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The Use of Satellite Navigation in Aviation: Towards a Multi-Constellation and Multi-Frequency GNSS Scenario

ICG Experts Meeting: GNSS Services

Session 3 – Applications of GNSS

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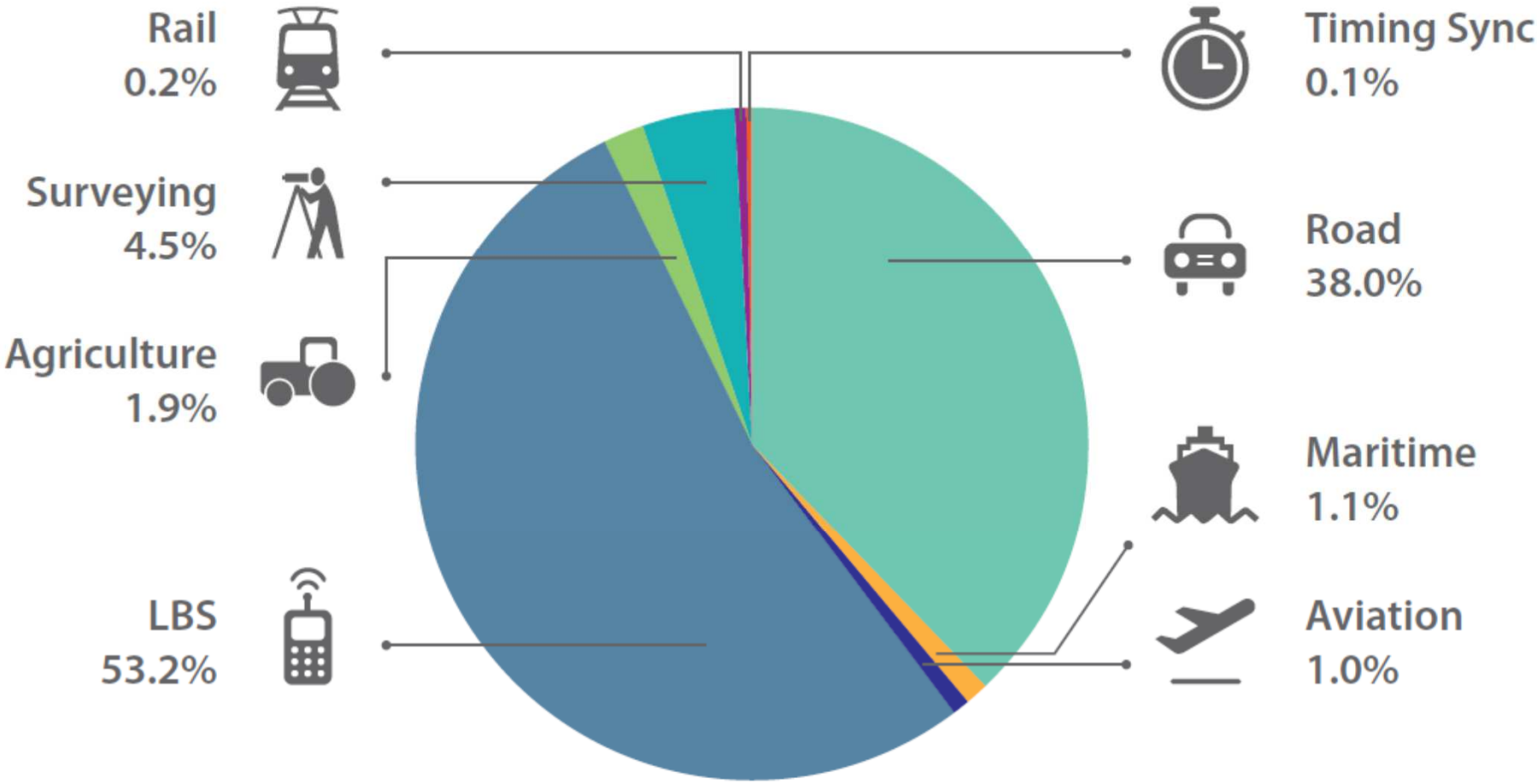
The Use of Satellite Navigation in Aviation: Towards a Multi-Constellation and Multi-Frequency (MCMF) GNSS Scenario

Satellite navigation systems in aviation (I)

Cumulative core revenue (%) - 2013-2023



Note: core revenues refer to the value of only GNSS chipsets in a device.

