# Research activities of advanced operations utilizing GBAS in Japan

Presented by Japan

# R&D programs related to GNSS based Navigation

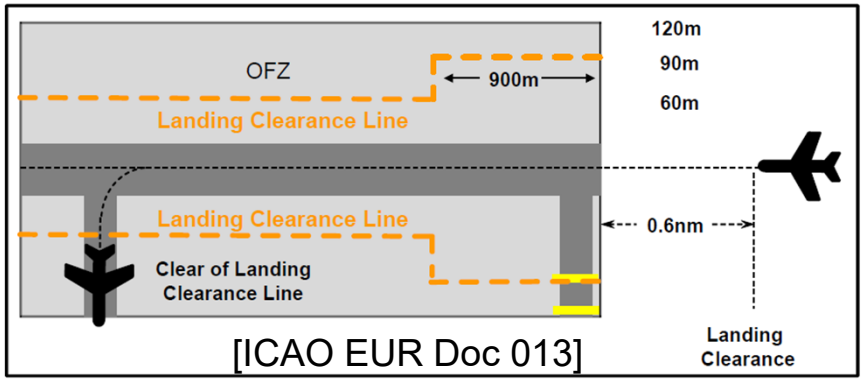
- Two aspects are considered at the Electronic Navigation Research Institute (ENRI), the National Institute of Maritime, Port and Aviation Technology (MPAT), Japan
  - System side: Developing system design, functions, and performances
  - Operational side: Identifying and solving operational needs
  - ENRI conducts R&D programs from the both perspectives
- The program for operational topics
  - The current program is conducted with a time frame of 5 years from April 2022 to March 2027
  - Purpose is development of new operational procedures to enhance operational benefits beyond ILS utilizing GBAS

# Researches on advanced operations utilizing GBAS

- Airport operations under the low visibility condition utilizing GAST-D
  - Improvement of runway capacity in comparison with the ILS operations
- Multiple approach paths
  - Increased glide slope (IGS): Noise reduction, avoidance of obstacles
  - Secondary runway aiming point (SRAP): + Wake turbulence avoidance
- Technical development to support advanced operations
  - Pilot supporting tools for runway exit and taxing guidance
  - Development of collision risk model (CRM) reflecting recent flight performances to improve Obstacle Assessment Surface (OAS)

# Airport operations under the low visibility condition
## Improvement of runway capacity with GLS

- Improvement of runway capacity under the low visibility condition
  - GAST-D operation (GLS) without the ILS equivalent Critical Sensitive Area (CSA)
  - Reduced separations of GLS arrivals in cases that the preceding aircraft are:
    - Departure: No need to wait for passing over the LOC
    - Arrival: Hold positions of taxiways can be closer to runway
- ICAO EUR Doc13 (European Guidance Material on All Weather operations at Aerodromes)
  - Concept of Landing Clearance Line (LCL) with Advanced Surface Movement Guidance and Control System (A-SMGCS)
- Previous researches
  - Charles de Gaulle international airport
    - P. Ladoux, IGWG/18, April 27, 2017.
  - Frankfurt international airport
    - O. Weber, IGWG/21, Brussels, September 2022
    - O. Weber, IGWG/22, San Francisco, June 2023



# Airport operation under low visibility condition
# A case study for RJAA (Narita international airport)

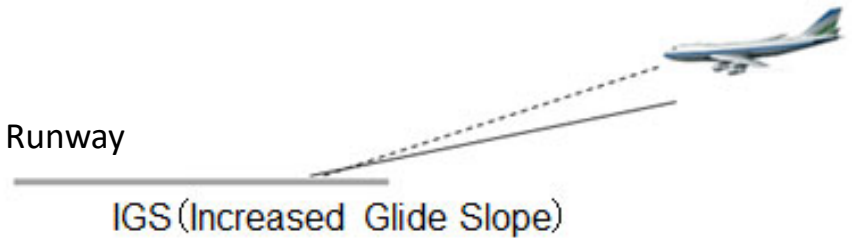
- Under the Category–III conditions
  - Mixed operation of departure and arrival aircraft using only runway A (RWY16R)
  - Taxiways are also limited to those with lighting systems, including exit taxiways
- Two patterns with reduced aircraft separations

