सत्यमेव जयते

नागर विमानन मंत्रालय, भारत सरकार

MINISTRY OF CIVIL AVIATION, GOVERNMENT OF INDIA

भारतीय विमानपत्तन प्राधिकरण

AIRPORTS AUTHORITY OF INDIA

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

Australia's GBAS Implementation and Operational Experiences

Ritesh Kapoor
Daniel Zakeri
Airservices Australia

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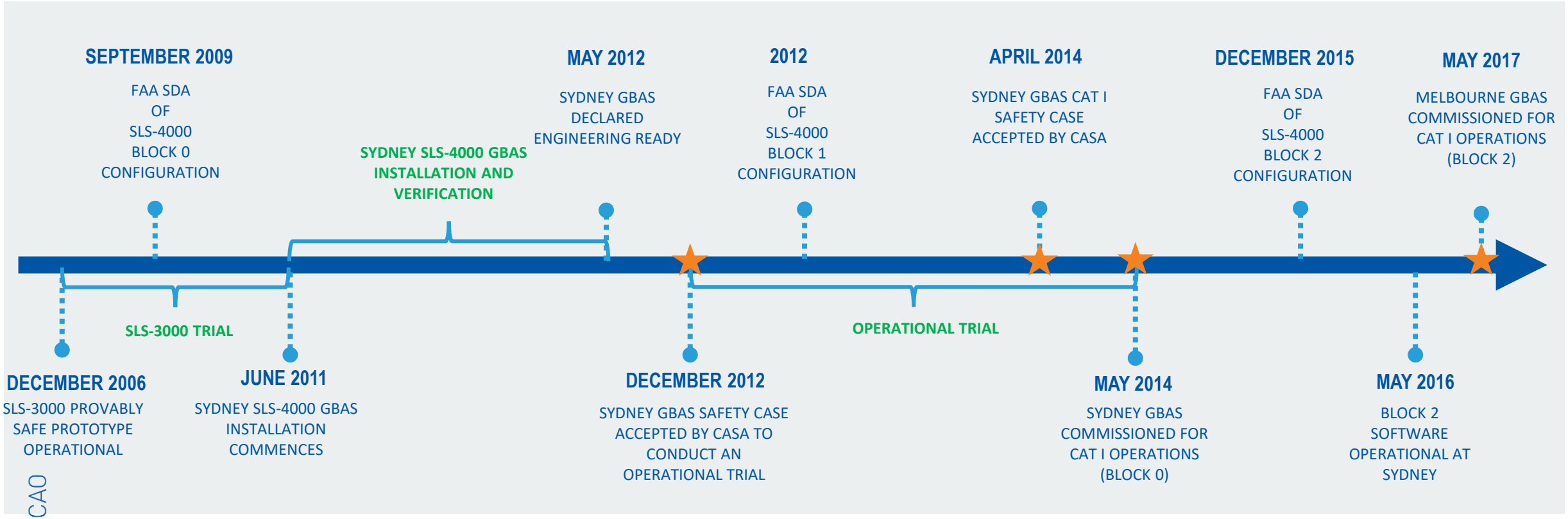
AUSTRALIA'S GBAS JOURNEY



NOTE: TIMELINE NOT TO SCALE

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ACRONYMS

FAA – Federal Aviation Administration
SDA – System Design Approval
CASA – Civil Aviation Safety Authority

TO CERTIFY GBAS FOR USE IN AUSTRALIA:

Demonstrate that *the Air Traffic Management System will be acceptably safe during and after the implementation of the Ground Based Augmentation System to support CAT-I landing operations*

KEY ELEMENTS OF THE CERTIFICATION ARGUMENT

CONCEPT DEFINED

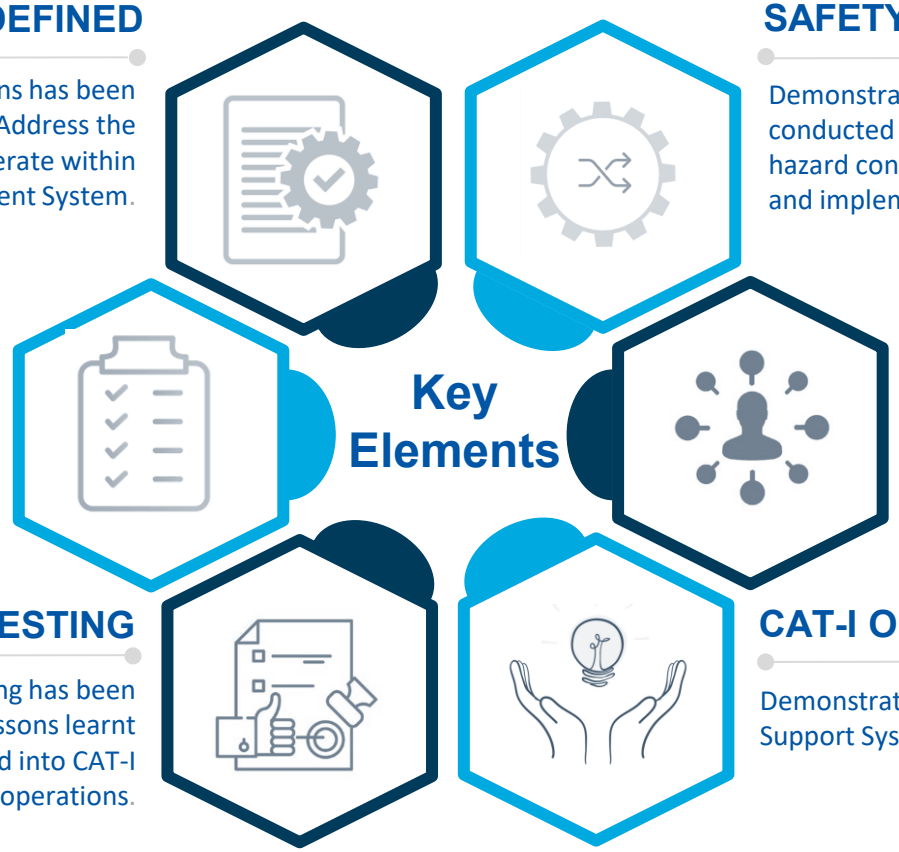
Demonstration that the concept of operations has been adequately defined and documented. Address the question how will the GBAS integrate and operate within the existing Air Traffic Management System.

