



# Highlights of the National Airspace System (NAS) Architecture



Department of Transportation  
Federal Aviation Administration



## NAS Architecture Highlights

NAS modernization involves providing new systems to enhance capabilities and services for users:

- Clear, less congested air/ground communications using digital technology
- Accurate navigation and landing services to more airports using satellite technology
- Expanded surveillance coverage of airspace and airport surfaces
- Increased air-to-air situation awareness for pilots
- More efficient sequencing of arriving and departing aircraft through improved air traffic control decision support tools
- Accurate and timely weather data to controllers and pilots
- Sharing of real-time information between users and providers
- Increased ability of users to fly more direct routes.

Modernization also includes making the critical infrastructure of air traffic control services easier and more cost-effective to operate and maintain. Critical infrastructure includes:

- Communications, navigation/landing, and radar surveillance systems
- Weather detection and reporting equipment
- Air traffic control computers and displays for controllers
- Power generation and backup systems
- Air traffic control facilities sustainment.

Here is a brief summary of key NAS systems/capabilities and their architectural improvements:

### Communications

Aviation communications systems will be upgraded, integrating systems into a seamless network using digital technology for voice and data. During the transition, the FAA will continue to support analog voice communications. Specific improvements include:

- Controller-pilot data link communications (CPDLC), which introduces electronic data exchange between controllers and the cockpit and reduces voice-channel congestion.
- Digital voice communications via new digital radios provided by the next generation air/ground communications program, which improves spectrum utilization. Ultra-high frequency (UHF) analog radios will be retained for Department of Defense users. Radios operating in the analog mode will be retained in many low-density areas for general aviation users.

### Navigation

Over the next 10 years, the navigation system is expected to use satellites augmented by ground monitoring stations to provide navigation signal coverage throughout the NAS. Satellite-based navigation will support direct routes and help users meet their schedules with more predictability. Reliance on ground-based navigation aids is expected to decline as satellite navigation provides equivalent levels of service.



## Goals of NAS Modernization

Modernizing the NAS is based on improving:

- Safety - such as better weather information in the cockpit and on controller displays
- Accessibility - such as instrument approaches to many more airports
- Flexibility - such as allowing users to select and fly desired routes
- Predictability - such as meeting flight schedules even in adverse weather conditions
- Capacity - such as increasing aircraft arrival rates to airports
- Efficiency - such as saving fuel by reducing taxing times to/from the runways
- Security - such as controlling access to facilities and critical information systems.

The transition to satellite-based navigation consists of:

- Use of the global positioning system (GPS) as a supplemental system for en route navigation and non-precision approaches.
- Deployment of the wide area augmentation system (WAAS) to augment GPS for primary means en route navigation and precision approaches. WAAS will be deployed in stages by adding ground reference stations, with operational capability improving in each stage.
- Deployment of a local area augmentation system (LAAS) to augment GPS for precision approaches in low visibility conditions.

## Surveillance

Surveillance in the future NAS will provide increased coverage in non-radar areas and include aircraft-to-aircraft capabilities for greater situation awareness. The NAS Architecture calls for gradual transition from current radar systems to digital radar and automatic dependent surveillance (ADS).

Air-to-air ADS-Broadcast (ADS-B), a new avionics surveillance package, is being developed to include a cockpit display of traffic information feature that shows the position of all ADS-B-equipped aircraft to enhance the pilot's awareness of the surrounding environment. Later, a compatible ground system will be deployed to provide the same ADS-B surveillance information to controllers as seen by pilots.

## Aviation Weather

The NAS Architecture contains improved ways to collect, process, transmit, and display weather information to users and providers, during flight planning and in flight. The goal is to give NAS providers and users depictions of weather information and provide more weather data in the cockpit to enhance common situation awareness. New features include:

- Integrated terminal weather system (ITWS), which provides near-term (0-30 minutes) prediction of significant weather in the terminal area. It generates products, including windshear and microburst predictions, storm cell hazards, lightning information, and terminal area winds. ITWS integrates data from radar, weather sensors, National Weather Service models, and automated aircraft reports.
- Weather and radar processor (WARP), which receives and processes real-time weather data from multiple sources for the en route environment. It prepares national and regional weather mosaics and mosaics for the



