE Manual)	Activity	Lead Project
1. Basic principles observed and reported	Bottoms-up, inductive logic, researcher generating an idea -Top-down domain studies to generate better understanding of domain characteristics and constraints; identify potential solution path	CTD
2. Technology concept and/or application formulated	Formulate individual concepts/ideas; algorithms formulated to address a specific operational need Potential solution paths further analyzed; benefit assessments to identify possible impacts and to identify technological challenges (R&D needs)	CTD
3. Analytical and experimental critical function and/or characteristic proof of concept	Conduct initial analysis to show the merits of the concept/ideas/algorithms Conduct thorough benefit assessments; evaluate potential benefits of combined concepts	CTD
4. Component and/or integrated components validation in laboratory environment	Conduct validation of initial integrated (as needed) concept prototype in a laboratory environment Develop initial technology prototype; validation in laboratory environment.	CTD and SAIE
5. Component and/or integrated components validation in relevant environment	Develop relevant environment, scenarios, and integrate multiple components Continue to mature a concept and technology based on simulation results	SAIE
6. System/subsystem model or prototype demonstration in a relevant environment	Integrate technology prototype in high-fidelity relevant environment; conduct testing and evaluation; update benefit, safety, and human factors assessments. Provide the concept/ technology prototype, description and algorithms for necessary demonstration	SAIE
7. System prototype demonstration in an operational environment	Support transition of technology to FAA; prototype modification to address site-specific operations; integration with other facility tools that operate in same environment Provide concept/algorithm modifications and descriptions as necessary to support technology transition	SAIE and CTD
8. Actual system completed and demonstrated in operational environment	No Project responsibility	No Project responsibility
9. Actual system operationally proven through use in operational environment	No Project responsibility	No Project responsibility

TRL (NASA SE Manual)	*Activity*	*Lead Project*
1. Basic principles observed and reported	***Bottoms-up, inductive logic, researcher generating an idea -Top-down domain studies to generate better understanding of domain characteristics and constraints; identify potential solution path***	***CTD***

2. Technology concept and/or application formulated	***Formulate individual concepts/ideas; algorithms formulated to address a specific operational need Potential solution paths further analyzed; benefit assessments to identify possible impacts and to identify technological challenges (R&D needs)***	***CTD***
3. Analytical and experimental critical function and/or characteristic proof of concept	***Conduct initial analysis to show the merits of the concept/ideas/algorithms Conduct thorough benefit assessments; evaluate potential benefits of combined concepts***	***CTD***
4. Component and/or integrated components validation in laboratory environment	***Conduct validation of initial integrated (as needed) concept prototype in a laboratory environment Develop initial technology prototype; validation in laboratory environment.***	***CTD and SAIE***
5. Component and/or integrated components validation in relevant environment	***Develop relevant environment, scenarios, and integrate multiple components Continue to mature a concept and technology based on simulation results***	***SAIE***
6. System/subsystem model or prototype demonstration in a relevant environment	***Integrate technology prototype in high-fidelity relevant environment; conduct testing and evaluation; update benefit, safety, and human factors assessments. Provide the concept/ technology prototype, description and algorithms for necessary demonstration***	***SAIE***
7. System prototype demonstration in an operational environment	***Support transition of technology to FAA; prototype modification to address site-specific operations; integration with other facility tools that operate in same environment Provide concept/algorithm modifications and descriptions as necessary to support technology transition***	***SAIE and CTD***
8. Actual system completed and demonstrated in operational environment	***No Project responsibility***	***No Project responsibility***
9. Actual system operationally proven through use in operational environment	***No Project responsibility***	***No Project responsibility***

Research transition paths to stakeholders vary depending on the type of product and/or interest of the stakeholder. Activities include integrated concepts/technologies that require complex, high fidelity simulations, interoperability/interactions considerations, and involvement of multiple RFA items/concepts/technologies. Another work area needing both projects is the conducting of testbed demos or field tests at appropriate sites. Demos in testbeds have been discussed with the FAA as a stakeholder and the NASA North Texas Research Facility (NTX) testbed will facilitate appropriate demos either independently or in the future in conjunction with the FAA NextGen testbed under development. Field tests will identify appropriate environments to use and may include FAA field sites such as Air Route Traffic Control Centers or “Centers”, Terminal Radar Approach Control facilities or TRACONs, and Airport Towers.

In the second transition path, SAIE transitions a product to external stakeholder directly. Tools or technologies being developed by SAIE and made available to stakeholders transition directly to the stakeholder. Analysis being conducted may also be conducted with or leveraged directly by stakeholders based on coordination or agreement. A key stakeholder for these types of products is the JPDO's IPSA division.

In the third transition path, CTD transitions a product to external stakeholder directly. This is usually a low TRL product that may have been defined by; a stakeholder's eagerness to transition at an early TRL, a stakeholder's need for early decision making, or a stand-alone item.

The various transition modes available demand that CTD-SAIE have a coordination strategy to keep foundation research unencumbered and still ensure that the research has a maturation and transition path to stakeholders. In order to accomplish this, CTD and SAIE will work together to accelerate high impact products based on stakeholder interests. Products include technologies, concepts, algorithms, prototypes, or knowledge such as functional allocation. CTD is focused on individual concept and technology development with a deeper focus. SAIE is focused on system-level, integration, and technology transition considerations with a broader focus. In each case, specific understanding between CTD and SAIE needs to be developed. Each technology or concept is likely to have differing needs and different involvements. Activities requiring joint efforts are defined jointly by both projects PI/PM/PS. During the course of normal project development CTD and SAIE will negotiate on how the collaboration will be handled year to year based on the unique requirements of the current concepts and technologies development phase they are in. This collaboration will be documented in the milestones and the associated milestone records for the upcoming year.

Research Transition Teams (RTTs), jointly established with the FAA, have been implemented to help identify research and development needed for NextGen implementation and to ensure that the research is conducted and effectively transitioned to the implementing agency. RTTs the projects are supporting jointly with FAA in all cases:

- Efficient Flow into Congested Airspace (EFICA) is the responsibility of the SAIE project and focuses on a few key technologies in the dense arrival/departure area such as merging and spacing including work with FAA's ATO-P and SBS office, Efficient Descent Advisor, including field test at FAA's Denver Center.

- Flow-based Trajectory Management (Multi-sector Planner) is the responsibility of the SAIE project with focus on identifying the feasibility and benefits of the Multi-sector Planner. This is a concept study with human in the loop simulations for demonstration to FAA.

- Integrated Arrival/Departure Surface (IADS) is the responsibility of the SAIE project and includes research from the CTD project. It includes the Precision Departure Release Capability that will conduct testbed studies at NASA's NTX facility. Also, the airport surface optimization is scheduled to conduct similar studies at NTX in the near future.

- Dynamic Airspace Configuration (DAC) RTT remains the responsibility of the CTD being long-term focused research.

RTTs are supported by CTD and SAIE milestones, some of them jointly.

Occasionally, unplanned research opportunities present themselves to the projects and program. These "Pop-up" concept or technology ideas may come from internal project staff or external stakeholders. Managing a new Pop-up Idea uses the following process:

- CTD/SAIE PI/PS/PM and involved researcher(s) meet to discuss idea. The Project team prepares the proposal to the Program with three options; pursue, don't pursue, or more information/base work/analysis is needed before decision. "Seedling" and other possible sources of funding explored.
- Host center management and partner center POCs and/or designees will be involved throughout the process.
- Program will make the final decision based on committee/board input.

3.3.2 Interfacing with Projects in Other ARMD Programs

The NextGen CTD Project Principal Investigator will communicate frequently with PIs from other projects which include: Integrated Systems Research Program, Environmentally Responsible Aviation, the Integrated Intelligent Flight Deck, and the Integrated Vehicle Health Management projects on cross-project and cross-program issues.

Additional cross-project/program collaboration will continue in research associated with NRA subtopics—e.g., the development of off-nominal scenarios in air traffic management. The Project will continue to develop NRA subtopics with input from the NextGen SAIE Project as well as projects in the Fundamental Aeronautics and Aviation Safety programs.

3.4 Milestones

Milestone documents appear in Appendix C, and include the following:

- C-1. Historical Milestones FY2007 – FY 2009
- C-2. Current Milestones FY2010 – FY2015
- C-3. Milestone Schedule FY2010 – FY2015
- C-4 Key Milestones FY2010 – FY2012

4. PROJECT EXECUTION

4.1 Resources

Table 2. NextGen CTD Resources Based on President's FY2010 Budget

Table removed from External Release Version of Project Plan.

4.1.1 Full-Time Equivalent (FTE) and Work-Year Equivalent (WYE)

Text removed from External Release Version of Project Plan.

4.1.2 Procurement

Project procurement dollars fund NRA and in-house contracts as well as competitively selected, performance-based contracts.

4.1.3 Facilities and Laboratories

NASA facilities and laboratories will be utilized extensively in FY2010 for research in SA and SDO.

4.1.3.1 NASA Facilities

NASA Facilities required in FY2010 include:

- The Crew-Vehicle Systems Research Facility is being used to conduct milestone AS.2.5.11:
  - HITL simulation in support of SDO to continue the investigation of procedures for enabling very closely spaced parallel approaches in all weather conditions.
  - Simulation of breakout maneuvers for two and three closely spaced runway operations. Requirements include definition of airspace and procedures, information requirements for pilots and requirements for other airport and airspace simulated traffic.

- The Cockpit Motion Facility is being used to conduct milestone AS.3.6.09:
  - Human-in-the-loop simulation in support of the SDO merging and spacing concept of operations for the terminal area that utilizes airborne-based technology requirements for FAA-planned merging and spacing operations.

4.1.3.2 NASA Laboratories

NASA laboratories required in FY2010 include:

- Airspace Operations Laboratory (AOL)

- Air Traffic Operations Laboratory (ATOL) is being used to conduct milestones AS.1.6.03, AS.2.5.06, AS.2.5.08, AS.3.5.06, AS.3.5.07, AP.2.S.10, AS.3.6.09, and AS.2.5.11:
  - Batch study to support a flight evaluation of an airborne situation awareness based application

- Air Traffic Control (ATC) Simulation Laboratory is being used to conduct milestone AS.2.5.11:

- Human-in-the-loop simulations of controller-managed separation on RNP routes that provide varying levels of control

- Airspace Concept Evaluation System (ACES) Laboratory

4.2 Management

4.2.1 Organizational Structure

The NextGen CTD Project management team is comprised of the PI, Project Manager (PM), and Project Scientist (PS). A group of research and programmatic personnel support the management team.

One or more Associate Principal Investigators (APIs) are assigned to each RFA. The API is responsible and accountable to the PI for supporting the technical content of each API's respective RFA. The APIs assist the PI and PS in the planning and execution of the Project's research objectives. The PI and PS, with the APIs, will define technical roadmaps, including Project goals, research performance objectives, and requirements.

For a detailed list of NextGen CTD Project roles and responsibilities, see Appendix B.

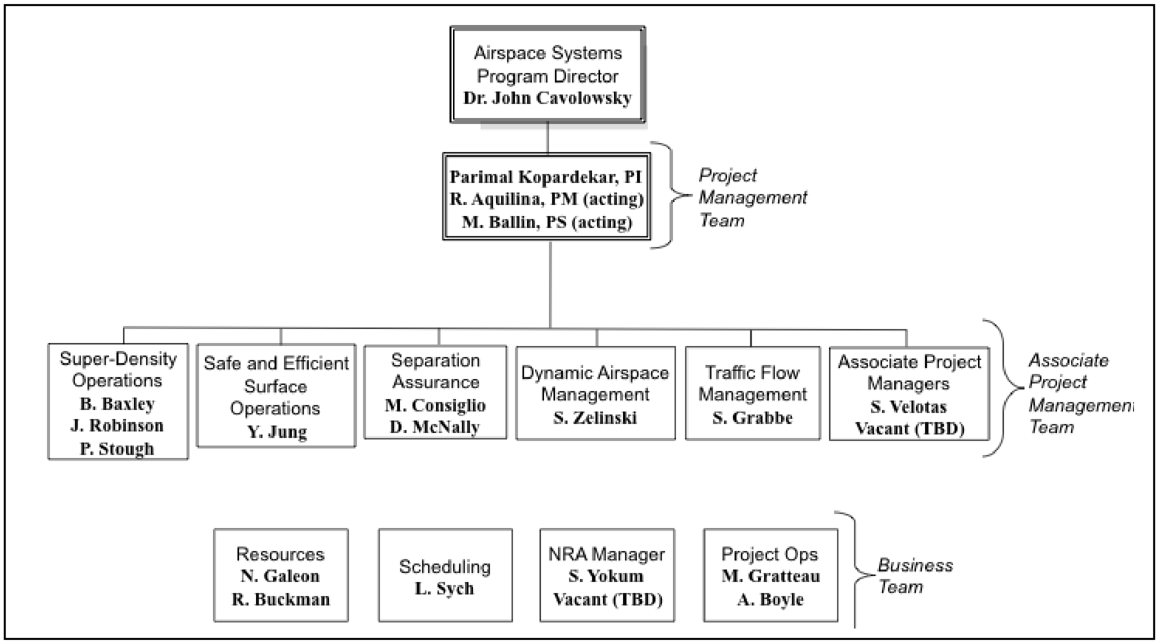

Figure 1. Project Management Structure

4.2.2 Project Reporting and Reviews

Reporting and reviews within the NextGen CTD Project and the Airspace Systems Program range from scheduled telephone conferences to internal and external peer technical reviews. The following section list reporting and review formats currently in place.

4.2.2.1 Reporting Formats

- Twice weekly telephone conferences between the PI, PM, and PS to discuss near-term issues and actions.

- Weekly telephone conferences with the Program Office involving PIs, PMs, and PSs from the NextGen CTD and NextGen SAIE projects to discuss near-term and strategic issues and actions.

- Weekly Project reports provided to Center POCs (CTD attends the Ames Director review regularly). Reporting includes budget, events and activities, accomplishments and Project milestone status.

