International Civil Aviation Organization

Asia/Pacific GBAS/SBAS Implementation Task Force (APAC GBAS/SBAS ITF/1)

24 – 26 June 2020, Tokyo Japan

Agenda Item 3: Global and regional GBAS/SBAS update (including relevant meeting outcomes, new technologies by Industry)

ICAO DOCUMENT REVIEW RELATED TO GBAS/SBAS

(Presented by the Secretariat)

SUMMARY

This paper provides information on ICAO document review related to GBAS/SBAS. ICAO included the implementation of GBAS/SBAS approaches in the Aviation System Block Upgrade (ASBU) of the 6th Edition of Global Air Navigation Plan (GANP) in October 2019, which was reflected in the Asia and Pacific Seamless ANS Plan, Version 3 in November 2019 for regional implementation.

1. INTRODUCTION

1.1 Ground Based Augmentation System (GBAS) and Satellite Based Augmentation System (SBAS) based approaches have many benefits, such as enhancement of safety through the geometric vertical guidance for final approach and improvement of accessibility to regional airports besides general benefits gained from PBN implementation, i.e. improvement of operational efficiency, increase of airspace capacity, reduction of noise and CO2 emission. In addition, approach procedures based on GBAS and SBAS will not be affected by local temperature and altimeter setting, and ground movement of aircraft, which is also related to the enhancement of safety.

1.2 Considering these benefits, ICAO has published various documents to support the implementation of GBAS and SBAS. Among them, global and regional GBAS/SBAS implementation strategies are found in the Global Air Navigation Plan (Doc 9750, 6th Edition) and Asia and Pacific Seamless ANS Plan (Version 3.0) respectively. In addition, Annex 10 Volume I – Radio Navigation Aids and Testing of Satellite Based Radio Navigation Systems (Doc 8071 Vol II) provide technical guidance for the GBAS/SBAS implementation.

1.3 For the flight procedure design and validation for GBAS/SBAS, PANS-OPS (Doc 8168) Volume II – Construction of Visual and Instrument Flight Procedures and Validation of Instrument Flight Procedures (Doc 9906 Vol 5) can be referred during the instrument flight procedure development. In addition, documents supporting GBAS/SBAS operations are PANS-OPS Volume I – Flight Procedures, PBN Manual (Doc 9613), GNSS Manual (Doc 9849) and Air Traffic Management (Doc 4444).

2. DISCUSSION

2.1 The **Attachment A** shows ICAO Document review related to GBAS SBAS mentioned above.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and
b) discuss any relevant matters as appropriate.

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GBAS/SBAS Implementation Task Force

ICAO Document Review related to GBAS/SBAS

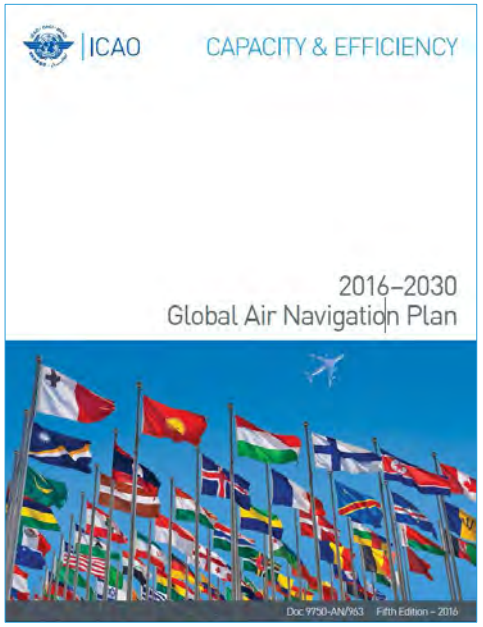
ICAO APAC Regional Sub-office
24-26 June 2020

Related documents on GBAS/SBAS implementation

- **Global Strategy**
  - Global Air Navigation Plan (Doc 9750)
- **Regional Strategy**
  - Asia/Pacific Seamless ANS Plan (V3.0, Nov 2019)
- **System requirements and testing**
  - Annex 10 Vol I - Radio Navigation Aids
  - Doc 8071 Vol II - Testing of Satellite-based Radio Navigation Systems
- **Procedure design and validation**
  - Doc 8168 Vol II - Construction of Visual and Instrument FPs
  - Doc 9906 Vol V - IFP validation
- **Operations**
  - Doc 8168 Vol I - Flight Procedures
  - Doc 9613 PBN Manual
  - Doc 9849 GNSS Manual
  - Doc 4444 Air Traffic Management

