2 INTRODUCTION

The release of the *NAS Architecture Version 4.0* marks a major planning milestone in the NAS modernization process. For the past 2½ years, the FAA has worked closely with the user community to develop a better understanding of its requirements for a safer and more efficient NAS.

2.1 Developing the Architecture

This architecture has evolved from earlier work. *NAS Architecture Version 2.0*'s release in October 1996 resulted in the submission of over 2,200 comments. After the December 1997 draft *NAS Architecture* (Version 3.0) was distributed, over 1,600 comments were received. All of the comments were considered in developing this architecture. The architecture has been coordinated within the FAA and with the aviation community. Appendix B lists the organizations that participated in the architecture's development. An overview of Architecture Version 4.0, the *Blueprint for NAS Modernization*, was also published in January 1999.

This architecture has been designed to achieve the following principles:

- Enhance overall NAS safety
- Introduce user benefits early and adapt to user needs
- Maintain and enhance existing services
- Modernize in an evolutionary manner using new technologies
- Use standard components, common systems, and common user interfaces wherever possible
- Ensure adequate security of systems and information
- Ensure compatibility across systems by using accepted systems engineering methodologies
- Give users and service providers wide access to NAS information
- Design the system to be adaptable and easily extensible as requirements change and traffic grows
- Make the architecture executable by staying within the FAA's funding projections.

The aviation community wants improved safety and capacity, increased flexibility, more access to airspace, and a larger role in decisionmaking.

Key internal and external events shaped the architecture.

Responsiveness to Customers. The FAA intends to be more responsive to its customers—the NAS users. Users clearly expressed their desire for a NAS that is more efficient and provides more benefits. These views were stated in the RTCA Task Force 3 Free Flight report.[1] The aviation community painted a picture of a NAS that meets its needs for more flexible routes and a larger role in the decisionmaking process that directs NAS operations.

A draft architecture, dated August 7, was provided to the RTCA Free Flight Steering Committee for review and comments. In its response, the steering committee recommended that the FAA release the NAS Architecture Version 4.0 as a baseline for managing NAS modernization. The RTCA response (see comments at the end of this section) provided six general themes and a list of more detailed comments on selected sections of the architecture. Some of the themes are beyond the scope of this document, while other themes require further discussion and consideration within the aviation community. Most of the detailed comments have been addressed in this document; the remaining comments require additional discussion and analysis before they can be incorporated. This work is underway as the FAA addresses the detailed transition steps in NAS modernization.

Modernization Plan. The White House issued Executive Order 13015, which established the White House Commission on Aviation Safety and Security after the loss of Trans World Airlines

1. *RTCA Task Force 3: Free Flight Implementation*, October 1995.

Flight 800. Key recommendations of the commission were: (1) that the FAA should develop a revised NAS modernization plan and set a goal of the modernized system being fully operational nationwide by the year 2005, and (2) that the Congress, the Administration, and users should develop innovative means of financing this acceleration. [2]

Safety. NAS Modernization will enhance safety through more effective risk management in critical areas of the aviation system. Recently, the FAA's focused safety agenda, "Safer Skies," identified high-priority safety concerns. Additionally, the FAA Administrator has established a risk management policy and has implemented safety risk management as a decisionmaking tool within the FAA. Modernization will strengthen safety risk management in several of these high-priority areas by reducing the potential for controlled flight into terrain and runway incursions, improving flow control of approach and landing operations, and providing better weather information.

Security. Another area of great importance to the FAA and the nation is protection of NAS aviation information systems against electronic intrusion and disruption. Information security has become an increasingly important component of the architecture and the modernization effort. A key recommendation of the White House Commission on Aviation Safety and Security was: "The FAA should establish a security system that will provide a high level of protection for all aviation information systems." Eight months later, the President's Commission on Critical Infrastructure Protection restated this recommendation as: "The Commission recommends the FAA act immediately to develop, establish, fund, and implement a comprehensive National Airspace System Security Program to protect the modernized NAS from information-based and other disruptions, intrusions, and attack."

Reform. The FAA recognized that it would need personnel and acquisition reforms in order to implement modernization. Less restrictive personnel policies allow the right talents to be applied to tasks in a more timely fashion. Streamlined acquisition procedures[3] allow new technologies to be acquired and fielded in less time and at lower cost.

Funding. The question of adequate funding levels for modernization was publicly examined. As directed by the Federal Aviation Reauthorization Act of 1996, Public Law 104-264, the FAA Administrator selected Coopers and Lybrand, L.L.P., to conduct an independent analysis of the FAA's budgetary requirements through fiscal year 2002. These results were provided to the National Civil Aviation Review Commission, which was tasked to evaluate the state of the NAS, determine the need and cost of modernization, and provide recommendations on funding sources. The commission's report clearly states that modernizing the aging NAS infrastructure is critically important and that a sufficient, stable funding source for modernization and the FAA must be identified.