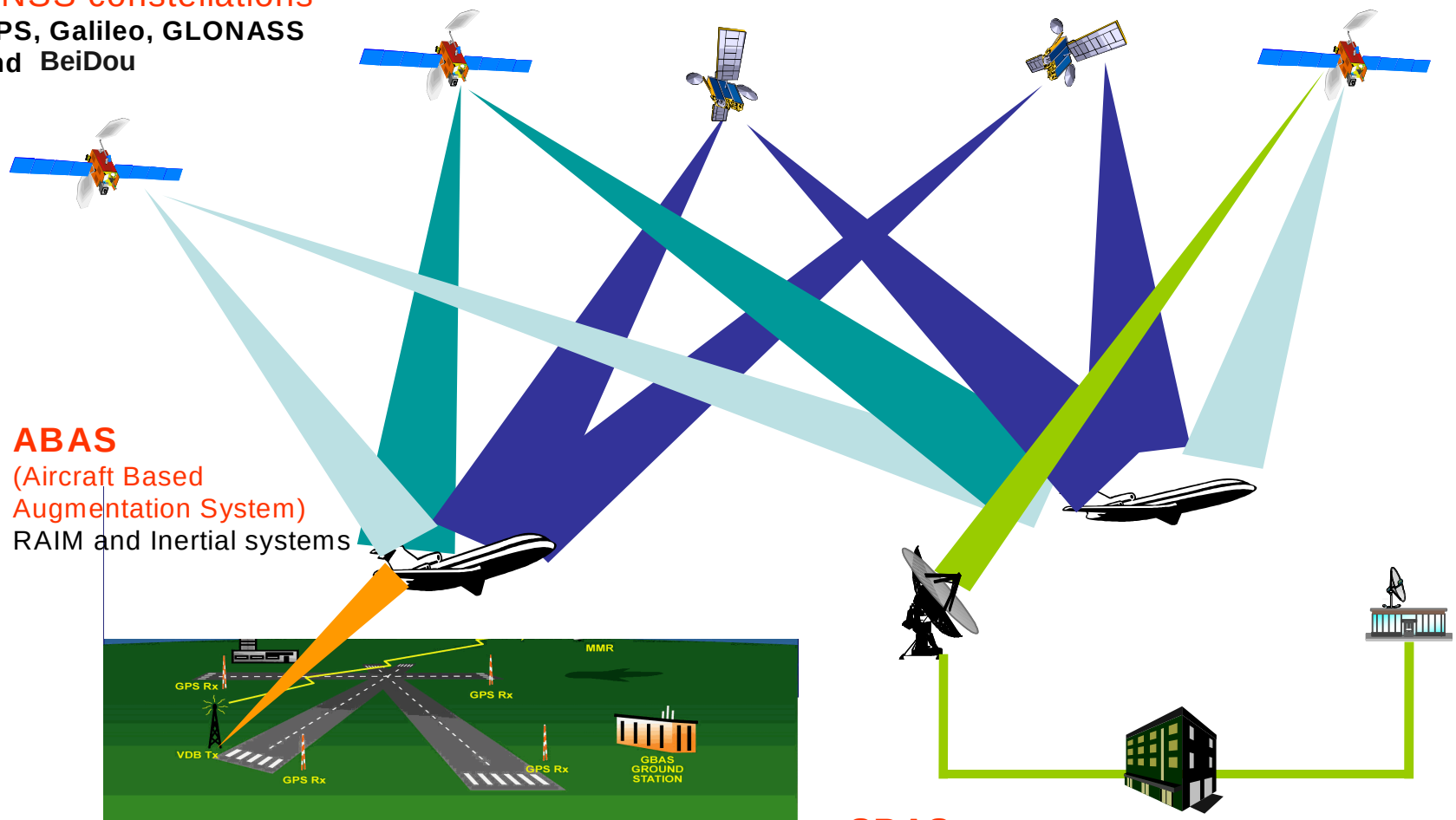
Source: GNSS Market Report, GSA, Issue 4, March 2015

GNSS Concept

GNSS components in aviation and ICAO standards.

GNSS constellations

GPS, Galileo, GLONASS and BeiDou



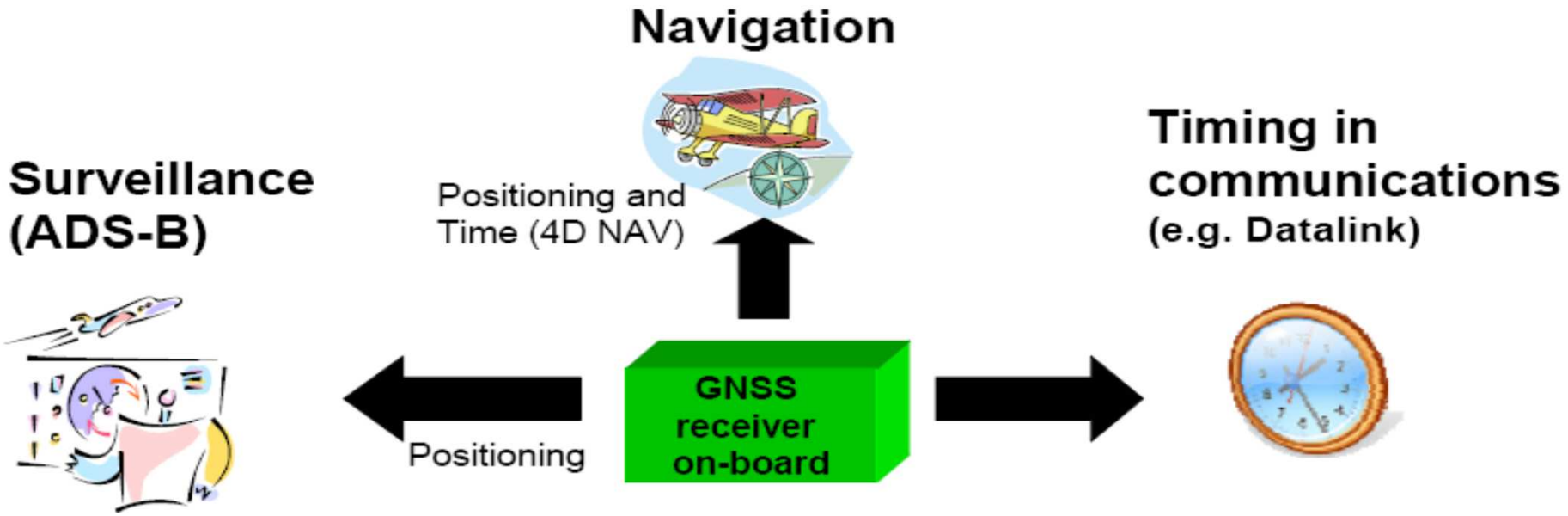
ABAS
(Aircraft Based Augmentation System)
RAIM and Inertial systems

