4 NAS OPERATIONS

This architecture is based on designing a NAS that provides the level of services set forth in the joint Government/Industry operational concept and the Air Traffic Services (ATS) concept of operations (referred to jointly as the CONOPS). Both concepts of operations were coordinated with the user community and take advantage of current and emerging technologies to advance NAS operations towards Free Flight. NAS efficiency is increased while safety is enhanced by incorporating new communications, navigation, and surveillance concepts with advanced automation that provides enhanced decision support tools. This section details the NAS evolution from its current state toward one of Free Flight.

4.1 Concept of Operations

The Government/Industry Select Committee for Free Flight Implementation prepared a report that outlines a user and service provider[1] program and delineates activities for implementing the concepts and capabilities of Free Flight. The report, *Government/Industry Operational Concept for Free Flight*, presents a joint perspective of the concept of operations (CONOPS)[2] and potential procedures and technologies for achieving these capabilities. It is intended to serve as the basis for an incremental and benefits-driven approach toward Free Flight. Free Flight allows aircraft operators to choose routes, speeds, altitudes, and tactical schedules in real time, thus improving air travel. Free Flight, which combines the flexibility of visual flight rules (VFR) with the safety (traffic separation capabilities) of instrument flight rules (IFR), will offer significant potential savings in both fuel and flight time.

The ATS CONOPS, described in *A Concept of Operations for the National Airspace System in 2005*, presents the service provider perspectives on NAS operations. It also incorporates International Civil Aviation Organization (ICAO) communications, navigation, and surveillance/aeronautical telecommunications network (CNS/ATN) concepts. By implementing these concepts, the NAS will evolve to meet user needs for greater flexibility and predictability and increased efficiency. Before this operational concept can be implemented, procedures and technologies must be further developed and validated, with an emphasis on human operator considerations.

The CONOPS proposes new or improved NAS capabilities and services, new facilities and equipment, and new roles for controllers, maintenance personnel, and managers. Understanding the capabilities and limitations of controllers, maintenance personnel, and pilots in current and future NAS configurations is critical to the success of the NAS modernization.

The CONOPS is the basis for procedural, investment, and architectural decisions on the operational capabilities and services required to achieve Free Flight.[3] These operational concepts are the first steps of implementing far-reaching concepts in the evolution toward a Free Flight environment and do not describe an end-state system.

4.2 Flight Planning

To support a strategic flight planning process, a NAS-wide information network must distribute timely and consistent information for both user and service provider planning. This information network will provide a greater exchange of electronic data and information between users and service providers—while simultaneously reducing workloads. The flight planning process will

1. The term “service provider” refers to anyone who provides separation assurance, navigation/landing services, aviation information, search and rescue, or other assistance to NAS users. The terms “user” and “NAS user” refer to anyone who uses the air traffic system, specifically air carriers, general aviation (GA), and the Department of Defense (DOD).
2. In the architecture, the term CONOPS applies to both the *Government/Industry Operational Concept for Free Flight* and Air Traffic Services *A Concept of Operations for the National Airspace System in 2005*. When a specific one is referred to, it is called out in the text.
3. Free Flight is defined as a “safe and efficient flight operating capability under instrument flight rules (IFR) in which the operators have the freedom to select their path and speed in real time. Air traffic restrictions are only imposed to ensure separation, to preclude exceeding airport capacity, to prevent unauthorized flight through special use airspace (SUA), and to ensure safety of flight.” Restrictions are limited in extent and duration to correct the identified problem. Any activity that removes restrictions represents a move toward Free Flight.

be improved by exchange of current information about pilot intentions and airspace flow restrictions. This real-time information sharing will be available to users both on the ground and in the air, via data link. As conditions change during the planning phase or during flight, the pilot will be able to determine the actions required to safely continue to destination.

NAS-wide information sharing will allow increased collaboration between users and service providers for resolving strategic problems. For situations such as demand-capacity imbalances or adverse weather en route, this capability will support collaboration in determining when, where, and how to initiate a ground delay program or revise the route structure. Collaboration will increase the capability of users to minimize disruptions to their operations (see Figure 4-1).

Interactive flight planning will permit airlines to monitor their aircraft fleet activities during both routine and nonroutine (e.g., adverse weather) operations, allowing better use of resources as well as cost savings. Increasingly accurate data will be distributed simultaneously to service providers and all users. The data will include dynamic information, such as current and forecast weather, hazardous weather condition warnings, information on updated airport and airspace capacity constraints, and special use airspace (SUA) schedules.

Currently, most airline operations centers (AOCs) electronically auto-file flight plans directly to en route center host computers, while some air carriers file bulk-stored flight plans with each en route center. Individual flight plans are filed through the nearest flight service station (FSS).

Department of Defense (DOD) Base Operations file military flight plans through the FSS, or in some cases, military pilots file directly with FSS personnel. A significant portion of general aviation (GA) VFR pilots do not file flight plans and will not be required to do so. GA pilots, who do file flight plans, interact directly with flight service specialists to acquire preflight briefings, to file VFR or IFR flight plans, and to obtain inflight weather forecasts. GA pilots can file online rather than through the FSS by phone. Airborne pilots can file or change any segment of their flight plan by contacting air traffic control (ATC) or the FSS. Flight service specialists log flight plans into the ATC system via the host computer.

NAS modernization will expand user support and streamline the flight planning process. Today's process does not inform flight planners about existing and projected conditions in the NAS. The result is that the intended flight route may be altered by the tactical controller after departure. This increases both flight deck and controller workload. Interactive flight planning will increase user self-reliance for preflight services, but some level of flight service assistance will always be available to users (see Section 25, Flight Services).

