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(IATA Headquarter, Montreal, Canada)

Agenda Item 3: SARPs for GNSS elements and signals (GBAS)

GBAS APPROACH SERVICE TYPE A PROVIDED VIA SBAS RELAY

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SUMMARY

This manuscript proposes to use the GAST-A provisions outlined in Annex 10 with corrections and integrity information generated by SBAS systems to enable APV approaches. This creates more accessibility to airports that are served by LPV final approach segments. These approach segements can then be used by aircraft with GLS only multi mode receivers. At high latitudes, where the SBAS satellite has a low elevation angle, continuity of service is enhanced by providing an additional means of transmissision of augmentation data.

1. INTRODUCTION

Generally, two different augmentation systems exist to improve the lateral and especially the vertical navigation integrity, accuracy, continuity and availability. These are based on ground stations at fixed and surveyed locations. For the Ground Based Augmentation System (GBAS, [2]) these reference sites are located at the respective airport. Correction and integrity data is provided via a VHF aeronautical data link. For the second system, the Satellite Based Augmentation System (SBAS) [3], reference sites are distributed over a country to continental sized service region and the data is provided via satellite downlink. Both systems use Final Approach Segment (FAS) data blocks to describe the approach funnel used by the aircraft to approach the runway. A FAS data block contains all the necessary information for the avionics to compute virtual localizer and glide path information. Using GBAS, the system is called GNSS Landing System GLS and the FAS data block is provided at the airport by the VHF data broadcast. Using SBAS, the procedure is called Localizer Performance with Vertical guidance (LPV). The LPV procedure is typically available as lowest minimum on an RNP approach procedure [5], and the FAS data block is provided by the navigation data base of the flight management system. Correction information and FAS data are largely identical for both systems (GLS and SBAS). Both systems enable a decision height as low as 200ft above the aerodrome and a minimum Runway Visual Range (RVR) of 550 meters.

For GBAS, Annex 10 Vol. I currently shows 4 GBAS Approach Service Types (GAST), labelled A-D. Annex 10 Vol. I, Att. D, Ch. 7.1.2.1 states: “GAST A, B and C are intended to support typical APV I, APV II and Category I operations, respectively. GAST D has been introduced to support landing and guided take-off operations in lower visibility conditions including Category III operations.”

The original intent of GAST-A was to support the Ground Based Regional Augmentation System (GRAS), which was to be used in Australia in lieu of SBAS (Crosby et al. 2000 [6]). Here, in lieu of broadcasting regional corrections via a satellite downlink, they were intended to be transmitted via a VHF data link.

GRAS is still described in Annex 10 Vol. I, Att. D, Ch. 7.1.5 “From a user perspective, a GRAS ground subsystem consists of one or more GBAS ground subsystems (as described in 7.1.1 through 7.1.4), each with a unique GBAS identification, providing the positioning service and one or more approach service types where required. By using multiple GBAS broadcast stations, and by broadcasting the Type 101 message, GRAS is able to support en-route operations via the GBAS positioning service, while also supporting erminal, departure, and operations supported by GAST A or B over a larger coverage region than that typically supported by GBAS. In some GRAS applications, the corrections broadcast in the Type 101 message may be computed using data obtained from a network of reference receivers distributed in the coverage region.”

Currently, the majority of commercial transport aircraft is not equipped with the capability to fly LPV approaches. Exemplary for Europe, the Eurocontrol dashboard lists the data depicted in Figure 1 for scheduled air transport services regarding the navigation specification stated in the filed flight plan:

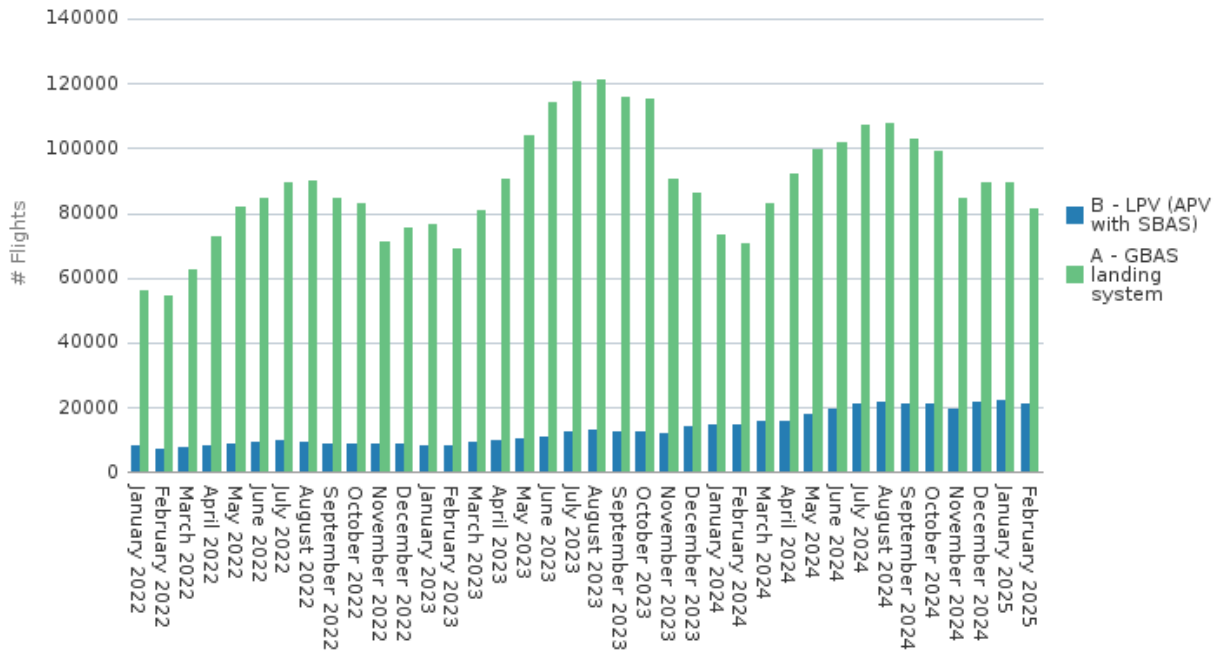

Figure 1 Number of scheduled flights with CS-25 aicraft equipped with GLS vs LPV complete dataset (Eurocontrol CNS Dashboard, https://www.eurocontrol.int/dashboard/communication-navigation-and-surveillance-dashboard, retrieved 07 April 2025)

Therefore, if an airport is not equipped with ILS and the aircraft is not able to utilize the LPV FAS, the only remaining option is an RNP APCH or a classical 2D instrument approach procedure based on VOR or NDB. All these approaches come with higher minima which can limit airport accessibility. Many of the Boeing 737-800 and above were delivered with GLS capability already built in, but not with LPV, see Figure 2 as an example for flights serving secondary airports in France.

