A CONOPS for DFMC GNSS
Dual Frequency Multi Constellation
Global Navigation Satellite System

GANIS
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Outline

- CONOPS: Background, objective and timeline
- Introducing DFMC GNSS in aviation
- DFMC GNSS: Opportunities and challenges
- Implementation roadmap
- Way forward
Background

2012: ICAO 12th Air Navigation Conference Recommendation 6/6 to States and aircraft operators on the use of multiple constellations

CONOPS objective

To build up consensus among stakeholders on how new GNSS technology will be introduced in ATM in a safe and cost-efficient manner bringing operational benefits while addressing identified technical and institutional challenges and retaining backwards compatibility
CONOPS: a vehicle for building consensus

ICAO States

Service providers of GNSS systems

Aircraft & avionics manufacturers

ANSPs

Aircraft operators

2014
NSP started CONOPS

Dec 2016
NSP approved initial version

2017
CONOPS consolidation Consultation (25 groups + GANIS)

April 2018
NSP to approve final version

Oct 2018
13th ANC
GNSS in aviation:
much more than navigation

GNSS Positioning: PBN, 4D NAV, GBAS CAT III, ADS-B and ADS-C, Enhanced Ground Proximity Warning Systems, Autonomous Distress Tracking, ….

- Increased dependency on GNSS over time from the 90s to 2030 +
- DFMC GNSS could support all systems and applications based on GPS today
Introducing DFMC GNSS in aviation

DFMC GNSS:
4 constellations
8 signals
+ Advanced RAIM, DFMC SBAS and DFMC GBAS

A complex multi-disciplinary subject

GPS L1 + RAIM, SBAS and GBAS

Avionics complexity
GNSS elements

Operation al benefits and costs
Legal, political, and service provision
ATM operational aspects
Opportunities: operational benefits

Technological and political push will improve performance and robustness

What operational benefits DFMC GNSS will bring to airspace users?
**Opportunities: operational benefits**

<table>
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<th>Safety</th>
<th>Improved 3D Approaches Worldwide</th>
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<td>Capacity</td>
<td>Improved Business Continuity for CNS Applications</td>
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<td>Operational Efficiency</td>
<td>Flight Planning</td>
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<td>No need for RAIM prediction</td>
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<td>Cost Efficiency</td>
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**Innovation**: Enable new concepts and applications.

**Regulatory Compliance**: With CNS requirements.

- Operational benefits depend on aviation user group
- No single overarching benefit for all user groups
- Cost-efficiency challenge
Technical challenge: DFMC GNSS avionics

1. DFMC GNSS avionics will be more complex than current GPS L1 avionics to ensure global interoperability:
   - Process more constellations: different signals, modulations and time
   - Process DFMC SBAS, DFMC GBAS and A-RAIM augmentations of different combinations of constellations/signals

2. Potential capability to accommodate approvals of GNSS elements from States would further increase technical and operational complexity/costs

3. EUROCAE/RTCA are developing DFMC avionics standards (MOPS) and contributing to develop avionics section of the CONOPS

Industry assessing options to limit complexity/costs without compromising operational benefits
Institutional challenge:
approval of GNSS elements by States

- Different types of approvals
- Some States do not formally approve GPS in AIPs, but GPS is used worldwide
- Uncertainty on permissible use of other GNSS elements which may not be approved at the same time in different States

Ongoing debate between States, industry, aircraft operators and ANSPs revolves around options on how DFMC avionics should consider the approval of GNSS elements by States
High level implementation roadmap

Introduction of DFMC GNSS operations could start in 2025-2028
Way forward: Developing opportunities and overcoming the challenges

- ICAO GANIS event in December 2017
- Continue iterations with RTCA SC159 and EUROCAE WG 62
- NSP meeting in February 2018: paper to 13th Air Navigation Conference
- NSP meeting in April 2018: approve CONOPS
- 13th Air Navigation Conference in Oct 2018
Back Up slides
That States, when defining their air navigation strategic plans and introducing new operations:

A. take advantage of the improved robustness and availability made possible by the existence of multiple global navigation satellite system constellations and associated augmentation systems;

B. publish information specifying the global navigation satellite system elements that are approved for use in their airspace;

C. adopt a performance-based approach with regard to the use of global navigation satellite system (GNSS), and avoid prohibiting the use of GNSS elements that are compliant with applicable ICAO Standards and Recommended Practices;

D. carefully consider and assess if mandates for equipage or use of any particular global navigation satellite system core constellation or augmentation system are necessary or appropriate;

It is not obvious how to reconcile both b) States approving some GNSS elements and c) adopt a Performance-based approach.
How DFMC avionics should consider States approvals?

NSP is considering options

- **Approvals of State managing airspace.** Avionics would use only GNSS elements approved by States managing airspace where the aircraft is flying

- **Approvals of State of registry.** Avionics would use only GNSS elements approved by the State of aircraft and/or Operator is registered

- **Avionics to decide.** Avionics would use GNSS elements based on technical and operational considerations only

- Work in progress, not consensus achieved yet
- NSP could assess operational, safety, technical, regulatory and economic criteria
- NSP cannot undertake a comprehensive trade-off because legal and political aspects are beyond NSP sphere of competence