To support improved planning capabilities, today's flight plan will be replaced by a flight profile. This profile can be as simple as the user's preferred path or as detailed as a time-based trajectory that includes the user's preferred path and preferred climb and descent profiles. The flight profile will be part of a larger data set called the flight object.

The flight object will be available throughout the duration of the flight to both users and service providers across the NAS. For an appropriately equipped aircraft operating under VFR, which has requested services from the FAA, the flight object may only contain the flight path, a discrete identification code, current location, and necessary information to initiate search and rescue.

For a flight operating under IFR, the flight object will be a much larger data set, including a preferred trajectory coordinated individually by the user and supplemental information, such as the aircraft's current weight, position, arrival and departure runway preferences, or gate assignment. Flight object information will be updated by the user and service provider throughout the flight.[4]

As the planner generates the flight profile, information on current and predicted weather conditions, traffic density, restrictions, and status of SUAs will be available to assist the planning. When the profile is filed, it will be automatically

4. The Flight object can be viewed as a discrete data file on the flight that is updated periodically and passed on by the NAS information network to service providers, as needed, to support that flight.

checked against these conditions and other constraints, such as terrain and infrastructure advisories. The operational reasons for requesting modifications or rejecting the flight profile will be

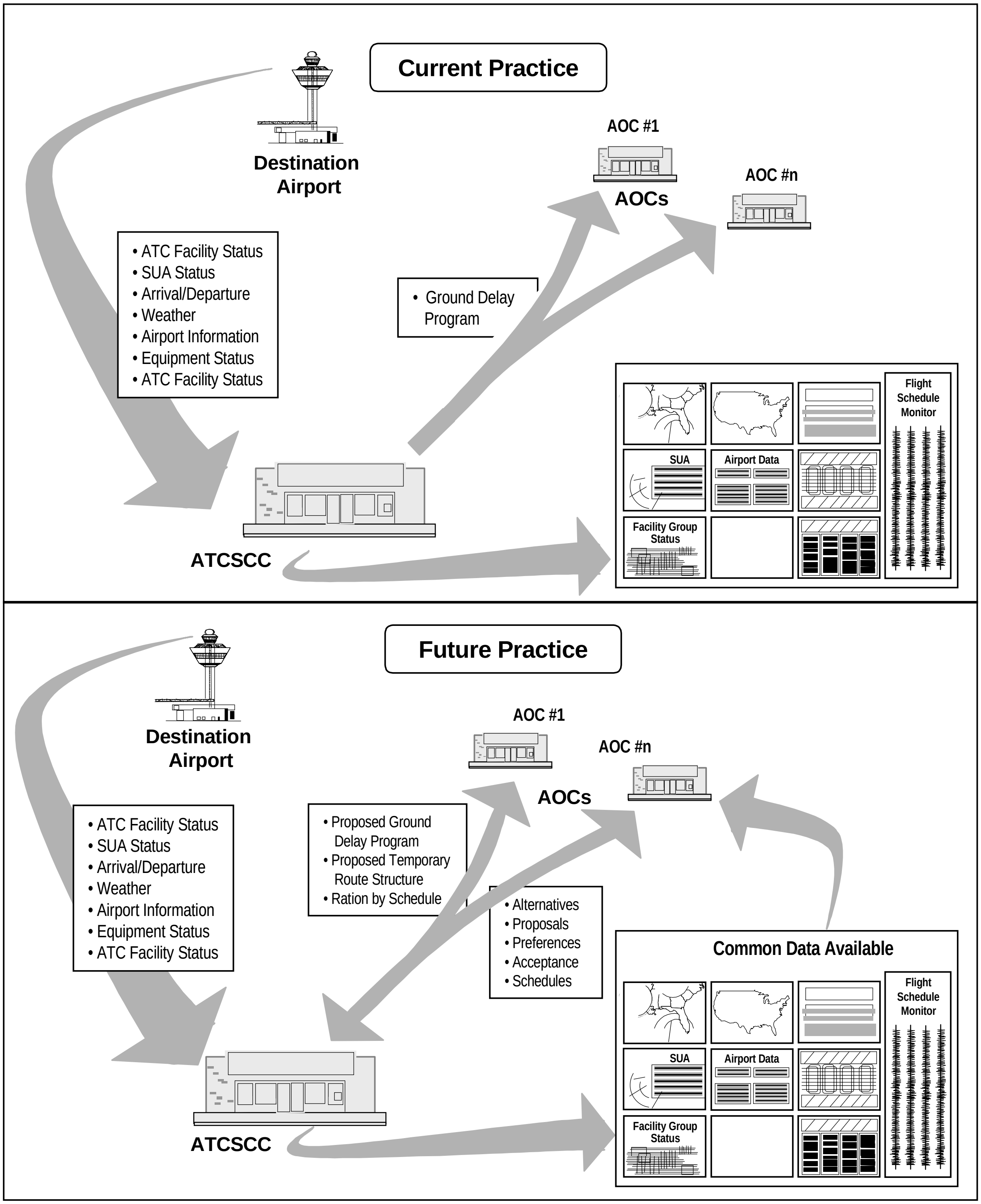

Figure 4-1. Collaboration and Information Sharing

As information sharing increases between NAS users and operators, collaboration will increase, and commercial aviation will be allowed greater control in making decisions that affect operating costs.

transmitted to the planner. After approval, the profile will be automatically distributed to service providers who will monitor the flight.

