FAA Navigation Programs AJM-32
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SatNav News

WAAS – Working for Wingfoot 1, 2, 3

When the Goodyear "blimp" shoots an instrument approach – yes, you read that correctly – a WAAS-enabled GPS navigation system is the pilot and crew's best friend.

That's because even though the mind's eye sees these majestic airships always flying in sunny scenes, the reality is that Goodyear's three Zeppelin NT airships do a great deal of cross-country flying in all types of weather, requiring the behemoths to be instrument-capable and to shoot approaches.

For that reason, the NT flight decks are equipped with GPS/WAAS so that crews are able to fly public and Goodyear-specific LPV approaches in actual IFR conditions. Or rather, they will be flying the approaches in actual conditions once the relatively new airships get certified for IFR operations, possibly later this year. For now, pilots practice the approaches in VFR conditions to stay current.

Being able to get Wingfoot 1, 2, or 3 into a predetermined airport after a mission is more than just a matter of skill and pride for Goodyear pilots.

"The tough part with an airship is that you really only get one chance at an approach because your crew is at the airport," says Michael "Doc" Dougherty, Goodyear Airship Operations chief pilot. "If you have to move the crew to another airport, that's another hour or more."

Goodyear regularly uses its airships to provide TV coverage above sports events, to travel around the country promoting the company brand, to move aircraft between the three bases (Akron, Ohio; Carson, California, near Los Angeles; and Pompano Beach, Florida), or to transit back and forth to its Akron home base when heavy maintenance is due.

> "If you have to move the crew to another airport, that's another hour or more."

The "greeting crew" for a Goodyear airship is extensive: 16 ground crew personnel in seven vehicles, including a tractor-trailer, two "mast" trucks for docking the airship, a crew bus, vans and TV trucks. That much equipment has inertia, and moving to an alternate airport can take hours, assuming there's even another facility nearby that can accommodate a blimp.

The size of the ground crew is not surprising given the size of the vehicle. The NT is 246 feet from nose to tail, with a maximum gross weight of almost 20,000 lbs. For buoyancy, it holds nearly 300,000 cubic-feet of Helium and to balance out that helium for varying loads in the 12-passenger gondola, it holds up to 1,500 lb. of water ballast. It can also hold another 1,500 lb. of metal shot in 22lb. canvas bags. The fly-by-wire control system uses three steerable 200 hp general aviation engines for propulsion, controlled by the pilot through a joystick from the airliner-style flight deck.

WAAS and the corresponding lower landing minimums (compared to GPS-based RNAV approaches) will be a boon for Goodyear, which serially replaced its fleet of three Goodyear GZ-20s blimps with the semi-rigid Zeppelin NTs between 2014 and 2017. The GZ-20s had electromechanical flight instruments, aka steam gauges, and basic GPS capability with moving maps. "We jumped from 1920s technology to a modern airliner flight deck," says Dougherty. The GZ-20s were IFR certified, but approaches were limited to precision ground-based ILS approaches and non-precision VOR and GPS approaches. Goodyear pilots prefer GPS approaches to avoid the stream of normal aircraft coming into an airport. There's a good reason for that – the NT flies at 30-35 kt from the final approach fix all the way to the airport. The airships cruise at 35-45 kt, typically at 1,000 feet above ground.

Goodyear has non-public approaches it developed for the Akron and Carson bases, and uses public procedures elsewhere. LPV approaches are particularly useful for the Carson base. "When the marine layer is present in Los Angeles, we have to shoot an approach when coming back to the base in the evening," says Dougherty.

> "If WAAS is especially helpful at airports where an LPV approach gets us down to 200-300 feet above ground level. . ."

The 200-foot or more difference in decision height between a basic GPS approach and an LPV approach can be significant. "WAAS is especially helpful at airports where an LPV approach gets us down to 200-300 feet above ground level," says Dougherty. "That's way nicer than shooting over the airport at GPS minimums of 600 feet and saying, 'We'll catch you later' to the ground crew."

For the New York City area, "later" can be way later. Dougherty says there are only 2-3 airports in the whole Eastern New York area that Goodyear can use as an alternate. "So if we're based in Orange County (west of the city) and have to move to Solberg (southwest of the city), or to Bristol, Connecticut (northeast of the city), to pack the whole crew up and get the 80-100 miles to the next location, that's 2.5 hours of driving time and then the setup time. You could be fuel-critical in the airship by then."