Documents related to GBAS/SBAS Implementation

❖ Global Air Navigation Plan



- A strategic plan to guide the implementation of CNS/ATM systems
  - Comprising technical, operational, economic, environmental, financial, legal and institutional elements; and
  - offering practical guidance and advice to regional planning groups and States on implementation and funding strategies.
- Contains near- and medium-term guidance on air navigation system improvements necessary to support a uniform transition to the ATM system envisioned in the operational concept.
- Introduced the Aviation System Block Upgrade (ASBU) methodology considering existing technologies and anticipated future development based on State/industry agreed operational objectives

Documents related to GBAS/SBAS Implementation

❖ Global Air Navigation Plan

- ➢ GBAS/SBAS implementation in the GANP (5th Ed)
  - B0 – APTA : application of GNSS, Baro-VNAV, LPV, GLS to enhance the reliability and predictability of approaches to runways, thus increasing safety, accessibility and efficiency
  - B1 – APTA : progress further with PBN and GLS (CAT II/III)
  - Navigation : explanation of GNSS infrastructure, SBAS (LPV, LP, CAT I), GBAS (CAT I, CAT II/III), policies for conventional navigation aids, mitigation measures to a GNSS outage, etc.

Documents related to GBAS/SBAS Implementation

❖ Global Air Navigation Plan

➢ Changes of ASBU elements in the update of GANP (6 Ed)

Current GANP (Fifth Edition 2016)	New GANP (Sixth Edition 2019)
B0/1 – APTA B0/1/2/3 - RSEQ B0/1 – FRTO B0/1/2 – CDO B0 - CCO B0/1/3 – TBO etc.	APTA-B0/1, B1/1 – PBN APCH APTA-B0/2, B1/2 – PBN SID/STAR APTA-B0/3 – SBAS/GBAS CAT I APTA-B0/4, B1/4 – CDO APTA-B0/5, B1/5 – CCO APTA-B0/6 – Helicopter PinS APTA-B2/1 – GBAS CAT II/III NAVS-B0/1 – SBAS NAVS-B0/2, B1/1 - GBAS NAVS-B0/3 - ABAS FRTO-B1/1 – Free route airspace FRTO-B1/2 – RNP routes, etc. See https://www4.icao.int/ganpportal

Documents related to GBAS/SBAS Implementation

❖ Asia/Pacific Seamless ANS Plan V3.0


INTERNATIONAL CIVIL AVIATION ORGANIZATION

ASIA/PACIFIC SEAMLESS ANS PLAN

Version 3.0, November 2019

This Plan was originally developed by the Asia/Pacific Seamless ATM Planning Group (APSAPG) and amended when appropriate by APANPIRG.

Approved by APANPIRG/30 and published by the ICAO Asia and Pacific Office, Bangkok

- The plan provides a framework for a transition to a Seamless ANS environment to meet future performance requirements.
- SBAS LPV and GBAS/SBAS CAT I implementation has the priority 1 and 3 in the plan respectively.
- GBAS and SBAS systems should be established as appropriate to the level and type aircraft operations and operating environment subject to an assessment of benefits and costs (Priority 2).