Information sharing will increase over time. Initially, data exchange between AOCs and the FAA will be the focus. As the flight object becomes more prevalent, the information available to all NAS users will be expanded to include time-based planned trajectory by flight. As information sharing and collaboration increase, NAS users will have greater influence on decisions that affect operating costs.

4.3 Airport Surface Operations

Separation of aircraft in the airport surface movement area is the responsibility of the airport traffic control tower (ATCT) (see Section 24, Tower and Airport Surface). The ATCT is also responsible for separating aircraft arriving at or departing from the airport and provides approval for vehicles to operate on airport runways. Other responsibilities include relaying IFR clearances, providing taxi instructions, and assisting airborne aircraft within the immediate vicinity of the airport (see Figure 4-2).

At today's busiest airports, surface operations often experience long delays. During low-visibility weather conditions, airport operations are dramatically slowed. Because communications are conducted via radio, frequency congestion can increase the possibility of missed instructions or confusing directions. NAS modernization will provide more efficient and safer surface operations for aircraft moving on runways and taxiways.

Users and service providers will derive significant benefits from new capabilities that improve low-visibility surface operations, taxi sequencing and

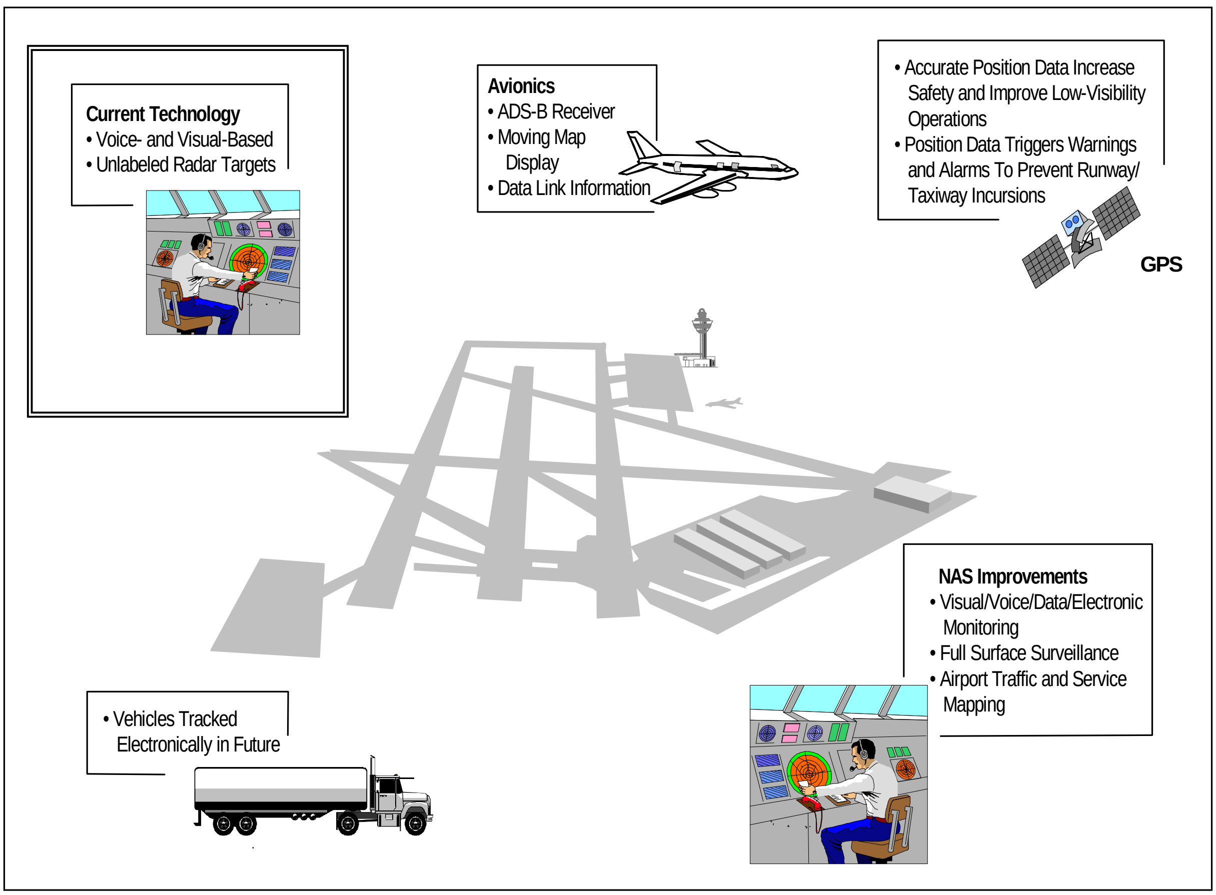

Figure 4-2. Improved Surface Operations

Improved surface operations reduce the impact of low visibility at the airport. As avionics and controller tools improve, weather-imposed delays will be minimized.

spacing, and weather and traffic situational awareness[5] in both the tower and cockpit. Faster and more reliable user/provider communications will also be realized. The use of satellite-based navigation and automatic dependent surveillance technology, updated cockpit avionics, and data link will provide the means for safer and more efficient low-visibility surface movement of aircraft and ground vehicles. These improved technologies will reduce the impact of low visibility on airport operations (see Figure 4-3).

