

Navigation service monitoring

ICAO documentation review and GBAS & SBAS system implementation

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What is the issue ?

Context :

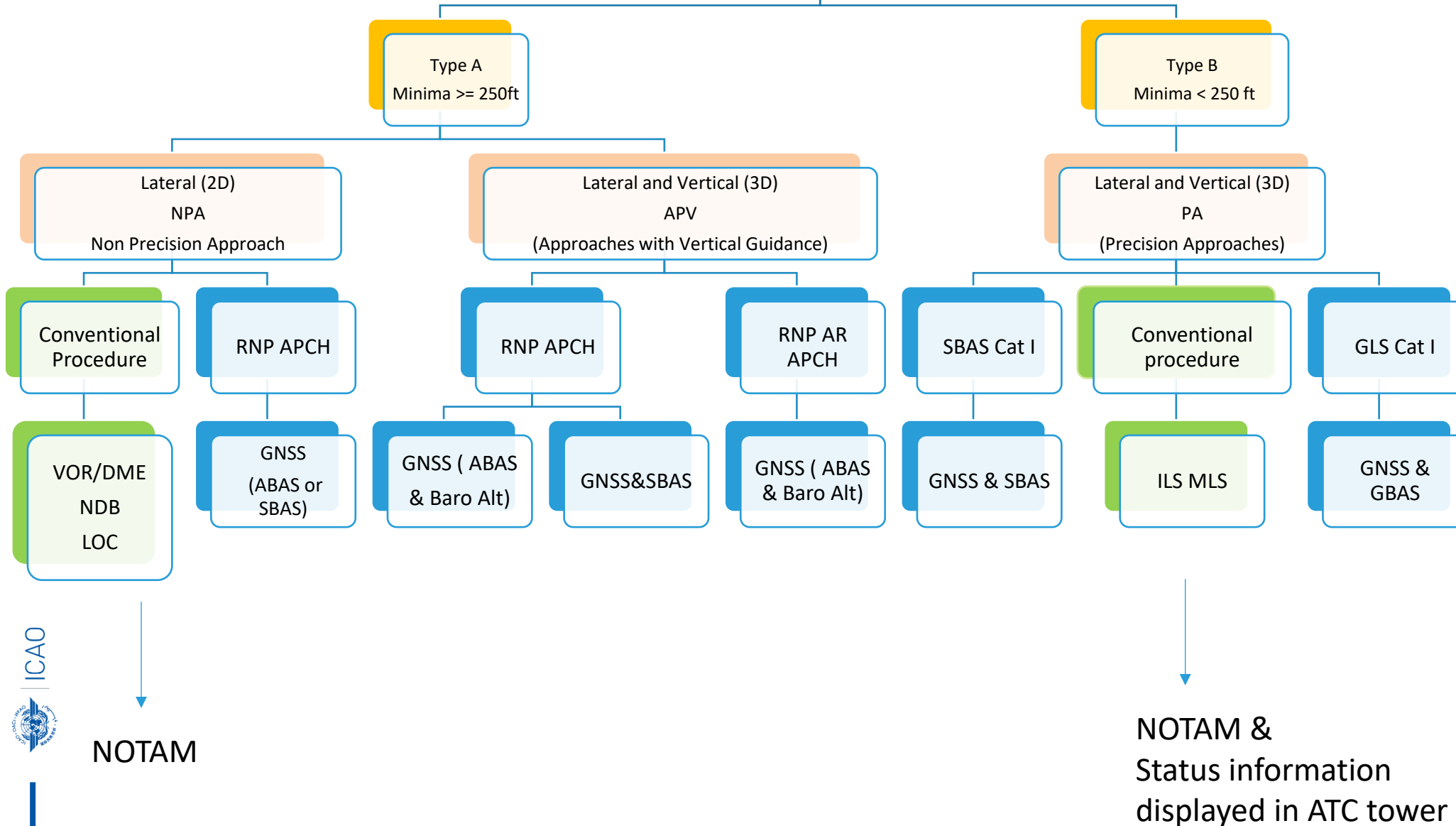
Navigation going from trajectories based on conventional navaids to trajectories based on performances using different navigation aids (based on satellite for example)

Question :

Which information should be provided to the pilot and to the air traffic controller in case of loss of performances/outages of navaids? NOTAM and ATC interface in the tower?