SAFETY ASSURANCE

Demonstration that safety assurance activities have been conducted for the system as a whole and that identified hazard controls have been incorporated into the design and implementation.

DESIGN AND IMPLEMENTATION

Demonstration that the system has gone through adequate system design and implementation process. Demonstration that the design and implementation meets legislative requirements and conforms with ICAO SARPs.



SUPPORT SYSTEMS

Demonstration that the necessary sustainment systems are in place, which are adequately defined with acceptable controls in place.

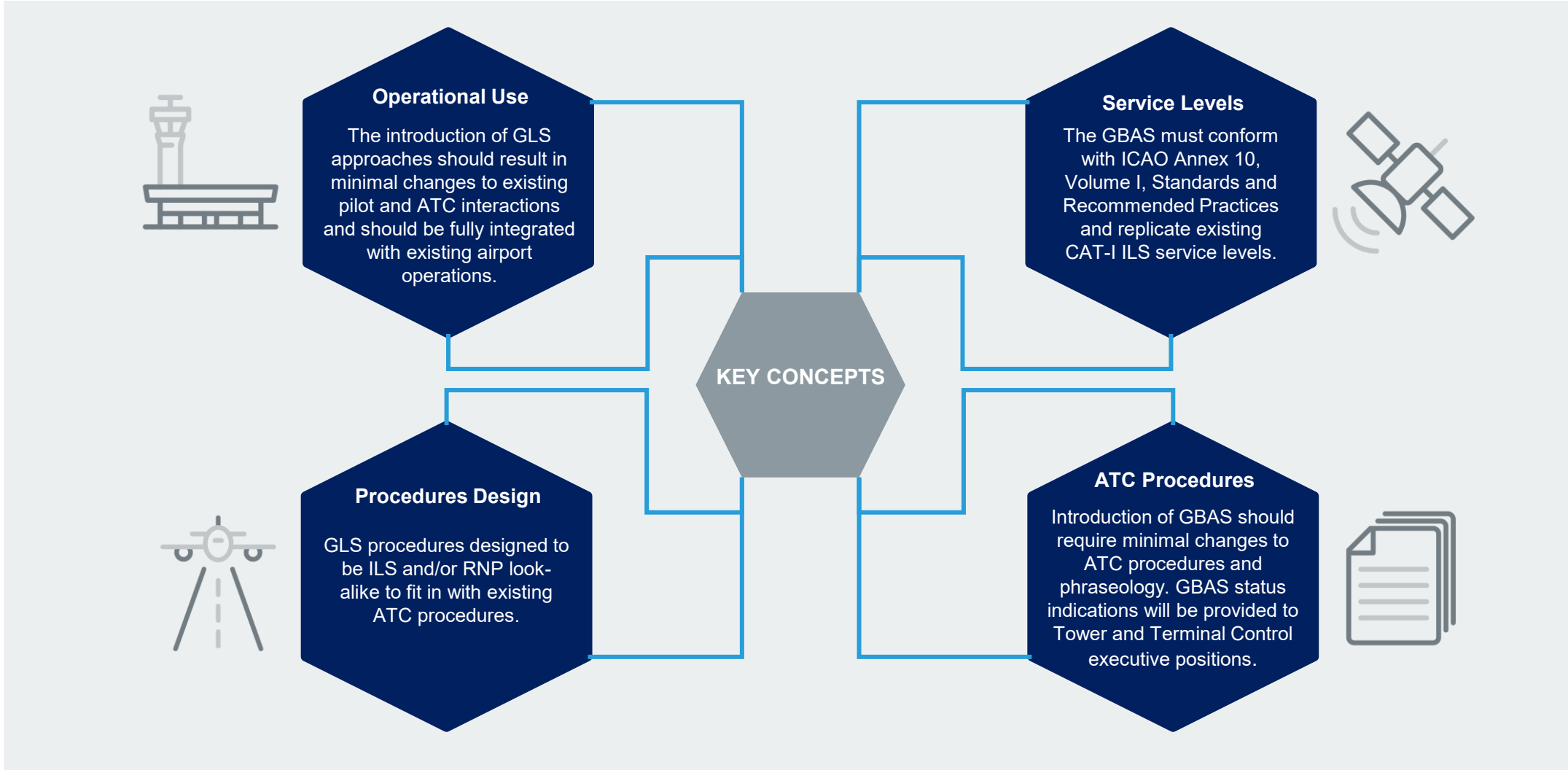
OPERATIONAL TESTING

Demonstration that Operational Testing has been adequately defined, completed and that any lessons learnt from Operational Testing have been integrated into CAT-I operations.

CAT-I OPERATIONS

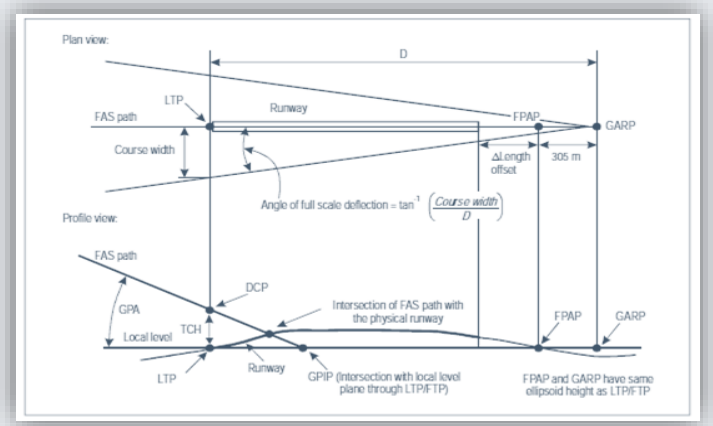
Demonstration that CAT-I landing operations are defined, Support Systems updated and the level of risk acceptable.

