EGNOS BULLETIN

Issue 34, Autumn'20 Edition

Credits: Finnair

European
Global Navigation
Satellite Systems
Agency

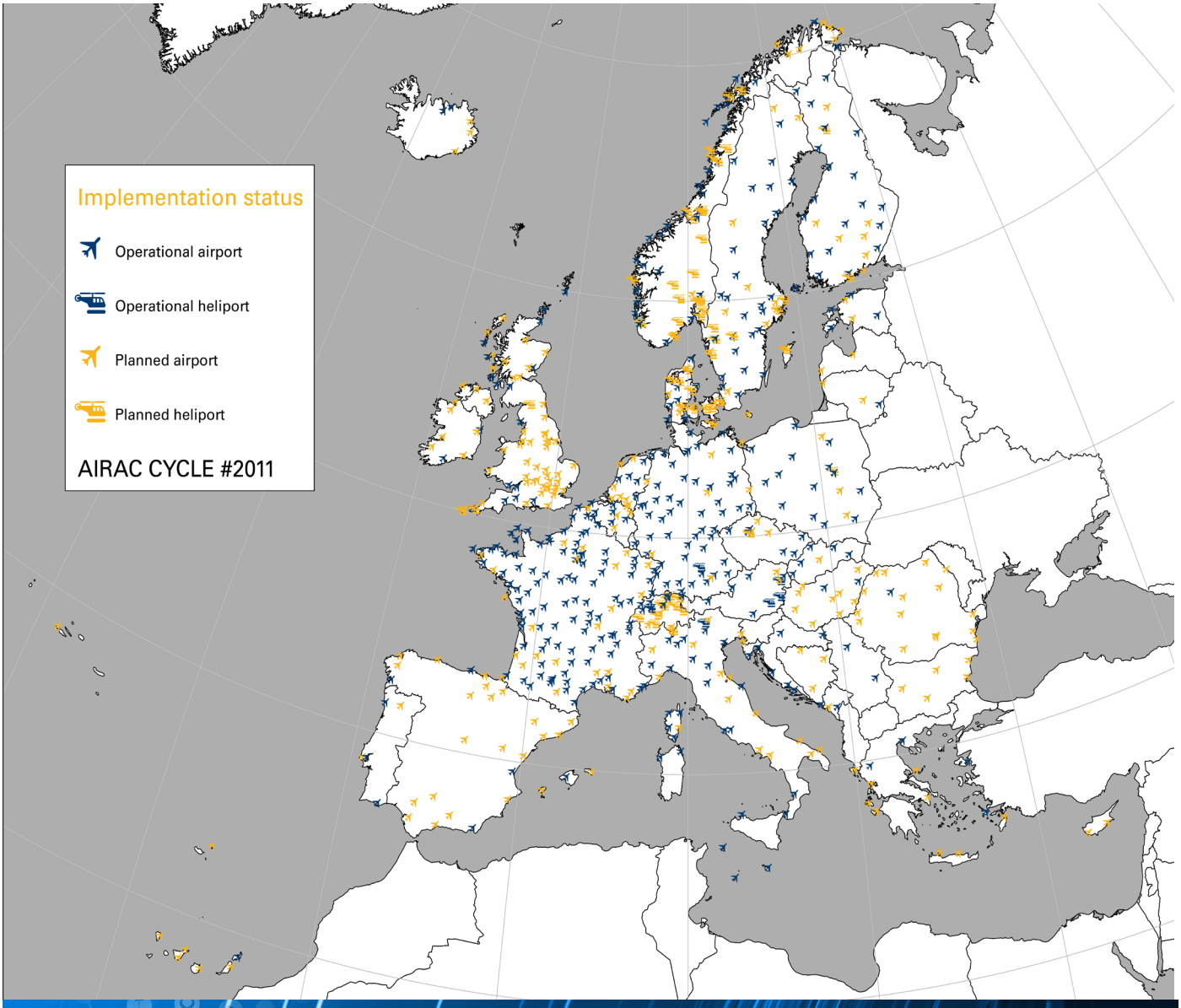
NAVIGATION
MADE IN
EUROPE

https://egnos-user-support.essp-sas.eu/

ESSP

https://www.essp-sas.eu/

EGNOS implementation



EGNOS Success Stories

FINNAIR'S A350 TRANSCONTINENTAL ROUNDTRIP USING SBAS LPV (WAAS & EGNOS) AT BOTH ORIGIN AND DESTINATION AIRPORTS

Finnair's A350 transcontinental roundtrip using SBAS LPV (WAAS & EGNOS) at both origin and destination airports

Credits: Finnair

Landing at HEL airport

Finnair's strategic vision of the future includes fundamental fleet management decisions that have borne fruit years later.

As a launch customer of the Airbus A350 XWB, Finnair received its first A350-900 in October 2015. Five years later, Captain Marko Valtonen, Finnair's Fleet Chief Pilot for the A330/350, has performed the first known transcontinental roundtrip between Europe and the USA using SBAS LPV approaches at both origin and destination airports with the A350 (tail OH-LWI).

This singular flight used the latest SBAS technology to approach both airports using the United States SBAS (WAAS) at John F. Kennedy International Airport (JFK) in New York and the European SBAS (EGNOS) at Vantaa Airport (HEL) in Helsinki.

This journey started many years before when Finnair not only opted for the Airbus A350's clean-sheet latest generation design but also for its revolutionary SBAS-LPV capability: the so-called "SLS function" in Airbus aircraft. A customer option that allowed following GNSS-based approaches down to LPV minima using satellite-based augmentation with no need for ground navaids support at the airports.

Moreover, they also confirmed the ADS-B out option, which is now an almost-basic requirement to comply with EASA's implementing rule and FAA one. Both decisions made Finnair's A350 future-proof from the manufacturing line.

Operational approval

Apart from airworthiness, the flight operation elements that allowed Finnair to perform those RNP APCH down to LPV minima comprised two main activities: the training of pilots and the modification of the operational manual described generically in the PBN Manual (ICAO Doc 9613, Vol I, 3.4.3 and attachment C), and translated to FAA and EASA regulations (See guidance material). Quoting ICAO: "Establishing approval procedures that are efficient and minimise overhead for both operators and regulators are important considerations." In Europe, EASA updated its AirOPS in 2016 to ease the process and remove all non-complex PBN from Part-SPA, meaning RNP APCH LPV no longer needs a "specific approval." Finnair and Liikenteen Turvallisuusvirasto, its

> "Establishing approval procedures that are efficient and minimise overhead for both operators and regulators are important considerations"

National Supervisory Authority –NSA-, were involved in the process. The training of pilots included the modification of the Type Rating Syllabus, CTR & CCQ (Common Type Rating Course & Cross-Crew-Qualification), and practical training in Finnair's Flight Simulation Training Devices. Finnair's A350 Operations Manual required checks from all staff before its submittal to the NSA. Eventually, Finnair received approval for both the training and the Flight Crew Operating Manual/ Aircraft Operations Manual modifications in the second quarter of 2020.

> "This [SBAS] service would be especially helpful for airlines that, under poor weather conditions, wished to land in certain airports that could not afford ground navaids"

When asked, Captain Valtonen recalls that the process was worthwhile but required effort and resources, and he believes it will be much easier to implement LPV capability in future Finnair planes. Each stakeholder, Finnair, and its NSA were intertwined and had their learning curve.

With its own EU-based NSA operational approval, Finnair then started the process directly with the FAA, which eventually recognised and approved Finnair's performance of LPV operations in US airspace as well. Captain Valtonen stated their experience with the FAA process was smooth and quick.

Benefits of interoperability

As there are more than 700 EGNOS-based procedures publications (AIRAC #2010) in Europe, 20 in Finland (12 being APV-I and 8 additional SBAS-based APV-Baro), Finnair now counts with many more options accessing many airports in poor weather conditions, and, when conventional ground navaids are not available, they fail or are out of service due to maintenance or substitution. Crossing the Atlantic has increased Finnair accessibility to North American airports, accomplished thanks to the A350's long range ability, as well as to 581 LPVs procedures in Canada and 4,064 LPVs in the USA, both served by WAAS.

All of this is possible due to the interoperability between different SBAS services, a core design feature developed by international standards, and (E)TSO-145/146 equipment design and certification that ensure users will be able to operate seamlessly in areas worldwide that are covered by an SBAS. Finnair's particular case is an example of such interoperability between WAAS and EGNOS.