New traffic situation displays will allow pilots, service providers, and ground vehicle operators to maintain situational awareness of all moving aircraft and vehicle traffic in their areas. This will help pilots follow taxi instructions and ground vehicle operators avoid conflicts with aircraft. Taxi operations will be possible in lower runway visual range (RVR) conditions than are possible today, reducing systemwide delays caused by weather.

Automated conflict detection and surveillance of airport movement areas, runways, and surrounding airspace will allow service providers to monitor traffic and be alerted to possible runway incursions. These capabilities will increase safety and airport capacity, and reduce taxi delays.

Surface movement decision support systems will save time and fuel by identifying the most efficient taxi sequence and routes appropriate to the departure and arrival activities. The NAS-wide information network will provide timely information about flight routes, traffic congestion, weather conditions, and destination airport operational conditions. Safety will be enhanced by reducing time between deicing operations and departures.

4.4 Terminal Area Operations

The Terminal Radar Approach Control (TRACON) provides separation and sequencing of aircraft in the terminal airspace (see Section 23, Terminal). Current TRACON operations consist mainly of standard departure and arrival routes coupled with radar vectors.[6] To improve traffic flow, departing aircraft are often vectored off the standard departure course until they can safely resume navigation along their filed route. The arrival sequence is established by vectoring aircraft and instructing them to begin descent, sometimes well before the terminal area, which results in excess fuel consumption.

NAS modernization—with augmented satellite-based navigation, automatic dependence surveillance, data link, and fully automated traffic flow management technologies—will support more flexible use of terminal airspace. Augmented satellite-based navigation will increase the number of runways available for IFR operations by providing precision approach capability to runways that lack this capability today.

Satellite-based navigation and automatic dependence surveillance will be used to establish low-altitude direct routes apart from the normal arrival and departure flows for each runway configuration used by airports. The low-altitude routes (including vertical flight) will support a segment of the user community that flies short routes between major terminal areas, providing reduced flight mileage, fuel consumption, and flight times.

Current arrival and departure procedures are based on flying fixed ground site radials (course) or distances, which are often oriented away from the destination airport. Many current arrival and departure procedures require aircraft to switch between ground navigational aids (Navaids) during critical phases of flight. Preferential arrival and departure procedures will be developed using the new capabilities inherent in satellite-based area navigation. Satellite-based navigation routes and approaches will be based on an earth geo-coordinate system that will provide accurate aircraft positions in relation to desired flight paths. This will allow aircraft to use a greater portion of the airspace around airports, increasing terminal airspace capacity.

New cockpit and ground system technologies will work together to improve traffic flow. The current practice of allowing pilots to maintain aircraft-to-

5. Situational awareness is knowledge about one's surroundings and intentions. Any improvements that can be made to increase a pilot's situational awareness will have a direct effect on increased safety and operational efficiency. Flight management systems, data link, heads-up displays, and multiple-function cockpit displays will assist in improving pilot situational awareness, providing that adequate human factors work is incorporated to prevent information overload.

