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# GBAS implementation status: international context and situation in France

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# *International context:*

## *- GBAS CAT-I implementation*

## *- GBAS CAT-II/III development*

# GBAS CAT-I situation: ground equipment implementation

- **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 notably
- **About 90 GBAS CAT-I installations in Russia (GPS+GLONASS)**
- **Planned GBAS CAT-I implementation in**
  - Melbourne, Brisbane, Oslo, Tokyo Haneda
- **Other envisaged locations but overall GBAS CAT-I deployment remains limited**

# GBAS CAT-I situation: A/C implementation

- **First-ever certified GPS Landing System receiver in 2006 (Rockwell Collins MMR GLU-925)**

- **GLS CAT-I function on Airbus A/C**
  - Certified on A380, A320, A330, A350
  - Certification on A320 NEO on-going
  - Remains an option on all A/C types
  - As of today, more than 400 aircraft have the GLS option selected

- **GLS CAT-I function on Boeing A/C**
  - Certified on B787, B737-800, B747-8
  - Certification planned on B777X in 2020, B777 retrofit later
  - GLS CAT-I is basic on B787, B747-8, option on B737NG/ B737MAX
  - As of today, more than 1500 aircraft have been delivered with the GLS option (47% with GLS function activated)

# GBAS CAT-II/III situation: SC-SF solution (1)

- **ICAO GBAS SARPs to support CAT-III operations nearly completion**
  - Solution based on Single-Constellation Single-Frequency technology (GPS L1 only)
  - Concept called GAST-D
  - Under validation since 2010 with strong involvement of US, EU (SESAR) and Japanese stakeholders
  - Should be approved by ICAO NSP at NSP3 meeting in December 2016
  - Publication in Annex 10 in 2018

- **GBAS FAST-D Ground Station development has already started**
  - System Design Approval (SDA) for Honeywell Ground Equipment is announced for 2019 by the FAA

- **EUROCAE ED-114B "MOPS for the GBAS ground subsystem to support precision approach and landing" in the context of GBAS CATI/II/III L1**
  - Planned for Q2 2018

# GBAS CAT-II/III situation: SC-SF solution (2)

- **GBAS GAST-D Avionics**
  - RTCA DO-253D GBAS airborne MOPS under finalization (FRAC should start in Spring 2017)
  - Should lead to new or amended GBAS airborne equipment TSO/ETSO

- **GLS CATII/III implementation by airframer will depend on market demand, maturity of standards/regulatory requirements, availability of infrastructure and other business factors**

# GBAS CAT-II/III situation: MC-MF solution

- **GBAS Multi-Constellation/Multi-Frequency ICAO SARPs development should start in 2017**
  - Solution called GAST-F
    - Should provide better robustness with respect to ionosphere anomalies and RFI thanks to the use of a second ARNS frequency
    - Overall availability performance expected to improve thanks to a better geometry (additional satellites)
  - Significant contribution should come from the work conducted in Europe (SESAR)
    - GAST-F based on GPS L1/L5+GALILEO E1/E5a
  - Inputs also expected from similar study in Japan

# *Overview of GBAS activities in France*

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# Overview of GBAS activities in France

