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Harmonized CNS for the Future – Prerequisites

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Introduction

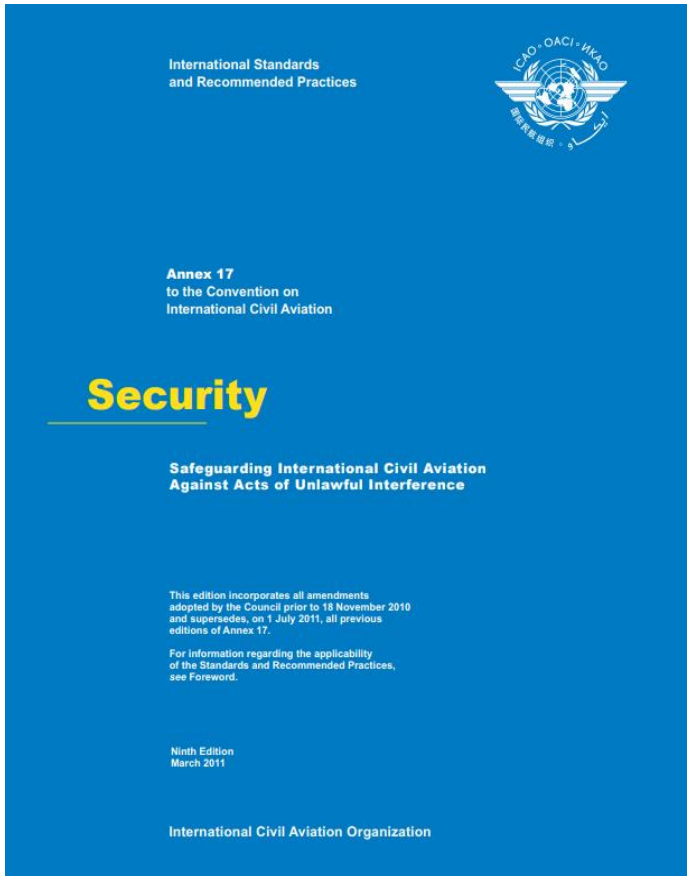
The Evolving Threat Landscape

- Security-related events, including attacks against ATS facilities and the CNS infrastructure
- Increasing frequency and sophistication of cyberattacks targeting aviation infrastructure
- Growing reliance on interconnected digital systems exposes new vulnerabilities
- GNSS services are particularly vulnerable to jamming and spoofing

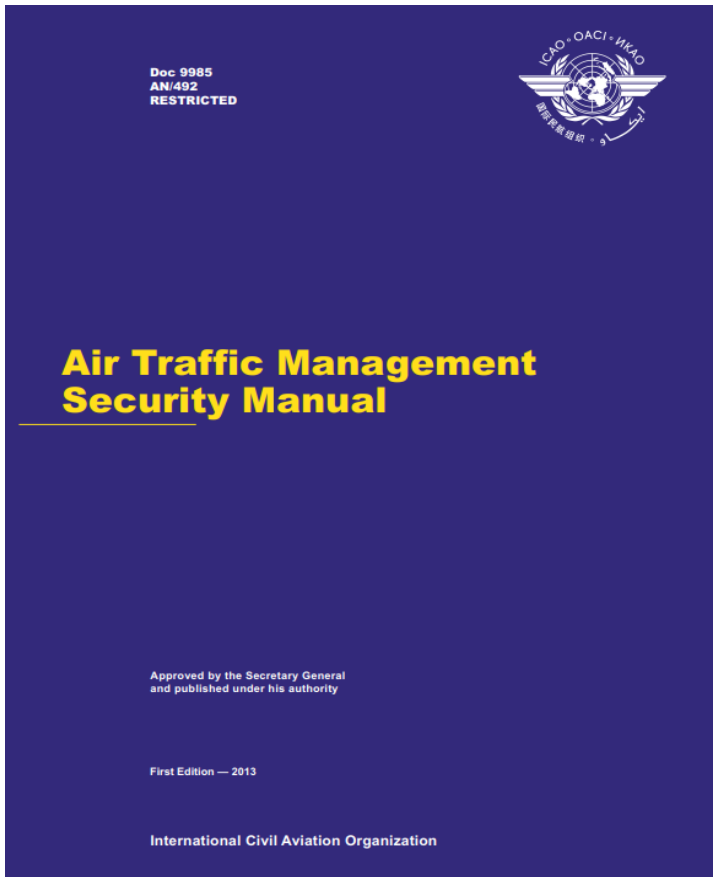
Some Key Initiatives for Harmonized CNS Resilience