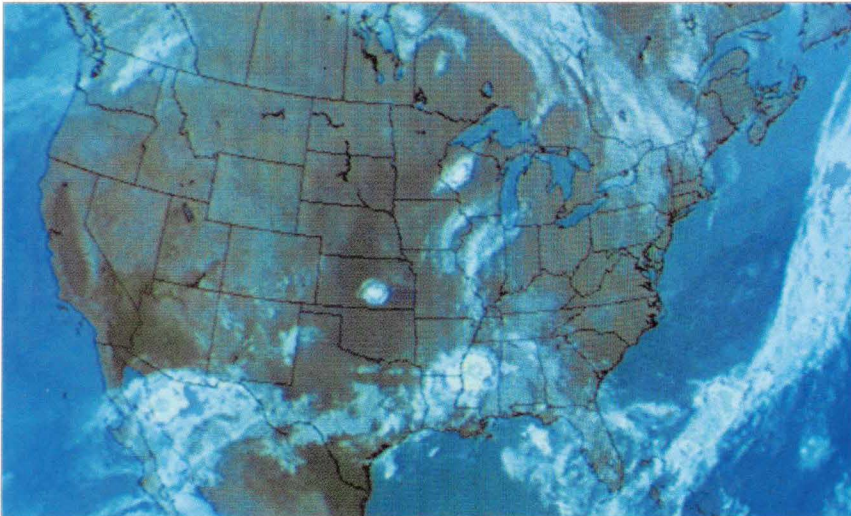
controller's displays and provides gridded forecast data from the National Weather Service to other NAS automation systems.

- Delivery of weather and other flight information services to the cockpit via a private service provider, primarily targeted to supporting general aviation users.

## Avionics

Avionics will evolve to take advantage of new communications, navigation, and surveillance-related technologies in the NAS Architecture, including:

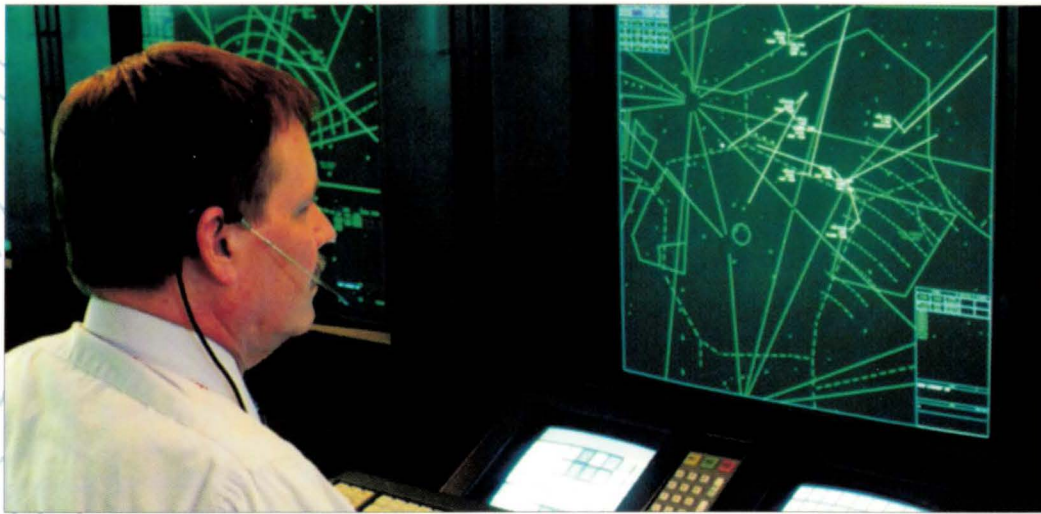
- GPS receivers that enable aircraft to navigate via direct routes and fly precision instrument approaches to virtually any runway. Combining GPS with cockpit electronic terrain maps and ground-proximity warning systems can help pilots avoid controlled flight into terrain.
- New multi-mode digital radios for voice and data communications among pilots, controllers, and various ground facilities.



## Key Influences on the NAS Architecture

Key influences on the architecture include the 1996 White House Commission on Aviation Safety and Security, which recommended that the FAA accelerate modernization of the NAS, and the 1997 National Civil Aviation Review Commission, which recommended funding and performance management methods for implementing NAS modernization.

RTCA, an advisory group to the FAA, and the FAA's Research, Engineering and Development Advisory Committee provided guidance in the operational and technical direction of the NAS.



- Digital communications technology that increases available voice channel capacity and provides a data link which enables instructions, flight information services, and graphical weather data to be sent directly to the cockpit.
- ADS-B that transmits GPS-based position, velocity, and intent information to ground stations and other aircraft.
- Multi-functional cockpit displays to present information that improves situation awareness.

Traffic alert and collision avoidance system (TCAS), which provides pilots with advisory information to prevent mid-air collisions with other transponder-equipped aircraft, will be enhanced and remain the primary safety system to prevent air-to-air collisions.

### **Free Flight Phase 1**

New tools that give controllers, planners, and service operators more complete information about air traffic control and flight operations comprise a large part of the NAS Architecture's near-term plan. Some of these tools are embodied in a program called Free Flight Phase 1 Select Capability/Limited Deployment. The Free Flight Phase 1 tools are:

- Controller-pilot data link communications (CPDLC) - a two-way data link communication

between the ground controller and pilot using predefined messages.