- Periodic meetings with PIs, PMs, and PSs in both NextGen CTD and NextGen SAIE projects to discuss common issues. NextGen CTD and NextGen SAIE inter-project technical planning and integration coordination between APIs is scheduled, at least annually and includes jointly developed, NRA subtopic discussions, gap analysis and strategy to address gaps, technical workshops, and NRA kickoff meetings.

- Biweekly telephone conferences with the PI, PM, PS, APIs, and APMs in the NextGen CTD Project to discuss current and near-term technical and programmatic issues.

- Annual Technical Interchange Meeting focusing on foundational and multi-disciplinary work. Participation includes university and industry PIs involved in NRA and Space Act Agreement (SAA) research activities supporting the project. Participation by other university, industry, and other government agencies requires written invitation.

4.2.2.2 Review Formats

- Quarterly technical status and programmatic review of the Project provided by the PI and PM to the Program Director. This review is the primary source of information used by the Director in the Program’s quarterly briefing and review with the ARMD Associate Administrator.
- Annual internal and external reviews, with schedule and content determined by the Program and ARMD.

4.3 Controls and Change Process

The FY2010 Project Plan is an agreement between the PI, PM, Center Directors (CDs), Center POCs, and the Program Director for ASP. The plan documents the technical plan, milestones/deliverables, schedules, resources management approach, etc., to ensure successful delivery of technical products to the Airspace Systems Program. Programmatically, milestone completion constitutes the delivery of technical products to the PI or Program Director from the API.

4.3.1 Documenting Milestone Completion

The process for documenting concurrence and approval of milestone completion is:

- The API will document all Milestone completions in writing using the NextGen CTD Milestone Completion Form. The form will be submitted by the APM, with API input, to the PI through the PM for concurrence.
- Level 3 and 4 Key Milestones - Milestone completion will be documented in writing by the API and APM using the NextGen CTD Milestone Completion Form. The form will be submitted to the PI for approval. The PI will forward the form to the Program Director for concurrence.

4.3.2 Documenting Milestone Change

The process of research is subject to change based on the acquisition and generation of new knowledge. As a research project, the NextGen CTD Project is subject to such change. Accordingly, the Project has established controls and processes to manage and document change.

- The judgment of the API(s) and PI are paramount in the assessment of change that may impact the overall success of the Project.
- The Project will use milestones, metrics, and goals as the focus of the change control process.
- The API is authorized to execute minor change to a milestone following notification to the PI and PM. For moderate-level changes, the API and APM will develop an impact report for PI/PM approval. If this change has impact on a dependent milestone, the API(s) working the dependent milestone(s) will also provide input on the impact coordinated through the APM. For substantial changes, a formal review will be convened by the PI/PM with the objective to assess the validity of the milestone or metric. This can be deferred if a technical paper is in the process of being published that outlines the information gathered in pursuit of the milestone and future research paths are described. If the PI determines that a goal change of the project is necessary, the PI will obtain Program Director approval.

The process for documenting concurrence and approval of milestone change is:

- Level 1& 2 - Milestone changes will be documented in writing by the API using the NextGen CTD Milestone Change Request Form. The form will be submitted by the APM, with API input, to the PI through the PM for concurrence.
- Level 3 and 4 - Milestone changes will be documented in writing by the APM, with API inputs, using the NextGen CTD Change Request Form. The form will be submitted to the PI for approval. The PI will forward the form to the Program Director for concurrence.

The API will coordinate the proposed change with the appropriate research manager(s). To ensure all changes are documented in the integrated master schedule, all change requests will be routed to the PM. Criteria for reporting change are:

- Schedule – Slip > 1 quarter or slip into next fiscal year
- Technical – API or PI Judgment

4.4 Work Breakdown Structure

The CTD work breakdown structure (WBS) is an alignment of the work that must be accomplished in order to complete the Project. The WBS is structured in levels of work details beginning with the five RFAs and Project Management. The Project WBS structure is as follows:

Table 3. FY2010 CTD Project Work Breakdown Structure

Table removed from External Release Version of Project Plan.

4.5 Risk Management

Risk management is a continuous process that requires a risk manager to identify risk items, analyze their impact on project milestones, prioritize risk items, develop and carry out a plan for risk mitigation or acceptance, track risk and mitigation plan, support timely decisions to control risk, and ensure that risk information is communicated and documented. The NextGen-Airspace Project documented a risk management process in 2007. The Project does not manage hardware used for flight (piloted or unpiloted), flight control software, wind tunnel testing, or systems that could result in potential harm to personnel or property and, as such, is not required to develop a Safety and Mission Assurance Plan, per Section 5.2.3.9 of NPR 7120.8.

4.5.1 NextGen CTD Risk Process

Risk Management responsibility resides with the CTD PM, this includes; identification, characterization, developing mitigation options and overall risk management across the project, this responsibility is delegated to the Project Risk Manager. Risk identification, assessment and mitigation options assessment is shared by all project team members.

Risk Processing Cycle

- Risk Identification
  - Any personnel involved in the project may raise a risk for evaluation at any point in the project cycle
  - Risk Manager will document in the Risk Management Database
- Risk review and evaluation
  - Project Management will evaluate the risk, perform a mitigation assessment and direct development of an action plan if warranted.
  - Risk will be reviewed each quarter and risks will also be reviewed in biweekly project meetings.
- Risk reporting
  - Risk are reported at Quarterly reviews
- Risk retirement
  - Risk are regularly evaluated for trending, mitigation actions and retirement.
  - Retired risks are documented in the database

Table 4. FY2009-10 Open Risk Items

Risk No	Risk Title	Approach
44	Technical Leadership	Watch
46	Metroplex Research	Watch
47	ASDO coordination among multiple groups - available time of APIs.	Mitigate
74	AP.3.S.02 ARRA dependence	Watch
75	AP.2.S.12 ARRA support Dependence	Watch
76	AP.3.S.05 ARRA support Dependence	Watch
89	MS AP.2.S.12- Flight Fuel Model Access	Watch
92	MS AS.2.6.13 and AP.2.C.04 Resources split	Watch
93	AP.2.S.12- short of Resources	Watch
96	NRA subtopic review time prior to NSPIRES posting excessive	Watch
99	Risk for AP.1.C.02, AP.1.C.07 and AP.2.C.06 Wake Data Access	Research
100	AP.1.C.02, AP.1.C.07, AP.2.C.06, AP.2.C.10 and AP.2.C.04 CS Resources limited	Research
101	AP.2.C.10 and AP.2.C.04 NRA dependence	Watch
102	Milestone AS.1.6.03 FTE availabliity	Watch
103	Milestone AS.3.6.09 ARRA funding delay potential impact	Watch

4.6 Acquisition Strategy

Approximately 70% of the NextGen CTD Project's FY2010 budget funds NASA Research Announcement (NRA) and competitively awarded, performance-based contracts. The Project's acquisition strategy for addressing the ATM research and development needs of NextGen, as defined by the JPDO, include:

- The ARMD NRA is used to solicit proposals for research in areas where NASA needs to enhance its core capabilities.
- Existing performance-based, in-house contracts are used to support research activities for facility and simulator operations, software integration and development, and project management tasks.
- Non-Reimbursable SAAs are pursued to collaborate with industry and other U.S. government agencies.
- Reimbursable SAAs, in alignment with CTD Project research and goals, are pursued to collaborate with industry.

The Project has established close working relationships with the acquisition organizations at NASA ARC and LaRC. At ARC a contracting officer is co-located with the NextGen CTD Project staff. In addition, the project has assigned one FTE to serve as a full-time NRA manager/Contracting Officer Technical Representative (COTR) to assist the project management team in the NRA and other acquisition activities.

Table 5. Awarded NRA Tasks

Round 1 FY06 - 07			
TFM	University of Maryland, College Park	Ball	Dynamic, Stochastic Models for Managing Air Traffic Flows
TFM	Georgia Tech Research Corp.	Clarke	Approaches to TFM in the Presence of Uncertainty
TFM	Washington State University	Roy	Control-theoretic Design and Numerical Evaluation of Traffic Flow Management Strategies under Uncertainty
TFM	University of California, Berkeley	Bayen	A Unified Approach to Strategic Models and Performance Evaluation for Traffic Flow Management
TFM	Massachusetts Institute of Technology	Hansman	Cognitively Based Traffic Complexity Metrics for Future NGATS Concepts of Operations
TPSU	L-3 Communications Titan Corp.	Vivona	Development of Algorithms and Techniques for Trajectory Prediction Accuracy and Uncertainty Estimation
TPSU	L-3 Communications Titan Corp.	Idris	Trajectory Flexibility Preservation and Constraint Minimization for Distributed ATM with Self-Limiting Traffic Complexity
SA	Purdue University	Landry	Analysis and development of strategic and tactical separation assurance algorithms
SA	University of California, Santa Cruz	Erzberger	Concepts and Algorithms for Automated Separation Assurance
SA	Stanford University	Tomlin	Integrating Collision Avoidance and Tactical Air Traffic Control Tools
SA	California State University, Long Beach	Strybel	Metrics for Operator Situation Awareness, Workload, and Performance in Automated Separation Assurance Systems
SDO	Metron Aviation	Krozel	Mitigation of Weather Impacts in Dense Terminal Airspace
SDO	Massachusetts Institute of Technology	Hansman	Optimization of Super-Density Multi-Airport Terminal Area Systems in the Presence of Uncertainty
SLDAST	San Jose State University	Freund	Computational Models of Human Workload: Definition, Refinement, Integration, and Validation in Fast-time National Airspace Simulations
SLDAST	George Mason University	Sherry	Analysis of NGATS Sensitivity to Gaming
Round 2 FY07			
PBS	CSSI, Inc.	Mondoloni	A Method for System Performance Evaluation from Air/Ground Application Performance Under Various Operational Concepts
PBS	Georgia Institute of Technology	Volovoi*	A Conceptual and Computational Framework for Identifying and Predicting the Performance of Novel Airspace Concepts of Operation
PBS	Intelligent Automation,	Manikonda	Multi-Fidelity CNS Models to Support NGATS Concepts

	Inc.		
TFM	Optimal Synthesis, Inc.	Menon	Multi-Resolution Queuing Models for Analyzing the Impact of Trajectory Uncertainty and Precision on NGATS Flow Efficiency
TFM	University of California, Berkeley	Hansen	Advanced Stochastic Network Queuing Models of the Impact of 4D Trajectory Precision on Aviation System Performance
TFM	Mosaic ATM, Inc.	Cook	Modeling Non-Convective Weather Impacts on En Route Traffic Flow Management
TFM	Metron Aviation	Krozel	Translation of Weather Information to Traffic Flow Management Impacts
TFM	L-3 Communications Corp.	Idris	Feasibility and Benefit Assessment of a Concept of Operations for Collaborative Traffic Flow Management
TPSU	L-3 Communications Corp.	Vivona	Analysis and Comparison of Capabilities and Requirements for Aircraft Trajectory Prediction Technologies
TPSU	University of Minnesota	Zhao	A Unified Approach to the Documentation, Analysis, and Cross-Comparison of Trajectory Predictors
DAC	Mosaic ATM, Inc.	Brinton	Assessment of Concepts and Algorithms for Dynamic Airspace Allocation
DAC	Metron Aviation, Inc.	Hoffman	Overall Airspace Organization and Dynamic Airspace Allocation Schemes
DAC	CSSI, Inc.	Rodgers	The Development of Concepts of Operation and Algorithms to support Dynamic Airspace Allocation as a Function of Equipage, Traffic Density and Weather
SDO (METRO)	Mosaic ATM, Inc.	Atkins	Investigating the Nature of and Methods for Managing Metroplex Operations
Round 3 FY08			
SDO	Purdue University	Landry	Transition to Super Density Operations Capability – 2015 Timeframe
SDO	San Jose State University	Gore	Identification of NextGen Air Traffic Control and Pilot Performance Parameters for Human Performance Model Development in the Transitional Airspace
PBS	Raytheon Intelligence and Information Systems ***(SOW negotiations)***	Finkelsztein	Weather Scenarios Generator and Server for the Airspace and Traffic Operations Simulation
PBS	Sensis Seagull Technology Center	Peters	Integration of Weather Data into Airspace and Traffic Operations Simulation (ATOS) for Trajectory Based Operations Research
PBS	Raytheon Intelligence and Information Systems	Finkelsztein	A Four Dimensional Dynamic Required Navigation Performance Construct to Support NextGen Concepts
SA	Logistics Management	Hemm	Safety Analysis of Today's Separation Assurance Function

	Institute		
SLDAST	The University of Virginia	Patek	Multi-scale Tools for Airspace Modeling and Design
SLDAST	San Jose State University	Lee	Identification, Characterization, and Prioritization of Human Performance Issues and Research in the Transition to Next Generation Air Transportation System (NEXTGEN)
SLDAST	Sensis Seagull Technology Center	Hunter	Linking Airspace Modeling and Simulation Tools of Variable Fidelity and System Scope
SLDAST	Optimal Synthesis, Inc.	Menon	Open-Source based Software Systems for Linking Disparate Software Components
Round 4 FY09			
TFM	George Mason University.	Hoffman	Market-based and Auction-based Models and Algorithms for En-route Allocation and Configuration
Round 5 FY09			
	No awards.		
Round 6 FY10			
	TBD		
ARRA NRA			
	2 NRAs TBD		

4.7 Partnerships and Agreements

The NextGen CTD Project is dependent upon industry, universities, and other government agencies to partner with NASA in NextGen ATM research. Early involvement of industry, other U.S. government agencies, and universities combined with frequent input, is necessary throughout the development and validation of NextGen concepts and research.

The development of system-level capabilities and integrated systems is a Level 4 effort that is appropriate for collaboration with industry partners and other government agencies. The Project will consider the following when assessing potential NASA/industry collaborations:

- Collaborations are established only when there is significant benefit to NASA and its constituencies (aerospace community, aerospace industry, academia, and ultimately the taxpayer).
- Once the collaboration is established, the results can be appropriately disseminated and validated through a peer-review process.