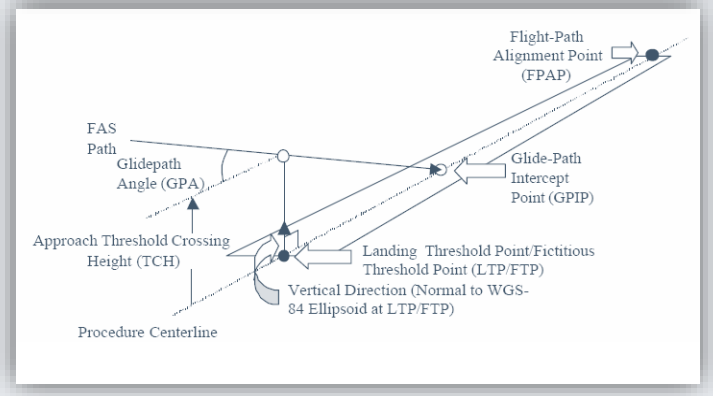
CONCEPT DEFINED

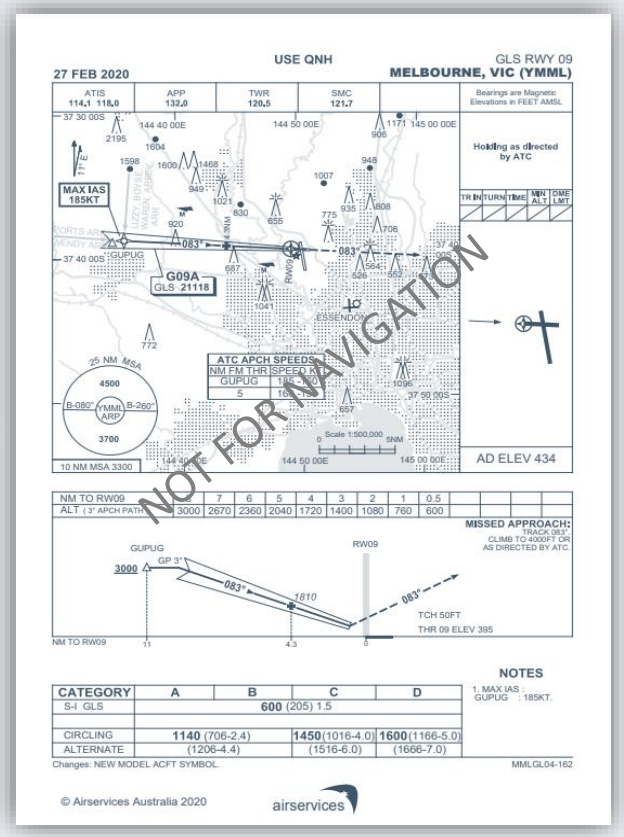


PROCEDURES DESIGN

FAS DATA AND APPROACH PLATE DEVELOPED BY PROCEDURES DESIGNER. PROVIDED TO TECHNICAL TEAMS TO CONVERT INTO A BINARY FILE FOR LOADING ONTO THE GBAS.







Aerodrome Location	Frequency (MHz)	Runway	Channel	IDENT
YMML	115.4	09	21118	G09A

Item	Units	Range of Values	Resolution	Value
Operation Type	-	0 = Straight in Approach 1 to 15 = Spare	1	**0**
SBAS Service Provider	-	0 to 13 = Not used in Australia 14 = FAS Data Block is to be used with GBAS only 15 = FAS Data Block can be used with any SBAS service provider	1	**14**
Airport ID	-	AAAA to ZZZZ	-	**YMML**
Runway Number	-	1 to 36	1	**9**
Runway Letter	-	0 = no letter 1 = R (right) 2 = C (centre) 3 = L (left)	1	**0**
Approach Performance Designator	-	0 = GAST A or B 1 = GAST C (Category I) 2 = GAST C and GAST D 3 = GAST C, GAST D and an additional approach service type to be defined in the future 4 = GAST C, GAST D and two additional approach service types to be defined in the future 5 to 7 = Spare	1	**1**
Route Indicator	-	A to Z	-	**W**
Reference Path Data Selector (RPDS)	-	0 to 48	1	**2**
Reference Path Identifier	-	3 or 4 letter alphanumeric characters (IDENT)	-	**G09A**
LTP/FTP Latitude	degrees	± 90.0°	0.0005 arcsec	**-37°39'38.7055"**
LTP/FTP Longitude	degrees	± 180.0°	0.0005 arcsec	**144°49'20.1030"**
LTP/FTP Height	metres	-512.0 to 6041.5 m	0.1 m	**125.8 m**
Δ FPAP Latitude	degrees	± 1.0°	0.0005 arcsec	**-0°00'05.4185"**
Δ FPAP Longitude	degrees	± 1.0°	0.0005 arcsec	**0°01'33.0230"**
Approach Threshold Crossing Height (TCH)	metres or feet	0 to 3276.7 feet or 0 to 1638.35 m	0.1 feet or 0.05 m	**50.0 ft**
Approach TCH Units Selector	-	0 = Feet 1 = Metres	-	**0**
Glide Path Angle (GPA)	degrees	0 to 90.0°	0.01°	**3.00°**
Course Width	metres	80 to 143.75 m	0.25 m	**105.00 m**
Δ Length Offset	metres	0 to 2032 m	8 m	**0 m**
FASVAL	metres	0 to 25.4 m	0.1 m	**10.0 m**
FASLAL	metres	0 to 50.8 m	0.2 m	**40.0 m**

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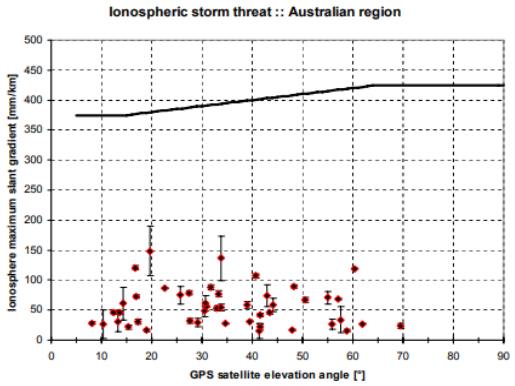
SUMMARY OF KEY INSTALLATION AND INTEGRATION ACTIVITIES

IONOSPHERE THREAT MODEL VALIDATION

- Validate that the magnitude of ionosphere gradients within the mid-latitude region of Australia falls within the bounds of the Ionosphere Threat Model
- Largest ionosphere gradients fell well within bounds of the model