Concepts of Operations. Two concepts of operations were a result of discussions between users of NAS services and FAA service providers. The FAA Air Traffic Services (ATS) organization's *A Concept of Operations for the National Airspace System in 2005* was distributed, followed by the *Government/Industry Concept of Operation*, developed jointly by RTCA and the FAA. Together, the concepts of operations define the capabilities and services needed in a modernized NAS and provide the general time frame for each capability. In this architecture document, the two concepts of operations (i.e., ATS's and the government/industry's) are *jointly* referred to as the CONOPS. This is possible because one is from a service provider perspective, the other reflects the user's perspective.

The labor agreement with the National Air Traffic Controllers Association (NATCA) in late 1998 reclassified air traffic control facilities. The effects of this reclassification on the total number of controllers required, and their salaries, have not been considered in the NAS Architecture Version 4.0.

Modernization Task Force. After distributing the draft *National Airspace Architecture 1997* (Version 3.0) in December 1997, the Administrator formed the NAS Modernization Task Force.

2. *White House Commission on Aviation Safety and Security, Final Report*, February 12, 1997, p. 20.
3. Federal Aviation Administration Acquisition Management System, June 1997.

The Task Force was charged with closing the gaps between the FAA and the aviation community's positions on the risks of NAS modernization. After consulting with industry (through RTCA), the Task Force concluded that users want the benefits of certain key technologies sooner than originally planned for in the NAS Architecture Version 3.0. The Task Force also recommended that users play a larger role in evaluating the potential benefits of modernization. This resulted in the formation of the Free Flight Phase 1 Core Capabilities Limited Deployment (FFP1 CCLD) program, which is discussed in Section 6.

The NAS architecture balances the capabilities requested by users and service providers, the funding level and sources that are expected to be available for modernization, the cost to users and their ability to equip, and the FAA's ability to manage the changes needed to make modernization a reality. Although other architectures are possible, Version 4.0 represents a plan based on a balance between needs and available resources.

2.2 Overview of the NAS

Today's System. Today's NAS is based on traffic patterns of the past, operations of a regulated industry, and information that is isolated by the limitations of obsolete computers. Additionally, accommodating the growth in air traffic is constrained by navigation and air-ground communications spectrum congestion.

Above all, the entire NAS is aging rapidly. Other countries, especially those without a major investment in an existing infrastructure, have already begun using modern technology for their aviation systems. This architecture will be in harmony with the global community. It is the goal of this architecture and the continuing architectural process to provide the roadmap for making our aviation system the safest, most cost-effective, and efficient system possible for the resources available.

The NAS is a complex collection of systems, procedures, facilities, aircraft, and people. The NAS includes thousands of pieces of equipment in hundreds of locations throughout the United States. These components comprise one system that ensures safe and efficient operations (see Figure 2-1). Thousands of people operate the equipment used to provide NAS services to the aviators and passengers who travel each day. The 18,000 plus airports in the United States are also a significant part of the NAS, particularly the more than 3,300 airports that are the core of the national transportation system and receive grants under the Airport Improvement Program. Airports of national importance include all commercial service airports, all reliever airports, and selected general aviation airports.

The main NAS users are air carriers, air cargo, commuter air carriers, air taxis, general aviation, the military, and civilian government. Air carriers conduct scheduled and nonscheduled operations using aircraft weighing more than 7,500 pounds and with 9 or more seats. Commuter air carriers conduct scheduled operations using aircraft weighing less than 7,500 pounds and with less than 9 seats. Air taxi operators are air carriers who conduct on-demand instead of scheduled operations. Air cargo flights carry freight and packages but not passengers. General aviation (GA) includes private pilots, business aviation, and all civilian operations not included above. A wide spectrum of government operations includes military aircraft, the Coast Guard, the Department of Justice, and other government agencies.

Each user group has special needs that must be balanced within the architecture. Commercial operations account for about 95 percent of aviation's impact on the economy.[4] There are over 260,000 GA pilots. The Department of Defense (DOD) has the world's largest fleet, with more than 16,000 aircraft.

As a plane departs the airport, tower, terminal, and en route controllers ensure that it does not conflict with other traffic during its climb to cruising altitude. The en route controllers ensure separation is maintained while en route to the destination airspace where the aircraft is once again controlled by terminal and tower controllers for arrival and landing. Figure 2-2 graphically depicts the various NAS domains.

Navigation systems provide position information to aircraft during flights and for landings. The

4. *The Economic Impact of Civil Aviation on the U.S. Economy, Update '93*, Wilbur Smith Associates, April 1995.

