FAA Navigation Programs AJM-32
http://gps.faa.gov

SatNavNews

The Tale of Two Mountains

Short final to Aspen RWY 15 during initial evaluation of the new RNP-AR approach

If you've ever had the opportunity of flying into Aspen, Colorado (KASE), especially in the winter, you may know that with all its majestic beauty, it is not for the faint of heart. As a passenger, I have flown into Aspen a few times in my life. Despite well intentioned efforts, for one reason or the other, the poor weather and limited instrument approach options resulted in us driving at least one leg of the journey. Similar things can be said for flying into Aspen's neighbor, Eagle, Colorado, an airport with equally challenging terrain.

Luckily, things are looking up for both of these airports, especially if you're flying behind Honeywell equipped flight decks going into Aspen or a passenger flying American Airlines to Eagle. Just this past June, the FAA approved the new GPS guided Required Navigation Performance (RNP) Authorization Required (AR) approach to RWY 15 at Aspen. Jim Johnson, Honeywell's Senior Manager for Flight Technical Services, described the process over the past few years working with the FAA's air traffic control and Alec Seybold the President of Flight Tech Engineering (the FAA authorized engineering firm behind the design).

These efforts originally began years ago when Honeywell established its own RNP Consultancy program, to support their customer base. Although the full consultancy program has changed throughout the years, Honeywell still offers support services to their customers. These types of advanced procedures require Honeywell to monitor and validate the data for RNP AR approaches before they are incorporated into the customers' Navigation Database system every 28-day cycle. This is something Honeywell is uniquely qualified to do with their own in-house navigation database services department. As part of its commitment to provide the best navigation capabilities to its customers, Honeywell developed an area navigation (RNAV) (RNP) approach at runway 15 at Aspen, CO that provides a vertically

All Photos courtesy of Flight Tech Engineering

Aspen's infamous Triangle Peak on the Approach to RWY 15

guided 3.48-degree stable approach to the runway and the lowest weather minimums available to operators at Aspen. It does this by avoiding the notorious Triangle Peak terrain feature, which requires pilots to descend at a higher than normal rate. "Aspen is the poster child for an approach like this" said Johnson. "There are a lot of good RNP public approaches out there but our customers can really benefit from this one, even on good-weather days." Additional benefits of this approach include the ability to conduct night operations, enhanced support for Category D aircraft, elimination of the dreaded "dive and drive" maneuver, and a fully guided RNP missed approach path. All of these factors combined should allow for less diversions and holding when compared to the high minimums required by the current approach procedures.

> "Aspen is the poster child for an approach like this"

In order to be eligible to fly the approach at Aspen, aircraft must have the appropriate certifications and avionics, and flight crew members must have completed an FAA approved RNP AR training program and reviewed the Aspen RNP AR briefing package from Honeywell. Current Honeywell customers with qualified aircraft that subscribe to the Honeywell RNP database will have access to the approach. "The waypoints are part of the National Airspace System now so controllers can start training and the approach should be ready for ski season and in the November navigation database." said Johnson.

Approximately 25 nautical miles North of Aspen is Eagle County Regional Airport (KEGE) which serves as another popular spot for recreational opportunities at nearby Vail Ski Resort. American Airlines had been looking into a new approach into Eagle, CO as a place to improve operations. When considering investment in new technology, American wanted to make sure this outlay would provide a true return for access, capacity enhancements and schedule reliability. Due to experience working in nearby Aspen, Flight Tech Engineering had recently begun development of a new approach into Eagle that would not only increase access but offer enhanced safety through the smaller containment found in Low RNP design techniques. Realizing the similar procedure goals, American Airlines joined this effort and decided to become the launch customer for the new Eagle RNP approach.

Speaking with Captain David Surridge the Sr. Manager for Airspace and Aircraft Modernization at American, it was clear they are looking forward to when this approach is active. Eagle has historically plagued airline operations due to the lack of vertically guided GPS procedures. Utilizing specialized criteria

in combination with American's investment in advanced avionics equipage, the team from Flight Tech Engineering was able to provide American a low minimums solution. "At Eagle, we have a lot of diversions, because the only thing we had at the time was the localizer"

Eagle County Regional Airport (KEGE)

Said Capt. Surridge. But now that is about to change with the new approach ready to go in the early October database for their equipped Airbus 319s, just in time for ski season.

