सत्यमेव जयते
नागर विमानन मंत्रालय, भारत सरकार
MINISTRY OF CIVIL AVIATION, GOVERNMENT OF INDIA

भारतीय विमानपत्तन प्राधिकरण
AIRPORTS AUTHORITY OF INDIA

Concept and benefits of GBAS – SBAS & Summary and outcomes of the workshop

ICAO APAC SBAS-GBAS IMPLEMENTATION WORKSHOP FOR AIRSPACE USERS

"Enhancing airport accessibility and safety on final approach with SBAS and GBAS"

14th to 16th October 2025
Bengaluru, India

Concept and benefits of GBAS - SBAS

Raphael GUILLET

Chief of the ICAO Asia Pacific
Regional Sub-Office

ICAO

GBAS & SBAS

Concept

Benefits

Implementation challenges

Satellite constellations

- GPS
- Glonass
- Galileo
- Beidou

Several types of errors :

- Satellite clock & ephemerid
- Ionosphere
- Troposphere

And lack of integrity

Need to elaborate corrections

Global Navigation Satellite System (GNSS)

GPS

Glonass

Galileo

Beidou

Three types of augmentations

\+

ABAS 

Aircraft Based Augmentation System

GBAS 

Ground Based Augmentation System

SBAS 

Satellite Based Augmentation System

Future : Development of dual frequency multi constellation receiver. Great improvement of PBN coverage all over the globe, especially for the vertical.

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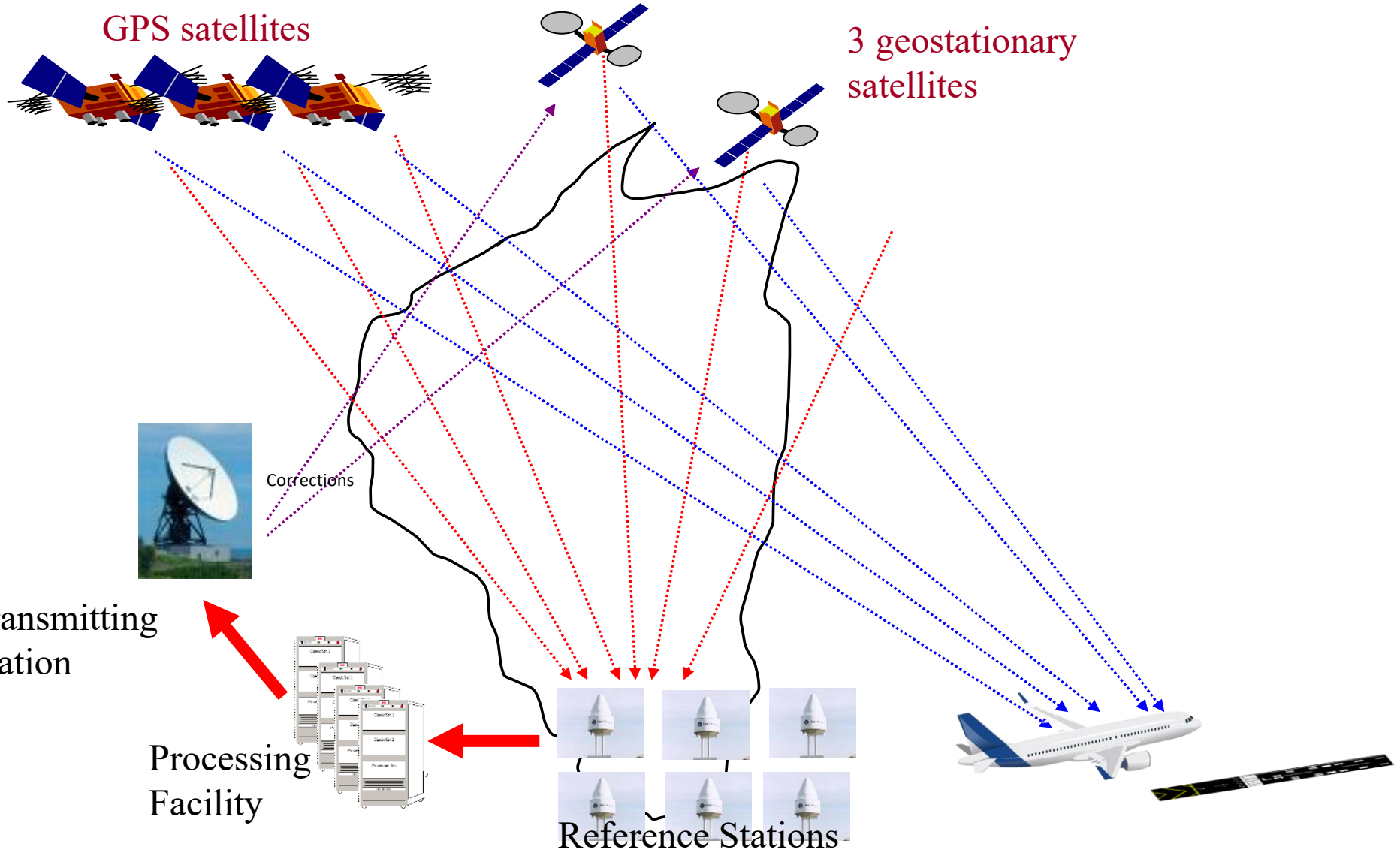
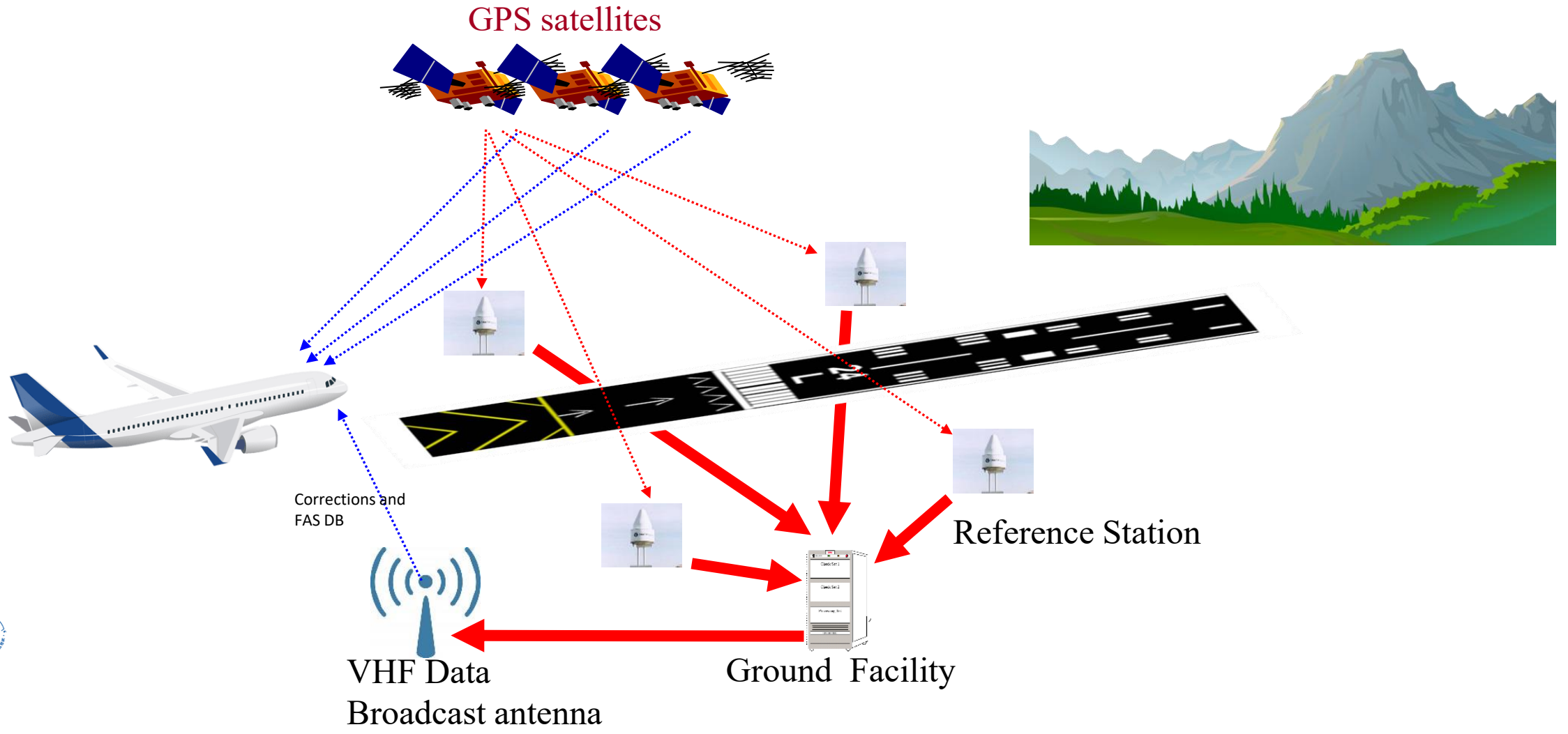
SBAS architecture