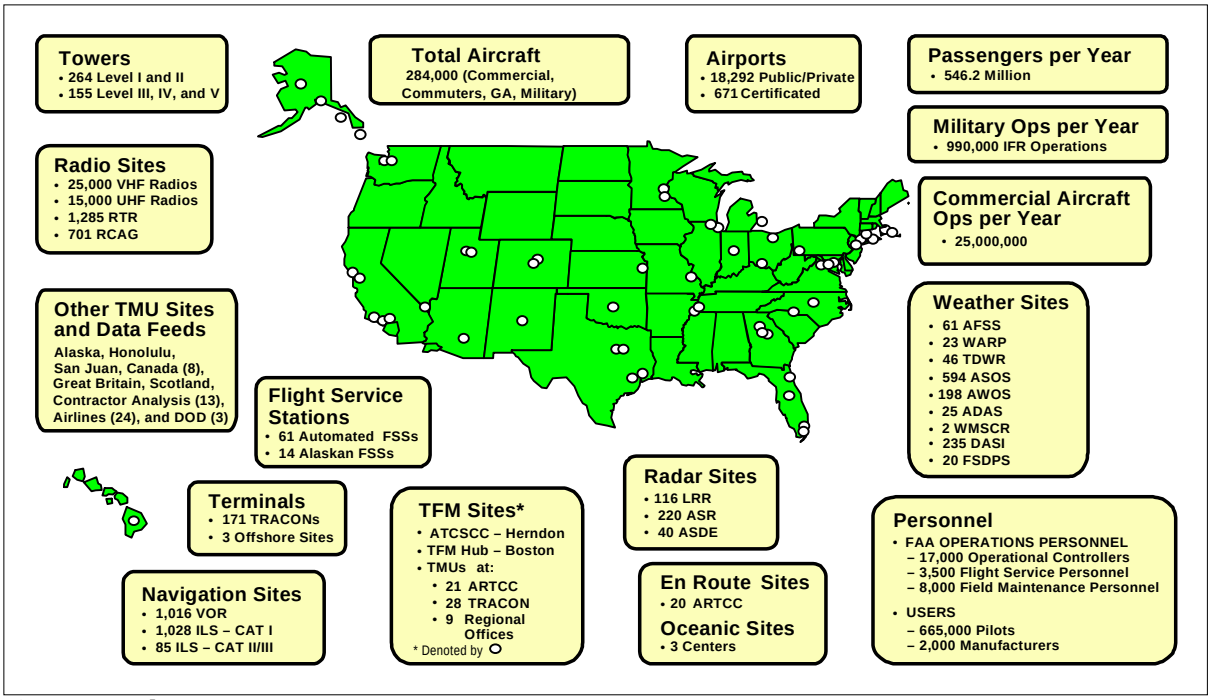


Figure 2-1. The NAS

The NAS is a complex collection of systems, procedures, facilities, aircraft, and people. These components work together as one system to ensure safe and efficient operations.

FAA uses radars to provide surveillance data (i.e., aircraft position) to controllers.

Automation systems assist controllers at oceanic, en route, terminal, and tower locations. Radios allow pilots and controllers to communicate, enabling safe and efficient operations.

Flight service stations (FSSs) assist GA pilots to plan and file flight plans. Airline operations centers (AOCs) work closely with traffic flow managers to plan commercial flights. Planning functions help pilots account for weather and winds along their intended routes and also help the FAA ensure that the demand is balanced for safe operations.

2.3 Modernizing the NAS

Key goals of modernizing the NAS are to provide existing services more efficiently and to provide new services and capabilities that will move the NAS toward a new type of operating environment known as Free Flight.

These goals must be achieved under two constraints: safety will not be compromised, and annual costs to the FAA and users must be kept at a reasonable level.

Service providers and service users interact with each other at three levels: a strategic level (e.g., an airline decision to establish an east coast hub); an operational level (e.g., an airline decision on which city to select for that hub—along with the routes, equipment, and frequency and time of service); and a tactical level (e.g., day-to-day decisions—both on the ground and in the air—on the operation of the hub regarding weather, equipment outages, and known traffic delays).

Given the complexity of the system, the FAA seeks to maintain a flexibility that allows users to achieve individual objectives. The objectives of an airline's operations may be much different from those of GA or DOD operations.

This complexity also is why modernization requires the active participation of all parts of the FAA and user communities. Modernizing even a single NAS function, such as navigation, affects FAA organizations and a broad range of users.

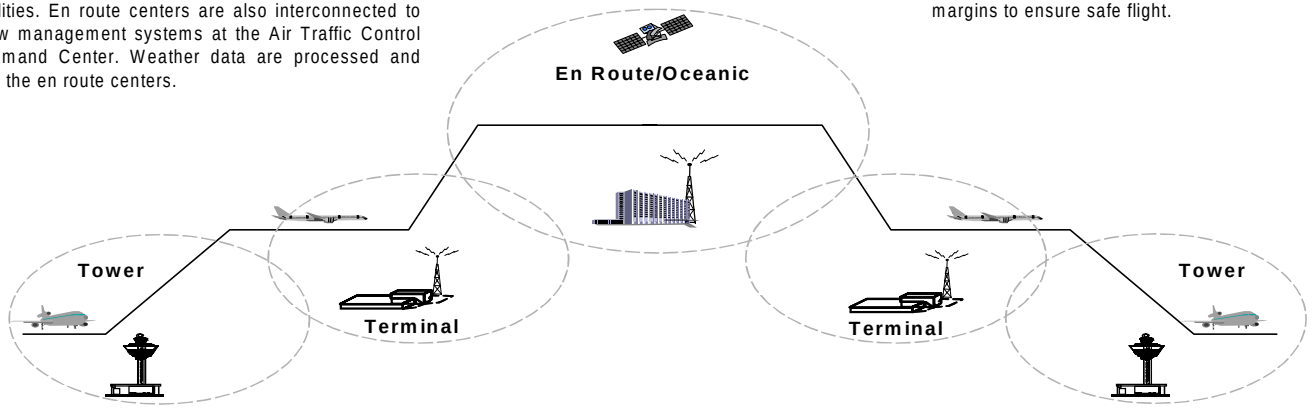
Figure 2-3 illustrates the complexity of the process and the interactions and activities needed to achieve modernization.