Both RNP procedures received numerous simulator evaluations, enhanced ground obstacle and terrain surveys, FAA ATC coordination, and were validated by an RNP-AR equipped turbine aircraft. The advances that RNAV (RNP) and GPS approaches provide are promising on so many levels. The safety afforded from a Low RNP containment area, eliminating step downs replaced by a stable vertical path, and increased reliability and access are just a few of the benefits. I myself, as a customer of the mountainous west, am looking forward to more approaches like these in the future.

- Amy Trevisan, FAA AJM-32/NAVTACII

Interested in RNP-AR technology? For more information check out the following sources:

FAA RNP-AR Guide:
https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/nas/procedures/rnav_rnp/

FAA PBN Compliance Guide:
https://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afx/afs/afs400/afs410/pbn/

Honeywell Aerospace RNP Guide:
https://aerospace.honeywell.com/us/en/learn/about-us/news/2020/04/approval-for-rnav

Honeywell Video Overview of RNP Approval:
https://aerospace.honeywell.com/us/en/learn/about-us/news/2021/07/getting-approval-rnp-ar

The WAAS program office had the opportunity to attend the Regional Airline Association (RAA) Leadership Conference Sept 27th – 28th, 2021. Speakers and panelists for this virtual "hybrid" event in Washington DC included numerous Regional Airline Chief Executive Officer's (CEOs), Federal Aviation Administration (FAA) Deputy Administrator Bradley Mims, government stakeholders and colleagues from the Original Equipment Manufacturer (OEM) and major regional airline communities. Session topics included the Pilot and Airframe and Power Plant (A&P) Mechanics shortage, lack of adequate infrastructure funding in the proposed Transportation Bill, and aviation workforce diversity. Of particular interest to the Navigation Programs, Satellite Navigation Team were RAA's challenges transitioning to NextGen equipage, i.e., Wide Area Augmentation System (WAAS), and RAA's forecast as to what the future may hold for Regional Airline operations, to include the addition of drones to their fleet to fly unmanned cargo in the NAS. It was also of note to learn as people have moved out of the larger cities as a result of the pandemic, the regional airports have become integral to the future of travel.

- Cornell Walker, FAA AJM-32/NAVTACII

Galileo Performance Monitoring by the Tech Center

For years, aviation has relied on the Global Positioning System (GPS) and its augmentations to provide navigation capabilities to aircraft. With the arrival of other satellite navigation systems, aircraft will rely on satellite navigation systems in addition to GPS. For example, the European Union operates a satellite navigation system known as Galileo. The United States and EU have coordinated to ensure that Galileo is compatible with GPS. ICAO is adding Galileo to the Standards and Recommended Practices (SARPs). Aviation standards organizations are writing avionics standards to include Galileo.

Adding another constellation for aviation use will be beneficial to the user. One reason is that more navigation satellites will help the user get more accurate performance. One application that will use the Galileo constellation is the Aircraft Based Augmentation System (ABAS) known as Advanced Receiver Autonomous Integrity Monitoring (ARAIM). ARAIM is a dual frequency/mulitconstellation (DFMC) aviation application. Like the long used predecessor known as RAIM, ARAIM will provide integrity service to a properly equipped user. The goal of ARAIM is to get worldwide 200 foot decision height performance; this is equivalent to an Instrument Landing System (ILS) Category 1 approach. ARAIM does this by using both the L1 and L5 frequencies (E1/E5 in Galileo) from the GPS and Galileo constellations. In addition, there will be an integrity support message (ISM) that provides additional integrity information to the user.

Since momentum is pointing towards Galileo use in aviation, the FAA wants to know the performance of the system. To address this