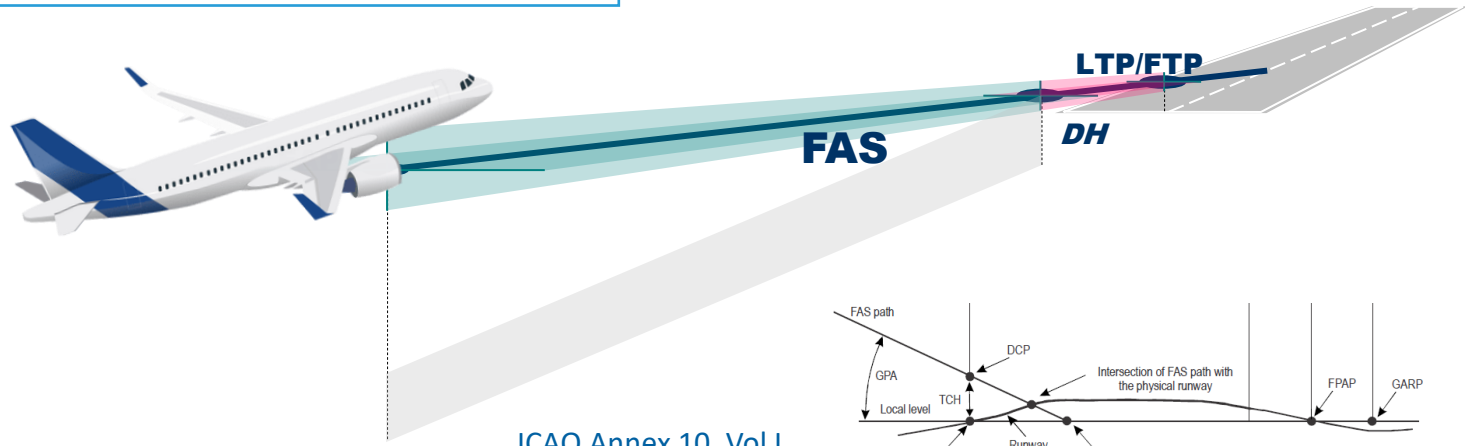
GBAS architecture



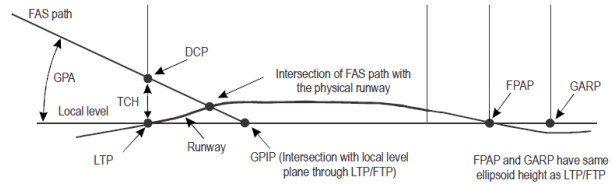
Final Approach Segment Data Block

Contains key parameters of the approach procedure

One FAS DB per approach procedure



ICAO Annex 10, Vol I



For GBAS, sent to the plane via VHF DB from GBAS ground station
For SBAS, stored in the aircraft data base

Pilot selects the desired approach and the avionics decodes the FAS DB, ensuring high level of integrity through the CRC (Cycle Redundancy Check)

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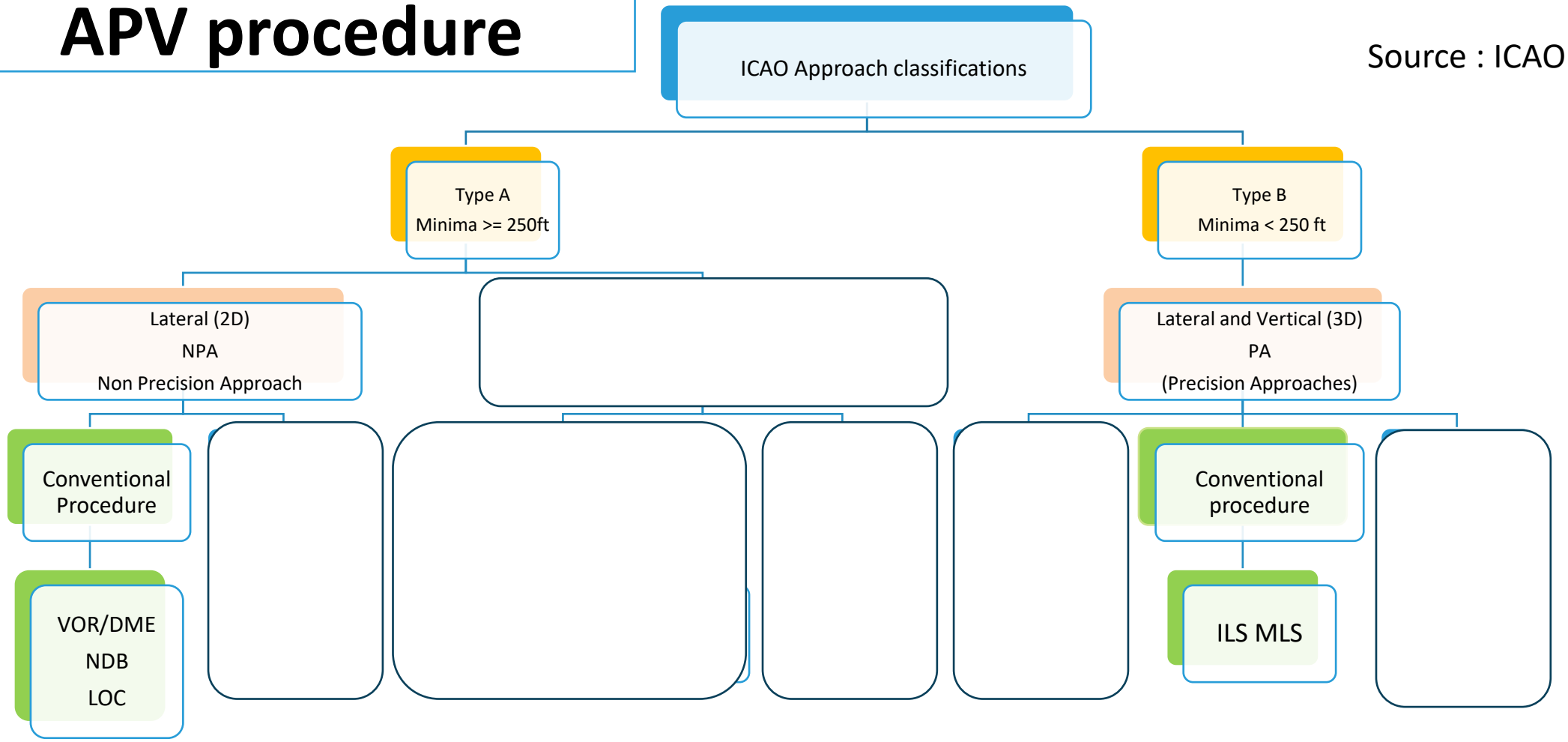
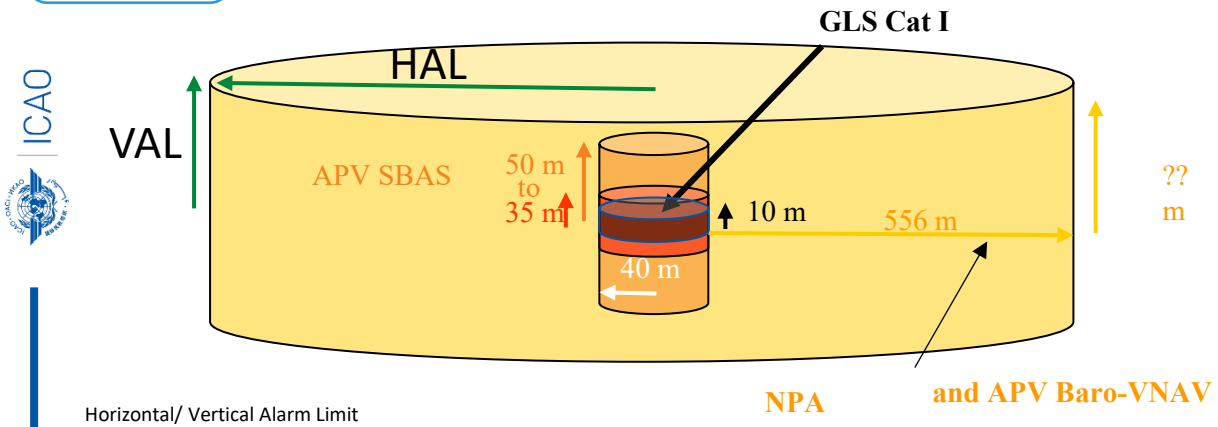
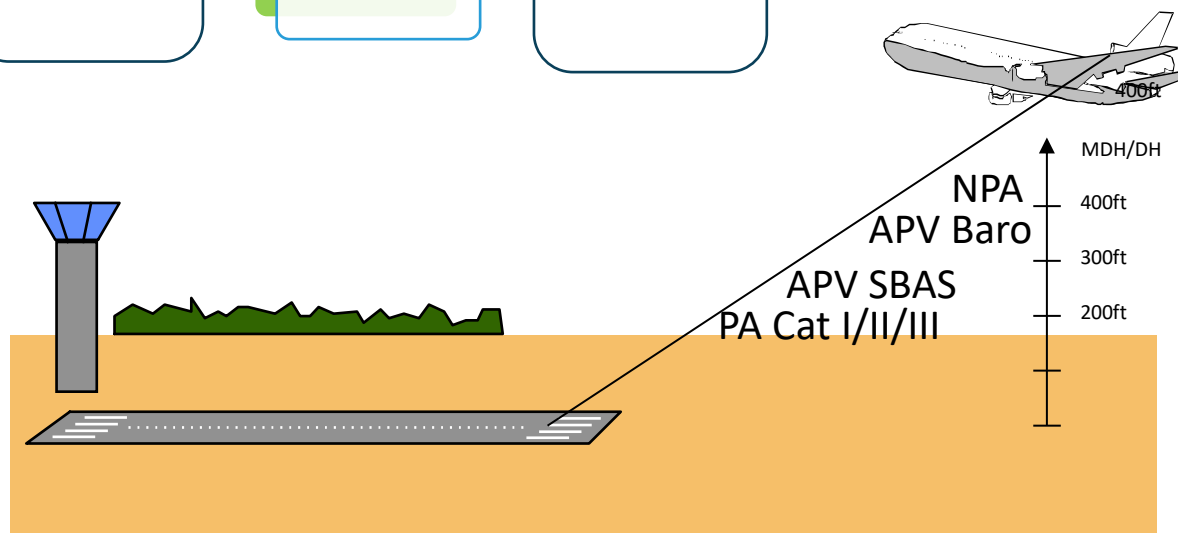
APV procedure