With WAAS and an LPV approach, the airships are typically able to arrive at their intended destination and to use runways that "regular" traffic is not using. "We can get right down to the threshold of the runway then we can hover-taxi at 10 feet altitude down to the taxiway and around the corner to get to our mooring site where the ground crew is waiting," says Dougherty. "This helps us to make sure we maintain a safe operation in IFR conditions."

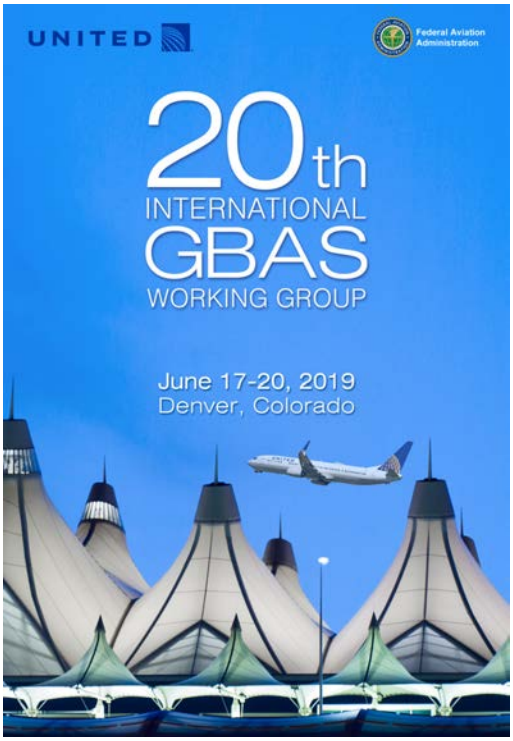
Dougherty says Goodyear is planning to complete IFR flight testing with the FAA and European Aviation Safety Agency this summer, to be followed by IFR certification, possibly by year's end. Once that happens, airship operations will take a leap in efficiency with no new required ground infrastructure.

"Probably 98% of our approaches are RNAV approaches of some sort, and being able to use the LPV minimums instead of the basic GPS minimums is a big deal sometimes," says Dougherty.

- John Croft, FAA/Office of Communications

20th International GBAS Working Group Meeting

Denver, CO, 17-20 June 2019



The 20th International GBAS Working Group (IGWG), chaired by Shelly Beauchamp of the FAA and Andreas Lipp of EUROCONTROL, took place June 17-20, 2019 in Denver Colorado. IGWG Secretaries for the meeting, hosted by United Airlines at their Training Center, were Dieter Guenter, FAA (NAVTAC) and David Duchet, EUROCONTROL.

About one hundred five (105) participants from twenty (20) nations, international service providers, industry, airports, airlines and aircraft manufacturers attended the meeting and working sessions with many new participants. Notably, representatives from eight major airlines and four regulators attended the meeting.

Continued commitment to GBAS development and implementation by

participants was impressive, and visible in airline presentations from Delta Air Lines, United Airlines, Southwest Airlines, Air Canada, Lufthansa, JAL and ANA.

Boeing and Airbus remain strongly committed to GLS and reported an increasing GLS customer base and increased number of GLS equipped aircraft sales. Boeing reported over 3500 equipped aircraft in use today with over 72% of all ordered aircraft GLS equipped. Boeing also confirmed that they were supporting CAT-III GLS implementation on aircraft including the 777X-8/9, 787, and 737 Max starting in 2020, as well as supporting work towards CAT-II approvals on current GBAS Approach Service Type (GAST) C ground systems. Airbus also reported that over 800 aircraft had GLS activated and more and more customers were choosing the GLS option on aircraft, including A320, A330, A350 and A380 families. Airbus is supporting work in GBAS Expanded Service Volumes, GLS CAT II on GAST C, and GLS development in the scope of SESAR.

The status reports of service provider plans, users and manufacturer updates were more numerous than in past meetings, with first presentations from China, Bulgaria and Ireland. Participants appreciated the possibility to get a concentrated overview of the worldwide state of the activities. Honeywell, Collins and CMC briefed on deployment status for their GBAS avionics focusing on the new MMR generation just having received TSO approval. They also outlined the development of GAST-D capable avionics suites.