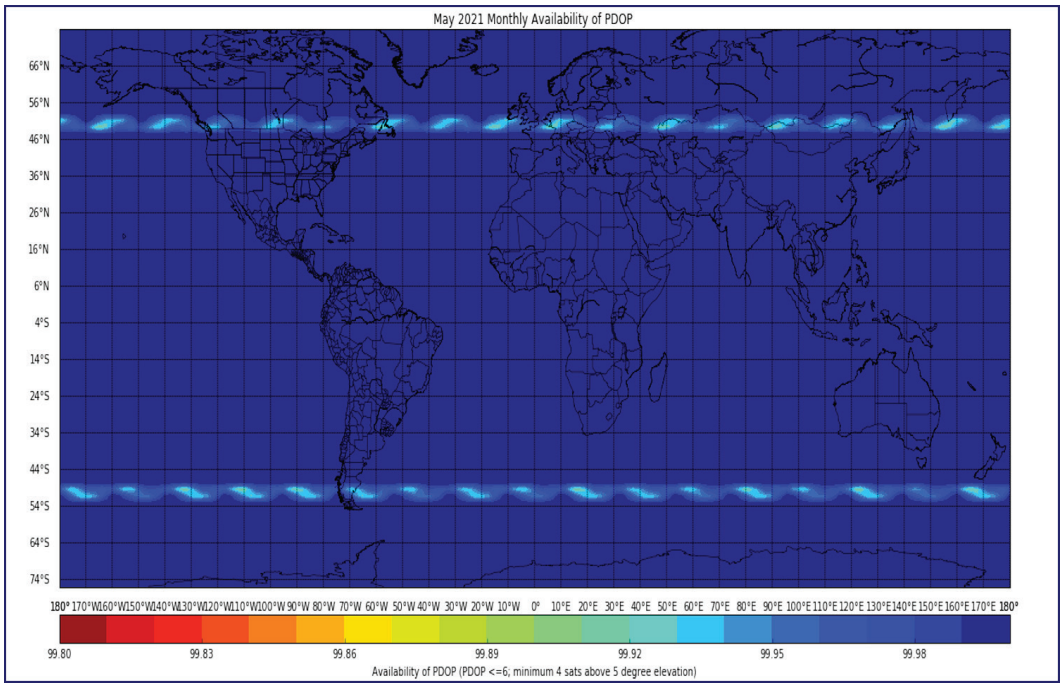


Figure 1: Example Graphic of Galileo Position Dilution of Precision

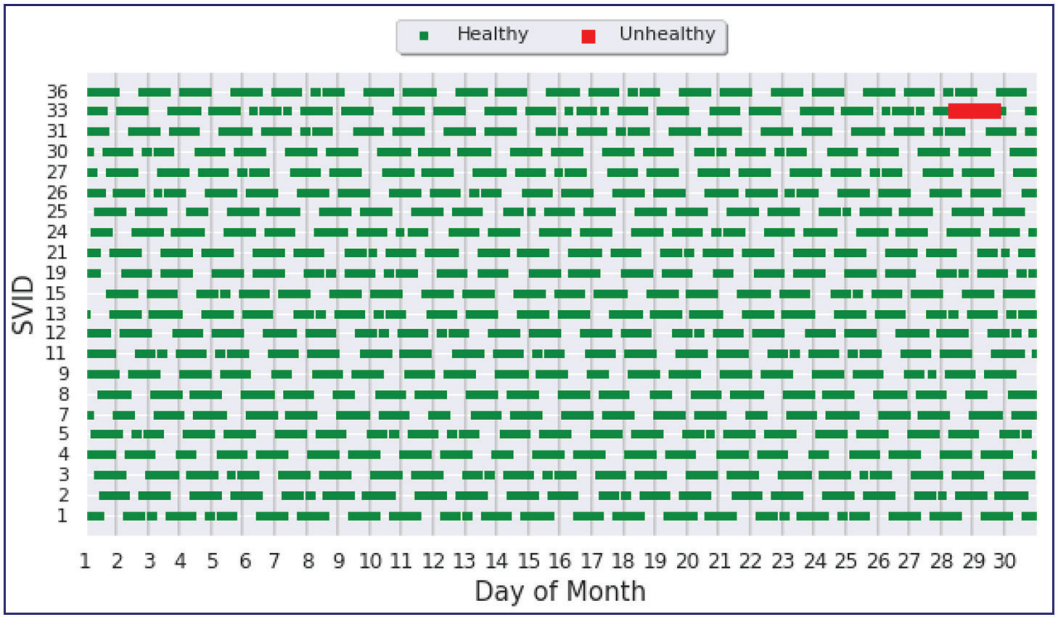


Figure 2: Example Graphic showing Galileo Signal Health from the FAA Galileo Quarterly Report

necessity, the Satellite Navigation Branch at the FAA William J. Hughes Technical Center (WJHTC) has begun to analyze Galileo performance. The results of this analysis are included in quarterly performance reports. These quarterly reports are similar to the reports written by European GNSS Agency. The reports are available at https://www.nstb.tc.faa.gov/.