GBAS (Ground Based Augmentation System)

SBAS (Satellite Based Augmentation System)

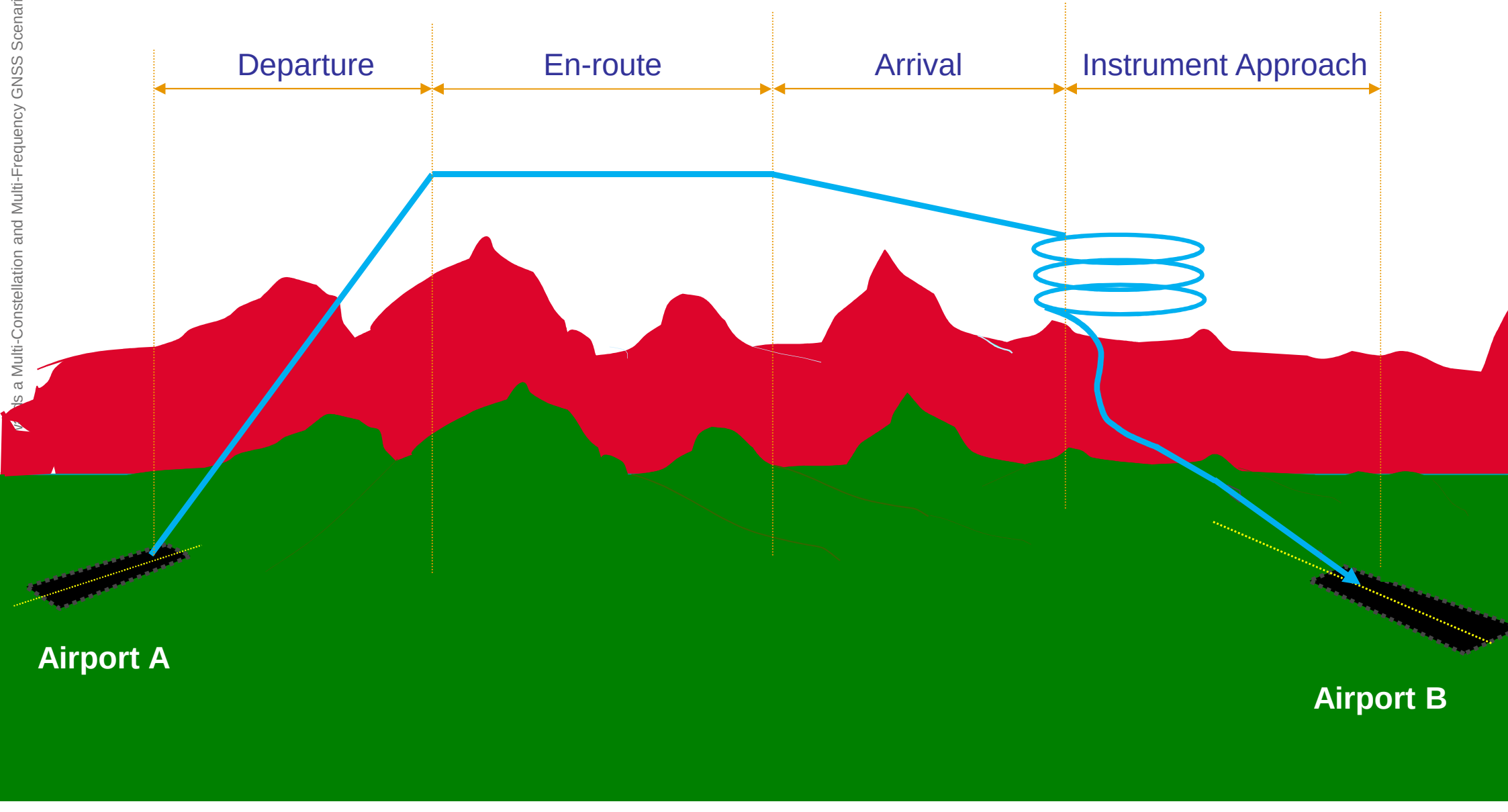
WAAS, EGNOS, MSAS, GAGAN,...