Pilot's corner

We asked Captain Valtonen for his opinion on the differences between WAAS or EGNOS-based procedures and flight operations from a pilot's perspective. He responded there are no differences at all in terms of SBAS services providers, nor in terms of the actual approach followed. From pre-departure flight planning, flight management, and

Credits: Finnair

Landing at JFK

display conception and symbology "it is essentially the same as you have always done before." He also added that the Airbus A350's cockpit design and advanced avionics made it even easier and transparent for the pilot.

On September 12, 2020, while parked at the gate in Helsinki airport, Finnair's flight crew AY5 HEL-JFK set the flight plan to New York and chose the RNP APCH at JFK down to LPV minima on RWY04R. During the flight, they received confirmation on RWY04R according to SOP and proceeded as planned. The approach and landing were uneventful and were carried out under optimal visual conditions and without much traffic: a "joy" [sic].

On September 13, after a 24-hour layover at N.Y., and using the same plane, they performed a pre-planning for cargo flight AY6 JFK-HEL choosing the RNP Approach down to LPV minima for RWY15 at HEL. Landing took place on September 14, after receiving confirmation for RWY15 and completing the roundtrip.

A more interesting feedback

When asked about his insight on the A350 LPVs roundtrip and the trip as a whole, Marko said "it is very easy to select LPV approaches at both ends, as there is no need to mess with low level details such as WAAS or EGNOS selection. Just enter your destination and the type of approach, and all the information is there. Confirm the SBAS channel and other info you need and go." [sic]

Marko encourages all pilots to get acquainted with, try out, and use RNP SBAS LPV approaches because even though it is a new feature that pilots have to face: "you essentially just do the same you would do with ILS or other approaches." [sic]. Marko also said that when you are flying conventional or with PBN-based navigation, "you always have to know what you are doing." [sic].

In terms of the future, which may bring SBAS LPV capability to relevant planes including the Airbus A320/A330 and Boeing B737MAX/B777X families, Captain Valtonen shared the thought that SBAS LPV "is now a reality, for sure a part of the future of air navigation"[sic]. He also highlighted this service would be especially helpful for airlines that, under poor weather conditions, wished to land in certain airports that could not afford ground navaids.

Credits: Finnair

Talking with Captain Valtonen about Finnair's success story with the Airbus A350, its SLS and ADS-B out capabilities, and its transcontinental roundtrip between Europe and USA using EGNOS and WAAS for SBAS LPV approaches, brings to mind the tagline of one of the most influential advertisements ever: "Isn't it nice when things just work?"[sic].

FOKKER SERVICES STANDALONE SOLUTIONS FOR EQUIPPING B737NG AIRCRAFT WITH LPV

Having developed several modifications for global operators, the objective of Fokker Services is to provide a complete STC for LPV, with an OEM look and feel that require no changes in avionics architecture for eligible aircraft

Credits: Fokker Services

Masoud Sarwari, Product Manager at Fokker Services:
"We have been working with EGNOS for a long time. Our collaboration started some years ago when we attended the EGNOS workshop in Prague. Since then, we have worked closely together to promote the use of EGNOS in Europe. Today, we collaborate to bring the right data directly to our customers, outlining the cost-saving benefits that can be expected from a modification like our LPV solution."

Boeing's 737 Next Generation series -B737 NG- represents one of the most commonly used aircraft in commercial operations worldwide and Europe. There are 1468 units from 69 different European operators, including cargo carriers (e.g., 737-800SF) and passenger aircraft, using the standard commercial layout (e.g., 737-700). Overall, 88.5% of the European Boeing 737NG fleet is currently in-service, flying to many destinations in Europe. Today, over 370 airports in Europe publish over 700 EGNOS-based approach procedures (Including APV-Baro, LPV, and LPV200 lines of minima). This number will increase in the years to come: the Commission Implementing Regulation (EU) 2018/1048 (so-called "PBN IR") establishes PBN as the basis of Air Navigation and will make LPV the mandatory approach procedure for NPA runway ends by the end of 2020, and for PA runway ends by the end of 2024. When combined with the United States ADS-B Out rule, which recommends using SBAS when flying within several U.S. airspaces, and the many benefits provided by SBAS, such as the increase in airport accessibility by reducing diversions, decreasing CO2 emissions, and enabling Continuous Descent Operations, many airlines have decided to study the possibility of implementing SBAS for ADS-B Out and LPV on their fleet. This will pave the way for maintaining safety in current operations, opening new routes, and reducing overall operational costs.

As an Independent Aerospace Services Provider experienced in developing modifications for global operators, including LPV, Fokker Services is undergoing the production of a new STC for the B737 NG series. The STC will be certified by EASA and FAA soon. Fokker Services is currently installing SBAS/LPV-capable CMA-5024 receivers on one of their customers' B737 NG aircraft.

Their solution includes the Engineering Bulletin, relevant manual updates, a modification kit including all the pertinent materials to be modified, and 24/7 engineering support. Moreover, as a standalone solution it requires no changes to the aircraft's existing avionics architecture, and due to the ILS look-a-like concept, it has no impact on the operational procedures. Fokker Services offers modular installation possibilities at a competitive price.

It is excellent news since this solution will allow the certification of B737 NG aircraft for LPV operations and ADS-B Out, thus bringing SBAS, and therefore EGNOS technology, closer to its users. Moreover, Fokker Services is also looking into providing an LPV solution to other aircraft types, such as the A320 and B747.

Additionally, they also provide the only independent LPV solution with a similar avionics setup for Boeing's 757 (B757) aircraft, which brings EGNOS technology and the possibility of performing SBAS-based approaches to many operators and destinations.

We encourage interested European aircraft operators to contact Fokker Services (email: info.fokkerservices@fokker.com). For those interested in SBAS/LPV, ESSP offers free cost-benefit assessments to support their decision to retrofit (email egnos-adoption@essp-sas.eu).

THE HYDROGRAPHIC OFFICE OF THE POLISH NAVY RELIES ON EGNOS FOR MARITIME SURVEYS

Credits: The Hydrographic Office of the Polish Navy (HOPN)

Figure 1: Survey ship of the Polish Navy (ORP Heweliusz) and its hydrographic room

The Hydrographic Office of the Polish Navy (HOPN) began its operations in 1920 and is currently in charge of the national maritime hydrographic services. Its tasks include the maintenance of the national hydrographic database, production, updating of navigational charts, and promulgation of navigational warnings.

To collect bathymetric and environmental data, the HOPN uses hydrographic ships, motorboats, rigid inflatable boats (RIB) and autonomous surface vehicles to conduct supervised surveys alongside the maritime areas of the Republic of Poland.

This information is used in the development of nautical charts, both in paper and electronic (ENC), as well as in generating and updating other nautical publications. For this purpose, HOPN prepares an annual hydrographic schedule to continuously survey Polish waters throughout the year, even though final missions may have to be adapted to ship availability and weather conditions.

In hydrographic surveys, precise positioning data is crucial. Consequently, the collected information, such as water depth and seabed elements, is accurately represented in the nautical charts. For instance, the International Hydrographic Office (IHO) S-44 standard states that the position of any collected feature should be determined so that the horizontal uncertainty meets the specified requirements. This maximum allowed positioning error is classified into different orders between 2 and over 20 meters, depending on the water depth. For instance, order 1a, which applies to areas shallower than 100 meters where under-keel clearance is less critical, but features of concern to surface shipping may exist, requires a maximum error of 5 meters + 5% of depth. Therefore, EGNOS is a cost-effective option to comply with these IHO positioning requirements. Captain Dariusz Kolator, Chief of the HOPN, confirms that they "use EGNOS since 2011, after we found it available in the GNSS configuration of a new delivered multibeam echosounder."

The HOPN hydrographic surveys are carried out in Polish sea waters, limited by the Exclusive Economic Zone (EEZ) border.

> "EGNOS is a cost-effective option to comply with these IHO positioning requirements"

In this way, the ship can be as far as 150 km from the coastline, where it can be difficult to get GNSS corrections by radio and/or the Internet. As EGNOS signal is provided by satellites and its coverage area includes Polish waters, the ship's GNSS receivers can make use of EGNOS corrections anywhere on the campaigns. In this sense, Captain Kolator comments that "during harbour and costal surveys the use of RTK is mandatory. However, during offshore surveys, our onboard positioning system (Applanix POS MV) uses EGNOS to meet the order 1a horizontal requirements of the IHO S-44 standard". In addition, the HOPN takes advantage of the information provided in the EGNOS User Support Website, as they consult it "mainly before a mission to check the risk of signal outage", explains Captain Kolator.