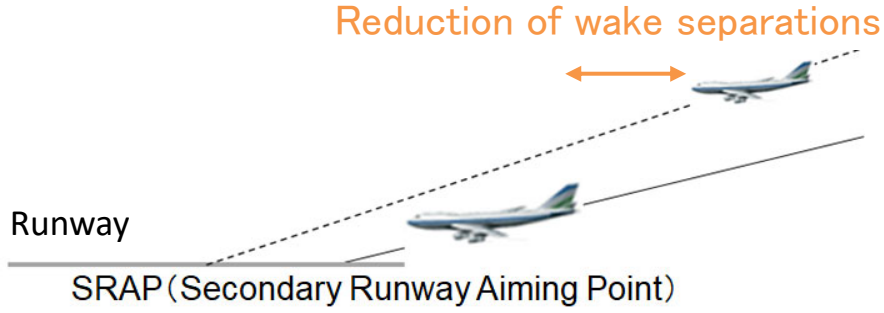

- A case study of the low visibility condition during 10:20UT and 13:02UT on January 8, 2020
  - During the period, there were 27 arrival and 36 departure aircraft based on actual radar track data
  - Assuming all arrival aircraft are equipped with GLS and considering the wake turbulence separations, Pattern A and B were counted 20 and 7 times, respectively

  –> Total reduced time simply added them is calculated as 323 seconds (13*20 + 9*7 = 323)
- Ongoing fast time simulation
  - A reduced separation of one aircraft contributes to the subsequent aircraft of arrival and departure
  - The ongoing analysis considers accumulation of the reductions based on the actual surface traffic

# Multiple approach paths with IGS and SRAP
## Potential benefits

- The concepts are proposed by SESAR 2020 project PJ.02
  - Reduction of environmental load and improvement of runway throughputs
- Our purposes
  - Development of operational concepts considering operational needs in Japan
- IGS (Increased glide slope)
  - Noise reduction
  - Avoidance of obstacles to precision approaches
- SRAP (Secondary runway aiming point)
  - Noise reduction
  - Avoidance of obstacles to precision approaches
  - Reduction of taxiing time (distance) on the airport surface
  - Reduction of wake turbulence separations



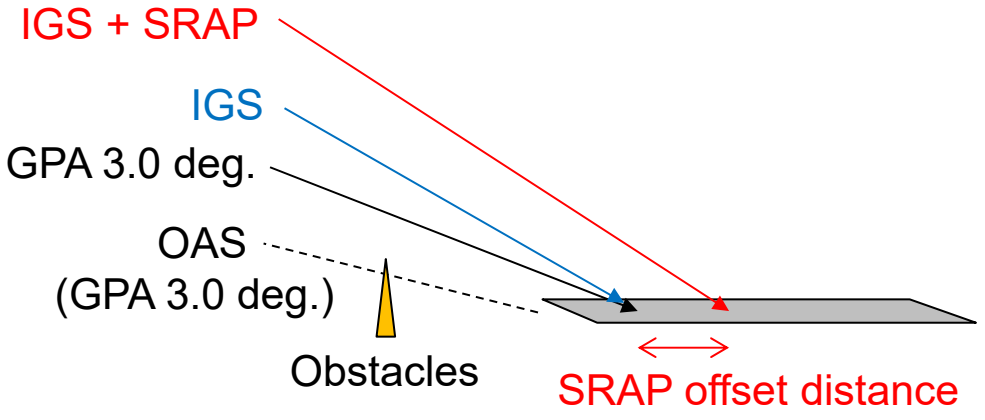



# Multiple approach paths with IGS
# Noise reduction

- Evaluation using full flight simulator (FFS) of the net noise reduction
  - FFS: B787-9 with GLS capability (ANA)
  - Steeper approaches with glide path angles of 3.2, 3.45, and 3.5 degrees
  - Feasibility study from both viewpoints of pilot operation and air traffic management
- J-FRAIN (Japan-FRamework for AIrcraft Noise simulation)
  - Sound source models based on measurements using microphone arrays under approach path on the ground [T. Takaishi, 2023, and T. Kobayashi, 2023]
- Prediction of noise levels at ground points under the flight path using J-FRAIN
  - In collaboration research with Kobayasi Institute of Physical Research
  - Input parameters: aircraft type, engine type, flight path, engine rate, true airspeed, flap angle, landing gear down
- The current status
  - Confirmed noise reduction tendency with steeper approaches and recognized importance to avoid increasing aircraft speed for preventing noise increase from typical scenarios
  - Investigating approach procedures that could achieve noise reductions, considering aircraft speed profile and pilot operations of gears, flaps, etc. through experiments with the FFS

