28 AIRPORTS

The airport is a key component of the NAS, and this section addresses the architecture from an airport operator's viewpoint, focusing on aircraft movement from gate to gate and chock to chock through the system. This section summarizes the services, operational concepts, and capabilities associated with surface movement, landing, and departures.

28.1 Airport Operations

Airport operators are involved with many aspects of system performance, including safety, capacity, environmental compatibility, and financial performance. These may be affected by various factors, including the layout of individual airports, the manner in which airspace is organized and used, operating procedures, and the application of technology.

The primary goal is to maintain the high level of safety. This involves providing pilots with information in a convenient and useful manner, maintaining airport facilities to high standards, and providing a safe and secure aircraft operating area.

Runway capacity to accommodate the anticipated number of aircraft operations is a concern at major metropolitan airports where passenger and cargo traffic are concentrated. Inadequate runway capacity results in air traffic delays, additional expense for airlines, inconvenience for passengers, and an increased workload for the FAA air traffic control system. Experience shows that delay gradually increases as air traffic levels rise, until the practical capacity of an airport is reached, after which the average delay per aircraft operation is from 4 to 6 minutes. After this, delays increase rapidly.

An airport is considered to be severely congested when average delay exceeds 9 minutes per operation. Beyond this point, delays become volatile, and a small increase in traffic, adverse weather conditions, or other factors can result in lengthy delays that disrupt flight schedules and impose a heavy workload on the air traffic control system. Adverse weather has a substantial impact on airport capacity, especially at major hubs. The 1997 Aviation Capacity Enhancement Plan indicates that from 1992 through 1996, adverse weather was a major factor affecting NAS capacity, accounting for 72 percent of system delays greater than 15 minutes. Seven airports with an average delay in excess of 9 minutes per operation accounted for most of the severe air traffic delays in the United States in 1996.

The FAA estimates that, if demand were to increase as expected, no new runways were added to major airports, and no advances were made in air traffic control, 15 major airports would be severely congested by 2006. Capacity enhancements are expected as a result of planned new runway construction at certain airports and also from the improvements in air traffic control, such as the passive Final Approach Spacing Tool (pFAST), a new air traffic control (ATC) spacing and sequencing tool that promotes a more efficient flow of air traffic (see Section 23, Terminal). For example, the Dallas-Fort Worth Airport has successfully blended airport capacity planning and the use of pFAST to significantly increase the airport acceptance rate. The effects of these improvements will vary from airport to airport, and site-specific analyses are needed to provide a reliable estimate of the combined effect of all anticipated improvements. The FAA intends to undertake such analyses in partnership with airport operators and users to better understand the future balance between demand and capacity at major airports.

To mitigate the effects of adverse weather on airport capacity, the FAA is implementing a weather architecture in the near term, featuring systems that will be integrated into the overall NAS architecture. One of those systems, the integrated terminal weather system (ITWS) will provide dedicated, enhanced weather support to 45 of the nations's busiest airports. ITWS will receive a myriad of weather data from radars, ground-observing systems, airborne observations, and computer model output. ITWS will then process these data and provide tailored products, such as short-range forecasts of airport-impacting weather to aid traffic supervisors and controllers in optimizing runway usage during storm passage. See Section 26, Aviation Weather, for more details.

Environmental considerations are critical in optimizing airfield capacity. Noise concerns have been a major obstacle to new runway construction and have limited the use of existing runways at some airports. Future enhancements of runway capacity must be compatible with surrounding land uses. Engine emissions are also a concern. The FAA is currently investing in improvements and new technologies for the NAS that will ease ATC restrictions. There are positive environmental and economic benefits to be realized with the planned improvements in capabilities. The estimated savings in fuel used and the reduced emissions are considerable.

Airports are typically owned and operated by local government, and are supported by charges, taxes, and fees paid by airport users. Every effort is made to provide services in a cost-effective manner.