COPERNICUS-EGNOS SYNERGY

Soil zoning using Copernicus and EGNOS

Credits: CICYTEX

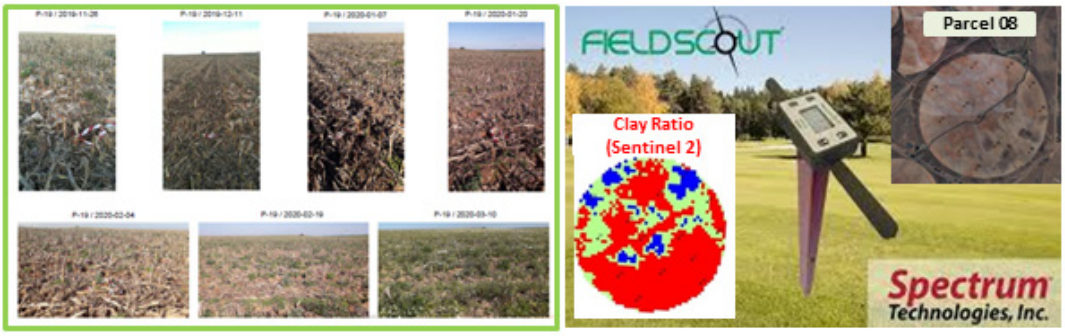


Figure 1: Analysis of a crop area in Setubal/Portugal ("parcel 08") using FIELDSCOUT TDR-350 sensor (EGNOS-enabled) and Sentinel data (Clay Ratio)

Credits: CICYTEX

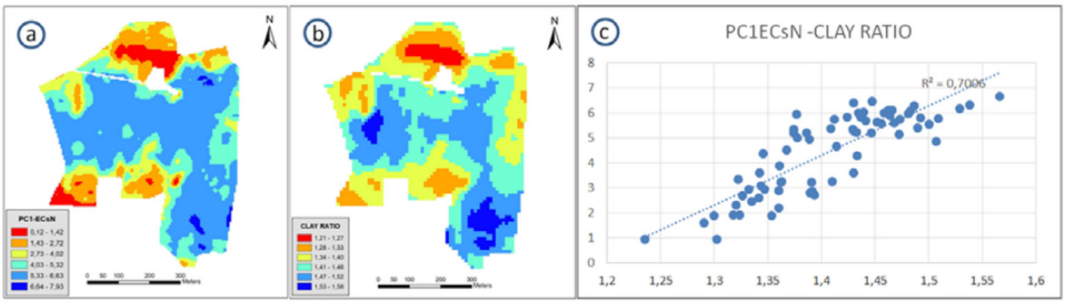


Figure 2: Relation between Main Component of Ec derived from sensor (EGNOS-enabled) and Clay ratio derived from Sentinel: a) PC1-ECsN; b) Clay Ratio; c) Linear regression between PC1- ECsN and Clay Ratio.

Effective agricultural zoning, also known as agricultural preservation zoning, is a land management tool that encourages farming while discouraging non-agricultural land uses that are incompatible with farm operations. It facilitates the planning and coordination process of agricultural sector activities, such as estimating which crops are the most recommended for certain areas and potential yields. By zoning agricultural areas, smaller spaces of greater homogeneity are established concerning their resources, allowing correlation with socio-economic factors and serving as support for the implementation of new development policies. Therefore, zoning soils is of great importance in precision agriculture practices.

> "The incorporation of EGNOS into on-site sensors has allowed evaluating with great accuracy and low cost the spatial variability of the soil's parameters in precision agriculture, at the same time it has enabled the evaluation of Sentinel images"

Nowadays, one of the soil parameters mostly used to carry out zoning soils is the Apparent Electric Conductivity (ECa) measurements (https://www.mdpi.com/2077-0472/8/6/84) that involve sensors partially buried in the soil that monitor relevant parameters such as humidity, apparent electrical conductivity, and temperature. The sensors are also equipped with GNSS devices that provide the location of such measurements (see both Figures). Unfortunately, having equipment that measures these parameters in extended areas is time consuming and expensive. However, satellite images, which provide information over large areas, are the perfect solution for the creation of zoning soil maps in extended areas at a low cost.

Copernicus, the European Earth Observation Programme, offers Sentinel-2, a free, full, and open imagery policy that provides sufficient spatial resolution and an adequate range of spectral bands. In particular, it allows analysing the moisture present in plants and soils by estimating the energy absorption of water in the short-wave infrared strip (SWIR). With such methodology, it is possible to derive clay ratio indexes related to zoning soils during the crop cycle. Sentinel-1 (SAR sensor –Synthetic Aperture Radar) can penetrate clouds, making it particularly valuable in areas that are frequently cloudy and complementing Sentinel-2 information. Therefore, Sentinel-1 can also be used to detect soil moisture and characterise types of soils (due to SAR's response to roughness and dielectric constant).

CICYTEX (Centro de Investigaciones Científicas y Tecnológicas de Extremadura) has developed a methodology using EGNOS for the zonal

characterization of soils based on the use of Sentinel (1 and 2) images and precise local measurements taken by the FIELDSCOUT TDR-350 sensor. The study has been carried out in an irrigated corn parcel in Setubal (Portugal) from 12/2019 to 04/2020.

By correlating in situ measurements (using EGNOS-enabled equipment) and the Sentinels' satellite images, it is possible to determine if the ECa (Electrical Conductivity) and moisture are adequate parameters for zoning soils and to estimate the connection between parameters related with clay soils and corn yields. Also, this allows determining areas with irrigation problems that can cause water stress or flooding. Jose Maria Terrón from CICYTEX states: "the incorporation of EGNOS into on-site sensors has allowed evaluating with great accuracy and low cost the spatial variability of the soil's parameters in precision agriculture, at the same time it has enabled the evaluation of Sentinel images."

This is a clear example that the combined use of EU space programs, in particular Copernicus and EGNOS, have made it possible to obtain and validate soil zoning methodologies to be applied in other areas and other crops.

EGNOS FOR SMART IRRIGATION IN AGRICULTURE WITH PROXIMA SYSTEMS' DEVICES

Credits: Proxima Systems'

Figure 1: Smart agriculture irrigation equipment using a Proxima Systems' EGNOS-enabled controller.

Global Navigation Satellite Systems (GNSS) is currently the key positioning technology in the smart irrigation sector and has replaced former methods for estimating position information based on mechanical switches, resolvers, and encoders. Farmers now employ GNSS-based control systems for both linear irrigation machines and centre pivots due to their high performance and ease of operation. In this context, Proxima Systems is a Spanish enterprise that has contributed for many years towards the development and adoption of smart irrigation solutions among both industry and farmers. Proxima Systems' products, based on sensors, controllers, and programming devices, make use of EGNOS to enable the automation and remote control of irrigation systems, allowing farmers to enhance their yields while saving on costs.

Proxima Systems' iControl Remote is an easy installation system that remotely controls centre pivots by means of a web browser so farmers can monitor and command their irrigation equipment in real-time with a computer, laptop, tablet, or smartphone. iControl Remote includes an EGNOS enabled GNSS receiver, which facilitates the performance of variable rate irrigation, i.e., the application of different amounts of water per sector, depending on specific soil's or crop's needs. Emiliano Muñoz, CEO of Proxima Systems, explains that they "discovered EGNOS in 2018 while studying the documentation of a new u-blox GNSS receiver intended to be integrated into the second version of the iControl Remote. They realised it could improve the position's accuracy and, therefore, the general performance of the product".

EGNOS is an efficient technology for smart agriculture irrigation since its satellites provide correction messages that improve GNSS accuracy anywhere in Europe at no cost and without the need for any additional ground infrastructure. The technical and financial suitability of EGNOS for Proxima Systems is confirmed by Emiliano, who corroborates that "EGNOS allows us to increase the positioning accuracy of the irrigation systems, without needing to invest in more complex solutions." Furthermore, "a better positioning means an optimised irrigation, allowing farmers to obtain higher yields while reducing water consumption," highlights Emiliano. Thus, the use of EGNOS for smart irrigation is beneficial not only in terms of cost efficiency but also from an environmental point of view, contributing to a more sustainable agriculture.

WALLOON AGRICULTURAL RESEARCH CENTRE

Credits: The Walloon Agricultural Research Centre

The Walloon Agricultural Research Centre (CRA-W) is a Belgian Public Interest Organization which brings together scientific research, service, and support functions to Walloon farmers, stockbreeders, horticulturists, forestry producers, and operators in the agri-food sector.