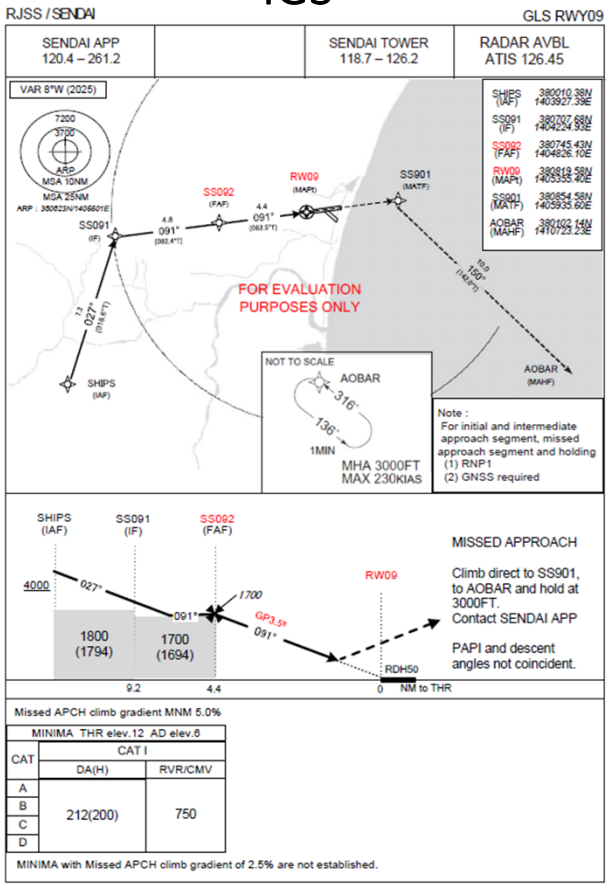
# Multiple approach paths with IGS and SRAP
# Avoidance of obstacles (1)

- Runways where precision approach cannot be set due to obstacles penetrating the OAS
- IGS: Effective for obstacles far from the runway approach end with an increased glide path angle
- SRAP: Effective for obstacles near the runway approach end with an offset distance of aiming point
- Combination of IGS and SRAP: Optimization by adjusting approach angle and the offset distance