6. A vector is a heading issued by controllers.

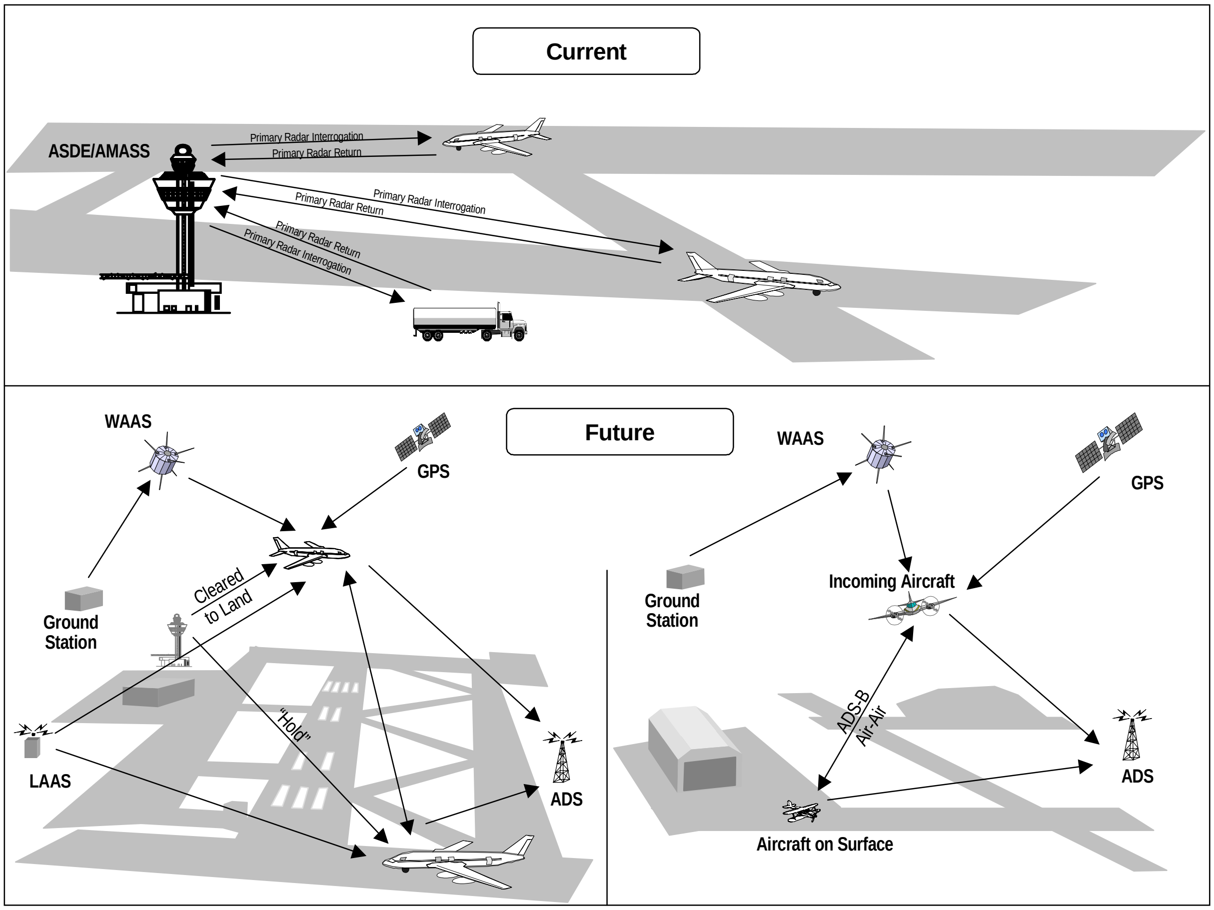

Figure 4-3. Improved Surface Movement Detection

As ADS-B equipage increases, smaller airports will benefit from better awareness of the location of aircraft and airport traffic, thereby reducing the potential for runway incursion incidents.

aircraft separation during visual weather conditions will be extended to instrument weather conditions, using cockpit display of traffic information (station-keeping), when operationally appropriate. Automated decision support tools will assist controllers in integrating departures with arrivals. Time-based metering techniques will be used to sequence and merge arrivals in accordance with users' preferences. Computerized conflict detection and resolution tools will allow service providers to monitor arrival and departure paths throughout the terminal airspace.

New terminal arrival/departure routes, based on satellite navigation, will reduce the number of vectors to airport areas. Users will receive the most expeditious route to the airport, but some radar vectoring or speed control will still be necessary to merge aircraft onto final approach. Airport capacity will be increased during instrument weather conditions by using simultaneous approaches to closely spaced parallel runways. Controllers who monitor precision approaches will be assisted by automation systems that more accurately track aircraft and calculate closure rates, vector geometries, and wake turbulence. Users will monitor adjacent traffic via cockpit display information, which will augment visual separation (see Figure 4-4).

New terminal procedures, cockpit avionics, and improved navigation and automatic dependence surveillance capabilities will enable aircraft to fly optimum climb and descent profiles. Departing aircraft will be able to fly optimum climb profiles, conserving fuel and reaching cruise altitude sooner. Arriving aircraft will remain at cruise altitude and begin descent closer to the airport. Exposure to lower-performance aircraft in low altitudes will be reduced.