GNSS as a Communications (C), Navigation (N) and Surveillance (S) element



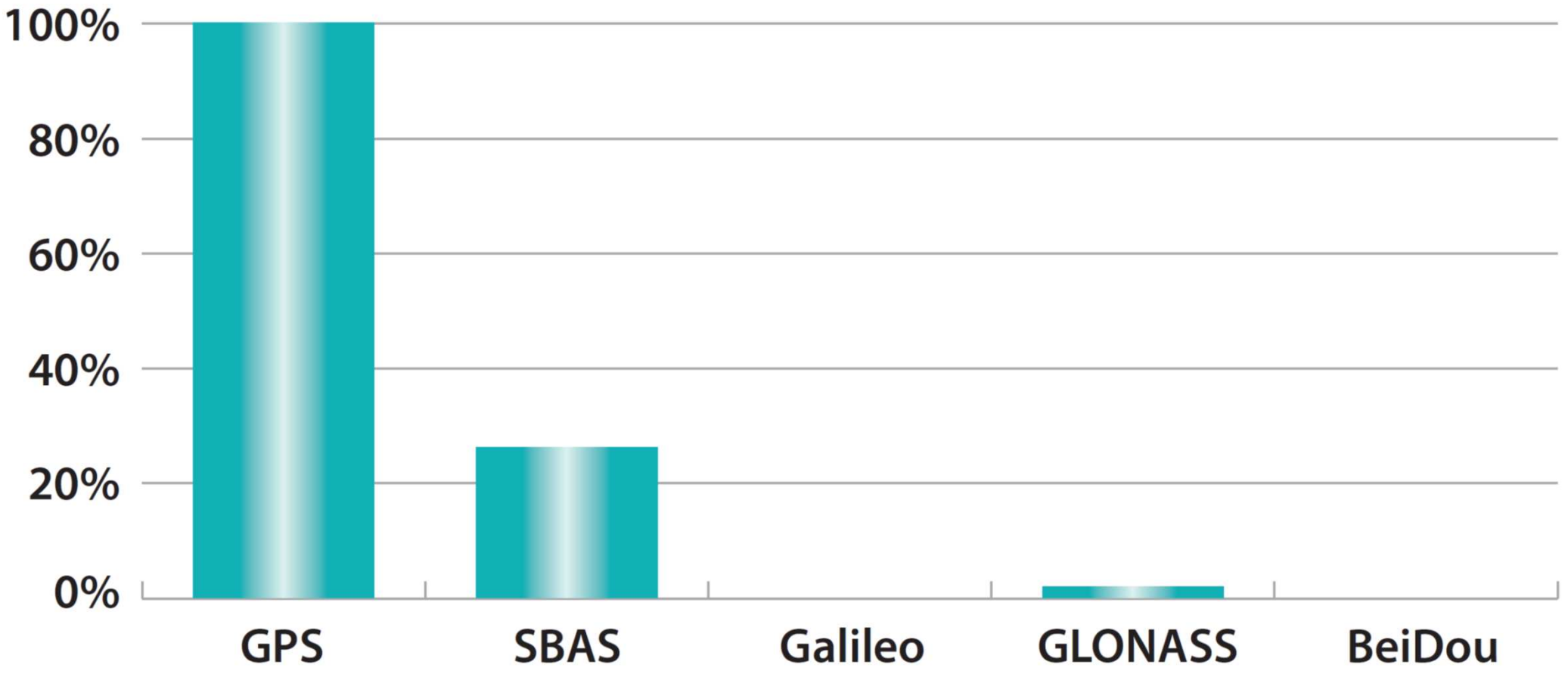
Source: EUROCONTROL

An IFR flight profile



MCMF avionics – GNSS sensors (I)

