GBAS CAT III- Optimized low visibility operations

Validation of the use of GBAS precision approaches for improved runway throughput in poor weather conditions

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OUTLINE

1. Problem statement – Todays operation
2. Solution– Operational concept
3. Validation– Objectives
4. Validation– Approach and Method
5. Validation– Results & Conclusions

1 Problem statement – Todays operation 1/3

CAT II / III

*A category II approach is a precision instrument approach and landing with decision height lower than **60m** (200ft) but not less than **30m** (100ft), and a runway visual range not less than **350m** (1200ft) (ICAO)*

A category III approach is a precision instrument approach and landing with no decision height or a decision height lower than 30m (100ft) and a runway visual range not less than 200m (700ft) . (ICAO/FAA)

1 Problem statement – todays operation 2/3

Drawbacks of Instrument Landing System (ILS) in CAT III

- Restrictions on building development and aircraft movements
- ILS is installed in the runway area (multi path effect)

- Large ILS protection areas in CAT III
- CAT III holding points
- Longer Runway Occupancy Time

Reduced Capacity

1 Problem statement – todays operation 3/3

Reduced capacity because the controller shall:

- Use CAT II/III holding points
- Protect the ILS sensitive area
- Increase separation between landing and departing traffic
- No longer give conditional clearances
- Give taxi clearances with precaution and monitor his ground radar

2 Solution– Operational concept 1/2

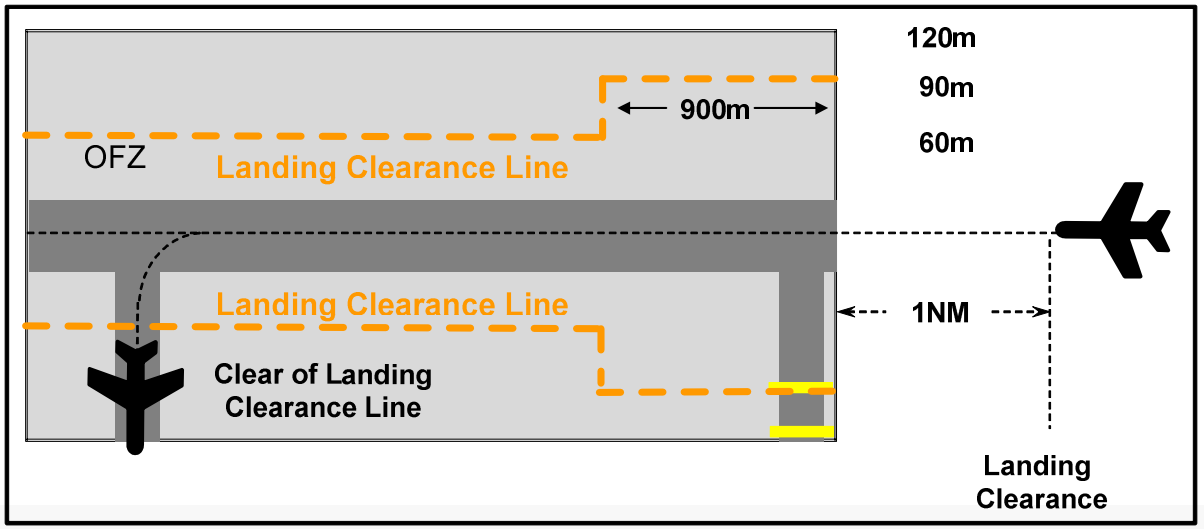
Concept developed within the Framework of SESAR (GBAS operational implementation)

- One GBAS station for all runway ends
- Less prone to interference than ILS as station is located outside aircraft movement area
- No false capture
- GBAS HMI on board is ILS look alike
- Reduced flight inspection costs

2 Solution– Operational concept 2/2

GBAS in CAT III to improve runway throughput

- Landing clearance line (closer than CAT III holding points)
- Later landing clearance (1NM)
- Reduce final approach spacing



3 Validation– Objective 1/2

Validate the increased runway capacity in poor weather conditions brought about by the use of GBAS CAT II/III for precision approaches.