En Route

Twenty en route centers control domestic air traffic not specifically delegated to an oceanic, terminal, or tower control facility. The airspace extends out to 100 miles beyond the United States coastlines and its borders with Canada and Mexico. The en route centers operate the computer suite that processes radar surveillance and flight planning data, reformats it for presentation purposes, and sends it to the displays used by controllers to track aircraft. En route centers control the switching of voice communications between aircraft and the center as well as between the center and other national airspace facilities. En route centers are also interconnected to the traffic flow management systems at the Air Traffic Control System Command Center. Weather data are processed and distributed by the en route centers.

Oceanic

The oceanic air traffic control centers control aircraft over portions of the Atlantic, Arctic, and Pacific oceans. Two oceanic centers are co-located with en route centers in New York and Oakland, while a third is located at Anchorage, Alaska. The air traffic control provided over the ocean is substantially different from that provided over land, because there are no surveillance systems that can provide exact aircraft position. Position reports based on on-board aircraft navigational systems are radioed to the controller. Due to the uncertainty in position report reliability, planned overseas flight tracks must provide greater separation margins to ensure safe flight.



Tower

Tower controllers manage and control the airspace within approximately five miles of an airport, including taxiways and runways on the ground. Tower controllers control ground operations on airport taxiways and runways and departing and landing traffic. Towers are provided with flight planning information by the en route computer suite. Weather information is available from the weather processing and distribution communications network.

Terminal

Terminal facilities provide air traffic control services for an air space located approximately 5 to 40 miles from an airport and usually below 10,000 feet in altitude. The terminal controller establishes and maintains the sequence and separation of aircraft taking off, landing, or operating within the terminal airspace. Terminals are interconnected with local towers and provide surveillance and position data of aircraft under terminal control to specialized displays within the tower. Selected terminal facilities are interconnected to the traffic flow management systems at the Air Traffic Control System Command Center. Flight planning information is provided from the en route computer suite. Weather data are provided from the weather processing and distribution communications network.

Figure 2-2. NAS Functional Domains

2.4 Free Flight

The main objective of NAS modernization is moving the NAS towards a new type of operating environment known as Free Flight.

The RTCA defines Free Flight as:

". . . a safe and efficient operating capability under instrument flight rules in which the operators have the freedom to select their path and speed in real time. Air traffic restrictions are imposed only to ensure separation, to preclude exceeding airport capability, to prevent unauthorized flights through special use airspace, and to ensure safety of flight. Restrictions are limited in extent and duration to correct the identified problem. Any activity which removes restrictions represents a move toward Free Flight."[5]

Users will derive benefits from the removal of current air traffic control (ATC) constraints and restrictions to flight operations. The benefits will be reflected in an operational environment that provides more efficient management of airspace and airport resources through better information exchange and collaborative decisionmaking among users and service providers.

Under the current system, users file flight plans along FAA-defined air routes determined by a system of ground-based navigational aids (Navaids); however, significant "free flight" area navigation (i.e., more direct routing) takes place above Flight Level 290 through the National Route Program.

The lack of flexibility of the current NAS is due to the inherent constraints of the older technologies used for communications, navigation, surveillance, computer systems, and decision support aids. The future NAS will include new technologies that support capabilities that will allow users and providers more flexibility in planning and in flight operations.

A key benefit to users will be their ability to select and use efficient flight profiles, a key aspect of Free Flight. The combination of cockpit technol-

