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## ***GBAS implementation status: international context and situation in France***



*Pierre Ladoux – DSNA/DTI/CNS/NAV  
Benoit Roturier – DSNA/DP*



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# *International context:*

- GBAS CAT-I implementation*
- GBAS CAT-II/III development*



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# GBAS CAT-I situation: ground equipment implementation (1/2)

- ICAO GBAS CAT-I SARPs published in 2001
- Honeywell SmartPath GBAS station certified (System Design Approval) by the FAA in 2009
- First worldwide GBAS CAT-I operational approval at Bremen airport (Germany) in 2012
- **GBAS CAT-I is now operational at several airports**
  - Frankfurt, Zurich, Malaga, Newark, Houston, Sydney, Melbourne notably
  - See next slide
- **~100 GBAS CAT-I installations in Russia (GPS+GLONASS)**
  - Russian specific technology
  - Re-use/certify in other part of the world unclear at this stage



# Worldwide GBAS Cat I facilities

## Honeywell+ Russia



Russia is now developing a Low cost GBAS network (~100 stations)

Honeywell GBAS/SmartPath® Installations - 2016

- CAT 1 Approved
- CAT 1 Pending
- Test Systems
- Deploying
- Planned

# GBAS CAT-I situation: ground equipment implementation (2/2)

- **Planned GBAS CAT-I implementation in**
  - Brisbane, Perth, Tokyo Haneda, Shanghai, Tianjin, Singapore, Hong Kong, Chennai, Krakow, Oslo
- **Other envisaged locations but overall GBAS CAT-I deployment remains limited**
  - In perspective with SBAS, which now supports > 4000 Cat I or near-Cat I approach procedures in the US, and close to 400 now deployed in Europe within a few years.
  - **The lesson learned is that this is related to economic rather than technology.** GBAS technology is of high quality. Indeed:
    - The cost of a single certified GBAS ground station is from SESAR studies and deployment in Europe 1,5 to 2 M€ per airport
    - Alternatively SBAS signals are free of charge for aviation



# GBAS CAT-I situation: A/C implementation



- **A320 family** : GLS Cat I Autoland
  - Certified
  - Selected by **7 customers** (2 additional customers have open the RFC)



- **A330/A340 family** : GLS Cat I Autoland
  - Planned to be certified in 2012/2013
    - A330 with GE engines
    - A330 with PW/RR engines
    - A340 with CFM engines
    - A340 with RR engines
  - **5 customers** have open the RFC



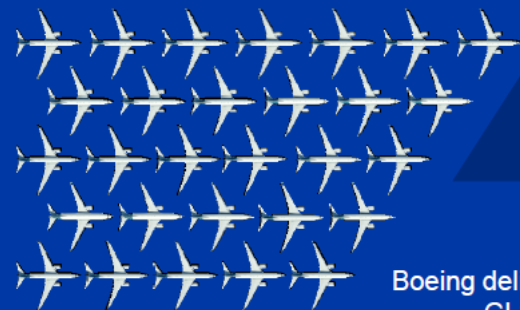
- **A380 family** : GLS Cat I Autoland
  - Certified
  - Selected by **9 customers** (2 additional customers have open the RFC)



- **A350 family** : GLS Cat I with autoland
  - Planned to be certified at Entry Into Service
  - Selected by **2 customers**

• *Note: SLS option is offered as a set with GLS option*

Boeing Fleet GLS Activation Growing



Over 1500  
airplanes today

**47%**  
Boeing deliveries with  
GLS activated

**>60**  
airlines with GLS  
activated

Update July 2017  
300 Airbus aircraft equipped  
1900 Boeing aircraft equipped



At Paris CDG, now ~ 4% users  
equipped

# GBAS CAT-II/III situation (1)

- **ICAO GBAS SARPs to support CAT-III operations are completed**
  - Solution based on Single-Constellation Single-Frequency technology (GPS L1 only)
  - Concept called GAST-D. GAST-D SARPs Approved by ICAO NSP in December 2016
  - Publication in Annex 10 in 2018
  - Strong involvement of US industry (Boeing, Honeywell, Collins)
- **GBAS CAT III capable Ground Station development has already started**
  - Honeywell is seeking for System Design Approval on the future GAST-D capable GBAS SLS-5000
  - Schedule to complete SDA dependent on vendor investment decisions & funding for FAA SDA support
- **ICAO GBAS CAT-III procedure design criteria under development by IFPP**





## GBAS CAT-II/III situation (2)

### ➤ GBAS GAST-D Avionics

- RTCA DO-253D GBAS airborne MOPS approved for publication in May 2017
- Will lead to new or amended GBAS airborne equipment TSO/ETSO