- To assess the increase of runway throughput in LVP
- To evaluate the suitability of runway safety nets and assess the safety of optimised LVP operations based on GBAS
- To evaluate the ATC workload and the new ATC procedures for final approach spacing
- To validate that provision of late landing clearance by ATC does not impair the pilot capability to prepare the landing

3 Validation– Objective (2/2)

Main Key Performance /Transversal Areas

- Capacity
  - Runway throughput
- Safety
  - Separation infringements
  - Runway incursions
  - Go-arounds etc.
- Human Performance
  - Workload
  - Situational Awareness
  - HMI usability
  - Acceptability of Procedures

4 Validation– Approach and Method 1/9

- Stakeholder workshop
- Safety & Human Performance Assessment
- Real-Time Simulation

*E-OCVM

3 Validation– Approach and Method 2/9

Stakeholder workshop

- Pilots
- Air traffic controllers
- Concept developers
- Engineers
- Human Performance & Safety experts

Decision on procedures for RTS

- Landing clearance line
- Landing clearance

3 Validation– Approach and Method 3/9

Safety (Safety Reference Material)

- Success & failure approach
- Concept can perform safely under normal, abnormal &degraded modes
- Safety requirements are realistic and achievable

Level of safety are at least as good if not better than in current CATII/III operations

3 Validation– Approach and Method 4/9

Human Performance Assessment (HP Reference Material)

- Proposed human roles are consistent with human capabilities
- Contribution of the human supports expected system performance and behaviour

Informs concept design & development

3 Validation– Approach and Method 5/9

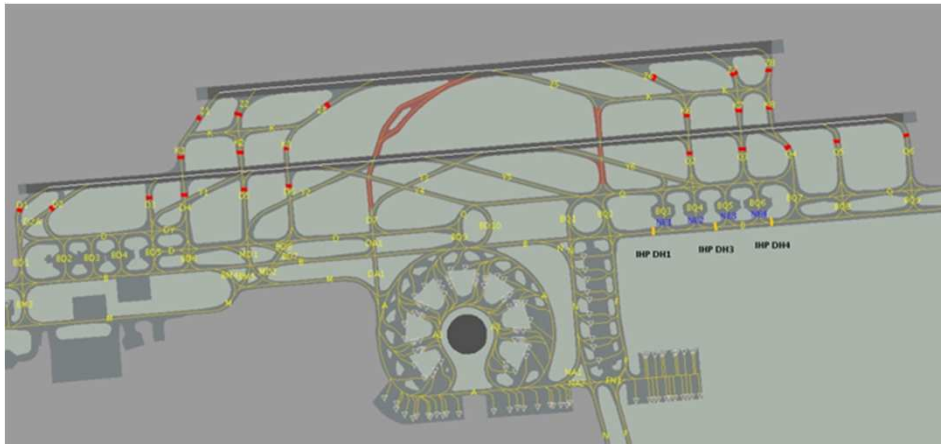
Real-time simulation

- EUROCONTROL eDEP/ITWP - Early Demonstration and Evaluation Platform / Integrated Tower working position
- EUROCONTROL ESCAPE – A real-time air traffic control simulator for en-route, TMA and approach
- EUROCONTROL MCS - Multi Cockpit simulator

3 Validation– Approach and Method 6/9

Real-time simulation –simulated environment

- The simulated Airport was Paris CDG
- Only one runway to the north RWY 27L
- RWY 27L was used for arrivals only and in mixed mode arrivals/departures



3 Validation– Approach and Method 7/9

Real-time simulation

- Simulation set up
  - 3 days of training
  - 12 runs (1 hour) in one week of simulation
  - 3 runs with safety scripts
- Participants
  - Three ATCO from ENAV licensed in Approach and Tower
  - Three pilots from Airspace User community
- Positions
  - Final approach position
  - Tower runway position
  - Pilot Cockpit
  - Pseudo pilots

3 Validation– Approach and Method 8/9

Safety scenarios- Pseudo Pilots were instructed

- Wrong read back (ILS instead of GBAS/GLS)
- On ground equipment failure
- On-board equipment failure (Failure within 10nm & outside 10nm)