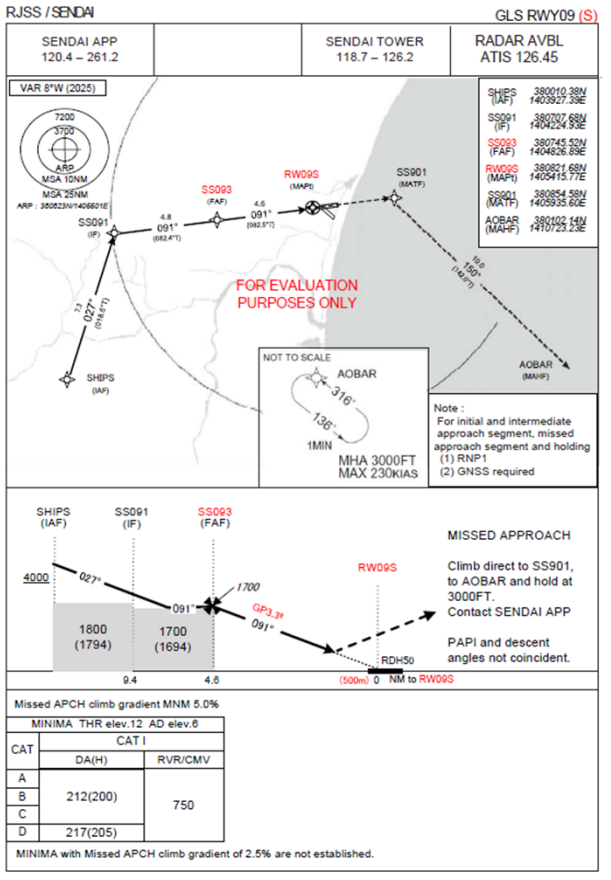



RWY09 approaches at Sendai airport to avoid obstacles over the mountainous area

IGS




IGS+SRAP



# Multiple approach paths with IGS and SRAP
# Avoidance of obstacles (2)

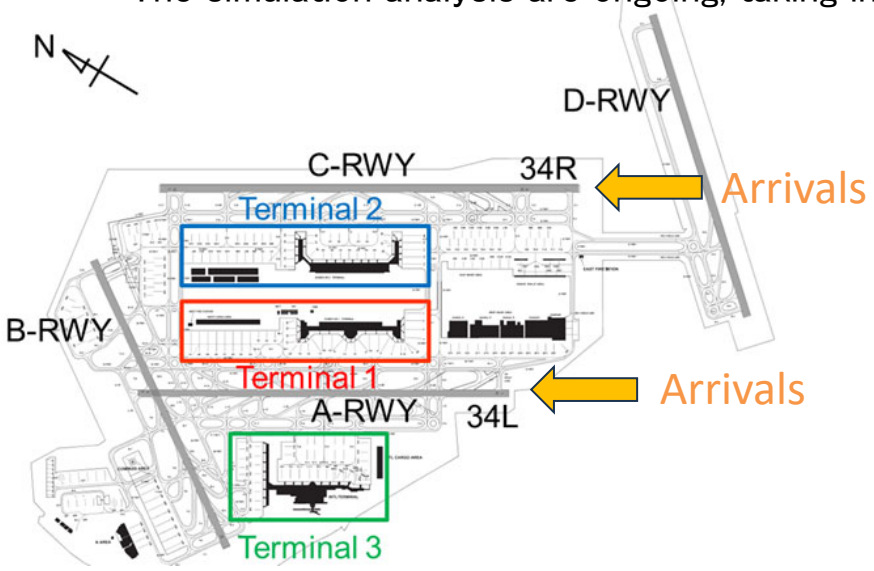
- Flight experiments at Sendai airport
  - ENEI's experimental GBAS ground facilities on the ground including VHF data broadcast (VDB)
  - ENRI's experimental aircraft of King Air B300 with experimental GBAS receivers including the VDB
  - Conducted on August 20–21, 2025 and November 26–27, 2025
- The current status
  - Identifying and extracting issues with perspectives of visual, usability, and workload from pilot interviews
  - Additional experiments are planned to demonstrate benefits of the obstacle avoidances at Hakodate and Kagoshima airports using ENRI's experimental portable GBAS ground facilities in summer 2026