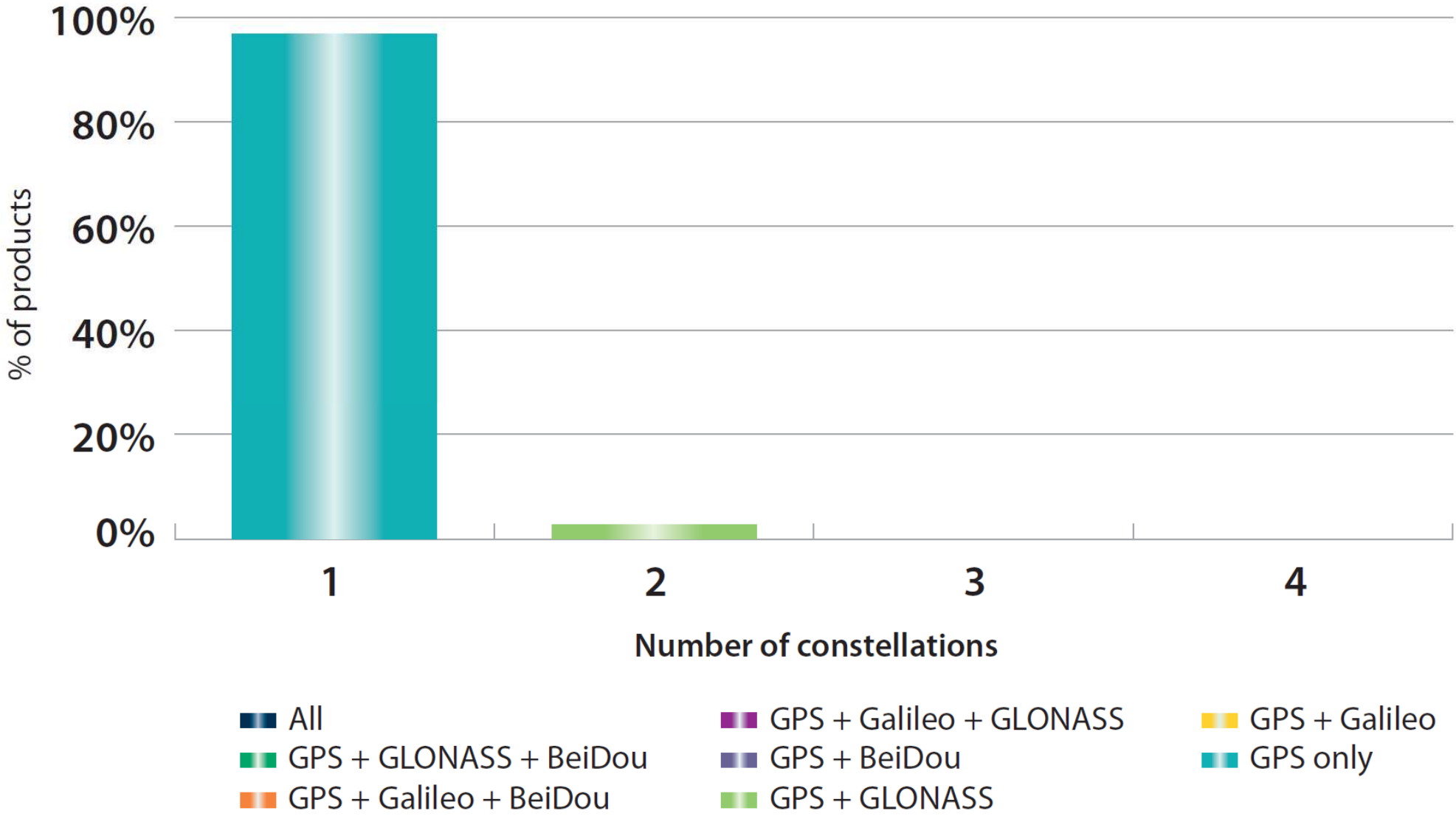
Capability of GNSS receivers – Aviation segment



Source: GNSS Market Report, GSA, Issue 4, March 2015

MCMF avionics – GNSS sensors (II)

Supported constellations by receivers – Aviation segment



Source: GNSS Market Report, GSA, Issue 4, March 2015

Challenges raised by MCMF GNSS (I)

Institutional and technical challenges

MCMF GNSS will enhance the performances and robustness of GNSS, but…

There are challenges to be sorted out:

- Institutional
- Technical

Challenges raised by MCMF GNSS (II)

Institutional challenges

- Currently States do preclude and/or approve some specific constellations within their airspaces.
- ICAO has proposed to assess practical solutions, e.g. MCMF avionics to automatically select or deselect a given constellation to navigate seamlessly over airspaces where constellations are either approved or precluded.
  - However, such a switching function might not be justified for en-route and terminal operations, but only for final approach and landing.
  - …on-going discussions at the ICAO Navigation Systems Panel (NSP).

Challenges raised by MCMF GNSS (III)

Institutional challenges

How to handle the constellation approval status at avionics level ?

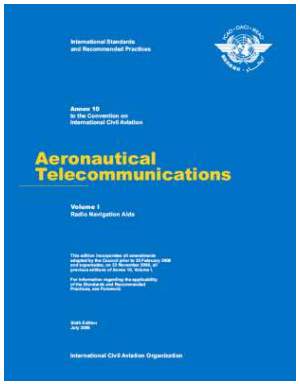
2025 situation

2040 situation: a dream ?

Source: EUROCONTROL

Challenges raised by MCMF GNSS (IV)

Technical challenges



- Key to ensure compatibility and interoperability
  - Standards and Recommended Practices (SARPS) in ICAO Annex 10, Volume I.