Documents related to GBAS/SBAS Implementation

❖ Asia/Pacific Seamless ANS Plan V3.0

➢ Asia/Pacific ASBU Block 0 and Block 1 Priority

Functional Category	Element	Priority
Operational	APTA-B0/1-2: Basic PBN SID and STAR procedures, PBN non-precision (PARS 7.4, 5, 10, 13, 14)	1
	APTA-B0/3 and 6: SBAS/GBAS CAT I precision approach procedures, and PBN Helicopter PinS Operations (PARS 7.5, 6, 10, 14, 21)	3
	APTA-B0/4-5, 7-8: CDO (Basic) and CCO (Basic), and performance-based aerodrome operating minima for advanced/basic aircraft (PARS 7.14, 19, 21)	2
	APTA-B1/1-5: advanced capability PBN approaches, PBN SID and STAR procedures and performance-based aerodrome operating minima for advanced aircraft with SVGS, CDO and CCO (Advanced) (PARS 7.14, 21, 22, 23)	3
	FRTO-B0/1 – 4: Direct routing, Airspace Planning and FUA, Flexible Routings, and basic conflict detection and conformance monitoring (PASL 7.29, 31, 36)	1
	FRTO-B1/1 – 7: Free Route Airspace, RNP routes, Advanced FUA and Airspace Management (ASM), Dynamic Sectorisation, Multi-Sector Planner Function, etc. (PASL 7.29, 51)	2
	RSEQ-B0/1 – 2: Arrival and Departure Management (PASL 7.32)	1
	RSEQ-B0/3: Point merge	3
	TBO-B0/1: Introduction of time-based management within a flow centric approach (PASL 7.52)	2
	TBO-B1/1 – Initial Integration of time-based decision making processes (PASL 7.52)	2
CNS Technology and Services	NAVS-B0/1-4: SBAS, GBAS, ABAS, MON (PARS 7.7)	2
	NAVS-B1/1: Extended GBAS	3

Documents related to GBAS/SBAS Implementation

❖ Asia/Pacific Seamless ANS Plan V3.0

➢ Performance Improvement Plan

- PARS Phase II (Expected implementation by 7 Nov 2019)

7.5 Where practicable, all instrument runways serving aeroplanes should have following precision approach systems consistent with APTA-B0/1 (Priority 1) and APTA-B0/3:

a) SBAS/GBAS precision approaches; or ILS/MLS (with APV as a backup); or

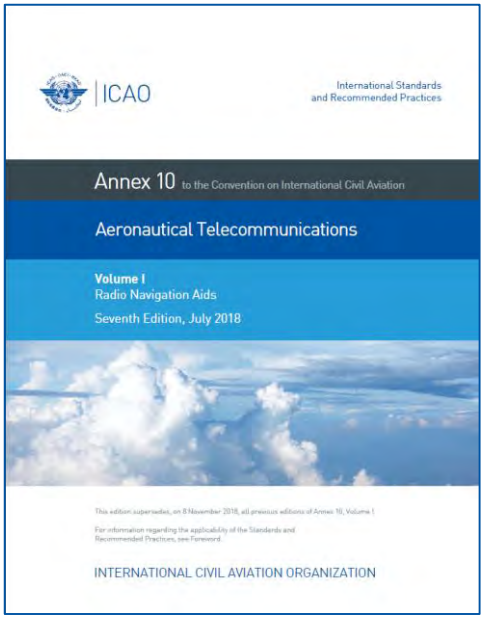
b) APV either Baro-VNAV or SBAS; or

c) if an APV is not practical, straight-in RNP APCH (LNAV)

7.7 SBAS, GBAS, ABAS and MON system should be established as appropriate to the level and type of aircraft operations and its environment consistent with NAVS-B0/1-4 subject to an assessment of benefits and costs.

Documents related to GBAS/SBAS Implementation

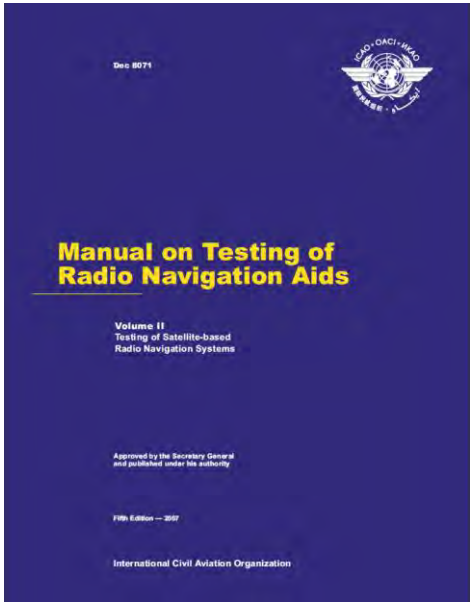
❖ Annex 10 Vol I Radio Navigation Aids



- ➢ Requirements for the GNSS (para. 3.7)
  - GNSS shall provide position and time data to the aircraft
  - GNSS elements include GPS, GLONASS, ABAS, SBAS, GBAS, GRAS and aircraft receivers (paras 3.7.3.1~3.7.3.6)
  - Position and time shall be expressed by WGS-84 and UTC
  - The signal-in-space requirements and GNSS elements specifications are also provided.
- ➢ Appendix B. Technical specifications for the GNSS
- ➢ Attachment D – Information and material for guidance in the application of the GNSS SARPs