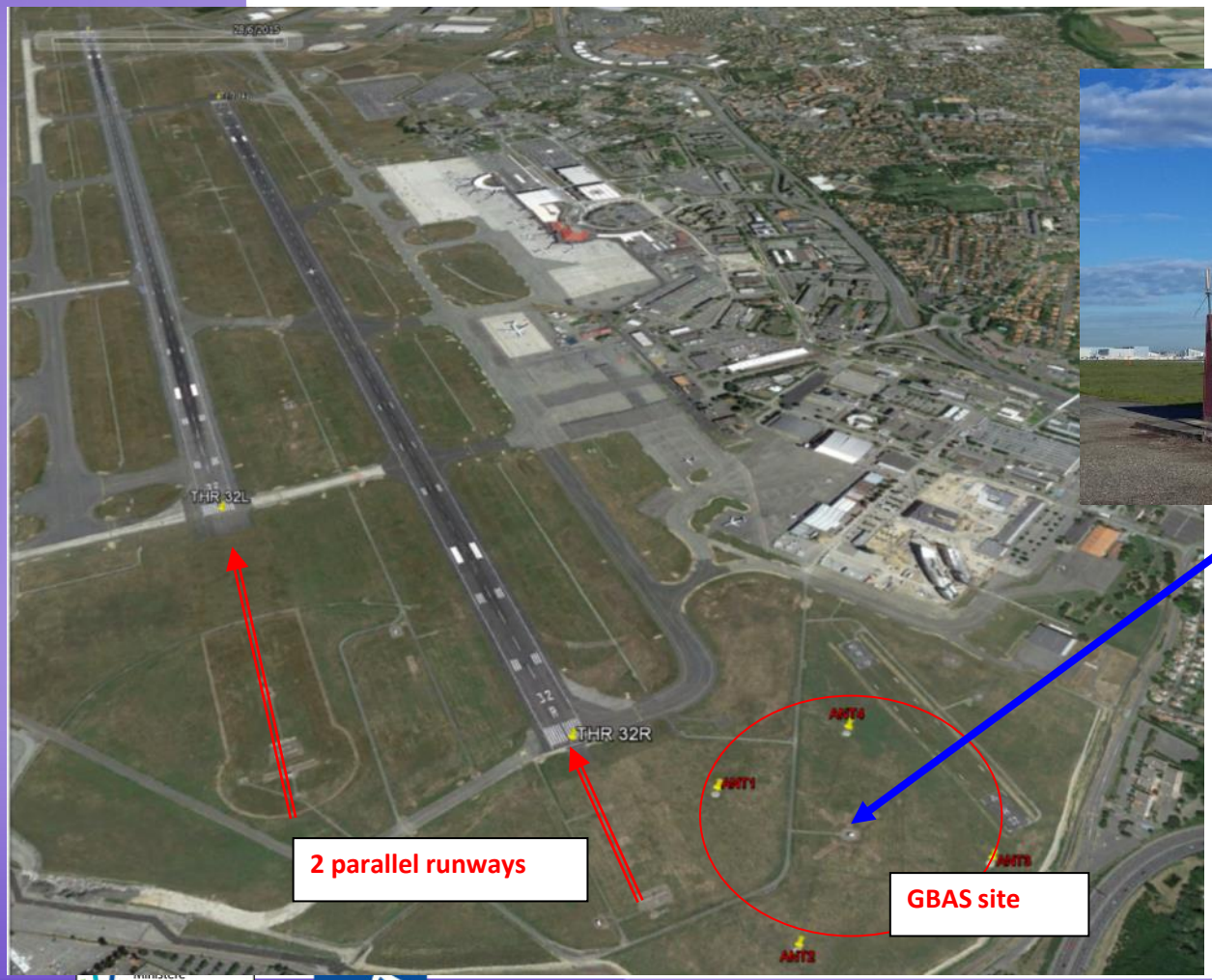
- **DSNA the French ANSP has been involved in GBAS standards and system development for more than 20 years**
  - First experience of a Local Area Differential GPS (LADGPS) experimental station at Toulouse airport in 1994
  - Key contribution to standardization activities related to GBAS CAT-I and CAT-III (ICAO, EUROCAE WG-28)
  - Strongly involved in the CAT-I technical and operational validation phase using a GBAS station operating at Toulouse Blagnac
  - Key partner in SESAR 15.3.6 and 15.3.7 projects related to GBAS CAT-III
- **GBAS CAT-I station only implemented at Toulouse Blagnac Airport**
  - No further CAT-I deployment in France is foreseen at the moment
  - GBAS use in Toulouse is in principle restricted to Airbus but possible for flight trials
- **GBAS CAT-III (GAST-D) prototype also installed**
- **On-going internal study to assess the operational benefits that a GBAS CAT-III system could bring to Paris CDG airport**