The FAA quarterly analysis reports on the Galileo Open Service (OS). Other services are defined for Galileo, but the OS is the one that will be used by aviation. The OS is defined in the Galileo Open Services System Definition Document (SDD). The SDD contains the performance metrics for Galileo. Metrics that are currently included in the FAA report are:

- Galileo Position Dilution of Precision (PDOP) and availability of PDOP (see Figure 1)
- Galileo Signal Health and Accuracy (see Figure 2)
- Timely Publication of Notice Advisory to Galileo Users (NAGU)

Future reports will include Galileo Signal in Space range accuracy (SISRA), time transfer performance, availability of Galileo positioning, user position errors and other analyses as needed.

Geographically spread out data sources for monitoring Galileo are key to determine performance since Galileo is a worldwide system. Currently, direct measurement of the Galileo signals rely on two Novatel G3 receivers located at the WJHTC in Atlantic City, NJ. More receivers will be added to future reports. In the near term, receivers located in North America via Wide Area Augmentation System (WAAS) and the FAA National Satellite Test Bed (NSTB) will be added to the performance assessment. Ultimately, the report will include data from Galileo receivers located throughout the world.

In addition to directly receiving data from Galileo satellites, data used in the report is also obtained by other sources. These sources of data include Galileo broadcast navigation data from the International GNSS Service (IGS) and precise Galileo ephemeris and clock data from the Center for Orbit Determination in Europe (CODE).

Customized tools have been developed to process the Galileo data. These tools automate daily data downloads of Galileo broadcast navigation data from the Crustal Dynamics Data Information System (CDDIS) archive site. Precise navigation data is also downloaded from CDDIS. The tools contain

algorithms to cleanse the data to remove duplications or discrepancies in the data collected from the various data repositories. There is numerous data available and these tools ensure that erroneous data does not become part of the report.

The Galileo quarterly reports published so far are still in the initial phase. There are more data sources and metrics to be added to the reports. Galileo is still in its initial operational capability phase but new Galileo satellites are being launched on a regular basis. With more satellites that means that the performance will continue to change. The purpose of the FAA reports is to get an understanding of Galileo performance so when that system is approved for use in aviation the FAA will have better understanding of Galileo's performance.
- Bill Wanner, FAA ANG/WJHTC