### ➤ GLS CAT II/III implementation by airframer will depend on market demand, maturity of standards/regulatory requirements, availability of infrastructure and other business factors

- Boeing announced the GLS CAT II/III capability on the 777X at EIS (option while GLS CAT I is standard fit), under study for 737MAX in 2020
- FAA work on advisory circulars related to GAST-D airborne implementation



## GBAS CAT-II/III situation (3)

- **Work on GBAS CAT III Multi-Constellation (GPS+GALILEO) Multi-Frequency technology (L1/L5) still remains R&D at the moment**
  - Will offer more robustness facing some threats (ionosphere effects, radio-frequency interferences, satellite geometry) while potentially introducing complexity
  - Seen by some actors as the only solution to foresee CAT III ILS rationalization
  - Lower involvement from Industry compared to GAST-D solution. European institutions through SESAR2020 may lead the effort toward MF/MC CATII/III GBAS.



# *Overview of GBAS activities in France*



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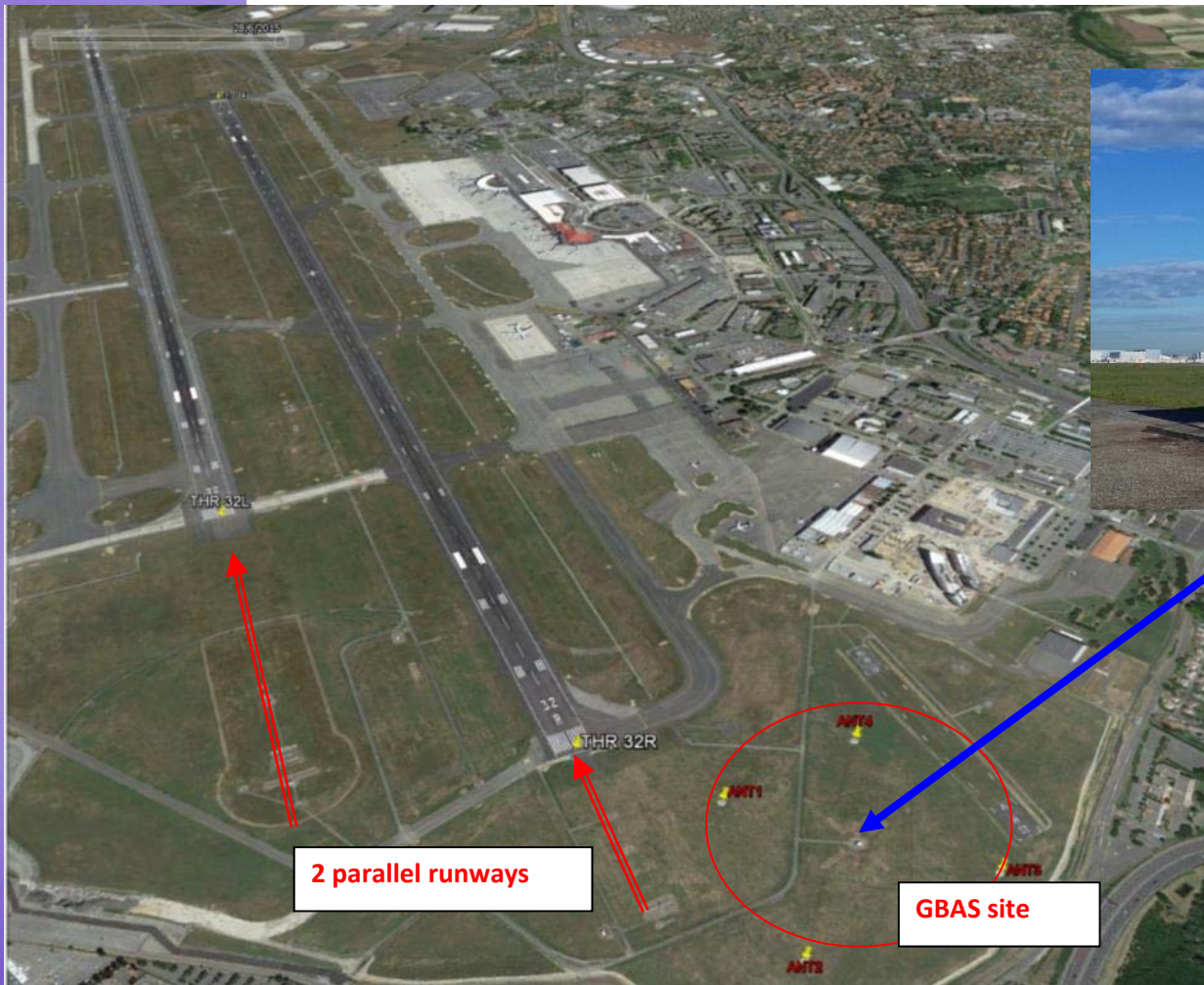
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# Overview of GBAS activities in France