Cas of conventional nav aids

ICAO Approach classifications



What is ICAO documentation saying?

References :

- Annex 10 Vol I (8th edition, 2023)
- Annex 11 (15th edition, 2018, including amdts up to 51, amdts 52 to 54 do not address this topic)
- GNSS Manual (Doc 9849, 5th edition, 2025)
- PBN manual (Doc 9613, 5th edition, 2023)
- Air Traffic Management (Doc 4444, 16th edition, 2016, amdts 1 to 13)

What is ICAO documentation saying?

Different ideas :

- Essential means
- Operational status
- Timely information to pilot, technical staff and ATC services

Annex 10

CHAPTER 1. DEFINITIONS

Essential radio navigation service. A radio navigation service whose disruption has a significant impact on operations in the affected airspace or aerodrome.

2.3 Provision of information on the operational status of radio navigation services

2.3.1 Aerodrome control towers and units providing approach control service shall be provided with information on the operational status of radio navigation services **essential** for approach, landing and take-off at the aerodrome(s) with which they are concerned, on a timely basis consistent with the use of the service(s) involved.

Note. — Guidance material on the application of this Standard in the case of PBN-based operations supported by GNSS is contained in the Performance-based Navigation (PBN) Manual (Doc 9613).

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3.1.2.1.3 Facility Performance Categories I, II and III — ILS shall provide indications at designated remote control points of the operational status of all ILS ground system components, as follows:

- a) for all Facility Performance Category II and Category III ILS, the air traffic services unit involved in the control of aircraft on the final approach shall be one of the designated remote control points and shall receive information on the operational status of the ILS, with a delay commensurate with the requirements of the operational environment;
- b) for a Facility Performance Category I ILS, if that ILS provides an **essential** radio navigation service, the air traffic services unit involved in the control of aircraft on the final approach shall be one of the designated remote control points and shall receive information on the operational status of the ILS, with a delay commensurate with the requirements of the operational environment.

Annex 11

7.3 Information on the operational status of navigation services

7.3.1 *ATS units* shall be *kept currently informed* of the *operational status of radio navigation services and visual aids essential for take-off, departure, approach and landing procedures* within their area of responsibility and those radio navigation services and visual aids essential for surface movement.

7.3.2 Recommendation.— Information on the operational status, and any changes thereto, of radio navigation services and visual aids as referred to in 7.3.1 should be received by the appropriate ATS unit(s) *on a timely basis consistent with the use of the service(s) and aid(s) involved*.

In Doc 4444, essential is used 54 times, with traffic or with information, but here we focus on nav aids.

6.4 INFORMATION FOR DEPARTING AIRCRAFT

6.4.2 Operational status of visual or non-visual aids

Information regarding changes in the operational status of visual or non-visual aids essential for take-off and climb shall be transmitted without delay to a departing aircraft, except when it is known that the aircraft already has received the information.

6.6 INFORMATION FOR ARRIVING AIRCRAFT

6.6.1 As early as practicable after an aircraft has established communication with the unit providing approach control service, the following elements of information, in the order listed, shall be transmitted to the aircraft, with the exception of such elements which it is known the aircraft has already received:

..d) changes in the operational status of visual and non-visual aids essential for approach and landing.

6.6.5 During final approach, the following information shall be transmitted without delay:

.. d) changes in the operational status of required visual or non-visual aids;

In Doc 4444, (ground-based) navigation aids are often opposed to GNSS/RNAV &

7.1.3 Failure or irregularity of aids and equipment

Aerodrome control towers shall immediately report in accordance with local instructions any failure or irregularity of operation in any equipment, light or other device established at an aerodrome for the guidance of aerodrome traffic and flight crews or required for the provision of air traffic control service.

