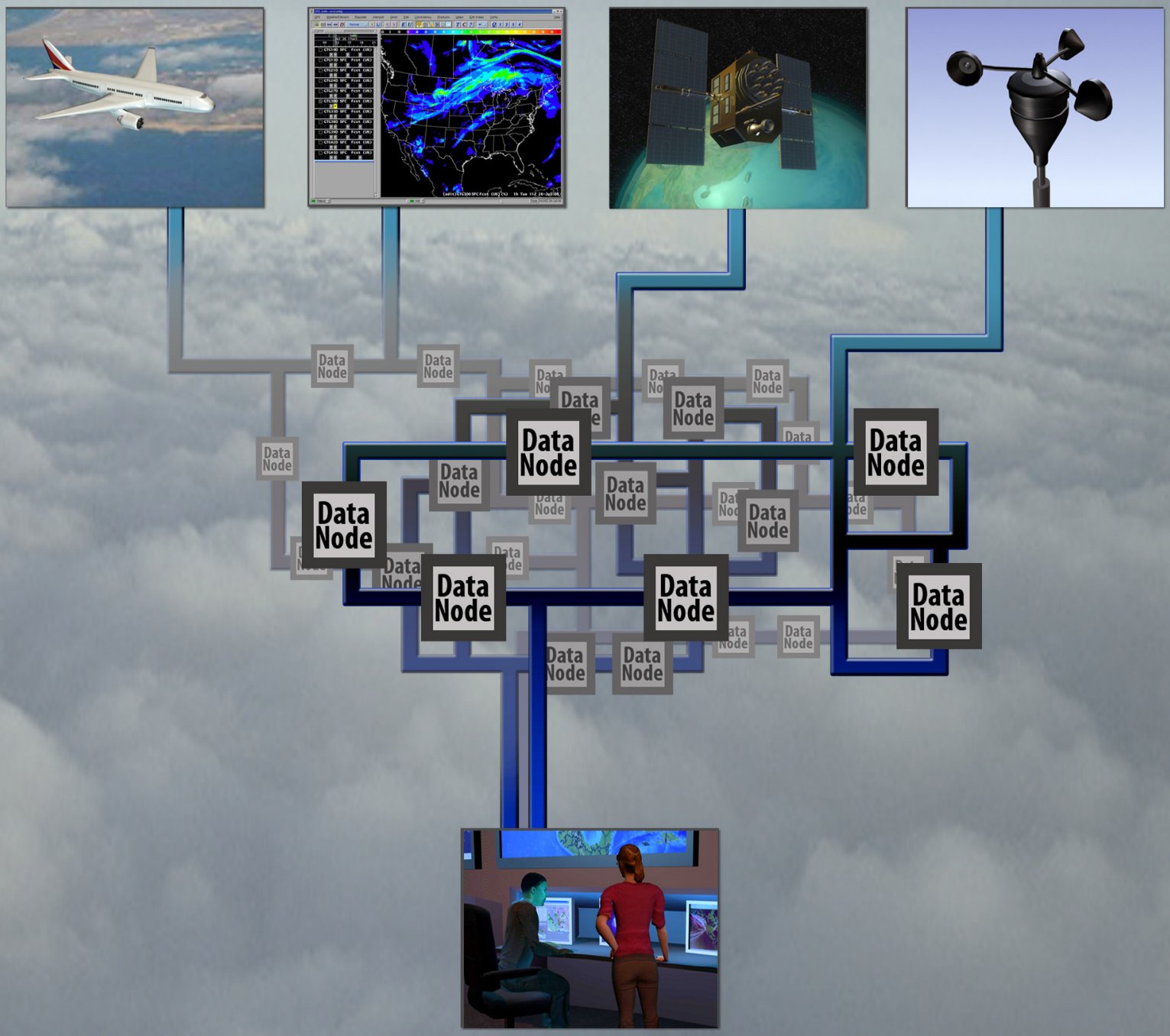
Joint Planning and Development Office

NextGen Weather Plan



Next Generation Air Transportation System
Joint Planning and Development Office

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EXECUTIVE SUMMARY

The NextGen Joint Planning and Development Office (JPDO) and the NextGen partner agencies are planning the evolution of the entire National Airspace System (NAS) from its current state to a completely new concept over the next two decades in order to meet the envisioned demands of its users. Based on the NextGen ConOps v 2.0 and other NextGen documentation, the currently envisioned changes to Air Traffic Management (ATM) capabilities and the operational improvements that will facilitate them will require network-enabled, aviation-tailored weather information. The weather communities within the National Oceanic and Atmospheric Administration (NOAA), the Federal Aviation Administration (FAA), and the Department of Defense (DoD) have developed this Plan to ensure accessible, network-enabled weather information will be available to meet the user's needs. A complementary follow-on effort, to describe a Plan that describes a common weather reference and its translation and integration into evolving operational decision support, will also be developed to support risk mitigation goals for NextGen. The Plans will be merged in 2010.

In the NextGen concept, weather information used by ATM decision-makers will come from a net-centric, virtual, data repository of aviation weather data, referred to as the "four-dimensional weather data cube." This concept allows each agency to leverage and merge their existing agency-specific efforts and aviation-weather requirements into a mutually supportable national and eventually global, construct. This Federal effort addresses a way to combine public and private sector aviation weather needs into the ATM process as well as allowing each agency to maintain various independent capabilities consistent with their own weather needs. A foundational element of this Plan builds upon and takes advantage of evolving information technology advances.

In order to achieve this Plan for weather access and use, the weather community must address certain unmet aviation weather user needs that exist today. If not addressed, many, if not all of these unmet needs will remain during any transitional ATM phase with increasing consequence. End-state ATM capabilities and performance-based goals will be greatly compromised without the envisioned weather infrastructure and support as described in this Plan. In short, weather access and use must change to support more performance-based operations as future NextGen capabilities are realized.

Ongoing, unmet aviation weather user needs include:

- **Weather information content**: Weather information content needs to be increasingly sufficient in terms of accuracy, timeliness, detail, and resolution consistent with the evolving NextGen functional and performance requirements.
- **Weather information availability**: There needs to be consistent and universal (ubiquitous) access to weather information by aviation decision makers and other users.
- **Weather information consistency**: Even when weather information is available it can be inconsistent in content or message. There is a need for weather information parity for more effective collaboration across multiple decision makers.

- **Weather Translation:** There is a need to translate and integrate weather information and its uncertainties within decision support constructs to meet evolving ATM operational missions and NAS user business models.
- **Weather predictability:** NAS users find it difficult to interpret and/or understand and effectively plan using current descriptions of weather uncertainly. There is a need to support ATM resource predictability and availability within the context of weather uncertainty
- **Weather information framework**: There needs to be an informational architecture for weather that facilitates growth, flexibility, and tailoring to support NextGen constructs.

It is proposed in this plan that a 4-D Weather Data Cube will address these user needs and serve as a foundational framework for continued weather access and use in NextGen timeframes.

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1 INTRODUCTION

1.1 Purpose and Scope of Plan

1.1.1 Purpose

One of the key tenets of NextGen is the assimilation of weather information into Air Traffic Management (ATM) decision making. The NextGen Joint Planning and Development Office (JPDO) Weather Working Group developed a Weather Concept of Operations (ConOps) to define this capability. This NextGen Weather Plan documents the NextGen weather concept and identifies the roles and responsibilities of the Government agencies within the National Weather Enterprise for developing an operational NextGen Weather Enterprise. This includes implementing a 4-D Weather Data Cube (also called the Cube), planning for the development and integration of digital weather information into user decision support tools, identification of the policy and governance issues that must be resolved to enable the use of the Cube, and providing a science roadmap to meet aviation weather needs. The initial version of the Plan includes a definition of the work, cost profiles, and timelines to achieve operational status for the Cube.