- Integration of defense mechanisms for threat detection and response
- Enhanced civil-military coordination to address GNSS interference risks
- Retention of sufficient conventional NAV infrastructure to ensure continuity of safe, efficient and secure ANS
- Implementation of trust frameworks for protected and resilient data exchange
- ICAO ICNSS Task Force is developing roadmaps and streamlining framework for CNSS standardization

ICAO COUNCIL adopted Amendment 12 to Annex 17 (Nov 2010) includes ANSP



Annex 17



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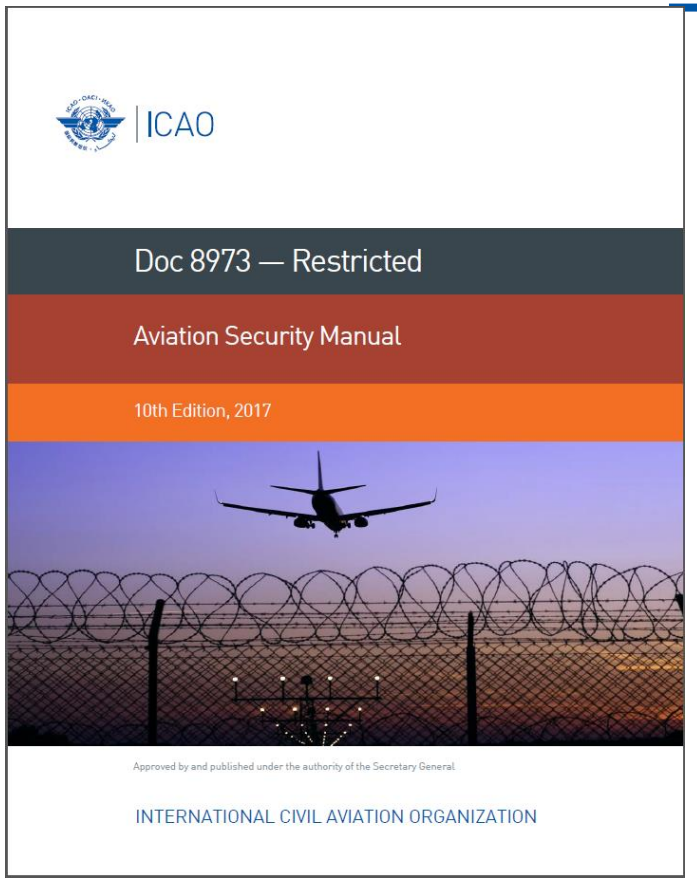

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Safeguarding of the ATM system from security threats and vulnerabilities (ATM protection)

1

ATM Security Scope

Provision of security services that contribute to civil aviation security, national security and defence (ATM security operations)

2

ATM Security Scope

Cyber resilience

- Civil aviation CNS (Communication, Navigation, and Surveillance) systems were mostly designed without much consideration for protecting communication channels or authenticating sources.
- Uncoordinated efforts to protect each CNS system individually will result in a disjointed set of incompatible technical solutions, which hampers interoperability.
- ICAO expert groups are working collaboratively to address the challenges in protecting CNS systems in a coordinated and globally harmonized way. They are developing and promoting common Standards and other technical materials that will provide safety and cyber-resiliency into the future.
  - This work is built on open standards, considering the unique challenges of civil aviation CNS communication links such as limited bandwidth and relatively small message sizes.
  - Alignment of efforts between ICAO and industry standards organizations.
  - Work is currently being concentrated in ground-ground and air-ground communications, satellite-based augmentation, and emerging areas.