Additional guidelines to be considered include:

- Is the collaboration suitable for NASA to pursue?
- Does the collaboration create a significant benefit to NASA, the aerospace community, and the U.S. taxpayer?
- Does the collaboration help advance and disseminate knowledge and technology?
- Dissemination and publication rights
- Is the result of the collaboration in a form that can be peer-reviewed?
- Have we ensured that restrictions for data distribution do not prevent the advancement of knowledge in the specific discipline?

Table 6 lists the formal agreements in place that will be utilized by NextGen CTD Project. The Project Office maintains copies of the agreements.

Table 6. Formal Agreements with Other US Government Agencies and Industry

Agency	Title/Focus	Responsible Center	IA Established
FAA	Four-Dimensional Flight Management to Support the NextGen System	Langley	Sept. 2007
National Oceanic and Atmospheric Administration/National Weather Service	Support of Research to Correlate Weather and NAS Performance For NASA's Airspace System Program	Ames	Oct. 2007
FAA	Support for FAA R&D Field Offices at Ames and Langley Research Centers	Ames/Langley	April 2008
FAA/NASA/UPS	Aircraft Trajectory Data Feed To Support En Route Metering Concept Validation	Ames	Sept. 2008
United States Air Force	Support NASA air traffic automation activities by providing data analysis, integrating various weather products with ATM tools	Ames	Sept. 2008
FAA	Establish roles and responsibilities for NASA and FAA in a collaborative effort to develop the NextGen system. (Establishes coordination for Research Transition Teams)	Ames	Oct. 2008

4.8 Foreign Collaboration

The Airspace Systems Program and its legacy projects actively established participation with foreign organizations to conduct joint ATM research. The NextGen CTD Project is committed to maintaining these efforts, where appropriate, and to identifying new areas of opportunity for foreign collaboration. Existing and new foreign collaborations will be aligned with the five Project RFAs.

In FY2010, foreign collaborations will be addressed by the ASP Office and the appropriate Center's management and will be in full compliance with the U.S. Department of State's International Traffic in Arms Regulations (ITAR) policy and amendments related to project research (e.g., trajectory prediction, algorithms, etc.). Titled, "NextGen-Airspace Project Guidance on Foreign Collaboration," the guidance document is tailored to NextGen ATM research and will serve as a template for current and future collaborative research. Rather than inhibit or discourage foreign research collaboration, the guidance is intended to facilitate and encourage collaboration where it can be demonstrated that the collaboration will add value to Project, Program, and ARMD mission, goals, and/or objectives.

The API in the respective RFA is empowered with, and responsible for, identifying new opportunities for foreign collaboration and for managing existing and new foreign research collaboration and will coordinate with both Project and Line management. A formal review and approval process has been developed for use in evaluating foreign collaboration proposals for consistency with Project, Program, and ARMD mission, goals, and/or objectives. Questions that must be adequately addressed by the API include, but are not limited to, the following:

- Is there a formal charter for the proposed research that delineates tasks, responsibilities, and time period?
- What vehicle will be utilized for the formal agreement (e.g., Action Plan, Letter of Authorization, Memorandum of Authorization, etc.) ?
- What are the respective responsibilities between NASA and the relevant foreign organization(s)?
- Which organization(s) are responsible for assigning and managing research tasks?
- What amount of effort is required to fulfill the duties (e.g., preparation, travel, meetings, etc.)?
- Will the conduct of the foreign research impact the completion of any NextGen CTD Project milestones?
- Is the research directly related to any Project milestones? If so, which milestone(s) are related?
- Does the research provide an advantage to foreign companies at the expense of the U.S. taxpayers? If the answer is no, why not?
- How will the performing organization(s) accommodate new requests for additional or follow-up research?
- Who will approve additional or follow-up research?

The API shall address these questions in a letter of interest and submit it to the PI for formal approval of the proposed foreign collaboration. The API should allow 30 days for Project Office and Program review and approval or rejection. Once an agreement is in place, the API will be responsible for managing foreign collaboration research.

4.9 Knowledge Dissemination

NASA has a unique charter in the Space Act of 1958 to "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."[4] At the Directorate level, ARMD is responsible for achieving NASA Strategic Goal 3E, to "Advance knowledge in the fundamental disciplines of aeronautics and develop technologies for safer aircraft and higher capacity airspace systems." In keeping with these aims, the NextGen CTD Project is committed to the widest possible dissemination of research activities and results, to the greatest extent practicable, in as timely a manner as possible. Each year the Project publishes scores of technical reports, research papers, peer-reviewed journal articles, and invited papers to disseminate the results of its research as a representative profile of FY2010 activities. In FY2009, the Project published 140 research papers and technical reports. In addition to publishing and reporting research in government, academia, and industry technical forums, the Project is establishing a public website where it will make research papers and reports available to the public. The FY2010 knowledge dissemination results will be available in the FY2011 Project Plan.

The project management team is also committed to the publication of lessons-learned concerning the planning, implementation, and execution of the Project. All lessons learned are fully and openly shared with existing projects, Centers, programs, and the appropriate organizations within the Agency. When appropriate, the Project also shares documented lessons learned with the Systems Management Office at NASA ARC and the ARD front office at NASA LaRC and/or the NASA Office of the Chief Engineer.

Table 7. Knowledge Dissemination

	ASDO	DAC	SA	SLDAST	TFM	TPSU	Adv. Veh. NRA	Total
AIAA Aerospace Sciences Meeting				1				**1**
AIAA Aviation Technology, Integration and Operations Conference	10	8	8	7	8	5	10	**56**

[4] Communicating NASA's Knowledge, A Report of the Communicate Knowledge Team, NP-1998-08-24O-HQ, August 1998, page 5.

AIAA Guidance, Navigation and Control Conference	3	3	2	1	9	1		**19**
AIAA Modeling and Simulation Technologies Conference	1			1		1		**3**
Air Traffic Control Quarterly	3	2			3			**8**
ATM2009 - The 8th USA/Europe Seminar on Air Traffic Management Research and Development	2	3	4	1	7	1		**18**
Electronic Navigation Research Institute International Workshop			1					**1**
IEEE/AIAA 28th International Digital Avionics Systems Conference	5	3	2	1			1	**12**
HCI - International Conference on Human-Computer Interaction			1					**1**
ICAT - MIT International Center for Air Transportation		1						**1**
Integrated Communications Navigation and Surveillance Conference	1							**1**
15th International Symposium on Aviation Psychiatry	1	1						**2**
International Journal of Industrial Engineering - Theory, Applications and Practice		1	1		2			**4**
Journal of Guidance Control and Navigation	1	2	1					**4**
Proceedings of the IEEE					1			**1**
Contractor Report			3	1				**4**
NASA Technical Manuscript			2					**2**
NASA Technical Report			2					**2**
Totals	**27**	**24**	**27**	**13**	**30**	**8**	**11**	**140**

5. MILESTONE RECORDS

In FY2010 the NextGen CTD Project will continue to maintain milestone records. The milestone record format is useful because of the following:

- The JPDO tracks NASA project milestones against research and development needs in the JPDO's *Next Generation Air Transportation System Integrated Work Plan.*
- The NASA Office of Inspector General has questioned the extent to which Project milestones support JPDO research and development needs.
- ARMD, the Airspace Systems Program, and the Program Assessment and Evaluation Office focus their interest and review at the milestone level, as opposed to task plans.

Milestone Records provide an annual update with a focus on the near-term fiscal year. Development and updating of the Milestone Record is the responsibility of the API, with support from the APM. Working with the research manager, the API and APM develop the Milestone Records for their respective RFAs. The Milestone Record describes the work to be conducted in the current fiscal year, identifies requirements for simulation facilities and laboratories, and provides Project milestone alignment with JPDO research and development needs. Milestone Records for each RFA appear in Appendix A.

6. APPENDICES

Appendix A. FY2010 Milestone Record Activity

Appendix B. NextGen CTD Project Roles and Responsibilities

Appendix C. Milestone Tables, Schedule, and Listing

Appendix D. Acronyms and Abbreviations

Appendix E. Waivers and Deviation Log

Appendix F. Review Comments and Discussion

Appendix G. Change Log

APPENDIX A. FY2010 MILESTONE RECORD ACTIVITY

Appendix A contains the following Milestone Records:

- A-1. Dynamic Airspace Configuration (DAC)
- A-2. Traffic Flow Management (TFM)
- A-3. Separation Assurance (SA)
- A-4. Super-Density Operations (SDO)
- A-5. Safe and Efficient Surface Operations (SESO)

A-1. Dynamic Airspace Configuration

[See separate attachment.]

A-2. Traffic Flow Management

[See separate attachment.]

A-3. Separation Assurance

[See separate attachment.]

A-4. Super-Density Operations

[See separate attachment.]

A-5. Safe and Efficient Surface Operations (SESO)

[See separate attachment.]

APPENDIX B. NEXTGEN CTD PROJECT ROLES AND RESPONSIBILITIES

Appendix B contains descriptions of roles and responsibilities for the following positions:

- B-1. Principal Investigator (PI)
- B-2. Project Manager (PM)
- B-3. Project Scientist (PS)
- B-4. Associate Principal Investigator (API)
- B-5. Associate Project Manager (APM)
- B-6. Research Manager
- B-7. Researchers, Technicians, Scientists, and Support Personnel
- B-8. Business Team
- B-9. NRA Manager
- B-10. Assumptions

B-1. Principal Investigator (PI) Working with Associate Principal Investigators (APIs)

The Project PI is responsible and accountable to the Director of the Airspace Systems Program for technical and resource planning and execution. Primary responsibilities include:

- Assume overall responsibility for the success of the Project.
- Assume final authority for technical content, including:
  - Agreement with milestone description, success metrics, exit criteria provided by APIs;
  - Annual agreement with Milestone Record and tasks proposed by the APIs.
- Provide technical guidance to the APIs, as needed.
- Work with the JPDO to align Project goals with NextGen requirements.
- Assume primary responsibility for tracking technical progress toward milestone completion (assisted by the PM and the PS).
- Provide the primary external interface for the Project, including:
  - Represent overall Project work to Program office, other ARMD project PIs, the JPDO, other government agencies, industry, and academia.
  - Work with PM to arrange partnerships involving the entire Project or multiple RFAs with other government agencies, industry, and academia
  - Serve as interface for international agreements between the Program office and Project-level initiators.

B-2. Project Manager (PM) Working with Associate Project Managers (APMs)

The PM is responsible and accountable to the PI for Project planning and execution. Primary responsibilities include:

- Maintain accountability to the PI in executing the programmatic requirements of the Project. Serve as project management POC to the Airspace Systems Program Office concerning budget, workforce acquisition strategy, management practices, and schedule.
- Serve as the Project's business POC for agreements with industry and other government agencies.
- Assume responsibility for the planning, development, and management of the Project's reporting, documentation, integrated master scheduling, and resource performance.
- Develop and oversee the acquisition strategy in support of the PI.
- Work with the APMs and project scheduler to establish an integrated master schedule for the Project to show:
    - Progress toward meeting milestones;
    - Major project activities.
- Manage and account for Project resources, working with APMs and budget analysts.
- Establish and lead an inter-center business management team to provide reporting, communications, and financial integration.

B-3. Project Scientist (PS) Working with Principal Investigator (PI)

The PS serves as a technical authority and is responsible and accountable to the PI for the integrity of the Project's technical plans. Primary responsibilities include:

- In the absence of the PI, assume overall technical responsibility for the NextGen CTD Project.
- Work with the APIs to track technical progress toward milestones, providing technical guidance when necessary.
- Maintain accountability to the PI for the technical integration of the Project.
- Lead development of the technical integration strategy by working with SLDAST APIs.
- Establish strategic goals and objectives for technical integration.
- Develop technical processes and communication methods for intra- and inter-Project integration.
- Work with the integration managers and project leaders in the Aviation Safety Program and the Fundamental Aeronautics Program to facilitate cross-project and cross-program integration.
- Work with the APIs to implement integration processes throughout the NextGen CTD Project.
- Work with the JPDO Systems Modeling and Analysis Division (SMAD) and the JPDO Evaluation and Analysis Division (EAD) and others at the JPDO to ensure integration strategies align with JPDO needs.
- Recommend strategies to increase collaboration and to mitigate barriers to collaboration across RFAs and Centers.

- Assist APIs in developing technical plans and activities that align with Project goals.

B-4. Associate Principal Investigator (API) Working with Research Team (Including Research Manager)

The API is responsible and accountable to the PI for supporting the technical content and the contract execution of the Milestone Records for each RFA. Primary responsibilities include:

- Sign Milestone Records with the APM and research manager/facility manager, in concurrence with the PI.
- Lead technical planning, working with the research manager and the APM.
- Manage the technical progress of the Project and report status to the PI, PM, and PS.
- Evaluate the results of the technical plan.
- Resolve technical issues within the technical plan and provide recommendations to the PI and PS for redirection based upon lessons-learned.
- Provide modifications to the technical requirements of current Milestone Record tasks, as required, or work with the research manager and the APM to devise alternative(s).
- Serve as subject matter expert (SME) advising the PI, PS, and PM, as required.
- Lead formulation and selection of NRA topics for his/her research area.

B-5. Associate Project Manager (APM) Working With Project Manager Across Centers and with Business Teams

The APM is responsible and accountable to the API for supporting Milestone Record execution across Centers. Primary responsibilities include:

- Sign the Milestone Record with the API and research manager, in concurrence with the PI.
- Manage implementation cost, schedule, and workforce allocations at the RFA-level with the API.
- Resolve resource barriers (e.g., procurement acquisitions and funding flow).
- Resolve schedule burdens (e.g., facility access).
- Recommend strategies and solutions for executing tasks efficiently and effectively based upon constraints. Work with the PM, PI, PS, and API to modify implementation requirements to address progress impediments of a technical nature. Work with the PM and PI to modify implementation requirements to address progress impediments of a resource nature.

B-6. Research Manager

The research manager is accountable to the API to support the implementation of Milestone Record tasks and activities at the respective Centers. Primary responsibilities include:

- Sign the Milestone Record tasks with the API and APM, in concurrence with the PI.
- Foster an environment that encourages technical excellence.