Documents related to GBAS/SBAS Implementation

❖ Doc 8071 Vol II Testing of Satellite-based Radio Navigation Systems



- Requirements for ground/flight testing of radio navigation aids are in para. 2.2 of Annex 10 Vol I.
- Vol II of Doc 8071 contains guidance on
  - Testing of NPA procedures using ABAS (Ch. 2);
  - Testing of SBAS and GBAS (Ch. 3 & 4); and
  - Flight validation of IFPs (Ch. 4).
- Vol II provides general guidance on the extent of testing and inspection of GNSS-based procedures
  - The guidance is representative of practices existing in a number of States

Documents related to GBAS/SBAS Implementation

- **Doc 8168 Vol I Flight Procedures**
  - Contains the use of SBAS/GBAS approach procedures (Part II, Section 5)
  - Includes helicopter procedures using SBAS
- **Doc 8168 Vol II Construction of Visual and Instrument Flight Procedures**
  - Part III contains PBN procedure design criteria
    - SBAS design criteria (NPA, APV I and CAT I) (Sec. 3, Ch. 5)
    - GLS CAT I (Sec. 3, Ch. 6)
    - Application of FAS data block for SBAS and GBAS (Sec. 2, Ch. 6)
  - Part IV contains design criteria for helicopters using SBAS receivers

Documents related to GBAS/SBAS Implementation

❖ Doc 8168 Vol I Flight Procedures

- ➢ Instrument approach procedures vs. operations

Procedure		*Operation*		
Chart identification	*Minima box label*	*Type of operation*	*Minima*	*Type (A or B)*
NDB RWY XX	NDB	2D	MDA/H	A
		3D (CDFA with Positive Guidance)	Derived DA	
VOR RWY XX	VOR	2D	MDA/H	A
		3D (CDFA with positive guidance)	Derived DA	
ILS RWY XX or LOC RWY XX	LOC	2D	MDA/H	A
		3D (CDFA with positive guidance)	Derived DA	
RNP RWY XX	LNAV	2D	MDA/H	A
		3D (CDFA with positive guidance)	Derived DA	
RNP RWY XX	LP	2D	MDA/H	A
		3D (CDFA with positive guidance)	Derived DA	
RNP RWY XX	LNAV/VNAV[1]	3D	DA/H	A
RNP RWY XX (AR)	RNP 0.X	3D	DA/H	A
RNP RWY XX	LPV[2]	3D	DA/H	A or B[3]
ILS RWY XX	CAT I CAT II CAT III A/B/C	3D	DA/H	A or B
MLS RWY XX	CAT I CAT II CAT III A/B/C	3D	DA/H	A or B
GLS RWY XX	CAT I	3D	DA/H	A or B

1. Requires baro-VNAV or SBAS equipment.
2. Requires SBAS equipment.
3. SBAS CAT I procedures may be Type A or Type B. SBAS APV procedures are only Type A.

Documents related to GBAS/SBAS Implementation

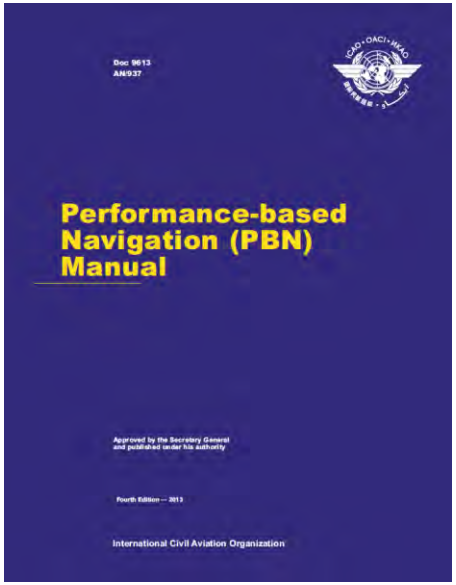
❖ Doc 9906 Vol 5 Validation of Instrument Flight Procedures