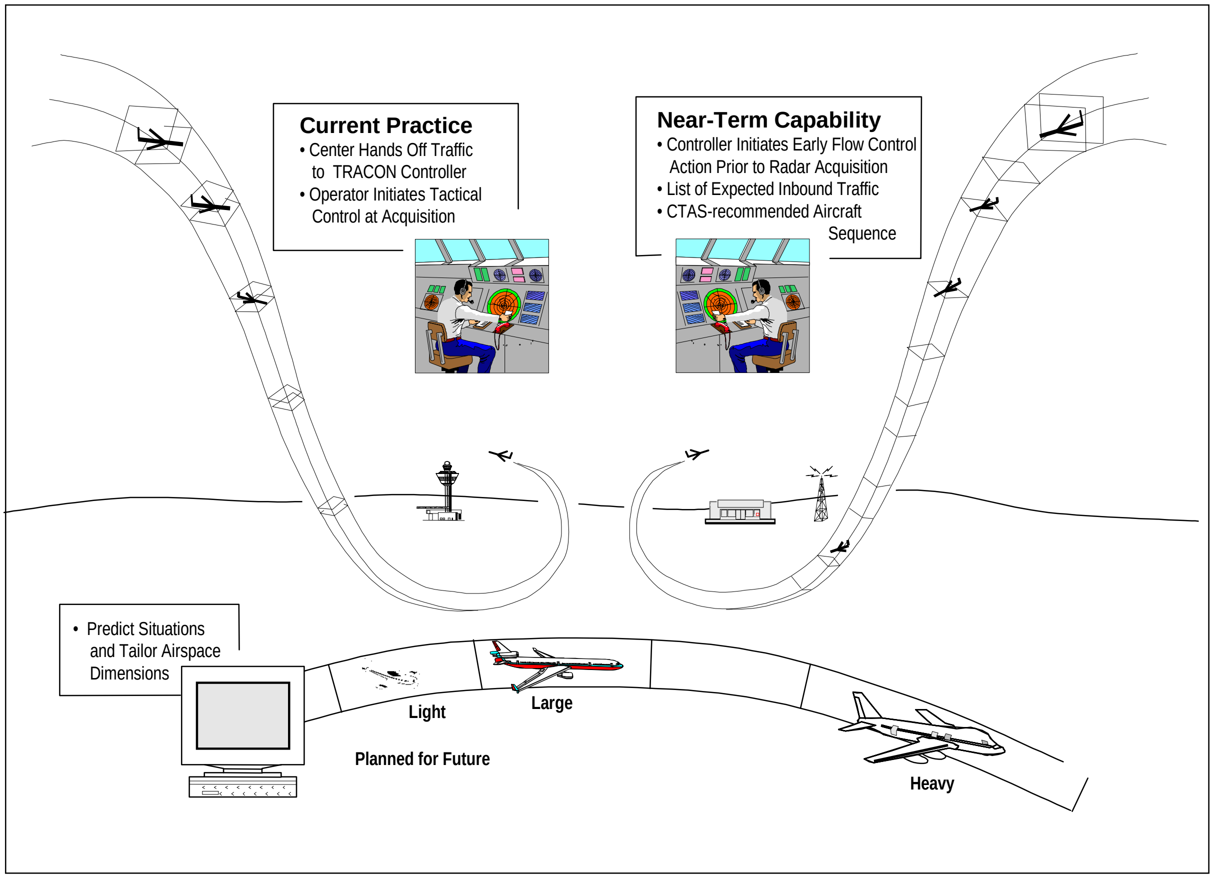

Figure 4-4. More Efficient Operations for Arrivals and Departures

Improved arrival and departure sequencing enables more planes to land or leave an airport during peak operating hours. This will alleviate the need for new runways at some airports.

Airport information, including weather reports, will be sent via data link to arriving aircraft approaching terminal areas. Data link will enable controllers and pilots to communicate using direct, addressed messages in conjunction with current voice radio communications. A direct benefit will be increased availability of voice communications channels. Data link is also expected to reduce the incidence of misinterpretation and operational degradation due to radio transmission blocking.

As satellite-based navigation augmentation is implemented, satellite precision approaches will become available throughout the NAS. This provides instrument precision approaches to many airports that currently do not have this capability. This will relieve some of the traffic congestion at major hub airports during IFR operations, easing the workload on both pilots and controllers, while allowing expanded use of other airports. The availability of additional precision approaches will provide an important safety benefit for a large segment of the aviation community and allow increased service to a greater number of airports.

4.5 En Route (Cruise) Operations

Air route traffic control centers (ARTCCs) provide en route ATC services through a ground-based network of radars, communications, and automation systems. Existing decision support tools for en route service providers are limited.

Evolving digital technologies, coupled with satellite-based navigation, automatic dependent surveillance capabilities, and cockpit avionics, will improve the way en route air traffic is managed in the future (see Section 21, En Route). Pilot situational awareness will be increased through improved cockpit avionics. The avionics will display critical flight safety information, such as weather, nearby traffic, terrain features, SUA status, notices to airmen, and significant weather advisories. Cockpit displays of real-time weather, such as heavy rain, lightning, and other thunderstorm activity, will assist pilots in avoiding hazardous conditions, thereby increasing flight safety.

Increased air traffic situational awareness of users and service providers will allow pilots to assume more responsibility for separation, routes, altitudes, and airspeed (i.e., Free Flight). The ability of air crews to dynamically select optimum routes, altitudes, and speed will be enhanced by improved communications, navigation, and automatic dependent surveillance technologies. This saves time and fuel, enabling users to make more cost-effective decisions and increasing the NAS flexibility.

Air traffic management procedures will incorporate advanced decision support tools to ensure positive separation of aircraft, while allowing maximum aircraft performance and flight path flexibility. The en route automation systems will enable a more flexible structuring of airspace and reduce current boundary restrictions. The airspace structure will be evaluated and adjusted, as necessary, to handle the demands of traffic flow or in response to weather conditions, and SUA and other NAS operational restrictions. Most en route communication and reporting will be done via data link, leading to faster and more reliable information exchange and allowing crews to more efficiently perform route and altitude planning (see Figure 4-5).

Some of the existing Navaids and airway route structures will be decommissioned consistent with the performance of satellite navigation. Routes will be retained to manage continuous high-traffic densities, terrain separation, and SUA, and to facilitate transition between airspace