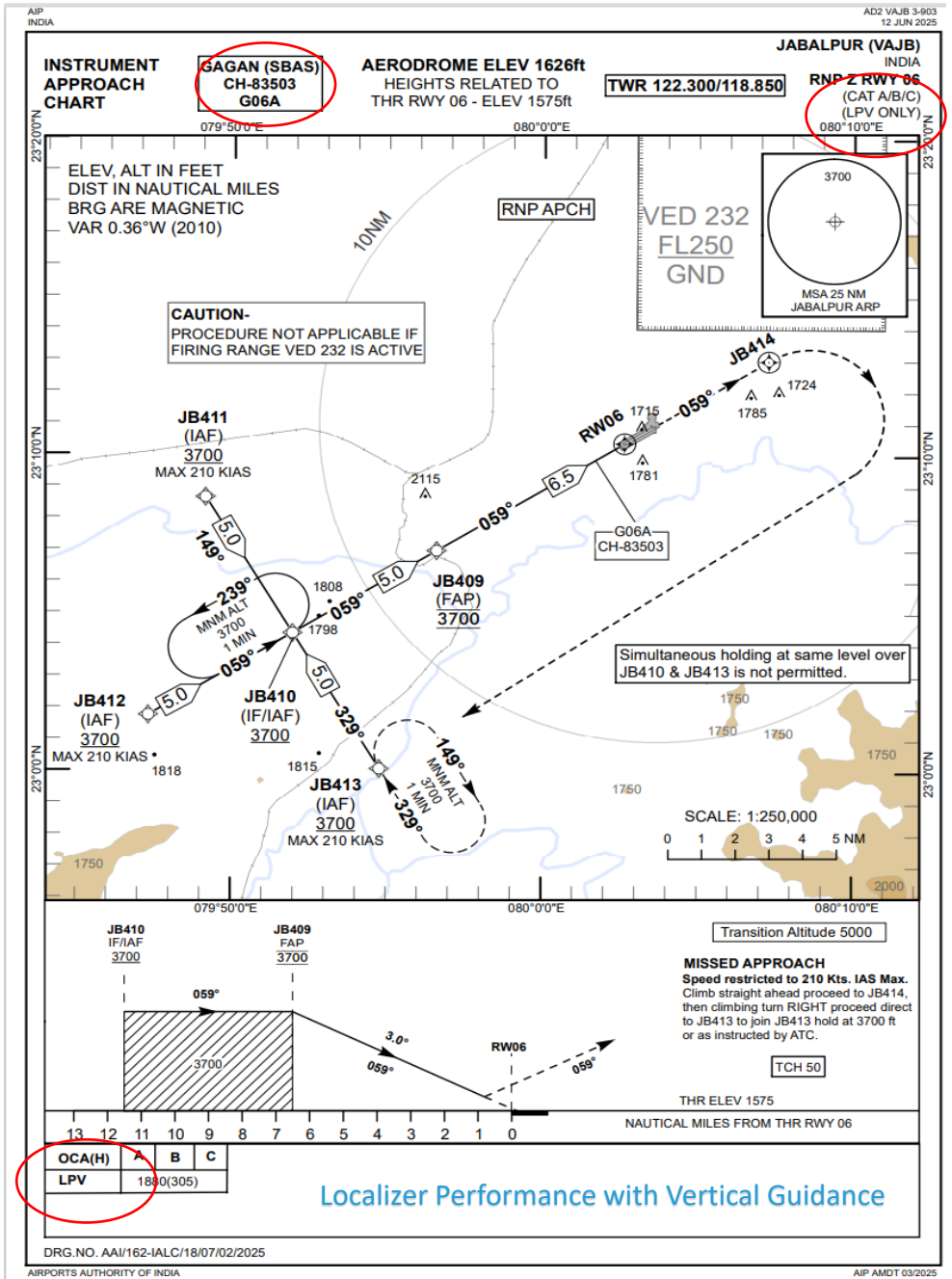
Source : ICAO Annex 6



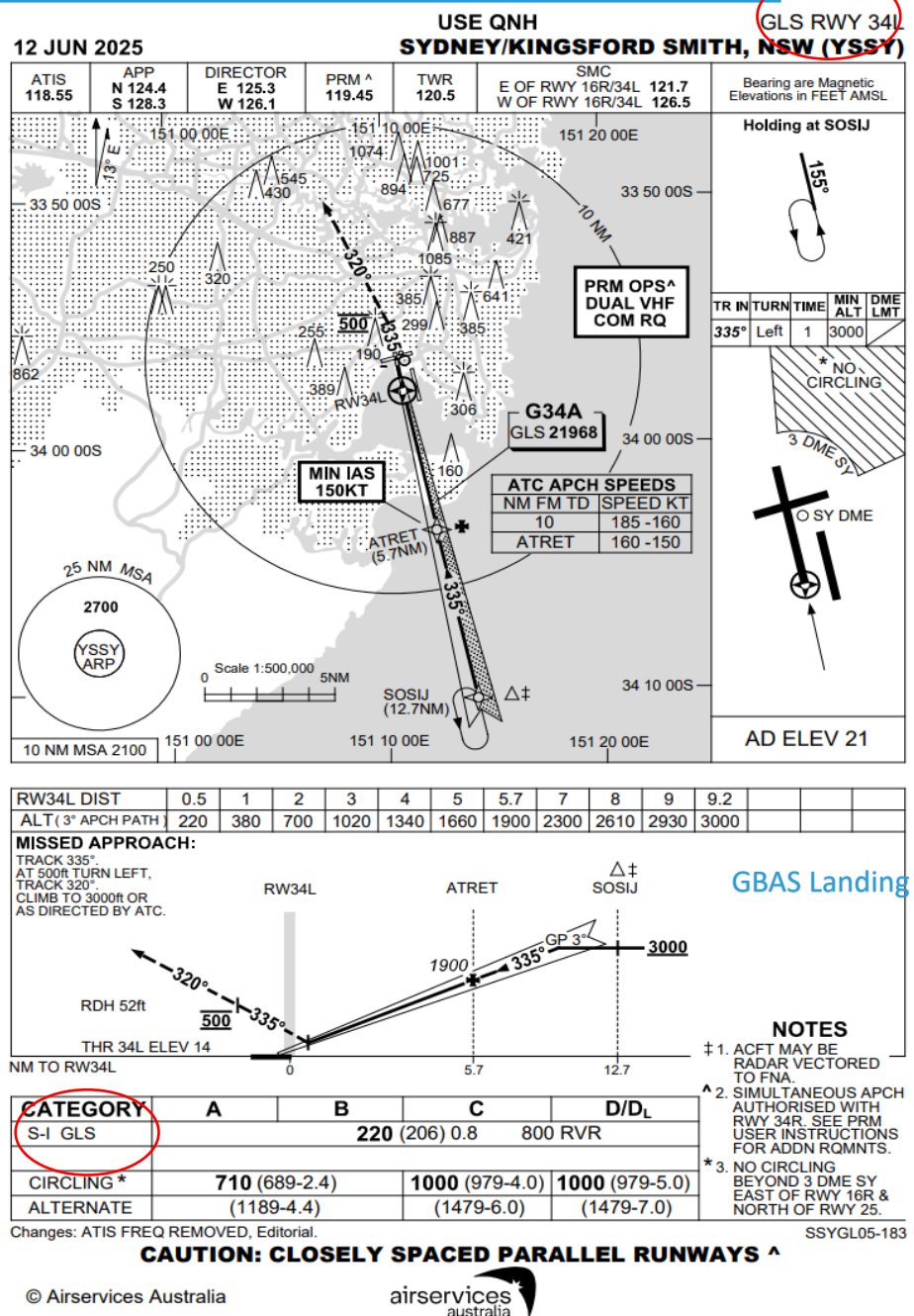




RNP with LPV minima and GLS charts



GLS RWY 34L



GBAS Landing System

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GBAS & SBAS

Concept

Benefits

Implementation challenges

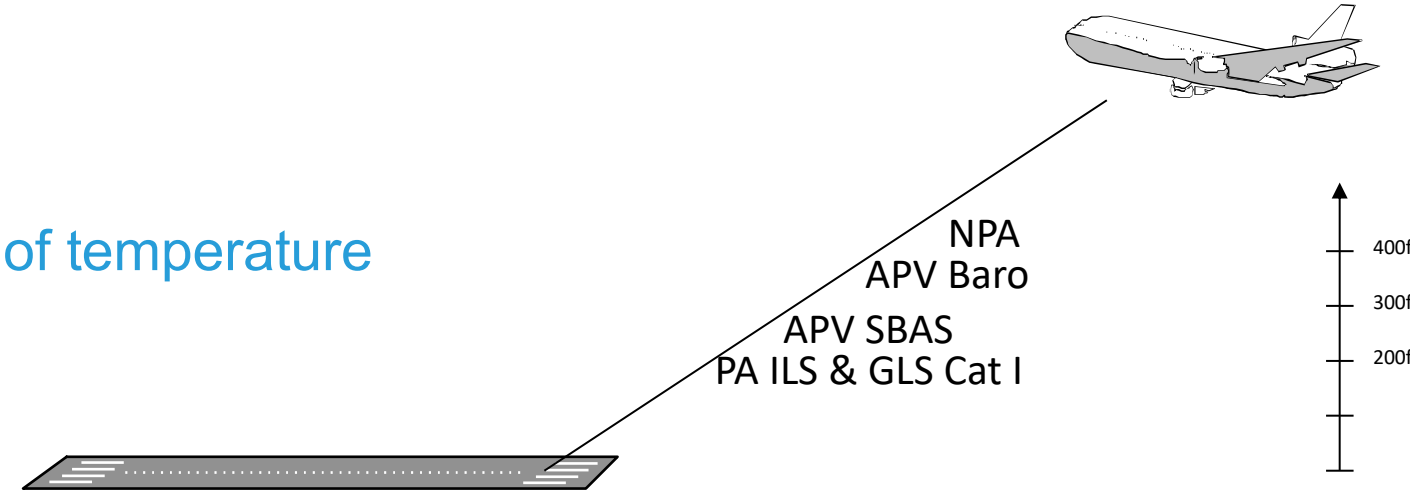
GBAS SBAS expected benefits

Main benefits on the final segment

Horizontal and Vertical **geometric** guidance to a Decision Altitude/Height

ILS look alike

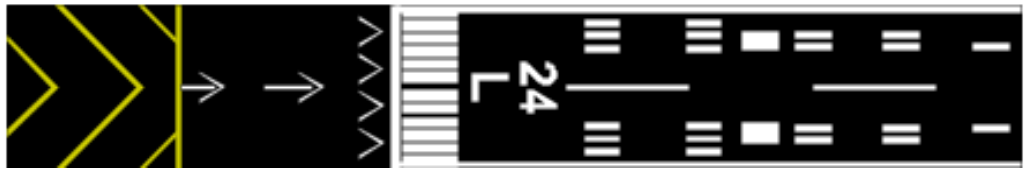
Independent of QNH setting and of temperature



NPA : Non Precision Approach
APV : Approach with Vertical guidance
PA : Precision Approach

GBAS SBAS expected benefits

- Can bring operations
  - SBAS : down to CAT I operations (APV 250 ft and SBAS CAT I 200 ft), not CAT II/III capable
  - GBAS : CAT I to CAT III operations (special study for Ionosphere)
- Can serve
  - SBAS : All IFR runway ends on a whole continent
  - GBAS : All IFR runway ends at the same airport



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GBAS SBAS expected benefits / Airlines

- ✓ILS like display in the cockpit so cost saving in pilot training
- ✓Improve accessibility to regional airports with RNP (LPV minima) approaches
- ✓Worldwide interoperability through GBAS/SBAS signal compliance to ICAO Standards Annex 10 and receiver standards
- ✓Improve safety and efficiency of procedures, reducing CO2 emissions and fuel consumption
- ✓Integrity of navigation approach segment data with FAS DB CRC

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GBAS SBAS expected benefits / ANSP - Airport

Improve safety and efficiency of procedures, reducing CO2 emissions

Less ground navaid infrastructure, saving costs

- GBAS :
  - ✓ One station to serve several runway ends
  - ✓ Much less sensitive area around GBAS station compared to ILS installation
  - ✓ Flexibility in the modifications of the approach data
- SBAS :
  - ✓ One system serving many airports
  - ✓ Can be used by Helicopter for PINS approach

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GBAS SBAS expected benefits / ATC

✓ **Stabilized & Predictable Approaches**
Highly precise paths reduce deviations, unstable approaches, and missed approaches — improving traffic sequencing and predictability.

✓ **Lower ATCO Workload**
Aircraft follow procedures down to DH with minimal vectoring, easing monitoring demands and reducing urgent re-directs.

✓ **Reliable Alternate to (ILS) or other landing procedures**
Maintains landing capability and traffic flow when ILS or other types of landing procedures is unavailable or under maintenance.