This Plan has been developed in coordination with industry representation from the NextGen Institute. This Plan provides industry a means to determine their business case to fit into the Next Gen Weather Enterprise based on the Government's plan.

This Plan will be updated to include more extensive sections on integration, policy and a science roadmap.

1.1.2 Scope

This document describes the management structure, tasks, and metrics that will be used to field the initial operational capability (IOC) of the Cube. This document also describes the policy and procedural issues that must be clarified or changed before network-enabled weather can be fully utilized in the National Airspace System (NAS). This document lays out the foundation for future Cube capabilities in an aviation weather science roadmap. A complementary follow-on effort, to describe a Plan that describes a common weather reference and its translation and integration into evolving operational decision support, will also be developed to support risk mitigation goals for NextGen. The Plans will be merged in 2010.

1.2 NextGen Weather Management Structure

The JPDO Board designated the NextGen Executive Weather Panel (NEWP) to act as the primary policy and decision-making body for issues related to NextGen Weather. The NEWP consists of the FAA ATO Senior VP for NextGen and Operations Planning Services; the NOAA

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Assistant Administrator for Weather Services; the Air Force Director of Weather; the Oceanographer of the Navy; the National Aeronautics and Space Administration (NASA) Director of Airspace Systems Program Office; and the Director of the JPDO. If, in the unlikely case this panel is unable to resolve any particular issue the issue would be elevated to the JPDO Board and/or Senior Policy Committee.

The NEWP is facilitated by the JPDO Weather Working Group co-chairs and the Executive Committee (EC). The JPDO Weather Working Group has Government and Industry co-chairs and the EC is composed of agency leads and industry reps, as well as the Government and industry co-chairs of the various Weather Working Group teams. (See Figure 1-1.) The Weather Working Group has five standing teams: the System Engineering Team, the Policy Team, the Weather Integration Team, the 4-D Weather Data Cube Team, and a Test/Demo team.

In the summer of 2008, the NEWP agreed on agency roles and responsibilities for Government NextGen activities. The two primary activities are the provision of net-enabled weather information and the application of the weather information in NextGen activities.

- NOAA is the lead for the development and implementation of the provision of net-enabled weather information, with the FAA, DoD, NASA, and Industry playing significant contributing roles.

- FAA is the lead for the integration of net-enabled weather information into air traffic management decision making, with the NOAA, DoD, NASA, and Industry playing significant contributing roles.

Consistent with the responsibility of the designation of "lead," it is anticipated that the NOAA and FAA will provide a significant amount of the funding required for the development and implementation of their respective lead tasks. Other agencies will identify relevant funding or internal programs which would complement the development and implementation activities and agree to allow the "integrated plan" to define tasks and preferred priorities for those particular funds.

The NEWP will approve on a recurring (at least annual) basis this NextGen Weather Plan, which will contain implementation timelines, identification and definition of critical milestones, and updates to the agreed upon roles and responsibilities contained in this document.

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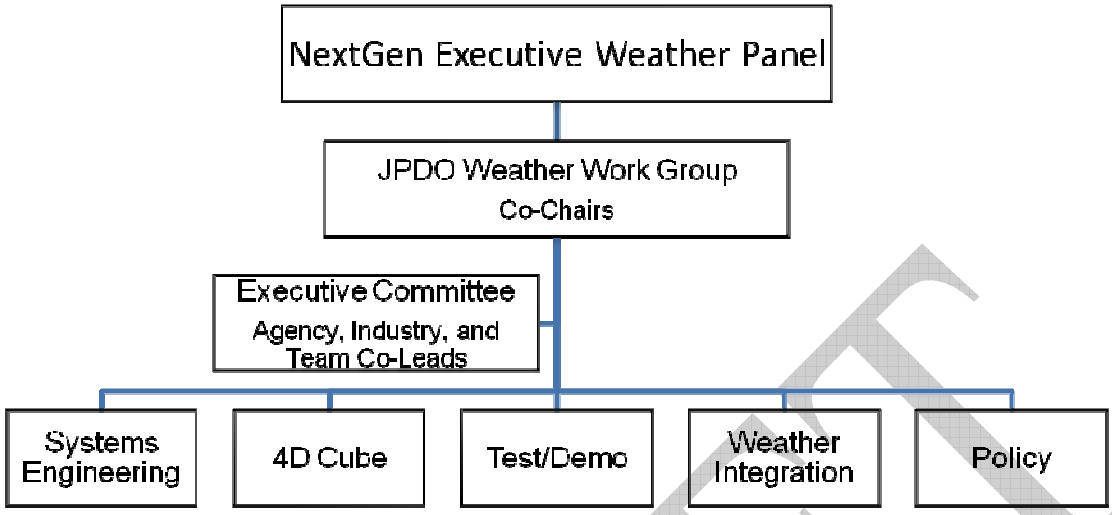

Figure 1-1 NextGen Weather Management and Governance Structure

1.3 Major Data and Information Sources Used

This plan used the following documents as references

a. Final Report of the Commission on the Future of United States Aerospace Industry
b. Vision 100 - Century of Aviation Reauthorization Act (P.L.108-176)
c. Next Generation Air Transportation System (NextGen) Integrated Plan
d. Next Generation Air Transportation System Weather Concept of Operations v1.0
e. NextGen ConOps v2.0
f. NextGen Integrated Work Plan v1.0
g. NextGen Business Case v1.0
h. 4-D Weather Functional Requirements for NextGen Air Traffic Management v0.1
i. NextGen Enterprise Architecture – Draft Weather Segment

1.4 Problem Statement

Today's national air transportation system is susceptible to weather disruptions causing flight delays, the impacts of which can be widespread. Fast moving summer or winter storms impacting one hub airport or key transcontinental route can ground aircraft thousands of miles away, further propagating flight delays and cancellations. Weather delays are more than an inconvenience; they cost the nation's airlines, cargo carriers, and corporate and private users in excess of $4 billion annually. While severe weather will likely continue to prevent airspace and airport access in the immediate vicinity of the event, many delays could be avoided with more proactive ways of dealing with weather throughout the national air transportation system. The current ATM system and supporting decision making tools are primarily reactive to weather events and are ineffective in implementing the NextGen vision.

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In the current system, weather information is not integrated into the ATM process. Many weather tools are added to ATM systems after the fact and are not integrated well. This requires interpretation by the controller who must manually integrate this information into traffic decisions based on his or her understanding of the information presented. The weather data provided by these systems may not be provided in a manner that is useful in human-made traffic-flow decisions. Automated systems, many of which are designed around fair weather scenarios, must be shut down when significant weather impacts operations. This lack of automated tools during weather events necessitates a cognitive, reactive, inefficient weather-related decision-making process and a meteorological competency on the part of decision makers during the times of greatest need for automated assistance. What results is a manual interpretation of potential weather impacts and perception based largely on experience for the determination of "best data source."

In some cases, current ATM processes ignore weather forecasts; claiming the weather forecast is not accurate or consistent. Where processes disregard weather data, this often can be traced to the fact that the present weather data system is a collection of diverse, uncoordinated observations, forecasts and supporting systems. Indeed, today a weather system infrastructure that adequately supports the timely and collaborative air transportation decisions does not exist.

There is a need to develop a multi-agency, synchronized plan to achieve solutions to these problems. As articulated in the NextGen vision, the solution must enable decision makers to identify areas where and when aircraft can fly safely with weather assimilated into the decision-making process in order to optimize the entire national airspace system. The NextGen Weather Plan provides the initial scope and implementation roadmap to address requirements to achieve the NextGen weather vision. It also addresses agency roles and responsibilities and includes resource requirements.

