Satellite Services for Personal Air Transportation

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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.

**NAIS** headquarter is based in Rome
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)

The Minor Airport System
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**
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)
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
**S2BAS solution:** Integrity Monitoring performed at the airport and transmitted to the aircraft via air-ground data-link

![S2BAS On-board Integrity Warning display](image)

**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
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)

![image of personal air vehicle](http://www.pplane-project.org/)

**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

[link to PPlane project website](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 indicator**; (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