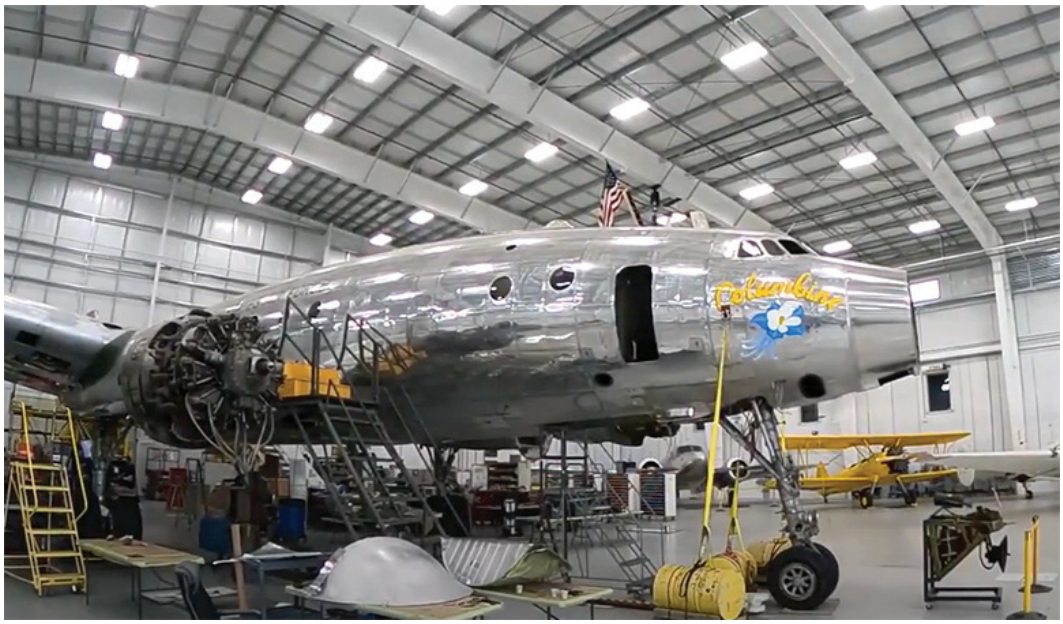
Modernizing Miss Virginia

Miss Virginia attending EAA Airventure at Oshkosh 2021

It's been nearly a year since the SatNav News interviewed Michael Stoltzfus and Rod Moyer of Dynamic Aviation about their restored 1943 DC-3 known as "Miss Virginia". Their love for the aircraft and others they have in inventory was palpable, and surely was generational as Michael's father Karl Stoltzfus was a real aviation enthusiast.

When restoring Miss Virginia, they knew equipping the aircraft with WAAS LPV would help them keep aviation history alive by giving them access to venues other non-equipped aircraft just could not get in. "…WAAS offers us the opportunity to take Miss Virginia…and share it with the world" says Stoltzfus, the President and CEO of Dynamic Aviation. Speaking on what equipping with WAAS has provided Mike said, "to take it into more complex airspace, ...into airports where the weather may be at minimums, we want to bring the airplane to the world, " With WAAS, Dynamic has the ability to do just that. Rod Moyer, Dynamic's Director of Flight Safety, echoed Stoltzfus' sentiments on the importance of WAAS avionics on board the aircraft and how it has paid off. "There have been some events that

> "…WAAS offers us the opportunity to take Miss Virginia…and share it with the world"



Restorations to Columbine II

we have attended where the ramp was pretty sparse because VFR-only aircraft were unable to make it in, and we were able to make it in" said Moyer.

Dynamic have a few vintage aircraft in their stable and the most notable is a Lockheed Constellation, also known as Columbine II, that became the first Air Force One under President Eisenhower. Plans are to equip Columbine with WAAS LPV and share her with as many people as possible. Eventually, the company located in Bridgewater, Virginia intends to open a museum once restorations are complete.

Miss Virginia was able to make it out for some appearances this summer. She was spotted at Oshkosh, flew in the Shenandoah Valley, provided a formation tribute for the 20th anniversary of September 11th, and was invited to be shown on static display at NBAA-BACE in Las Vegas. Dynamic's commitment to aviation's past and future is solid as is Miss Virginia.

- Amy Trevisan, FAA AJM-32/NAVTACII

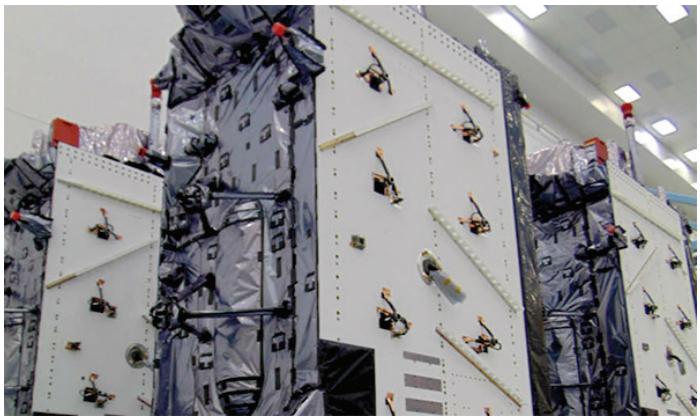
Your WAAS Story

. . . We're collecting testimonials about the benefits of Wide Area Augmentation System (WAAS) navigation from users. If you are a pilot, passenger, airport manager, controller, dispatcher, airline employee, or are involved in aviation in any capacity - whether you fly fixed-wing or vertical flight aircraft - we want to hear from you! Please send your stories and contact information to Amy Trevisan at: amy.ctr.trevisan@faa.gov

Three GPS III Space Vehicles Ready, Willing and Able;

One Named for Hidden Figure Katherine Johnson

Reprint from *Inside GNSS,* September 8, 2021



GPS III satellite

The U.S. Space Force's Space Systems Command recently declared the eighth GPS III satellite as "Available for Launch." This marks the third GPS III satellite to be declared available for launch in the past three months.

The satellite is named "Katherine Johnson" in honor of the now-famous "hidden figure" in NASA history.

GPS III SV06, SV07, and SV08 are now awaiting official call up for launch in Lockheed Martin's GPS III Processing Facility in Waterton, Colorado.