7.2 SELECTION OF RUNWAY-IN-USE

7.2.2 Normally, an aircraft will land and take off into wind unless safety, the runway configuration, meteorological conditions and available instrument approach procedures or air traffic conditions determine that a different direction is preferable. In selecting the runway-in-use, however, the unit providing aerodrome control service shall take into consideration, besides surface wind speed and direction, other relevant factors such as the aerodrome traffic circuits, the length of runways, and the approach and landing aids available.

In Doc 9613

... 4.3.1.1 GNSS operational status monitoring - an activity performed by a State or delegated entity, with the main objective of providing timely information to technical staff and ATC services on the operational status of GNSS services in relation to a defined operation in a particular airspace (and to therefore inform the user of any operating restrictions that may be required),

Real time monitoring for PBN operations

In Doc 9613

... 4.3.1.4 There are a number of specific features of PBN approaches that render **real-time operational status monitoring neither practical nor required for PBN operations**, whether the service is assessed as **essential or non-essential**.

4.3.1.4.1 Impracticability of real-time service monitoring for PBN operations

4.3.1.4.1.1 As noted in the GNSS Manual, Chapter 7:

“Given the variety of avionics designs, one service status model cannot meet all operators’ requirements. A conservative model would produce false alarms for some aircraft. A less conservative model would lead to missed detection of a service outage for some and false alarms for others. Regardless, only the aircrew, not ATC, is in a position to determine whether, for example, it is possible to continue an ABAS-based instrument approach. In contrast, **ATC has access to ILS monitor data and can deny an ILS approach clearance based on a failure indication. The real-time monitor concept is neither practical nor required for GNSS ABAS operations.**”

4.3.1.4.1.2 For PBN approach operations supporting SBAS minima, building an SBAS real-time monitor could be more practical than for ABAS. However, PBN approach procedures supporting SBAS (LPV) minima also support ABAS (lateral navigation (LNAV) and/or lateral navigation or vertical navigation (LNAV/VNAV)) minima in most cases. Since the ATC clears the aircraft to a PBN procedure chart identification and not to a specific line of minima, this specific SBAS monitor would not help ATC to manage the PBN approach procedure unavailability, unless all aircraft are SBAS equipped. **Consequently, there has been no operational need for this interface to**

In Doc 9613

4.3.1.4.2 Mitigating the absence of service monitoring for PBN operations

4.3.1.4.2.1 Whereas the availability of ground-based navigation services is directly related to failures of the electronic equipment, the availability of PBN services depends mostly on the geometry of the GNSS constellation, as interpreted by the specific airborne augmentation layer. **Where PBN is implemented as an essential service**, one active mitigation to the impracticability of building operational status information is to ensure a high availability at the airspace user level of the PBN approach procedure through the requirement of a pre-flight prediction of the GNSS constellation geometry. Airspace users are then required to delay departure until the predicted geometry is sufficient.

4.3.1.4.2.2 Another mitigation measure, applicable to both **essential and non-essential PBN approaches**, is the **advisory predictive GNSS service availability NOTAMs** broadcast to users and ATC services. These are based on the status information provided by the core satellites or augmentation system operator. Finally, since only the aircrew are able to determine the availability of a particular PBN operation, **real-time information to ATC is provided by pilots' reports based on the status information provided by the PBN avionics**.

4.3.1.5 It is important that airspace users notify ATC of interference events and ,as a consequence, ATC should consider notifying other airspace users of these events through automatic terminal information service (ATIS), NOTAMs or other means.

Case of SBAS/LPV

Rationale :

- ✓ ATC is clearing A/C on RNP APCH
- ✓ RNP APCH chart may include up to three different types of approaches NPA (LNAV/VNAV), APV Baro (LNAV/VNAV) and APV SBAS (LPV) and ATC does not know which one the pilot will follow, especially in vertical path
- ✓ Only aircraft system can really determine the onboard performances due to type of receivers, mask angle, geometry... A ground receiver will not be able to reflect the onboard performances.
- ✓ Providing non representative information to ATC is of no interest, could create more problems than bring help to decision.
- ✓ No distinction is done between 250ft and 200ft (LPV minima), as same rationale.