Cyber resilience

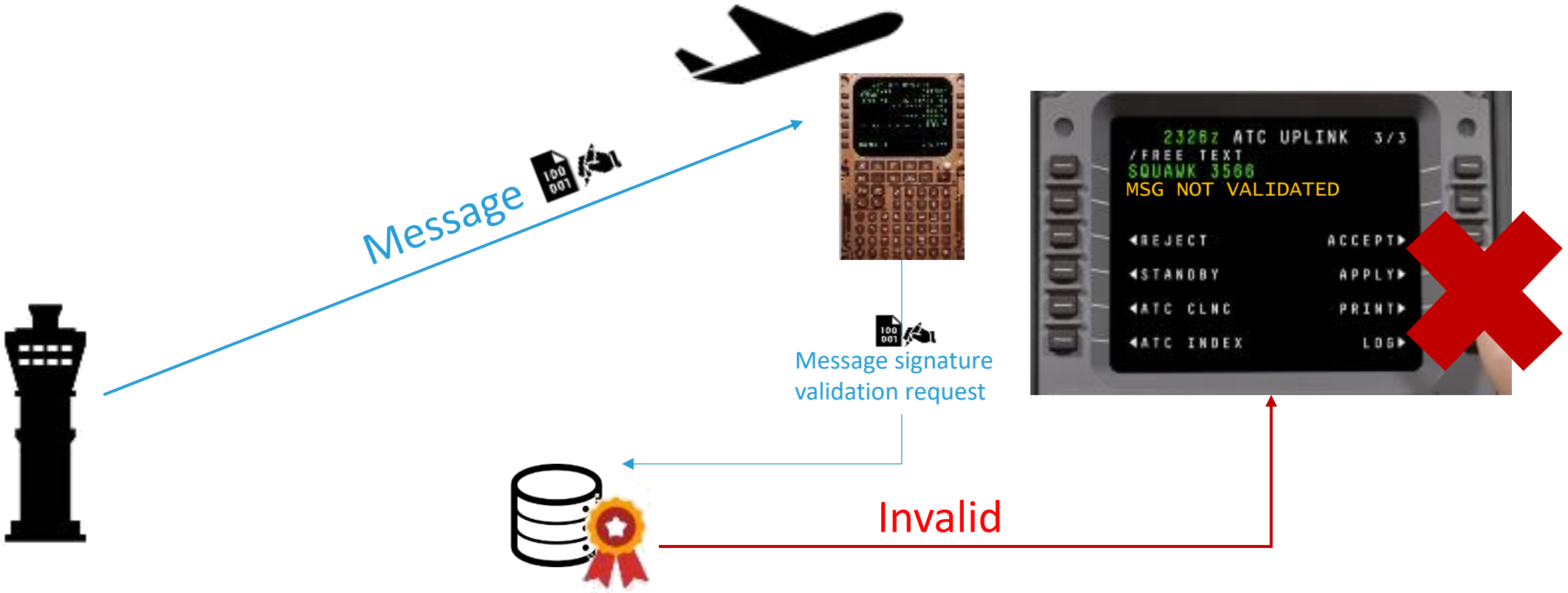
- Specifically, ICAO is developing provisions for cyber-resiliency in CNS systems in the following areas
  - Air-ground communications – protecting air-ground communications in the ACD
  - Satellite-based augmentation systems – authenticating augmentation signals against impersonation
  - Identification and authentication of drone aircraft

- Work in these areas is being closely coordinated with industry standards bodies such as RTCA and EUROCAE for associated MASPS and MOPS, as well as technology groups like the Internet Engineering Task Force (IETF) for work with drones

Information Exchange via Trust Frameworks

- Allows for digital trust through common policies, methods and technical requirements
- Facilitates protected, secure and resilient information exchange in the global aviation ecosystem
  - Global interoperability standards for confidentiality, integrity and availability
  - Robust methods for authenticating people, systems and information
- Key enabler for cyber-resilience of CNS systems

Example


Message
Message signature validation request
2326z ATC UPLINK 3/3
/FREE TEXT
SQUAWK 3566
MSG NOT VALIDATED
◂REJECT
ACCEPT▸
◂STANDBY
APPLY▸
◂ATC CLNC
PRINT▸
◂ATC INDEX
LOG▸
Invalid

GNSS for Aviation
(PNT)

1 Performance-Based Navigation (PBN)

GNSS can supports navigation applications in all phases of flights

2 ADS-B & ADS-C

Automatic Dependent Surveillance-Broadcast and Contract systems rely on GNSS for accurate positioning.

3 Airborne Safety Net Systems

GNSS enhances collision avoidance and terrain awareness systems.

4 Search and Rescue (SAR) Operations

GNSS improves the efficiency and accuracy of locating distressed aircraft or vessels.

