Ground Based Augmentation System: Current Operation and Future Perspectives

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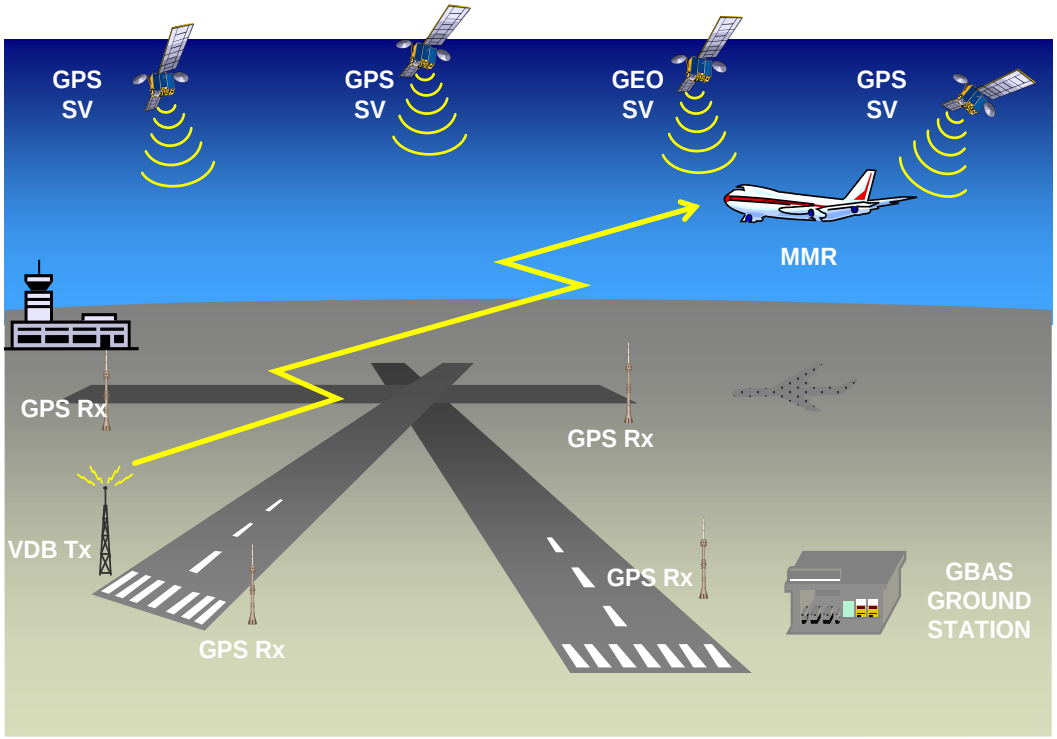
GBAS OVERVIEW

Ground Based Augmentation System is an ICAO concept standardized mainly to serve precision approach needs in GNSS.

- GBAS is a component of the ICAO Global Navigation Satellite Systems (GNSS)

Principle:

- Differential GPS/GNSS systems providing
  - corrections
  - integrity information
  - information related to the approach.



