Mead &Hunt

Appendix E – NextGen Appendix

PART 150 STUDY
JACKSON HOLE AIRPORT

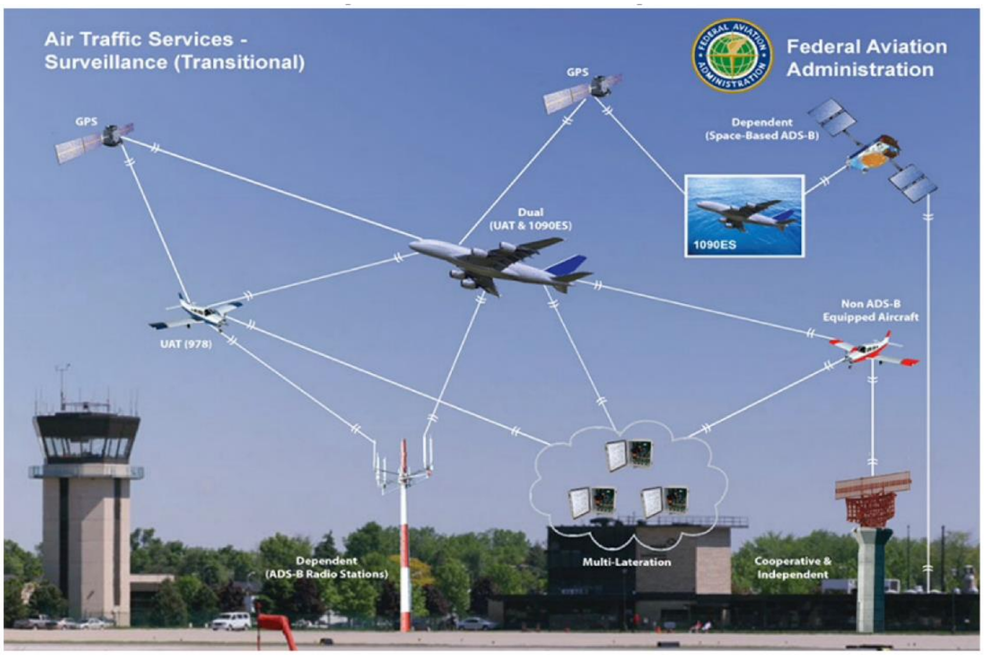
NEXTGEN BACKGROUND

This appendix is intended to supplement the information provided in the chapter to give additional technological background to NextGen.

ADS-B Services

ADS-B, an enabling technology program, is a critical surveillance component to the implementation of NextGen. ADS-B uses GPS signals to determine aircraft location instead of radar. Aircraft operating in controlled airspace must be equipped with ADS-B Out by January 1, 2020. ADS-B Out will broadcast an aircraft's position to the FAA air traffic control (through an ADS-B ground station) and to other aircraft that are equipped with an ADS-B transmitter/transceiver. As of January 1, 2015, approximately 8,800 general aviation (GA) aircraft are equipped for ADS-B Out and approximately 225 commercial aircraft are equipped with ADS-B avionics. This is approximately 4% of the GA fleet in the United States; according to the General Aviation Manufacturers Association, in 2013 there were approximately 209,000 GA aircraft registered in the United States. **Figure 1.1**, ADS-B Architecture, shows how the components of ADS-B communicate with aircraft and air traffic control facilities.

Figure 1.1
ADS-B Architecture



Source: Federal Aviation Administration, January 2015

Traffic Information Service – Broadcast (TIS-B), Flight Information Service – Broadcast (FIS-B), and Automatic Dependent Surveillance Rebroadcast (ADS-R) provide aircraft equipped with ADS-B **In** with situational awareness of other aircraft within a 15 NM radius (+/- 3500 feet). The traffic information includes:

- Altitude
- Ground track
- Speed and distance of other aircraft
- Airport surface data
- Graphic based weather data
- Text based weather advisories
- Notices to Airmen (NOTAM)

Installing an Automatic Dependent Surveillance–Broadcast (ADS-B) receiver in the cockpit provides a situational display and an audio alert to warn the pilot of approaching traffic. ADS-B has two basic services: ADS-B **Out** and ADS-B **In**. ADS-B **Out** broadcasts the aircraft's position to other aircraft and the Air Traffic Control (ATC) systems through an onboard transmitter to provide a target on the controllers display.

