Aviation

GNSS MARKET REPORT

ISSUE 4

Excerpt from the GNSS MARKET REPORT, ISSUE 4 (2015)
Aviation

GNSS applications

Regulated applications in Aviation use certified equipment to achieve safe and efficient operations:

- **Performance Based Navigation (PBN)**, whereby an aircraft follows a specific procedure or route within a prescribed error margin. These procedures are available in en-route flight and when approaching airports.
- Aircraft should be equipped with **Emergency Locator Transmitters (ELTs)** that help Search and Rescue operations in the event of an incident. Many ELTs utilise GNSS to report their position when triggered.
- In Surveillance, aircraft can automatically report their position to air traffic controllers on the ground using **Automatic Depended Surveillance – Broadcast (ADS-B)**.

In the unregulated market, many recreational pilots using Visual Flight Rules (VFR) make use of GNSS applications on devices to supplement their visual navigation techniques:

- Pilots can use **moving maps** that show their current position on a map of surrounding airspace to help monitor progress against their flight plan.
- **Infringement alarms** can warn the pilot if they are getting too close to restricted airspace.
- New applications are being developed to improve **situational awareness** of other aircraft by receiving ADS-B transmissions and plotting them on the moving map.
- Pilots can carry **Personal Locator Beacons (PLBs)**, which are almost always equipped with GNSS, to help rescue services locate them in emergencies.

*This issue of the GNSS Market Report does not include figures for surveillance devices.*

In this chapter

- **Key trends**: GNSS benefits almost a billion European passenger journeys each year.
- **Industry**: List of main players by value chain segment.
- **Recent developments**: Historical shipments remained stable between 2008 and 2013.
- **Future market evolution**: IFR devices are reaching a plateau, while VFR continues to grow.
- **User technology**: Multi-GNSS solutions to deliver improved integrity, accuracy and continuity.
- **Focus on European GNSS**: EGNOS remains a key enabler for Aviation as preparations are made for Galileo.
- **Reference charts**: Yearly evolution of GNSS devices' installed base and revenues by segment and geographic area.

NEW! This issue of the GNSS Market Report includes two new applications: Search and Rescue ELTs and Search and Rescue PLBs.
GNSS benefits almost a billion European passenger journeys each year

Key market trends
- Usage of GNSS navigation is rising, particularly for Performance Based Navigation (PBN).
- SBAS-based procedures are increasingly available at many European aerodromes and operators are equipping aircraft with SBAS enabled avionics.
- GNSS enabled ELTs are also gaining importance in Aviation.
- GNSS is more utilised in surveillance through technologies like ADS-B and as a component of the data connection services.

What is the Aviation market?
The aviation industry continues to grow. According to Eurostat, in recent years passenger numbers are up within the EU by 1-2%. Most people are familiar with flying to go on holiday or a business trip, which is termed Commercial Aviation. However, Aviation comprises of more than just commercial passenger flights and in fact can be split into two broad categories:
- Flights operating under Instrument Flight Rules (IFR) include Commercial, General and Business (for example private jets), regional (typically on smaller aircraft flying to smaller airports). These must comply with strict regulations that ensure safe and efficient operations and are controlled by air traffic controllers.
- Flights operating under Visual Flight Rules (VFR) are typically recreational (for example kit planes, micro lights, gliders and balloons).

Business and commercial operators tend to use GNSS receivers that are tightly integrated into their avionics. Regional operators predominantly also have tight integration, but like general aviation pilots, can use panel mounted displays that offer a cheaper and often more easily upgradeable solution.

The move to Performance-Based Navigation drives GNSS uptake
Performance-Based Navigation (PBN), which is increasingly being used, places requirements on the quality and accuracy of aircraft navigation along predefined routes, on an instrument approach procedure or in designated airspace. GNSS enables PBN and provides navigation guidance for all phases of flight, from en-route to precision approach.