Conclusion :

No need to provide SBAS status or LPV unavailability to Air Traffic Controller in the tower

Solutions implemented in the world

SBAS : solutions implemented for aerodromes with RNP APCH (LPV minima) published

WAAS :

EGNOS : NOTAM, to be checked; no information in real time to ATC in tower

GAGAN :

MSAS :

KASS :

SouthPAN :

Beidou SBAS :

Rationale :

- ✓ GBAS station is installed at the airport facility and field monitoring can clearly indicates if GLS Cat I is available or not or if GBAS Station unavailable
- ✓ GBAS station is designed in a way to have a status monitoring output to be connected to ATC tower, like for ILS system, “OK” or “Not OK” status (but what is the real conditions for this indicators, VPL exceeding VAL or others?)
- ✓ “GLS capable” is also displayed on radar screen of ATC
- ✓ GLS chart is standalone, like ILS chart, may have Cat I, II and III but today in GBAS only Cat I

EUROCAE ED-114B : MOPS For Global Navigation Satellite Ground Based Augmentation System Ground Equipment To Support Precision Approach and Landing

3.9.6.2 ATC Status Functions :

A change in operational status of the GBAS Ground Subsystem shall be displayed at the ATCU status display within 2 seconds, excluding network lag times.

The operational status **shall** be provided with at least the following indications:

- i) “Normal” indication which is displayed when the Ground Subsystem equipment is operational and no executive alarm has been generated.
- ii) “Alarm” indication which is displayed when the Ground Subsystem equipment is not available through the generation of an executive alarm or other means.

The following indications **may** also be provided:

- ii) GAST status
- iii) The status of each approach path that can be operationally used. In case control of individual FAS blocks or runway ends is provided, the corresponding status shall be displayed.

Conclusion :

Provide GBAS status to ATC tower

Solutions implemented in the world

GBAS :

Australia GLS Cat I :

Japan GLS Cat I :

GBAS MONITORING AND OUTAGE NOTIFICATIONS

ATC STATUS MONITORING AND NOTAM

- GBAS OK/NOT OK status monitoring provided directly to the local Tower and responsible approach control unit
- GBAS technical monitoring provided to the Technical Operations Centre including:
 - GBAS Fail, GBAS Service Alert, GBAS on Battery, Loss of monitoring
- Dedicated laptop in the responsible approach control unit providing supplementary GBAS information
- Pilots notified of GBAS outages through a NOTAM
- ATC will inform pilots directly if their monitor indicates GBAS NOT OK
- GLS is not available during periods the VPL is predicted to exceed the VAL
- Example NOTAMs
 - GROUND BASED AUGMENTATION SYSTEM (GBAS) U/S
 - GROUND BASED AUGMENTATION SYSTEM (GBAS) U/S DUE CONSTELLATION AVAILABILITY
 - GROUND BASED AUGMENTATION SYSTEM (GBAS) ON TEST, DO NOT USE, FALSE INDICATIONS POSSIBLE, NOT TO BE USED FOR NAVIGATION

The diagram illustrates the GBAS monitoring and notification system. It features two status boxes: a grey box labeled 'GBAS OK' and a magenta box labeled 'GBAS NOT OK'. A hexagonal box labeled 'GBAS MONITOR ON CONTROLLERS SCREEN' is connected to the 'GBAS NOT OK' box. Another hexagonal box labeled 'LAPTOP FOR SUPPLEMENTARY GBAS INFORMATION' is connected to the 'GBAS MONITOR ON CONTROLLERS SCREEN'. A screenshot of a software interface shows 'GBAS MODE' as 'NORMAL' and 'CONSTITUTION ALERT STATUS' as 'LOSS OF SERVICE'. The screenshot also displays a table with columns for 'PREDICTED DATE', 'PREDICTED TIME', and 'TIME', and rows for 'LOSS OF SERVICE' and 'LAPTOP FOR SUPPLEMENTARY GBAS INFORMATION'.



Thank You!