ADS-B **In** enables an aircraft to receive the ADS-B **Out** broadcasts from other aircraft to provide the pilot with a cockpit situation display showing other aircraft flying nearby. If aircraft are flying intercept courses, the ADS-B **In** avionics will sound an alert, enabling the pilots to take evasive action to avoid a collision.

ADS-B **In** provides additional benefits specific to general aviation aircraft, including receiving and displaying weather and other aeronautical information to enhance pilots' situational awareness of in-flight hazards and help prevent accidents. Three types of FAA broadcast services provide benefits to pilots of ADS-B **In**-equipped aircraft:

- **Traffic Information Service–Broadcast (TIS-B)**: This advisory service provides the altitude, ground track, speed and distance of aircraft flying in radar contact with controllers and within a 15 NM radius, up to 3,500 feet above or below the receiving aircraft's position. A GA aircraft equipped with ADS-B In can also receive position data directly from other aircraft broadcasting on the same ADS-B Out frequency. TIS-B also enables pilots to see Non-ADS-B equipped aircraft with transponders flying nearby.

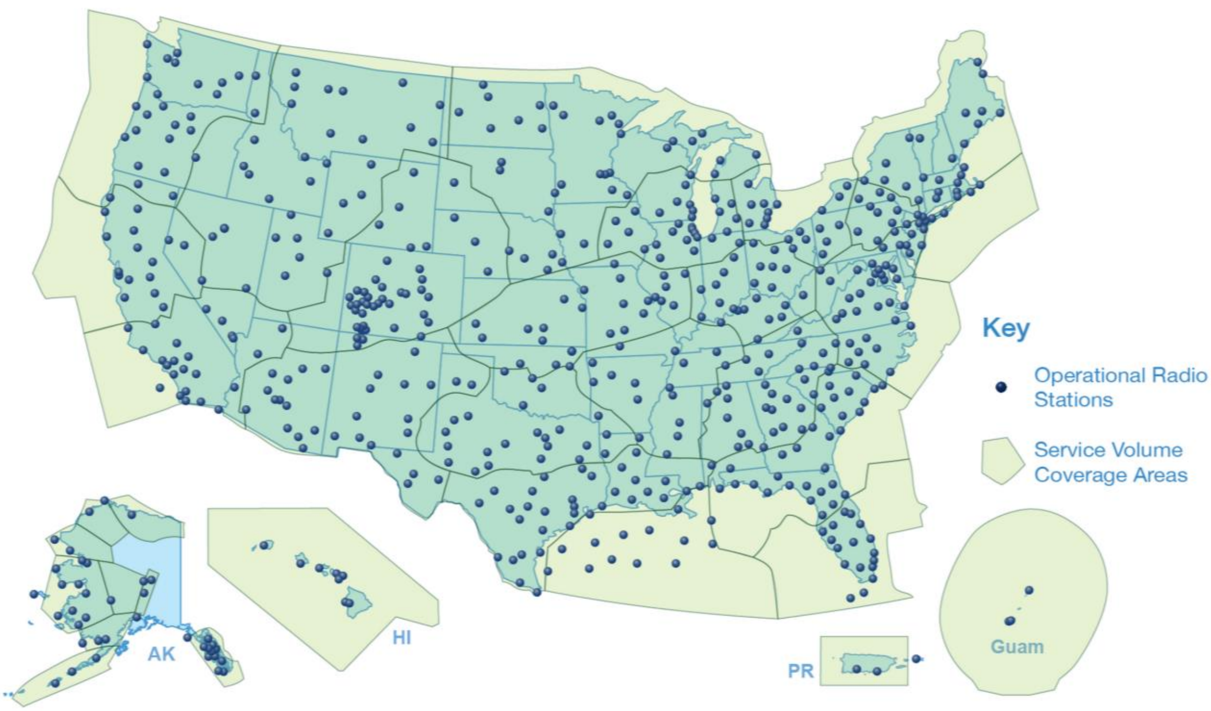
- **Automatic Dependent Surveillance–Rebroadcast (ADS-R)**: ADS-R takes position information received on the ground from equipped aircraft and rebroadcasts it to commercial aircraft. In concert with TIS-B, ADS-R provides all ADS-B In-equipped aircraft with a comprehensive view of the airspace and airport situation. ADS-R delivers traffic data within a 15 NM radius 5,000 feet above or below relative to the receiving aircraft's position.