- Support development of skills and capabilities in personnel to support ARMD programs.
- Provide workforce and facilities to implement the tasks.
- Monitor task implementation to achieve a level of awareness of subordinates' work and technical objectives of specific tasks.
  - Provide insight into impediments to progress that require Program and Center coordination to achieve success.
  - Provide insight into technical issues that may result in a Center Independent Technical Authority process.
  - Monitoring functions will include approval of purchase requests, travel orders, WebTADS, and award of contracts/tasks (e.g., performance-based contract) as defined within the Milestone Record tasks.
- Resolve issues of an internal nature (i.e., facility-use conflicts, workforce challenges, etc.) with the Center POC and notify the APM.
- Work with the API and APM to modify Milestone Record tasks, as appropriate.
- Work with the APM to resolve implementation impediments to success. Work with the API and APM to modify Milestone Record tasks, as appropriate.

B-7. Researchers, Technicians, Scientists, and Support Personnel

Researchers, technicians, scientists, and support personnel with day-to-day responsibilities are accountable to the API/APM for execution of the research in support of Milestone Record tasks. Primary responsibilities include:

- Identify and communicate impediments to the execution of research tasks to the research manager and API for resolution. Enable, through communication, the research manager to maintain a level of awareness of research activities.
  - Resolve technical impediments with the API and research manager.
  - Resolve implementation impediments with the APM and research manager.
- Participate in technical forums and conferences to share knowledge gained within execution of the Project.
- Publish technical peer-reviewed papers.
- Understand overall tasks and propose ideas and alternatives to improve task execution and Project quality and impact.

B-8. Business Team

The business team works with the PM to provide reporting and analysis of resources (workforce and dollars) and schedule. Business team members are assigned directly to the Project. The roles below describe functions important to project operations. Within a given project, a single individual may fill several of roles. Full discretion is vested in the PM to determine how this will be achieved in the best interest of the Project. Only the resource analyst is a full FTE per project. The business team consists of the following:

- Resource/Budget Analyst

  - Assist in budget development, service pool, and workforce planning across all Centers. Track budget. Provide timely budget and workforce analysis as requested by the PM and APM. Assist the PM and APM in the identification and timely resolution of budget and workforce issues. Assist in the development of the Program Operating Plan and phasing plans and all phases of the budget cycle. Work closely with the Center Chief Financial Officer.
- Scheduler
  - Provide the NextGen CTD Project schedule, as requested by the PM and/or PI. Implements schedule changes and maintain updates. Advise the PM and PI on schedule improvements. Solicit necessary data from Project personnel for schedule development and updates.
- Risk Manager
  - Develop resource and schedule risk management strategies and makes recommendations to the PM to enable research success.
- Project Operations
  - Provide support to the project management team including maintaining and archiving Project documentation. Provide configuration control of critical Project documentation. Provide and/or coordinate support for responding to ARMD actions. Serve as primary assistant to the PM.

B-9. NRA Manager

The NRA Manager is the COTR for the NextGen CTD Project's NRA contracts, cooperative agreements, and other contracts and agreements. Primary responsibilities include:

- Interact frequently with NextGen CTD Project management, the Contracting Officer (CO), contractor management, NASA technical organizations, and the NASA Shared Services Center (NSSC).
- Direct the preparation and review of procurement documents prior to review by the CO and/or release to the NSSC.
- In conjunction with contract technical monitors, monitor contractor activities to ensure compliance with technical, financial, delivery and other terms of the contract. Assess contractor performance.
- Collect, review, and enter data into the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) database. Prepare and distribute NSPIRES data to the APIs.

B-10. Assumptions

- The API and PS report to the PI. The API may support more than one project and may or may not be full-time on ARMD projects. The API and PS must be committed at least halftime to the Project.
- The PM and PS report to the PI.
- The APM reports to the PM and supports one or more APIs.
- A researcher works with the APM to report progress to API, PI, PS, and PM.

- A research manager (i.e., NASA Branch Chief or Division Chief) supervises the researcher.
- The Center POC office may supervise the research manager.
- The API and APM may be supervised by the research manager but are not directly supervised by the Center POC.
- The API, APM, PI, PM, and PS cannot hold a supervisory position.
- The PI, PM, and PS are not supervised by the research manager or the Center POC.
- Business team members are not directly supervised by the Center POC.
- Performance reviews for PI, PM, and PS are handled at the Centers with input from the Program Director .

C-1. Legacy Milestones FY2007 – FY 2009

APPENDIX C. MILESTONE TABLES, SCHEDULE, AND LISTING

Appendix C contains the following milestone documents:

- C-1. Legacy Milestones FY2007 – FY 2009
- C-2. Current Milestones FY2010 – FY2015
- C-3. Milestone Schedule FY2010 – FY2015
- C-4 Key Milestones FY2010 – FY2011

C-1. Legacy Milestones FY2007 – FY 2009

Appendix C-1 contains legacy milestones for FY2007 – FY2009.

Table 8. Legacy Milestones FY2007 – FY 2009

Milestone ID	Key Milestone	Title	Scheduled Completion	Planned Metric	Exit Criteria	Status
AS.4.3.01	Critical	Dynamic Airspace Configuration Concepts Experimentally Validated		Frequency of airspace reconfiguration, extent of airspace reconfiguration, system stability measures, amendments and restrictions imposed on users, airspace complexity distribution		Original Cancelled
AS.4.7.01	Critical	Develop Refined System-level Concept of Operations Based on Results of Modeling, Safety, Cost-benefits, and Human-in-the-loop Simulations		A refined concept of operations will be delivered		Original Cancelled
AS.3.1.01	Critical	Develop, Validate, and Document Common Trajectory Model Algorithms and Capabilities for NGATS Applications Within En-Route and Transition Airspace	FY08	Trajectory accuracy, predictability	Experiment plan for interoperability	Original Cancelled Merged
AS.3.2.01		Produce a List of Candidate NGATS Operational Concepts.	FY07	NGATS vision mapping gaps		Original Completed

AS.3.2.02	Critical	Produce a Detailed Hierarchical Structure of RTSP Elements and Advanced Performance Measures Needed to Support Candidate NGATS Operational Concepts	FY08	Organization of performance attributes to map with level of service		Original Cancelled
AS.3.2.03		Working with Industry and JPDO's Shared Situation Awareness IPT, Define the Parameters Associated with RCP and RSP.		Definitions of RCP, RSP, RNP		Original Cancelled Realignment Merged
AS.3.2.04	Critical	Parametric RTSP Batch Studies of AAC and 4D-ASAS Concepts are Completed Under Nominal and Failure Mode Conditions		Capacity, throughput, efficiency, safety, predictability		Original Cancelled Realignment Merged
AS.3.2.05		Human-in-the-loop Studies of AAC and 4D-ASAS Concepts are Completed Using Minimum RTSP Levels Determined by Previously Performed Batch Studies		Capacity, throughput, efficiency, safety, predictability		Original Cancelled Realignment Merged
AS.3.3.01		Categorize Events that Trigger Airspace Reconfiguration	FY08	Number of scenarios documented, number of events cataloged.		Original Completed
AS.3.3.02		Develop an Operational Framework for Dynamic Airspace Configuration	FY08	Breadth and depth of taxonomy of the "building blocks" for airspace configuration and the "degrees of freedom" available to dynamically modify them.		Original Completed
AS.3.3.03	Critical	Identify Complexity Metrics for Higher Levels of Automation and Higher Traffic Densities	FY08	Binary: milestone completion status		Original Completed

AS.3.3.04	Critical	Airspace Flexibility	FY09Q4	Workload measures per amount and frequency of airspace change. Degree of airspace change.	Publication, white paper or report.	Original Completed
AS.3.4.01	Critical	Develop Traffic Flow Management Concepts at the Regional and National Levels for Different Planning Intervals to Increase Efficiency, Reduce Delays, and Accommodate User Preferences	FY08	The output of this effort is an integrated set of advanced TFM concepts and the associated algorithms/models that will be integral to the development of the Evaluator.		Completed Original
AS.3.4.02		Early Integrated TFM Concept Definition and Development, Including Initial Concept of Operation Focused on National and Regional TFM for Increasing Flow Management Efficiency and Accommodating User Preferences.	FY09Q4	The output of this effort will be a baseline integrated TFM concept of operations that describes the composition and architecture of TFM functions as well as their temporal and geographic scope.	Conference or white paper describing the early integrated TFM concept definition.	Original Completed
AS.3.4.06		Simulation Assessment of Advanced TFM Concepts		The output of this effort will be a system-level simulation assessment of the feasibility and benefits of implementing advanced TFM techniques.		Original Cancelled
AS.3.5.01	APG	Flight Test Evaluation of an Airborne Situation Awareness-based Application	FY07	Metrics that will be obtained in these flight trials include fuel savings compared to normal operations, system effectiveness in a flight environment, and operational acceptance.		Completed Original

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AS.3.5.02		Field Evaluation of Trajectory Analysis Technology with Aircraft CNS Technology for Time-based Metering	FY07	Trajectory accuracy, fuel savings, noise footprint, workload, emissions		Original Completed
AS.3.5.03	Critical APG	Trajectory Analysis Technology for Automated Separation Assurance	FY08	Trajectory efficiency comparable to or better than today's operations. Near zero losses of separation. Integrated and coordinated functionality for strategic and tactical resolutions. Integrated trajectory analysis for aircraft with mix of equipage. Trajectory analysis for limited failure modes. Results based on laboratory analysis of actual Center traffic data in en route and transition airspace. Metrics analyzed as a function of traffic density and complexity.		Original Completed
AS.3.5.04	PART APG	Service-provider-based Automated Separation Assurance Simulation	FY08	Objective experimental data to quantify human workload, safety, and trajectory efficiency as a function of human/machine operating concept during nominal and failure modes in en route & transition airspace. General consistency with laboratory derived metrics (e.g., AS.3.5.03) and understanding of inconsistencies. Subject matter expert feedback (FAA, airlines, controllers, pilots) on operating concepts.		Original Completed

AS.3.5.05	PART IBPD APG	Auto SA Performance: Time-based Constraints	FY09Q3	SA performance measures for efficiency and safety.	At least one technical manuscript written and submitted for publication that meets the research objective as stated in the milestone description.	Original Completed
AS.3.5.08	PART	Safety Assurance via Light-weight Formal Methods and Simulation		Methods and scenarios developed and tested with SA technology and operating concepts that probe the possible safety envelope. System safety defined under wide range of scenarios and conditions.		Original Cancelled Realignment Merged
AS.3.5.10		Development of ASAS Applications in Procedural Airspace	FY09Q4	Work complete in FY08.	Published paper or NASA TM on process to develop airborne based separation procedures, and a published paper on results from batch study of ITP.	Realignment Completed
AS.3.5.14		Parametric RCNS	FY09Q4	RCNS capability as function of capacity, throughput, efficiency, safety, predictability	At least one technical manuscript written and submitted for publication.	Realignment Completed

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AS.3.6.01		ASDO Initial Concept Definition	FY07	n/a	Internal report minimum, conference paper preferred.	Completed Original
AS.3.6.02	Critical	Refine Algorithms and Procedures for Merging and Spacing Operations to a Single Runway.	FY09Q4	- Spacing variation at threshold of less than 10 seconds under normal conditions; - Off-nominal events do not disrupt overall flow.	Publication (or acceptance for publication) of NASA TM or at a technical conference.	Original Completed
AS.3.7.02	Critical	Develop Fast-time System-level Simulation of NGATS Technologies		The system-level simulation includes models of ASDO, SA, TFM, and DAC technologies.		Original Cancelled
AS.3.7.04		Develop Prognostic Safety Assessment Methods for Systems and Operations		Independent peer review research results with ARMD AvSP and two external technical associations, including JPDO. System safety assessment methods to cover 85% of 2008 baseline safety case parameters. Operations safety assessment methods to provide quantitative methods for runway incursions, pilot/controller workload, taxi time over active runways, and unacceptable wake encounters. Prognostic safety assessment method recognized by two regulator bodies as providing credible assessments.		Original Cancelled

AS.3.7.06		Initial Common Definitions	FY09Q4	Completeness of common definitions set, with verified applicability/traceability to other NextGen Airspace RFAs, and JPDO Goals/Objectives, and Metrics. Broad and appropriate use by NextGen Airspace Program RFAs in their experiments, allowing apples-to-apples comparison with alternative concept approaches.	Published paper documenting the common metrics, demand sets and assumptions.	Original Completed
AS.2.1.01		Develop Scripting Language and Protocols for a Common-trajectory-model Architecture (in Collaboration with U.S. (FAA) and European Trajectory-prediction Research Organizations (Eurocontrol))	FY08	Trajectory modeling consistency for various concepts	Lit search for AIDL and experimental plan for interoperability, panel chair for REACT workshop.	Original Completed
AS.2.1.03		Develop Vertical and Horizontal-profile Algorithms to Model Complex Combinations of Trajectory Constraints (Stemming from NGATS 4D Trajectory-based Operations) Involving Multiple “Simultaneous” Constraints (e.g., Path, Speed, Altitude, and/or Time) for En Route, Transition (to Terminal), and Terminal Airspace. Validate Algorithms for En Route and Transition Airspace.	FY08	Trajectory accuracy parameters	4D FMS demo, GenAlt work checked into CTAS baseline and used by default	Completed Original

AS.2.1.04		Survey and Advance Algorithms for Predicting and Describing Propagation of Trajectory Uncertainty	FY08	Algorithms account for effects of initial condition errors, aircraft dynamic model errors, and environmental variables.	Contractor report on uncertainty estimation toolbox	Original Completed
AS.2.1.06		Complex Combinations of Constraints	FY09Q4	Trajectory prediction accuracy in 4 dimensions.	Software deliverables - (4DFMS) multiple RTA capability, enhanced gen alt capabilities (constraint relaxation).	Original Completed
AS.2.1.08		Trajectory Uncertainty Modeling for EDA	FY09Q4	Predicted meet-time distribution statistics at the meter point, predicted trajectory error distributions along the descent path.	Model the weight, winds, and performance errors for the three look-ahead times. In CTAS, calculate the meet-time and path performance errors based on the weight, wind, and performance error models.	Realignment Completed
AS.2.2.01		Produce a Comprehensive List of Performance Attributes Corresponding to the List of Candidate NGATS Operational Concepts	FY07	Operational performance attributes such as capacity, throughput, delays, predictability, flexibility, user preference, safety, workload, efficiency		Original Completed

