Satellite Services for Personal Air Transportation

Antonio MONTELEONE
www.nais-solutions.it

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NAIS at a glance

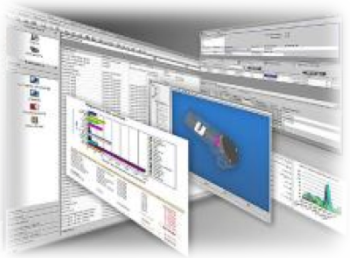
NAIS is an Italian System House, classified as SME, founded in 2006.

- Core competencies based on ICT and on Space technologies
- Applications oriented to specific market domains.

DEFENCE

ROAD & MARINE TRANSPORT

AERONAUTICS



ICT

NAIS headquarter is based in Rome

Personal Air Transportation system

Between Surface and Scheduled Air Transport

Airliner

Regional A/C

Scheduled Air Transport

Light A/C

Very/Ultra Light A/C

Personal Air Transport

Road

Rail

Surface Transport

Private aviation (non-CAT) users

- **point to point personal travels**
- **sporting and leisure aviation**, secondarily business-related
- using **"non-complex" aircraft (LA, VLA, AUL)**
- short-to-medium range flights at
  - relatively low-speed, relatively low-altitude
- **flying VFR** (Visual Flight Rules) in uncontrolled airspace (class G)

Operate within a network of **small airports and airfields** located in uncontrolled airspace (G category)

- highly distributed but underutilized
- not equipped with any ground navigation aid

Can be exploited to

- *increase people's mobility*
- *reduce transportation costs*
- *reduce transportation time*

On-going NAIS projects in the PAT domain

S2BAS (Space Services Benefits in Aviation Systems)

- ARTES 20 IAP ESA contract, co-funded by ASI, coordinated by Techno Sky, an ENAV company

- Satellite assets jointly used (GNSS, EO, SatCom) to the benefit of GA/VFR stakeholders (pilots, operators, ANSPs)

AIRONE (sAtellite lInk for personal aiRcraft meteO informatioN sErvice)

- Project co-funded by the Italian Space Agency (ASI), coordinated by NAIS

- Focus on **in-flight meteorological information services** over a **satellite bidirectional data link in the S-band** and on-board **weather decision support tools**
  - S-band particularly suitable for mobile end-users and applications.

Stakeholders and needs in the current PAT scenario

Pilots

Enhanced Navigation and Situation awareness when flying

- navigation assistance (route conformance, terrain awareness, landing)
- Up-to-date information when flying (**weather weather weather**)
- Surrounding **air traffic information** and **collision avoidance** tools on-board

Operators (Airport, Airfields and Aeroclubs)

Ease access to small/regional airports

Increase traffic (more revenues)

Air Navigation Service Providers (ANSP)

Means to ease the coexistency of CAT and non-CAT air traffic

Cost-effective flight assistance and flight information services tailored to PAT pilots on small/regional (unmanned) airports

Satellite enablers for Personal Air Transportation

GNSS

- *GNSS RNAV (aRea NAVigation)*
- *Assisted approach/landing*
- *Terrain awareness tools (CFIT)*
- *Surrounding air traffic information (CDTI)*
- *Navigation warnings (area infringements)*
- *Contingency and Safety tools on-board*

Satellite Communication

- *In-flight aeronautical/weather information*
- *Remote management of unmanned airports / airfields (remote command and control)*

Earth Observation

- *Airport surrounding topographic*
- *Obstacles survey*

Solutions fitting the PAT market

NOT a solution to CONTROL air traffic

NOT a solution to FORCE pilots to strictly follow rules other than VFR

A solution to SUPPORT pilots and ground operators to

- **Increase safety**
- **Enhance aerodromes accessibility**
- **Increase cost-effectiveness of operations**

low power, **low cost**, potentially panel-mounted or **hand-held**

derived from CAT/business aviation solutions, properly scaled-down

Ease the access to small airports and airfields

Means to ease the access to small airports and airfields

- Extend the development of **RNAV-like GNSS routes and approach procedures** to non-towered/non-controlled airports
  - **suggested procedures** to/from the ground surface.
  - taking into account special operating constraints due to **terrain**, **obstacles**, **hazards** or **noise abatement**

- Provide pilots with **up-to-date information from ground** when flying
  - Aerodrome and Ground services availability and status
  - Meteorological and Aeronautical Information
  - Environment (e.g. Tourist information)

- **Provide pilots with direct access to ground services** when flying
  - Reservations, refueling, runway & airfield lighting, …

Pilots are
  - still **responsible for maintaining separation** from other aircraft and obstacles (according to VFR rules).
  - **visually supported** by a flight display powered by **GNSS R-NAV procedures**

Increase cost-effectiveness of operations

Arrange the PATS airports network into clusters of manned/unmanned airports to serve with specific **flight information services** and **remote resource management**

- No human intervention required when providing pilots with flight information
- Broadcasted Information
- Traffic monitoring to support SAR activities (via ADS-B OUT on-board)

Enhance Navigation and Situation awareness when flying

Pilots can rely on moving maps

- Position, attitude, altitude, ground speed
- Route information
- Surrounding air traffic,
- 3D Terrain and obstacles
- Navigation warnings