✓ **Enable High-Capacity Parallel Operations**
Precision supports simultaneous parallel approaches, sustaining runway throughput safely and efficiently.

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Summary of the workshop

The first GBAS& SBAS workshop took place in 2019 in Seoul, ROK
The second one in Bangalore, India

Participants :

150 onsite and 35 online

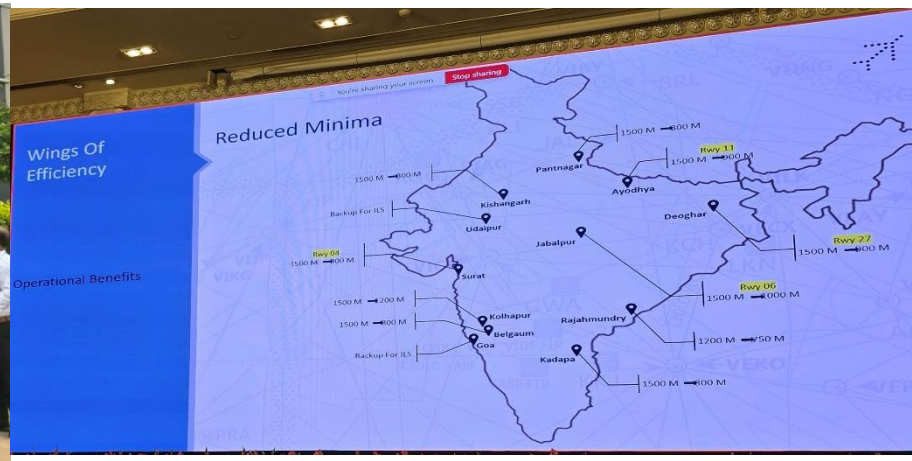
- States both CAAs/ANSPs from States implementing SBAS/GBAS and interested neigbhoring States

- Industry & Airlines

Premises : Very good installation and organization with MC

A big thank to AAI and all participants for the very interactive sessions

A big thank to AAI for welcoming all participants to the GAGAN center



A special thank to

नागर विमानन मंत्रालय
MINISTRY OF CIVIL AVIATION

भारतीय विमानपत्तन प्राधिकरण
AIRPORTS AUTHORITY OF INDIA

for making this workshop possible

Programme

Day 1 (14 Oct 2025) Session 1 – Introduction to SBAS/GBAS		
Time	**Program**	**Speakers**
08:30 – 09:30	**Registration**	
09:30 – 10:15	**Welcoming of Chief Guest and dignitaries with Bouquets** **Lighting of Lamp &Invocation** **Opening remarks** **Setting the tone** **Keynote Address** **Vote of Thanks**	*Shri Vipin Kumar, IAS, Chairman, Airports Authority of India* *Mr. Raphael Guillet, ICAO APAC Office, Chief of the Regional Sub-Office* *HMCA/MoCA* *DGCA/MoCA*
10:15 – 10:30	**Group photo** **Coffee/Tea Break**	
10:30 – 10:45	**CNS Implementation in India**	*Shri M. Suresh, Member (ANS), AAI India*
10:45 – 11:00	**Concept and benefits of SBAS/GBAS**	*Mr. Raphael Guillet, ICAO APAC Office, Chief of the Regional Sub-Office*
11:00 – 11:15	**ICAO documentation on SBAS/GBAS**	*Dr. Soniya Nibhani, ICAO APAC office, Regional Officer*
11:15 – 11:30	**GBAS SBAS Implementation Task Force Outcomes and deliverables**	*Dr. Susumu SAITO, Principal Researcher, Electronic Navigation Research Institute, Japan, co-chair of GBAS SBAS ITF*
11:30 – 11:45	**SBAS/GBAS benefits for airspace users**	*Shri T.F. Moosa, ED(ASM), AAI India*
11:45 – 12:00	**GAGAN system**	*Shri G.K. Venugopal, ED(CNS-P-I), AAI India*
12:00 – 12:30	**Q&A session**	
12:30 – 13:30	**Lunch Break**	
13:30 – 13:45	**MSAS implementation and airline's feedback**	*Mr. Koji Nakaitani, Civil Aviation Bureau of Japan, Special Assistant to the Director*
13:45 – 14:00	**Introduction to KASS, Challenges and Solutions**	*Mr. Lee Kyung Won, Republic of Korea, MOLIT(Ministry of Land, Infrastructure and Transport), Assistant Director*

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14:00 – 14:15	**Australia's GBAS implementation and operational experiences**	*Mr. Ritesh Kapoor, Airservices Australia, Senior Engineering Specialist and Mr. Daniel Zakeri, Airservices Australia, Engineering Team Leader (online)*
14:15 – 14:30	**GBAS and SBAS status update in China**	*Mr. Tong Wei, CAAC, Southwest ATMB, Senior engineer (online)*
14:30 – 15:00	**Coffee/Tea Break**	
15:00 – 15:15	**Japan's GBAS implementation and airline's feedback**	*Mr. Ryuhei Kaikura, Civil Aviation Bureau of Japan, Section Chief of CNS Planning Office ANS Engineering Division*
15:15 – 15:30	**ESSP Experience as EGNOS Service Provider in Europe**	*Mr. Carlos Martin, European Satellite Services Provider SAS, Service Development Engineer*
15:30 – 15:45	**Wide Area Augmentation System (WAAS) status and implementation**	*Mr. Gregory Thompson, US Federal Aviation Administration, WAAS Program Manager*
15:45 – 16:15	**Q&A session**	
Day 2 (15 Oct 2025) Session 2 – SBAS/GBAS Benefits for airspace users		
08:30 – 11:30	**Industry visit**	*Arrival at GAGAN Complex for demonstration of GAGAN Reference Station, Uplink Station & Master Control Centre*
11:30 – 13:00	Arrival at Workshop Venue	
13:00 – 13:45	**Lunch Break**	
13:45 – 14:25	**SBAS/GBAS Operational Approval**	*Mr. Manu Bhasin, Boeing Test and Evaluation, Senior Operational Regulatory Affairs - Indian Subcontinent*
14:25 – 14:45	**ATR PBN capabilities**	*Mr. Nitin Sanodiya, ATR India Customer Support, Regional Field Support Representative*
14:45 – 15:15	**Airbus fleet capabilities for GLS / SLS**	*Mrs. Caroline Portales, Airbus, navigation system marketing manager*
15:15 – 15:20	**Video of JAL A350 cockpit during RNP APCH (LPV) approach at Fukuoka**	*Mr. Koji Nakaitani, Civil Aviation Bureau of Japan, Special Assistant to the Director*

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15:20 – 15:35	**SBAS and LPV STC**	*Mr. Noud Schoffelmeer, Programme Manager, Fokker Services Group (online)*
15:35 – 16:00	**Coffee/Tea Break**	
16:00 – 16:15	**Guided by GAGAN, IndiGo's Path to Precision & Efficiency**	*Mr. Aakash Bhatnagar, IndiGo, Vice President, Flight Operations (Support)*
16:15 – 16:30	**EGNOS benefits in France**	*Mr. Benoit Roturier, Program Manager CNS by Satellite, France DGAC/DSNA*
16:30 – 17:00	**Q&A session**	
Day 3 (16 Oct 2025) Session 3 – SBAS/GBAS Implementation in APAC		
09:00 – 09:25	**SouthPAN programme update**	*Mr. Matt Amos, Technical Director, Land Information New Zealand, & Mr. Vincent Rooke, Technical Director, Geoscience Australia (online)*
09:25 – 09:50	**Procedure design & safety assessment of GBAS/SBAS procedures**	*Shri Gaurav Raghuvanshi, DGM(ATM-FPD), AAI India*
09:50 – 10:15	**Flight validation process for SBAS procedures**	*Shri Anoop Kacharoo, Chief Pilot, FIU, AAI India & Shri Sachin, Flight inspector, AAI India*
10:15 – 10:40	**GBAS-SBAS Procedure Design courses at APAC FPP**	*Mrs. Ying Liu, Manager, ICAO APAC Flight Procedure Program*
10:40 – 11:10	**Coffee/Tea Break**	
11:10 – 11:35	**Regulatory framework for SBAS / GBAS procedures**	*Shri Ravinder Singh Jamwal, Director (Operations)- DGCA India*
11:35 – 12:00	**Training of Air Traffic Controllers on SBAS/GBAS procedures implementation**	*Shri S. Senthil Valavan, GM(ATM-Training), AAI India*
12:00 – 12:30	**Q&A session**	
12:30 – 12:45	**Summary of the workshop Close of the Workshop**	*Mr. Raphael Guillet, ICAO APAC Office, Chief of the Regional Sub-Office India*
12:45 – 13:30	**Lunch Break**	