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AS.2.2.02		Working with Industry and the JPDO Shared Situation Awareness IPT, Produce a Set of Parametric Performance Models of CNS Systems	FY07	Communication, navigation, and surveillance characteristics and operational parameters (e.g., delays, response time, navigation precision, bandwidth)		Original Completed
AS.2.2.03		Group the Performance Attributes Under RNP, RCP, RSP, or an Advanced Performance Measure	FY08	Grouping of performance attributes		Original Completed
AS.2.2.04		CNS Performance Models are integrated into simulation systems and their performance is verified by actual operational data, where available.		CNS Performance (accuracy, reliability)		Original Realignment Merged
AS.2.3.01		Candidate Airspace Allocation Algorithms Proposed.		Number of candidate algorithms proposed		Original Cancelled Realignment
AS.2.3.02		Candidate Airspace Allocation Algorithms Validated		Number of candidate algorithms assessed, number of candidate algorithms validated		Original Cancelled Realignment
AS.2.3.03		Adaptable Airspace Algorithms	FY09Q4	Number of algorithms developed.	Publication, white paper, or report.	Realignment Completed
AS.2.3.04		Airspace Redesign Benefit Analyses	FY09Q4	% delay recovered over current sector design, number of sectors, workload and capacity variance, corridor utilization.	Publication, white paper, or report.	Realignment Completed
AS.2.4.01		Develop Oceanic Traffic Flow Optimization Concepts	FY08	Efficiency, throughput, delays, predictability		Original Completed

AS.2.4.02		An Improved Metric for Airspace Complexity is Defined	FY09Q4	Statistical correlation between metric and airspace complexity.	Conference or white paper describing an improved metric for airspace complexity.	Original Completed
AS.2.4.03		Assess System-wide Performance of Oceanic Traffic Flow Optimization Concepts		Efficiency, throughput, delays, predictability		Original Cancelled
AS.2.4.04		Update and Refine Airspace Evaluator Requirements for the Airspace Functions of the Evaluator		Identify interface control requirements for 85% of predictive throughput functionality to FY10 L4 "initial Airportal Evaluator". Airportal Evaluator concept functionalities to demonstrate 20% improvement in strategic decision optimization vs. capacity and throughput at 4 major airports over a 30 day period. Validate surface optimization requirements using 2010 OEP capacity and 3X forecast domain in fast-time simulation.		Original Cancelled
AS.2.5.01	PART	Strategic Automated Resolution and Trajectory Change Technology	FY07	95% of traffic conflicts are detected and resolved prior to the 3-5 min to loss of separation point with overall resolution delays and near-miss separation characteristics that are comparable or better than that of today's operations while operating under a significant increase in traffic density (e.g., 2-3x) and in the presence of uncertainty and under a variety of traffic conditions.		Original Completed

AS.2.5.02		Initial Operating Concept Options Description for Service-provider-based SA Approach	FY07	Description of a range of operating concepts (2 or 3) that will be evaluated in human-in-the-loop simulations. Operating concept descriptions include required technology, primary operator (controller/pilot) tasks, general user interface characteristics, examples of relevant operational traffic scenarios during nominal and failure modes.		Original Completed
AS.2.5.03		Initial Service-provider-based Automated Separation Assurance Simulation	FY08	Provides opportunity for researchers and stakeholders (e.g., FAA, airlines, controllers, pilots) to gain initial insight and provide initial feedback by viewing operating concept with humans in the loop. Initial objective analysis of operating concept during nominal and failure recovery operations. Initial evaluation of methods for gathering and analyzing experimental data, including metrics collected in laboratory analysis, during human in the loop simulations.		Original Completed

C-1. **Legacy Milestones FY2007 – FY 2009**

AS.2.5.04		Tactical Automated Safety Assurance Trajectories	FY08	Tactical detection and resolution logic computes safe tactical trajectories and thereby prevents a loss of separation for the majority of those traffic conflicts (~95% of the 5% not solved strategically) that were not resolved by strategic automated resolution technology and thereby prevent loss of separation while operating under a significant increase in traffic density and in the presence of uncertainty and under a variety of traffic conditions.		Original Completed
AS.2.5.05		Technology for Determining Weather Impacts on Tactical Airspace Operations	FY08	More useful/accurate characterization of weather impacts, ability to reduce lost usable airspace by 50% in some areas/conditions compared to today's operations.		Original Completed
AS.2.5.07		Analysis of Aircraft CNS Performance as it Relates to Separation Assurance Technology	FY09Q4	Communications delays, negotiation delays, workload.	At least one technical manuscript written and submitted for publication that meets the research objective as stated in the milestone description.	Original Completed

AS.2.5.09		Human Workload, Performance, and Situation Awareness Analysis of Higher Levels of Automation for Service-provider-based Separation Assurance		Workload, performance (response time and error), and situation awareness.		Original Cancelled
AS.2.5.14		Integration of CNS Performance Models into Simulation Test Beds	FY09Q3	TBD	Technical manuscript written and submitted for publication (may be NASA internal).	Realignment Original Completed
AS.2.6.01		Flight Validation of Low Noise Guidance (LNG)	FY07	Ground noise measurements, conformance to guidance, fuel burn.		Original Cancelled
AS.2.6.02		Support for Initial Algorithm, Procedures and Information Requirements for Merging and Spacing Technology	FY07	Spacing variation at threshold of less than 10 seconds under normal conditions; off-nominal events do not disrupt overall flow.	Publication (or acceptance for publication) of NASA TM or at a technical conference	Original Completed
AS.2.6.03		Initial Sequencing and Deconfliction Algorithm	FY08	Throughput/capacity at major airports and regional/reliever airports, noise and emissions impacts, fuel use.	Internal report minimum, conference paper preferred.	Original Completed
AS.2.6.04		Develop Method for Airborne Maneuvering Within Established Limits to Make Gross Corrections to Inter-aircraft Spacing				Original Cancelled Realignment

AS.2.6.05		Information and Decision Support Requirements for Terminal Area Operations.	FY09Q4	Definition of information content, accuracy, and frequency to enable development of Metroplex scheduling tool that meets arrival, departure, and surface operations needs, as well as complies with metroplex airspace constraints.	Publication (or acceptance for publication) at a technical conference.	Original Completed
AS.2.7.10		Human Factors Assessment I	FY09Q4	Prioritized list of NextGen human performance issues, vetted by relevant human performance research community (e.g. composite University, NASA, FAA) for thoroughness (breadth & depth).	Publication of research results in relevant conference or journal.	Realignment Completed
AS.2.7.11		Define Candidate Updates to FAA's Multi-Sector Planner (MSP) Midterm Concept of Operations (ConOps.)	FY09Q4	Vetted (with DAC, SA, ASDO, & TFM) list of candidate MSP Midterm ConOps updates.	Published white paper describing possible extensions to MSP midterm ConOps for 2018, specifically calling out significant areas of overlap or potential integration with SA, TFM, DAC and/or ASDO research.	Realignment Completed

C-1. Legacy Milestones FY2007 – FY 2009

AS.1.1.01		Survey and Document the Current SOA of Trajectory Prediction/Modeling Algorithms and Software Capabilities and the Requirements Envisioned for Trajectory Prediction to Support NGATS Automation Systems	FY08Q4	Current SOA reported and documented.	Draft documents detailing capabilities for existing tools, 5 docs delivered	Completed Original
AS.1.1.02		Survey and Document the Trajectory Prediction/Modeling Algorithms and Software Capabilities (e.g., EDA, PARR, 4D-FMS) Supporting the Current State of the Art (TMA, URET, FMS), and Requirements Envisioned for Future TP Capabilities to Support NGATS-Relevant Trajectory Prediction for the Evaluator and Related Automation	FY08Q4	Trajectory accuracy parameters	Presentation on developing requirements for new tools	Original Completed

C-1. Legacy Milestones FY2007 – FY 2009

AS.1.1.03		Develop Algorithms for Measuring the Difference Between 4D Trajectories	FY07Q4	Algorithms developed with sufficient sensitivity to identify differences between actual vs. predicted trajectories, FMS vs. ground-tool trajectory predictions, and U.S. vs. European trajectory specifications.		Completed Original
AS.1.1.04		Identify and Quantify a Complete Set of Constraints and Objective Functions Typically Applied to Trajectories to Support ATM Functions	FY08Q4	Constraints and objective functions documented from DAC, TFM, SA, and ASDO. Quantification includes typical values, bounds, or conformance precision, as appropriate to the ATM function.	Paper on abstraction techniques	Completed Original
AS.1.1.05		Identify and Quantify Sources of Uncertainty for Trajectory Prediction	FY07	Characterization of trajectory prediction uncertainty includes sensitivities to wind prediction uncertainty, aircraft aero/engine performance variables, auto-flight mode, RNP, crew procedures, and flight segment type.		Original Completed
AS.1.1.06		Develop Data Mining Techniques for Identifying Trends in Trajectory Intent Error	FY08	Techniques validated to accurately identify trends in at least 80% of known trajectory intent errors from a current-day validation data set.	Paper on data mining of intent errors GN&C 2008	Completed Original
AS.1.2.01		Identify Suitable Techniques for Modeling RTSP Performance Characteristics.	FY09Q1	The metrics include comprehensiveness and peer review acceptance.		Original Completed
AS.1.2.02		Synthesis of Human Factors and Operational Literature	FY08	The metrics are the comprehensiveness of human performance characteristics.		Cancelled Original

C-1. Legacy Milestones FY2007 – FY 2009

AS.1.2.03		Extensions of Analytical and Statistical Techniques for Modeling RTSP Performance Characteristics		The metrics are the techniques explored are of sufficient maturity to construct parametric models for RTSP for use in modeling and simulation.		Original Cancelled Realignment Merged
AS.1.2.04	Critical	Identify Grouping Techniques that will Classify/Represent the Multi-dimensional Nature of RTSP Performance Characteristics. Identify Decision Support and Information Presentation Techniques Applicable to Grouping Techniques.	FY10	The metrics are the grouping characteristics (robustness, consistency, sensitivity, and face validity)		Original Cancelled
AS.1.3.01		The State of the Art is Surveyed and Documented	FY07	Breadth and depth of survey.		Completed Original
AS.1.3.02		The Elements of Airspace Structure in the NAS are Inventoried, and "Best Practices" in Airspace Design are Documented. Adapt for NGATS.	FY07	Breadth and depth of inventory.		Original Completed
AS.1.3.03		Utilize Formal Mathematical Methodologies, such as Genetic Algorithms and Neural Networks, to Develop Dynamic Airspace Structures Supporting both New and Conventional Classes of Airspace.		Number and type of airspace units within the NAS		Original Cancelled Realignment

AS.1.4.01		Develop Empirical and Data Mining Models for Correlating Weather and Key Metrics for NAS Performance. The Milestone will be Evaluated in Terms of Improvements in estimating NAS Delay Over Current Methods.	FY08	This research should improve our ability to estimate aggregate delay based on predicted weather and expected traffic to within 10,000 minutes based on 2006 traffic levels.		Completed Original
AS.1.4.02		Assess and Develop Aggregate Models, such as Network Flow and Linear Time Varying Models, for Traffic Flow under Nominal and Off-nominal Conditions	FY08	The aggregate models should demonstrate a 10 times reduction in the size of the models used for analysis.		Completed Original
AS.1.4.03		Characterize Current and Future ATM Systems by Adapting Concepts from Network and Graph Theory	FY08	The success of this milestone will be measured by its ability to characterize the new ATM network with a higher level of varying demand than today.		Completed Original
AS.1.4.04		Expand the Concept of Traffic Complexity to Controller, Pilots and Varying Levels of Automation	FY08	The metric for this research is the increase in the ability to define traffic complexity from the current state of the art and expand it to pilots and varying levels of automation.		Original Merged
AS.1.5.02		Methodology for Analysis of Tactical ATC and Airborne Collision Avoidance Interaction	FY08	Method developed and validated with actual air traffic data in the presence of uncertainties.		Original Completed
AS.1.5.04		Methods for Quantifying Safety Level of Human Operators in ATM System	FY08	Method developed and validated in simulation in the presence of uncertainties.		Original Cancelled
AS.1.5.06		Formal Proof of Separation Assurance for Oceanic Applications	FY07	Completeness		Original Completed

AS.1.5.07		Recommended Complexity Metric	FY08	Number of machine operations		Original Completed
AS.1.6.01		Characterize and Quantify the Uncertainty Impact of ASDO Procedures	FY08	n/a	Internal report minimum, conference paper preferred.	Completed Original
AS.1.6.04		Explore Innovative Guidance and Control Methods for the Super Density Terminal Environment		Review of guidance and control methods, their strengths and weaknesses		Cancelled Realignment Original
AS.1.6.05		TRACON Operational Error Analysis	F709Q4	Detect all provided operational errors at least 2 minutes ahead of time.	Publication (or acceptance for publication) at a technical conference.	Realignment Completed
AS.1.7.01	Critical	Develop initial system-level Con-Ops. Leverage JPDO NGATS Con-Ops, and Expand Development as Required, to Support Airspace Systems Program (Airspace & Airportal) Research, and Concept Development.	FY07	Completeness by containing JPDO (stakeholder) and technologist views on separation assurance, demand/capacity imbalance and airspace modifications.		Completed Original

C-1. Legacy Milestones FY2007 – FY 2009

AS.1.7.03	Critical	Develop Individual Agent-based Models of NextGen Technologies	FY08Q4	These models shall include at least ASDO, TFM, SA, and DAC	Document agent-based model development (completed models and planned models). Publish available capabilities in relevant conference or journals	Original Completed
AS.1.7.04		Develop Interim System-level Concept of Operations to Accommodate 3x Demand Based on Results of Studies and Identified Gaps		Less than 50% change from initial version and stakeholder vetted.		Original Cancelled
AS.1.7.05		Develop Approach for System Validation and Certification Methodology		Results for AAC, ASAS, and TCAS algorithms.		Original Cancelled Merged

C-2. Current Milestones FY2010 – FY2015

Appendix C-2 contains current milestones for each RFA planned for FY2010 – FY2014. Project milestones are distinguished by level of research, according to the following criteria:

- Level 1 milestones focus on foundational physics and modeling and include research in automation design, human factors, the use of applied mathematics for system optimization and design.
- Level 2 milestones focus on discipline such as safety analysis and recovery methods, trajectory design and conformance, and multi-aircraft flow and airspace optimization.
- Level 3 milestones consider multi-discipline capabilities with a key focus on adaptive air and ground automation concepts and technologies, airspace simulation and modeling, and systems analysis and integration.
- Level 4 milestones address system-design with an emphasis on integrated solutions for a safe, efficient, and high-capacity national airspace system.

