EUROCONTROL Policy for GNSS In Europe

ENRI International Workshop on ATM/CNS

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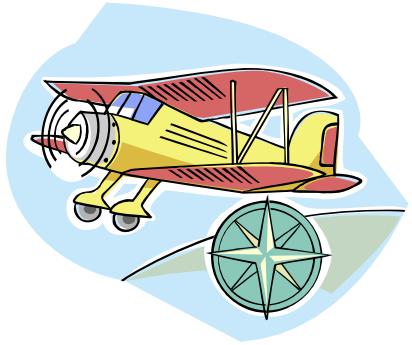
Presentation Overview

- Use of GNSS in aviation applications
- GNSS policy
- GBAS
- SBAS (EGNOS)
- Transition to GNSS: implementation aspects

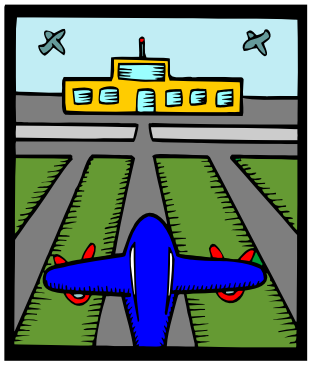
Use of GNSS in aviation applications

Civil domain

Surveillance (ADS-B)



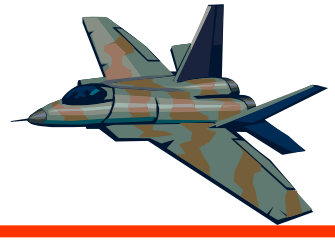
Navigation



Airport operations

Timing

Military domain



Based on GPS Precise Positioning Service (PPS)
And Galileo Public Regulated Service (PRS).

GNSS components in aviation and ICAO standards

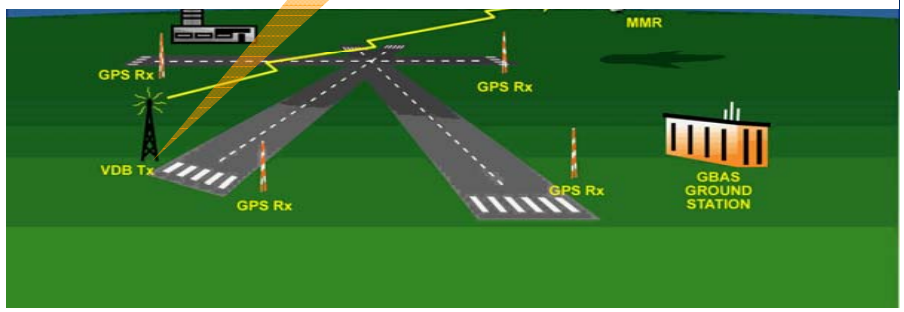
GNSS constellations

GPS, Galileo, GLONASS and COMPASS

ABAS

(Aircraft Based Augmentation System)

RAIM and Inertial systems



GBAS (Ground Based Augmentation System)