Airports have a complex interrelationship with other NAS components, and good communications among FAA, state, and local officials are essential for NAS modernization to enhance the performance of the airport system.

28.1.1 Surface Movement Guidance and Control Goals

Like the rest of the architecture, airport surface movement begins with goals and operational concepts. The All Weather Operations Panel of the International Civil Aviation Organization (ICAO) has established high-level goals that have become the basis for considering which capabilities are required and may be useful in developing improvements for surface movement operations.[1] The following subset of those goals are applicable to the NAS architecture:

- Pilots, controllers, and vehicle operators should continue to have clearly defined roles and responsibilities that eliminate procedural ambiguities—which may lead to operational errors and deviations.
- Improved means of providing situational awareness should be developed for pilots, controllers, and vehicle operators, considering visibility conditions, traffic density, and airport complexity.
- Improved means of surveillance should be in place (beyond primary radar).
- Delays in ground movements should be reduced, and growth in operations should be accommodated without increases in delays on the ground.
- Surface movement functions should be able to accommodate all aircraft classes and necessary ground vehicles.
- Improved guidance and procedures should be in place to allow:
  - Safe operations on the airport surface, considering visibility conditions, traffic density, and airport layout
  - Pilots and vehicle operators to follow their assigned routes in a continuous, unambiguous, and reliable way.
- Airport visual aids that provide guidance for surface movement should be integrated with the surface movement system.
- Air traffic management automation should provide linkages between surface and terminal to produce a seamless, time-based operation with reduced controller and pilot workload.
- Surface movement guidance and control improvements should be developed in a modular form and accommodate all airport types.
- Conflict prediction/detection, analysis, and resolution should be provided.

28.1.2 Surface Operations Characteristics

In addition to the broad goals of ICAO, the Air Traffic Services (ATS) concept of operations (CONOPS) also covers characteristics for surface movement operations and services.[2] The following operating characteristics are consistent with the architecture:

- Improve information exchange and coordination activities, including the expansion of data link capabilities, to more users at more airports.

1. *All Weather Operations Panel Working Paper (AWOP/WP756)*, Sixteenth Meeting, Montreal, June 23 to July 4, 1997.
2. *A Concept of Operations for the National Airspace System in 2005, Air Traffic Services*, September 1997.

- Use automation to enhance the dynamic planning of surface movement, balance taxiway demand, and improve the sequencing of aircraft to the departure threshold.
- Integrate surface and terminal automation so that the most appropriate runway and taxi route can be utilized for the assigned gate. Current and projected areas of congestion on the surface, runway loading, and environmental aspects such as noise balancing will be considered.
- Share information between users and service providers to create a more realistic picture of airport departure and arrival demand.
- Use automation to improve the identification and predicted movement of all aircraft and vehicles on the airport movement area and provide conflict advisories.
- Enhance safety and efficiency by planning an aircraft's movement so that a flight can proceed from deicing to takeoff without stopping.

Airport surface movement guidance and control systems will be used by aircraft and airport vehicles during low-visibility conditions. In addition, drivers' enhanced vision systems will allow better aircraft rescue and firefighting and other airport vehicle operations in low-visibility conditions. The enhanced vision systems will include forward-looking infrared cameras and monitors in vehicles.

28.1.3 Airport Security

Security at major airports is provided through interrelated security measures and resources involving the FAA, airport operators, air carriers, and passengers.

The FAA is responsible for identifying and analyzing threats to security, prescribing security requirements, coordinating security operations, enforcing regulations, and directing law enforcement activities under the governing statutes and regulations.

Airport operators are responsible for providing a secure operating environment for the air carriers and other airport users by ensuring that responsive security programs and emergency action plans are maintained, air operations areas (AOAs) are restricted and protected, law enforcement support is provided to respond to various security threats, and physical security measures for the airport are provided.