Table 9. Current Milestones FY2010 – FY2015

6.1.1.1.1.1	**Key Milestone**	**Title**	**Scheduled Completion FY**	**Q**	**Planned Metric**	**Exit Criteria**	**Status**
AS.4.3.02		Airspace Class Integration	14	4	% delay recovered over current sector design, corridor utilization.	Publication, white paper or report	Realignment Current
AS.4.3.03		Incorporate System Level Feedback	15	4	% delay recovered over current sector design, corridor utilization.	Publication, white paper or report.	Current

C-2. Current Milestones FY2010 – FY2015

AS.4.4.01	Critical APG	Develop and Test Early Integrated Traffic Flow Management (TFM) Concepts for Advanced Traffic Flow Management to Accommodate User Preferences, Reduce Delays and Increase Efficiency Under All-weather Conditions	11	4	The specific metrics for this milestone include delays, throughput, fuel efficiency, flight duration, complexity distribution, workload, and user preference accommodation. The actual savings will be dependent on the concept of operations.	Conference or journal publication describing key algorithms and models associated with the TFM Evaluator and the results of fast-time simulation experiments.	Original 09 Change Current
AS.4.5.01	Critical PART IBPD	Auto SA Simulation: Homogeneous Airspace Under Off-nominal Conditions	13	2	SA performance measures for efficiency, safety & capacity; human workload & situation awareness measures; subjective data.	Technical manuscript written and submitted for publication that meets the research objective as stated in the milestone description.	Original Current
AS.4.5.02		Auto SA Simulation: Mixed Operations Airspace Under Off-nominal Conditions	14	2	SA performance measures for efficiency, safety & capacity; human workload & situation awareness measures; subjective data.	Technical manuscript written and submitted for publication that meets the research objective as stated in the milestone description.	Realignment Current
AS.4.5.03		Final Report on Functional Allocation	14	4	none	Technical manuscript written and submitted for publication.	Realignment Current

C-2. Current Milestones FY2010 – FY2015

AS.4.6.01		Final Concept of Operations for Automated, Mixed Operations in Metroplex Environment	15	3	For major airports, increase peak aircraft throughput by 15%, decrease mean delay by 25% and decrease mean flight time during descent by 2 minutes. For metroplex, increase peak operations by 100%, decrease mean flight time during descent by 3 minutes and ensure full utilization of available runway resources.	Technical Publication documenting refined concept of operations. Conference publication minimum, journal publication preferred.	Original Current
AP.3.C.09		Concept of Operations and Requirements for Integrated Operations at a Single Airport	11	2	Results provide requirements for interfacing concepts, information exchange, and operational procedures developed within the CTD Project for culminating experiments to be conducted by SDO and SESO.	Completion of Requirements Review headed by CTD Project Scientist. NASA TM documenting concept of operations and requirements for integrated operations at a single airport	Current
AP.3.C.13		Evaluation of RCM and CADRS Tools in the Context of Other Tools and Systems Being Used by Traffic Flow Managers and Flight Crew	15	4	Impacts of adverse weather conditions and variations in traffic flow mix and rate will be assessed for multi-runway operations at a representative airport. Evaluation may be performed at a cooperating airport or through high-fidelity simulation.		Current

AP.3.S.02		Integrate and Evaluate Surface Traffic Planning Algorithms	10	4	Via simulation to show the ability to manage up to 2x traffic demand scenarios with taxi delays similar to the baseline (1x throughput without optimization). Results of this milestone will be used to determine the utility of this optimization approach. Metrics include average taxi delay reduction, throughput increase, environmental impacts, and fuel efficiency under increased Airportal traffic density. The performance improvement will be assessed by subject matter experts presented with the same current and future traffic-demand scenarios. Results are used to feed benefits analysis and trade studies to assess potential utility of taxi route optimization.	Conference paper reporting the results of modeling and analysis of NextGen surface operations.	Current
AP.3.S.03		Develop Ground-Based Surface CD&R Algorithms	12	2	Metrics include false, nuisance, and missed alert rates of conflict detection (for runway/taxiway incursion) via simulations. Assess time-to-conflict at detection of the conflict. Errors in surveillance data should be considered. The targets for acceptable rates for false, nuisance, and missed alerts will be determined through RTCA Sub-committee-186 Working Group 1.	A final report of NRA contract documenting the description of ground-based CD&R algorithms, performance evaluation results of the algorithms, and description of software design.	Current

AP.3.S.04		Evaluate Ground-Based Conflict Detection and Resolution (CD&R) System	13	4	SME acceptance of alert/warning/resolution advisories generated by the ground-based CD&R system on timing and format of displays. Metrics include qualitative measure of false, nuisance, and missed alert rates of conflict detection (for runway/taxiway incursion) via simulations. Assess time-to-conflict at detection of the conflict. Human factors analysis results in pilot/controller evaluation on alerting and resolution advisories.	Conference paper documenting the results of real-time simulations of the integrated ground CD&R system.	6.1.1.1.1.1.1
AP.3.S.05		Evaluate Initial Surface Trajectory-Based Operations with ATC in the Loop	12	4	SME acceptance of traffic advisories. Performance of surface operations in terms of taxi delay and throughput with traffic demands increased up to 2X.	Conference paper reporting the results of real-time simulations of the integrated system of optimized surface planning, environmental planner, and taxi conformance monitoring.	Current
AP.3.S.07		Integrate 4D Taxi Clearance Compliance and Optimized Surface Planning	13	4	Pilot acceptance of 4D taxi clearances and advisories generated by the AC-based taxi clearance compliance algorithms. Pilot performance of taxi clearance compliance (e.g., time of arrival errors) will be measured. Effectiveness of taxi clearance messages and conformance monitoring tool for the tower controller will be	Conference paper reporting the results of real-time simulations of the integrated system of 4D taxi clearance compliance and optimized surface planning.	Current

					examined.		
AP.3.S.08		Integrate Surface Trajectory-Based Operations with Flight Deck Technologies	14	4	SME acceptance of traffic advisories, cockpit displays and alerts. Performance of pilot clearance compliance (e.g., time of arrival errors) with traffic demand increased up to 2X. Performance measure of surface operations (e.g., taxi delay, throughput). Performance measure of taxi conformance and CD&R algorithms (e.g., false, nuisance, missed alert rates)		Current
AP.3.S.09		Conduct Field Evaluation of Initial Surface Trajectory-Based Operations	15	4	Controller acceptance of traffic advisories and alerts. Measure controller workloads in performing tasks	Conference paper reporting the results of field evaluation of initial surface trajectory-based operations.	Current
AS.3.3.05		Generic Airspace	10	4	Time to learn sector-specific knowledge, amount of sector-specific knowledge eliminated, effectiveness of methods.	Publication, white paper or report.	Realignment Current
AS.3.3.06		Validate Flow Corridors Feasibility	11	4	Workload measures for each procedure.	Publication, white paper or report.	Realignment Current

AS.3.3.07		Interactions Between Airspace Classes	12	4	Number of algorithms, procedures developed.	Publication, white paper or report.	Realignment Current
AS.3.3.08		Dynamic Terminal Airspace II	12	4	Number of integration methods developed, capacity, efficiency, and robustness.	Publication, white paper or report	Realignment Current
AS.3.3.09		Refine DAC Concepts	13	4	% delay recovered over current sector design	Publication, white paper or report	Realignment Current
AS.3.3.10		Refine Flow Corridor Procedures	13	4	% delay recovered over current sector design, corridor utilization.	Publication, white paper or report	Realignment Current
AS.3.3.11		Operator Roles and Responsibilities	11	4	Airspace capacity, description of operator roles and responsibilities.	Publication, white paper or report.	Current
AS.3.4.03		Determine User and Service Provider Roles to Accommodate User Preferences and Increase Efficiency	10	4	The product of the milestone will identify the type of decisions that users and service providers should make to promote maximum efficiency, balance workload, and accommodate user preferences. The milestone report will also describe the information needs and exchanges to enable CDM to handle 3x capacity.	Conference or journal publication describing methods or concepts for incorporating user preferences into the traffic flow management decision making process.	Original Current

AS.3.4.04		Expand Traffic Flow Management Concepts to Address Weather Modeling Uncertainty to Promote Higher Predictability and Efficiency	10	4	The outputs of this activity are probabilistic models/algorithms, and weather product requirements, for improved predictions of NAS resource demand/supply under uncertainty.	a. A conference and/or white paper with a CD or DVD containing the actual and predicted sector capacities, and the corresponding traffic/weather scenarios. b. A conference and/or white paper with a CD or DVD containing the actual and predicted peak traffic demand data in fifteen-minute intervals over a 2-hour planning horizon, and the corresponding traffic/weather scenarios.	Original Current
AS.3.4.05	Critical	Assess Representative System-wide TFM Models	10	4	The output of this effort is a suite of advanced TFM tools integrated into a simulation test bed.	Conference or journal publication describing the results of the system-wide traffic flow management experiments conducted in support of this milestone.	Original Current
AS.3.4.07		Initial Collaborative Experiments	12	4	Demonstrate a 5% improvement in the ability to accommodate user preferences with the algorithms and models	Conference or journal publication describing the results of the initial	Realignment Current

					developed in support of this milestone over more traditional traffic flow management approaches that neglect to account for user preferences.	collaborative traffic flow management experiments	
AS.3.4.08		Refined Collaborative Experiments	14	4	Demonstrate a 10% improvement in the ability to accommodate user preferences with the algorithms and models developed in support of this milestone over more traditional traffic flow management approaches that neglect to account for user preferences.	Conference or journal publication describing the results of the refined collaborative traffic flow management experiments	Realignment Current
AS.3.4.09		Baseline Flow Planning Under Uncertainty	12	4	Demonstrate a 5% reduction in total delays when managing flights in the presence of system uncertainties over current TFM practices that rely on an uncoordinated collection of open-loop deterministic controls, such as ground delay programs, miles-in-trail restrictions, and playbook reroutes	Conference or journal publication describing the enhancements to the baseline Evaluator and the results of the fast-time simulations conducted in support of this milestone.	Realignment Current
AS.3.4.10		Refined Flow Planning Under Uncertainty	13	3	Demonstrate an 8% reduction in total delays or a 5% improvement in the ability to accommodate user preferences when managing flights in the presence of system uncertainties over current TFM practices that rely on an uncoordinated collection of open-loop deterministic controls, such as ground delay programs, miles-in-trail restrictions, and playbook	Conference or journal publication describing the agile, iterative approaches to managing traffic flows.	Realignment Current

					reroutes.		
AS.3.4.11		Agile Decision Making with Uncertainty	14	4	Demonstrate a 10% reduction in total delays or an 8% improvement in the ability to accommodate user preferences when managing flights in the presence of system uncertainties over current TFM practices that rely on an uncoordinated collection of open-loop deterministic controls, such as ground delay programs, miles-in-trail restrictions, and playbook reroutes.	Conference or journal publication describing the key models, algorithms, and concepts that comprise the integrated, agile decision making system.	Realignment Current
AS.3.4.12		Environmental Impact Assessment of Traffic Flow Planning	15	4	The environmental toolkit should demonstrate an ability to compute emissions of carbon dioxide, water vapor, and nitrogen oxide and also fuel flow for a representative traffic flow concept.	Conference or journal publication describing the key components of the environmental toolkit and results demonstrating the use of the toolkit on a representative traffic flow management concept.	Current

C-2. Current Milestones FY2010 – FY2015

AS.3.4.13		Risk Management Based Flow Management	15	4	Demonstrate an improvement in the ability to manage the risks associated with flow planning under uncertainty over the current state-of-the-art.	Conference or journal publication describing the key models, algorithms and concepts developed for managing traffic flow management risks in the presence of system uncertainties.	Current
AS.3.5.06	PART IBPD APG	Auto SA HITL: 4D with Common Definitions	10	4	SA performance measures for efficiency, safety & capacity; human workload measures; subjective data.	At least one technical manuscript written and submitted for publication that meets the research objective as stated in the milestone description.	Original Current
AS.3.5.07	Critical IBPD PART	Integrated SA Capabilities: 4D with Dynamic Weather & Complexity Constraints	11	6.1.	SA performance measures for efficiency and safety.	At least one technical manuscript written and submitted for publication that meets the research objective as stated in the milestone description.	Original Current
AS.3.5.09		3D-PAM/EDA Evaluations	11	4	SA performance measures for efficiency, safety & capacity; human workload & situation awareness measures; subjective data.	Technical manuscript written and submitted for publication that documents the findings of the evaluations.	Original Current
6.1.1.1.1.1.1.		Mixed Operations Concepts Formulated	10	4	6.1.1.1.1.1.1.2.1 Number of	Concepts documented and	Realignment Current

					concepts formulated .	reviewed by non-advocate board.	
AS.3.5.13		Auto SA simulation: Mixed Operations Airspace Under Nominal Conditions	12	2	SA performance measures for efficiency, safety & capacity; human workload & situation awareness measures; subjective data.	Technical manuscript written and submitted for publication that meets the research objective as stated in the milestone description.	Realignment Current
AS.3.5.16		Develop Approach for System Validation/Certification of SA Systems and Concepts	13	3	Stakeholder vetting and peer review	Technical manuscript written and submitted for publication that meets the research objective as stated in the milestone description.	Realignment Current
AS.3.5.17		3D-PAM/EDA Simulations	10	4			Current
AS.3.5.18		Dynamic Flow Control for Airborne Trajectory Management with Self Separation	15	4			Current
AS.3.6.03		6.1.1.1.1.1.1.2.2 Evaluation of Single Airport Operations Using	11	2	For major airports, increase peak runway throughput by 5%, decrease mean flight time during descent by 1 minute, and attain 75% conformance to prescribed trajectories in nominal conditions.	Publication (or acceptance for publication) at a technical conference.	Original Current