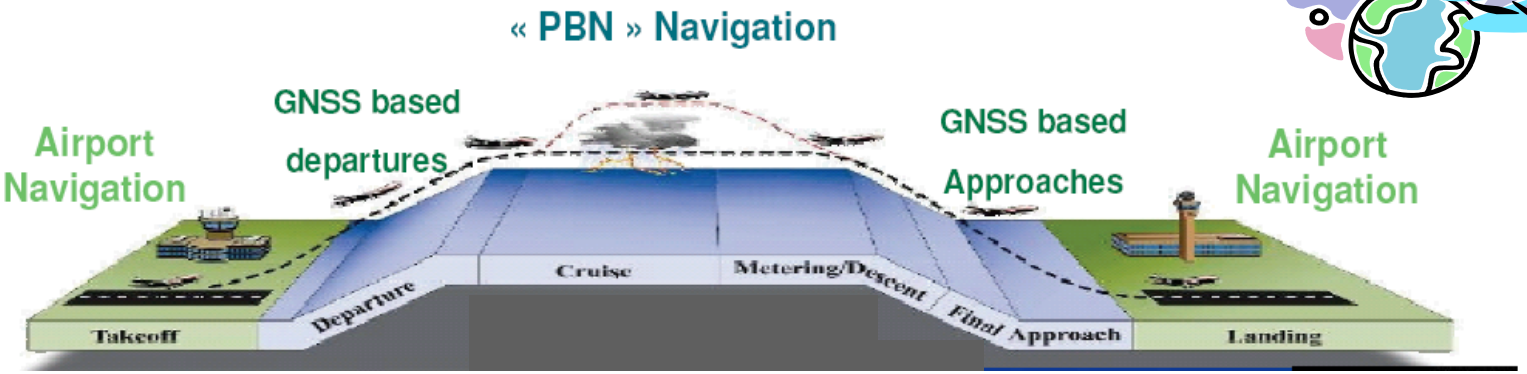
SBAS (Satellite Based Augmentation System)

WAAS, EGNOS, MSAS, GAGAN,…

Use of GPS in European aviation today

- Around 70 % of European flights are made by aircraft equipped with GPS/RAIM.
- GPS offers a very efficient and nominally free service …..but current GNSS based on GPS only has some deficiencies impeding its comprehensive use in aviation:
  - ✓ single system/operator
  - ✓ single frequency
  - ✓ low power signals
  - ✓ number of satellites
  - ✓ lack of sufficient guarantees
- The use of GPS has been authorized in Europe since 1998, based on a Safety assessment, the existence of ICAO Standards and a letter with a political commitment sent from the US government to ICAO.
- Safety Case relies upon reversion to conventional navigation means.

Transition to GNSS in European aviation



Operational needs

- More capacity to cope with increasing traffic demands
- Improve safety
- Reduce environmental impact
- Reduced costs

Operational implementation

- More flexible routes (e.g. RNAV)
- More demanding performance (e.g. Integrity, Accuracy,..).
- Safety (e.g. Vertical guidance in approaches)
- Better surveillance capabilities (ADS-B) to reduce separations
- Improved low visibility operations
- Common and accurate time reference

Infrastructure

Transition to a multi-constellation GNSS

Driven by operational needs pull rather than by the technological push

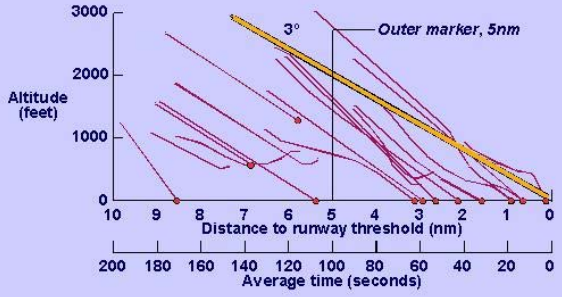
In line with :

- **ICAO global strategy**
- **SESAR Master Plan**

Safety is of paramount importance and GNSS can improve it further.

CFIT ALAs (continued, #2)

Vertical profile of some recent CFIT accidents/incidents



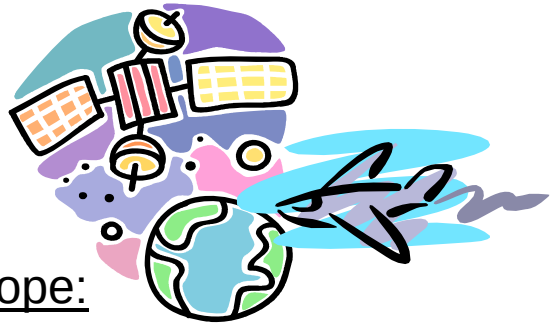
There was a lack of vertical situation awareness.