- Provides guidance for conducting validation of IFPs, incl. safety, fliability and design accuracy.
- Flight validation for GBAS/SBAS procedures require
  - analysis of additional parameters contained in the FAS data block and data link (GBAS)

    i.e. GPA, TCH (LTP or FTP), LTP coordinates or FTP, and FPAP coordinates
  - Record and save VPL, HPL and maximum observed VDOP (SBAS)
- Flight inspection for GBAS may be required for GBAS data broad cast and/or FAS data which supports the procedure

Documents related to GBAS/SBAS Implementation

- **Doc 9613 Vol II Part C, Ch. 5. Implementing RNP APCH – Section B RNP APCH Operations down to LP and LPV Minima**

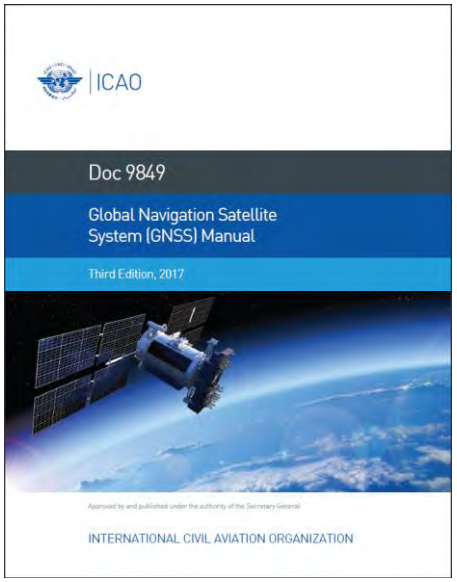


  - PBN Manual provides practical guidance on RNAV and RNP application and their performance requirements to States, ANSPs and airspace users.
  - Section B
    - provides guidance to States implementing RNP APCH operations down to LP and LPV minima
    - includes CNS considerations, ATC training, navigation service and ATC system monitoring, operational approval, aircraft requirement, operating procedures, pilot knowledge and training, navigation database, oversight of operators, etc.

Note – GBAS (GLS) is not a PBN navigation specification but a PBN initial segment may be used to link up with GLS.

Documents related to GBAS/SBAS Implementation

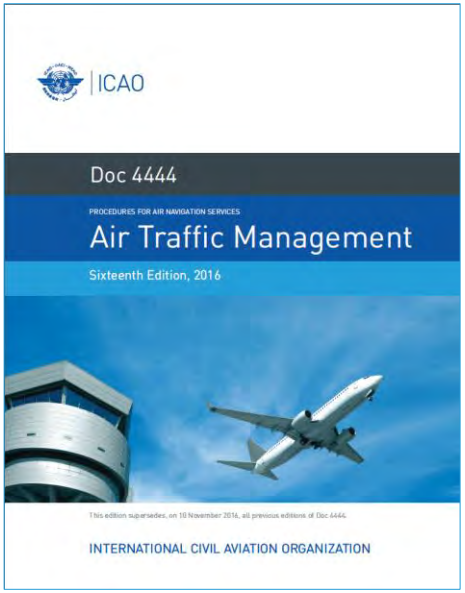
❖ Doc 9849 GNSS Manual



- GANP and ASBUs recognize the GNSS as a technical enabler supporting improved services that meet their objectives
- GNSS supports positioning, navigation and timing (PNT) applications, which is the base of PBN.
- The Manual provides information about GNSS technology and operational applications to assist State regulators and ANSPs to introduce GNSS-based services.
  - Contents include performance requirements, core satellite constellations, augmentation systems, GNSS vulnerability, GNSS evolution, considerations on the implementation of GNSS-based services, etc.

