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Considerations for future GBAS evolutions

From the STANDARDS project to NSP WG4 WP35

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GBAS and Approach Operations
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FOUNDING MEMBER SESAR JOINT UNDERTAKING

NETWORK MANAGER

Recall of GBAS services definition (initially 2010, with evolution)

- Positioning service
  - “Old style” positioning service
  - “Future” positioning service
- Regional service
  - GRAS as defined for Australia
  - Regional services by overlapping positioning service areas
- Approach service (8 max.)
  - GAST A and B – equivalence to APV
  - GAST C, D, E and F – precision approach services, allowing downgrades (selected/active service)
  - Future, separate service types “G” and “I”

Recall of GBAS services definition as agreed around 2010

- Positioning service
  - “Old style” positioning service
  - “Future” positioning service

Current Situation

- Regional service
  - GRAS as defined for Australia
  - Regional services by overlapping positioning service areas

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  - GAST A and B – equivalence to APV
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  - Future, separate service types “G” and “I”

NSP JWG4 WP35 proposals (2019)

- VHF data Broadcast Physical Layer
  - Capacity increase
  - Coverage increase
  - New applications
- Support for Surface operations (high multipath environment)
  - Autotaxi
  - Drones/new entrants
- Accomodation for P_{sat} and P_{const} – mitigation of constellation degradation
- GBAS positioning service
  - Geometric vertical navigation
  - Removal of constraint limiting performance with distance from station
- Carrier phase positioning
  - Higher accuracy (drones)
  - Lower multipath sensitivity (surface ops)
- Cyber security
- Robustness (RFI, constellation loss, scintillation)

VHF

Surface

Pxx

POS

CF-P

Cyber

Robust

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POS

- Regional service
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Cyber

- Approach service (8 max.)
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Pxx

Robust

VHF

Surface

CF-P

Details regarding the WP35 services as grouped (1/2)

- Cybersecurity – not an urgent concern for augmentations
  - In jamming and spoofing incidents, up to now aviation is collateral only:
    - Military operations in operational and training scenarios
    - PPD's, mostly aimed at hiding criminal activities
  - Incidents aimed at core constellations, not augmentations
  - GBAS already has limited protection on the VDB

- Positioning service – useful, but embedded in fundamental change of aviation operations
  - Geometric vertical in the terminal areas as tested in SESAR PJ02
  - Better compatibility between ATM and UTM

- Covered in current SESAR development (PJ14) - covered
  - Accomodation for P_{sat} and P_{const} – mitigation of constellation degradation
  - Robustness (RFI, constellation loss, scintillation)

Details regarding the WP35 services as grouped (2/2)

- Support for Surface operations (high multipath environment)
  - New application, requirements and performance to be defined – may be different from CAT III
  - New user groups also relevant (complex sites, urban canyons, close to obstacles)
  - Threat environment, exposure time, duration of operation to be reviewed

  => development of a use case and requirements document needed

- Carrier phase positioning
  - Enabler for operations above
  - Issues of integrity performance, instantaneous vs long-term performance

  => development of a work list needed

- VHF data Broadcast Physical Layer
  - Enabler for new data messages and applications above
  - Two styles:
    - New transmission scheme in existing physical layer -> coexistence of both and transition
    - Alternative physical layer - > redefinition of requirements independent of physical layer

  => development of a work list needed

Ideas for “GAST G” use cases and requirements

- Objectives
  - Autotaxi in entire airport including apron and stand areas,
  - PiS approach capability at all descent angles with 3D multi-segment approach paths (TAP actualisation?)
  - Automated approach service for applications requiring accuracy and/or integrity different from GAST A-F
  - Application also in high multipath/cluttered environment, including limited sky and/or VDB coverage
  - Unlimited user number (implies monodirectional datalink)
- Requirement ideas
  - Integrity around 10^{-7} level (suitable for unmanned landing and manned surface ops)
  - Accuracy at decimetre level (current stand positioning ≈30cm 2/3D)
  - Position update rate up to 10 Hz, Datalink update rate 2Hz
  - TTA in 2-5s region, datalink latency up to 2,5s (0,5*TTA)
  - Service coverage even with some blockages above 45° elevation and elevation mask above 30°
  - At least 50NM datalink coverage, including non-line-of-sight capabilities, no minimum coverage limit from surfaces
  - Availability at least 99,9% and continuity at $1\text{-}10^{-5}$ - exposure duration at least 15-30 min

Start of a CF Positioning work list

- What are realistic expectations on ?
  - Accuracy
  - Integrity
  - Availability/continuity
  - Computing resource need
  - robustness
- Is anything of the existing GBAS interfaces reusable (message contents, datalink characteristics, …)?
- What are new threats/ monitoring needs?
- Can any of the existing monitoring needs be eliminated?
- …