SITE SELECTION

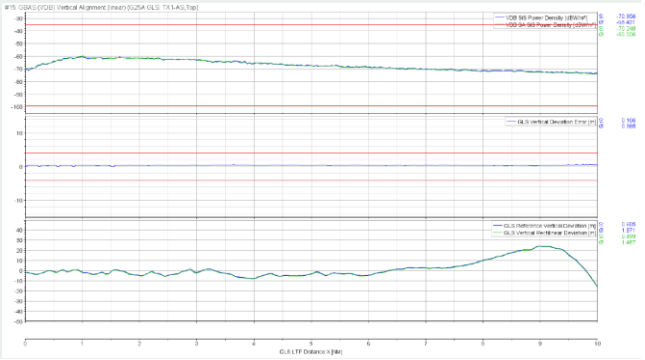
- Identify preliminary sites based on manufacturer Siting Process
- Set up a GPS antenna/receiver to evaluate GPS environment
- VHF coverage modelling using available software tools

INSTALLATION & INTEGRATION

- Site Design
- Civil Works
- Shelter & Tower Installation
- RSMU Installation
- VDB Installation
- Integration into ATM Systems

VERIFICATION ACTIVITIES

- Factory Acceptance Testing
- Site Acceptance Testing
- Flight Inspection



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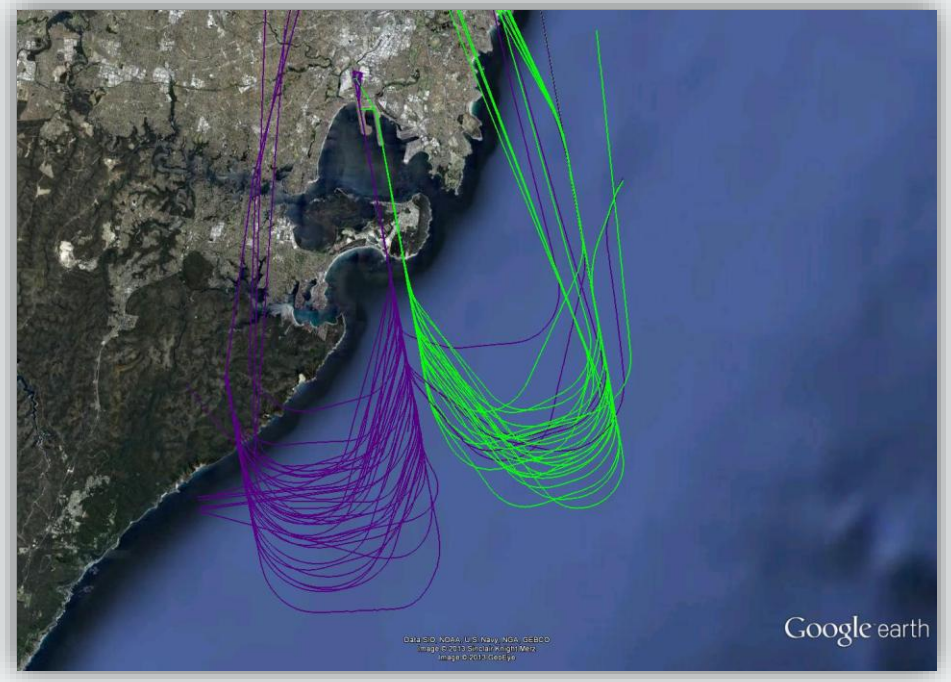
OPERATIONAL TESTING

TESTING IN A REAL-WORLD ENVIRONMENT

- Safety Case (for Operational Testing) submitted and accepted by the Civil Aviation Safety Authority
- Objectives
  - Validate GBAS is meeting designed System Performance parameters
  - Validate that the service is operating as intended through aircraft using the GLS service
- Open to “Authorised Operators” only. Visual conditions only.
- Temporary Local Instruction in place for ATC
- No change to Service Provider Certificate. Operational Evaluation was conducted under test transmissions clause of the regulations.



Pilot Feedback:

“Very good intercept and approach was flawless”

CAT I OPERATIONS

OPERATIONALISING THE CHANGE

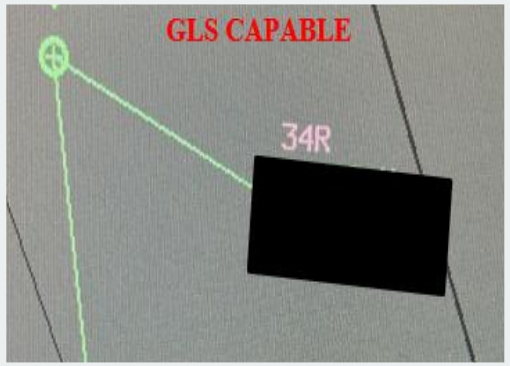
- Hazards reviewed and updated to reflect CAT-I operations
- ATC instructions integrated into procedures and Aeronautical Information Publication documents were updated
- All evidence collated during the Operational Testing consolidated into Safety Case for CAT-I operations and accepted by CASA
- Future GBAS deployments managed as any other Navigation Aid deployment
- GBAS available for use by all operators authorised to conduct GLS approaches by their National Aviation Authority

CASR-171 Service Classifications (Chapter 2 MOS Part 171)	Coverage	ICAO Defined Services	Airways Systems	Support Services (External)
AERONAUTICAL RADIO NAVIGATION	National	Aeronautical Radio Navigation	• Distance Measuring Equipment • Instrument Landing System – Localiser, Glide Path and Marker • Non Directional Beacon • Very High Frequency Omni-Range • Ground Based Augmentation System **Common Systems** • Communications systems - Microwave radio links - Satellite ground stations - Terrestrial cabling - Multiplexers - Data networking systems • Voice Communication and Control System • Audio and Control Systems • ATC Consoles	• Public Telecommunication Networks • Copper and Fibre cables(Airport Owner)

OPERATIONAL EXPERIENCES

GLS EXPECTED APPROACH METHOD

- Based on industry feedback, GLS became the expected approach method from 2018.
- To support GLS as the expected approach method, a key update was made to the ATM system.
- This allows ATC to identify GLS-equipped aircraft by automatically scanning flight plans for GLS capability.
- GLS capability detected based on Flight Plan Field 10A, “A”.
- If GLS capability is detected the arrival runway is highlighted in a distinct colour for Approach Controllers.