Air carriers are responsible for screening passengers with metal detectors, as well as x-raying and inspecting their carry-on articles, securing baggage and cargo areas, protecting the aircraft, and maintaining responsive security programs. Air carriers generally use contractors to perform these functions but are held accountable by the FAA for the effectiveness of the screening operation.

Federal regulations set forth specific requirements for airport security programs, physical security and access control, and law enforcement support. Access control is required for perimeter, terminal, and ramp security areas. Airport perimeter access control usually includes signs announcing restricted areas, a fence barrier around key security areas, fence and perimeter alarm sensors, and lighting of important areas.

Terminal buildings present special security problems because of the proximity of public areas to the AOA. The security plan must allow access for authorized personnel while excluding unauthorized individuals from the AOA. Access controls from the terminal concourse to the AOA must be consistent with fire code provisions regarding exits from areas of public assembly.

The state of the art in airport security is expected to improve over time through accumulated experience and the application of new technology. Changes in security practices and requirements must be thoroughly coordinated with all affected parties, particularly airport operators, because of their potential impact on the cost and efficiency of airport facilities.

28.1.4 Airports Without Air Traffic Control Towers

The United States has 5,200 public-use airports—only 419 of them have airport traffic control towers (ATCTs). Air traffic controllers in the tower provide separation between aircraft and vehicles on the surface and between aircraft in the traffic pattern. At airports without towers, the separation is conducted by the pilots themselves. However, the architecture does include significant improvements, such as the Wide Area Augmentation System (WAAS) for improved navigation and instrument approaches, to assist pilots who use these airports. Towers will be built at new airports and airports experiencing significant growth that meet establishment criteria contained in Aviation Planning Standard Number 1.

28.1.5 Airports Without Radar Surveillance

Many airports today are not covered by radar surveillance. At these airports, instrument flight rules (IFR) services rely on pilot position reports to ensure separation. This is known as a “one-in and one-out” procedure. An arriving aircraft must confirm landing before another aircraft can be cleared to take off or to start an approach under IFR. This reliance on procedural separation increases air traffic controller workload. Procedural separation is less efficient for the pilots than radar separation.

Use of the one-in and one-out procedure will increase with the introduction of instrument approaches to airports that currently do not have approaches. Many of these airports are below radar coverage. The extension of radar coverage is not anticipated in the NAS architecture. The real promise for improved separation services rests with automatic dependent surveillance broadcast (ADS-B) as a basis for automatic dependent surveillance (ADS). Aircraft equipped with ADS-B and cockpit display of traffic information (CDTI) could be cleared for approaches and departures based on either self-separation or by air traffic control facilities that receive ADS-B reports from a nearby ADS ground station. The degree to which the one-in/one-out procedure can be eliminated will depend upon aircraft equipage with ADS-B avionics and installation of ADS ground stations in areas where there is no radar surveillance. Additional details on ADS may be found in Section 16, Surveillance.

28.1.6 Satellite-Based Navigation

The Global Positioning System (GPS) and its Wide Area and Local Area Augmentation Systems (WAAS and LAAS) will provide navigation guidance for all phases of flight, including surface movement. For most airports, approaches will be based on WAAS. For those requiring the equivalent of Category (CAT) II and III approaches, LAAS will be used. LAAS will also be installed at locations where, because of mountainous terrain or high latitudes, WAAS coverage is inadequate. See Section 15, Navigation, Landing, and Lighting Systems, for a further description of the navigation architecture.

28.1.6.1 Instrument Approaches

The FAA intends to develop thousands of new GPS-based approaches, including approximately 200 approaches to heliports. These approaches are currently under development at a planned rate of 500 approaches per year. GPS-based approaches provide both course and vertical guidance. Instrument approaches with vertical guidance were expensive to provide in the past, requiring the installation of specialized, ground-based, electronic approach aids, typically an instrument landing system (ILS) or microwave landing system (MLS) for each runway end. They also required extensive amounts of unobstructed airspace.