1.5 Concept of NextGen Weather

The NextGen Weather Plan is a multi-agency, synchronized plan that optimizes resources and creates a synergy that promotes more rapid and effective implementation. The execution of this NextGen Weather Plan will put into place a proactive system better able to address and limit the impact of weather.

In the NextGen Enterprise, weather information, including its future uncertainties, will be integrated into Flight Management Systems, as well as NAS automation and decision-support systems to support safer and more efficient flight and a more proactive reduction of air traffic delays by balancing demand with system capacity. This translates into user cost savings and air transportation system efficiencies.

The new paradigm promotes sharing weather information, not data. It replaces the use of individual and potentially conflicting weather products with network-enabled common weather information that supports a common situational picture. Enhanced tailored, probabilistic weather information that has been translated and integrated into NAS automation and decision-support

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systems enables users and service providers to more precisely identify specific weather impacts on operations (e.g., trajectory management and impacts on specific airframes, arrival/departure planning) to ensure continued safe and efficient flight. NAS automation tools use integrated weather information (including uncertainty), demand information, and other capacity constraints to analyze the integrated information picture. The results of this analysis allows users and service providers to select from among proposed mitigation strategies to balance demand to available capacity, both strategically and tactically. These strategies will be less disruptive (e.g. fewer flights rerouted) because the definition of the weather-impacted airspace will be more precise in extent and timing, based on enhanced weather availability including enhanced weather observations and forecasts, including probabilities. Automation will exist on both the user side and the Air Navigation Service Provider side, and will be linked to enable automated negotiation of these proposed strategies. The availability of enhanced weather information integrated with automated decision-support tools will be increasingly extended to the cockpit to ensure safety and maintain flight efficiency.

1.6 Alternatives Considered for Providing Weather Information

The NextGen Weather ConOps team recognized the need to look at improving the weather information infrastructure before it could be incorporated into the ATM decision-support processes. This section briefly discusses the four weather data architectures considered during the development of the NextGen ConOps. The emphasis of this discussion is on the Cube itself. The network infrastructure that will distribute this information is considered separately.

Alternatives	Description	Feasibility	Ability to deliver NextGen vision
Status quo – do nothing	Maintain separate architectures and costly point-to-point communication solutions. The data are neither deconflicted nor net-centric.	Green	Yellow/Red
Update all systems to a single existing weather system design	Upgrade all of the various weather systems to match one of the existing weather data distribution systems.	Red	Yellow/Red
Develop a new weather data architecture from scratch	Start with a clean sheet of paper and convert the architectures of all agencies to this architecture. This option would meet NextGen requirements, but would be the costliest, involve the most implementation risk, and would unnecessarily replace existing	Red	Green

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	architectures.		
Develop a new weather data distribution architecture, leveraging net-centric standard and existing architectures	Leverage net-centric standards and incorporate legacy architectures. This option overcomes the deficiencies of the other alternatives, meets all NextGen goals and requirements, is the most cost effective, and involves acceptable implementation risk.	Green	Green

Table 1-1 Alternatives Considered for Providing Weather Information

1.6.1 Status Quo - Do Nothing

The baseline, multi-agency weather data processing, access, and dissemination architecture consists of multiple distributed processing systems collecting sensor data and producing value-added analysis and forecast products. Organizations access the data by arranging with managers of weather processing systems and agency telecommunication systems for point-to-point transport of the weather products. Some data are also available via access to special web pages (e.g., Aviation Digital Data Service [ADDS]). The status quo is an unacceptable option because it involves diverse architectures, technologies, and standards; it does not meet numerous NextGen requirements (e.g., publication/subscription registry, push/pull access, tailored information, and a single authoritative source (SAS) of weather information); and point-to-point dissemination is a costly option, resulting in critical information being unavailable to all stakeholders.

1.6.2 Update All Systems to a Single Existing Weather System Design

The second alternative considered is to upgrade all of the various weather systems to match one of the existing weather data distribution systems to meet NextGen needs. This alternative was determined to be problematic, costly, complex, and risky. Here are several examples. The exclusive use of the DoD's virtual Joint Meteorological and Oceanographic (METOC) Data Base (JMDB) to be the NextGen architecture, would involve major (and perhaps insurmountable) data standard issues for non-military users, as well as issues involving multi-mission focus and priorities. ADDS currently makes weather forecasts, analyses, and observations available to aviation stakeholders via the internet; however, ADDS may not meet the reliability, scalability and security for NextGen. NOAA's National Digital Forecast Database (NDFD) is altitude limited (i.e., surface to 5,000 feet) and does not meet the goal of the Commission on the Future of the US Aerospace Industry to provide "high-resolution weather forecasts creating 4-D (space and time) profiles, accurate for up to 6 hours for all atmospheric conditions affecting aviation, including wake vortices."

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1.6.3 Develop a New Weather Data Architecture from Scratch

The third alternative considered a new architecture that would start from a clean sheet. It would include centralized weather data processing, publication, and access. This option would meet NextGen requirements, but would be the costliest, involve the most implementation risk, and would unnecessarily replace existing architectures.

1.6.4 Develop a New Weather Data Distribution Architecture, Leveraging Net-Centric Standards and Existing Architectures

The last alternative is to develop a new, weather-data distribution architecture by heavily leveraging net-centric standards and incorporating legacy architectures. By leveraging net-centric data sharing standards such as the Joint METOC Brokering Language (JMBL) and the Open Geospatial Consortium (OGC) standards across multi-agency architectures the views and needs of different communities can be better accommodated. The FAA, NOAA, and DoD were already moving toward this service oriented architecture. This option overcomes the deficiencies of the other alternatives, meets all NextGen goals and requirements, is the most cost effective, and involves acceptable implementation risk. It also allows for the provision of current regulatory weather products (e.g., convective Significant Meteorological Information [SIGMETs]), while policy is changed to transition the NAS from a "product" to an "information" environment. This option includes distributed data processing, with centralized publication/subscription, using much of the current baseline architecture; and develops a single authoritative source of weather information for collaborative decision making.

1.7 Recommended Solution

1.7.1 New Infrastructure for Providing Weather Information: 4D Weather Data Cube

The JPDO Weather Working Group decided to follow the lead of several agencies and selected the fourth alternative - Develop a New Weather Data Architecture, Leveraging Net-Centric Standards and Existing Architectures for implementation. This solution became known as the 4-D Weather Data Cube within the NextGen community and referred to as the Cube within this document. Section 2 of this document describes the Cube implementation plan with more program specifics found in the appendices. Version 1.0 of this document includes the program plan to meet the Initial Operational Capability (IOC) in 2013. Future versions will include development plans to meet NextGen requirements out through 2025.

The Cube contains all public domain, unclassified, domestic weather information relevant to aviation decision making including human and machine-derived observations (ground, air or space-based), analyses, and forecast products (text, graphic, gridded, machine readable), model information, and climatological data. Foreign, proprietary/private sourced products are also included.

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The information in the Cube will be tagged to allow users to access the necessary information required to complete a task (flight planning, reroute, fuel load, etc). This tagging will also facilitate redundancy and transition from legacy Agency platforms

Cube weather data will be archived as driven by user need and regulations

1.7.1.1 Weather Information Network Functionality

Technologies now exist to develop and provision (e.g., sustain an implementation) the described 4D Weather Data Cube via a weather information network (WIN). The WIN is an architecture of network-enabled enterprise services that consists of a series of weather collection servers or databases containing weather information from Government and Industry suppliers (e.g., National Weather Service (NWS), other Agency processing facilities, research or laboratories, etc) that are distributed and networked across multiple locations. The locations are based, in part, on the ability to leverage or optimize current or planned capabilities at these facilities to collect, process, store, archive, and disseminate weather information. The individual (remote) weather information locations together with the WIN comprise the Cube.