MAXIMUM USE DISTANCE EXTENSION (Dmax)

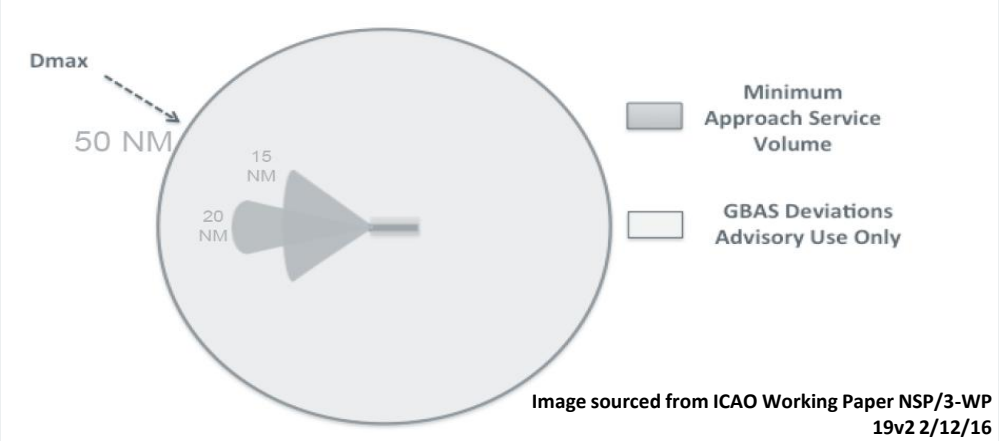


Image sourced from ICAO Working Paper NSP/3-WP 19v2 2/12/16

- Based on industry feedback, GBAS Maximum Use Distance extended from 23NM to 50 NM.
- Enabled through a change to the definition of Dmax in ICAO Annex 10, Volume I, Amendment 91.
- Between 23 NM to 50 NM from the GBAS site, the GBAS guidance information is advisory only.
- Enhances pilot situational awareness, provides an indication of GBAS station health and improves GBAS course capture.

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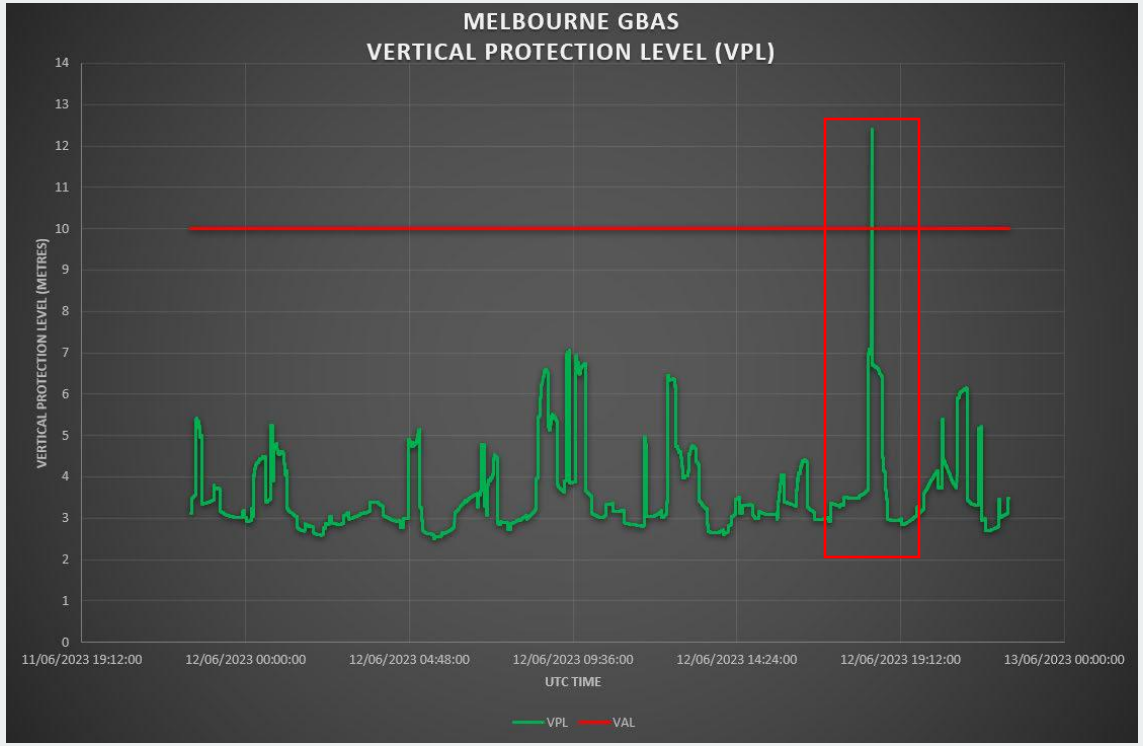
OPERATIONAL EXPERIENCES (continued)

LOSS OF GLS GUIDANCE EVENTS

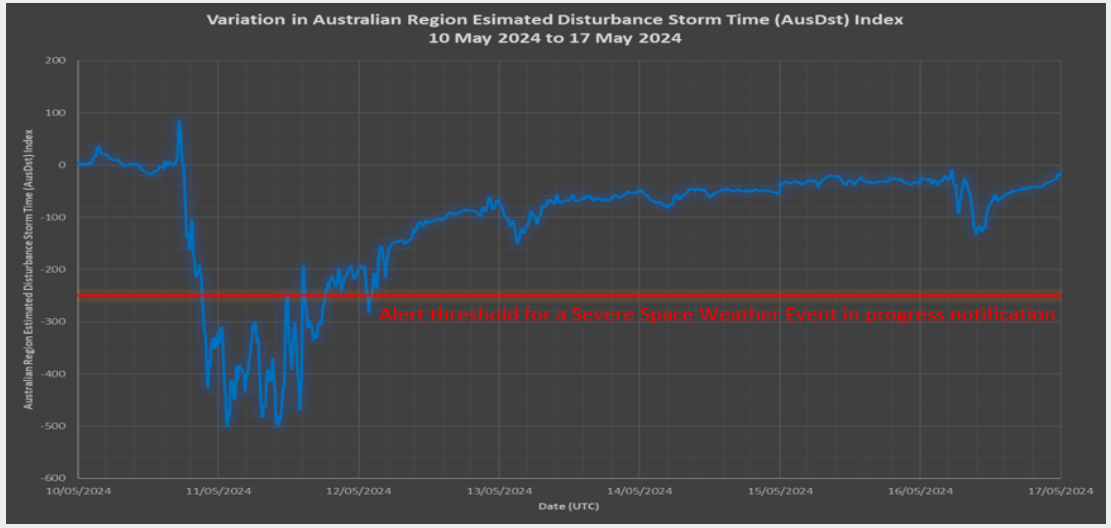
- Limited number of pilots experienced a loss of vertical deviation indications whilst performing a GLS approach
- In all instances, pilot had visual reference of the runway and continued the approach
- Attributed to Vertical Protection Level (VPL) exceeding the Vertical Alert Limit (VAL) due to satellite outages
- Australia actively monitors predicted changes to the GPS satellite constellation configuration and will remove the GBAS from service (through a NOTAM) during periods the VPL is predicted to exceed VAL
- Continuity of Service requirements continue to be met at both Sydney and Melbourne