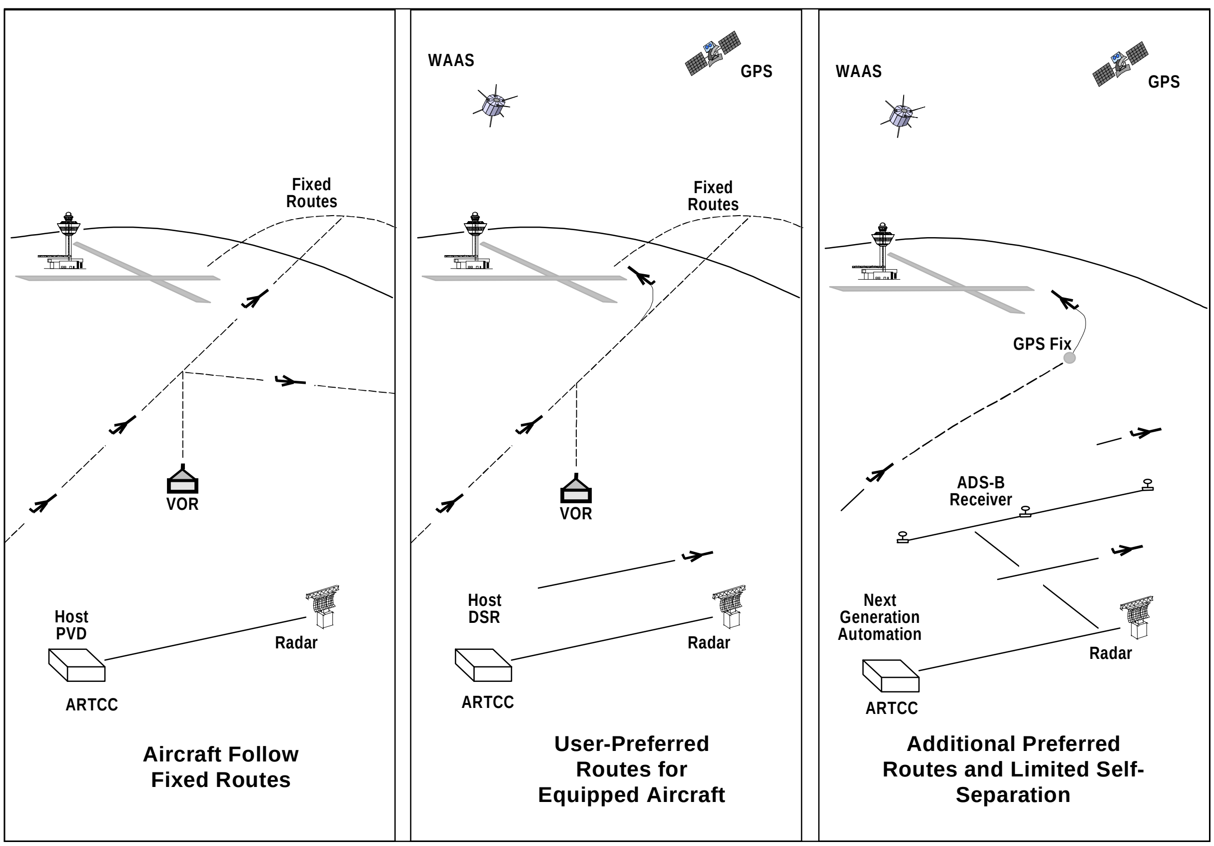

Figure 4-5. Aircraft Fly Preferred Routes

Enhancement in en route navigation and surveillance will allow users to fly preferred direct and wind-aided routes more often. This saves time and fuel, enabling users to make more cost-effective decisions and increasing the flexibility of the NAS.

with different separation standards. En route low-altitude direct routes will be implemented so that regional, business, GA, and other users whose aircraft operate most efficiently in low altitudes can benefit from Free Flight. Satellite-based navigation and procedural changes will enable lower-performance aircraft to fly desired routes at altitudes that are optimum for fuel consumption and cruise speeds.

Broadcast and processing of aircraft position and speed using automatic dependent surveillance will support air traffic services in areas not covered by ground-based radar. More accurate barometric altitude reporting will enable vertical separation above 29,000 feet to be reduced. The new capabilities, when available, will allow users to fly optimal altitudes and flight paths, thus reducing flight times and fuel consumption. A global grid of locations, defined by latitude and longitude coordinates, will augment the remaining fixed IFR routes. These grid locations will be used to define routes and transition points.

4.6 Oceanic Operations

Currently, en route and oceanic facilities are co-located in ARTCCs, but do not share communications or automation systems. In addition, oceanic controllers rely upon pilot voice position reports via high-frequency radio. The vast oceanic airspace has no ground infrastructure of Navaids or VHF radio communications. This unique operating environment has forced the en route and oceanic domains to evolve separately. As the capabilities in aircraft and on the ground improve, en route and oceanic cruise operations will become increasingly similar.

Today's oceanic operational capability is constrained by lack of surveillance, poor communications, and limited controller automation tools. Oceanic service providers use "time and distance" separation procedures based on periodic aircraft position reports relayed by a commercial service provider to oceanic ATC facilities. Some specially equipped aircraft (with the future air navigation system (FANS-1/A)) fly flexible tracks in the Central Pacific that reduce distance, separation, flight times, and fuel consumption.

Oceanic aircraft are equipped with the latest navigation avionics, such as GPS receivers and inertial navigation systems (INS), to compensate for the lack of ground-based navigation systems. In-trail climbs and descents are now available for aircraft equipped with the Traffic Alert and Collision Avoidance System (TCAS), allowing greater fuel efficiency and flexibility.

Cockpit traffic display avionics will extend pilot situational awareness. Automatic dependent surveillance broadcast (ADS-B) is expected to provide additional operational gains by allowing oceanic aircraft to laterally pass other aircraft at the same altitude by establishing an aircraft offset track. Using cockpit displays, the pilot will be responsible for maintaining minimum lateral separation from other aircraft and rejoining the original flight track (see Figure 4-6).

Oceanic operations will improve with NAS modernization (see Section 22, Oceanic and Offshore). Service providers will have a surveillance capability by means of automatic dependent surveillance addressable (ADS-A), and new automation displays. New advancements in ATC decision support tools, data link communications, surveillance, and navigation will facilitate merging domestic en route and oceanic control methods. As a result of these new capabilities, separation standards may be decreased, thereby increasing capacity.

Communications and coordination between users and service providers will be improved to a real-time capability by means of satellite communications (SATCOM) and/or high-frequency data link (HFDL). The FANS-1/A-based data link environment will evolve to one that includes ICAO/ATN-compliant communications and application services.

Any changes made to the NAS portion of oceanic airspace will be coordinated through ICAO. Coordination and information exchange between adjacent flight information regions (FIR) will be provided by interfacility data communications. Flight plans and flight progress information will be transmitted to adjacent FIRs in ICAO format.