In essence, some portion of a "weather network" already exists – facilitated by the Internet – where users 'browse' and 'request' weather information (e.g., from different NWS Weather Forecast Offices, private vendors (WeatherBug), etc). However, the WIN is a much more robust network and contains functionality that partitions access (e.g., for premium commercial services, etc.), allows data search/query and manipulation, facilitates an information 'smart push or pull' based on weather thresholds driven by regulation, aircraft performance, user preferences, or other safety critical triggers, archives data as per user need and regulation, etc.

Such a network facilitates information sharing in broader, more timely and consistent ways among differing groups of users (e.g., AOC and TFM, Pilots and ATC, etc.), applications, and user service or decision support platforms during each transitional phase of NextGen. The networked information is secure, distributed, and easily expandable to accommodate increased performance requirements (e.g., larger volumes, greater complexity, higher fidelity weather data for automation ingest, low latency information for immediate user response, etc.) or enlarged user base. It enables situational awareness among local and between remote decision makers. It enables collaboration and shortened decision cycles.

Information sharing among users is standardized (protocols and formats that are universally acceptable) with controlled exchange structure and services. This facilitates communication and collaboration across time and space boundaries to achieve common mission objectives. This also supports evolving standards and protocols and is independent of the underlying communications infrastructures.

The Cube will contain and the WIN will provide data for that data domain in which a user or decision support tool has requested data and the user is authorized to receive that data. This includes the ability to separate, restrict or protect access to certain kinds of information, such as proprietary or private vendor weather data/products, or based on user (pilots, dispatch,

controllers, marine, space, etc.) and Agency (DoD, Department of Commerce [DOC], Department of Transportation [DOT], etc.) business rules and service needs.

1.7.1.2 Single Authoritative Source (SAS)

The two most important features of the WIN is that it 1) facilitates the development of a source for common weather, and 2) facilitates the integration of common weather into aviation decision support tools and platforms.

1.7.1.2.1 SAS Common Weather

Because all the weather information is linked via the WIN, techniques can be developed to de-conflict the disparate observations, analyses, and forecasts contained across the Cube to achieve a common current and future state of the atmosphere for NextGen Air Traffic Management decision making.

The 4-D Weather SAS definition is the weather information that supports NextGen ATM aviation decision making. It is one or more 4-dimensional grid(s) of aviation-specific observations, analyses, and forecasts organized by 3-D spatial and time components (x, y, z, t) that extends from the surface to low earth orbit. To enable a common weather operating picture and enhance collaboration, the SAS provides a single value at each grid point that is the 'best representation' of a weather element (e.g., wind speed and direction, runway visual range, turbulence, etc.).

The SAS is a subset of the weather information available from the NextGen network enabled Cube. Much of this distinct subset is derived from other weather information residing in the Cube and is designed specifically to provide common weather situational awareness, foster improved collaboration among users and air navigation service providers (ANSP), and support NextGen decision making. This aviation specific representation of current and future states of the weather is accomplished through methodologies to fuse (or merge) the various observations and forecasts contained in the Cube.

The SAS contains weather elements that are focused towards all aviation communities; the SAS content is consistent with the time and performance attributes important to operational aviation users and their decision support tools. The SAS content includes probability of occurrence forecasts for weather parameters determined to improve operational decision making. Although the SAS will be the source of weather information used to produce aviation alerts, advisories, and warnings associated with significant and potentially hazardous changes in the weather, these derived products will not be contained in the SAS.

The SAS information is consistent because it provides the common reference source of aviation focused weather. SAS information is available to all National Airspace System (NAS) participants via network enabled mechanisms, under open and unrestricted data rights.

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1.7.1.2.2 Facilitating Integration: SAS Weather into Operations

Of particular operational importance, the WIN network-enabled enterprise services will prepare and deliver the SAS weather information in a format ready for integration into aviation decision support systems – a tenet for a successful NextGen implementation. In NextGen, SAS weather information will be integrated into the users' decision supports tools that will apply the user's specific thresholds to alert the user to potentially adverse weather and determine the risk to the user's operations.

To meet these integration needs, the NextGen weather ConOps utilizes the SAS concept to create a new way of looking at the role of weather in aviation. The focus of this new paradigm is on common weather "information" that can be easily understood by users and eventually be integrated with automation tools. This is in contrast to the current use of "products" that are often inconsistent and must be manually interpreted by decision makers. To meet this new paradigm, the NextGen weather domain authority determines the SAS content and eliminates the need for decision makers to choose among potentially competing/conflicting weather "products". SAS information is quality controlled by the appropriate and respective domain authority(s) and approved for use in Air Traffic Management (ATM) decisions and regulatory use; therefore it will be the primary source of weather information used by the Government, as well as by operational participants in joint, collaborative Government/user decision making discussions and processes in NAS operations.

Although the SAS is defined as the foundational source of aviation weather information, it should not be viewed as the sole source for the aviation industry. Industry and aircraft operators are not obligated to use the SAS and may choose to employ other weather information, if they feel it better fits their business model; however, this would be a departure from the collaborative decision making process. As an example, flight and flow management will become increasingly difficult if alternate weather predictions are used for decision making.

The SAS, and its integration into Decision Support Tools (DST), supports several required NextGen capabilities for capacity management, trajectory management, flow contingency management, separation management and improved surface operations. As an example, for strategic timeframes, common weather supports the assignment of traffic flows that best achieve capacity balance, safety and end user desires. It effectively allows traffic flow plans to be developed based on a consistent analysis of weather as well as the common understanding and uncertainty of the future state of the atmosphere.

As described, the SAS will be a valuable yet crucial tool for NextGen operations. The common weather picture will greatly improve collaboration between users and ANSPs to enhance the ability to apply risk management to reduce the impact of weather on their operations. The SAS will enhance the ability to make unified aviation decisions and manage the strategic and tactical plans required to meet NextGen NAS needs.

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1.7.2 Weather Integration

Today, the collection of diverse, uncoordinated weather observations, forecasts and systems does not support the growing need for "information, rather than data" to support timely and collaborative air transportation decision making necessary to avoid bad weather. Additionally, the manner and methods of the actual decision-making process involving weather information is not well developed to support the NextGen concept. In the previous section, the initial solution to the Problem Statement described how the Cube will be designed and built to form the set of weather information that NextGen will use. This is the precursor to the second part of the solution to the Problem Statement that necessarily involves what is termed "weather integration." The Weather Integration Phase, herein referred to as "Integration," is an overlapping phase in the Weather Plan in which weather information developed in the Cube is used in decision-support tools, models, algorithms, and so forth to achieve one of eight key capabilities established in the NextGen ConOps, "Weather Assimilated into Decision-Making."

Integration is the action of taking weather information from the Cube and using it in sophisticated decision-support tools that will, among other things, enable trajectory-based operations (TBO) and high density operations. TBO is a major transformation in NextGen and is the main mechanism for managing air traffic in high density or high complexity airspace. A major element in calculating optimum trajectories is knowing where weather phenomena are located, their intensity, their movement, and so on. A lack of weather information puts TBO at significant risk, particularly when convective weather is present. Integration incorporates weather information into the decision-support tools that formulate the most efficient air traffic routing solutions and continually account for inherently dynamic weather phenomena.

Integration also allows NextGen stakeholders to make informed decisions affecting a variety of other operations, such as ground refueling, snow removal, or maintenance activities. As operations models are refined and synchronized with air traffic flow management, they depend more and more on timely and accurate weather information. As the Cube develops, there is a natural progression toward incorporating this weather information into more sophisticated decision-support tools that continue to optimize resources for these operations.

While integration is considered a key phase in the execution of this Plan, there is much work that must be done to understand and develop the tools to actually use the Cube's information efficiently and effectively. As articulated in the ConOps, NextGen will move toward automation in its pursuit of decision-support tools.