"SV06, SV07, and SV08 AFL milestones in just three months prove that GPS III production continues to benefit from efficiencies with each satellite delivery," said Col. Edward Byrne, chief of SSC's Space Production Corps' Medium Earth Orbit Space Systems Division.

The first of the three recently completed satellites, SV06, is scheduled to launch in 2022 and will join the operational constellation of 31 GPS satellites.

In keeping with the tradition of naming GPS III satellites after famous explorers and pioneers, SV08 was named "Katherine Johnson" in honor of the trailblazing National Aeronautics and Space Administration (NASA) mathematician and "human computer" who designed and computed orbital trajectories for NASA's Mercury, Apollo and space shuttle missions. One of four African-American women at the center of the nonfiction book by Margot Lee Shetterly and the movie titled"Hidden Figures," Katherine Johnson was awarded the Presidential Medal of Freedom in 2015 for her groundbreaking contributions to the U.S. Space program.

NASA research mathematician Katherine Johnson is photographed at her desk at Langley Research Center in 1966.
Credits: NASA

Did You Know . . .

We received a question about GPS in aviation, and when it began. In response, we have developed a timeline of significant GPS aviation development and operational milestones. We may not have caught them all, but here are some of the big ones:

1957 — Sputnik launched by Soviet Union

1960 — First test of U.S. Navy Transit system

1963 — U.S. Air Force Project 57 and 621B

1967 — U.S. Navy Timation Program

1973 — U.S. Department of Defense initiates the NAVSTAR GPS program, combining attributes of Transit, Timation, and Project 621B

1978 — U.S. Air Force Launched the prototype NAVSTAR GPS satellite

1983 — Soviet Union shoot-down of a civilian airliner, Korean Airlines Flight 007 (KAL 007) and subsequent Presidential statement saying GPS would be available for civil use. This was later codified in a Presidential Decision Directive in 1996.

1988 — ICAO identifies that satellite technology is central to air navigation

1990 — TSO 129 approved

1991 — First aviation receiver, Garmin 100AVD

1992 — Collier Trophy awarded to the GPS Team - THE UNITED STATES AIR FORCE, THE UNITED STATES NAVAL RESEARCH LABORATORY, THE AEROSPACE CORPORATION, ROCKWELL INTERNATIONAL CORPORATION AND IBM FEDERAL SYSTEMS COMPANY For the most significant development for safe and efficient navigation and surveillance of air and spacecraft since the introduction of radio navigation 50 years ago

1993 — GPS achieves Initial Operational Capability (IOC) with 24 satellites in orbit providing Standard Positioning Services

FAA approves use of GPS for Instrument Flight Rules operations

1994 — ICAO approves satellite navigation global implementation plan

Garmin GPS-155 panel-mounted unit was the first GPS receiver on the market to receive full FAA certification for instrument approaches

4/1995 — U.S. declares Full Operational Capability (FOC) of GPS with 24 operational GPS Block II/IIA satellites

5/1/2000 — GPS ceases use of Selected Availability, resulting in improved accuracy for civil GPS users

7/10/2003 — WAAS commissioned as first Satellite-Based Augmentation System, enabling use of GPS as a source of primary navigation

9/2003 — FAA published the first RNAV/GPS precision approach to Local Performance with Vertical Guidance (LPV) minima using WAAS

8/2008 — WAAS fields final WAAS Phase III build, enabling WAAS support of RNAV (GPS) approaches to 200-ft minima (LPV-200)

2010 — FAA System Design Approval of the Honeywell SmartPath 4000, first approved Ground Based Augmentation System (GBAS)

5/2010 — First L5 capable GPS satellite launch (II-F)