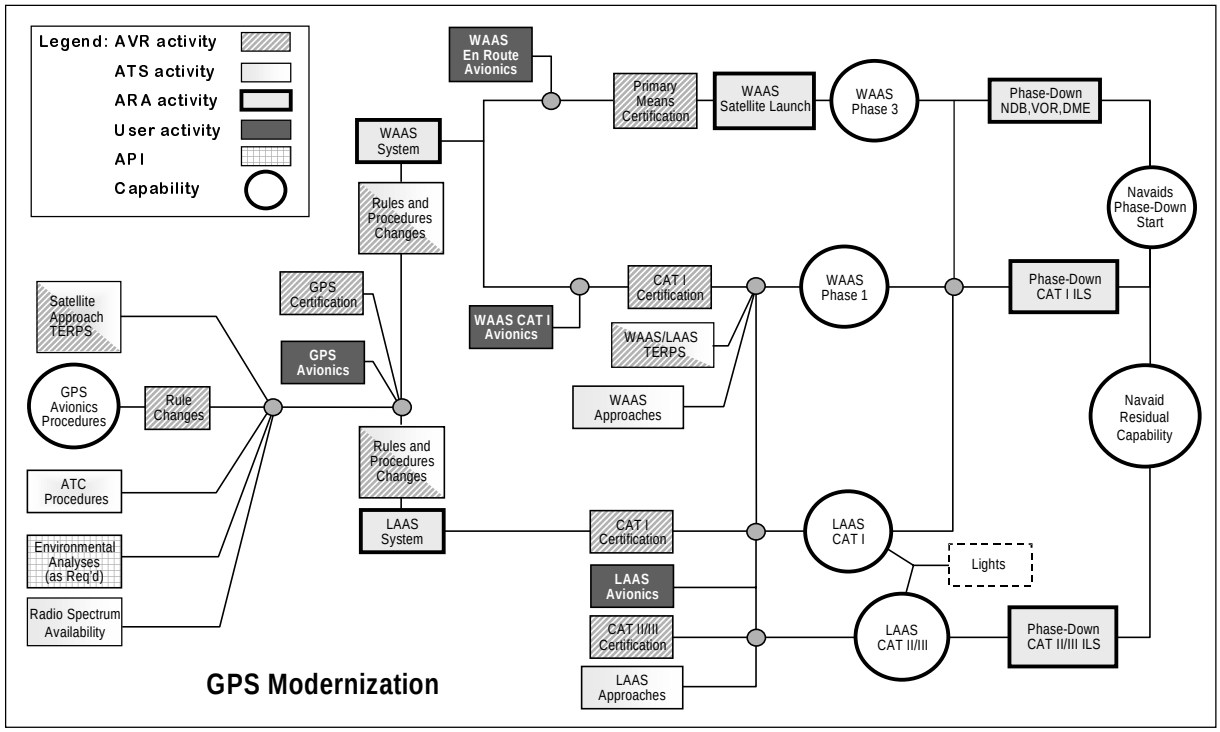


Figure 2-3. Modernization is an Aviation-Community-Wide Task

Deploying new systems, although a significant and critical step, is not sufficient to enable new capabilities and services. New procedures, new avionics, new rules, and public hearings are all integral to NAS modernization. The FAA and user community must work together to realize the benefits of a modernized NAS.

5. Free Flight Action Plan Update, April 2, 1998, pp. 2-3.

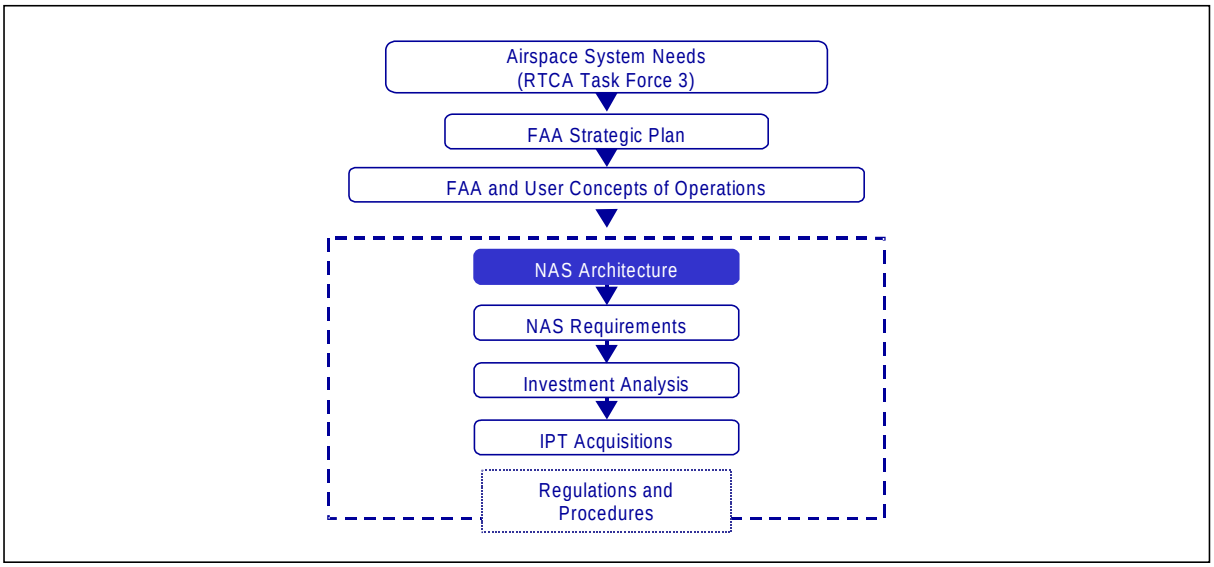


Figure 2-4. The NAS Architecture in Context

A logical architecture, based on the FAA and the Government and Industry Concepts of Operations, the architecture defines the path for NAS modernization. The architecture's approach to modernization strikes a balance between the desires of NAS users, available funding, safety, and the speed at which transitions can occur.

ogy and satellite-based navigation will enable users to fly optimized climb profiles, and the most efficient cruise speeds, altitudes, and routes. Flight planners and pilots will be able to select the most fuel-efficient routes based upon winds aloft and fly optimal descent profiles to the destination airport.