Currently, the FAA is the lead agency charged with developing integration tools. The FAA's NextGen Implementation Plan (NGIP) includes the Reduce Weather Impact (RWI) Program. Activities in the near term will focus on: developing a concept of use and initial requirements for weather dissemination; preparing for and conducting a weather dissemination interoperability demonstration; developing a concept of use and requirements for weather information needed by manual and automated traffic management and cockpit decision-support tools; assessing gaps and redundancies in the current aviation weather observation networks; development of a weather radar replacement; and development of improved forecasts (e.g., convection, turbulence, icing).

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The FAA has a budget to develop the Weather Integration Plan. This JPDO Weather Working Group will incorporate the Weather Integration Plan into the NextGen Weather Plan in 2010.

While the Cube is being developed, the Weather Integration Team will address the issue of assimilating weather into the ATM decision-making process. The team is comprised of experts from the weather community, pilots, air traffic management, airports and other NextGen work groups. They are developing a separate plan for integrating weather into automation and decision-supports systems. The team is reviewing the FAA NGIP, the JPDO NextGen Integrated Work Plan (IWP), and other research plans to identify insertion points for integrating weather into operations. The team will work with operators and automation developers to understand their needs and recommend specific, weather-diagnostic tools for integration into operational systems.

1.7.3 Updates to Operational Policies and Procedures

The Cube concept and integration of weather information into the ATM decision-support process introduces three additional areas requiring planning—governance of the Cube, updating existing policies and regulations pertaining to weather requirements for flight safety, and coordinating the research and development for future capabilities to meet NextGen end-state requirements.

A governing body is required to regulate and manage the operational Cube for weather providers and users. The governing body will have the capability to add, delete, or change database locations, content, and functionality as driven by future agency capabilities or as required by future user needs. The governing body will develop policies regarding standards and Cube access requirements.

Current aviation regulations, applications, and services that require weather information will need to be supported. The Cube, at IOC will contain weather information from legacy (current) observational and system ground, air, and space-based sources. This will include information from supporting Agency weather radars, weather satellites, aircraft (on-board sensors and pilot reports), weather products (aviation-centric and otherwise) in traditional alpha-numeric forms, surface observations, model outputs, and forecast products. The Cube will also contain weather information from outside of the Continental United States [CONUS] (e.g., Canada, Caribbean, etc.).

Section 3 of this document will describe the governance and policy plan. It will be incorporated into the Plan in a future version.

1.7.4 Plan to Meet NextGen Requirements Beyond IOC

In order to support NextGen initiatives, the weather information collected and contained in the Cube will change throughout the development of NextGen. The IOC for the Cube will consist, primarily, of current weather data required for flight safety available via a net-centric

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infrastructure. In future spiral developments, the Cube will eventually expand the breadth of its data to include weather information from the Earth's surface up to an altitude of 500 kilometers (low Earth orbit). Additional sensor, model, or forecast information, including improvements in accuracy, update rate, resolution, etc, will become incorporated. The Cube will contain associated analysis and forecast probabilities for user-defined decision-support and other automated tools. Finally, specific weather information for other Agency needs (e.g., fire weather, emergency management, highway transportation) will be incorporated into the Cube as the needs are realized.

The agencies and industry will need to conduct extensive R&D to meet many of the future NextGen requirements. Section 4 of this document will describe the coordinated science roadmap to meet these requirements. By developing this Plan during the initial IOC development phases, the R&D can be directed to meet future, spiral developments of the Cube and meet integration requirements. Section 4 will be incorporated in a future version of this document.

1.8 Anticipated Benefits and Impact

Many of the 4D Weather Data Cube benefits directly support the FAA Flight Plan and the capability required to provide increased capacity and margin of safety in the face of large anticipated increases in demand. Some of these capabilities will be dependent on the net-centric access of weather information, improved weather observation and forecasting capabilities, and the development of a common weather picture and the integration of that weather information into operational DSTs. to support specific trajectory based operations and improve optimal routing and re routing.

1.8.1 Net-Centric Benefits

The Cube enables the point-to-multipoint, networked access of observational and forecast weather information by all NextGen users, service providers, military planners, security personnel, and the flying public, of observational and forecast weather information from the distributed sources. The 4-D Cube will enable net-centric access by system users to consistent tactical and strategic level weather information. The Cube will also employ Networked-Enabled Operations (NEO) compatible data management techniques to enable information to be accessible across varied space and time scales. Changes to weather information will be rapidly disseminated and all categories of weather users will have improved access to timely and accurate flight information at their homes, businesses, airports, and in the air to support improved decision making for increased capacity and enhanced safety.

These benefits will drive ancillary improvements in the detection, lead time and provision of weather information. These include, but are not limited to improvements in weather sensing capability (e.g., a more complete, operationally relevant, consistent, and cost effective measurement of the atmosphere), which is required to provide better aviation-tailored analyses and forecasts in time and space, and the universal and common access of that data, information, and knowledge by all users. Aviation driven high resolution modeling requirements will

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additionally enable NOAA to produce more accurate public forecasts.

1.8.2 Common Weather

Common weather data, information, and knowledge will enable pilots and aircrews to engage in shared situational awareness and shared responsibilities with controllers, dispatchers, flight service station specialists, and others, pertaining to safety and efficient preflight, en route, and post flight aviation decisions involving weather. Such common weather information, integrated into controller decision support tools, will improve the efficiency of controller decisions and greatly reduce controller workload during unfavorable weather.

1.8.3 Reduced Costs

The Cube proposed solution eliminates need for unique interfaces to support access to duplicate weather information Additional benefits are realized from reduced costs by use of weather data access /format open standards and common weather data base. This facilitates the reuse of weather data access software documentation and code, greatly streamlines software update and change management strategies, and reduces communications lines required by weather data subscribers

1.8.4 Multi-Agency Benefits

In the end-state, the 4-D Cube will benefit from complimentary agency research and development focused on improved numerical weather prediction, aviation hazard prediction/detection, automated decision rules, and net-centric weather data standards.

NOAA will use the Cube technology to improve access to all NWS products and services via their portion of the Cube. The increased availability of networked weather information supports automated decision assistance tools for other agencies and entities beyond FAA.

IT and Data Management enhancements required by the Cube will allow NOAA to establish a virtual repository and access for critical NWS products and services beyond aviation. It also extends the AWIPS enterprise services into a ‘system of systems’. These two enhancements will support GEOSS requirements and enhance continuity of operations for NOAA. Finally, the idea that one could “data mine” information that was tied spatially and temporally to a common datum or frame, allows for truly coordinated decision making between and within Agency users.

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2 NEXTGEN 4-D WEATHER DATA CUBE IMPLEMENTATION PLAN, COST ESTIMATE, AND RISKS

2.1 Management Structure Required to Develop and Deliver the 4-D Weather Data Cube

The Weather Working Group Board of Directors established the NextGen 4-D Weather Data Cube Team to coordinate the efforts of the agencies and avoid the duplication of Cube programs. This team consists of NOAA, FAA, DoD (USAF), and Industry representatives. Under the Cube Team are two sub-teams focusing on specific aspects of the Cube: the Environmental Information (EI) Team and the Information Technology (IT)/Enterprise Services (ITES) Team. The Cube management structure is illustrated in Figure 2.1. While there are agency and industry specific leads for each sub-team, all of the agencies are participating. Appendix E contains a list of agency and industry representatives for each of the teams.