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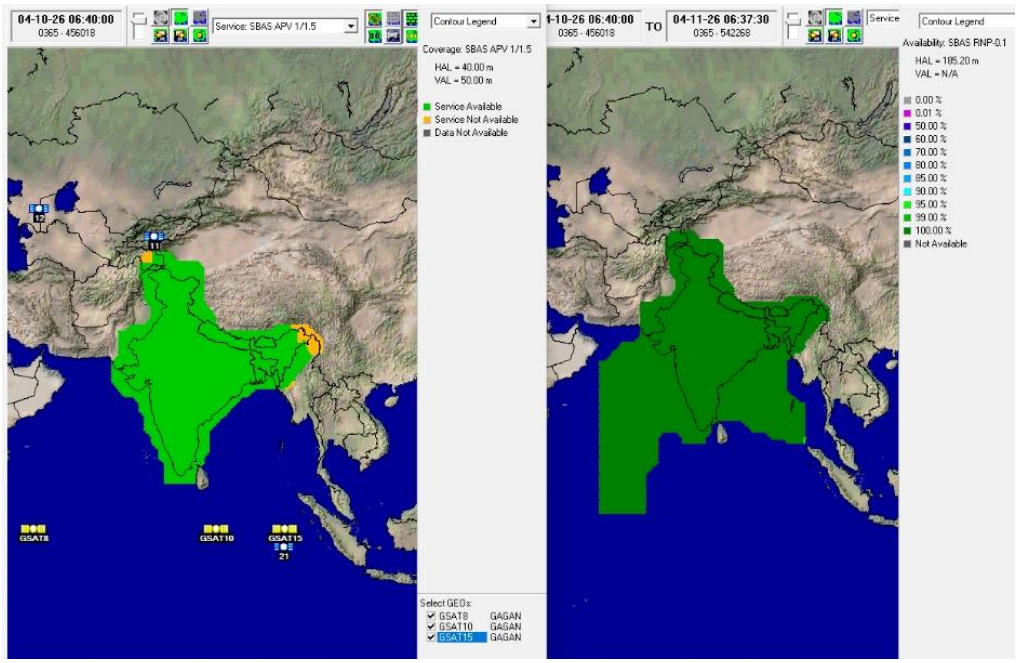
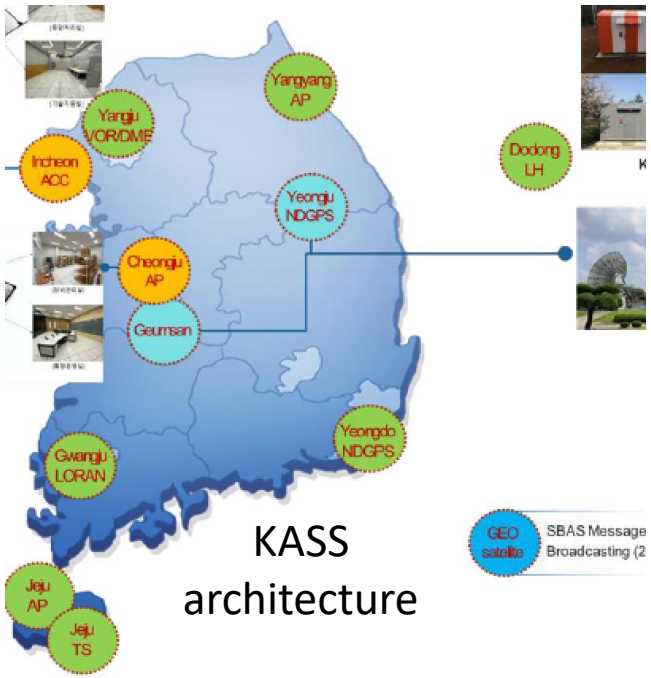
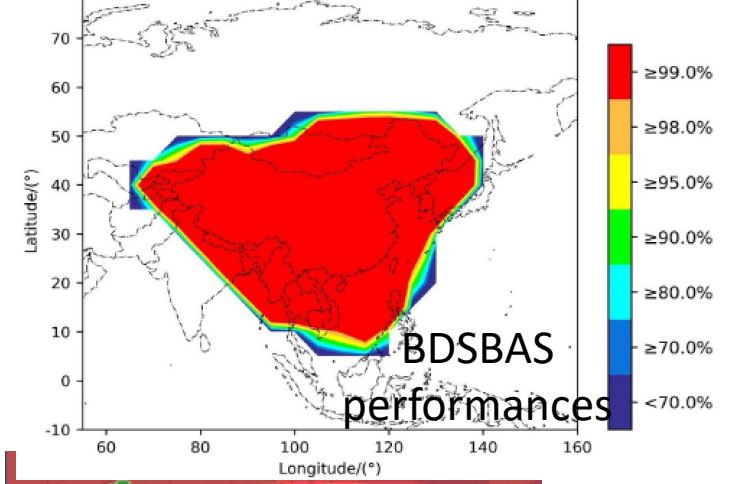
Outcomes : SBAS