Six different manufacturers in attendance have GBAS ground stations in development, with Indra Navia, Honeywell and NEC briefing their intended timeline for CAT-III GBAS development work. Indra Navia confirmed that they have formally requested consideration for System Design Approval from FAA for their GAST-D GBAS. NEC is delivering their CAT-I GBAS to Haneda Airport in Q3/2019 and the station is planned to be in operational service in 2020. CETC is in the approval process for their CAT I GBAS at Tianjin Binhai and is developing a GAST D/E/F prototype using BDS (Beidou) in Dongying Shengli. INVAP and IACIT also presented the status of their prototypes.

The newly formed European GBAS Alliance presented their goal of synchronizing implementation of ground and airborne GAST D systems by preparing a clear strategy and soliciting support for ground system certification. US industry participants discussed forming a similar initiative.

The key value of the GBAS working group continues to reside in the parallel strings of technical and operational working sessions on day two and three, where more in depth briefings can take place. More than two-thirds of the participants attended the operational working sessions at this meeting. Major aspects of the operational working groups were discussions on implementation of expanded service volumes and independent parallel approaches, an important step for GBAS operations at airports with a requirement for extended final approach segments.

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As in previous meetings, another topic of particular interest with lively discussions was the desire on progress towards approval of CAT-II operations on a GAST-C GBAS system, which is in Europe also a Single European Sky ATM Reserach (SESAR) Operational Demonstration. The SESAR AAL2 project briefed on their status towards achieving this goal and

cooperation between European and US airlines on this matter was agreed. A newly formed, industry-led subgroup will formulate the current status on CAT II operations with GAST-C and develop an issue paper to provide a clear statement on the path forward to the regulators involved.

There are several SESAR work packages dedicated to pursuing advanced arrival procedures enabled by GBAS, LVP operations into secondary airports and for curved approaches, using notably geometric height from transition altitude.

Another strong focus also developed on the ATC interface, where the recent NBP developments and DFS efforts to standardize the data exchanged over these interfaces were presented and intensively discussed.

The technical sessions, which included Data Collection and Evaluation and Ionospheric Aspects, remained active. During the ionospheric aspects session, the progress of the ICAO Ionospheric Gradient Monitoring Ad-hoc group was briefed, as well as data analysis and research work done by low-latitude states such as Brazil and Japan. The Data Collection and Evaluation session focused on VDB compatibility and Flight Inspection processes. Updates on EUROCONTROL'S PEGASUS data processing software, for GAST C, D and F were also shared.

Participants were extremely satisfied with the outcome of the working group meeting, and agreed that the IGWG continued to fulfil a recognized important function in GBAS development, cooperation and implementation work. It has been emphasized by the participants that the meeting's format seems well adapted to the participants' needs, allowing for coordination between ANSPs, airports, airlines and OEMs. The working group addresses relevant issues for GBAS, and enables exchanges of data and information which can be effectively used by participants in formulating their business strategies and implementation plans.

The next International GBAS Working Group will be located in Europe, likely Ireland or France in May/June 2020 according to the usual alternating principle. Final location and dates will be determined as preparations progress.

- Dieter Guenter, FAA AJM-32/NAVTAC

Participants at the 20th International GBAS Working Group in Denver, CO, June 17-20, 2019

How GPS III is Performing in Orbit

First published in GPS World on May 13, 2019
by Alan Cameron

Plus an update on GPS III satellites in production

Editor Alan Cameron talked with Johnathon Caldwell, Lockheed Martin's vice president of navigation systems.

Tell us about the on-orbit performance of the GPS III SV01, launched in December.

On Jan. 8 we began broadcasting navigation data across all signal chains, and the satellite has been in checkout mode since then. According to all the reports I get from various independent agencies, the vehicle has been performing outstanding, and the payload performance has been exceeding expectations.

We've been evaluating in depth how the payload performs, including independent agencies assessing the signal quality. Later this fall we'll transition satellite ground control from the OCX Block 0 ground control system installed at Lockheed Martin's Waterton Launch & Check Out facility over to the GPS Operational Control Segment (OCS) the 2SOPS is using now, and we'll really see the performance improving from where it is today.

The satellite is doing what everybody had hoped. There's always great anticipation when a new system goes up. It's actually been a very smooth on-orbit test campaign. We're wrapping up on the early side; we'll be ready to transition into the OCS this fall.