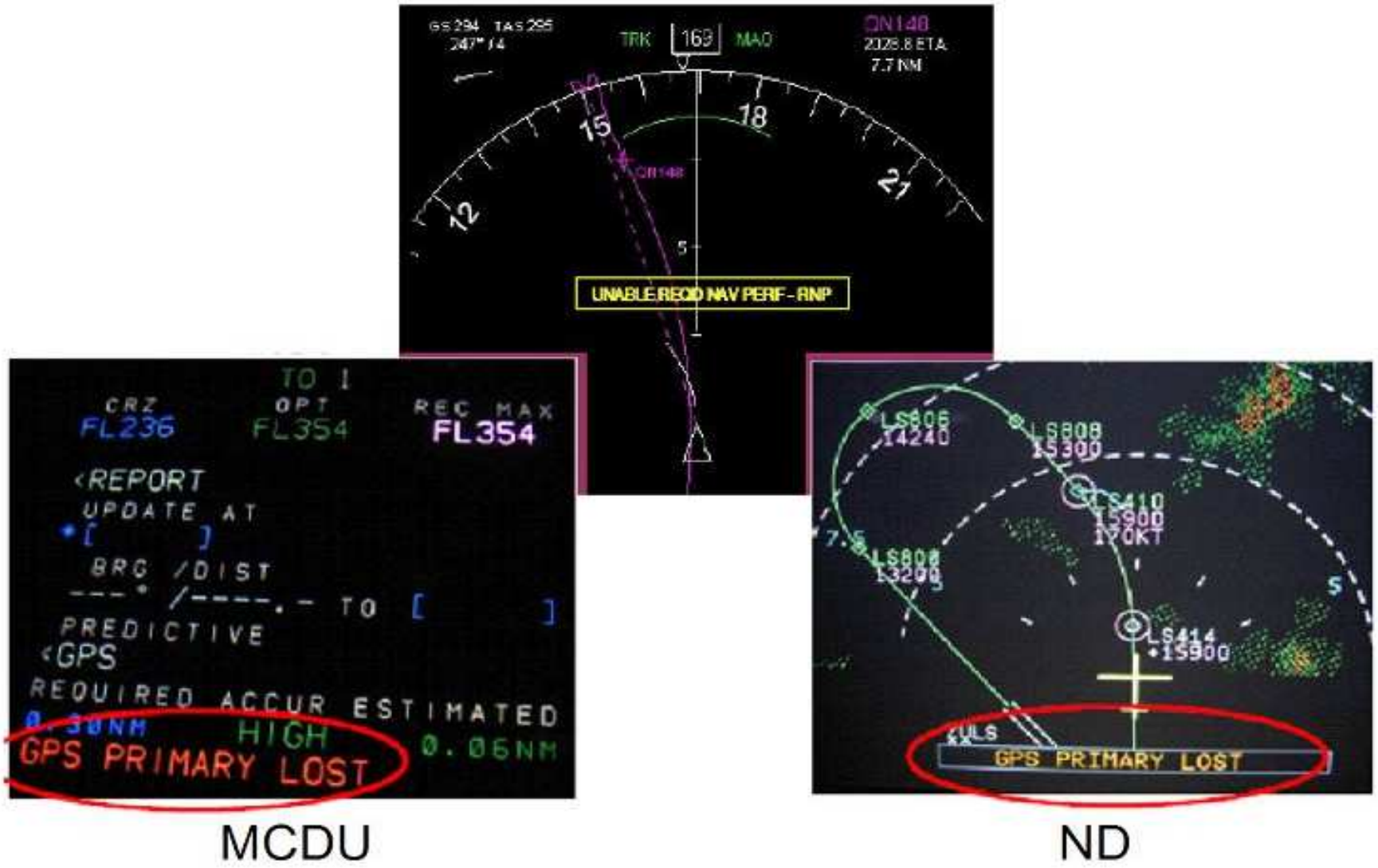
- GNSS vulnerabilities
  - GNSS signal disruption might affect multiple aircraft over a wide area;
  - MCMF GNSS will help mitigate interference,…however
  - Disruption cannot be completely ruled out;
    - Air Navigation Service Providers (ANSPs) must be prepared to deal with potential loss or degradation of GNSS signals.

Challenges raised by MCMF GNSS (V)

…it might happen that GNSS is degraded, disrupted on unable to support the on-going flight operation.

Challenges raised by MCMF GNSS (VI)