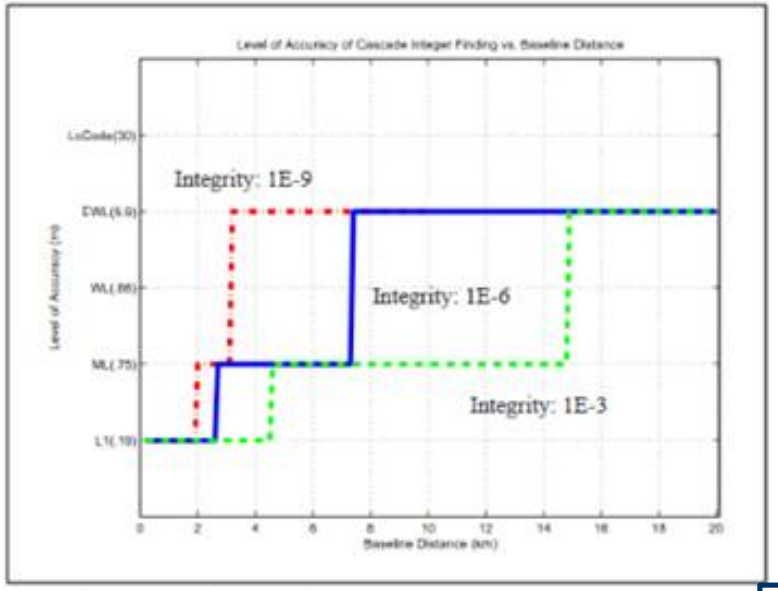


Figure 12: Level of Accuracy and Integrity of the Cascade Integer Finding method over Distance

From: Jung (Stanford)
IONGPS 1999

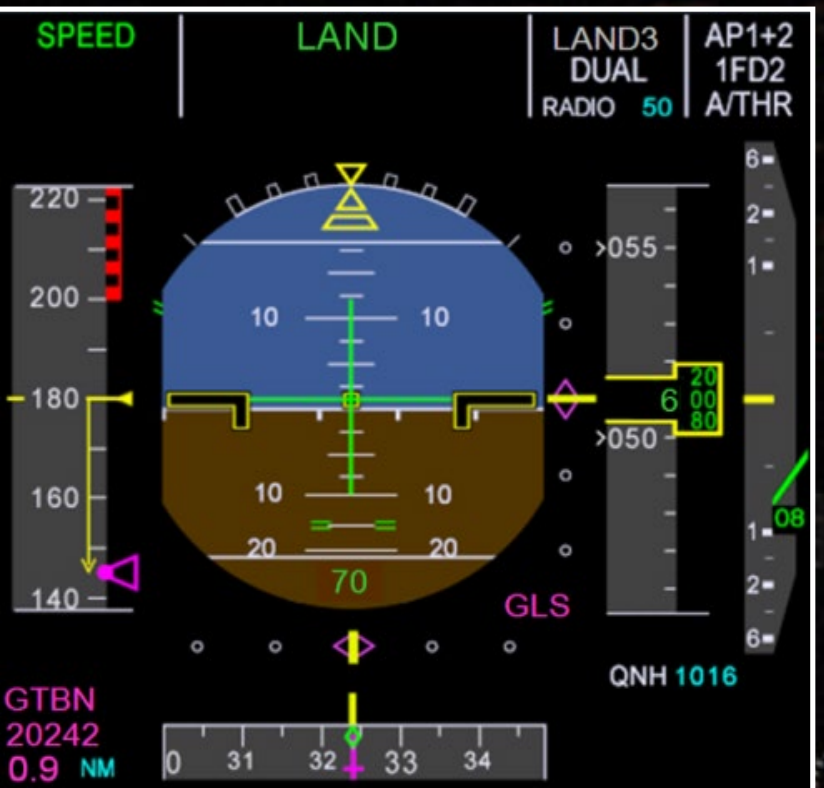
Start of an alternate datalink definition work list

Two ways forward

- Extension (backwards compatibility) of existing VDB concept with new capacity
  - MT2 ADB specifying which slots have new/old coding
  - MT2 ADB specifying a new frequency for use of additional slots
  - Higher capacity coding definition on a slot basis
  - More authentication options?
  - …

- Definition of current (and future) datalink protocols independent of physical layer
  - Review of max/min message update rates and timeouts
  - Review of time information in messages (for instance currently no Tzcount in MT2/4)
  - Review of implicit monitor assumptions on datalink features
  - Definition of latency and message repetition constraints independent of physical layer
  - More authentication options?
  - ..

Discussion


SPEED
LAND
LAND3
DUAL
RADIO 50
AP1+2
1FD2
A/THR
220
200
180
160
140
10
10
10
10
20
20
70
>055
>050
20
6 00
80
GLS
QNH 1016
GTBN
20242
0.9 NM
0
31
32
33
34