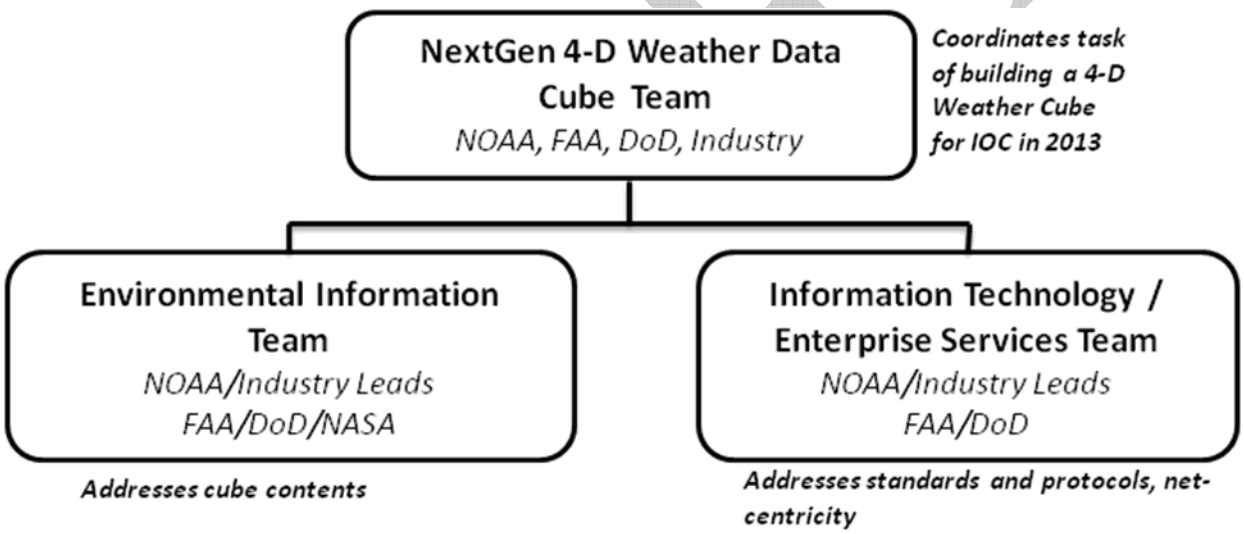

Figure 2.1: 4-D Weather Data Cube Management Structure.

For planning purposes there are three main periods for development and implementation of the Cube capability:

- Near Term (2009-2013) – Initial Operational Capability (IOC)
- Mid Term (2011-2018) – Mid-Term Operational Capability (MOC)
- Long Term (2016-2023) - Full Operational Capability (FOC)

The Cube Team developed a Work Breakdown Structure (WBS) for the development and implementation of an IOC Cube for this NextGen Weather Plan, v1.0. It is anticipated that the Cube Team will update the WBS to reflect any new tasks from the JPDO sponsored Weather Integration Plan, the JPDO Net-Centric Division work plan, and the maturity of the NextGen concepts.

The following sections will cover the overarching assumptions, major WBS tasks and timelines, and the risks involved in developing and implementing the IOC Cube. The detailed tasks outlined in Section 2.5 are found in Appendix C. The estimated costs are found in Appendix D. The public version of the NextGen Weather Plan will not include Government budgetary information due to its pre-decisional status.

2.2 Scope

The initial version of this portion of the Plan will outline the high level tasks that must be completed to develop the operational Cube. These tasks will be allocated to the agencies. Agency budgets and program plans will be compared to see they are commensurate with the level of tasking. Future versions will extend focus onto the integration and governance portion of the Plan.

2.3 Assumptions

Assumptions made for the IOC Cube in this Plan are:

a. Once the Cube Team develops and delivers requirements, the organizations responsible for obtaining the network infrastructure will ensure that the network infrastructure and throughput necessary to support the sharing of Cube data will be operationally available at IOC.
b. Agency funding will match this Plan.
c. Agency Science and Technology roadmaps will align with this Plan.
d. The NextGen Integrated Work Plan (IWP) will be updated to match this Plan.
e. The *4-D Weather Functional Requirements for NextGen ATM* document will be validated by the operators and decision makers.
f. Implementation dates for IOC, MOC and FOC are 2013, 2016, and 2022, respectively.
g. The Net-Centric Operations Division will define an architectural framework that will be compatible with the architecture being defined by the activities within this plan.
h. The Net-Centric Operations Division will define an inter-agency security framework with sufficient lead time to be implemented by IOC.

2.4 Methodology

The Cube Team started the Cube planning by requiring all the team members to become familiar with the existing JPDO NextGen documentation as well as their respective agency's or employer's plans for NextGen. Based on this knowledge, the first task was to define IOC for the Cube.

IOC definition and plan

- The Cube Team divided the work between the teams to develop thresholds and objectives
- The Cube Team and sub-team leads developed tasks to meet IOC requirements
- The Cube Team organized the tasks into a WBS along with required management activities into this NextGen Weather Plan (Appendix C)

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- Annual demonstrations and reviews, as well as providing regular updates to the NEWP will provide opportunities to refine this plan
- The EI team focused on the data content for the Cube to include a subset identified as an initial SAS capability
    - The EI team
        - Compiled a lengthy list of products that are either currently in the inventory for the IWP parameters or are well along in the R&D process.
        - Determined the IOC Cube data and product thresholds and objectives based on FAA stated requirements for IOC
            - Threshold - committed to providing that product or dataset in a net-enabled fashion at IOC
            - Objective – data or product will be considered but not promised for IOC or beyond. The reason for leaving a product or data set as Objective may be that it is not sufficiently mature in the R&D process to expect it will be operational at IOC.
        - Determined the data and products needed to meet current regulatory requirements
        - Determined which intermediate products are needed to meet a proposed IOC solution
        - Will review list annually to ensure the right data will be in the Cube to meet the requirements
- The ITES Team focused on the IOC infrastructure
    - ITES team drafted an IT ConOps based on use cases to help define IOC
    - Determined the IT thresholds and objectives
        - Threshold
            - Ability to exchange data between systems
            - Respond to requests
            - Support publish and subscribe
        - Objective
            - Support complex retrievals and calculations
    - Annual reviews and demonstrations will refine these goals over time

2.5 Program Plan

The WBS activities to reach IOC are shown in Figure 2.2. This schedule does not show all activities; lower level activities are rolled up to the first major sub-level. This section will describe the major tasks of the WBS: (1) Program Management, (2) IT Services, (3) Cube Contents, (4) IOC SAS, and (5) IOC. The high level tasks are broken down and described in Appendix C. The schedule of the activities described in Appendix C is shown in Figure 2.3.

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WBS Element	Task Name
1	**Program Management**
1.1	4-D Weather Data Cube IT Conops
1.2	Operational Requirements
1.3	Governance
1.4	Program Management Plan
1.5	Risk Management Plan
1.6	Configuration Management Plan
1.7	Integrated Science Roadmap
1.8	Definition of IOC Content
1.9	Investment Analysis
2	**IT Services**
2.1	Architecture
2.2	Services and Format Standards
2.3	Software Development
2.4	Security
2.5	Latency and Performance Analysis
2.6	Efficient XML Technology
2.7	Demonstrations
2.8	Procure-Deploy HW-SW
2.9	OT&E
3	**Cube Content**
3.1	Element R&D
3.2	Contents Tool Production
3.3	Element Transition to Operations
3.4	Forecast Process
3.5	Verification
4	**IOC SAS**
4.1	SAS Concept
5	**IOC**
5.1	IOC