Monitoring and alerting in the cockpit



MCDU ND

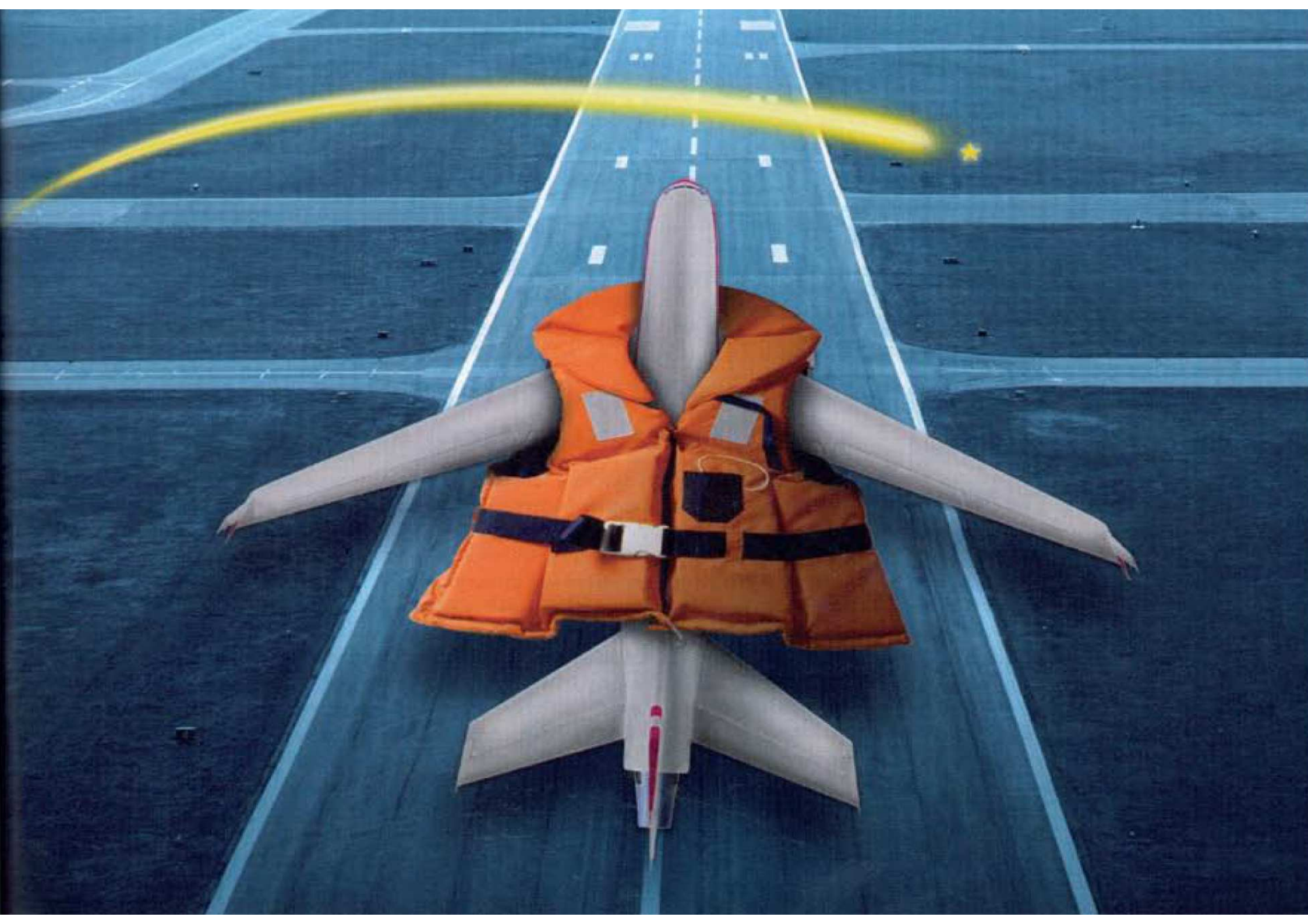
Source: EUROCONTROL

Disruption of GNSS requires realistic and effective mitigation techniques

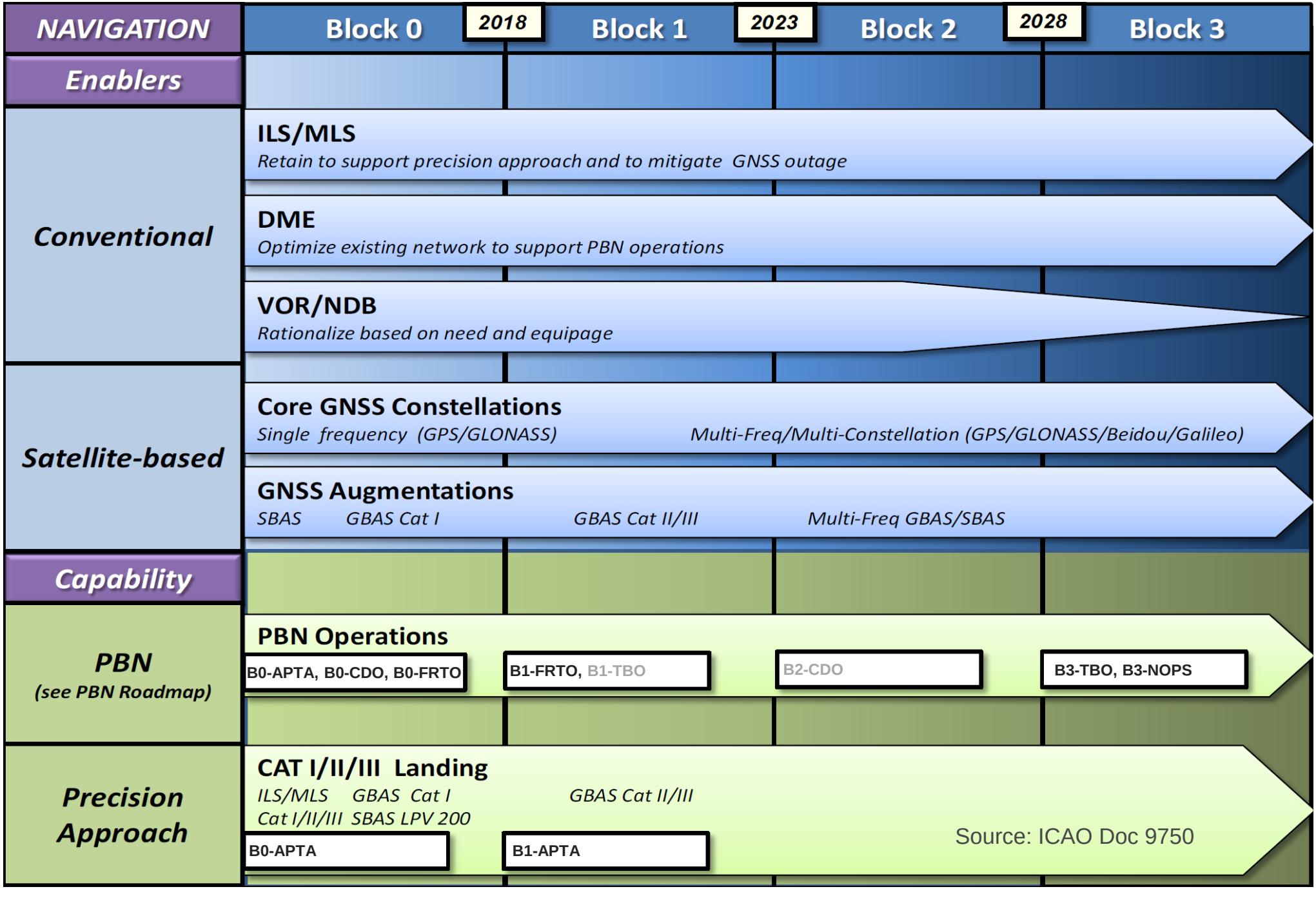
Three main methods (can be applied in combination):