- User request evaluation tool/core capability limited deployment (URET CCLD) - an automated tool that assists en route controllers in identifying conflicts up to 20 minutes in advance of their occurrence.
- Traffic management advisor (TMA) single center - an automated tool that assists en route radar controllers with sequencing aircraft to terminal areas.
- Passive final approach spacing tool (pFAST) - an automated tool designed to work in conjunction with TMA to help controllers assign runways and sequence aircraft according to user preferences and airport capacity.
- Collaborative decision-making (CDM) - a real-time exchange of flight plan and system constraints data between the FAA and airline operations centers in order to work collaboratively to better manage NAS traffic.
- Surface movement advisor (SMA) - a system that provides information sharing to airline and airport personnel who plan and manage the sequence of taxi out and plan for arrivals in the ramp and gate areas at larger airports.

### **Automation Infrastructure**

Free Flight Phase 1 tools and other future tools depend on infrastructure improvements already underway, such as the display system replacement (DSR), standard terminal automation replacement system (STARS), and host/oceanic computer system replacement (HOCSR), to operate.

DSR provides new controller workstations and a network infrastructure for the air route traffic control centers (ARTCC). DSR has the capability to show weather data from the next generation weather radar. STARS is the new terminal workstation that will interface with the new sequencing and spacing tools and the advanced communications, navigation, surveillance, and weather systems. HOCSR replaces the host and oceanic processors and peripherals at the ARTCCs to solve immediate hardware supportability problems.

The NAS Architecture also plans for an integrated NAS information service - a system-wide information network, use of standardized data formats, and interoperability across applications - in order for users and providers to receive and share common data and jointly make operational planning decisions.

**America's aviation industry is soaring into the 21st Century with projected increases in business, recreation, and personal travel.**

**In order to manage this increased load on the National Airspace System (NAS), the air traffic control system and supporting services must be state of the art, led by a coordinated long-term modernization effort.**

**The Federal Aviation Administration (FAA), with the participation of the aviation community, is developing such a plan called the NAS Architecture.**

**The NAS Architecture is a blueprint for modernizing the NAS and improving NAS services and capabilities through the year 2015. The architecture's intent is to provide increased benefits to all users while increasing safety through new technologies, procedures, airspace changes, and collaboration among users and providers.**

### **Importance of the NAS**

The NAS operates non-stop - 24 hours a day, every day of the year - providing safe air transportation for millions of passengers.

The NAS includes more than 18,300 airports, 21 air route traffic control centers, over 460 air traffic control towers and 75 flight service stations, and approximately 4,500 air navigation facilities. Over 34,000 pieces of maintainable equipment including radars, communications switches, ground-based navigation aids, computer displays, and radios are used in NAS operations. NAS components represent billions of dollars in investments.

The NAS spans the country, extends into the oceans, and interfaces with neighboring air traffic control systems for international flights.

The NAS relies on approximately 30,000 FAA employees to provide air traffic control, flight service, security, and field maintenance services. More than 616,000 active pilots operating over 280,000 commercial, regional, general aviation, and military aircraft use the NAS.

It is the NAS that provides the services and infrastructure for air transportation. Air transportation represents 6 percent of the Nation's gross domestic product, so the NAS is a critical element of our national economy.

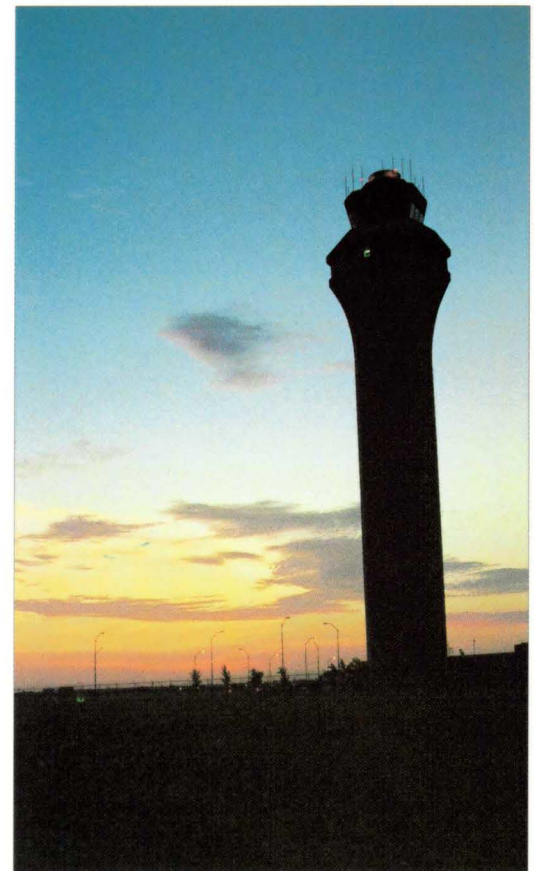
Although the U.S. has the safest aviation system in the world, we must modernize the NAS to meet the anticipated growth in air traffic, improve safety, and bring about greater efficiencies.