- **Flight Information Service– Broadcast (FIS-B)**: This service broadcasts graphical and text-based weather information to the cockpit, providing a weather radar-like display similar to commercial aircraft, without the need to invest in expensive radar avionics. In addition, FIS-B broadcasts text-based advisories including Notice to Airmen messages and reports on significant weather such as thunderstorm activity. Properly equipped general aviation aircraft can receive this information at altitudes up to 24,000 feet.

The FAA has completed the baseline deployment of more than 600 ADS-B ground stations, making TIS-B, ADS-R and FIS-B services available across the United States. FAA is working with the aviation community to set standards for how ADS-B In provides pilots with a low-cost traffic alerting capability that included flight testing in 2013.

The traffic alert application uses ADS-B data to identify conflicting traffic nearby, alerting the pilot to look out the window and see the traffic being called out. Hopefully, the new rules and regulations for ADS-B In will be completed prior to the mandate to equip with ADS-B Out with sufficient time for manufacturers to provide both ADS-B Out and In equipment to meet the ADS-B Out mandate. All things considered, ADS-B will be an attractive option for general aviation. **Figure 1.2**, *ADS-B Ground Stations*, shows the location of the over 600 ground stations. There are nine ADS-B stations in Wyoming.

Figure 1.2
ADS-B Ground Stations



Source: Federal Aviation Administration, February 2015

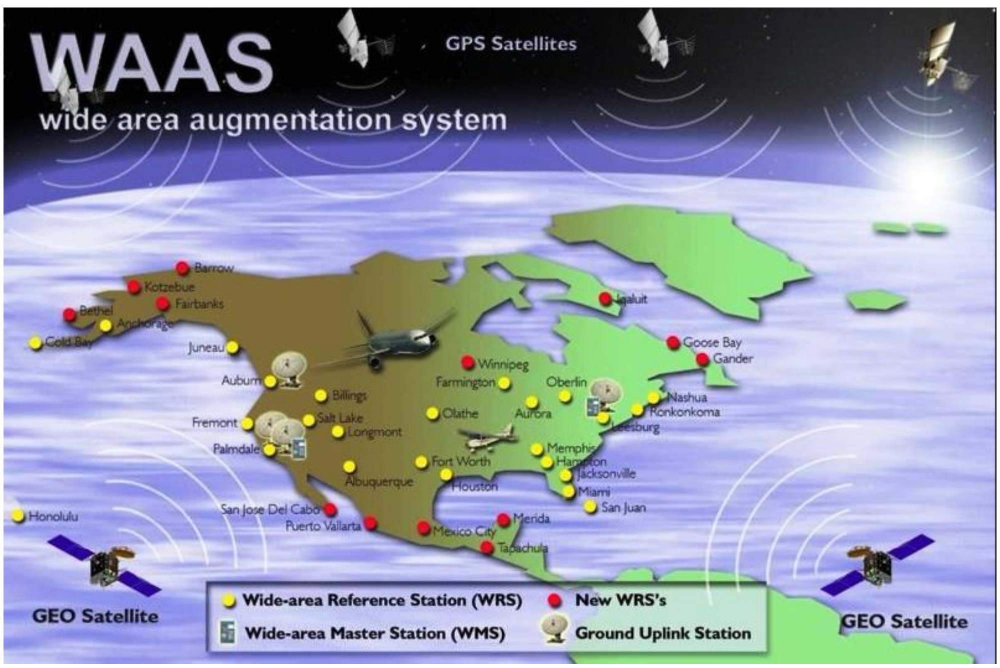
ADS-B Out equipped aircraft will also receive traffic and weather information for display on some mobile devices. Many general aviation pilots routinely use electronic tablets (such as iPads) to view aeronautical charts, so using these devices to depict weather and traffic information is a natural fit. The FAA is also exploring the possibility of setting standards for battery-powered ADS-B Out transmitters that can be used on gliders and general aviation aircraft certificated without an electrical system.