# *SESAR GBAS activities conducted by DSNA*

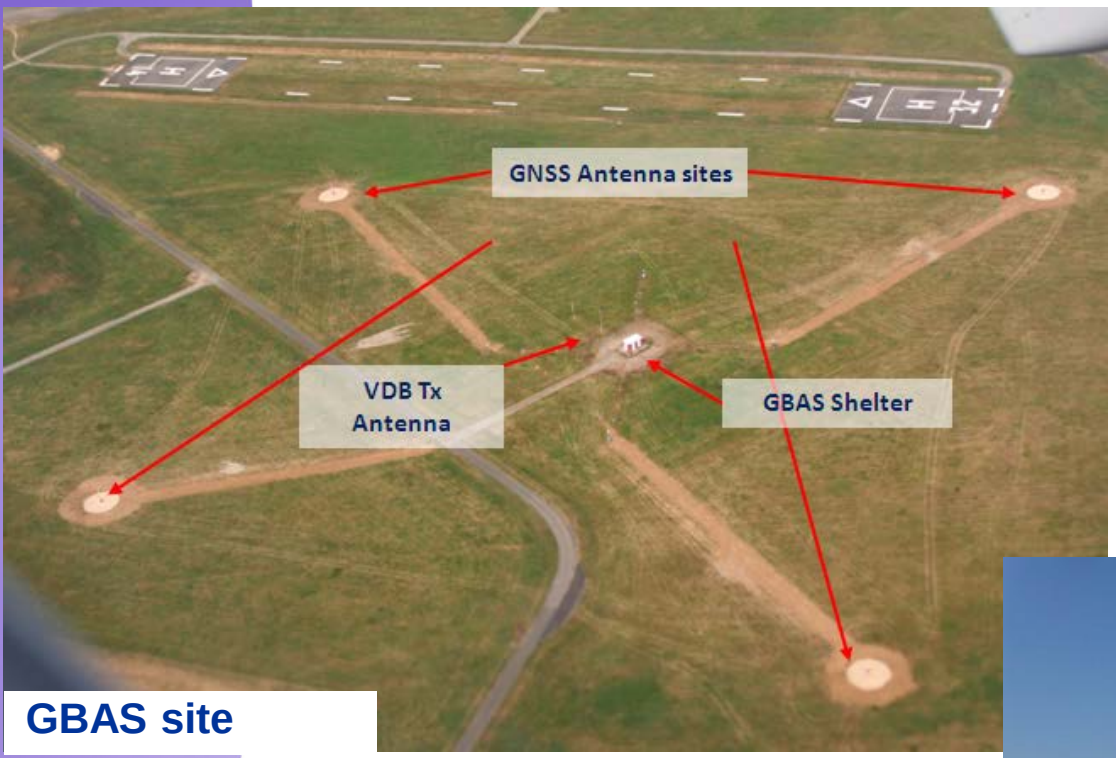
# SESAR 15.03.06

- **Validation of GBAS CAT-III solution based on GPS L1 only (GAST-D)**
- **DSNA contributions on operational and technical tasks:**
  - Strong participation to the GAST-D ConOps and Safety Assessment Report development
  - Participation to system architecture, requirements definition, system verification plan development,…
- **Implementation of a THALES GAST-D GS prototype at Toulouse airport:**
  - Verification activities to support GAST-D ICAO SARPs validation
  - Toulouse GAST-D platform used by Airbus and Honeywell to perform interoperability and performance validation flight trials
  - Prototype now running in Phase 3 (full GAST-D capability)
- **Project now under completion:**
  - Closure gate in November 2016

# GBAS site at Toulouse Blagnac




# GAST-D Prototype at Toulouse/Blagnac




**GBAS site**

**Reference Receivers antennas**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# SESAR 15.03.07

- **Definition and verification of GBAS CAT-III MC/MF concept (GAST-F)**
- **Main contributions on technical aspects:**
  - Leader through ENAC (French Civil Aviation school) of the preliminary research studies
  - Participation to system architecture and definition, system verification plan development,…
- **Implementation of a GBAS MC/MF GS mock-up at Toulouse airport:**
  - Real-time broadcast of GPS L1/L5 and GALILEO E1/E5a differential corrections
  - Used in May 2016 to perform GBAS MC/MF interoperability flight trials with Honeywell Airborne mock-up installed on Falcon F900EX A/C
- **Project now under completion:**
  - Closure gate in November 2016
- **Work on GBAS MC/MF to be continued in SESAR 2020**
  - Should start end of 2016

# DSNA views with respect to GBAS CATII/III technical aspects

# DSNA views on GBAS CATII/III

- **GBAS CAT-III solution based on GPS L1 only (GAST-D)**
  - Concerns about robustness against ionosphere events , RFI and siting constraints
    - Degraded availability performance in areas where strong ionosphere activities occur (low-latitude and high-latitude regions)
    - L1 frequency jamming (PPDs, Repeaters) may cause interruption of GBAS CAT-III service
    - Ground Ionosphere Gradient Monitor may impose siting restrictions
  - Seen as a short-term, mid-term solution that could work during an ILS/GBAS transition phase (ILS remain as back-up)