4.7 Traffic Flow Management

Traffic flow management (TFM) optimizes airspace capacity for all phases of flight, based on demand and weather. The TFM system organizes traffic nationally and locally in order to balance

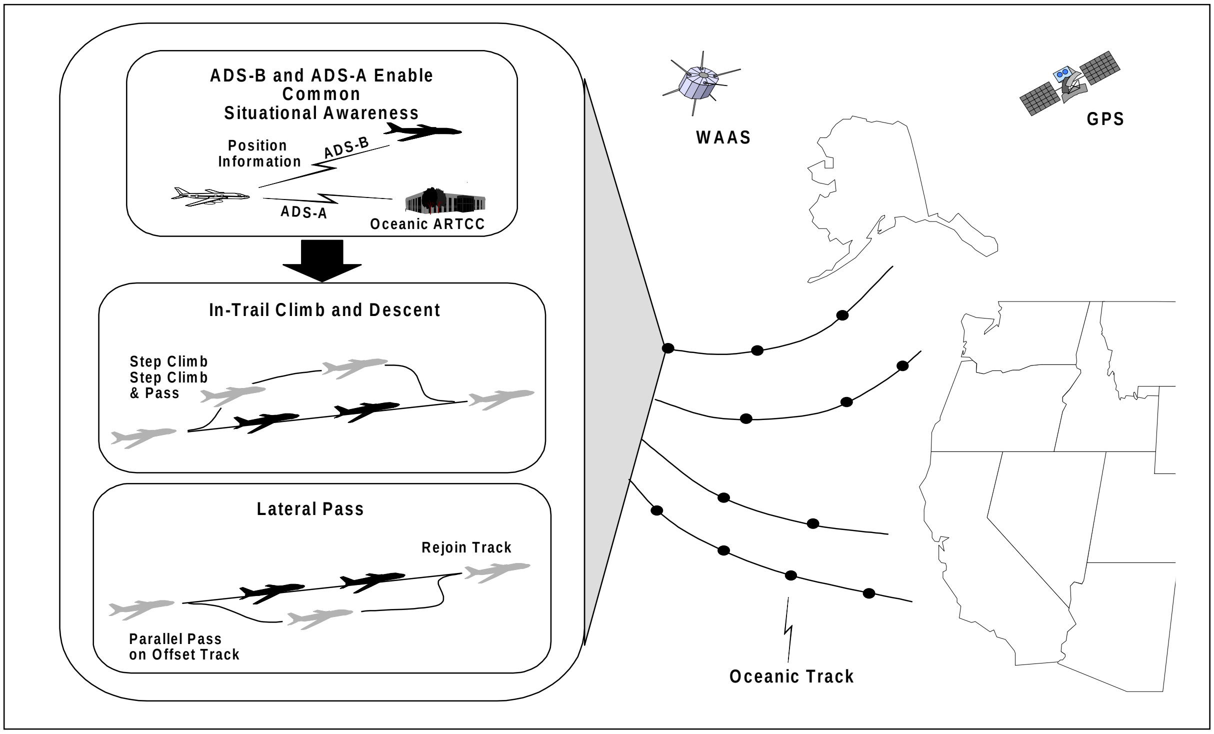

Figure 4-6. Improved Oceanic Operations

In oceanic environments, properly equipped aircraft will benefit from reduced separation standards. This will enable them to fly more wind routes and allow limited oceanic "passing" capabilities.

capacity and demand throughout the NAS (see Section 20, Traffic Flow Management). At airports, TFM determines and manages airport acceptance rates adjusted for winds, severe weather, runway configuration, operational factors, and equipment outage.

In the future, TFM, in collaboration with users, will employ both ground delays and airborne flight metering to manage traffic to meet the airport/sector acceptance rate. Instead of being assigned arrival slots at specific times for each flight, each user will be allocated a set number of arrivals within a specified time frame. Users will schedule departures to meet the designated arrival times.

TFM will monitor all SUA to identify availability of airspace for general use. Allocating inactive SUA to civilian users will optimize use of this shared resource. This requires strategic and tactical airspace management based on planned and actual movements of aircraft in real time.

To improve strategic planning, new tools will enable the FAA and users to evaluate operational activities at the end of each day. The tools will simulate the impacts of various decisions. In this manner, more efficient "game plans" between the FAA and the users will be developed. These strategic plans can then be implemented by NAS users and service providers to ensure that operations proceed smoothly and delays are minimized.

4.8 Managing the NAS Infrastructure

Many internal agency functions support the array of new technologies and operations that characterize the modernized NAS (see Section 27, Infrastructure Management). In the maintenance area, infrastructure maintenance activities will be monitored on a day-to-day basis. This service will be based on a national perspective rather than individual elements of the NAS infrastructure. It will increase the use of remote monitoring and control and facilitate collaboration between service providers and users, allowing users to participate in prioritizing scheduled and unscheduled repairs to essential NAS equipment.

4.9 Summary

NAS modernization emphasizes user benefits, technology insertion, and new procedures. The flight-specific and generalized operational descriptions are drawn from the anticipated flight operations, which range from clearance delivery to arrival at the destination airport using NAS enhancements derived from the modernization plans.

The essential focus is the Free Flight vision of a future NAS that permits users to fly without the constraints of today's structured routes and airspace. Air traffic restrictions are imposed to ensure separation, preclude exceeding airport capacity, prevent unauthorized flight through SUA, and ensure flight safety. This shift will be made possible by decision support tools for controllers, an enhanced pilot role in separation assurance using advanced cockpit avionics, use of space-based navigation aids, and use of a dynamic collaborative decisionmaking process. NAS modernization represents an approach that takes advantage of technology used in conjunction with new requirements and standards. NAS modernization will help the FAA operate more efficiently and enable the agency to be more responsive to user requests while maintaining the highest level of safety.

The current CONOPS is not an end state and it will be adjusted in collaboration with the user community as the NAS is modernized. The CONOPS will accommodate changes that will likely result from lessons learned from implementing new capabilities and potential benefits of new technology.