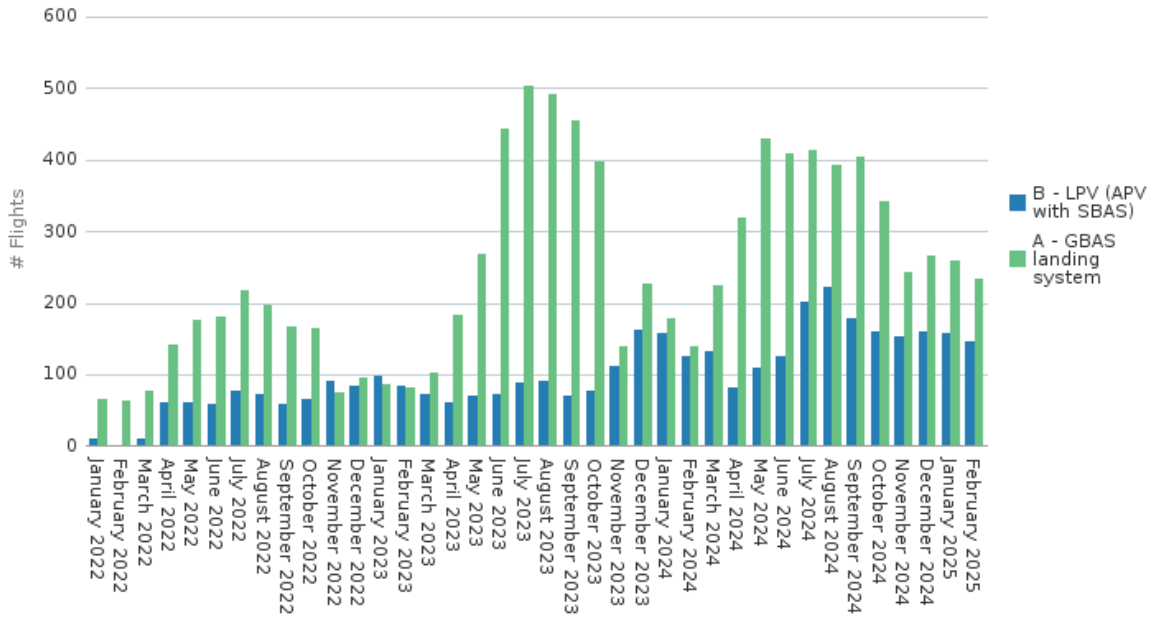

Figure 2 Number of scheduled flights with CS-25 aicraft equipped with GLS vs LPV at French secondary airports[1] (Eurocontrol CNS Dashboard, https://www.eurocontrol.int/dashboard/communication-navigation-and-surveillance-dashboard, retrieved 07 April 2025)

Explanation of Terms

Acronym	Meaning
FAS	Final Approach Sement
GAST	GBAS Approach Service Type
GBAS	Ground Based Augmentation System
LPV	Localizer Performance with Vertical guidance
NDB	Non Directional Beacon
SBAS	Satellite Based Augmentation System
VOR	VHF Omnidirectional Range

2. DISCUSSION

The attached document [1] describes the technical implementation of a system repurposing SBAS correction data to provide an LPV service akin to GAST-A via a GBAS VDB Link.

2.1 Benefits of GAST-A

The European Commission Implementing Regulation (EU) 2018/1048 of 18 July 2028, the so-called Performance-Based Navigation Implementing Regulation (PBN IR), fosters exclusive PBN operations as from June 6, 2030. Article 5 of the regulation states*: "1. Providers of ATM/ANS shall not provide their services using conventional navigation procedures, or using performance-based navigation which is not in accordance with the requirements of point AUR.PBN.2005 of the Annex. 2. Paragraph 1 shall be without prejudice to Article 6 and to the possibility of providers of ATM/ANS to provide their services using landing systems enabling CAT II, CAT IIIA or CAT IIIB operations within the meaning of points 14, 15 and 16,*

[1] LFBH - La Rochelle Laleu, LFBI - Poitiers Biard, LFBZ - Biarritz-Bayonne, LFBT - Tarbes Lourdes, LFMK - Carcassonne Salvaza, LFMP - Perpignan Rivesaltes, LFMU - Beziers, LFME - Nimes Courbessac, LFTW - Nimes, LFMN - Nice, LFLG - Grenoble Le Versoud, LFLS - Grenoble, LFCR - Rodez Marcillac, LFBV - Brive La Roche, LFBL - Limoges Bellegarde, LFXF - Limoges Romanet, LFBI - Poitiers, LFOK - Chalons Vatry, LFGJ - Dole Tavaux

respectively, of Annex I to Regulation (EU) No 965/201" As a consequence, ILS CAT I approach procedures are to be discontinued by the effective deadline of the regulation. In turn, if an airport's only 3D Type A approach is an SBAS LPV and an aircraft is not equipped, the lowest approach minimum decision height is the one of the LNAV/VNAV type which in most cases is significantly above the the LPV CAT 1 minimum.

In the light of GNSS RFI and due to a number of other factors, the current PBN IR may be amended prior to 2030, specifically with respect to its article 5. However, regardless of actual implementation timescale and detail provisions, the aim of the PBN IR is to make vertically guided approaches available to all instrument runway ends, in line with ICAO Assembly Resolution 37-11. This paper supports this general objective.

Furthermore, at high latitudes, geostationary satellites which provide the SBAS corrections are only visible to aircrafts' antennas at very low elevation angles. This increases the risk of signal shadowing or blockage by terrain or high wings during banking in a turn. A secondary means of providing correction data, namely the GBAS VHF data link, could enhance the service availability and continuity within these regions.

Lastly, a wider spread of GLS installations can lead to a better acceptance of the technology by operators, pilots and aircraft manufacturers. As such, even further GAST-A installations would drive the spreading of the technology.