		Medium-term Technologies.					
AS.3.6.04		Concept of Operations and Requirements for Coordinated Operations at a Single Airport.	6.1	2	Results provide requirements for interfacing concepts, information exchange, and operational procedures developed within the Projects for culminating experiments to be conducted by ASDO, CADOM, SESO, and AMI.	Completion of requirements review headed by Airportal and Airspace Project Scientists, NASA-TM documenting concept of operations and requirements for integrated operations at a single airport.	Original Current
AS.3.6.05		Evaluate Single Airport Operations Using Late-term Technologies.	12	4	For major airports, increase peak airport throughput by 15%, decrease mean flight time during descent by 2 minutes, and attain 90% conformance to prescribed trajectories in nominal conditions.	Publication at a technical conference minimum, journal preferred.	Original Current
AS.3.6.06	Critical	Definition of Coordinated Arrival/Departure/Surface Operations for Metroplex	12	2	For metroplex, decrease flight time during descent by 2 minutes	Publication (or acceptance for publication) at a technical conference	Original Current
AS.3.6.07		Evaluation of Metroplex Operations using Near-term Technologies	14	3	For metroplex, increase peak operations by 50%, reduce flight time during descent by 2 minutes, and attain 75% conformance to prescribed trajectories in nominal conditions.	Publication (or acceptance for publication) at a technical conference	Realignment Current

AS.3.6.08		Evaluation of Metroplex Operations using Late-term Technologies	15	2	For metroplex, increase peak operations by 100%, reduce flight time during descent by 3 minutes and attain 90% conformance to prescribed trajectories in nominal conditions.	Publication at a technical conference minimum, journal preferred	Realignment Current
AS.3.6.09		Evaluation of Interval Management Procedures to a Single Airport with Dependent Parallel Runways	12	2	For major airports, reduce fuel usage and emissions by 5%, noise by 1dB, and increase conformance of aircraft to prescribed trajectory by 5% while maintaining throughput.	Publication of experiment results	Current
AS.3.6.10		Evaluation of Interval Management Procedures to a Single Airport with Delegated Separation	12	4		Publication of Experiment Results	Current
AS.3.6.11 (was AS.2.6.11)		Initial Evaluation of Terminal Tactical Conflict Prediction and Resolution Functions	11	4	6.1.2 Marginally acceptable ratings for workload and situational awareness. Achieve false alert rate less than 5% and missed alert rate less than 1% for dense terminal airspace.	6.1.3 Publicatio n (or acceptanc e for publicatio n) at a technical conferenc e	6.1.4 Re ali gn me nt Cu rre nt
AS.3.6.12		Definition of Integrated Arrival/Departure/Surface Operations for Metroplex	13	4		Publication at a technical conference	Current
AS.3.6.13		Initial Terminal Airspace Reconfiguration Techniques for Single Airport during Peak Traffic Periods	13	4		Publication at a technical conference	Current

AS.3.6.14		Evaluation of Single Airport Operations using Integrated Scheduling, Control and Tactical Conflict Prediction & Resolution	14	2		Publication of experiment results	Current
AS.3.6.15		Initial Terminal Airspace Reconfiguration Techniques for Metroplex during Peak Traffic Periods	15	2		Publication at a technical conference	Current
AS.3.6.16		Evaluation of Interval Management with Tactical Conflict Prediction & Resolution to a Single Airport or Metroplex	14	2		Publication of experiment results	Current
AP.2.C.04		Initial Airport Runway Configuration Management (RCM) and Combined Arrival/Departure Runway Scheduling (CADRS) Algorithms for a Single Runway at a Single Airport	10	3	Metrics include airport throughput and/or total aircraft delays with a fixed demand during steady state weather conditions and during wind shifts requiring runway configuration changes. Benefit is validated by comparing throughput to that produced by subject matter experts (SMEs) in the same scenarios and by comparison to the estimated theoretical maximum throughput values (considering no uncertainties or unused slots). The target for the initial algorithm is performance at least equal to an experienced SME.	Referenceable publication, preferably a NASA TM or TP, documenting the algorithms, evaluation scenarios, and stand-alone performance	Current

AP.2.C.06		Wake Vortex Predictor that Provides Probabilistic Estimates of Wake Location	10	4	Defined confidence intervals (confidence levels for spatial accuracy of prediction as a function of wake age, wind values, generating-aircraft weight range, and ground proximity). Confidence bounds validated via separate data sets, new data sets that may become available from FAA field tests. Validation extent is contingent upon availability of new data sets.	NWRA status report and preliminary PDFs for wake vortex predictor that provides probabilistic estimates of wake location.	Current
AP.2.C.08		Develop PDFs for Probabilistic Wake Model	11	4	Resulting probabilistic model will output, for any given time and location, the probability of a wake of a certain strength existing.		Current
AP.2.C.09		Dynamic Aircraft Wake Spacing Tool Development	13	4	Decision support tool will provide recommended aircraft spacing based on wake avoidance with sufficient lead-time for controller to position aircraft for approach and landing.		Current

AP.2.C.10		Airport Runway Configuration Management (RCM) and Combined Arrival/Departure Runway Scheduling (CADRS) Algorithms for a Single Airport with Multiple Runways	11	3	Metrics include airport throughput and/or total aircraft delays with a fixed demand during steady state weather conditions and during wind shifts requiring runway configuration changes. Benefit is validated by comparing throughput to that produced by subject matter experts (SMEs) in the same scenarios and by comparison to the estimated theoretical maximum throughput values (considering no uncertainties or unused slots). The target for the initial algorithm is performance at least equal to an experienced SME.	Referenceable publication, preferably a NASA TM or TP, documenting the algorithms, evaluation scenarios, and stand-alone performance	Current
AP.2.C.11		Extend RCM and Arrival/Departure Balancing Algorithms to Multiple Airports with Multiple Runways	15	1	Metrics include airport throughput and/or total aircraft delays with a fixed demand during steady state weather conditions and during wind shifts requiring runway configuration changes. Benefit is validated by comparing throughput to that produced by subject matter experts (SME) in the same scenarios and by comparison to the estimated theoretical maximum throughput values (considering no uncertainties or unused slots). The target for the initial algorithm is performance at least equal to an experienced SME.		Current

AP.2.C.13		Wake Encounter Hazard Characterization	15	4			Current
AP.2.C.14 (was AP.3.C.14)		Integration of Dynamic Wake Spacing into Arrival/Departure Operations Tools	15	4	Dynamic aircraft wake spacing will be factored into arrival stream scheduling with sufficient lead-time for controller to position aircraft for approach and landing. Airport throughput and surface operations will be compared with and without dynamic wake spacing.		Current
AP.2.S.10		Develop Interim Aircraft-Based CD&R Algorithms	12	4	Metrics include false, nuisance, and missed alert rates, and time-to-conflict at detection for runway/low altitude/taxiway conflict via Monte Carlo simulations, at a minimum. Errors in surveillance data should be considered. The targets for acceptable rates for false, nuisance, and missed alerts will be determined through RTCA SC-186 WG1.	Conference paper reporting the performance of the algorithms of aircraft-based terminal area conflict detection and resolution.	Current
AP.2.S.11		Assess System Performance of Varying Options for 4D Taxi Clearance Information to Provide a Scientific Basis for Future Systems Requirements for Mature Surface Automation and Arrival/Departure Seamless Airspace Transition	11	4	Metrics of interest in pilot conformance include time error at significant waypoints (runway or taxiway intersections), pilot workload or errors in secondary tasks, and incidents of incorrect turns or taxiway selection for varying level or options of automation interface.	Conference paper reporting the results of pilot-in-the-loop simulation to evaluate pilot interfaces, procedures, and ConOps for refined 4D taxi concepts and seamless airspace transition. A report documenting the effects of pilot	Current

						workload of 4D taxi clearance ConOps using a formal analysis approach.	
AP.2.S.12		Augment Surface Optimization and Environmental Algorithms	11	4	For each optimization solution method, solve surface traffic planning problems for at least two major airports for both current-day traffic and future demand (e.g., 1.5x). Compare efficiency metrics (e.g., taxi/queue delays, reduction in fuel consumption) and airport throughput for each method. Compare robustness of the solutions against uncertainties.	Final reports documenting NRA efforts, including surface/environmental algorithms, integration of algorithms, simulation results of integrated systems. Conference papers describing performance of the algorithms in the presence of uncertainties and off-nominal situations.	Current
AP.2.S.13		Investigate NextGen Surface Operations	4	4	Characterization of NextGen surface operations. Scenarios and modeling of NextGen surface operations. Performance metrics of surface operations (e.g., taxi delay, runway throughput) based on various optimization solutions will be measured upon fast-time simulations results for proposed	Conference paper reporting the results of modeling and analysis of NextGen surface operations.	Current

					NextGen scenarios.		
AS.2.3.05		Adaptable Airspace Benefit Analyses	10	4	% delay recovered over current sector design, complexity and capacity variance, degree of airspace change, corridor utilization.	Publication, white paper, or report.	Realignment Current
AS.2.3.06		6.1.4.1.1.1 Define Flow Corridors Procedures	6.1.4.	6.1.4.1	6.1.4.1.1.4 Number of procedures defined.	6.1.4.1.1.5 Public ation, white paper, or report.	6.1.4.1.1.6 R e a l i g n m e n t C u r r e n t C o

							npleted
AS.2.3.07		Dynamic Terminal Airspace I	11	4	Number of algorithms, procedures developed.	Publication, white paper, or report.	Realignment Current
AS.2.3.08		Flow Corridor Benefit Analyses	12	4	% delay recovered over current sector design, corridor utilization.	Publication, white paper, or report	Realignment Current
AS.2.4.05		Initial Weather Translation Models	12	4	Demonstrate a 5% improvement in the ability to estimate the capacity of a weather impacted region of airspace over traditional approaches that assume capacity reduction is equal to the percent area covered by VIL >= 3.	Conference or journal publication that describe the initial weather translation models	Realignment Current
AS.2.4.06		6.1.4.1.1.6.1.1.1 Refined Weather Translation Models	14	4	Demonstrate a 10% improvement in the ability to estimate the capacity of a weather impacted region of airspace over traditional approaches that assume capacity reduction is equal to the percent area covered by VIL >= 3.	Conference or journal publication describing the testing and development of weather translation models over multiple time-horizons	Realignment Current
AS.2.5.06		Dynamic Weather Technology	10	4	Fidelity of the convective weather representation.	Test report(s) written that document the V&V results for the convective weather representation capability in the relevant test bed(s).	Original Realignment Current

AS.2.5.08		Auto SA Performance: Complexity Constraints	10	4	SA performance measures for efficiency, safety, and complexity.	At least one technical manuscript written and submitted for publication that meets the research objective as stated in the milestone description.	Original Realignment Current
AS.2.5.10		Identify Failure Modes for Off-nominal Studies	11	4	Number of failure modes identified for each candidate operating concept to be evaluated in the functional allocation studies	Technical report written that documents the method and results of the analysis.	Original Realignment Current
AS.2.5.11		Laboratory Integration of Multiple SA Algorithms into Simulation Testbeds	11	1	Number of algorithms integrated into each simulation test bed.	Test report(s) written that document the results for the respective algorithms that have been successfully integrated into the relevant test bed(s).	Original Current
AS.2.5.12		Safety Assessment for SA Systems and Concepts	12	2	7. Number of hazards identified, depth of analysis of each hazard	At least one technical manuscript written and submitted for publication that meets the research objective as stated in the milestone description.	Realignment Current
AS.2.5.13		Auto SA Performance: Dynamic Weather Constraints	11	1	SA performance measures for efficiency and safety.	At least one technical manuscript written and submitted for publication that	Realignment Current

						meets the research objective as stated in the milestone description.	
AS.2.6.07	Critical	Procedures and Technologies for Initial ASDO Concept of Operations in Simple Airspace	11	3	* Metric will vary based on the type of procedure being researched, and the intended goal of that procedure.	Technical conference publication minimum, journal preferred.	Original Current
AS.2.6.08		Develop ASDO Operations that Leverage Advanced FMS and Enhanced Control Guidance	11	2	For major airports, reduce fuel usage and emissions by 5%, noise by 1dB, and increase conformance of aircraft to prescribed trajectory by 5% while maintaining throughput.	NASA TM or technical conference publication minimum, journal preferred.	Original Current
AS.2.6.09		Concept of Use for Terminal Tactical Conflict Prediction and Resolution Functions	10	4	Achieve concurrence from Project researchers and SME's that all fundamental requirements are present.	Publication (or acceptance for publication) at a technical conference.	Realignment Current
AS.2.6.10		Fast-Time Simulation and Shadow Assessment of Terminal Tactical Conflict Prediction & Resolution Algorithm	10	3	Achieve false alert rate less than 10% and missed alert rate less than 5% for dense terminal airspace.	Publication at a technical conference minimum, journal preferred	Realignment Current
AS.2.6.12		High Fidelity Evaluation of Terminal Tactical Conflict Prediction & Resolution Function	12	4	Acceptable ratings for workload and situational awareness. Achieve false alert rate less than 1% and missed alert rate less than 1% for dense terminal airspace.	Publication at a technical conference minimum, journal preferred	Realignment Current
AS.2.6.13		Initial Scheduling Capability for Static RNAV/RNP Operations using Efficient Descents in Dense Terminal Airspace	7.1	2	For major airports, reduce flight time during descent by 1 minute and enable 75% of arrivals to execute user-preferred descent profile.	Publication (or acceptance for publication) at a technical conference.	Realignment Current