Figure 2.2 High-Level Work Breakdown Structure

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WBS	Task Name
1	Program Management
1.1	4-D Weather Data Cube IT Conops
1.2	IT Requirements
1.3	Governance
1.4	Program Management Plan
1.5	Risk Management Plan
1.6	Configuration Management Plan
1.7	Integrated Science Roadmap
1.8	Definition of IOC Content
1.8.1	Sources of IOC Content
1.8.2	IOC Content Definition
1.9	Investment Analysis
1.9.1	FAA Investment Analysis
1.9.2	NWS Operational Services Improvement Processes (OSIP)
2	IT Services
2.1	Architecture
2.1.1	High Level Architecture
2.1.2	FAA Detailed Architecture
2.1.3	NOAA Detailed Architecture
2.2	Services and Format Standards
2.2.1	FAA Weather Specific Services Design Standards
2.2.2	FAA Weather Product Data Format Standards
2.2.3	NWS JMBL Gap Analysis
2.2.4	NWS IOC Services
2.3	Software Development
2.3.1	Web Coverage Service (WCS)
2.3.2	Web Feature Service (WFS)
2.3.3	Service Adapters
2.3.4	Registry/Repository
2.3.5	Ontology & Mediation
2.3.6	Complex Retrieval Process (CRP)
2.4	Security
2.5	Latency and Performance Analysis
2.6	Efficient XML Technology
2.7	Demonstrations
2.8	Procure-Deploy HW-SW
2.8.1	Procure-Deploy FAA HW-SW
2.8.2	Procure-Deploy NOAA HW-SW
2.9	OT&E
3	Content
3.1	Element R&D
3.1.1	Develop IOC Icing Content
3.1.2	Develop IOC Turbulence Content
3.1.3	Develop IOC Convective Content
3.1.4	Develop IOC C&V Content
3.1.5	Develop Obs Content
3.2	Contents Tool Production
3.3	Element Transition to Operations
3.4	Forecast Process
3.4.1	Framework Development
3.4.2	MITL Tool Development
3.5	Verification
4	SAS
5	IOC

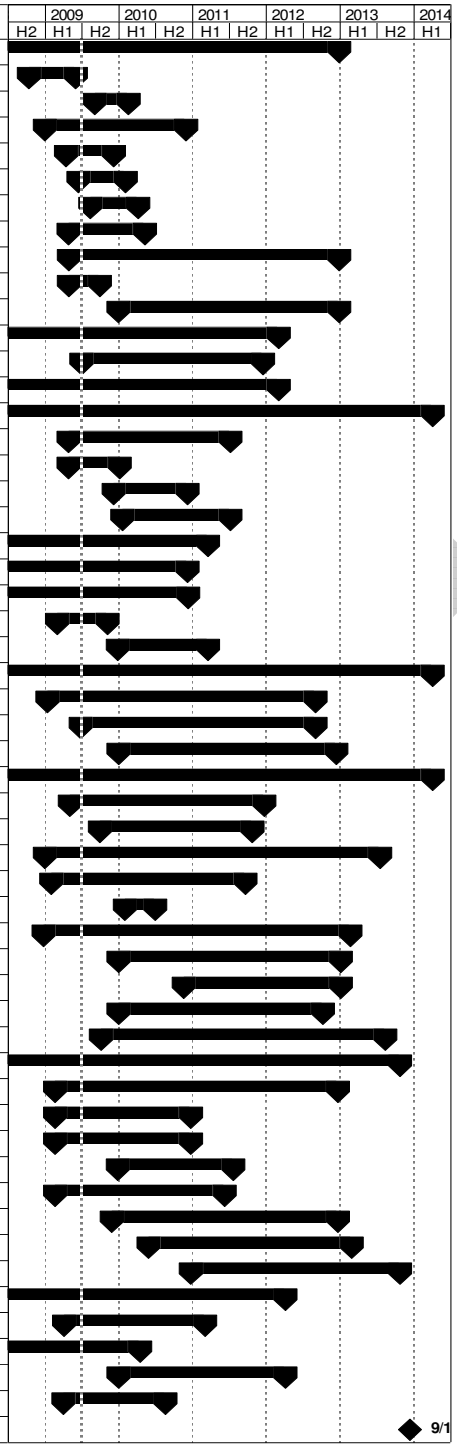

Figure 2.3 4D Weather Data Cube High Level Schedule

2.5.1 Program Management

Reference: WBS 1

Description: This task defines the execution of the necessary management activities that support and guide the work. This includes intra-agency coordination, interagency coordination, as well as coordination with other JPDO working groups. The team will ensure agency tasks are aligned with the Plan and there is no duplication between agencies. It includes coordination and oversight of contract staff and all procurement activities.

Year by year objectives are defined in the following:

- FY09
  - Stand-up rigorous program management structure
- FY10
  - Formalize execution processes
  - Develop acquisition strategies
  - Complete supporting management plans
- FY11
  - Interface control documents approved and base-lined
- FY12
  - Test plan complete
- FY13
  - Manage deployment and development of follow on capabilities

Deliverables: Deliverables under this task include, but are not limited to, the following:

i. Quarterly Status reports
ii. Budget reports
iii. Budget updates and inputs to the budget planning process
iv. Tasking for contractors and staff for all sub-tasks
v. Earned Values reports
vi. Supporting Management Plans

Agency roles and responsibilities: Each agency will maintain a separate management structure responsible for planning and executing the tasks assigned by this plan. The overarching management structure is governed by the Cube Team, which is chaired by representatives from NOAA, FAA, DoD, and Industry.

2.5.2 IT Services

Reference: WBS 2

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Description: The ITES Team is responsible for the activities within this task. The task will define and deliver the infrastructure necessary for the Cube at IOC. The activities to meet this task include:

Year by year objectives are defined in the following:

- FY09
  - Demonstrate agency data sharing
  - Evaluate agency-specific architecture solutions
  - Develop an IT security plan
  - Define and enhance data and exchange standards
  - Prototype interagency information sharing services
- FY10
  - Demonstrate agency data sharing in a NEO environment
  - Baseline data standards for IOC
  - Develop IT security services
- FY11
  - Finalize IOC architecture and requirements
- FY12
  - Begin building data services infrastructure
- FY13
  - Test and deploy IOC 4-D Cube

2.5.3 Cube Content

Reference: WBS 3

Description: The EI Team is responsible for the activities within this task. The task will define and deliver the aviation weather impact variables present at IOC in the Cube. The activities to meet this task include:

Year by year objectives are defined in the following:

- FY09
  - Initiate evaluation of forecast process improvements
  - Provide initial set of NEO weather sources available in proposed 4-D Cube formats
- FY10
  - Develop IOC forecast processes
  - Evaluate aviation impact variable research

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- FY11
  - Evaluate forecast processes
- FY12
  - Transition aviation weather impact variable research to operations
  - Implement IOC forecast process changes
- FY13
  - IOC Data Sources Available

2.5.4 IOC Single Authoritative Source (SAS)

Reference: WBS 4

Description: The EI Team is responsible for the activities within this task. The task will define and deliver the aviation weather impact variables present at IOC in the Cube and SAS. The activities to meet this task include:

Year by year objectives are defined in the following:

- FY09
  - Produce White Paper and ConOps defining IOC SAS concepts
- FY10
  - Define preliminary SAS business rules
  - Validate SAS requirements with Integration Team
- FY11
  - Evaluate potential SAS data sources
- FY12
  - Develop SAS business rules
- FY13
  - Implement, test and deploy business rules

2.5.5 IOC

Reference: WBS 5

Description: Initial Operational Capability of the 4-D Weather Data Cube will be delivered, having completed all required OT&E and C&A processes. The IOC capability may be regional in coverage, with a limited number of users. Appropriate IT infrastructure will be in place to provide weather information from the Cube to NAS users.

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2.6 Estimated Total Costs

A bottom up approach was used to develop the interagency cost profile outlined in Appendix D. It breaks out the projected costs by task and agency. There is an estimate to complete for each task by agency and a total projected cost break out by agency for each year. Sources for cost estimating included historical data from both FAA and NOAA programs.

The major cost drivers are the modification of current systems to meet the planned Cube IT standards/protocols, enhancing existing infrastructure to better utilize Network Enabled Operations, and meeting the reliability and availability requirements for the Cube.