2.2 Differences between GAST-A and GAST-C

The different service types of GBAS are coded in the FAS DB in the field corresponding to the Approach Performance Designator APD. APD=0 indicates GAST-A or GAST-B whereas a higher number correspond to the GAST-C and above (Annex 10 Vol. I, App. B, Ch. 3.6.4.5.1). This value direcly influences the computation of the Alert Limits. For GAST-C and above, the maximum value that can be coded in the FAS data block is 25.4 meters (resolution 0.1m) and varies with distance from the threshold. For GAST-A and B the maximum value in the FAS DB is 50.8 meters (resolution 0.2m) and does not vary with distance. Annex 10 Vol. I, Att. D, Ch. 7.13.3 states: *"The lateral and vertical alert limits for procedures supported by GAST A service type associated with channel numbers 40 001 to 99 999 are computed in the same manner as SBAS as given in 6.6",* with Ch. 6.6 being the specifications for SBAS.

Furthermore, GAST-A can use either GBAS Message Type 1 or the Message Type 10, where message type 101 was specifically introduced for the GRAS. (Annex 10 Vol. I, Att. D, Ch. 7.19.2: *"Differential position solution for approach service GAST A, B and C. When the active approach service type is A, B or C, the position solution used to generate deviations is based on 100 second smoothed pseudo-ranges corrected withcorrections obtained from message Type 1 or message Type 101".*

It is to be noted that the presented concept is not the same as the "Bent Pipe" principle described in [7] which tried to provide full CAT-1 capability but could not match the required time to alert.

2.3 Compatibilty to Available Avionics Hardware

Annex 10 Vol. I, Att. D, Ch. 7.1.7 states: *"Interoperability of the GBAS ground and aircraft elements compatible with RTCA/DO-253() is addressed in App. B, Ch. 3.6.8.1. GBAS receivers compliant with RTCA/DO-253A will not be compatible with GRAS ground subsystems broadcasting Type 101 messages. However, GRAS and GBAS receivers compliant with RTCA/DO-310 GRAS MOPS, will be compatible with GBAS ground subsystems. SARPs-compliant GBAS receivers may not be able to decode the FAS data correctly for GAST A transmitted from GBAS ground subsystems (i.e. a FAS data block with APD coded as "0"). These receivers will apply the FASLAL and FASVAL as if the active service type is GAST C. ANSPs should be cognizant of this fact and relevant operational restrictions may have to be applied to ensure the safety of the operation".*

As a matter of fact, tests with Collins GLU925, GLU2100, CMC and Funke Avionics show, that the APD is ignored by all legacy receivers and the alert limits are computed in accordance with GAST-C/D. However, the study [1] performed in the Appendix to this paper shows that this can be accepted with sufficient performance by choosing the parameters appropriately.

2.4 Proposed addition to Annex 10 Vol. I, Attachment D, Ch. 7.1.4

Overall, an operational use of a GAST-A service for repurposing SBAS correction data is well within the scope of the current SARPS. This results in particular from Annex 10 Vol. I, Att. D, Ch. 7.1.2.1.3 which states: *"Service providers should give consideration to what service type or types are actually required for each runway given the planned operations and encode the availability of the appropriate service types in the APD field of the associated FAS block."*

To establish a basis for the provision of aircrafts with SBAS correction data via a VHF aeronautical in accordance with the GAST-A service, the paper proposes the following addition to Annex 10 Vol. I, Attachment D, Ch. 7.1.4:

"*e) a configuration that supports GAST-A and is used to relay SBAS data"*

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) Review and discuss the proposal to provide aircrafts with SBAS corrections via a GAST-A Service

b) Consider and discuss the proposed changes to Annex 10 Vol. I, Attachment D, Chapter 7.1.4

4. REFERENCES

[1] Dautermann, T., Ludwig, T., Geister, R. et al. Extending access to localizer performance with vertical guidance approaches by means of an SBAS to GBAS converter. GPS Solut 24, 37 (2020). https://doi.org/10.1007/s10291-019-0947-7

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[4] Javier Ventura-Traveset and Didier Flament, editors. EGNOS ï¿½ The European Geostationary Navigation Over-lay System. Number ESA SP-1303. ESA Publications Division, 2006.

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[6] Crosby GK, Kraus DK, Ely WS, Cashin TP, McPherson KW., Bean KW, Stewart JM, Elrod BD, (2000) A Ground-based Regional Augmentation System (GRAS) - The Australian Proposal, Proc ION GPS 2000, Salt Lake City, UT, September 2000, pp. 713-721.

[7] Sam Pullen et al. Proosed LAAS VDB WAAS Repeater Protocol, Briefing to the GSAT, 7 March 2005

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