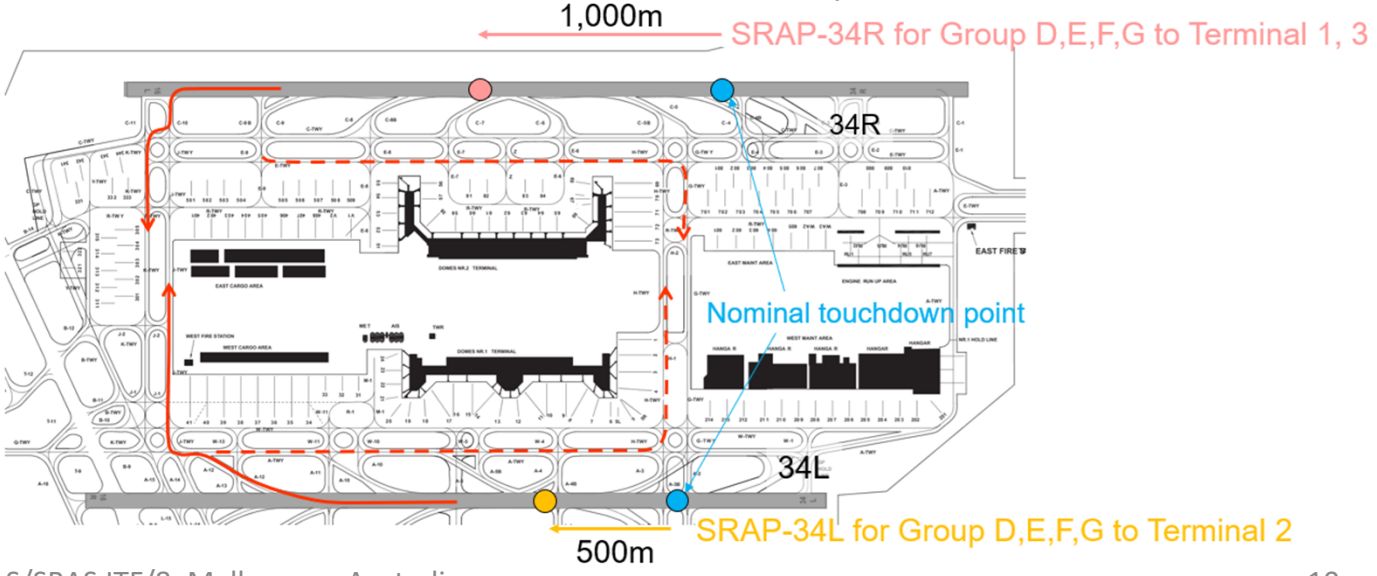
# Multiple approach paths with SRAP

## Study on future advanced operations at Tokyo international airport

- Potential advantages of the SRAP
  - Improvement of runway occupancy time and reduction of taxiing time (distance) by assigning each aiming point considering final spot of each aircraft
- Terminal-1 and -2 are both located slightly North of the center of A- and C-runways
  - Arrivals at RWY-34R and going to Terminals 1 or 3 have to detour around Terminal 2 area
  - Arrivals at RWY-34L and going to Terminal 2 have to detour around Terminal 1 area

  -> The SRAP operations for lighter aircraft could potentially reduce runway occupancy time and taxing distance
- A fast time simulation using scenarios based on the actual traffic flow
  - The current, it is identified that there are additional benefits such as simplification of aircraft routes on the airport surface
  - The simulation analysis are ongoing, taking into account the reduction in the wake turbulence separations