- Taking advantage of on-board equipment, particularly Inertial Navigation Systems;
- Taking advantage of conventional navigation aids (such as Distance Measuring Equipment and Instrument Landing System), and radar; and
- Employing procedural (aircrew and/or Air Traffic Control) methods.

Source: ICAO Doc 9849 – GNSS Manual



Evolution of the air navigation infrastructure



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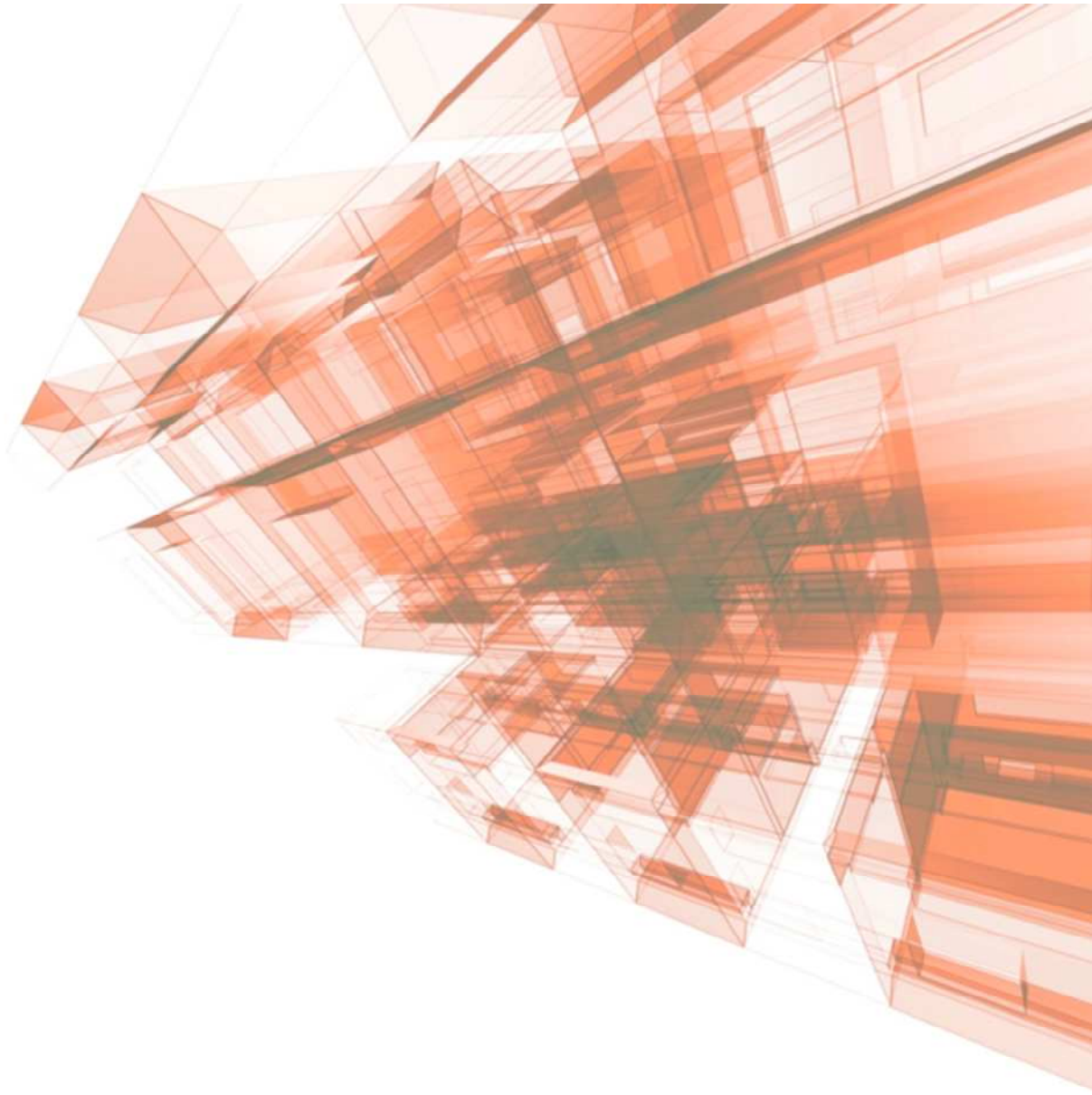

Thanks for your attention

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