2011 — WAAS LPVs/LPs approaches exceeded the number of ILS approaches

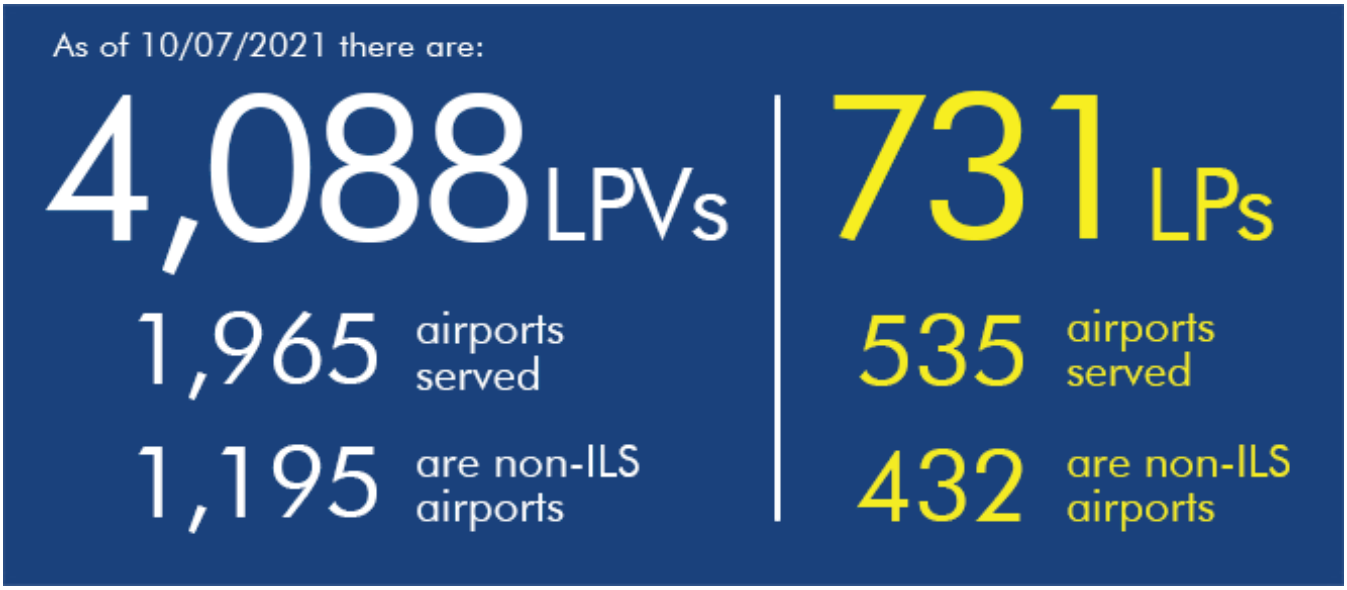
2018 — Successful launch of the first GPS III satellite

The SatNav News is produced by the Navigation Programs AJM-32 branch of the Federal Aviation Administration (FAA). This newsletter provides information on the Global Positioning System (GPS), the Wide Area Augmentation System (WAAS) and the Ground Based Augmentation System (GBAS).

Satellite Navigation Approach Procedures

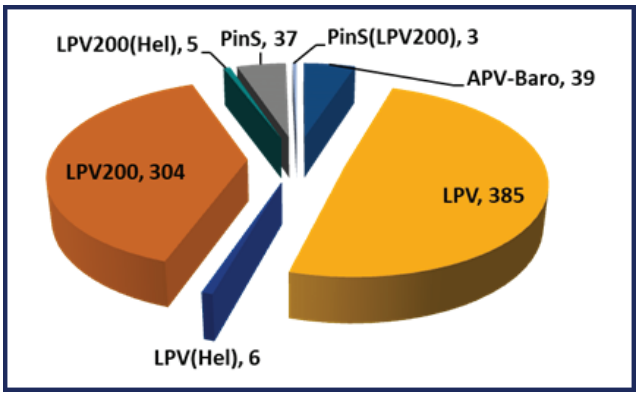
WAAS

The charts below reflect the continuing growth of satellite-based approach procedures. For more detailed information about satellite-based instrument approach procedures, please visit our GPS/WAAS Approach Procedures web page. *http://www.faa.gov/about/office_org/ headquarters_offices/ato/service_units/techops/navservices/gnss/ approaches/ index.cfm*

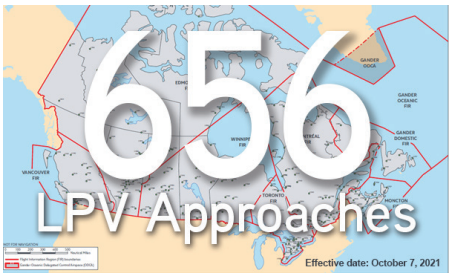


EGNOS

The number of LPVs in Europe is also growing. The chart below shows LPV procedures in Europe as of November 4, 2021.



Canada



Numbers provided by NAV CANADA
as of October 7, 2021
(click for map)

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