> "EGNOS is used to locate research plots installed in agricultural fields to find their position more accurately on satellite imagery"

The main research activities of the CRA-W are focused on precision farming, risk management, quality production, and precision livestock farming to produce more sustainably. It is composed of 440 employees involved in 130 scientific research projects.

The Global positioning technology has been tested and used by CRA-W researchers after the commissioning of GPS for civil applications.

As explained by Quentin Limbourg, a researcher in the Crop Production Unit of CRA-W, centimetre-level precision receivers and the use of RTK measurements on different agricultural machines are needed for research on precision farming (e.g., precision seeding, weeding robots, variable rate applications of fertilisers).

On the other hand, as explained by Cozmin's LUCAU DANILA, Ph.D. in Geomatics from the Catholic University of Louvain (BE) and formerly responsible for the validation of GNSS receivers and aerial/spatial imagery for the area measurement for CAP at an EU level, EGNOS is used "to locate research plots installed in agricultural fields to find their position more accurately on satellite imagery." In their activities, the identification on the field of specific spots observed in different satellite/aerial images to be validated by ground observations becomes more straightforward and accurate. The crop diseases in part of agricultural parcel or even diseased trees in forests are the most common examples.

Additionally, Cozmin explains that EGNOS supports them "in projects to prepare the operational implementation of the next CAP reform, providing enough accuracy in areas without an internet connection." Thanks to EGNOS, it allows them to reach isolated areas and take measures.

Another advantage mentioned by Cozmin is that "the integrity and availability of the service, and the easy configuration and use of EGNOS in our Trimble Geo 7X, are really helping us in our work."

Talking about EGNOS with… ANA Luxembourg

The Air Navigation Administration (ANA), placed under the authority of the Ministry of Sustainable Development and Infrastructure, is the air navigation service provider of Luxembourg

Credits: ANA Luxembourg

How is Luxembourg's airspace distributed / designed? Is there any particularity?

The TMA of Luxembourg covers the whole country of Luxembourg some parts of Germany, Belgium, and France. The procedures within the TMA of Luxembourg are tributary to the military areas and airspace structure of the surrounding countries.

In such complex airspace, strong coordination is required in the form of "Sectorization with different ANSPs" to ensure safety and smooth operations. PBN procedures allow easing the management of the airspace.

Which elements condition Luxemburg's airport operations (traffic flows, fog, terrain…)?

The airport's operations are conditioned by a mixture of different types of traffic, including business aviation, general aviation, flight schools, cargo activities (being one of the busiest cargo airports in Europe), and passenger commuting. During 2019, Luxembourg airport (ICAO: ELLX) counted more than 4 M passengers/year and served more than 80 destinations.

Moreover, Luxembourg is a single runway airport with ILS on both RWY ends, located in the proximity of the city of Luxembourg. Therefore, many restrictions apply due to noise abatement procedures. All of these factors have to be harmonised to operate for as many as 4 M passengers/year and to more than 80 destinations in 2019.

During the winter season, we experience many low visibility periods that sometimes last for days. Consequently, it is important for us to have a Precision Approach procedure in place to help

us cope with these situations. This is where the LPV plays its role.

Tell us about your experience with EGNOS. What is the process that led you to publish two LPV publications at ELLX?

From the beginning of the project, ESSP was part of the working group Luxembourg ATC created together with the flight design support of SKEYES, our DAC regulator, the representatives of Cargolux, Luxair, and Ryanair.

The quality of the signals necessary for the operation of GNSS-based flight procedures has initially been assessed by ESSP on 20-25 May 2018 and documented (GNSS' local performance, interference and multipath assessment at Luxembourg Airport's Final report 15.06.2018)

We did not experience any degradation of EGNOS since we use our PBN procedures.

What made you decide to develop and publish LPV approaches to both runway ends? Did the decision to use the most stringent minima LPV200 require any special treatment or study?

We decided to develop LPV200 APCH procedures to offer non-ground-based approaches on both runways, used in a proportion of 60% (RWY 24) to 40 % (RWY 06). The publication of a 200 minima line did require a separate study, but, luckily, we revised our conventional procedures at the same time, including our ILS CAT-I, with a major update of our obstacle database, used to develop the LPV procedure.

> "It clearly provides a more accurate approach system as a backup for our conventional ILS, which allows, without any degradation of our capacity to assume the approaches to Luxembourg"

We recommend other ANSPs to study EGNOS performance in the area before publishing LPV approaches to make sure the accuracy, availability, and continuity comply with the requirements for the approach, since some local considerations, such as multipath errors, should be addressed.

Could you share with our readers your experience with LPV200 at ELLX?

The ILS of RWY 24 was in maintenance for about two months (June and July), and, at that time, the main approach was the RNP.

The approaches went very well. It clearly provides a more accurate approach system as a backup for our conventional ILS, which allows, without any degradation of our capacity, to assume the approaches to Luxembourg.

Do you consider the LPV200 at RWY06 in ELLX could eventually replace the ILS CAT-I?

For now, it seems unlikely that the LPV 200 will replace the ILS CAT-I for runway 06. We encourage pilots to use RNP approaches, but, unfortunately, we have experienced that, for the moment, most still prefer to fly an ILS approach.

This is because either the aircraft flying to Luxembourg are not equipped (during the COVID crisis many operators have reduced their flights to ELLX), or pilots are already used to ILS approaches and prefer to stick to these. Nevertheless, pilots are usually ready for RNP approaches, and some even request them.

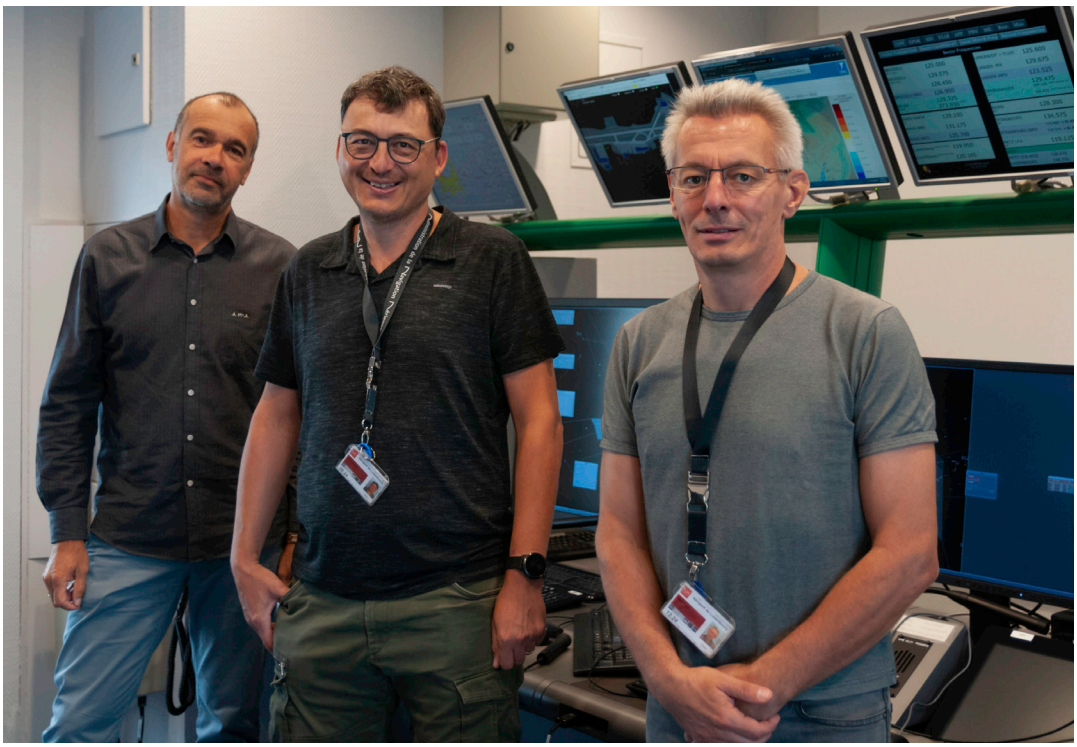
ANA annual reports give importance to Environmental Issues (i.e., Continuous Descent Operations –CDOs- benefits) and point out to further improvements by projects using PBN and RNP approaches with vertical guidance. Could ANA actually quantify fuel savings and reduction in CO2 emissions as part of its implementation of PBN and EGNOS-based LPV approaches?

For now, and after the implementation of the CDO procedure, ANA is measuring the use of both fuel and noise CDOs. The number of CDO approaches established and flown into ELLX per the total number of approaches was 65% for 2018 (with 17% noise CDOs and 48% fuel CDOs) and 81% for 2019 (with 36% noise CDOs and 45% fuel CDOs).