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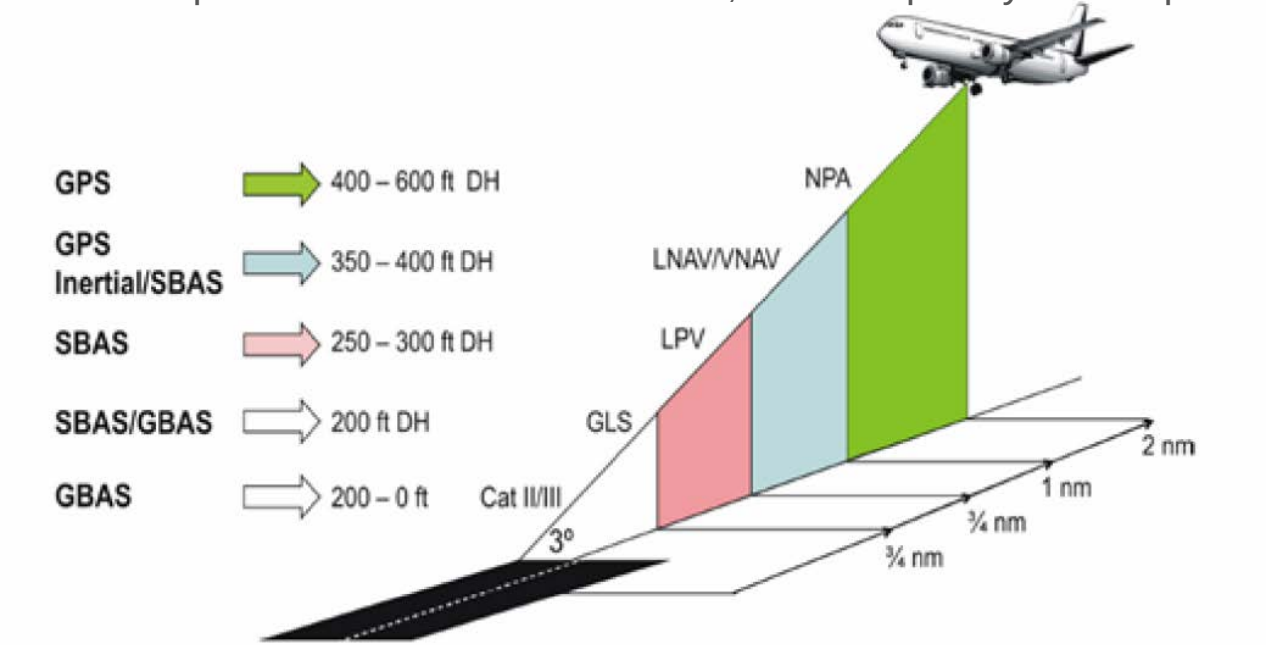
GBAS SERVICES

GBAS services overview:

- ICAO standardizes different GBAS Approach Service Types (GAST)
  - GAST-C: for operations to CAT I performance level
  - GAST-D: for operations to CAT III performance (with specific aircraft integration assumptions)
  - GAST-F: planned for multi-constellation, multi-frequency CAT III performance level



GBAS OPERATIONAL BENEFITS

Airlines benefits

Fuel savings, **noise abatement** and reduced emissions from efficient, **flexible flight path**

Less flight disruptions and associated costs caused by ILS interference

Greater precision guidance for **improved safety**

Minimal pilot training (common procedures with current ILS make pilot training easier and reduce human factors associated with new flight deck technology)

Airport benefits

Improved airport **capacity** from accurately guided **simultaneous operations**

Flexibility in GBAS station location, unlock valuable airport land and alleviate traffic restrictions which are otherwise required to protect ILS signals from interference sources

Improved airport access, even when ILS cannot be installed for terrain or economic reasons

ANSP benefits

Reduced traffic delays and congestions as a result of more accurate and efficient and predictable approaches

Reduced capital investment cost and lower on-going maintenance, as one **GBAS covers all runways**, compared to one ILS installation per one runway end

Flexibility to add or change **Final Approach procedures** without changing the system configuration

Easier and **less frequent** flight inspection than ILS

Continued operations even during routine flight inspections or airport works.

GBAS CERTIFIED OPERATIONS

Precision Approach Definition

Precision Approach Category	Decision Height	Runway Visual Range
CAT I	≥ 60 m (200 ft)	≥ 550 m
CAT II	200 ft >DH ≥ 100 ft	≥ 350 m
CAT III A	< 100 ft or no DH	≥ 200 m
CAT III B	< 15 m or no DH	200>RVR ≥50 m
CAT III C	No minima	No minima

GBAS current operation

Current system enabler:

- GBAS GAST C technology based on the augmentation of GPS L1C/A signals

GBAS IN THE WORLD: CERTIFIED AIRCRAFT

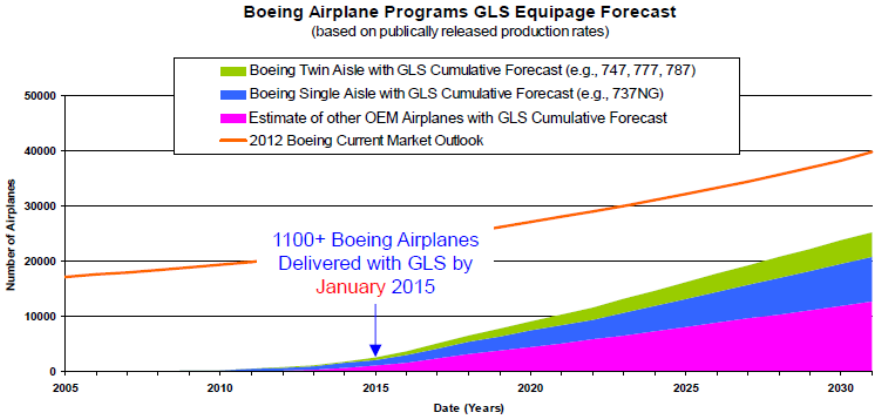
Aircraft Manufacturer Status

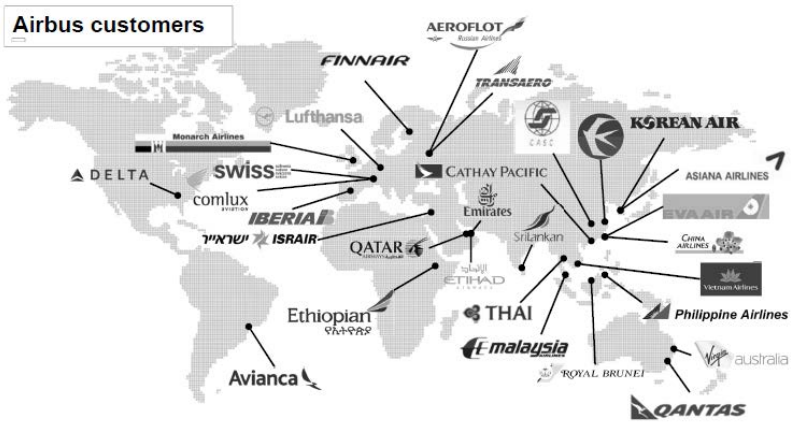
Airbus

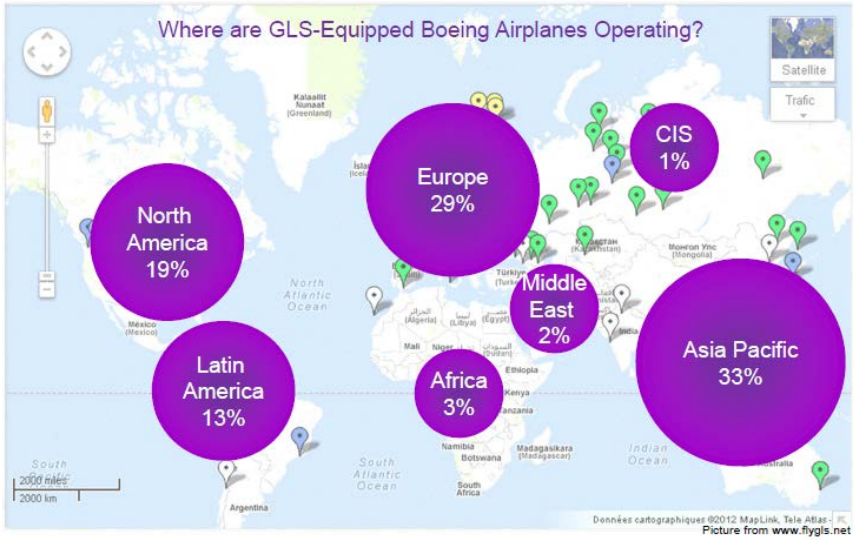
- GLS CAT I with autoland certified in A320, A330, A350, A380

Boeing

- GLS CAT I certified in B737, B787, B747-8







Sources:

- IGWG 16 Item 5.1 Boeing GBAS status
- IGWG 16 Item 5.2 Airbus GBAS status

GBAS IN THE WORLD: GROUND STATUS

Legend:

Blue: Prototype/Research (with dot: actively transmitting)
Yellow: S-CAT (with dot: charts published)
Green: Operational (with dot: charts published)
Purple: plannned installations

Ground system manufacturers:

- Honeywell (certified product)
- Indra

Ref.: http://flygls.net/

NEW CONCEPT OVERVIEW

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CAT III B	< 15 m or no DH	200>RVR ≥50 m
CAT III C	No minima	No minima

GBAS current operation

GBAS future operation

New concepts:

- GBAS GAST D
- GBAS GAST F technology based on the augmentation of dual frequency multiple constellation signal (DFMC)

GBAS GAST-D

Mature concept based on the augmentation of GPS L1C/A signals

- Concept of operation initiated in 2010 and consolidated in 2014
- Standardisation activity initiated
  - GBAS GAST-D ICAO SARPS under development since the last 5 years
    - To be finalized by end of 2016
  - Avionics equipment standard well advanced
  - Ground segment standard completed
- Prototyping activity already realized
  - Toulouse (DSNA) and Frankfurt (DFS) ground segment prototype in operation
  - Honeywell airborne prototype developed.

Not approved for operation (either at ground or airborne side) but foreseen to be done in a short term.

GBAS GAST-F

GBAS evolution concept for tomorrow technology based on the augmentation of dual frequency multiple constellation signal (DFMC):

- This concept takes credit for the development and modernisation of core constellation systems such as GPS L1/L5, Galileo or Beidou
  - Being able to mitigate space-ground propagation issue
  - Being able to use more space vehicle
- Concept of operation initiated in 2015 still under final consolidation at European side
- Standardisation activities to be completed by 2025
- Prototyping activity initiated in 2016
  - Static test in GBAS Toulouse Blagnac upgraded in a GAST-F configuration last week
  - Dynamic test in Toulouse Blagnac using a Falcon 900 aircraft equipped with the Honeywell GAST-F prototype planned in May 2016.

Promising concept being dependent on the standardisation and approval process of new constellations

GBAS IN ACAC

Observation :

- No GBAS operation in North Africa and Middle East regions

Main reasons:

- No ground systems infrastructure deployed in ACAC regions

Potential Opportunity:

- Aircraft operators will be equipped with GBAS Landing System capability

Need to assess a GBAS strategy analysis to identify when and where implement GBAS.

GBAS IMPLEMENTATION ROADMAP

Navigation strategy first steps:

- Feasibility study taking into account technology readiness versus the implementation timeframe targeted
- Business Case accounting for
  - Local safety requirements
  - GNSS/GBAS fleet equipage and potential trends
  - Current navigation strategy plan for GNSS and conventional navigation aids
  - Implementation cost

The outcomes can support a decision making process to include GBAS in a state navigation policy.

GBAS INTERNATIONAL COMMUNITY

Having further technical or operational questions on GBAS ?

International GBAS Working Group:

- Led by FAA and EUROCONTROL gathering around 100 people from 15 nations
- Main topics:
  - Programatic Aspects / National GBAS activities
  - Airlines/Aircraft/Avionics/Ground Systems updates
  - Ionospheric Aspects and Monitors
  - CAT I post approval and implementation activities
  - Data collection/sharing/evaluation, test case harmonization/site specific configuration requirements and testing requirements
  - GBAS future operations: Operational and implementation aspects
  - Ground System siting and ground monitoring aspects
  - GBAS CAT III aspects
- Next meeting in Oslo April 18-21 2016

CONCLUSIONS

GBAS is a key element of the GNSS systems being standardized in ICAO.

GBAS is the only GNSS systems providing approach services in low visibility condition.

Aircraft operator starts to be equipped with GBAS Landing System capability, this capability being provided in commercial aircraft baseline.

An evaluation of **GBAS costs and benefits** for implementation in ACAC Member States can be of interest as **quick wins** can be anticipated.

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