Worldwide Summary

Region	IFR airports	ILS	Non-Precision	Total Approaches
Africa	293	114	267	381
Canada/Alaska	373	124	684	808
Eastern Europe	255	138	308	446
Western Europe	729	509	672	1,181
Latin America	133	25	285	310
Middle East	264	122	319	441
Pacific	198	120	333	453
South America	316	60	456	516
South Pacific	347	88	301	389
USA	2,630	1,029	5,705	6,734
Total	5,538	2,329	9,330	11,659

ICAO Strategy:
To replace NPAs by Baro VNAV or LPV approaches

GNSS policy for Navigation applications in civil aviation



- <u>May 2008: Agreement among aviation stakeholders in Europe:</u>

- **Gradual** migration towards GNSS for all phases of flight as it will become **more robust** progressively.

- **A multi-constellation and multi-frequency GNSS** environment in 2020. **Galileo** signals will be used in combination with GPS and other GNSS components to have:

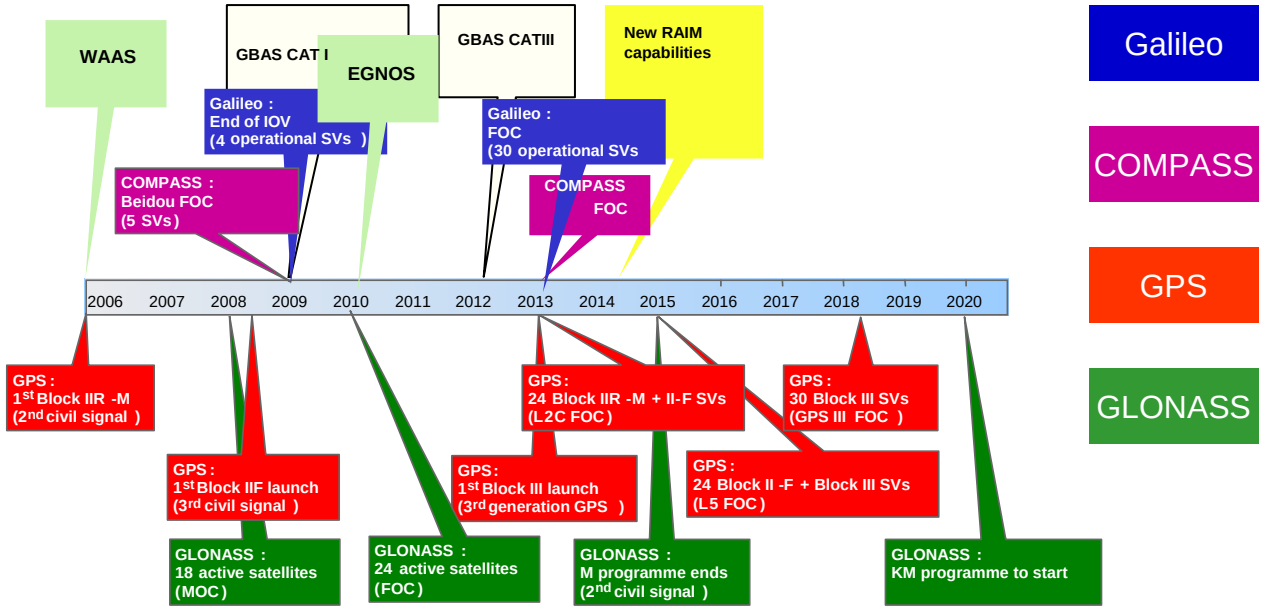
  - ✓ Better performance (accuracy, availability, continuity and integrity).
  - ✓ More robustness against vulnerabilities.

- User receivers will process signals from **different GNSS constellations in diverse frequency** bands in combination with augmentations, depending on individual business cases and the phase of flight.

- **Final goal** is its use as **sole service** to the extent that this can be shown to be the **most cost beneficial** solution and if supported by successful **safety** and **security** analyses.

- A rationalised terrestrial infrastructure must be retained for the foreseeable future.

The scene: GNSS developments and aviation



a) Moving schedule and many uncertainties !

b) Many potential combinations of Signals, constellations and augmentations (SBAS, GBAS, RAIM, INS..).

c) A new GNSS configuration every 2-3 years … whereas aviation equipment has very long lifecycle and very high installation & certification costs

e) Different integrity schemes/concepts not always compatible.