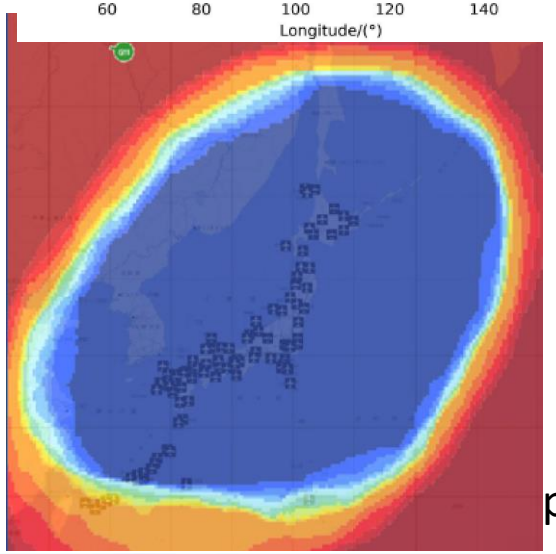
GAGAN performances



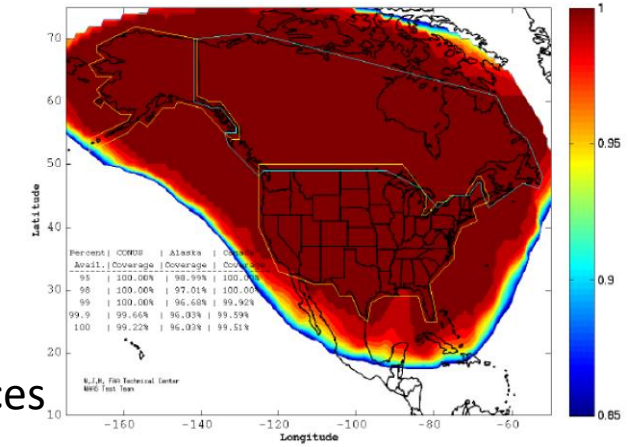
KASS architecture



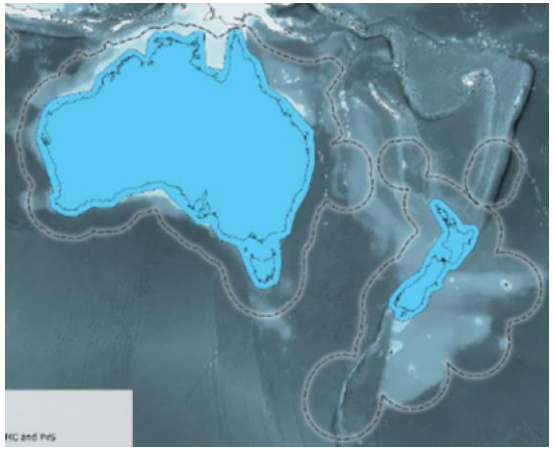
BDSBAS performances



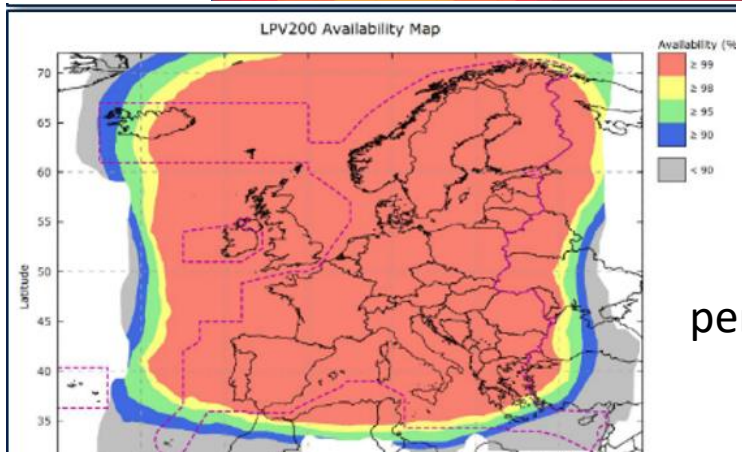
MSAS performances



WAAS performances



SouthPAN coverage



EGNOS performances

Outcomes : GBAS

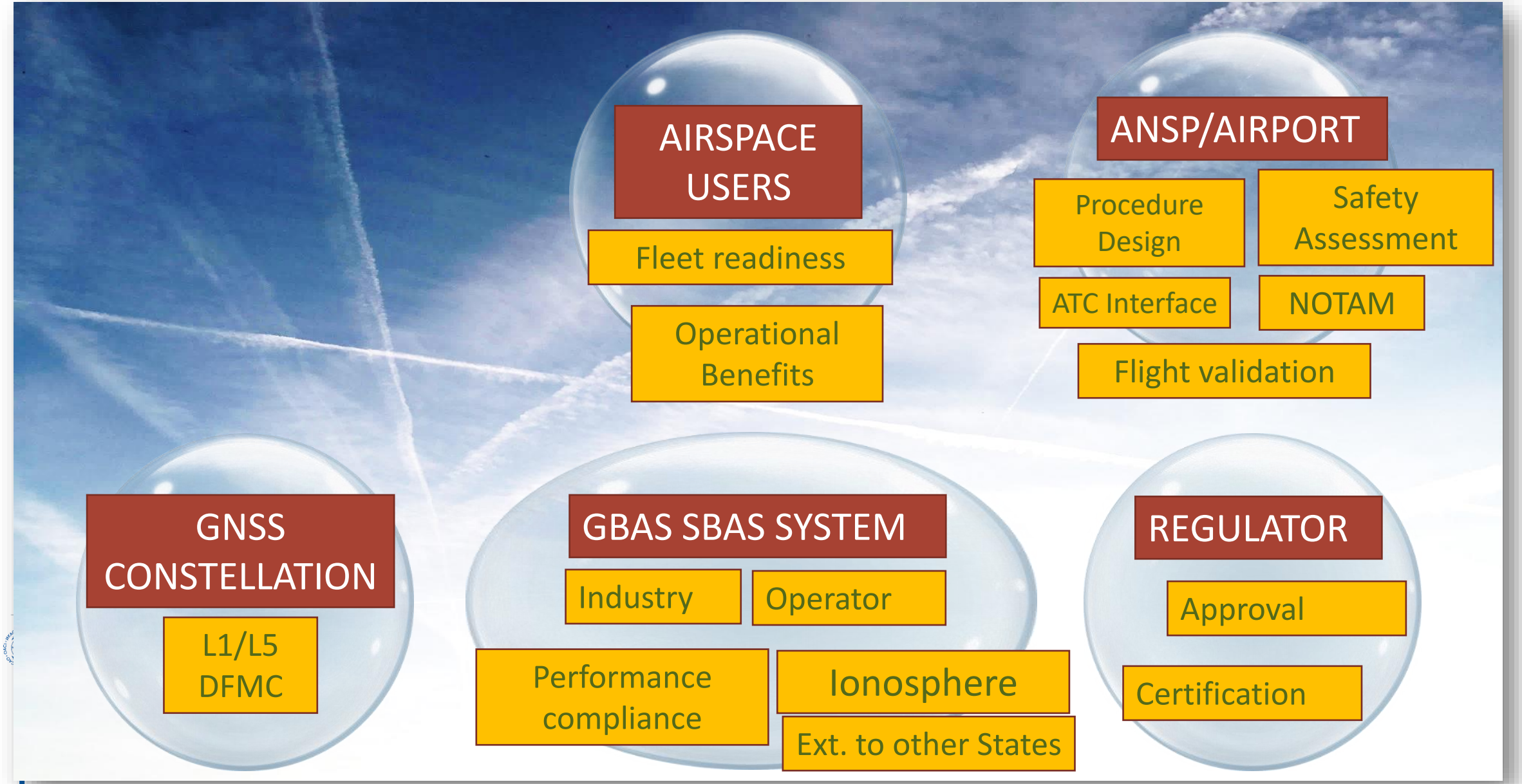
GBAS stations
in Australia
(Sydney and Melbourne)

(courtesy of NEC)

GBAS station
in Japan
(Tokyo)

GBAS stations
in China
(Tianjin and Lhasa)