2.5 Role of the Architecture in NAS Modernization

The NAS architecture is the aviation community's roadmap for modernization. It describes the schedules and costs necessary to implement the capabilities and services defined in the CONOPS.

Figure 2-4 depicts the relationship between the Architecture and more strategic documents. Section 11, Regulation and Certification Activities Affected by New NAS Architecture Capabilities, discusses the architecture's regulatory impact.

The NAS Architecture Version 4.0 is a logical architecture. It provides a high-level description of NAS capabilities and services, the functions to be performed, their dependencies and interactions, and the information flow to support these functions. This architecture contains:

- The timing of functional enhancements and operational capabilities
- A sequence of infrastructure improvements
- FAA costs projected for research, engineering, and development (R,E&D); facilities and equipment (F&E); and operations (OPS) budgets, including:
  - System acquisitions
  - Personnel
  - Infrastructure sustainment
- User cost estimates and schedules for equipage (air carrier, regional/commuter, GA, and military).

2.5.1 Using the Architecture Within the Aviation Community

The NAS architecture represents the FAA's commitment to the aviation community. It spells out in detail the vision that the FAA has for the modernized NAS, based on expected funding. It specifies the steps along the modernization path and the time frames for each. It shows FAA products, such as new systems or new capabilities provided by a combination of systems. The architecture also serves as a planning tool for the users of the NAS.

The FAA is working diligently to further understand the users' current aviation service needs.

Major capital purchases, such as avionics, require long lead times.

The architecture is a mechanism for continuing dialog on NAS modernization between the FAA and users.

The transition schedules in Version 4.0 assume a dual operations period of 5 years or more for avionics equipage. As navigational services are transitioned to satellite-based service, the FAA will coordinate with users before finalizing the schedules for phasing down Navaids or discontinuing ground-based services.

The architecture provides direction and challenges for research and development from now through 2015. The architecture is a plan for investigating benefits, examining alternatives, and developing applied technologies and procedures to meet the needs of aviation.

Finally, the architecture serves as a mechanism for a continuing dialog between the FAA and NAS users and becomes the point of departure for further refinement of NAS modernization requirements. The success of the process depends on user involvement.

2.5.2 Using the Architecture Within the FAA

Establishing long-range goals is a key element of the FAA's strategic planning process. The architecture provides a basis for the agency's mission analysis and program planning and defines specific strategic objectives to be achieved by 2015.

After extensive coordination within the FAA and the user community, the Joint Resources Council (JRC)[6] approved the NAS architecture and designated it as "baseline planning guidance" for the agency.

As illustrated in Figure 2-5, the architecture plays an important role in the FAA's new acquisition management system (AMS). The architecture describes the resources needed to modernize the NAS and meet user and service provider requirements. It identifies the required timing and numerous links that tie various programs together. Associated costs have also been estimated.

Funding requirements in the mid term and beyond will be used as starting points for future investment analyses. The JRC can use the architecture as a point of departure for mission need and in-

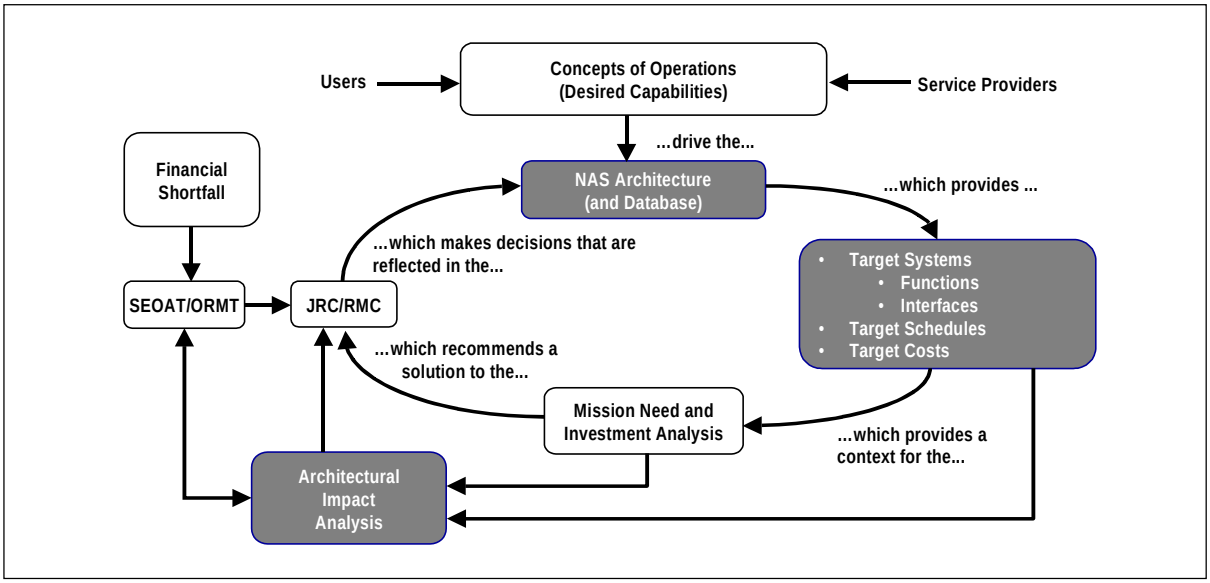


Figure 2-5. The NAS Architecture and the Acquisition Management System

The architecture provides the context for all FAA decisions. It enables decisionmakers to establish priorities and to understand how individual decisions affect the NAS.