C-2. Current Milestones FY2010 – FY2015

AS.2.6.14		Off-nominal Recovery Methods for Highly-Automated Super Dense Operations	11	3	Reduction of terminal delay in off-nominal scenarios of 50%. Reinsertion of non-conforming aircraft with 90% success before conflict avoidance layer.	Technical conference publication minimum, journal preferred.	Realignment Current
AS.2.6.15		Initial Scheduling Capability for Coordinated Arrival/Departure/Surface Operations for Single Airport	11	4	Degree to which Airspace and Airportal schedulers employ common interfaces for range of data exchange options.	Software code for Airspace and Airportal schedulers employing different (commonly defined) interfaces.	Realignment Current
AS.2.6.16		Initial Scheduling Capability for Coordinated Arrival/Departure/Surface Operations for Metroplex	13	2	Degree to which Airspace and Airportal schedulers employ common interfaces for range of data exchange options.	Software code for Airspace and Airportal schedulers employing different (commonly defined) interfaces.	Realignment Current
AS.2.6.17		Initial Scheduling Capability for Integrated Arrival/Departure/Surface Operations for Metroplex	14	4		Publication at a technical conference	Current
AP.1.C.02		Assess Sensitivity and Accuracy of Current Real-tie Wake Vortex Models and Improve Performance as Needed	10	4	The results define the key parameters needed for assessment of wake prediction and provides quantification of wake motion and decay uncertainty from deterministic wake models in terms of these parameters. Compare model results against LES results and available field data to estimate accuracy of predictions for various aircraft types and realistic ambient conditions. Estimate the range of ambient conditions where vertical shear	Referenceable publication documenting enhancements to fast-time model	Current

					effects may be operationally significant. Target values are not appropriate for this milestone; the intent is to quantify the state of the art in terms relevant to application of wake knowledge to alternate operational procedures.		
AP.1.C.07		Develop New LIDAR Algorithm	11	4	When processed using the new algorithm, LIDAR data from field experiments will provide position and circulation values consistent with established benchmark cases.	New algorithm, or derivative of existing algorithm, for processing LIDAR measurements from field experiments, and referenceable publication documenting quantitative assessment of the accuracy of LIDAR measured position and circulation strength and suggested methods for improving the accuracy of LIDAR data	Current
AP.1.C.08		Develop Improved Fast-Time Model	11	7.1.	Model outputs will be assessed relative to LES results and available field data to estimate accuracy of predictions for various aircraft types and realistic ambient conditions.		Current
AP.1.C.09		7.1.1.1.1.1.1.1.3 Wake and Weath	13	4	Aircraft position, wake location and strength, and relevant atmospheric conditions, such as wind, temperature, and		Current

		er Data Collection for Robust Model Validation			turbulence at various altitudes, will be collected for transport aircraft operations into and out of a selected airport over a twelve-month period.		
AP.1.S.03	7.1.1.1.1.2	Develop and validate surface 4D trajectory model and taxi-clearance monitoring algorithm	11	2	Resulting trajectory model predicts aircraft trajectories against actual trajectories within target tolerance approved by the project PI. Validation of the trajectory model will be performed based on the validation metrics to be developed in the milestone. The initial, largely subjective, validation will be updated in AP.3.S.03 as the performance of conflict detection algorithms using these trajectory models is assessed.	A final report of NRA contract documenting surface trajectory analyses, algorithms for trajectory modeling and conformance monitoring, and performance results.	Current
AS.1.4.05		Develop Probabilistic and Stochastic Methods for Flow Management to Address Uncertainties in Weather Prediction. Metric Used will be Improvements over Current Deterministic Methods	10	4	The probabilistic methods should demonstrate a 10% improvement in the aggregate system delay or other appropriate system measures over deterministic methods.	Conference or journal publication describing probabilistic or stochastic flow management algorithms, concepts, models for managing individual flights or flows of flights in the presence of system uncertainties.	Original Current

AS.1.4.06		Develop Linear/Nonlinear/Dynamic Programming and Decomposition Methods for Advanced Traffic Flow Management	11	4	The decomposition methods are aimed at achieving a real-time planning capability (two minutes for a six-hour planning horizon) for NAS-level TFM problems.	Conference or journal publication describing the linear/nonlinear/dynamic programming and decomposition methods developed in support of this milestone.	Original Current
AS.1.5.01		Alternative Criteria for Minimum Separation Standards	11	2	Number of alternative constructs proposed and evaluated. Reduction in risk and/or increase in capacity associated with a given construct.	At least one technical manuscript written and accepted for publication that meets the research objective as stated in the milestone description.	Original Realignment Current
AS.1.5.03		Analytical Methods to Assess System Response to Failure Events	10	4	Method developed and validated with actual air traffic data in the presence of uncertainties.	At least one technical manuscript written and accepted for publication that meets the research objective as stated in the milestone description.	Original Current
AS.1.5.05		Verification and Validation Methodologies for SA Algorithms and Software	12	2	Code coverage, path coverage, V&V time, V&V cost, software robustness.	At least one technical manuscript written and submitted or submitted for publication that meets the research objective as stated in the milestone description.	Original Current

AS.1.5.08		Verification and Validation Technologies for Analysis of N-Aircraft SA Algorithms	11	2	Number and scope of assumptions required to complete the proof.	At least one technical manuscript written and submitted for publication that meets the research objective as stated in the milestone description.	Realignment Original Current
AS.1.5.09		RCNS Parameter Definition	10	4	Suggested definitions for future CNS performance requirements.	Technical manuscript written and submitted for publication (may be NASA internal).	Realignment Current
7.1.1.1.1.3	7.1.1.1.1.4	7.1.1.1.1.5 Extensions of Analytical and Statistical Techniques for Modeling RTSP Performance Characteristics	7.1.1.	7.1.1.1	7.1.1.1.1.8 Techniques are sufficiently mature to construct parametric models for RTSP for use in modeling and simulation.	7.1.1.1.1.9 Technical manuscript written and submitted for publication.	7.1.1.1.1.10 Realignment Completed C

										urrent
7.1.1.1.1.11	7.1.1.1.1.12	7.1.1.1.1.13	Investigate Scheduling and Rationing Algorithms for Weather Impacted NAS Resources	7.1.1.	7.1.1.1	7.1.1.1.1.16	Decrease weather induced delay by 30%.	7.1.1.1.1.17	Publication at a technical conference minimum, journal preferred.	7.1.1.1.1.18	Original Current
7.1.1.1.1.19	7.1.1.1.1.20	7.1.1.1.1.21	Develop Advanced FMS Guidance and Control Algorithms to Enable Late-term ASDO Operations	7.1.1.	7.1.1.1	7.1.1.1.1.24	Reduce fuel usage during high density terminal operations by 5% while increasing the percentage of aircraft achieving stabilized approach criteria by 5%.	7.1.1.1.1.25	1) ATOL upgraded with eNAV capability by July 2009. (Complete). 2) NASA	7.1.1.1.1.26	Original Curre

						TM or technical conference publication by summer of 2010.	n t

C-3. Milestone Schedule FY2010– FY2015

Appendix C-3 contains the Milestone Schedule for FY2010 – FY2015.

Table 10. Milestone Schedule FY2010 – FY2015

Table removed from External Release Version of Project Plan.

C-4. Key Milestones for FY2010 – FY2012

Appendix C-4 contains a listing of key milestones for each RFA planned for FY2010 – FY2012. The Project tracks key milestones at the Program and Directorate level according to the following designations:

- Critical = Milestones provided by the Project and Program in response to Congressional Questions For the Record 2007.
- PART = Performance Assessment Rating Tool. The PART is OMB's agency performance measurement process.
- IBPD = Integrated Budget Performance Document. The IBPD is NASA's internal reporting document. It is also a section within the NASA Budget.
- APG = Agency Performance Goal. The APG is an element within the Agency Performance Plan.
- HPPG = High Priority Performance Goal. Support Program response to OMB.

Table 11. Key Milestones for FY2010 – FY2012

FY	Milestone Number	TYPE	Center Supporting
10	AS.3.5.17	HPPG	Ames
10	AS.3.5.06	PART, IBPD, APG	Ames, Langley
10	AS.3.4.05	Critical	Ames
11	AS.3.5.09	HPPG	Ames
11	AS.3.5.07	PART, IBPD, Critical	Ames, Langley
11	AS.3.6.11	APG	Ames
11	AS.2.6.07	Critical	Ames, Langley
11	AS.4.4.01	Critical	Ames
12	AS.3.6.06	Critical	Ames, Langley

C-4. Key Milestones for FY2010 – FY2012

FY2010 performance Plan From the FY 2010 Annual Performance Goals (APGs) and Out-year Commitments for the ARMD FY 2010 Integrated Budget and Performance Document (IBPD)

APG 10AT05	Conduct simulations of automated separation assurance with sequencing, spacing, and scheduling constraints. Success Criteria: Green – Human-in-the-loop simulations produce results for air service-provider and flight deck-based concepts using comparable assumptions, scenarios, and metrics. Yellow – Human-in-the-loop simulations produce results for air service-provider and flight deck-based concepts, but the results are not directly comparable (i.e., assumptions, scenarios, and/or metrics are incompatible). Red – Human-in-the-loop simulations produce results for only one concept (either service-provider or flight-deck based). Comparison is not possible. From FY09 IBPD Out-year Commitments: Conduct simulations and analysis of TBM with ANSP-based automated separation assurance From 2007 PART Assessment: Conduct simulations and analysis of time-based metering with service-provider-based automated separation assurance Change rationale: The measure has not changed, but text was reworded slightly.	Airspace Systems (NextGen Concepts and Technology Development Project)

APPENDIX D. ACRONYMS AND ABBREVIATIONS

4D	Four-dimensional (latitude, longitude, altitude, and time)
4D-ASAS	Four-dimensional airborne separation assurance system
AA	Associate Administrator
AAC	Advanced Airspace Concept
ACES	Airspace Concept Evaluation System
AFRL/IF	Air Force Research Laboratory, Information Directorate
AIAA	American Institute for Aeronautics and Astronautics
AOL	Airspace Operations Laboratory
API	Associate Principal Investigator
APM	Associate Project Manager
ARC	Ames Research Center
ARMD	Aeronautics Research Mission Directorate
ARRA	American Recovery and Reinvestment Act
AS	Airspace Systems
ASP	Airspace Systems Program
ASTOR	Aircraft Simulation for Traffic Operations Research
ATC	Air Traffic Control
ATM	Air Traffic Management
ATOL	Air Traffic Operations Laboratory
ASA	Automated Separation Assurance
ATSP	Air Traffic Service Providers
AvSP	Aviation Safety Program
CADOM	Coordinated Arrival/Departure Operations
CAST	Commercial Aviation Safety Team
CD	Center Director
CDM	Collaborative Decision Making
CD&R	Conflict Detection and Resolution
CD&T Project	Concept Development and Technology Project
CFO	Chief Financial Officer
CNS	Communication, Navigation and Surveillance
COMM/OBL/ACCR	commitments/obligations/accruals
COTR	Contracting Officer Technical Representative
CS	Civil Servant
CTD	Concepts and Technology Development
CTFM	Collaborative Traffic Flow Management
DAC	Dynamic Airspace Configuration
DFRC	Dryden Flight Research Center
DOD	Department of Defense
DOT	Department of Transportation
DPI	Deputy Principal Investigator
DST	Decision Support Tools
EFICA	Efficient Flow in Congested Airspace
FAA	Federal Aviation Administration
FACET	Future ATM Concept Evaluation Tool
FAF	Final Approach Fix

EDA	En Route Descent Advisor
FMS	Flight Management Systems
FTE	Full-time Equivalent
FY	Fiscal Year
GDP	Gross Domestic Product
HCI	Human-Computer Interaction
HITL	Human-in-the-Loop
HQ	Headquarters
IADS	Integrated Arrival/Departure/Surface
IEEE	Institute of Electrical and Electronic Engineers
IIFD	Integrated Intelligent Flight Deck
INC	Including
IP	Intellectual Property
IPT	Integrated Product Team
ITA	International Transport Association
ITAR	International Traffic in Arms Regulation
JPDO	Joint Planning and Development Office
JView	software visualization package developed by AFRL
LaRC	Langley Research Center
LNG	Low Noise Guidance
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NextGen	Next Generation Air Transportation System
NPG	NASA Procedures and Guidelines
NPR	National Procedural Requirements
NRA	NASA Research Announcement
NTX	North Texas Research Facility
PARR	Problem Analysis and Resolution Ranking
PBC	Performance-based Contract
PBS	Performance-based Services
PD	Program Director
PI	Principal Investigator
PM	Project Manager
PMT	Program Management Tool
POC	point of contact
POP	Program Operating Plan
PS	Project Scientist
RCP	required communication performance
RNP	required navigation performance
RFA	Research Focus Area
RFI	Request for Information
RSP	Required Surveillance Performance
R&T	Research and Technolgy
RTA	Required Time of Arrival

RTSP	Required Total System Performance
RTT	Research Transition Teams
SA	Separation Assurance
SAA	Space Act Agreement
SAIE	Systems Analysis, Integration and Evaluation Project
SBIR	Small Business Innovative Research
SDO	Super-Density Operations
SESO	Safe and Efficient Surface Operations
SLDAST	System-level Design, Analysis and Simulation Tools
TBD	To Be Determined
TBO	Trajectory Based Operations
TFM	Traffic Flow Management
TP	Trajectory Prediction
TPSU	Trajectory Prediction, Synthesis and Uncertainty
TRACON	Terminal Radar Approach Control
TRL	Technology Readiness Level
URET	User Request and Evaluation Tool
WBS	Work Breakdown Structure
WebTADS	Web-based Time and Attendance System
Wx	Weather
WYE	Work Year Equivalent

APPENDIX E. WAIVERS AND DEVIATION LOG

APPENDIX F. REVIEW COMMENTS AND DISCUSSION

Table removed from External Release Version of Project Plan.

APPENDIX G. CHANGE LOG

Revision	Description of Change	Responsible Author	Effective Date
1.0	Baseline Document	R.Aquilina	11/17/06
2.0	FY2008 Adjustments	M. Landis	6/26/08
3.0	FY 2009 Update. DRAFT	M. Landis	11/26/2008
4.0	FY 2010 Update, Version 3.0	R. Aquilina	5/18/2010