This past December we completed a major Architecture Evolution Plan (AEP) 7.5 OCS upgrade. This included both hardware and software upgrades to the legacy control system, and the Contingency Operations (COps) upgrade is coming later this fall. This is the software upgrade that will let OCS fly this first GPS III satellite and let the Air Force take advantage of great new capabilities. We will deliver the upgrade in May; it will get packaged up and delivered into the OCS in the fall. SV01 will then move from Lockheed Martin's Waterton launch and checkout facility control to Air Force 2SOPS control and join the constellation on the OCS.

> "We're certainly at the top end of what we thought we might be able to achieve in terms of signal accuracy."

A GPS satellite doesn't do its mission by itself. It takes an entire system to run. You're always monitoring signal quality and tweaking things to get the optimal performance. Today, we're flying SV01 by itself. The OCS and the 2SOPS crew will start flying it like they do the others, giving it the daily update and looking at the signal quality and maximizing the performance.

We're certainly at the top end of what we thought we might be able to achieve in terms of signal accuracy.

And GPS III SV02 has shipped to the Cape.

We've wrapped up functional testing; it's in great shape. We're now in a quiet period prior to final review leading up to fueling decisions in May for a planned July launch.

Using the Delta IVb rocket for SV02 offers a good opportunity to demonstrate the wide range of launch vehicles that GPS III is capable of. The satellite has great compatibility across platforms, a flexibility that's a benefit for the Air Force.

The factory was also getting pretty full so it was great to ship out SV02. When it gets to the end of the line and ready to go, you want to get it out and have it doing the mission it's designed to do.

How about the production status of SVs 03 through 10 on the factory line?

SV03 has gone through complete environmental tests and is ready for delivery to the Air Force later this spring. SV04 is in final environmental test and will deliver later this year. SV05 is in thermal vacuum (TVAC) testing now, and doing an outstanding job. TVAC is the hardest test we go through, and it's as if it's flying in the environment of space. It's the stress test. SV06 is put together, and now in its initial functional testing.

There aren't many production lines of this size of large satellites. It's very impressive. As you look down the line, our high bay is modeled after the best of production lines. Hardware and avionics and power systems are coming in as piece parts, getting built in. As you go down the bay, the vehicles are getting more and more complete. Now on the front end of the line we've got SV07 and SV08 starting. SV09 will begin later this summer, and not long after we hope to open up space for the 10th vehicle.

Last words: Progress so far on GPS IIIF?

We're now in the full design campaign for the follow-on satellites that will lead to critical design review, the capstone of the process. The CDR will wrap up in February 2020.

GPS III production line. (Photo: Lockheed Martin)

GPS Update

Next Milestone for GPS: GPSIII Space vehicle 02 (GPS SV02) is scheduled to be launched July 25, 2019

Satellite-Based Augmentation System (SBAS) Interoperability Working Group (IWG)

The 35th meeting of the SBAS IWG was held on June 11-13, 2019 in Brisbane, Australia. The meeting was hosted by Geosciences Australia. Participating organizations included FAA, EGNOS, European Space Agency (ESA), GPS-aided GEO augmented navigation (GAGAN)-India, Agency for Aerial Navigation Safety in Africa and Madagascar (ASECNA), Joint Program Office (JPO)-Africa, Multifunctional Satellite-based Augmentation System (MSAS)-Japan, System for Differential Corrections and Monitoring (SDCM)-Russia, Korean Augmentation Satellite System (KASS), BeiDou SBAS (BDSBAS)-China, and Australia SBAS (AUSBAS). Some of these organizations had participants from air service and equipment providers. The activities included concurrent meetings by Technical Sub-Groups (TSG) and Operational Sub-Groups (OSG) followed by Plenary sessions.

In opening remarks, the co-chairs noted increased interest and participation in the IWG. They acknowledged the gracious reception from Geosciences Australia. TSG sessions were focused on addressing SBAS technical aspects while OSG sessions were discussing expansion of SBAS in the world, demonstrations and outreach of SBAS including communication and exchange of lessons-learned on SBAS deployment.