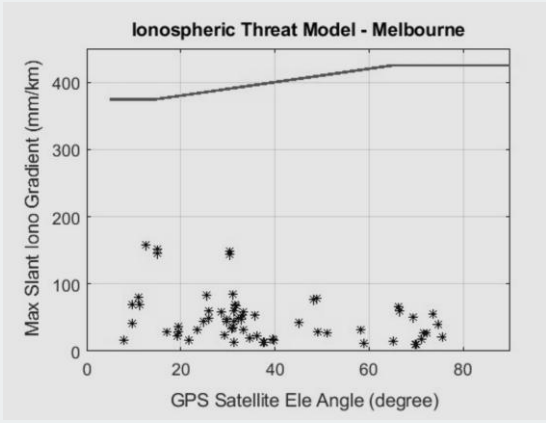


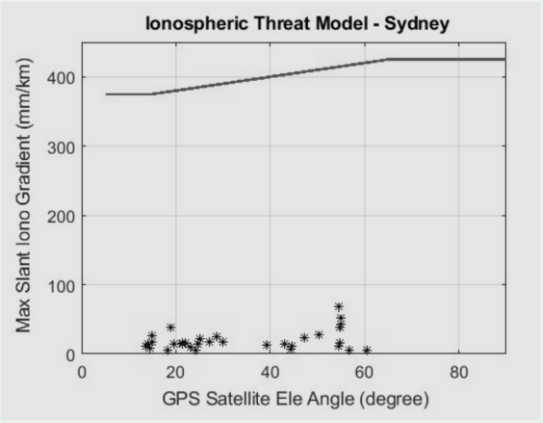
OPERATIONAL EXPERIENCES (continued)

SEVERE SPACE WEATHER EVENTS

- Increased number of severe space weather events in the preceding two-year period
- During all these severe space weather events, the GBAS ground station continued to operate normally
- Observable increase in the number of code-carrier divergence events on the GBAS ground station resulting in the short-term exclusion of a satellite.
- In most instances the VPL did not exceed the VAL even with the short-term exclusion of a satellite
- With the increase in severe space weather events, Australia undertook a study to validate that the existing Ionosphere Threat Model continues to bound the worst-case anomalous ionosphere gradients
- Study concluded magnitude of anomalous ionosphere gradients continues to fall well within the bounds of the Ionosphere Threat Model