Surveillance supplements ground based radars with GNSS
ADS-B uses GNSS to allow aircraft to inform others (aircraft and controllers) of their location. Its increase is being driven by regulations, such as the Federal Aviation Administration (FAA) mandate to equip ADS-B by 2020. ADS-B is also designed to be interoperable with existing requirements for surveillance transponders, which aircraft must equip. This is being supported by Air Navigation Service Providers (ANSP) who can utilise the technology to cover areas they previously couldn't, such as Avinor (the Norwegian ANSP), who are deploying an ADS-B system for their North Sea operations.

ELTs required on aircraft
For IFR, Emergency Locator Transmitters (ELTs) have been in use for some time. For every aircraft carrying 19 or more passengers, ICAO Annex 6 recommends that all aeroplanes carry an automatic ELT. Their use is increasing, as any aircraft obtaining a certificate of airworthiness issued after July 2008 must be equipped with at least one automatic ELT. Although in VFR ELTs are not required, many pilots carry handheld PLBs.

How do users benefits from GNSS in aviation?
Increasing GNSS and SBAS use
GNSS will become an ever more critical infrastructure to aviation as more flight procedures are designed to take advantage of PBN. EGNOS-enabled instrument approach procedures to LPV minima are being rolled out across Europe. Localiser performance with vertical guidance (LPV) is an instrument approach procedure that provides lateral and vertical guidance based on GPS augmented by SBAS (EGNOS/WAAS) and allows a 250 ft decision height, improving safety and allowing operations to continue in adverse weather conditions. This benefits the economy and environment by reducing the occurrences of aircraft being forced to re-route to alternative airports during bad weather.

* 14 CFR §92.225 and §91.227
The EU GNSS industry in the global arena
The aviation industry has historically been dominated by avionics manufacturers from the United States. Globally, two of the top three avionics manufacturers (Honeywell and Rockwell Collins) are based there. The European Thales Avionics, as the main avionics integrator for Airbus, has also seen its market share increase in tandem with the success of the aircraft integrator. Thales is a key partner within SESAR, actively developing and validating new avionics as part of SESAR initiatives in the areas of multi-constellation GNSS, GBAS and enhanced ADS-B.

* European companies and organisations
Value chain considers the key global and European companies involved in the GNSS downstream activities.
Historical shipments remained stable between 2008 and 2013

GNSS is included in all modern aircraft, whereas SBAS capable receivers are usually found as standard fit only in modern business and general aviation aircraft.

General Aviation is the largest aviation sub-segment, with more aircraft and pilots than the business, regional, and commercial segments combined. The vast majority of these are located in North America. Sales in this segment are dominated by VFR users who upgrade their devices more frequently to ensure they have the latest functionality or application. In 2013, North America had a 70% share of shipments of GA VFR GNSS devices, followed by the EU28 region with 20%. Such equipment often does not have installation costs (as carry on devices) and can be purchased for around €1,000 per unit - substantially less than for IFR General Aviation where it costs €10,000 - €30,000 to equip each aircraft (although this provides IFR users more capabilities – e.g. LPV approach procedures). Equipping within Commercial Aviation costs substantially more than this, in the order of €100,000 and up.

Due to the cost of devices certified for IFR use, most Commercial, Regional, and Business Aviation aircraft are retrofitted with enhanced avionics only once during the aircraft’s lifetime (often around 30 years).

New for this year’s market report is the inclusion of Search and Rescue ELTs and PLBs into the chart data. The number of ELTs shipped is far exceeded by the PLBs. This is primarily due to the PLBs being used by smaller aircraft of less than six seats, which are much more numerous. Commercial, Regional and Business Aviation tend to be the prime target for ELTs.
IFR devices are reaching plateau, while VFR continues to grow

Shipments of IFR devices are expected to fall and plateau around the 15,000 per annum level, due to the increased equipage penetration of GNSS devices within an already strong market segment. The retrofit market continues to dominate the aviation market – especially in General and Business Aviation, where pilots are keen to adopt the latest technology and with GNSS enabled procedures beginning to open previously inaccessible aerodromes.