1) Share a GNSS baseline among stakeholders

2) Extend interoperability to integrity

3) Define a Multi-constellation receiver architecture

GNSS vulnerabilities: impact on aviation

Remaining GNSS signals vulnerabilities

Interference | **Ionosphere**

Impact on applications

Lost or degraded NAV and ADS-B applications

Affects large airspace areas and many aircraft

Impact on ATM

Operational scenario

En-route and TMA:
✓ Total RNAV environment
✓ No conventional navigation by 2015
2020: Decommission of NDBs and VORs
Radar based surveillance

Contingencies/mitigations

✓ Diversion to areas without GNSS problems
✓ Reversion to non-GNSS systems
✓ Limited number of aircraft with GNSS only can be handled by ATC (radar vectoring)

- **Need for dual RNAV equipment for continuity**
- **Need for dual sensor (e.g. DME/DME+GNSS) RNAV equipment**
- **Need to keep ILSs and DMEs**

- **Need to assess effectiveness of contingencies**
- **Need to characterise GNSS signals failures**

GBAS
(Ground Based Augmentation System)

- ILS (Instrumental Landing Systems) are providing a very efficient service in many European airports, but are facing some problems (e.g. multipath effects, frequency spectrum).
- Airports may overcome these problems by implementing GBAS for low visibility operations.
- Multi-constellation GBAS for CAT II/III.

- EUROCONTROL policy on GBAS is to support a progressive and cost effective transition from ILS towards GBAS by supporting the development of:
  - Advanced concept of operations
  - Safety assessments
  - Technical and standardisation aspects
  - Airborne aspects
  - Operational implementation

The implementation of GBAS can be economically viable for an increasing number of airports and airspace users.

Green: GBAS in Operation
Blue: GBAS Research/Test
Yellow S-CAT I in Operation

SBAS
Space Based Augmentation System

- EGNOS can provide operational benefits and be a cost-effective option for “small” aircraft (e.g. General Aviation, Business jets, Regional Airlines) and to retrofit some old “big” aircraft.

- EGNOS provides little performance benefit to Air Transport aircraft and most of the airlines do not plan to invest in EGNOS.

- EGNOS LPV procedures to be published by 2010.

- **Uncertainties about EGNOS** in terms of date of its operational introduction, life-time period, institutional issues and charging policy are impeding some ANSPs and airspace users to take their business decisions.

Individual business cases will determine the suitability of EGNOS for each aviation stakeholder.

Towards a multi constellation GNSS

2009

30 GPS L1
1 GPS L1/ L5
15 GLONASS

2010

EGNOS (APV)
GBAS CAT I
24 GLONASS
4 Galileo satellites (E1/E5)

2015

Galileo
COMPASS
EGNOS (LPV)
GBAS CAT II/III
(based on GPS L1)