FAA contributes a proportionately greater share of the costs for WBS Task 2, which defines the IT Services standards, while NOAA contributes a significantly greater share of WBS Task3, which details the generation of the meteorological information for the Cube.

The NOAA cost profiles assume support from base-funded full time equivalents (FTEs). The work done by NOAA base-funded personnel is not captured in the costs as these FTEs are considered a supplemental resource the project can draw on. However, there will be project-funded personnel in FY10 and beyond to take on the full range of management, scientific, and technical issues.

2.7 Major Implementation Risks and Issues

As the Cube Team developed the IOC Program WBS, they determined the top three risks for the 4-D Weather Cube IOC are a lack of sufficient agency funding, technical interdependencies, and regulatory constraints. The Cube Team will develop a Risk Management Plan to mitigate these and other risks.

The first major implementation risk is whether the agencies will receive the necessary funding to develop the Cube in time to meet the desired IOC date of 2013. The NWS and FAA both have NextGen weather programs in their current budgets that seek to achieve NextGen objectives. To avoid duplication and optimize resources, the Cube Team synchronized the tasks, which are dependent on the other agency completing their tasks, in this Plan. However, budget guidance has not been released for FY10 and beyond. Any cuts to either agency's funding could impact both agencies' efforts and IOC will be delayed. The Cube Team will mitigate this risk by working closely with agency leadership to try to prioritize funding for critical-path weather programs that lead to Cube IOC.

The next major implementation risk is the delay of the net-enabled capability. A key requirement of the Cube is a net-enabled infrastructure with sufficient communication throughput to allow NextGen decision-support tools to query for and receive the weather data needed to make decisions. The NextGen weather concept is completely reliant on the existence of NEO infrastructure and communication with a stated IOC of 2012. The NextGen NEO standards, formats, security policies, and architecture must be in place in time for the

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development of the Cube to meet IOC in 2013. If the net-centric infrastructure is not available, then the Cube cannot feed the NextGen decision-making process. The Weather Working Group has established a working relationship with the JPDO Net-Centric Operations Division to develop a consolidated plan to meet these requirements.

The third risk is not related to the actual development or fielding of the Cube capability, but involves regulatory constraints that affect implementation. Current Federal Aviation Regulations (FAR), International Civil Aviation Organization policies, and DoD regulations must be updated to account for new weather support concepts considered within the NextGen CONOPS such as probabilistic forecasts, aviation decision-support tools creating products from weather data, etc. Historically, changes to policy and regulations take considerable time due to the nature of the vetting process. Though many of these issues will not be applicable at IOC, they must be addressed as Cube, and SAS information become more widely used in ATM processes. To mitigate the delay associated with this process, the Weather Working Group has reestablished a policy team to address these issues, as discussed in section 1.7.3 of this Plan.

A final risk is that needed cultural changes driven by NextGen within each agency will delay implementation and adoption of the Cube. Current agency cultures will need to evolve as NextGen is implemented to embrace the new paradigm. If these cultures do not evolve quickly enough, the agencies could have difficulty implementing aspects of the Cube, and fully integrating it into operations. As the full scope of these needed changes become clear, both in the IOC timeframe and in later phases, the Cube Team will advise the agencies of expected impacts. Each agency must develop suitable implementation plans to and strategies to minimize this risk.

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3 POLICY, GOVERNANCE, AND STANDARDS

A Policy Team established under the NextGen Weather Working Group has begun developing policies and governance systems for NextGen weather. The Policy Team has proposed the following framework and approach to complete this effort. The following section should be considered preliminary. The Policy portion of this plan will be updated in the next iteration of this plan, to be completed by 30 Sept 2009.

Framework

1. All participants in the Cube fall into one or more of the following categories:
    a. Providers (Publishers) create weather information available in the
    b. Consumers (Subscribers) access weather information from the
    c. Authorities[1] establish the rules that Providers and Consumers abide by and operate infrastructure elements of the Cube that implement/enforce these rules.
2. As a condition of participation, Providers must agree to:
    a. Follow rules established by the Authorities.
    b. Make Service information available (publish) to Consumers in accordance with these rules.
3. As a condition of participation, Consumers must agree to:
    a. Follow rules established by the Authorities or Providers
4. Authorities operate within an established governance system which grants them specific authorities with respect to the operation of the Cube and identifies the institutional structure they will use to exercise this authority.
5. Rules for different subdomains of the Cube will vary in alignment with information requirements established by operational applications.

Approach

Within this framework, the Policy Team's work can be described in simple terms:

1. What is the range of applications of information from within the Cube that place requirements on, and drive rules for the Cube?
2. What are the rules[2] for Providers?
3. What are the rules[2] for Consumers?
4. How many Authorities are needed, what is the scope of the functions responsibilities[3] of each, and what governance system will each Authority employ? *Existing mechanisms*

[1] The term "Authority," when capitalized, is used throughout to refer to the category of NextGen weather participants. When not capitalized, the term is used in its common sense. For example, "What authorities will each Authority exercise?" Also note this term is used in a very broad sense. For example, it encompasses bodies that might convene occasionally / intermittently to review / revise Cube standards as well as bodies that might operate 24x7 to execute certain Cube functions.

[2] Policy Team needed to establish initial rules for Providers and Consumers until Authorities are established and assume this role.

(i.e., committees, boards, groups, etc) will be used to the extent feasible to implement these "Authorities."

The "rules" for Providers and Consumers and the "responsibilities" for each Authority are likely to change over the life of NextGen. Recognizing this, the following policy maturity model is proposed:

Level I policies are essential to the design / architecture of the Cube.
Level II policies are essential to IOC operations of the Cube.
Level III policies are essential to healthy evolution of the Cube from IOC to FOC.

The Policy Team's work will proceed through the following steps:

1. Inventory and describe existing models of NEO governance for lessons learned.
2. Inventory and describe a range of applications of information from within the Cube that would drive pub/sub rules for that information.
3. Adapt/develop policies for Providers
    a. Identify necessary Authorities
    b. Identify and propose initial "Level I" policies for Providers.
4. Adapt/develop policies for Consumers
    a. Identify necessary Authorities
    b. Identify and propose initial "Level I" policies for Consumers
5. Adapt/develop policies for Authorities
    a. Propose governance system for each Authority
    b. Develop (initial) governance documents

The Policy Team will sunset in stages as each Authority is established.

The intent is to establish these Authorities with sufficient time for the Authorities (not the Policy Team) to be responsible for Level II and III policies.

These policies will be established by going through the following generic process:

1. IOC team identification of Level I policies.
2. Policy team identifies, describes, and evaluates existing governance models and applications of information to identify best practices for use in Cube governance.
3. Policy team develops recommendations for identified areas.
4. IOC team review and concurrence.
5. NEWP review and concurrence.
6. As appropriate, publication, comment, and approval through standard JPDO publication and review procedures.

[3] For example some Authorities will address data standards, others will address access controls, and others will address content management.

High-Level Schedule

Fall 2009:
Identification of best practices for use in Cube governance.
Detailed schedule for policy and governance work reflected in NextGen Weather Work Plan.
June 2010:
Completion of Level I policies for Providers and Consumers. Supports IOC Team with policies that affect design/architecture.
June 2011:
Completion of governance system and initial governance documents for each Authority. Allows a year for approval of governance documents, and establishment of each Authority as a working organization.
June 2012:
Each Authority established and operating.

4 NEXTGEN WEATHER SCIENCE ROADMAP

The NextGen Functional Requirements for weather present a set of daunting research challenges. In order to maximize the research contributions of each agency, we will define a NextGen Science Roadmap that will define science activities by agency by year. The objective of the science roadmap is to align each agency's activities, prevent duplication and identify gaps for further investment. The Science Roadmap will be complete in the next iteration of this plan, to be completed by 30 Sept 2009.

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