Commercial Aviation is expected to continue using APV Baro approach procedures (at airports where ILS is not available) until Ground Based Augmentation Systems (GBAS) CAT II and CAT III become available, which should increase interest in retrofits. However, the ubiquitous nature of SBAS in aviation receivers would be expected to lead to Commercial Aviation users eventually having SBAS on board.

Future developments in equipment are expected to focus on the integration of multi-constellation and enable capabilities such as Advanced RAIM (A-RAIM), which uses two independent GNSS core constellations to monitor position integrity. This is expected to lead to additional benefits in the more remote regions where the installation of terrestrial navigation aids can be limited by available resources or security.

The number of PLB devices shipped is expected to grow, continuing to exceed the number of ELT devices shipped. North America is by far the largest market region in terms of aircraft, pilots and GNSS equipment, followed by the EU28, which is reflected in GNSS device shipments.

The major growth areas for Commercial Aviation will be Asia Pacific and Middle East and Africa. In particular, Asia Pacific growth is expected to outpace all other regions in the near future, with the region purchasing nearly double the number of aircraft forecasted for Europe. There will be also a long-term, strong demand in Asia for the most costly GNSS receivers.

The UAV market is taking off

Unmanned Aerial Vehicles (UAVs) are an emerging and promising market for GNSS in Aviation, thanks to their need for precise positioning and orientation. UAVs were initially used for military and security purposes. However, a wide range of civil applications will further drive market growth. The market for UAVs is not quantified in this market report, but other sources estimate it at about $7 bln*, with forecasts predicting a steady increase of annual revenues over the next decade. Civil applications that have already become popular include geographic survey and mapping, scientific applications (such as ash cloud inspection) and pipeline/power-line inspection.

* Teal Group Corporation, 2013
Multi-GNSS solutions to deliver improved integrity, accuracy and continuity

GNSS developments in Aviation focus on enabling navigation applications, such as advanced Required Navigation Performance (RNP) and aerodrome manoeuvring, by leveraging multi-constellation/multi-frequency GNSS solutions. The technical requirements are being developed in this context to allow the aviation industry to benefit from improved integrity, accuracy and continuity. The transition to multi-constellation will also enable the introduction of Advanced Receiver Autonomous Integrity Monitoring (ARAIM), which will extend the benefits of LPV performances to those areas of the world not currently serviced by SBAS systems like EGNOS.

The provision of these capabilities in more integrated platforms is expected to provide significant benefits to aircraft that have been typically limited in space or capability. For example, the helicopter industry is expected to benefit from EGNOS and new Instrument Flight Procedures (IFP), allowing flights to occur under Instrument Flight Rules (IFR), not only access to helipads in low visibility conditions. New developments include:

- **Point in Space (PinS) procedures to LPV minima**: they effectively enable cloud break procedures to allow landing in adverse weather conditions without the need for costly ground infrastructure.
- **Low-level RNP routes**: they allow for more suitable operations during the en-route phase of flight. As a consequence, it enables a helicopter to remain outside icing conditions that would be encountered if higher en-route altitudes needed to be flown.
- **Simultaneous Non-interfering Approaches (SNI)**: specific implementation of PinS approach procedures combined with low level routes enable IFR helicopters to operate to and from airports without conflicting with fixed-wing traffic or requiring dedicated runway slots.

For fixed wing, the availability of multi-constellation/multi-frequency GNSS is expected to enable the capabilities of other approach aids such as GBAS CAT II and III.

Applications on the aerodrome surface would also benefit from Multi-GNSS and ARAIM enabled receivers as accuracy is expected to improve enough to support the ability of performing on-board integrity and accuracy checks and thus enabling ground based navigation assistance. This could include automated taxi guidance, especially in low visibility conditions and display to the pilot the relative positions of other aircraft.

In addition to navigation, applications such as Spaced Based ADS-B (Automatic Dependent Surveillance Broadcast) are expected to benefit from the aircraft position reporting enhanced by multi-GNSS also in oceanic and remote regions of the globe. Such solutions would have been of direct benefit in the aircraft searches for both AF447 and MH370, both lost over the sea, away from their initial route.