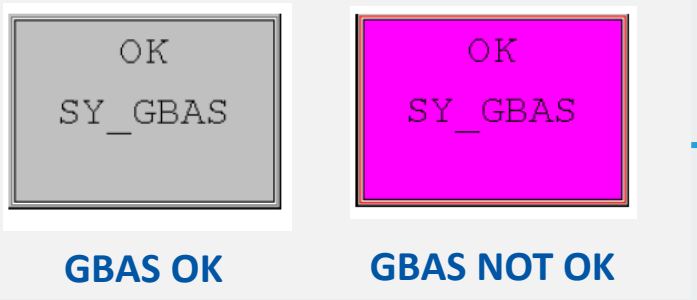


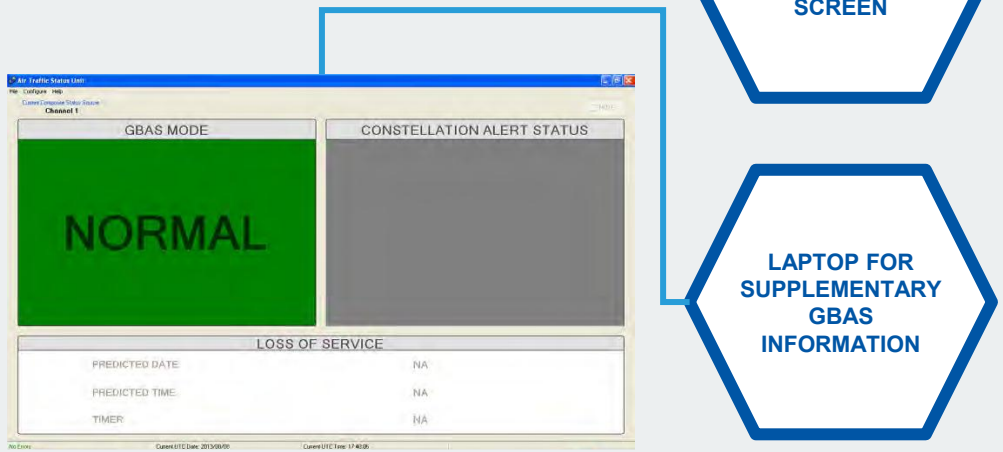


GBAS MONITORING AND OUTAGE NOTIFICATIONS

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





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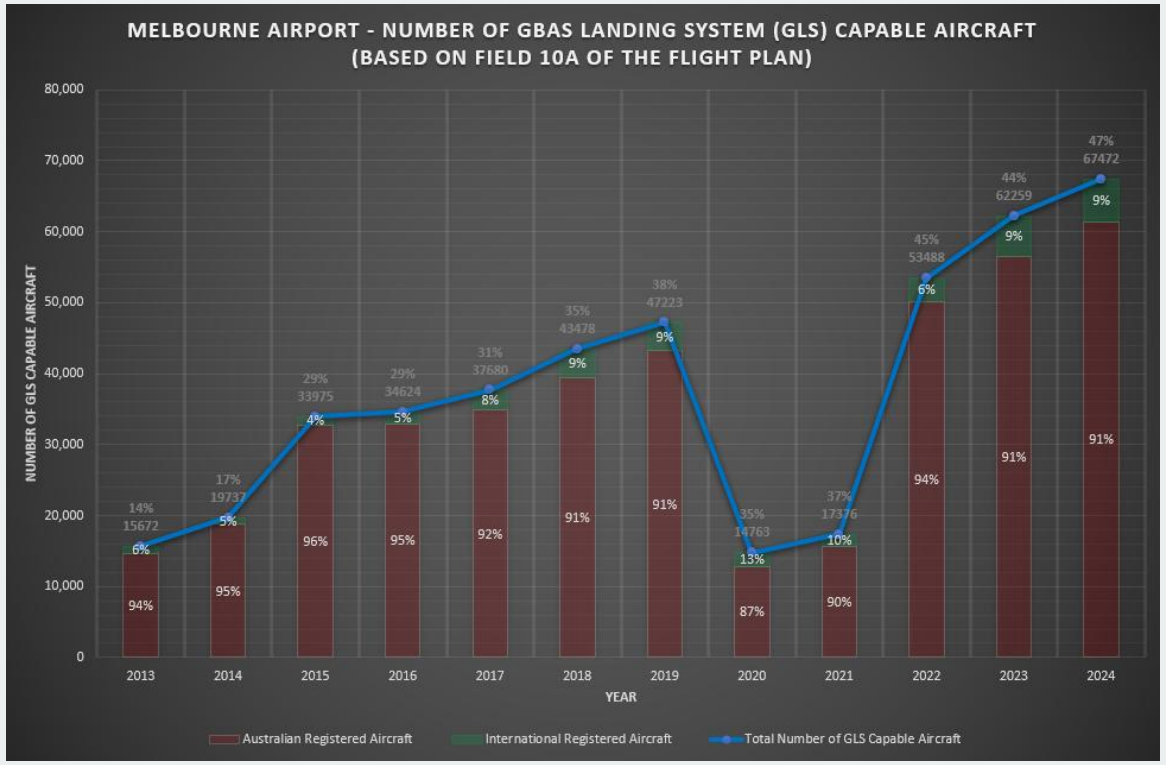
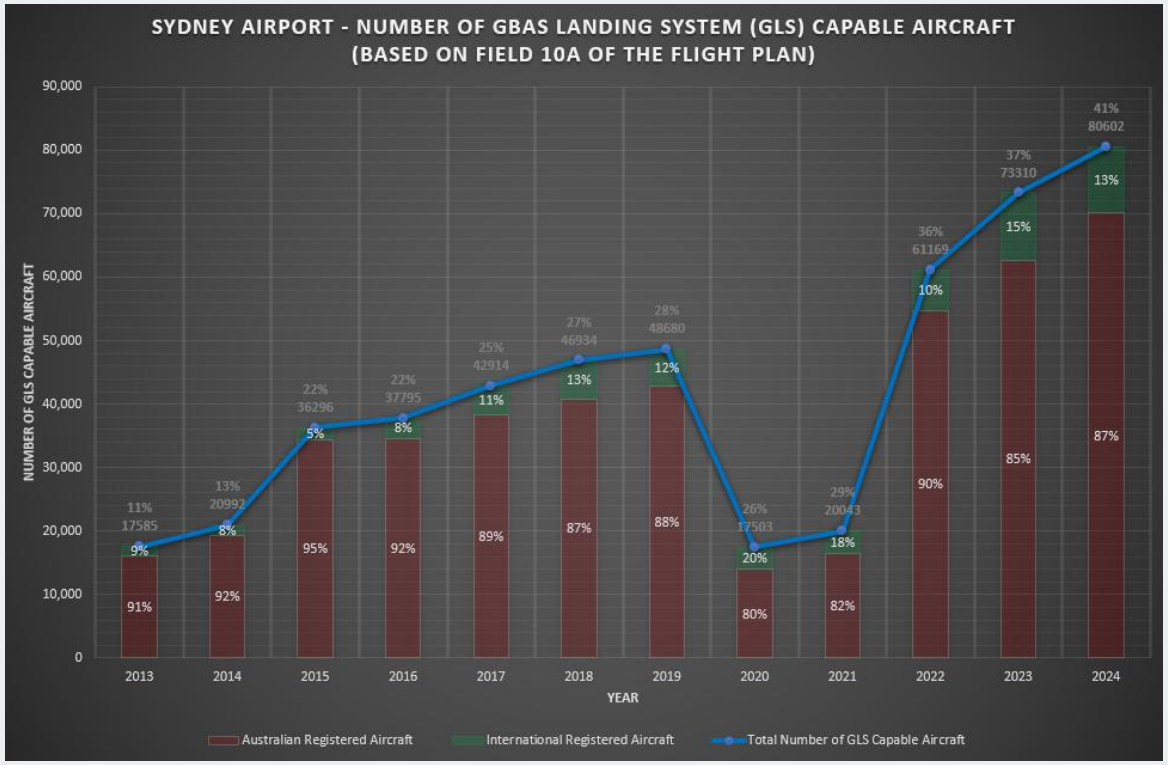
FLEET EQUIPAGE