3 Validation– Approach and Method 9/9

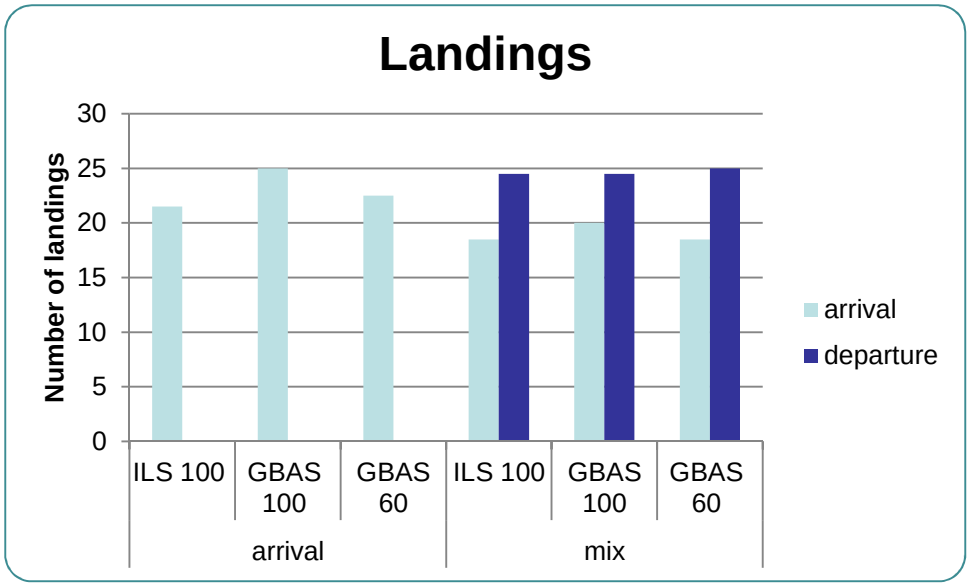
Real-time simulation – simulated scenarios

- ILS arrivals only (reference scenario)
- ILS arrival/departures (reference scenario)
- GBAS arrivals only
- GBAS arrival/departures
- GBAS/ILS arrival only (60% GBAS)
- GBAS/ILS arrivals/departures (60% GBAS)

5 Validation– Results 1/8

Capacity

Expectation: More or the same number of landings take place in the solution scenarios compared to the reference scenarios

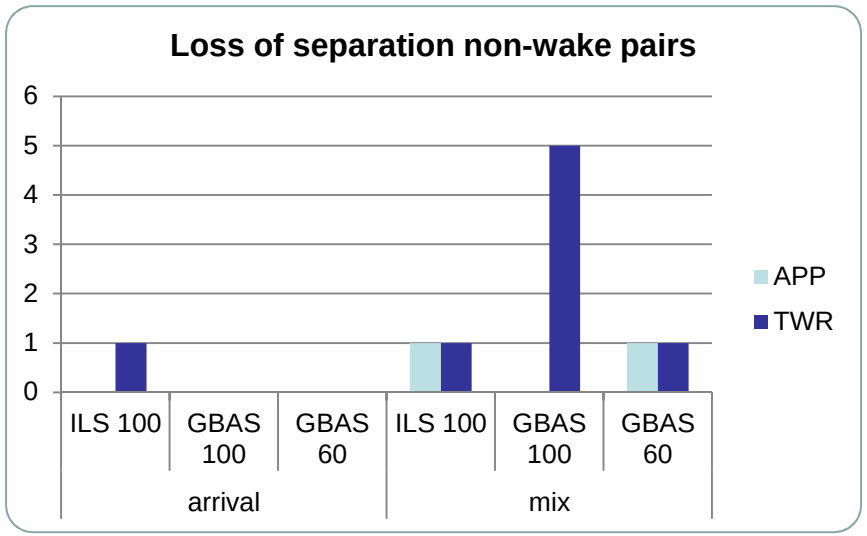


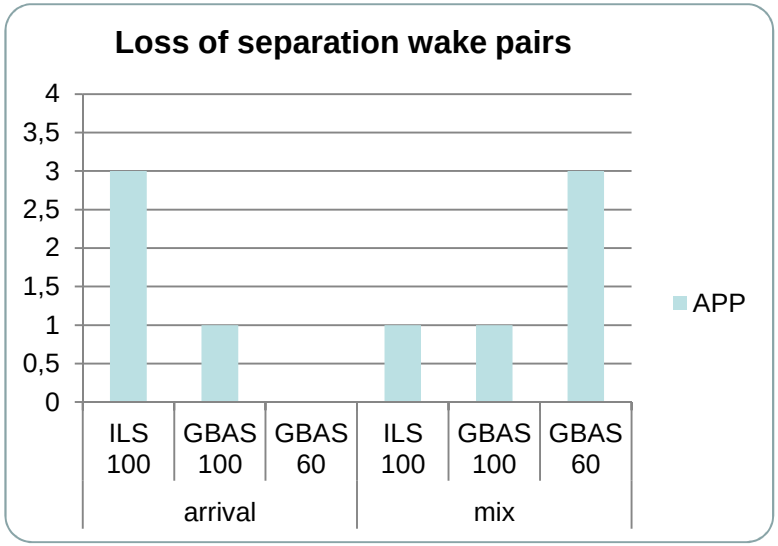
The expected benefit was observed in the segregated runway scenario where more landings took place in the GBAS scenario.