Provide pilots with Flight Information on-board, via AGDL:

- up-to-date meteorological data
- aeronautical information(e.g. NOTAM),
- airport information and services requests

Enhanced Navigation and Situation Awareness is essential to safety

In-flight weather information

Weather encounters constitute a serious threat to the safety
(lowering ceiling, flew into clouds or fog, reduced visibility, …)

Means to Prevent or Recover from Weather Encounters:

1. Provide **in-flight weather updates** (current weather, now-casts)

2. Deploy **Meteorologically-aware GNSS flight navigation** and **weather decision support tools** aboard to prevent or recover from weather encounters by the **execution of recovery maneuvers**
   - Detect hazards along the route, propose new routes/maneuvers and visually support their execution

- Bi-direction satellite link enabling "Real-time Weather Reports for Met Office"
  - **on-board meteorological sensors** data
  - **pilot reports** (PIREPs)

VFR LA/VLA/AUL aircraft & Navigation equipment

By regulation GNSS is just an aid to VFR navigation. Some concerns

- RAIM alerting capability
- Antenna position
- Navigation maps (accuracy, currency)

VFR GNSS navigation equipment :

(1)Panel mount (2) Hand-held (3) **apps on COTS PEDs**

Hundreds of Aviation Apps in App Store and Google play

- Panel mount – certified & high cost, option on LA, N/A on VLA&UL
- Hand-held GPS – diffuse on VLA, SBAS/WAAS receivers
- **Tablet internal GPS** – growing trend (VLA, AUL, old A/C models)

Navigation apps based on the Tablet internal GPS

- No SBAS compatible, Internal GPS antenna
- Lack of integrity monitoring
- Lack of correction information

GNSS Integrity Monitoring in the Airport surroundings

S2BAS solution: Integrity Monitoring performed at the airport and transmitted to the aircraft via air-ground data-link

S2BAS On-board Integrity Warning display

Other solutions:

1. **EU**: Navigation Apps on PEDs (tablet) coupled with external GNSS receivers and AHRS devices by Bluetooth connections
   Accurate positioning and integrity powered by the EGNOS SDK (© European Commission, licensed under the EUPL)

2. **US**: Navigation Apps on PEDs (tablet) coupled with external devices integrating (a) GPS+WAAS, (b) AHRS, (c) ADS-B (traffic + ADS-B weather (UAT 978 MHz)), (b) WiFi Access Point

Conclusions

Satellite services can dramatically **contribute** to the **safety, cost-effectiveness** and **accessibility** of the Personal Air Transportation system **(LA & VLA pilots + small airports/airfields operators)**

- GNSS area navigation & Navigation warnings
- Traffic awareness and conflict detection
- Airport Remote service access and management

- **GNSS RNAV procedures** can help pilots to fly safer VFR routes, including the approach
- **Navigation** equipment combined **with in-flight satellite weather information** can dramatically help pilots in **preventing and recovering from weather encounters**

Navigation apps running on PEDs are a growing trend

- **based on the internal GPS - not SBAS enabled**
  - Lack of integrity assurance and correction information can be critical in some circumstances
  - Countermeasures are recommended

Antonio MONTELEONE

antonio.monteleone@nais-solutions.it

Personal Air Transportation system … the future

Personal Air Transportation in the future

- based on the introduction of **innovative personal air vehicles**
- **analogous to the private car** in terms of accessibility and ease of operation,
- … but with the benefits of speed and routing efficiencies enabled by **direct-to-destination flight**
  - **automation** will play a central role
  - **operations** permitted **in almost all weather conditions** (like cars)

courtesy myCopter EU FP7 project

courtesy PPlane EU FP7 project

PPlane (EU FP7 project) concept:
to make an air vehicle able to fly without a pilot on board
passengers only will be on board, and with a pilot on the ground

http://www.pplane-project.org/

EASA Aircraft categories

EASA Complex motor-powered aircraft
aeroplanes with a **maximum certificated take-off mass exceeding 5700 kg**, or certificated for a maximum passenger seating configuration of more than nineteen, or certificated for operation with a minimum crew of at least two pilots, or equipped with (a) turbojet engine(s) or more than one turboprop engine

EASA CS-VLA aircraft
Single engine (spark- or compression-ignition) with not more than two seats,
Maximum Certificated Take-off Weight of not more than 750 kg,
stalling speed in the landing configuration of not more than 83 km/h (45 knots) (CAS), to be approved for day-VFR only.
Required flight and navigational instruments:
(a) An **airspeed indicato**r; (b) An **altimeter**; (c) A **magnetic direction indicator**.

EASA CS-LSA aircraft
single non-turbine engine with a maximum of two seats and non-pressurized cabin, **MTOW of 600 kg** and a maximum stalling speed in the landing configuration (Vs0) of 83 km/h equipped, to be approved for day-VFR non-acrobatic operation only.
No flight and navigational instruments explicitly required
Instruments and other equipment may not in themselves, or by their effect upon the aircraft, constitute a hazard to safe operation

Panel mount

Aspen EFD1000 VFR PFD (Price range 5000-10000 euros)

Garmin G1000 and G500

Hand-held Portable GPS

Price range 500-1500 euros