### **Contents of the NAS Architecture**

The NAS Architecture is based on aviation community recommendations for a Free Flight operational concept. Free Flight centers on allowing pilots, whenever practical, to choose the optimum flight profile. This concept of operations is expected to decrease user costs, improve airspace flexibility, and remove flight restrictions.

The NAS Architecture describes changes in communications, navigation, surveillance, automation tools, avionics, and computers/networks. The NAS Architecture also includes transition schedules for functional enhancements and projected costs for the FAA and users.

Implementation of the NAS Architecture is being synchronized with the International Civil Aviation Organization (ICAO) to ensure interoperability and global integration.



## Implementation Schedule

The NAS Architecture is divided into three implementation phases through the year 2015. Highlights of each phase are:

- Phase 1 (1998 - 2002) focuses on sustaining essential air traffic control services and delivering early user benefits. Free Flight Phase 1 will be implemented. Controller computer workstations will begin major upgrades. Satellite-based navigation systems will be deployed, and air-to-air surveillance will be introduced. The "Year 2000" computer problem will be fixed.
- Phase 2 (2003 - 2007) concentrates on deploying the next generation of communications, navigation, and surveillance (CNS) equipment and the automation upgrades necessary to accommodate new CNS capabilities. Satellite-based navigation systems will be further augmented in local areas for more precise approaches. New digital radios that maximize the spectrum channels will be installed. As users equip, automatic dependent surveillance ground equipment will be installed to extend air traffic control surveillance services to non-radar areas. Tools from Phase 1 will be deployed throughout the NAS and upgraded as necessary.

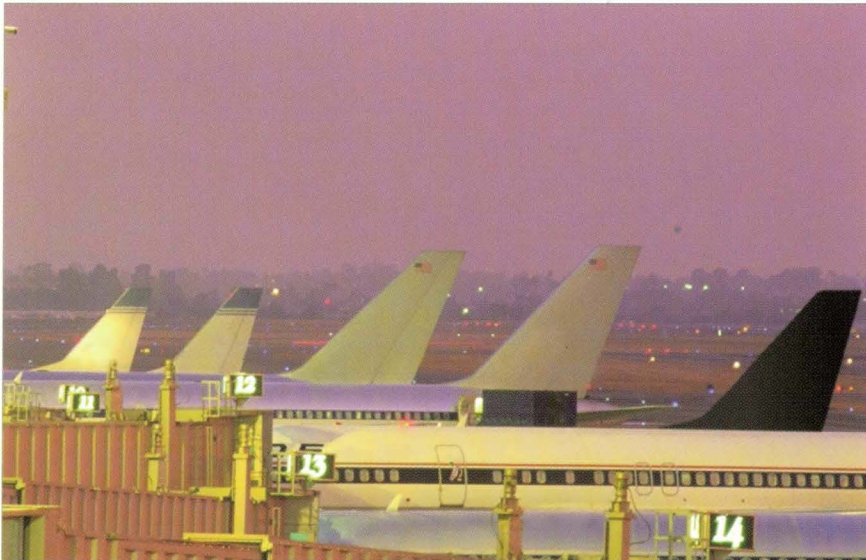
- Phase 3 (2008 - 2015) completes the required infrastructure and integration of automation advancements with the new CNS technologies, enabling additional Free Flight capabilities throughout the NAS. NAS-wide information services are planned.

The future NAS means more users flying safely and in the most efficient way. Achieving this depends on a sound plan for using the best technologies, procedures, and training, backed by a compatible infrastructure. The NAS Architecture is this plan.

## Why an Architecture?

The NAS Architecture serves various purposes for the users and service providers, including:

- **Modernization.** The architecture is the plan for evolving the NAS to handle future growth in aviation and enhance safety.
- **Evolutionary Implementation.** The architecture is structured to phase new or improved capabilities into the NAS so there is no interruption of services.
- **User Benefits.** The architecture supports increased user access to the NAS, improved operational predictability, optimal use of the airspace, reduced delays, less fuel consumption, and increased flight safety.
- **Integration.** Compared to the current infrastructure of stand-alone systems, the architecture integrates the various systems and procedures with collaborative operational planning to improve efficiency and safety.
- **Investment Guide.** The architecture is a guide for users and service providers for planning operations and making investment decisions that correlate with the future NAS.



## Learn About the NAS Architecture

Visit the NAS Architecture web page at [www.faa.gov/nasarchitecture](http://www.faa.gov/nasarchitecture).

Federal Aviation Administration  
ASD-1  
800 Independence Avenue, S.W.  
Washington DC 20591

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