5 Validation– Results 2/8

Safety

Expectation: No increase in separation minima infringements for non-wake aircraft pairs and for wake aircraft pairs in the solution scenarios compared to the reference scenarios





Segregated runway: more separation infringements with ILS than with GBAS

5 Validation– Results 3/8

Safety

Go-arounds – Expectation: The number of go-arounds is not greater in the solution scenario than in the reference scenario

Segregated runway: no go-arounds were recorded in GBAS scenarios (1 in ILS scenarios)
Mixed mode runway: no go-arounds in 60% GBAS, two go-arounds in GBAS 100% and two go-arounds in ILS 100%

Runway incursion – Expectation: Number of runway incursions shall not be greater in the solution scenarios compared to the reference scenarios

Only one runway incursion recorded (GBAS 100%)→ No conclusion

5 Validation– Results 4/8

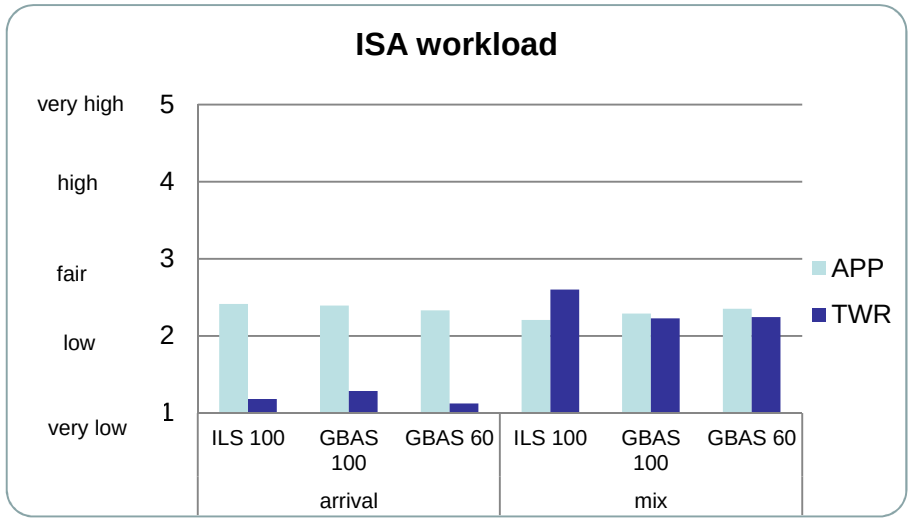
Safety Scenarios

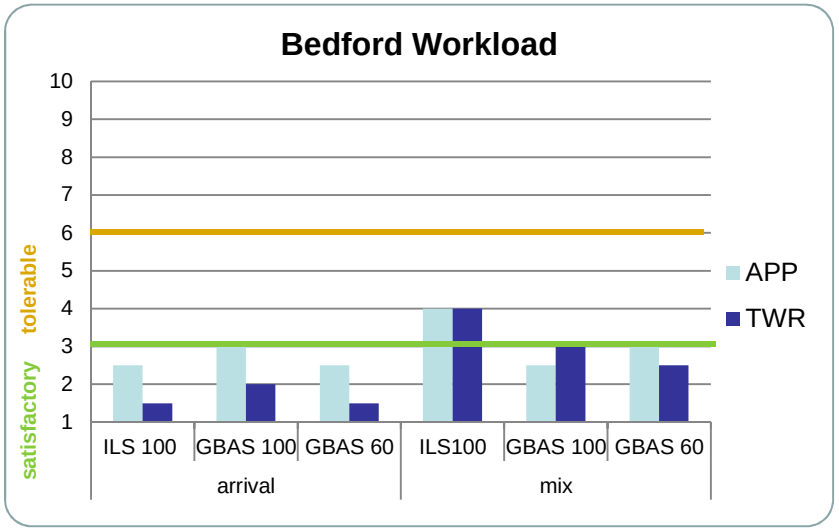
- Wrong read-back not always picked up (for both GLS & GBAS)
- Procedures for ATCOs acceptable
- Pilots did not agree with the criteria for go-around (10nm)

5 Validation– Results 5/8

Human Performance

Workload –Expectation: Workload will be not “significantly” higher in the solution scenario than in the reference scenario/ the level of workload is within acceptable limits