TSG discussions included the following:

- Standardization progress at RTCA, EUROCAE and ICAO
- Discussion and resolution of outstanding technical items related to development of DFMC SBAS standards
- Discussion of the ability of DFMC SBAS to support procedures that are not available to single frequency SBAS users and how those procedures will be identified

Additional discussions and new action items included the following topics:

- Alternate user equipment smoothing filter concepts
- Enabling SBAS to use upper range GPS PRNs consistent with the GPS Interface Standard

OSG discussions included major objectives as deployment of LPV procedures, outreach to airline, aircraft and aviation manufacturers, and update of SBAS Global Status. Most of the participating organizations presented the status of their LPV procedure with number of procedures, implementation schedules, issues involved, support needed, and backup strategies in resorting to legacy systems as DME and VOR in case of PBN/GPS system failures. GAGAN discussed processes associated with their regulatory organization (Director General of Civil Aviation) and making India-registered aircrafts LPV-capable by 2020; and lack of LPV simulators in India.

During the plenary sessions, IWG reviewed status of current and developing SBAS systems. South Korea, Australia, Russia, India, Japan, China and Russia, ASECNA and EGNOS-Africa JPO provided updates on development of SBAS systems in their countries and regions.

KASS
- In Critical Design Review with Integration and Test planned for 2020
- Initial Operation Capability and Certification is planned for 2022

GAGAN
- Working to qualify and publish LPV procedures
- Developing GAGAN Messaging Service (GMS) especially for areas that have limited or no terrestrial communications infrastructure

AUSBAS
- Completed two-year SBAS test-bed demonstration that included broadcast of SBAS signals on L1 and prototype DFMC SBAS signals on L5
- RFP for implementation system planned for early 2020

EGNOS
- EGNOS V3 (ESR 3.1) Operational Transition will start in 2024

MSAS
- Transition to QZSS as SBAS satellite in 2020
- Expand to 3 QZSS satellies and extend to LPV operation in 2023

BeiDou
- Construction of BeiDou-3 system will be fully completed by the end of 2020 (currently 19 satellites)
- Preliminary BDSBAS testing planned for June 2019
- Certification activities to commence in 2020

SDCM
- Testing with GLONASS and GPS is complete using 19 refernce sites in Russia and 6 abroad
- In initial stage of certification

The 36th IWG meeting is tentatively planned for February 2020 in New Delhi being hosted by GAGAN.

- Ram Rao, FAA AJM-32/NAVTAC

Participant's at the 35th meeting of the SBAS IWG in Brisbane, Australia, June 11-13, 2019

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

WAAS Program Office supports STEM day and "Tech Center Tuesday"

The Tech Center had more than 300 students visiting this year in May for the annual Aviation STEM Day to see and experience the latest aviation technology innovations. The WAAS program office provided hands-on experience of flying a WAAS LPV on a FlyThisSim Cirrus 22 simulator along with displays of real-time system monitoring. Students new to the concept took particular interest in how the system supports GPS and the accuracy it provides to the end user.

The next day, "Tech Center Tuesday", also had increased interest in WAAS with the new information about helicopter routes as well as our recent addition of the Goodyear blimp as a user and ambassador for WAAS. Attendees of Tech Center Tuesday were able to understand how WAAS connects to other technologies and see live data and performance of the system. This year was one of the best attended and most successful events for the Tech Center exposing present and future aviation enthusiasts and engineers to the technology behind National Airspace System.

- Amy Trevisan, FAA AJM-32/NAVTAC

FLY WAAS

Did You Know . . .

We had a question that is very timely come across our desks recently about the replenishment/replacement of WAAS communication satellites. A reader asked **"How often are the communications satellites replaced, and how long does this process take?"** The following article may shed a little light on the process.

Preparing for Cutover

The FAA and WAAS program office maintain a constellation of three WAAS Navigation payloads on commercial geostationary satellites to distribute the WAAS messages to aviation and non-aviation users across North America. To maintain this constellation, the WAAS Program Office prepares every 2-4 years for replacement of a new communications satellite to support the system and removal of the old satellite. The term used for this transition is "Cutover" and it is complete when the new communication satellite is operational for aviation use. As one can imagine, this is not a simple "flip of the switch". Preparation begins years ahead with WAAS Program Office initiating a procurement for a new satellite leased service. The first step in the process is finalization of the specific requirements and design for the WAAS satellite payload and ground equipment. The satellite payload is developed, tested and then launched into a Geostationary orbit. Once on orbit, the payload is tested then integrated with the ground equipment. Once the satellite and ground equipment are integrated, the new satellite and ground equipment are testing within the WAAS test systems. Once fully tested and operation is verified and validated, the new GEO begins cutover into the WAAS. This complete process takes over 3 years.