- **DSNA has been involved in GBAS standards and system development for more than 20 years**
  - First experience of a Local Area Differential GPS experimental station at Toulouse airport in 1994
  - Key contribution to standardization activities related to GBAS CAT-I and CAT-III (ICAO, EUROCAE)
  - Strongly involved in the CAT-I technical and operational validation phase using a GBAS station operated at Toulouse Blagnac
  - Key partner in SESAR 1 (WP15) related to GBAS CAT-III with the implementation of a GBAS CAT-III (GAST-D) prototype at Toulouse Blagnac
  - Work continuing in SESAR 2020 (PJ14)
- **GBAS CAT-I station implemented at Toulouse Blagnac Airport**
  - The GBAS Toulouse station is not operational but used by Airbus for development/certification of the GLS function
  - No further CAT-I deployment in France is foreseen at the moment
- **DSNA internal analysis to assess the operational benefits that a GBAS CAT-III system could bring at Paris CDG airport**



# GBAS site at Toulouse Blagnac



# GBAS station at Toulouse/Blagnac



**GBAS site**



**Reference Receivers antennas**

# ***GBAS internal study for Paris CDG***



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# Objectives of the GBAS@CDG study

- **The main objective was to assess the operational benefits that a GBAS CAT-III system could bring at Paris CDG airport**
  - **Is it possible to remove some or all of 8 ILS serving Paris CDG?**
  - **Is it possible to increase capacity under Cat II/III meteorological conditions?**
- **The potential interest for the nearby Paris Le Bourget business aviation airport was also assessed**
  - **Assessment of the possibility of a GBAS station installed at CDG to support offset approach (with vertical guidance) at Le Bourget RWY 25**
- **Conducted by DSNA Technical Directorate (Navigation team) and DSNA ATC service at Paris CDG**



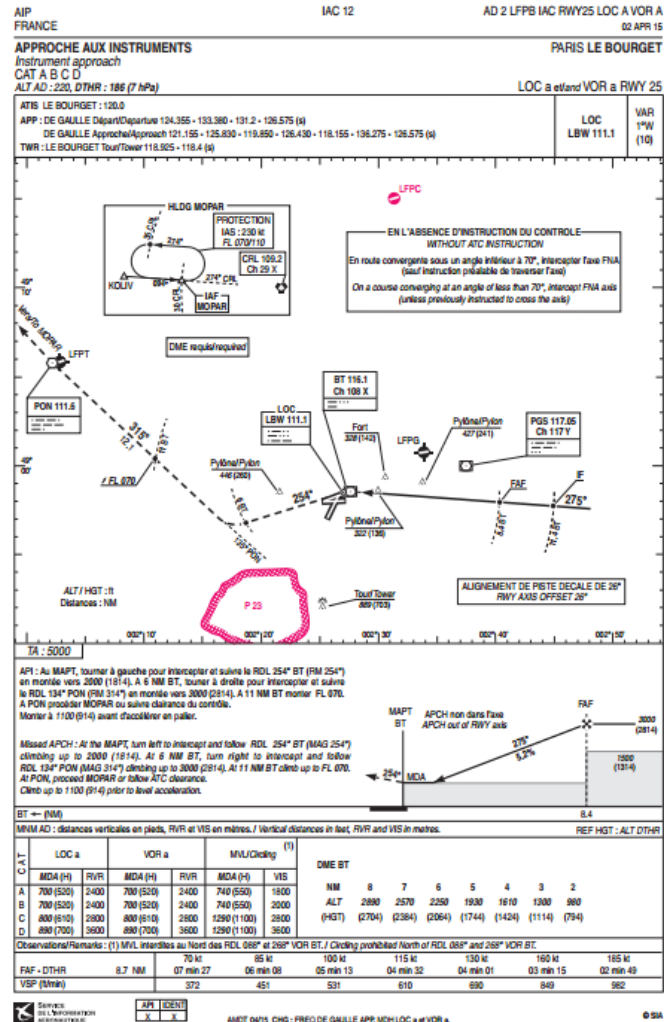


# Outcomes of the GBAS@CDG study (1)

- **Simultaneous triple independent parallel approach operations conducted on LFPG (Paris CGD) 27R, 26L and LFPB (Paris le Bourget) 27**
  - Typically supported by CAT III ILS on 27R and 26L, CAT I ILS on LFPB 27
  - Also supported by an PBN approaches on RWY 26L
- **The study has shown that a GBAS system could also support this type of operations (one GBAS and two ILS simultaneous approaches)**