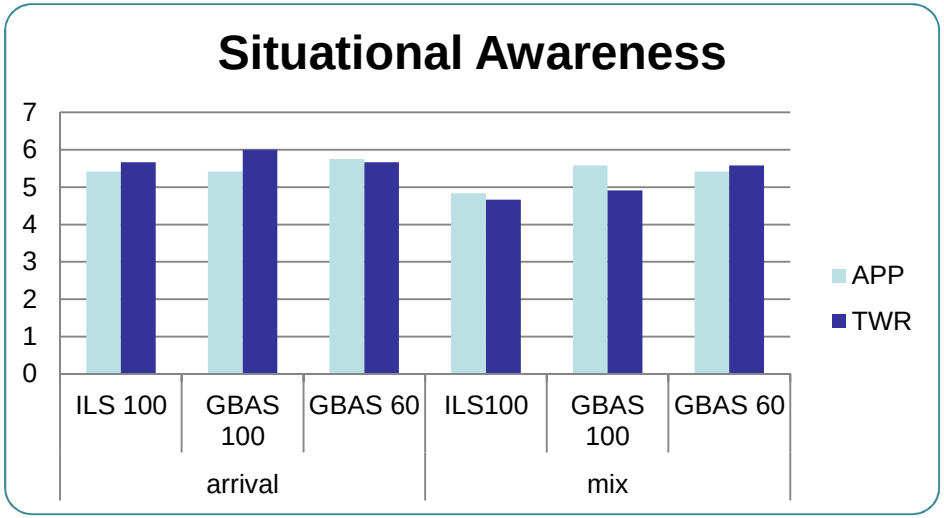


Mixed mode runway: Highest workload in ILS 100%
Segregated runway: workload satisfactory. No high workload recorded

5 Validation– Results 6/8

Human Performance

Situational Awareness–Expectation: Situational awareness will be not lower in the solution scenario than in the reference scenario / SA is within acceptable limits



Higher or the same level of situational awareness was recorded in the solution scenarios compared to the reference scenarios. The lowest situational awareness was recorded in the ILS 100% mix

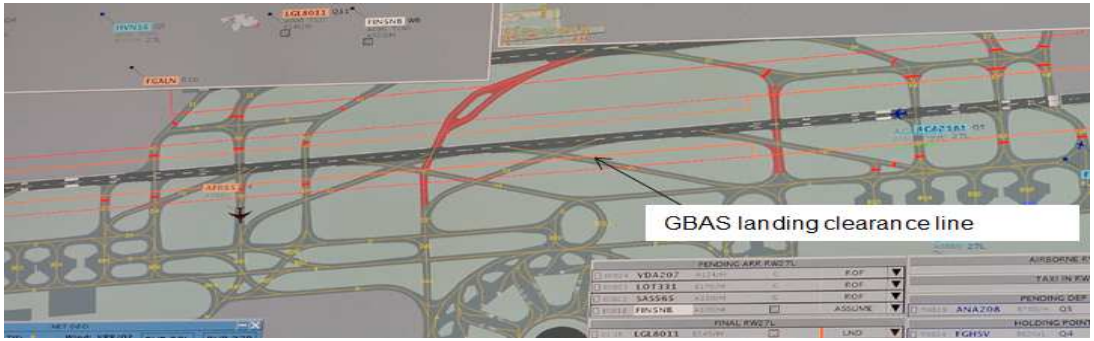
5 Validation– Results 7/8

Human Performance

HMI usability - Expectation: The controllers score the ATC HMI as being usable/acceptable

Questionnaire:

- Label (G/I) and interaction
- Landing clearance limit
- GBAS landing clearance line



The HMI was very well received and accepted

5 Validation– Results 9/8

Human Performance

Acceptability of procedures - Expectation: The controllers score the procedures being usable/acceptable

Questionnaire:

- Late landing clearance
- When to “frame” a G/I
- Phraseology

Segregated runway: The procedures were acceptable (pilots & controllers)
Mixed mode runway: The late landing clearance & reduced spacing raised concerns.
Phraseology: the proposed “GLS” was not unanimously accepted

5 Validation– Conclusions 1/4

Capacity

No negative impact on capacity

Increased throughput can be reached

5 Validation– Conclusions 2/4

Safety

Segregated runway environment

The final approach spacing for arrival only runway configuration was considered appropriate

Level of Safety can be maintained

Mixed mode runway

The final approach spacing for mixed mode runway need to be fine tuned according to airport local constraints

Level of Safety was decreased

5 Validation– Conclusions 3/4

Human Performance

- Workload and Situational awareness acceptable
- Positive feedback on HMI elements
- Positive feedback on procedures

5 Validation– Conclusions 4/4

The GBAS in LVP operations for segregated runways can bring the expected runway throughput benefits without negatively impacting safety and human performance

The mixed mode runway environment needs further assessment taking into account local airport characteristics

THANK YOU!

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