6. The JRC is the FAA's top investment decision group.

vestment decisions. Plans made by the JRC or the Administrator and decisions affecting investments will be incorporated into the architecture, and changes will be made as required. User input to the architecture process will continue.

The architecture provides the context for investment analysis, with cost, schedule, and functional targets as starting points. It highlights the interdependencies of functions and capabilities. Although the architecture provides one candidate technical alternative to be analyzed, the investment analysis process may consider and select other alternatives. It provides a framework to use in assessing the implications of various alternatives and the implications of changes in funding, schedule, or functional targets.

This architecture is not an end state. Rather, it will continue to evolve based on the results of projects like Safe Flight 21, the availability of new technologies, new user and service provider requirements and priorities, and funding. Work continues to identify the new capabilities, systems, and activities required to modernize the NAS and achieve Free Flight. Funding requirements continue to be developed and validated. Production and installation schedules continue to be integrated to ensure that the various elements—including regulation and certification activities, new systems, user equipage, and procedural changes—are brought together at the correct time to provide benefits to users.

2.6 Near-Term Risk-Mitigation Activities

Modernizing the NAS will involve technology and cost risks. Some of the new technologies that may be used during modernization have not been tested or proven in an operational environment. Of equal significance are the new procedures that the Free Flight operational concept envisions. Important new controller decision support tools and aircraft air-air separation are two examples of new capabilities that require testing and validation prior to implementation. Three key risk-mitigation strategies the architecture will use are Free Flight Phase 1 Core Capabilities Limited Deployment (FFP1 CCLD), Safe Flight 21, and Capstone.

2.6.1 Free Flight Phase 1 Core Capabilities Limited Deployment

FFP1 CCLD incorporates guidance provided by the NAS Modernization Task Force. FFP1 CCLD is intended to provide early user benefits and mitigate technical risk by implementing key automation capabilities at specific sites within the NAS, for evaluation by aviation stakeholders and FAA operators. The deployments will allow computer-human interface (CHI), training, and safety factors to be evaluated. After the FAA and users have gained experience and evaluated the individual FFP1 CCLD capabilities, decisions will be made on whether to deploy them to additional locations.

2.6.2 Safe Flight 21

Many of the new technologies identified for modernization have been demonstrated in the laboratory or on a limited scale, but their true benefits and costs have not been conclusively established. These demonstrations, while instructive, have not been compelling enough to convince most NAS users to equip with modern avionics. Safe Flight 21 provides the opportunity to take these activities to the next logical step—full operational demonstration and validation, where significantly more accurate user and service provider cost-benefit assessments can occur.

Safe Flight 21 deploys and evaluates certain air traffic control systems and avionics, which use new communications, navigation, and surveillance technologies for determining technical risk and operational suitability. These new technologies include applications such as automatic dependent surveillance broadcast (ADS-B) for air-air and air-ground surveillance and flight information services via data link. Avionics, certification, and procedural development are cost and schedule risks that must be mitigated. Additionally, user benefits must be conclusively proven before avionics and associated ground equipment capital investments can be made.

2.6.3 Capstone

The FAA Alaskan Region's Capstone Program of infrastructure modernization will provide and validate safety and efficiency improvements recommended in the NTSB Safety Study *Aviation Safety in Alaska*. Capstone focuses on safety by improving infrastructure in Bethel and the surrounding

area, a small portion of western Alaska. It will address the operating environment and aviation infrastructure, weather observations and recording, airport condition reporting, and adequacy of the current instrument flight rules system.

2.7 Summary

This architecture is a joint plan of the FAA and NAS users on how to modernize the NAS. Today's NAS, while safe and efficient, can be improved significantly through use of new technologies and operating procedures. Successful modernization depends on effective continuous FAA and NAS user planning as well as their mitigation of the risks of new technology.

This document describes how the NAS will evolve consistent with the *Government/Industry Concept of Operations* and the FAA's *A Concept of Operations for the National Airspace System in 2005*.

2.8 Detailed Comments on Architecture 98 From RTCA Free Flight Select Committee

The following pages present the RTCA Free Flight Steering Committee letter and comments on the draft Architecture 1998.

RTCA

RTCA, Inc.
1140 Connecticut Avenue, N. W., Suite 1020
Washington, D. C. 20036

Telephone 202-833-9339
Facsimile 202-833-9434

December 10, 1998

The Honorable Jane Garvey
Administrator
Federal Aviation Administration
800 Independence Avenue
Washington D.C. 20591

Dear Mrs. Garvey,

The Free Flight Steering Committee applauds the FAA's substantial effort to develop and document a single, coherent plan for NAS modernization. As we all agree, the main purpose of this architecture is to document a plan on which both the FAA and the users can base investment decisions. We encourage the FAA to publish Architecture 4.0, thereby setting the baseline for managing NAS modernization activities and reaping the many programmatic benefits that will accrue therefrom. We also encourage FAA to continue working closely with the entire aviation community to move the very important modernization effort forward.