The development of a tool to quantify fuel savings and reduction in CO2 emissions is in progress. ANA is already in contact with companies for the elaboration of such a tool.

Which have been your main lessons learnt in this process?

We learned that, with the help of external experts like SKYES, ESSP, and flight companies, a small



Credits: ANA Luxembourg

ANSP as ANA within 2 years is able to implement a new procedure that requires not only a redesign of the final approach but also a new design of the entire approach from the IAF, including a missed approach.

Which do you consider are the benefits brought by PBN, especially by EGNOS?

The benefits are:

1. Keeping the same traffic capacity down to LPV 200 minima if we experience a technical problem in our main approach system, which is the ILS.
2. Having developed STAR's and transitions that are more adapted to our complex TMA structure.
3. The approach controller has more tools for handling traffic with the additional PBN procedures to tackle congestion.
4. The environmental benefits (fuel and noise) due to a better prediction of the flight path that favours continuous descend operations.

And, to finish, is there any final message you would like to share with our readers?

The ambitious project finally fulfils more than the required minima of RNP approaches.

New PBN STAR's and transitions to the final approach track have been designed for both runways.

In the near future, we aim to design new PBN SID's as well, to complete the offer of satellite-based procedures and to improve respect for operational aspects and noise abatement procedures in the departure sectors.

During this whole project, we have had good cooperation with the involved airlines, our project designers from SKEYES, our DAC regulator, and, last but not least, with ESSP, who was responsible for the GNSS multipath assessments.

Many thanks to all involved parties in the project.

> "In the near future, we aim to design new PBN SID's as well, to complete the offer of satellite-based procedures and to improve respect for operational aspects and noise abatement procedures in the departure sectors"

LPV Steep Approaches - Isles of Scilly (Skybus)

The number of EGNOS-based procedures publications has substantially risen since the first publication in 2011, reaching 717 published procedures in Europe as of last AIRAC cycle #2010, including a wide and rich variety of configurations and particularities. In this autumn edition we want to focus on a very impressive case: the publication of LPV steep approaches

Credits: Isles of Scilly (Skybus)

What is a steep approach?

Conventional instrument approaches include descent angles of 3 to 3.5 degrees that allow for a smooth and comfortable operation, which is the regular course of action in the majority of published procedures. But not every airport allows such horizontal glide paths. Due to requirements, such as terrain characteristics, noise abatement, or nearby urban areas, some airports need to establish more abrupt approaches, and that is where steep approach operations take part.

ICAO's PANS-OPS (Doc 8168) recommends 3.5 degrees as the maximum descent angle for approaches with vertical guidance and CAT I precision approaches. Nevertheless, it is not until 4.5 degrees that things get complicated. Commission Regulation (EU) No 965/2012 (the so-called 'Air Ops Regulation') establishes that approaches with descent angles **equal or steeper than 4.5 degrees** are permitted only in aircraft with performance classes A and B if the air operator gets prior approval from the competent

authority, which requires certain aircraft and aircrew characteristics.

Our readers may remember the famous case of London City Airport, whose nearby buildings required a descent angle of 5.5 degrees, previously reduced from 7.5 degrees in 1992.

What about LPV steep approaches?

And just as conventional procedures, steep approaches can also count on EGNOS for NPA with vertical guidance and CAT I lines of minima, translated to LPV and LPV200 for EGNOS-based procedures.

There are three LPV approaches in Europe for fixed-wing aircraft with a 4.5-degree descent angle:

Those three aerodromes are Land's End Airport (ICAO code EGHC) in the UK, with a 4.5 degree approach at runway 25, Forde Airport (ICAO code ENBL) in Norway, with its steep approach published at runway 25 and Mosjoen Airport (ICAO code ENMS), also in Norway, with a steep approach at runway 16.

An interesting feedback from the operator

We had the opportunity to talk with Christopher Pearson from the Isles of Scilly Steamship Group, and Airport Manager and Senior ATCO at Land's End.

The airline, Isles of Scilly Skybus (Skybus), is based at Land's End Airport. Its fleet relies on EGNOS for their operations with their four De-Havilland Twin-Otter 300, a two-crew aircraft without A/P, and their four Britain-Norman Islander, a single crew aircraft with A/P.

These aircraft regularly fly LPV approaches at destinations like Land's End and Exeter. They retrofitted their aircraft in 2015/16 with Garmin's GTN series avionics because LPV was useful for them.

At Land's End Airport, there are four LPV approaches published in each one of their four primary runways – 07/25, 16/34-, required due to high ground to the East of the airport. The LPV steep approach is published at runway 25. It is set at 4.5 degrees and only approved aircraft in speed Category A are permitted to perform this unusual descent. The STOL –Short Take-Off and Landing- aircraft that Skybus use is well suited for the steeper approach.

An approach in a speed Category-A aircraft to runway 25 with a 4.5-degree vertical path angle implies an approximate 30% increment in the descent rate. For aircraft in speed Category-A conducting an approach in still air at 90kt, the 715 ft/min rate of descent is well within the 1000 ft/

Credits: Isles of Scilly (Skybus)

Min' limit required by PANS-OPS. With this high rate of descent, still below the 1000 ft/min, there is a need for high precision, accurate guidance, high integrity, a minima usually below the cloud ceiling, etc. All those factors are protected by EGNOS in an LPV approach.

Based at Land's End Airport, Skybus operates under an AOC, and all crews routinely fly the 4.5-degree visual approaches to runway 25. The Skybus crews will receive appropriate training and will be maintained current in the execution of the 4.5-degree LPV Approaches.

Their experience with LPV steep approaches is very complimentary, having performed hundreds of them successfully at Land's End Airport. Flight crews have found the approach to be both reliable and stable.

Skybus also commented that "the use of SBAS as a form of integrity monitoring to augment GPS

for PVT is useful with LNAV. In addition, at certain Airports such as Exeter, the LNAV minima is better than the NDB minima."

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The role of Land's End Airport

Land's End Airport and its ATC team also play a crucial role in the success of these approaches.

Paving the way for other aerodromes, their experience with LPV started in 2011. Their runway ends were non-instrumental (NIRE), equipped with only TWR control, and required certain modifications before publishing the LPV. These modifications included developing a safety case, implementing runway lighting, removing obstructions, and ATC training. They even had to buy a piece of land to ensure the required instrument runway strip was wide enough!

Although the steep approach required additional documentation, implemented at runway 25, they finally obtained the UK CAA's approval.

To support the LPV implementation, the visual guide available for runway 25 comprises High-Intensity APAPI, white Stroboscopic Runway Threshold Indicator lights (RTILs), High-Intensity Green threshold lights, and High Intensity Runway Edge lighting. Additional mitigation required is ATC does not permit tail-wind approaches.

A particular feature is the UK AIP Charts that state that the use of the Land's End Instrument Approach Procedures is PPR (Prior Permission Required) strictly, and the use of the 25 LPV by other operators has to be approved by the Aerodrome Authority.

When asked if they were thinking about other means for implementing the steep approach, they stated that "only the LPV would have worked." They could not afford an ILS or an NDB, and they were not even sure if an ILS would have solved their problem since they would have needed an extensive obstacle clearance.

We were impressed to hear from them. Without a doubt, we can say that Land's End Airport and Isles of Scilly Skybus are pioneers for LPV steep approaches. We hope they keep benefiting from EGNOS in the future!

Credits: Isles of Scilly (Skybus)

EGNOS HELPDESK

We are pleased to remind EGNOS users about the availability of our Helpdesk service, allowing to submit any kind of question related to EGNOS or to report any experienced issue.

We will be pleased to hear from you since!

Our pull of experts is ready to quickly provide support on:

- Troubleshooting assistance
- EDAS Registrations management
- Answering general and technical EGNOS questions (about Usage, Architecture, Documentation, Performance, Coverage area, etc.)

The EGNOS Helpdesk interacts with users every day, providing a customized helpdesk experience focused on each type of user and delivering the fastest resolution time possible.

During **2019**, our users rated the service with **8.5** and, so far, in **2020** we are at **9.0**!

But we don't want to settle for this. Our team looks forward to continuously improving the service and support the EGNOS Helpdesk provides to the EGNOS community.

Let's answer your questions!

What are our users asking?

- Am I inside the EGNOS coverage area?
- How can I know if a drone can use EGNOS?
- What is EDAS?
- What can I obtain with EDAS?
- Is my receiver compatible with EGNOS?
- Where can I get HPL, HPE, VPL and VPE historical data?
- How could EGNOS help users in the maritime sector?