The cost and difficulty of providing approaches with vertical guidance limited them to very busy runways, particularly those serving scheduled commercial airlines. This paradigm will shift to a concept wherein satellite-based instrument approaches will serve many runways, with approach minima being determined by such factors as terrain, obstructions, missed approach path, airport geometry, and airport and approach lighting.

For example, if a general aviation airport were seeking a new approach for a runway, a WAAS precision approach might be established to provide minima of 400 feet and 1-mile visibility. This would be adequate for most general aviation users and would not require as extensive approach lights, runway lighting upgrades, or other capital improvements as are associated with a CAT I ILS with minima of 200 feet and ½-mile visibility.

If that same runway had obstructions in the approach that could not be removed by the airport operator, the minima would be adjusted upward. GPS precision approach minima need not be equivalent to CAT I ILS minima, even though GPS with WAAS will support approaches to 200 feet and ½-mile visibility. An airport that already has a CAT I ILS would receive a GPS/WAAS approach to the same runway with the same minima that exist today. When the ILS is decommissioned, the approach capability would continue, only it would be satellite-based.

Approaches to less than 200 feet and ½-mile visibility will require local area augmentation from LAAS, which provides the accuracy, availability, and integrity necessary to support lower minima. One LAAS can accommodate all runways on the airport and is significantly simpler to install, operate, and maintain than the multiple ILSs that were needed for an equivalent capability.

GPS/LAAS is currently planned for 143 locations, ultimately replacing CAT II/III ILS systems, supporting runway upgrades from CAT I ILS to CAT II/III GPS, providing differential correction for airports where terrain or limited WAAS coverage affects performance, and augmenting ADS-B surface surveillance. Additional locations may benefit from LAAS, but airport development would be necessary to realize these opportunities.

Airport managers need to know which ground-based systems will be used to back up GPS during the transition period and thereafter. The FAA is considering a variety of options and intends to select preferred scenarios at the earliest possible date. That information will be shared as it becomes available with airport operators and state aviation agencies to help support their planning activities. The FAA will budget for transition costs related to the facilities, equipment, and services that it has provided historically.

28.1.6.2 Precision-Missed Approach Navigation

WAAS or LAAS can also provide precision-missed approach navigation, resulting in lower approach minima for those airports that have difficult terrain or obstacle clearance situations. A precision-missed approach provides course and vertical guidance. Increased precision on missed approach is tied to a concept called required navigation performance, which would change the criteria by which procedures are to be developed. The FAA is evaluating changes in terminal procedure criteria to take advantage of satellite-based efficiencies in airspace use.

28.1.6.3 Precision Departures

This capability would replace or overlay current standard instrument departures. The advantage to the airport operator is increased precision on ground tracks and the possible benefits in managing airport noise.

28.1.6.4 Nonprecision Approaches

Less precise approaches are adequate to meet the needs of some users. Avionics cost will be lower, since the avionics will not require differential correction. At every runway end with a precision approach, there will also be a published, nonprecision approach with higher minima. This redundancy is important since the nonprecision approach acts to back up the precision approach.

28.1.7 Phasing Down Ground-Based Instrument Approach Aids

The FAA expects augmented GPS will eventually meet all instrument approach needs. However, an assessment of actual satellite-based navigation performance will be made after the fielding of WAAS and certification of approach procedures. Therefore, the FAA intends to phase down ground-based navigational and approach aids (Navaids) as discussed in Section 15, Navigation, Landing, and Lighting Systems.

Decisions on the decommissioning of any ground-based Navaids will take into consideration the availability of a replacement satellite-based navigation procedure, and there will be an overlapping period of coverage at each location to allow for avionics equipage. Phase-down of airport Navaids (excluding visual aids) is expected to begin as soon as practical. The FAA intends to recover and reassign the associated radio frequency spectrum.