- **GBAS CAT-III MC/MF solution (GAST-F)**
  - Built on the use of the GALILEO constellation
  - Should constitute a more robust solution and improve siting flexibility
  - Availability performance improved and expected to be suitable to start ILS decommissioning
  - Seen as a mid, long-term solution

# GBAS internal study for Paris CDG

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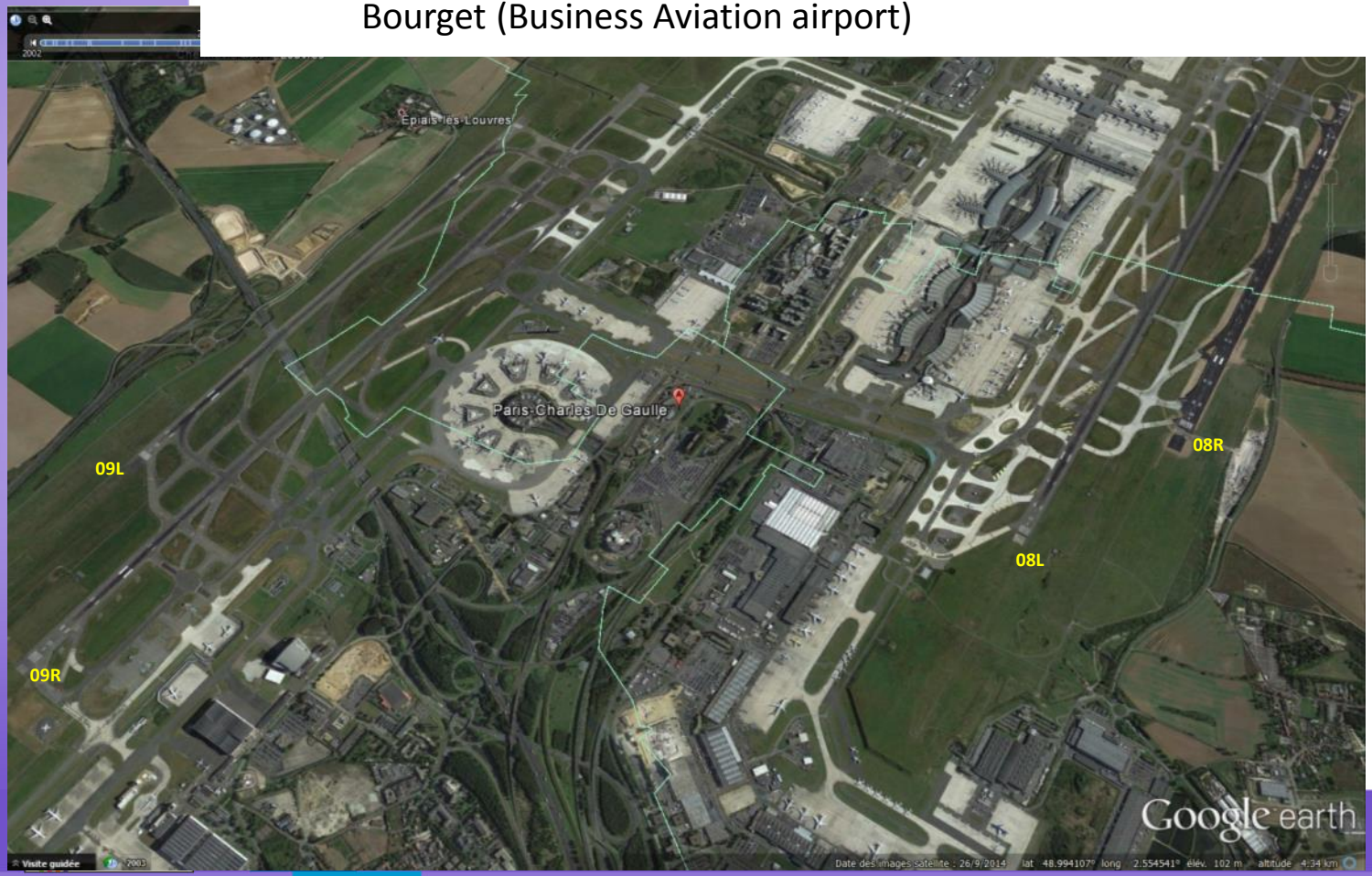
# GBAS study for Paris CDG (1)