Use the channel you prefer to contact the EGNOS Helpdesk...

... via online form: available at the EGNOS User Support Website and the EGNOS app (**Android** and **IOS** versions), send us an email or give us a call.

EGNOS Helpdesk 24/7

+34 911 236 555 | egnos-helpdesk@essp-sas.eu | online form

EGNOS services highlights

SINCE JULY 27, 2020, EGNOS CONFIGURATION INCLUDES THE GPS BLOCK III NEW SATELLITES

As part of the US GPS modernization plan, new capability-improved GPS Block III satellites replaced two Block II satellites.

The EGNOS program launched specific activities to integrate these GPS constellation updates. Since the end of July 2020, the EGNOS configuration includes the modern GPS Block III PRN 4 and PRN 18, improving performance robustness in the North area.

Hence, EGNOS has achieved a key milestone, ensuring the robustness of the system and demonstrating its commitment to deliver users a high-quality performance. More information here.

What's new?
Since the last bulletin...

EGNOS WORKING AGREEMENTS SIGNED (EWA)

The following EWAs have been signed in the last quarter:

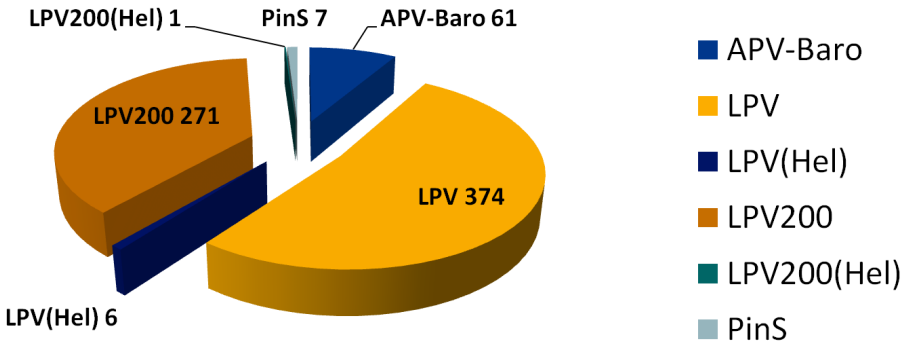
European Air Cargo **Sweden**

Norwegian National Police Air Support Unit **Norway**

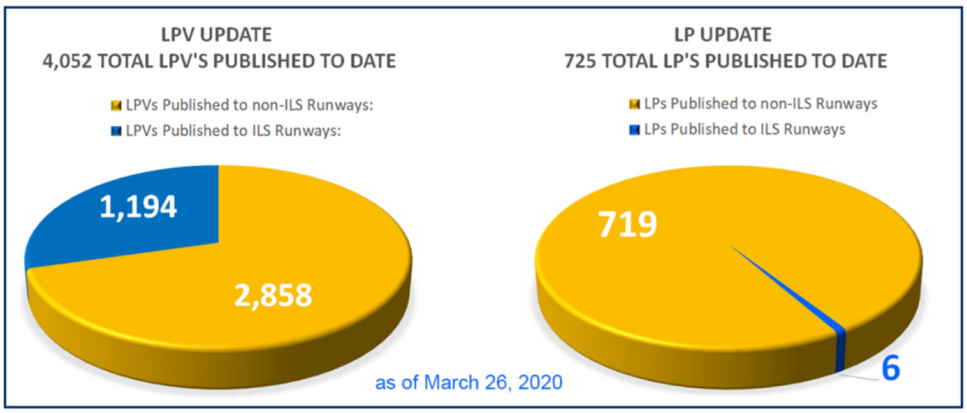
LPV, LPV-200, PinS & APV Baro procedures published

(including AIRAC cycle 2020 #11– 08/10/2020)

Next graph shows, the number of procedures
LPV, LPV-200, PinS, APV-Baro, LPV-Hel and LPV200-Hel. The total number is **720**



FAA procedure table

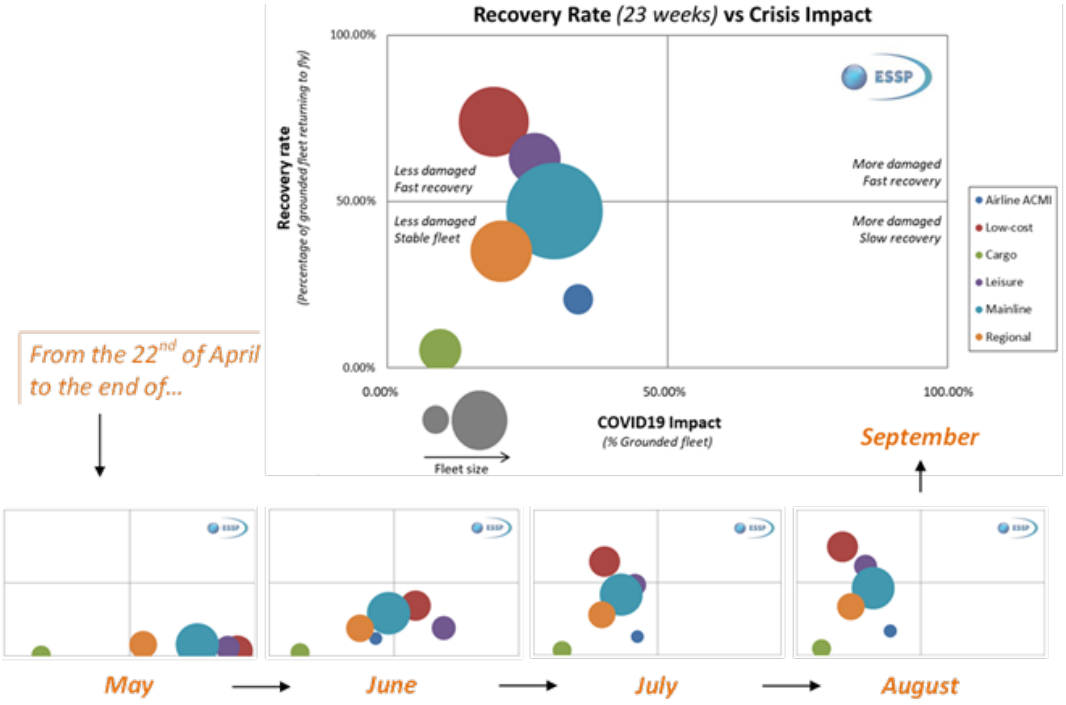


What's going on...

in aviation.

COVID IMPACT ON EUROPEAN AVIATION

Unfortunately, one of the most impacted industries during COVID-19 has been aviation. Borders closure, endless restrictions, and widespread fear of traveling have led to an unpredictable air traffic evolution. Many studies analyse the impact this crisis has had on aviation, regarding diverse facts such as the evolution of flights, the number of passengers, economic figures on different companies, etc. Our approach wanted to focus on a costly practice that most –if not all- airlines have been forced to rely on as their last resource: grounding.



Credits: ESSP

Did you know...?

There is an increasing trend in the aviation market to fight obsolescence. New technologies bring improvements to legacy aircraft, from ADS-B out to FMS. Legacy FMS lack memory to hold the increasing navigation database due to the novel instrumental procedures around the world or what is worse: they are simply reaching the end of their life cycle.
ADS-B out upgrades can combine with FMS upgrades enabling RNP APCH down to the LPV minima, finding a more favourable business case than separate upgrades. 2020 brought some webinars by Universal explaining FMS upgrades for LPV.

Reading the chart…

The diagram illustrates the relationship between the overall impact COVID-19 has had on each aviation submarket and the recovery rate experienced from 22 April to 5, 10, 15, and 20 weeks later.

The horizontal axis shows COVID-19's impact in terms of the percentage of the grounded fleet, such as aircraft in storage. The vertical axis shows the recovery rate experienced since the first week the analysis begun (22 April), calculated as the difference between the current percentage of the grounded fleet and the percentage from the first week (22 April). The size of the circles represents the amount of aircraft owned by airlines, which are classified by the different colours assigned to them, such as cargo, ACMI, low-cost, leisure, mainline, and regional.

When you combine these facts, the graph places each aviation segment in a space where they can be analysed in terms of robustness/ sensibility against COVID-19 and resilience to its crisis as follows:

On the bottom left area are the airlines that are currently less affected by COVID-19 and whose fleets are stable compared to the first week: that is, there has been almost no change in time in the amount of grounded fleet. On the top left area are those that now are less affected because they have been recovering quickly since the first -and worst- week. On the top right area are the airlines that are still more affected and have been recovering quickly since the first week. And on the bottom right area are the airlines with a relevant percentage still grounded and still not recovered.