The FAA is initiating a study to determine how many Navaids should remain in service to provide a redundant navigational capability. The participation of airport operators and users in the study is planned. The following key service issues are to be studied:

- Developing a phase-down schedule of Navaids beginning in 2005 matched to user equipage with GPS-compatible avionics
- Identifying sufficient ground-based Navaids to support IFR navigation throughout the transition to satellite-based navigation
- Identifying which Navaids will be required to support IFR operations at key airports for general aviation, scheduled air carrier, and

commuter service operations, and along principal air routes following the transition to satellite-based navigation.

28.1.8 Surface Surveillance

Today, airport surface surveillance is provided visually by pilots, controllers, and vehicle operators. At larger airports, visual surveillance is augmented by airport surface detection equipment (ASDE-3). Due to the high cost, equipping additional airports with the ASDE-3 radar would not be feasible; however, a new program for a lower cost surface movement detection system paired with a conflict prediction capability has been approved and potential applications are being evaluated.

The airport movement area safety system (AMASS), which tracks targets, applies safety logic, and alerts tower controllers to potential surface movement conflicts, is being deployed to ASDE-3-equipped airports. This AMASS function has also been demonstrated using ADS-B. Section 16, Surveillance, contains additional details about the surveillance architecture.

28.1.8.1 ADS-B

ADS-B avionics broadcast aircraft position, speed (as derived from GPS), and other useful information (e.g., altitude, intent, aircraft identification) at regular intervals to other aircraft and ground stations. Depending on developments in the Safe Flight 21 Program, use of ADS-B for air-to-air surveillance (i.e., cockpit situational awareness) will begin in Phase 2 of the architecture. Use of ADS as a basis for airport surface surveillance is slated to begin around 2006; its use as a means of surface surveillance has been demonstrated by the FAA and the National Aeronautics and Space Administration (NASA).

Ground vehicles can be equipped with ADS-B for surface surveillance and vehicle management. Benefits such as more efficient aircraft servicing, snow removal, and airport maintenance will encourage airports to equip vehicles. As long as the message broadcasts from the vehicle and aircraft are compatible, ATC and airport surveillance capabilities can be merged.

Ground vehicle equipage costs are likely to be lower than the costs for aircraft equipage. Likewise, cheaper communications links would be possible for systems used to track ground vehicles only. Some vehicles would need to transmit position only, while others, such as operations and firefighting vehicles, would need to have targets displayed to the vehicle operator.

28.1.8.2 Cockpit Moving Maps

By combining GPS aircraft position data with an electronic map of the airport, the pilot can see the aircraft's location on a cockpit display. Adding ADS-B position reports from other aircraft and vehicles to that same display will present a complete surface traffic depiction, which could facilitate operations in limited visibility. Both NASA and the FAA have demonstrated the capability to transmit ATC traffic information via data link to cockpit displays. The advantages to airports might include reduced need for pavement fillets based on more accurate surface navigation by large aircraft and reduced reliance on lighting and signage in extremely low-visibility operations.

28.1.9 Information Sharing and Collaboration

To improve capacity and reduce delay, the architecture provides for information sharing and collaboration between users and service providers. Airports will be able to receive information through the services described in Section 19, NAS Information Architecture and Services for Collaboration and Information Sharing. This includes the flight objects, which contain the status of all aircraft flying into and from the airport. This information can be used for flight information systems within the airport terminal and for scheduling maintenance and snow removal operations. Airport systems will be able to communicate with FAA systems through appropriate information security protocols.