# Outcomes of the GBAS@CDG study (2)



- Offset approach at other LFPB runway
- RWY 25 (2991 m long) used by A/C for which landing distance would make RWY 27 (1853 m) too short
- Approach served by a 26° offset localizer providing guidance nearly parallel to LFPB RWY 26L
  - No vertical guidance
- PBN GNSS approach also available
  - Published with LNAV minima only
- **According to the current regulations, no benefits from GBAS are foreseen**
  - ICAO PANS OPS\* requires the GBAS CAT I final approach track to intersect the runway extended centre line at an angle not exceeding 5°
  - Similar situation with SBAS

\*Note: ICAO PANS OPS – Vol II - Part III — Section 3, Chapter 6 - § 6.7.1



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# Outcomes of the GBAS@CDG study (3)

- **GBAS CAT-I station installation at short-mid term to gain operational experience and pave the way for potential future CAT-III operations not seen as relevant:**
  - Very few operational benefits compare to the additional complexity to manage mixed equipage
  - Limited interest on GBAS CAT I considering the existence of PBN approaches down to LNAV/VNAV and SBAS Cat I minima
- **General concern about the multiplication of approach types and approach plates related to PBN implementation with a low number of users**
  - GLS procedure charts would increase the risk of potential confusions by the pilot while only a few % of GBAS equipped users land at CDG
  - The situation is different for SBAS, which is published on a PBN chart addressing 90% of CDG users

# Outcomes of the GBAS@CDG study (4)

- **Possibility to replace at mid-term ILS Cat III by GBAS Cat III for the 4 inner runways (departure) not considered as relevant**
  - Inner runways are expected to absorb arrival flows in the near future providing a very high flexibility
  - Inner runways are currently used for landing when outer runways or ILS approaches are unavailable
  - Sorting GLS equipped A/C to a GBAS only runway would penalize ILS only A/C (holding cannot be envisaged)
  - **Would work only under a very high GLS equipment rate (90%)**
- **From an economic perspective, ILS infrastructure cost reduction could only be possible once sufficient proportion of GLS equipped A/C is achieved**
  - **This could require a GBAS equipage mandate**
  - Same conclusion now reached by German DFS



# Outcomes of the GBAS@CDG study (5)

- **Dedicated GBAS runway to concentrate GBAS equipped A/C not possible**
  - Requires a very high GLS equipment rate to optimize the runway pair utilization
  - Crossing traffic flows coming from North and from South may reduce efficiency and kill any GBAS benefits
- **“Optimized Operations in LVC” concept not applicable with the existing ATC tools**
  - Concept can only be envisaged if ATC radar display indicates the GBAS CAT III A/C capability/pilot intent and provides a spacing management tool (similar to Time Based Separation concept)
  - A/C GBAS capability is not visible to the ATCOs through current French Flight plan system
  - Managing a different spacing for GBAS-ILS and GBAS-GBAS arrivals considered as too complex without spacing management tool by ATCOs
  - **Capacity gain only foreseen when sufficient GLS equipment rate is achieved**
  - **High performance new ILS localizers are scheduled for 26L/08R and 27R/09L at CDG. These LLZ may reduce the size of the critical/sensitive areas and allow to increase the runway throughput under LVC without the implementation of a new technology like GBAS (same as London Heathrow /Zurich/Geneva)**

*To summarize...*



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- **Worldwide GBAS Implementation is progressing, but still quite limited vs. other GNSS technologies (PBN, SBAS)**
- **GPS/L1 GBAS CAT III technology is available but further work is needed on operational aspects (regulations, standards, ATC tools definition,...)**
  - Benefits vs. ILS over main airports may require a high % of GBAS equipage
- **MC/MF GBAS CATIII technology is still at R&D level with less industry involvement**
- **Implementing GBAS at Paris CDG is considered as too ambitious for a first GBAS CAT III project**
- **However, DSNA confirms his commitment to GBAS technology**
  - Toulouse airport has been proposed as an alternate to further progress with GBAS CAT III – ongoing discussions with Airbus
  - Pursuing R&D work in SESAR 2020
  - Continuing participation to standardization groups (ICAO, EUROCAE)



**Thank you for  
your attention !**



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