What can we deduce from the diagram?

As expected, cargo aviation has proven to be the most stable submarket during the crisis since conventional and sanitary supplies had to be delivered to sustain the population in Europe. On the other hand, the slow mitigation of national mobility restrictions in Europe allowed regional aviation to start flying again in May, being the first group of companies that began to recover slightly. But this situation changed when the opening of barriers allowed mainline, low-cost, and leisure to operate, reaching a peak in the summer season, and with the low-cost airlines being the most oscillating one. Last but not least, ACMI airlines are recovering slowly but at a constant and stable rate. Considering the uncertainty of the current market, could this leasing practice be a possible solution for operators?

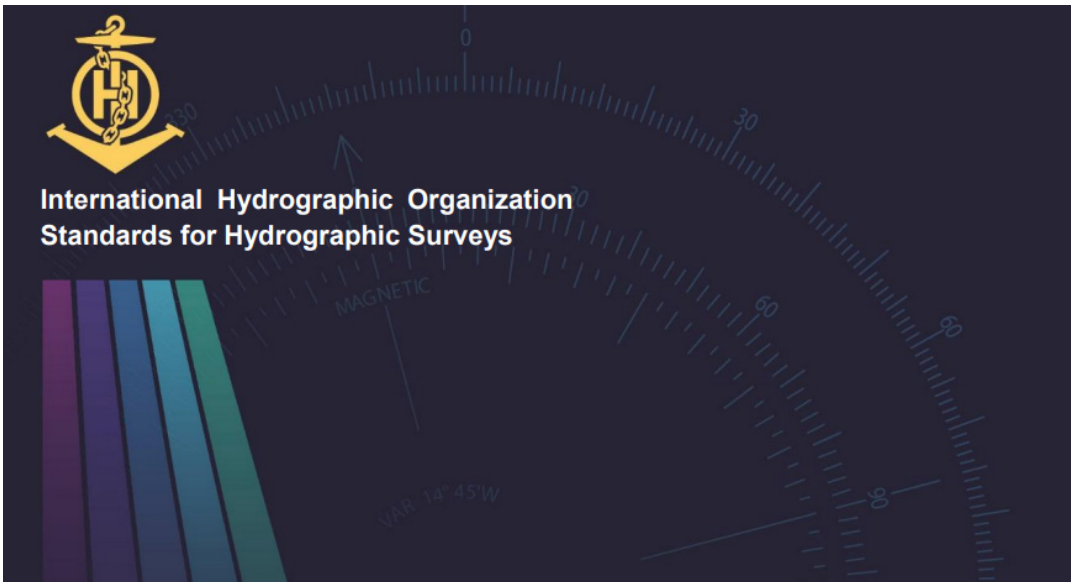
Compared with other studies (for example, the Eurocontrol Report), we find that the numbers of flights and passengers have not recovered as quickly as the percentage of the grounded fleet, indicating that aircraft are flying empty and with less frequency, but airlines are storing as few aircraft as possible.

Did you know...?

Aircraft equipped with SBAS LPV capabilities keep enlarging the fleets of European operators. The main carriers received new deliveries from Airbus in the form of the A220 and featuring SBAS & LPV as standard, and the A350, where SBAS & LPV is a customer option. You can check orders and deliveries here. Business jet operators are also taking aircraft with standard SBAS & LPV like the Pilatus PC-24, and rotorcrafts operators keep taking helicopters with standard LPV, as the Airbus H145.

in geomatics.

NEW EDITION FOR THE S-44 STANDARD FOR HYDROGRAPHIC SURVEYS



Credits: IHO Standards for Hydrographic Surveys

A new version of the IHO Standards for Hydrographic Surveys (S-44) was published last September 2020. The previous version (Edition 5) was published in 2008, and since then, hydrographic technology and methodologies have evolved considerably.

This new edition of standards applicable to hydrographic surveys introduces some changes, such as a new and more stringent exclusive order to limit those areas with exceptional conditions and specific requirements.

This publication, which received inputs from IHO stakeholders, is an international reference for hydrographic surveys and is focused on improving the safety of navigation, knowledge, and protection of the marine.

Did you know...?

GEAR and EASE tools have been uploaded in the Inventory of FAIRshare to disseminate EGNOS benefits to farm advisors.

GEAR (eGnos dEmonstrator for AgRriculture) is an interactive virtual demonstrator that allows farmers to discover the benefits of EGNOS in a friendly and entertaining way.

EASE (Egnos sAvingS in agriculturE) provides farmers with cost-benefit analyses on the use of EGNOS for machinery guidance in some of their typical agricultural labours.

Faishare project received funding from European Union Horizon 2020 Research and Innovation Programme and consists of a Digital Advisory Tools and Services platform about the agricultural sector.

in agriculture.

A CEREALIST'S DIARY

Credits: ESSP

Take the opportunity to discover how EGNOS supports farming by listening to a cerealist's testimony.

EGNOS plays an important role in contemporary European agriculture, helping farmers increase their productivity while being more environmentally sustainable. In this video (link to video), you will see how EGNOS supports cerealists during a crop campaign by easing several tasks such as ploughing, fertilizing, sowing, and spraying.

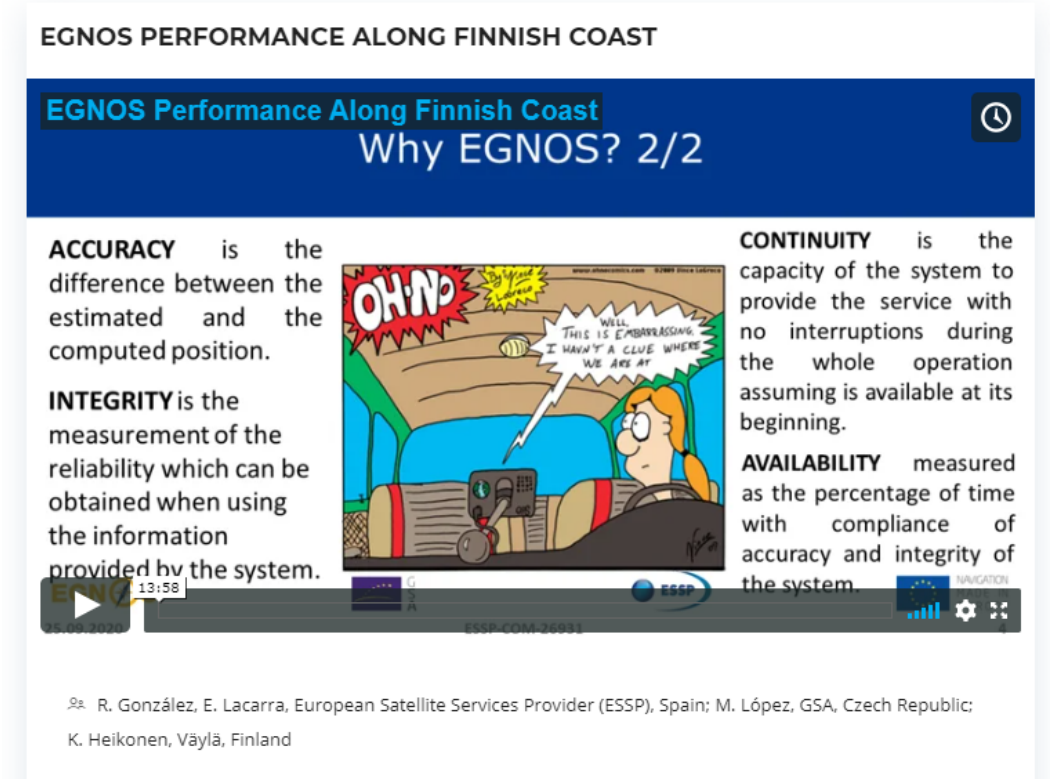
European farming can count on this free and public service, which improves GPS accuracy that is used, among other applications, for tractor guidance. The sub-meter level accuracy provided by EGNOS (20-30 cm pass-to-pass) offers an affordable solution for farmers allowing them to optimise fuel, chemicals, as well as their working hours while reducing fatigue. EGNOS performance, measured as the pass-to-pass error, is available here.