28.1.10 Coordination of Plans

It is essential to coordinate the NAS architecture with airport operators and state aviation agencies in order to achieve the potential airport-related benefits. The NAS architecture provides information about changes in how and when services will be provided. Locally prepared airport master and layout plans provide details about future activity at specific airports and the development that will be needed to accommodate it. Together, these documents will assist in planning capital investments, addressing future noise and emissions strategies, and identifying opportunities to provide additional services to airport users

28.2 Airport Development

Airport development—especially construction of new runways, runway extensions, and major terminal expansions—can affect the local FAA workforce, facilities and equipment (F&E) funding, and operations appropriations. Typical impacts include the need for new Navaids; construction of new towers and their necessary equipment; and relocation of existing Navaids, underground communications and power cables, radar units, weather sensors, and other miscellaneous equipment. Depending on the circumstances, the cost of this work may be shared between FAA and airport operators, with some costs paid for by airport operators through reimbursable agreements.

Changes in the NAS can result in new requirements for airport development. For example, establishing a WAAS instrument approach for a runway that does not already have an approach for comparable minimum weather conditions may generate projects to upgrade runway marking and lighting and remove obstructions. Very large investments may be needed to acquire land, relocate parallel taxiways, and otherwise bring airfields up to the standards for low-visibility operations. Airport operators will need to decide whether or not to accept the approaches.

Needed airport development that is significant to national transportation is included in the National Plan of Integrated Airport Systems (NPIAS), a biennial report to Congress by the Secretary of Transportation. Airfield capacity is the largest development category in NPIAS, accounting for 23 percent of development costs. The NPIAS contains 3,294 existing airports, but development is concentrated at the busiest airports, with 44 percent at the 29 large hub airports that each accounts for at least 1 percent of the nation's total passenger enplanements. The airfield capacity development included in the NPIAS will help alleviate congestion at many busy airports. However, certain large metropolitan areas, such as New York, will still have severe problems, and the FAA will continue to focus on the need for additional capacity at those locations.

FAA initiatives to enhance capacity are described in the Aviation Capacity Enhancement Plan. Published annually, the Aviation Capacity Enhancement Plan focuses on the top 100 airports by enplanements. It addresses the application of new procedures, technology, and airspace development to supplement and enhance airfield construction.

28.3 Airport Funding

Airport capital improvements are funded from a variety of sources. Through the F&E program, the FAA pays for most navigation and approach aids and air traffic control facilities. Other airport improvements on the airfield and in the terminal area are undertaken and financed by the airport operator, usually a state or local agency. Local funds, particularly from airport revenues and the issuance of bonds that are backed by future airport revenues, are supplemented by the Airport Improvement Program (AIP) and Passenger Facility Charge (PFC) Program.

The AIP is a federal grant-in-aid program that accounts for about 25 percent of airport capital investments. The 3,294 airports in the NPIAS are eligible to receive AIP funds, and more than 1,000 grants are issued annually.

The AIP is distributed largely in accordance with FAA priorities, and the program focuses on airfield improvements, especially those that are safety-related. The AIP is particularly important to thousands of lower-activity airports that use all of their revenues for operations and maintenance and have little ability to undertake development without financial assistance. There may be a significant future requirement for AIP grants to assist improvements—such as paving, lighting, grading, land acquisition, and obstruction removal—needed by airports to obtain additional instrument approach capability and other potential benefits of the improved NAS.

The PFC is a locally imposed charge by air carriers for each enplaned passenger. PFCs account for about $1 billion annually and are particularly important at busy airports where there are large numbers of enplanements. The FAA must authorize PFC collection and use, but the eligible uses are broad, and the use reflects the airport operator's priority. There is a tendency to use PFCs to improve passenger movement areas, such as terminal buildings and ground access systems.

28.4 Summary

The airport is a key component of the NAS. Airport operators are involved in many aspects of system performance, including safety, capacity, and environmental capability. The FAA will continue to work with airport operators to maximize the effectiveness of NAS modernization initiatives.

28.5 Watch Items

- AIP funding level and stability in funding. The AIP program helps large and small airports expand to meet aviation needs. At the current rate of aviation growth, new runways will be needed. New airports at major urban locations may also be needed between now and 2015.
- Airport development and FAA capital development need to be closely linked so that airport operators and local FAA offices can plan delivery of new capabilities more effectively.