FLIGHT PLAN ANALYSIS





BENEFITS OF GBAS

GREATER OPERATIONAL FLEXIBILITY

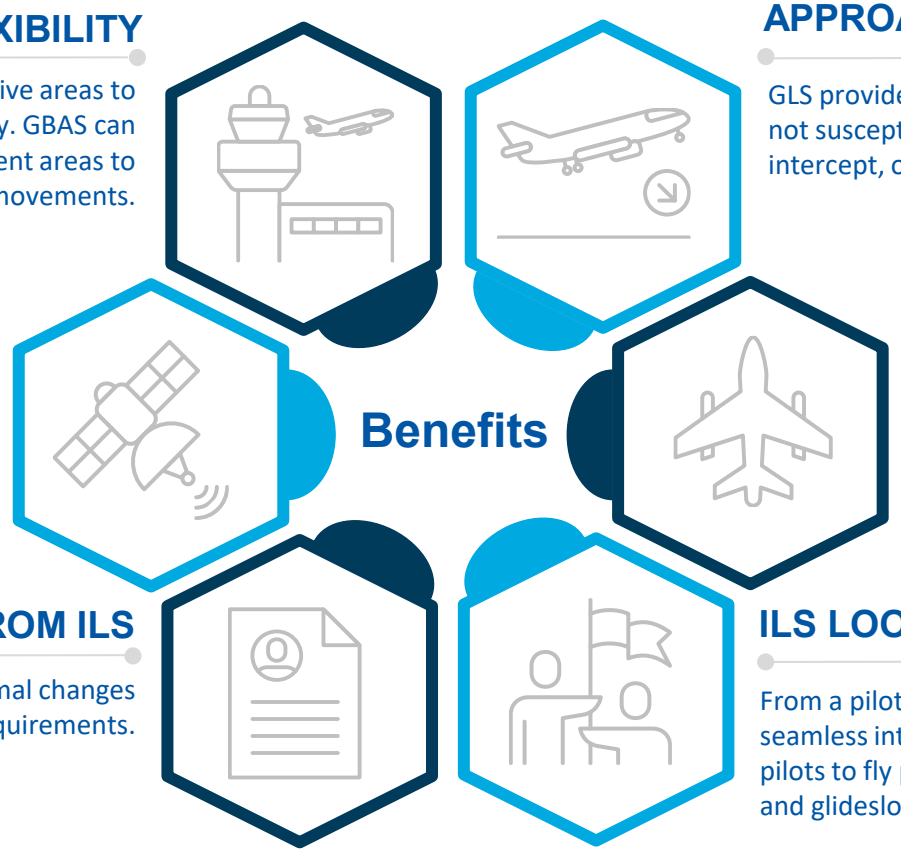
Expect no equivalent ILS critical or sensitive areas to protect allowing greater operational flexibility. GBAS can be sited away from runway and movement areas to minimise restrictions on aircraft movements.

APPROACH STABILITY

GLS provides excellent vertical and lateral stability and is not susceptible to scalloping that may be observed during intercept, or on final on an ILS approach.

ENHANCED SERVICE AVAILABILITY

Compared to the ILS, significantly less maintenance and no loss of service during periodic flight calibration activities enhancing service availability.



LOWER PLANNING MINIMA

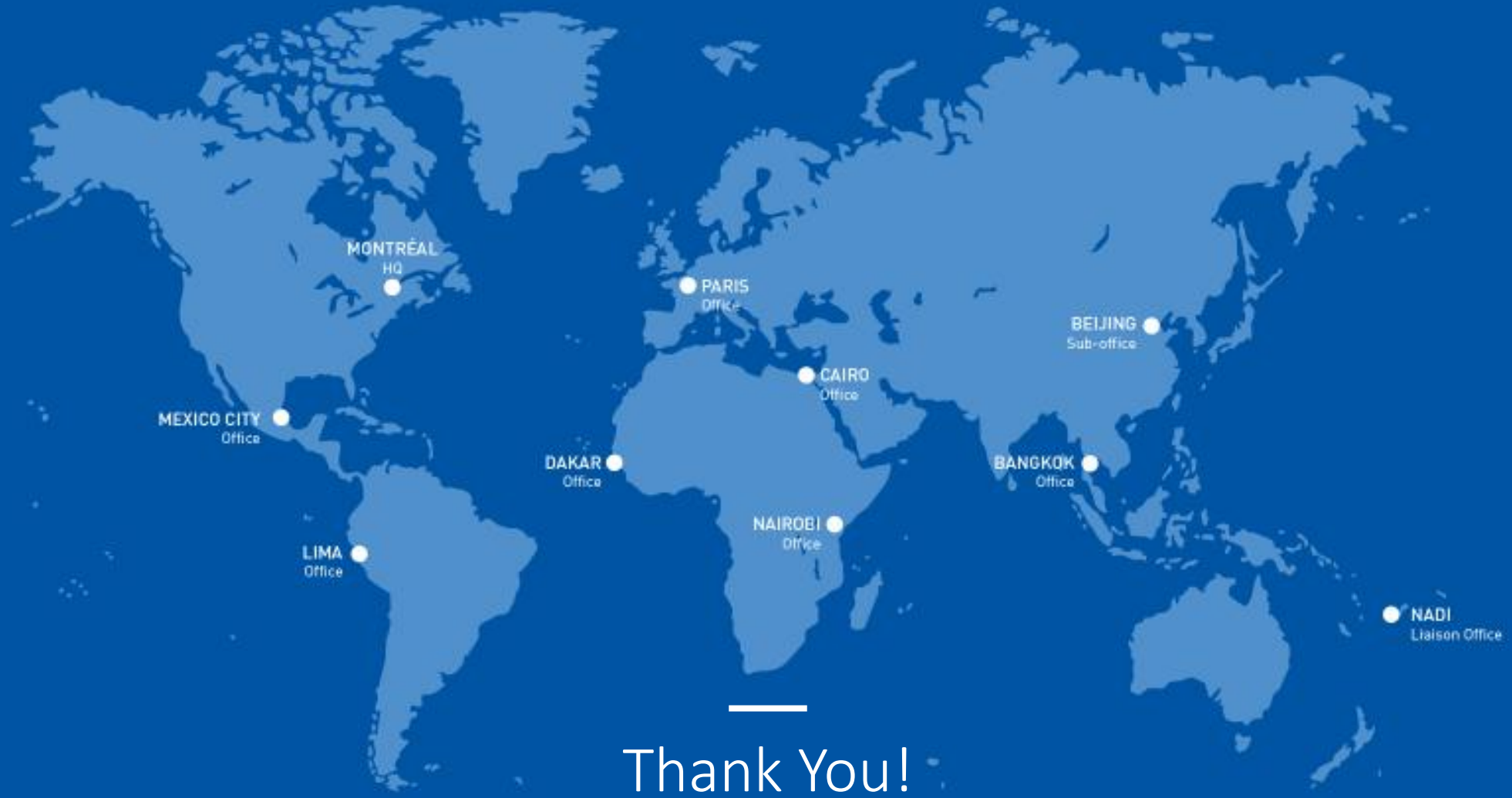
Capability to lower the alternate planning minima with the introduction of precision approaches to runways not currently equipped with an ILS, introducing operational efficiencies to the airlines.

SEAMLESS TRANSITION FROM ILS

Seamless transition from ILS to GLS with minimal changes to existing practices reducing ATC training requirements.

ILS LOOK ALIKE

From a pilot's perspective, GLS is ILS look alike allowing seamless integration with existing operations and allowing pilots to fly precision approaches using familiar localizer and glideslope indications.



Thank You!

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