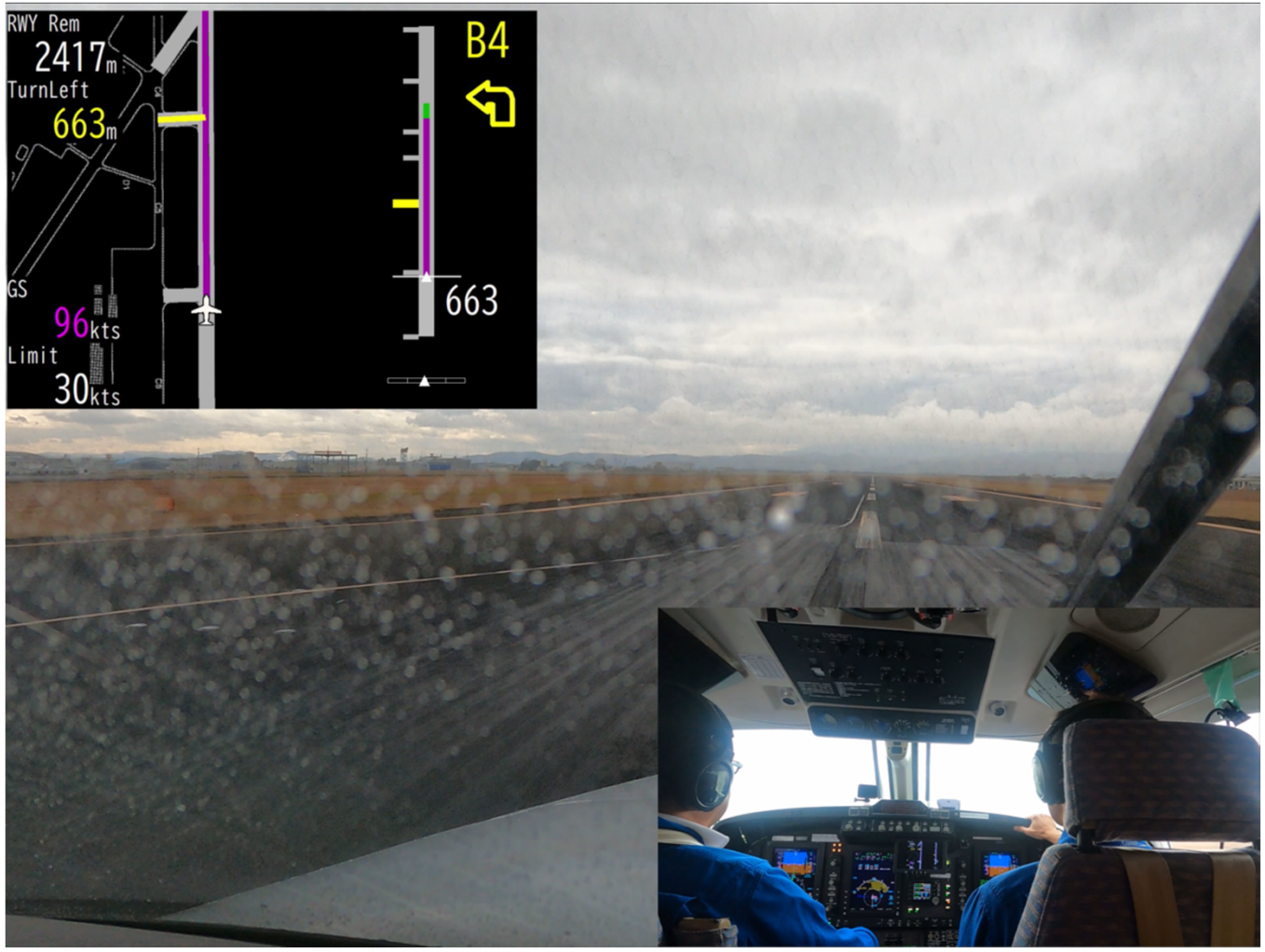
# Pilot supporting tools

## Runway exit and taxing guidance using GBAS functions (1)

- Concept of this tools
  - Reduction of pilot loads and enhance safety in a viewpoint of human factors
  - Usage under the normal weather conditions and the low visibility condition in near and long terms, respectively
- Development of testbed equipment
  - To verify and demonstrate its feasibility thorough experiments
  - To extract requirements for DFMC GBAS standards and information sharing with the ATC
- Experiments with the ENRI's experimental aircraft
  - The cockpit has a research-purpose display that shows reference information from the developed testbed equipment for supporting runway exit
  - Conducted on August 20-21, 2025 and November 26-27, 2025 at Sendai airport in simultaneous with the experiments for IGS and SRAP approaches
  - The supporting tools have been modified based on the pilot interviews
- Current status
  - Evaluating its functionality and usefulness and extracting further key challenges from pilot interviews
  - Additional experiments are planned at Hakodate and Kagoshima airports in summer 2026

# Pilot supporting tools

## Runway exit and taxing guidance using GBAS functions (2)



# CRM development

- Purposes
  - Development of CRM reflecting recent flight performance improvements and evaluation of operational performance using the GNSS navigation system
  - Improvement of the OAS for GBAS with a long term aspect
- ADS-B data of position, speed and rate of climb
  - Used for development of CRM by accumulating a large amount of data
  - Deviations from approach path obtained from the ADS-B data at Tokyo International Airport (RJTT), by using Kalman smoother
- Current status
  - In addition to the existing ADS-B data, we are going to start to collect ADS-B data at the other airports

# Summary

- The research program for operational topics
  - A time flame of 5 years from April 2022 to March 2027
- Subjects and progress
  - Improvement of airport operations in the low visibility condition
    - A case study at RJAA is being conducted for evaluation of GAST-D benefits to be finalized
  - Multiple approach paths with IGS and SRAP
    - Experiments for evaluations of noise reduction with FFS
    - Listed up runways with potential benefits to avoid obstacles, and conducting flight experiments
    - Study on SRAP for future advanced operations at Tokyo international airport
  - Pilot supporting tools for runway exit and taxing guidance
    - Testbed equipment have been developed
    - Flight experiments with the ENRI's aircraft have conducted at Sendai airport, and additional experiments are planned at Hakodate and Kagoshima airports in 2026
  - GBAS CRM development and improved OAS for GBAS
    - ADS-B data are going to accumulated including the new sites

# References


- Airport operation under low visibility condition
  - ICAO EUR Doc 013: European guidance material on all weather operations at aerodromes
  - P. Ladoux, “GBAS@Paris CDG study,” 18th International GBAS Working Group (IGWG/18), April 27, 2017.
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  - O. Weber, The Way to GLS CAT II at Frankfurt Airport from ANSP perspective, IGWG/22, San Francisco, June 2023.

- Multiple approach paths with IGS and SRAP
  - F. Rooseleer, “SESAR Enhanced Approach Procedures (EAP)” 20th International GBAS Working Group (IGWG/20), June 19, 2019.
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  - T. Takaishi et al., “Component-wise regression sound source models for the aircraft noise prediction framework J-FRAIN, ” Congress Proc. of Inter-noise 2023, No.457, Chiba, Japan, August 2023.
  - T. Kobayashi, “Verification and application of the aircraft noise simulation framework J-FRAIN, ” Congress Proc. of Inter-noise 2023, No.458, Chiba, Japan, August 2023.