In the Jackson Hole area, the baseline ADS-B infrastructure is complete. TIS-B, ADS-R, and FIS-B are available services to equipped users.

WAAS Progress

The Wide Area Augmentation System (WAAS) provides general aviation pilots with Area Navigation (RNAV) capabilities that in many cases rival or exceed what commercial aircraft have. WAAS enables vertically guided approach procedures to any qualifying airport in most of North America with minimums as low as 200 feet decision altitude (DA), without the need to install costly Instrument Landing System (ILS) equipment. These minimums can be lower than other conventional based navigation aide (NAVAID) approaches. When rising terrain is an issue near an airport, precise vertical guidance enhances safety regardless of visibility and whether the approach is being flown during the day or at night. **Figure 1.3**, *WAAS Infrastructure*, shows the current satellite and ground stations.

Figure 1.3
WAAS Infrastructure



Source: Federal Aviation Administration

As of December 2014, the FAA has published 3,450 WAAS-enabled approach procedures that feature Localizer Performance with Vertical Guidance (LPV) minima. There are 2,326 of those LPVs at airports where no ILS is available. LPV provides an access benefit especially to GA aircraft.

Users say that LPV procedures are more accurate and easier to fly than ILS approaches because the flight paths are generated within the aircraft avionics, rather than from ground-based signals that are plagued by beam bends and interruptions from aircraft taxiing on the airport surface. Nationwide, more than 70,000 general aviation aircraft are equipped with the WAAS receivers needed to fly WAAS-enabled procedures with LPV minima or WAAS-enabled non-precision approach procedures with Localizer Performance (LP) minima. RNAV (GPS) approaches with LPV minima to airports that have no ILS now make these destinations accessible when visibility is limited, rather than ruling them out, thus enhancing airport access for many users.

The FAA has also published 560 RNAV (GPS) non-precision procedures as of December 2014, with LP minima that employ WAAS for lateral guidance but without the added safety benefit of vertical guidance. These approaches are needed at runways where obstacles or other infrastructure limitations prevent the FAA from publishing a vertically guided approach. Non-precision LP minima are generally higher than LPV minima, with somewhat reduced airport access in poor weather.

The FAA plans to meet any new requirements for Category 1 approach procedures with WAAS and LPV while maintaining an existing network of Instrument Landing Systems (ILS) to provide alternative approach and landing capability. The agency also intends to transition from defining airways, routes and procedures using VOR, and more to RNAV procedures using GPS and DME/DME/IRU (inertial reference unit) in the National Airspace System. An IRU is an internal navigation system used on large aircraft. The network of Distance Measuring Equipment stations provides an RNAV-backup to GPS for suitably equipped commercial aircraft. A Minimum Operational Network of VOR stations (VOR MON) will be maintained to provide a conventional navigation capability for aircraft that don't have DME/DME/IRU avionics.