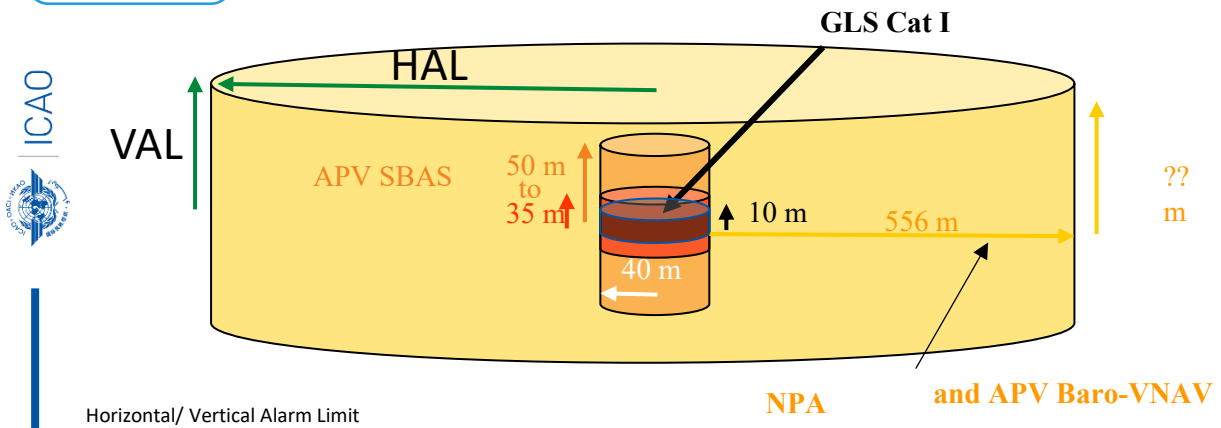
Outcomes

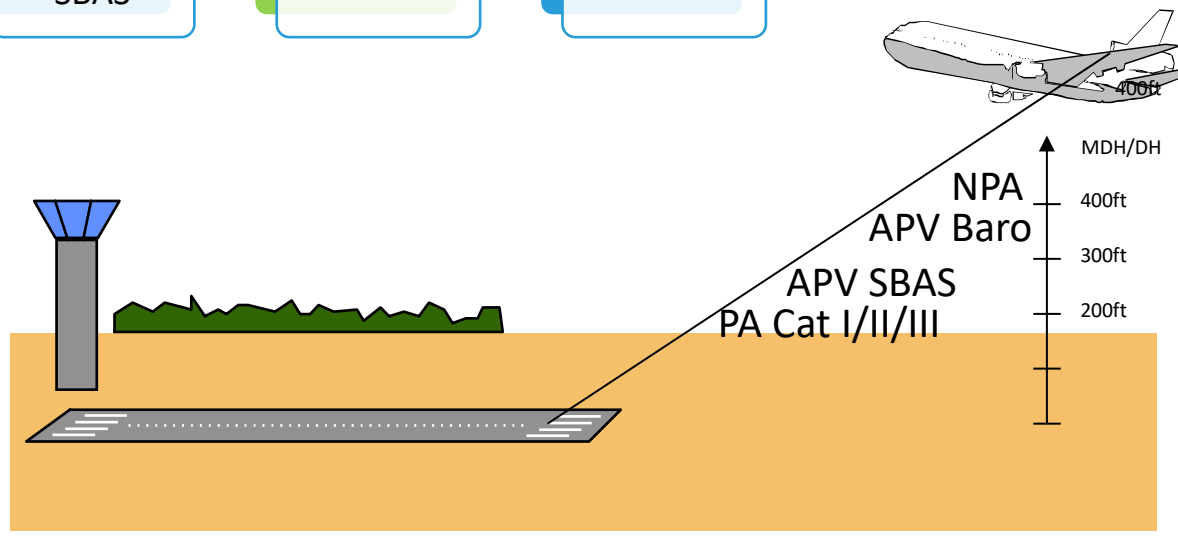

AIRSPACE USERS
Fleet readiness
Operational Benefits
ANSP/AIRPORT
Procedure Design
Safety Assessment
ATC Interface
NOTAM
Flight validation
GNSS CONSTELLATION
L1/L5 DFMC
GBAS SBAS SYSTEM
Industry
Operator
Performance compliance
Ionosphere
Ext. to other States
REGULATOR
Approval
Certification

APV procedure

Source : ICAO Annex 6

- ICAO Approach classifications
  - Type A — Minima >= 250ft
    - Lateral (2D) — NPA — Non Precision Approach
      - Conventional Procedure
        - VOR/DME
        - NDB
        - LOC
      - RNP APCH
        - GPS (ABAS or SBAS)
    - Lateral and Vertical (3D) — APV — (Approaches with Vertical Guidance)
      - RNP APCH
        - GPS (ABAS & Baro Alt)
        - GPS&SBAS
      - RNP AR APCH
        - GPS (ABAS & Baro Alt)
  - Type B — Minima < 250 ft
    - Lateral and Vertical (3D) — PA — (Precision Approaches)
      - SBAS Cat I
        - GPS & SBAS
      - Conventional procedure
        - ILS MLS
      - GLS
        - GLS SCAT I





Fleet capabilities

Airbus fleet readiness synthesis for A320/A330/A350/A380

	A220	A320	A330	A350	A380
ILS	BASIC	BASIC	BASIC	BASIC	BASIC
GLS	N/A	OPTION	OPTION	OPTION	OPTION
SLS	BASIC LPV capability but different from SLS	OPTION	OPTION	OPTION	OPTION
FLS	N/A	BASIC	BASIC	BASIC	BASIC

Boeing Airplanes GLS & LPV Availability

Airplane Model	GBAS GLS GAST C	GBAS GLS GAST D	SBAS LPV
737MAX	Available Option (92% uptake)*	Future Study	ECD 2Q27
737NG	Available Option	Future Study	Current Study
777	Not Planned	Not Planned	Not Planned
777-9/8F	Standard	Available Option (94% uptake)*	Available Option (25% uptake)*
747-8	Standard	Not Planned	Not Planned
757/767	Not Planned	Not Planned	Not Planned
787	Standard	Current Study	Current Study

ATR

ATR -500

- LNAV
- LPV (Option)

ATR -600 with FMS 220

- LNAV
- VNAV
- RNP AR (Option)
  - 0.3 / 1
  - 0.3 / 0.3 (+IRS)
- LPV (Option) (+2nd GPS)

Q&A session

- What challenges the regulator faced in approving the SBAS procedure and training of inspectors?
- GBAS, does ATC tower get any alert indications in case of system degradation or failure? How frequent GBAS is unavailable to be used as an approach procedure? Were ATCOs only dependent on NOTAMs for this information or the monitor status enough to provide alternate procedure? What types of NOTAM are issued for SBAS service? Does GAGAN provide RAIM prediction service? SBAS status is not available to ATCOs at LPV equipped airports. Is it required for situational awareness?
- What are the major challenges of ionosphere in the implementation of SBSA/GBAS implementation in the APAC region. Whether different ionospheric models will be required by APAC countries.
- Which kind of safety assessment did you conduct before the publication of RNP APCH (LPV) procedures?
- How long does the whole STC process take?

Q&A session

- Do you allow parallel approaches ILS and GLS?
- To Indigo, if the airport is having LPV and ILS approach, then what is the preferred approach by your pilot. Is there any company policy? Can GBAS facilitate auto land?
- What criteria are used to phase out the rationalization of ILS replaced by LPV? What about aircraft that are not comply with SBAS,
- In approach chart, how India manages channel numbers? Is there any limitation on numbers?
- Does GAGAN have an opportunity to expand its services to other countries/regions? If an APAC State is interested in an extension of the MSAS coverage, which person should be contacted? What would be the conditions? Have Australia or SouthPan considered to include small Pacific Island States in their coverage.
- Helicopter operation can benefit more on SBAS, for helicopter operations near airports, is there a maximum number of PinS procedure to be established using SBAS?

Serious Incident in Paris CDG May 2022

Transmission of incorrect altimeter setting (QNH)

Context :

Transmission of incorrect altimeter setting (QNH) by air traffic service, near-collision with ground during satellite approach procedure with barometric vertical guidance

Paris CDG airport in May 2022

Available information :

- BEA SAFETY INVESTIGATION REPORT https://bea.aero/fileadmin/uploads/9HEMU/9H-EMU_EN.pdf
- Presentation of France at the SBAS GBAS workshop in Bengaluru India Oct 2025

https://www.icao.int/sites/default/files/APAC/Meetings/2025/2025%20GBASSBAS%20Implementation%20Workshop%20for%20Air%20Space/Presentations/2-1-6-EGNOS-benefits-in-France-Roturier.pdf

- French order of Dec 2025 to increase minima of 100ft for APV Baro : Arrêté du 11 décembre 2025 portant majoration des minimums opérationnels d'aérodrome associés aux procédures d'approche aux instruments dotées d'un guidage vertical de type barométrique – Légifrance

Serious Incident in Paris CDG May 2022

MINISTÈRE CHARGÉ DES TRANSPORTS

dgac

Conclusion

- **EASA has also now taken France surveillance authority barometric concerns on-board**, and has launched its own analysis of barometric safety issues.
- We now **collectively** know that the barometric PBN landing technology cannot match the Target Level of Safety (TLS) for approaches in EU: **this is a major PBN paradigm change, which strongly increases in contrast the landing safety importance of SBAS.**
- The too low barometric operational minima designed through ICAO PANS-OPS (vs. TERPs) increases the risk: **the proposed France authority raise of minima will increase the role of SBAS to maintain the best airport accessibility, for PBN landings.**
- We need as a consequence a **faster adoption of SBAS by commercial aviation. We need everyone help: this is a EU safety issue.**
- We also need **industry** to workout **SBAS vertical guidance solutions for the most complex PBN landing applications,** such as RNP AR and RNP VPT.

Serious Incident in Paris CDG May 2022

Transmission of incorrect altimeter setting (QNH)

Questions raised by this serious incident during an APV Baro VNAV :

- Could this situation also occur in the APAC region?
- How to ensure correct transmission of QNH ?
- Should we need to increase minima of RNP APCH (with LNAV VNAV minima) ?
- ….

Main achievements of the workshop

- ✓Good knowledge and experience sharing on the implementation of GBAS&SBAS
- ✓Good interaction among participants and networking
- ✓All presentations are available on https://www.icao.int/APAC/meetingdocs?fid=572
- ✓Did not get as many airlines as expected as IATA was organizing a significant event on the same days in Xiamen, China. Participated on 14 April in the IATA Regional Coordination Grou to share information on the implementation of GBAS and SBAS in the APAC region

Thank You!

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