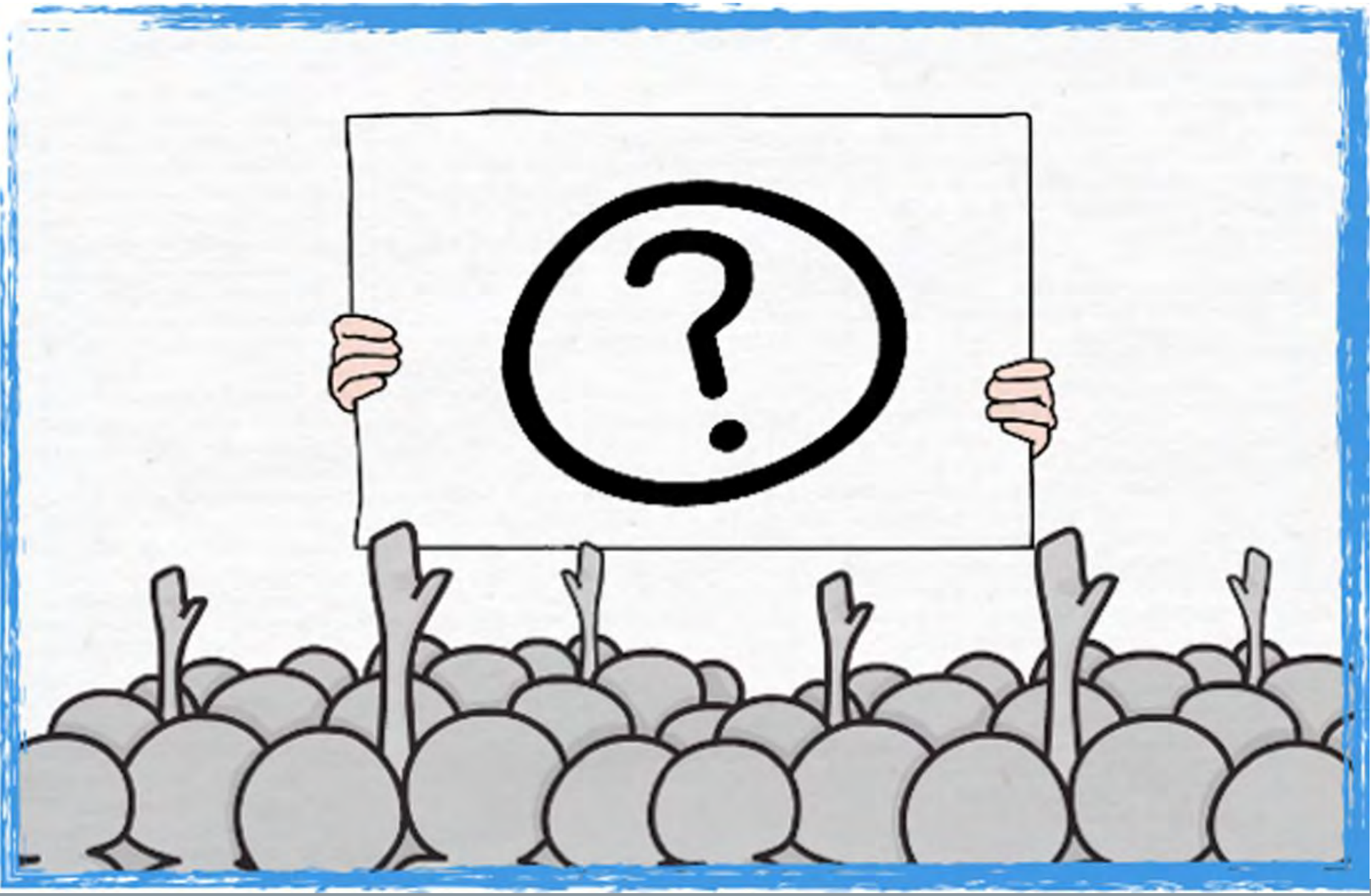
Documents related to GBAS/SBAS Implementation

❖ Doc 4444 Air Traffic Management



- ➢ Phraseologies related to GBAS/SBAS application (Chapter 12)
  - Approach clearance will be the same as other conventional approaches

    E.g. Cleared ILS/ GLS/RNP Approach Runway 23
- ➢ GLS/LPV capability should be included in the Item 10 of flight plan (Appendix 2)
  - A – GBAS landing system / B – LPV (APV with SBAS)
  - G – GNSS, then in Item 18, NAV/GBAS, SBAS, if required by ATS
  - R – PBN, then in Item 18, PBN/2 letter PBN navspecs, max. 16



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THANK YOU