The current en route air traffic control structure will also migrate away from VOR navigation to RNAV. But instead of merely replacing the existing VOR airways with RNAV routes, the en route system will adopt a new concept called "Structure Where Necessary, and Point-to-Point Navigation Where Structure is not Needed." This phrase simplifies the overall plan for redesigning the en route system. "Structure where necessary" means that PBN routes will not replace VOR airways one-for-one. Instead, PBN routes will be published where they are actually needed, for example between Chicago, Boston, New York, Washington, Atlanta, and along the North-South corridor of the west coast. Many VOR routes are not used and ATC relies on playbooks, wind routes, and other uncharted traffic flow schemes instead of the published routes to actually make the system work. The existing route system of VOR airways is no longer needed.

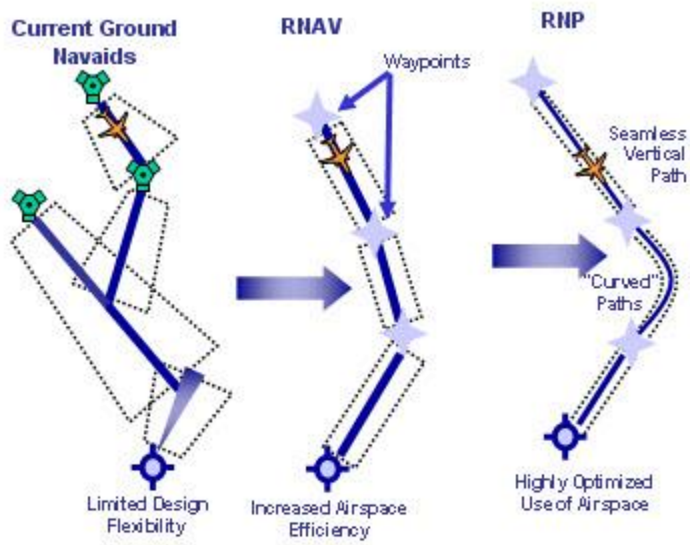
"Point-to-Point Where Structure is not needed", means that outside of the busy en route flows, there is no need for published routes and aircraft will fly point-to-point direct. Reality is that most aircraft file flight plans based on VOR airways and then after they are airborne ask for a more direct route so the airways are really not used for other than a flight planning exercise and for radio outage procedures, neither of which is a sufficient justification for keeping them. The intent is to provide an en route system that matches how aircraft actually fly and for how ATC manages the flow.

As the NAS has modernized, communications, navigation, surveillance, and automation systems will enable the majority of traffic outside congested areas to proceed to their destination using the most direct great-circle routes without the need for dedicated airways. RNAV Q and T Routes (high altitude routes) will be established where structure is needed for en route traffic. Overall, the expectation is that the majority of VOR airways will be removed and a smaller number of Q/T Routes will replace them.

PBN Navigation

One of the opportunities NextGen offers is Performance Based Navigation (PBN), which allows more efficient use of airspace through point-to-point navigation. Rather than restricting flight paths between ground-based radio navigation systems. PBN procedures consist of RNAV and Required Navigation Performance (RNP). The FAA's strategy for implementing PBN is to provide "RNAV Everywhere and RNP Where Beneficial." All RNAV and RNP approach procedures rely on satellite-based navigation, breaking free of the dependency on Ground Based Navigation Aids. PBN enables procedure designers to maximize efficient use of the airspace, altering the traditional flight paths around an airport. While the FAA ultimately has responsibility for defining the airspace system, it is the airport that has had to deal with the brunt of local community issues, such as airport noise. Providing the airport community with an understanding of why these changes will occur, and what the benefits are, can help communicate the benefits of these navigation enhancements. **Figure 1.4**, *PBN Navigation*, shows the change between ground-based NAVAIDS and RNAV/RNP procedures, and highlights the difference between current point-to-point navigation and new, more flexible, PBN navigation, which offers increased efficiency.