Cutover of the new GEO into WAAS occurs over a few weeks of time and is the culmination of years of work:

- Communication links to the GUS site are transition from test network to operational network
- WAAS software on the operational system is updated to communicate with and process messages for the new GEO in the TEST mode
- Once stable in the TEST mode, the GEO is transitioned from TEST mode to operational mode where avionics can see and now use the signal
- The old GEO is removed from the operational system via a change to operational software
- Old GEO sites are decommissioned

This summer, a new satellite to support WAAS, SES-15, will replace Galaxy 15, launched October 2005. SES-15, also known as GEO 6, was launched in May of 2017 and has been waiting to get all of the pieces in place before its turn to shine. GEO 6 was set July 15, 2019. Galaxy 15 will be decommissioned on or before July 31. For about two weeks there will be four operational GEO satellites supporting WAAS. The WAAS team will monitor and correct for all four then back to three at the end of July with the planned removal of Galaxy 15. Since SES-15 will be operating from 129 degrees, a similar orbital position to Galaxy 15, performance estimates for the new satellite are similar to Galaxy 15.

Summer is an exciting time for the WAAS program, ushering in support from SES-15, for many years to come.

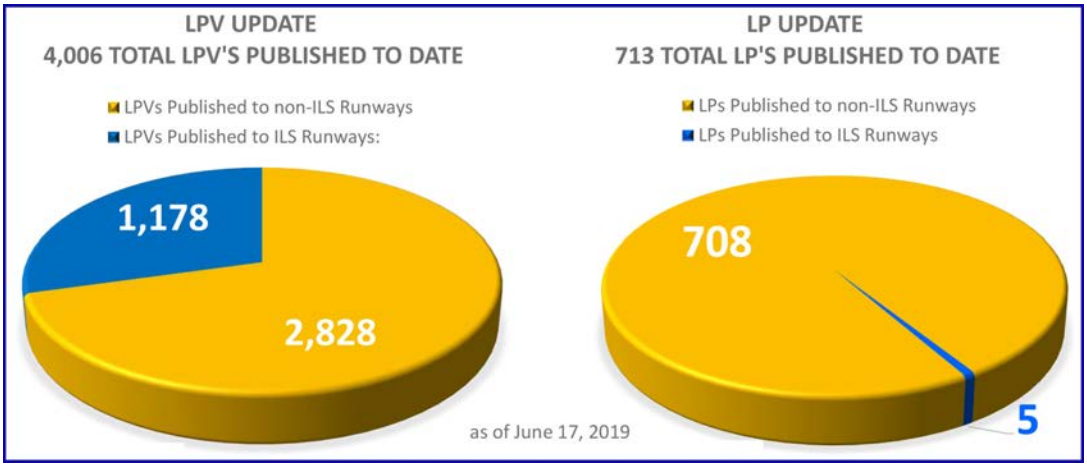
- Edward Sigler, FAA AJM-32/NAVTAC

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

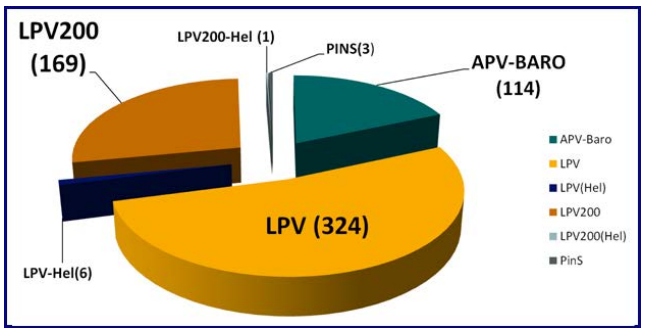
The chart below reflects the continuing growth of satellite-based approach procedures. For more detailed information about satellite-based instrument approach procedures, please visit our GPS/WAAS Approach Procedures web page.
http://www.faa.gov/about/office_org/ headquarters_offices/ato/service_units/techops/navservices/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



EGNOS

The number of procedures in Europe is also growing. The table reflects growth in Europe as of March 29, 2019, as included in the EGNOS Bulletin, Issue 29, Q1 2019.

Follow this link to the most recent EGNOS Bulletin, Issue 29, Q1 2019:
http://egnos-user-support.essp-sas.eu/new_egnos_ops/ content/quarterly-bulletin



Canada

Numbers provided by
NAV CANADA
as of July 16,2019