A number of themes emerged as we consolidated our views about the architecture. They are captured in the attachment, along with more detailed comments and concerns about selected sections of Part III, NAS Architecture Description. As a way to underscore FAA's past and continuing commitment to modernizing the NAS as a collaborative, government / industry endeavor, we request that you include this letter and the attachment as part of the published architecture package.

We appreciate the opportunity to work closely with your management team to address the issues we have identified. This collaboration will greatly enhance our collective chances of success. We recognize that such a process is new to all of us and creates new institutional challenges for you. We take our role seriously and will remain responsible and constructive in our feedback.

Sincerely,

Robert Baker
Co-Chair
Free Flight Steering Committee

Monte Belger
Co-Chair
Free Flight Steering Committee

Attachment
Detailed Comments on Architecture 4.0

"Requirements and Technical Concepts for Aviation."

Detailed Comments on Architecture 98 from
RTCA Free Flight Select Committee

A number of themes emerged as the RTCA Free Flight Select Committee reviewed and consolidated comments into a single package. They are presented below:

1. The steps in the plan need to be more benefits-driven. Motivation for user equipage, for example, is not addressed adequately. The document should describe the link between each increment of operational capability and enabling technologies and its associated benefits.
2. Issues related to transition from one step to the next, such as mixed equipage, are not addressed adequately. It is difficult to discern a series of discrete steps from this document. The architecture does not define activities necessary to move between consecutive steps.
3. The architecture should acknowledge throughout, where appropriate, that lessons learned from ongoing experiments and initiatives (e.g., Safe Flight 21) will be integrated into the architecture and will drive technology and other related decisions.
4. The year 2005 needs to be defined as a milestone, describing all components that will be in place. This description should match the FAA and the Government/Industry Operational Concept for 2005. Further, the FAA should continue to apply beyond Free Flight Phase 1 the evolutionary development paradigm that industry / RTCA has recommended.
5. A chapter on Airspace should be included. Airspace is a critical national resource that must be optimized in order for the NAS to gain full benefit from programmed infrastructure enhancements, emerging technology initiatives, and procedural changes that support the transition to Free Flight.
6. The relatively high risk of implementing automation (hardware and software) infrastructure is not addressed adequately.

Following is a list of more detailed comments about selected sections of the Architecture.

SECTION 15 - Navigation and Landing

- Architecture should clarify how phasing down of ground navigation aids will be accomplished
- Sole means issue should be resolved and policy documented in the architecture

SECTION 16 - Surveillance

- Policy should be clearly stated
- Transition path is not clear and needs to be described
- Architecture should address how a mixed equipage environment will operate, and how users will be motivated to equip
- Technology decisions, such as Mode-S, should be based on the results of the RTCA Surveillance subgroup and of Safe Flight 21.

SECTION 17 – Communications

- Architecture should acknowledge that industry is on record as not endorsing VDL Mode 3
- Architecture should acknowledge the CDPCL Build 1 program and describe how lessons learned will be incorporated into the NAS

SECTION 18 - Avionics

- Human factors, certification, equipage and transition issues are not adequately addressed

Detailed Comments on Architecture 98 from
RTCA Free Flight Select Committee

SECTION 19 - NAS Information Architecture
- Architecture should acknowledge that NAS Information Architecture encompassed more than CDM
- Data ownership and security issues should be addressed, and FAA policy stated

SECTION 20 - TFM
- Architecture should clearly distinguish TFM from NAS Information Architecture and CDM
- Architecture uses CTAS terms interchangeably. It should include clear definitions of the following terms/programs: CTAS, TMA, pFAST.

SECTION 21 - En Route
- Incremental, evolutionary development should be incorporated as the basic development philosophy so that enhancements of both capabilities and infrastructure can be adequately addressed.

SECTION 22 - Oceanic
- Architecture should acknowledge alternative acquisition strategy being considered for the ocean.

SECTION 23 - Terminal
- Architecture should acknowledge that STARS is a major risk area, and should define a risk mitigation strategy
- Architecture uses CTAS terms interchangeably. It should include clear definitions of the following terms/programs: CTAS, TMA, pFAST.

SECTION 24 - Tower/Surface
- Architecture should acknowledge the Safe Flight 21 Program, and indicate that lessons learned in ADS-B experiments will be fed into the Architecture.

SECTION 25 - Flight Stations
- Architecture should better define transition benefits and the role of the private sector in the evolution of Flight Service Station Services.
- It should be clearly stated what role commercial services are to play in providing weather data

SECTION 28 - Airports
- Consider deleting this chapter. Most of what is covered is covered in other chapters on Terminal and Surface Operations. Other aspects of airports are outside the scope of the FAA's Architecture