Figure 1.4
PBN Navigation



Source: Federal Aviation Administration, January 2015

Data Communications

Over the long term, pilot/controller communications will transition from voice to data communications, contributing significantly to increased efficiency, capacity, and safety of the NAS. The Data Communications (Data Comm) program will gradually implement new technology to transition from the current analog voice system to an International Civil Aviation Organization (ICAO) compliant system in which digital communication becomes an alternate and eventually predominant mode of communication. Data Comm is an essential enabler to shift air traffic control from a workload-intensive tactical control to automation-assisted strategic traffic management. To achieve this goal, more efficient data communications between aircraft and air traffic management must be implemented. The Data Comm program is a key element in the implementation of NextGen.

In addition, the FAA is developing concepts for Dynamic RNP (DRNP), a capability that enables real time management of traffic flow and capacity when the airspace is constrained as a result of weather, high traffic density, or the presence of special activity airspace or a combination of these. The premise is that more solutions to the problem can be made available through the generation of DRNP routes that can be uplinked to affected aircraft. This is accomplished by moving traffic streams closer together and making minimal route adjustments to circumvent the constraint. Ultimately, DRNP will save fuel for operators by generating RNP routes that have minimal impact on the original flight plan trajectory.

Over the long term the FAA will implement DRNP in domestic airspace. In order to capture the benefits, aircraft must equip with Future Air Navigation System (FANS) 1A equipment.

Each of the types of NextGen procedures are described below:

Localizer Performance with Vertical Guidance (LPV). LPV approaches take advantage of the refined accuracy of WAAS lateral and vertical guidance to provide an approach very similar to a Category I ILS. Like an ILS, an LPV has horizontal and vertical guidance and is flown to a Decision Altitude (DA). The design of an LPV approach incorporates angular guidance with increasing sensitivity as an aircraft gets closer to the runway (or point in space (PinS) type approaches for helicopters). Sensitivities are nearly identical to those of the ILS at similar distances. This is intentional to aid pilots in transferring their ILS flying skills to LPV approaches.

Lateral Navigation/Vertical Navigation (LNAV/VNAV). LNAV/VNAV approaches provide both horizontal and approved vertical approach guidance. Vertical Navigation (VNAV) utilizes an internally generated glideslope based on WAAS or baro-VNAV systems. A baro-VNAV system determines barometric altitude and RNAV information. Minimums are published as a Decision Altitude. If baro-VNAV is used instead of WAAS, the pilot may have approach restrictions as a result of temperature limitations and must check predictive receiver autonomous integrity monitoring (RAIM). RAIM monitors the integrity of the GPS signal.

Localizer Performance without Vertical Guidance (LP). LPs are non-precision approaches with WAAS lateral guidance. They are added in locations where terrain or obstructions do not allow publication of vertically guided LPV procedures. Lateral sensitivity increases as an aircraft gets closer to the runway (or PinS type approaches for helicopters). Unlike and ILS, LP is not a fail-down system. While flying an ILS, if the glideslope goes out of service, the pilot can continue the approach using just the localizer and switching from descent to a DH to the higher MDA. LPV does not have the feature to fail down to the LP (localizer equivalent). LP and LPV are independent procedures. LP minimums will not be published with lines of minima that contain approved vertical guidance (LNAV/VNAV or LPV).

LP lines of minima are Minimum Descent Altitudes (MDAs) rather than DAs. It is possible to have LP published on the same approach chart; an LP is published if it provides lower minima than the LNAV.

Lateral Navigation without Vertical Guidance (LNAV). LNAV approaches are non-precision approaches that provide lateral guidance. The pilot must check RAIM prior to the approach when not using WAAS equipment. Both LP and LNAV lines of minima are Minimum Descent Altitudes (MDAs) rather than DAs. It is possible to have LP and LNAV published on the same approach chart. An LP is published if it provides lower minima than the LNAV.

GPS Approaches. These are legacy GPS approaches that use GPS without the benefit of WAAS. They are being updated and replaced over time with one of the above WAAS enabled procedures.

Currently there are no LPV procedures at Jackson Hole.