The safety requirements, certification and the necessity to comply with international standards are naturally slowing down the adoption of multi-constellation compared to non-regulated markets. The majority of GNSS devices in offering today are GPS only, with more than 20% penetration of SBAS.*

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*For the methodology applied to the charts please go to page 15 of the Report.
EGNOS a key enabler for Aviation whilst preparations are made for Galileo

An increased number of European Regional, Business and General Aviation operators are equipping their aircraft with EGNOS certified avionics, allowing them to take advantage of already published procedures. It gives them the competitive advantage of continuing to offer services and reducing flying time in adverse weather conditions.

With the advent of NPA25/2013, which places EGNOS approach procedures on the private pilot licence course, LPV is on course to become not only a widely deployed procedure, but one that is widely incorporated into pilot training, meaning all new IFR pilots will be certified to fly LPV approaches. As a result, when the LPV training becomes part of standard IFR training, there will be no need for specific approvals for pilots to fly LPV approaches.

Galileo, as part of a multi-constellation and multi-frequency navigation solution, will enable ever more accurate PBN routes, maximising the capacity of airspace around the world. Innovative techniques such as GBAS approaches (with minima at CAT II or CAT III standards) are expected to be possible using multi-constellation/multi-frequency GNSS, which will enable A-RAIM.

Work is on-going within ICAO to produce standards for the use of Galileo in Aviation. EUROCAE is addressing standardisation issues in its Working Group 62. This will cover:
- Recommendations for operational use of GNSS;
- Airborne GPS/Galileo/SBAS receiver equipment Minimum Operational Performance Standards (MOPS); and
- Precision approach for combined Galileo/GPS systems.

“Filling the gap” in GNSS Advanced Procedures and oPerations

FiGAPP was an FP7 funded project ended in 2014, that demonstrated efficient and accurate methods for navigating airspace based on GNSS. Such advanced operations included approaches with curved approach or missed approach segments, delivering such benefits as increased accessibility and safety in mountainous airports, increased accessibility in constraint aerial zones, and reduced noise impact for cities neighbouring airports. The project successfully demonstrated advanced arrival and departure flight operations performed by business and regional operators in German and Spanish airports facing such constraints (Egelsbach, Saarbrucken, Valencia and Pamplona).

The demonstration was the first time a high-precision, high-integrity missed approach/departure performed in Europe. It was based on innovative flight management systems and a GNSS receiver. The operations, including curved approaches, demonstrated a reduction in the trajectory to be flown – saving fuel and time and reducing the overall environmental impact of the flight. The demonstration flights also validated technical and operational independence from nearby ATC systems, assuring increased operational capacity for airports.

Availability of EGNOS in Europe is increasing

Key to ensuring the uptake of EGNOS in Europe is the availability of avionics that can be installed on the European aircraft fleet. Over the past years, the European GNSS Agency has been supporting projects focused on increasing the availability of procedures, along with working with regulators to ensure the availability of upgrade solutions.

A small fraction of aircraft have EGNOS solutions available as forward fit option, but for the majority the ability to retrofit aircraft was perceived as being the main hurdle. Our analysis shows that although the solution is now available for the majority of the General and Business Aviation fleet, there is much lower availability within the Commercial and Regional segments where upgrade costs are significantly higher. For rotorcraft (considered within General and Business Aviation) there is an increasing demand for EGNOS enabled operations (e.g. PInS), but the segment is currently lacking suitable retrofit paths compared to fixed-wing aircraft, as the rotorcraft options are more challenging from a certification perspective.

EGNOS availability to European fleet

* The chart shows the percentage of aircraft within the fleet which have an EGNOS solution available to them, VFR is not included as the devices are hand held.
The use of IFR devices is expected to increase, driven by PBN implementation. Despite increasing GNSS shipments, revenue growth will slow down as the market becomes dominated by forward-fit aircraft (which have a lower cost). The increase of an average price of Commercial Aviation devices in 2016 is due to anticipated retrofits of SBAS capability.