To use EGNOS, all you need is an SBAS-enabled antenna and an adequately configured receiver to get the signal. For those interested in equipment configuration details, you can download the guidelines at this link. You can also download GEAR, an interactive (and free) virtual demonstrator that, in a friendly and entertaining way, allows simulating some farming tasks under different weather conditions and shows the benefits of EGNOS in machinery guidance. If you want to calculate how much money you save by using EGNOS on your farm, the EASE tool provides cost-benefit analyses to compare it with other solutions for guidance, "GPS alone" mode, or no guidance at all.

Do not miss the video and discover how EGNOS supports European cerealists!

in maritime.

MARINE APPLICATIONS SESSION AT ION GNSS+ 2020



Credits: ESSP

This year, ION GNSS+ 2020 has taken place in virtual mode. Within the "Marine Applications and Search and Rescue" session, ESSP presented the "EGNOS Performance Along Finnish Coast" on September 25th, 2020.

This presentation aims at demonstrating EGNOS benefits for the maritime community, showing EGNOS performance provided by SBAS compatible receivers on-board a commercial vessel over the Finnish coast during 14 days. According to IMO Res .1046 (27) operational requirements, the results observed on board the oil tanker, Mastera, indicate EGNOS service can support "Harbour entrances/approaches and coastal/ocean waters" along the Gulf of Finland, meeting the 10-meter confidence level at 95%, the signal-in-space availability requirement at 99.8%, and the service continuity at 99.97%.

To play this video presentation, click on the following link:
https://www.ion.org/gnss/virtual-abstract-view.cfm?paperID=8780

Video, paper, and other content will be available for 30 days following the conference.

in rail.

NEW FEASIBILITY STUDIES ON EGNSS-BASED RAIL SAFETY SERVICE

Credits: ESSP

September has finally brought the announcement of both the award and the start of the RAIL projects linked to the "H2020: EGNSS-Based Rail Safety Services" tender by the EC_DEFIS. Two consortiums, one led by Airbus Defence & Space (with partners FDC, SNCF, and ESSP), and the other led by EGISAVIA, are the selected winners. The adequacy of the team, the quality of the proposals, and the relevance of the approach have made the proposals of both consortiums highly valued.

The main objective of the projects (developed in parallel and for the following two years) will be to carry out a feasibility assessment for an EGNSS-based rail safety service beyond 2022, which would enable rationalization of the rail signalling infrastructure. The results of this analysis will help the EC to determine whether an EGNOS service needs to be created for rail safety specifically.

The GSA (on behalf of the EC) supported by a dedicated working group of experts will respectively manage the project. With the celebration of their respective Kick-Off Meetings, they will become part of the portfolio of the H2020 projects in execution.

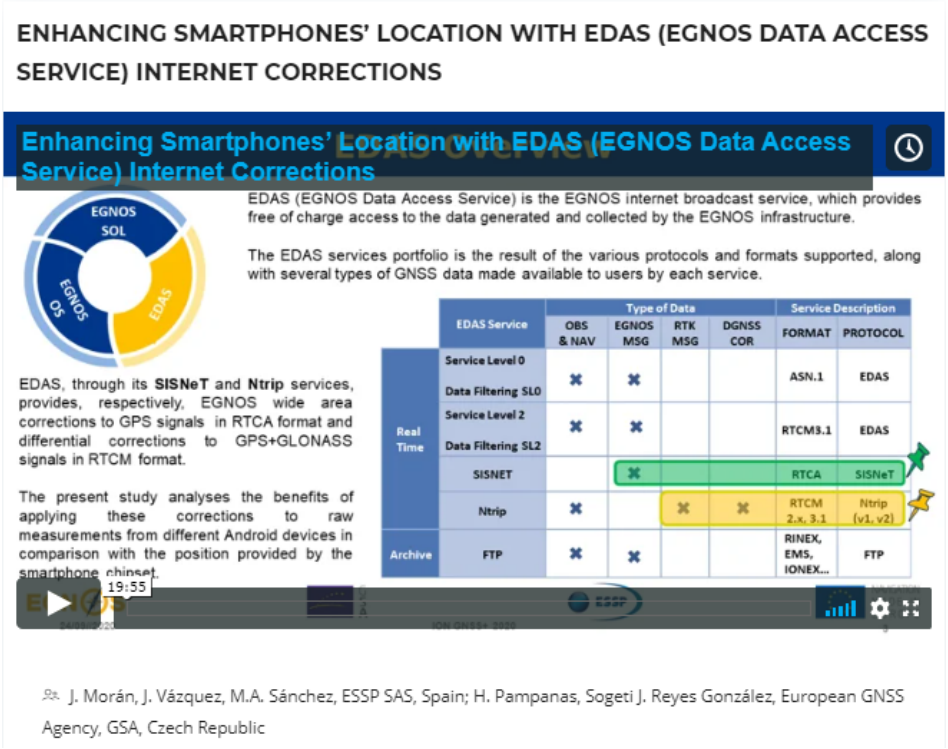
These projects strengthen Europe's commitment towards exploring and maximizing synergies between its EGNSS assets while supporting the evolving improvements and efficiencies of the Rail sector and the concept of safe and seamless multimodality transport.

Did you know...?

The European Union Agency for Railways (ERA) organises and processes the Change Control Management (CCM) for the ERTMS specifications and related documents listed in Annex A of the Control Command and Signalling specification (CCS TSI). Change Request (CR) analyses any modification to the ERTMS specification, so this is the mechanism to include GNSS into future ERTMS baselines. You may find more information about the submission of CRs here.

in GNSS.

NOVEL APPLICATIONS OF GNSS MEASUREMENTS FROM SMARTPHONES AT ION GNSS+ 2020



Credits: ESSP

J. Morán, J. Vázquez, M.A. Sánchez, ESSP SAS, Spain; H. Pampanas, Sogeti J. Reyes González, European GNSS Agency, GSA, Czech Republic

EGNOS was present at this year's virtual ION GNSS+ 2020 within the "NOVEL APPLICATIONS OF GNSS MEASUREMENTS FROM SMARTPHONES" session on the 24 Sept., where the ESSP and GSA paper "Enhancing smartphones' location with EDAS (EGNOS Data Access Service) internet corrections" was presented.

With the release of Android 7 (Nougat), Google provided Android developers with access to the GNSS raw data from the smartphones' chipset. The paper addressed the benefits of applying EDAS corrections to raw measurements from different Android devices in comparison with the position provided by the smartphone chipset.

To assess EDAS potential in this context, GNSS raw measurements collected by different Android devices (Huawei P30, Xiaomi M8) have been tested in open sky and rural, as well as in static and dynamic (i.e. pedestrian) scenarios. Performance results based on the data recorded during the tests were presented looking at the key performance indicators that characterise the GNSS navigation solution (i.e., accuracy, availability) and how they reflect in the different indicators that are made available by the Android API.

Once the need to smooth the reconstructed code measurements to reduce their noise level and it identified erroneous measurements was established, the study focused on the assessment of the potential benefits of the application of EDAS broadcast corrections (EGNOS and DGPS).

In the static scenarios analysed, the paper showed that the application of EGNOS and DGPS corrections over the reconstructed and smoothed smartphone's measurements can support average horizontal accuracies below 1m with availability above 95%, significantly improving the performance delivered by the embedded GNSS chipset of the tested smartphones.

Upcoming Events

ActInSpace 2020

13 - 14 Nov.

Take part in the ActInSpace challenge to propose an "Innovative Location-based App powered by EDAS" capitalizing on the GNSS raw measurement accessibility now enabled by Android devices.

Register in this link

European Space Week 2020

7 - 11 Dec

This year's edition of the European Space Week will focus on how the European Union Space Programme is contributing to the achieving of the EU priorities for 2019-2024, with sessions on the European Green Deal, the EU Space Program and a functioning economy for people, among other interesting topics.

The EGNOS Service Status Session is scheduled for December 8 from 14.00h to 15.30h.

WATM 2021

26 - 28 Oct

A new edition of the World ATM Congress, the principal Air Navigation Services Providers (ANSPs) congress in the world, will be held again in Madrid between 26 - 28 October 2021. Operated by CANSO BV in association with the Air Traffic Control Association (ATCA), the event provides an excellent opportunity for worldwide ANSPs and the ATM Industry to meet. Visitors will have the chance to walk the exhibition and enjoy a large number of free conferences.

EGNOS will be present at Stand 1141

World ATM Congress

EGNOS

https://egnos-user-support.essp-sas.eu

EGNOS applications. Developers platform. Business support.
Information on historical and real-time EGNOS performance. EGNOS Signal in Space (SIS) status. Forecast on SIS availability and EGNOS performance. EDAS information and registration. EGNOS adoption material and tools.

For questions & information

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