2018

24 GPS(L1/L5) and
30 Galileo (E1/E5)
New RAIM capabilities
GBAS CAT II/III (GPS-Galileo)

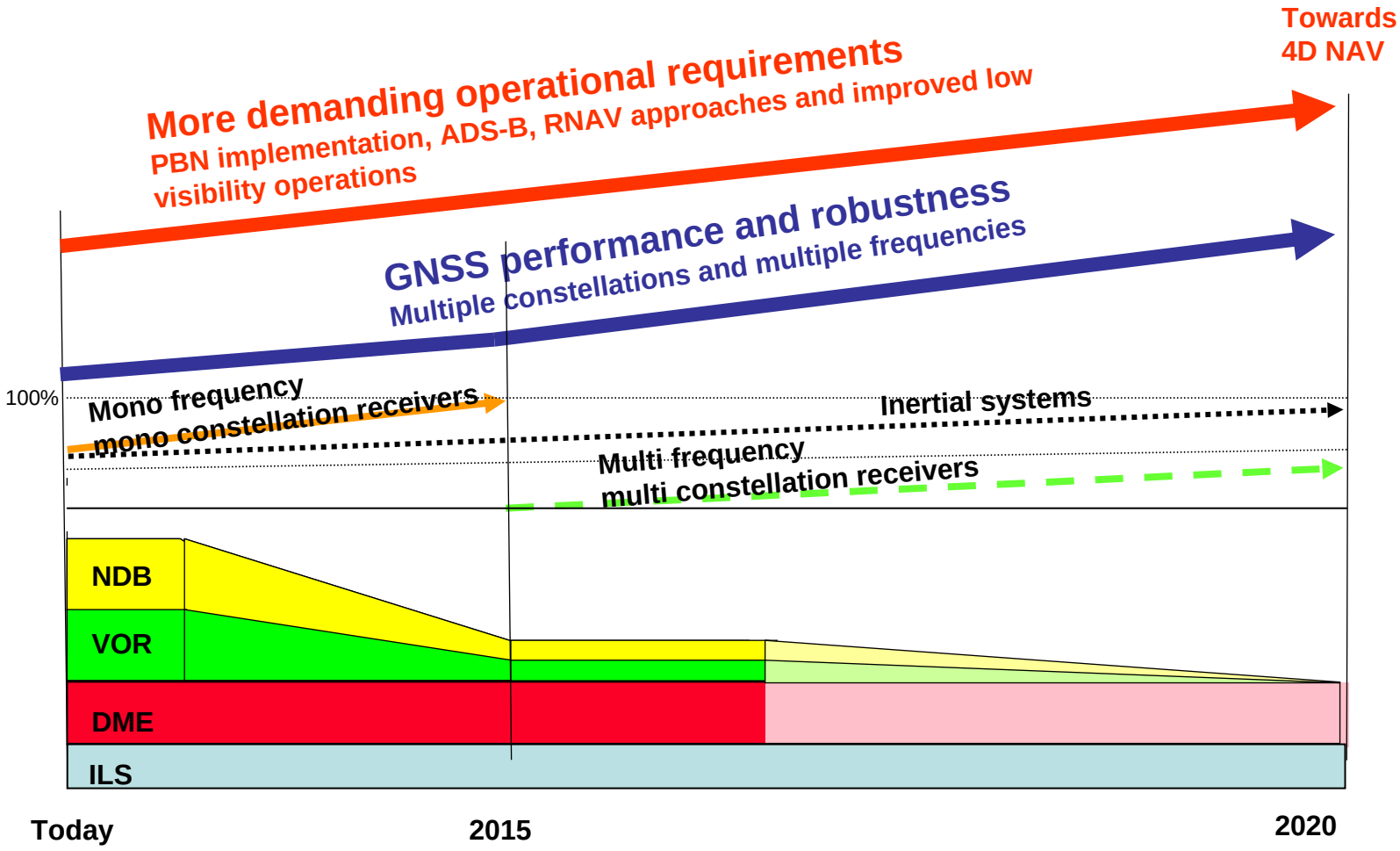
2020

Performance & robustness

- (Too) many uncertainties on schedule and performance
- (Too) many possible GNSS configurations
- SESAR to define 2020+ GNSS baseline

- Increasing GNSS robustness and performance ….
but GNSS signals will still be vulnerable.
- Feasibility of sole-service concept to be demonstrated

Transition to GNSS: Implementation aspects



Summary

- **Gradual transition** towards GNSS to support **more demanding** navigation, surveillance and timing **applications**…….as we get **better performance and more robustness in a multi-constellation and multi-frequency environment**.

- **GNSS baseline configuration** for aviation and future GNSS receiver architecture to **be agreed by stakeholders** to allow a **cost effective transition** (one main driver to reduce avionics related costs).

- **Final goal** (very long term) is **sole service** concept to the extent that this can be shown to be the **most cost beneficial** solution and if supported by successful **safety** and **security** analyses.