- **Very good candidate airport for GBAS operations**
  - 4 parallel runways
  - 8 CAT-III ILS !
  - GBAS ground station at CDG may also support GBAS operations at Paris Le Bourget (Business Aviation airport)

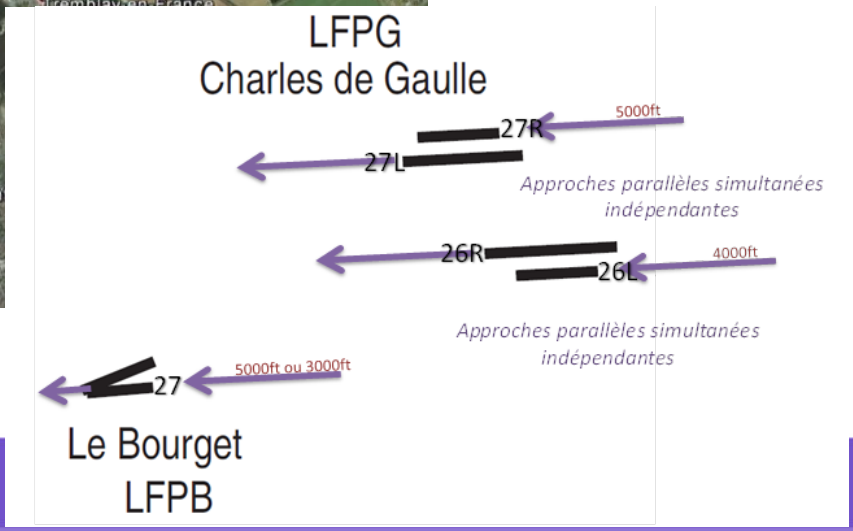


# GBAS study for Paris CDG (2)

- **Work made to assess the operational benefits that a GBAS CAT-III system could bring to Paris CDG airport**
  - Study built on the GBAS SESAR operational and technical work
  - Analysis of necessary operational changes to allow GBAS operations under LVP conditions
  - Evaluation of the applicability of the “Optimized Operations in LVP conditions” concept to this airport and estimation of the potential gain in terms of runway throughput
  - Assessment of the capability of GBAS to support simultaneous triple parallel approach operations (Paris CDG RWYs 27R, 26L with Paris Le Bourget RWY 27)
  - Also assessment of the possibility of a GBAS station installed at CDG to support offset approach (with vertical guidance) at Le Bourget RWY 25

# GBAS study for Paris CDG (3)

- **Simultaneous triple parallel approach operations (Paris CDG RWYs 27R, 26L and Paris Le Bourget RWY 27)**

# GBAS study for Paris CDG (4)

- **Preliminary outcomes**
  - Dedicated GBAS runway to concentrate GBAS equipped A/C not possible
    - Crossing traffic flows coming from North and from South not permitted
  - "Optimized Operations in LVP" concept not applicable with the existing ATC tools
    - GBAS capability not visible in French Flight plan system at the moment
    - Managing a different spacing for GBAS-ILS and GBAS-GBAS arrivals considered as too complex by ATCOs without the provision of adequate tools
    - Concept can only be envisaged if ATC radar display indicates the GBAS CAT-III A/C capability and provides a spacing management tool
  - On-going installation of wide-aperture ILS localizers reducing the size of the critical/sensitive areas should allow to increase the runway throughput under LVP without the need to necessarily implement a new technology like GBAS
  - However, it could be worth to implement a GBAS CAT-I station to gain operational experience and pave the way for potential future CAT-III operations

# *Next steps*

# Next steps

- GBAS Toulouse CAT-I signal to sustain for Airbus needs
- GBAS CAT-III Paris CDG study finalization and decision making
- SESAR 15.03.06 and 15.03.07 work completion (Autumn 2016)
- GBAS CAT-III work will continue in SESAR 2020 (fall 2016)

# *Summary*

# Summary

- **GBAS CAT-I station only implemented at Toulouse Blagnac Airport**
- **GBAS CAT-III activities on-going**
  - SESAR 1 work under completion: GAST-D and GAST-F solutions
  - Paris CDG internal study under finalization
- **GBAS CAT-III work to be continued in SESAR 2020**

# Thanks for your attention !