Additionally, GNSS is crucial for time synchronization in various CNS/ATM systems and plays a vital role in Unmanned Aircraft Systems (UAS) operations.

GNSS for Aviation (Benefits)

1 Enhanced Safety

GNSS provides accurate positioning and timing information, significantly improving aviation safety.

2 Fuel Efficiency

Precise navigation allows for optimized routes and reduced fuel consumption, benefiting both the environment and operational costs.

3 Increased Capacity and Accuracy

GNSS enables more efficient use of airspace and improved traffic management, increasing overall system capacity.

4 Global Coverage

With multiple satellite constellations, GNSS offers worldwide coverage, ensuring reliable positioning services across the globe.

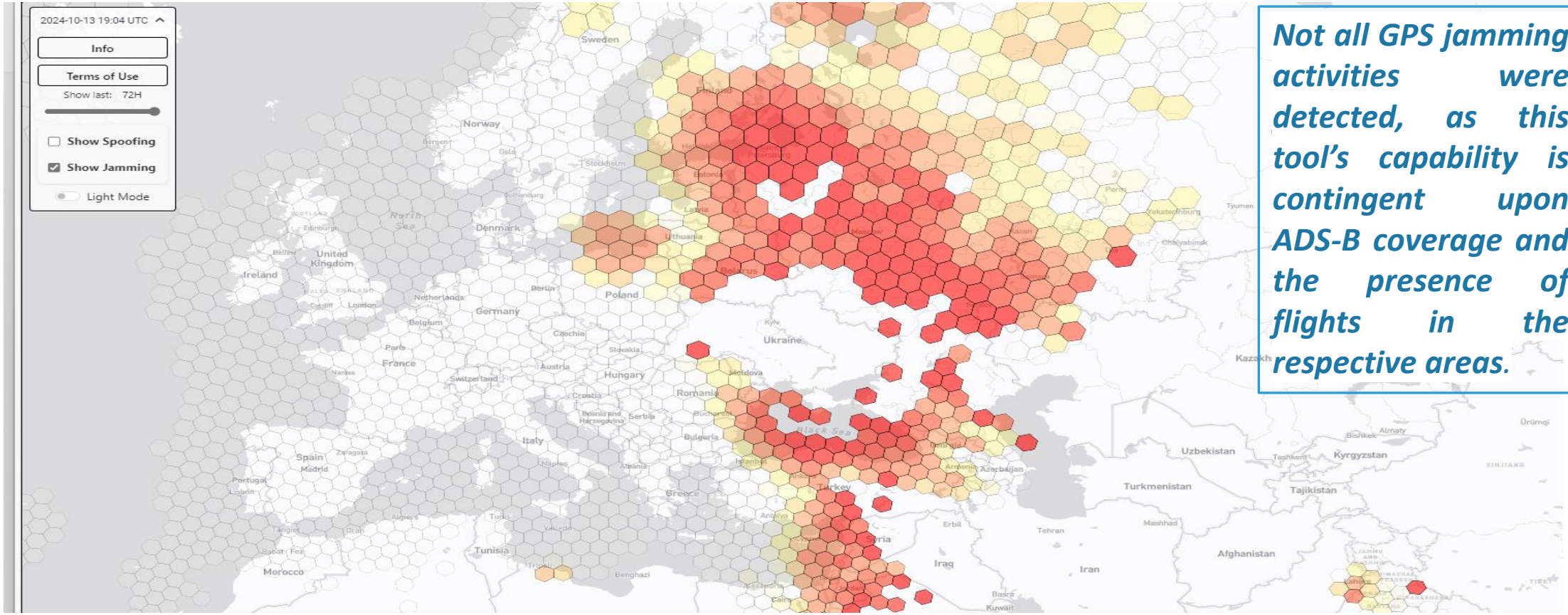
GNSS Vulnerability

GNSS signals are susceptible to interference, both intentional and unintentional, which can compromise system reliability and accuracy

Jamming is Intentional broadcasting of radio signals at GNSS frequencies can disrupt services, posing a significant threat to navigation and timing applications.

Spoofing is the broadcast of GNSS-like signals that cause avionics to calculate erroneous positions and provide false guidance. This sophisticated form of interference can be particularly dangerous as it may go undetected by the receiver.

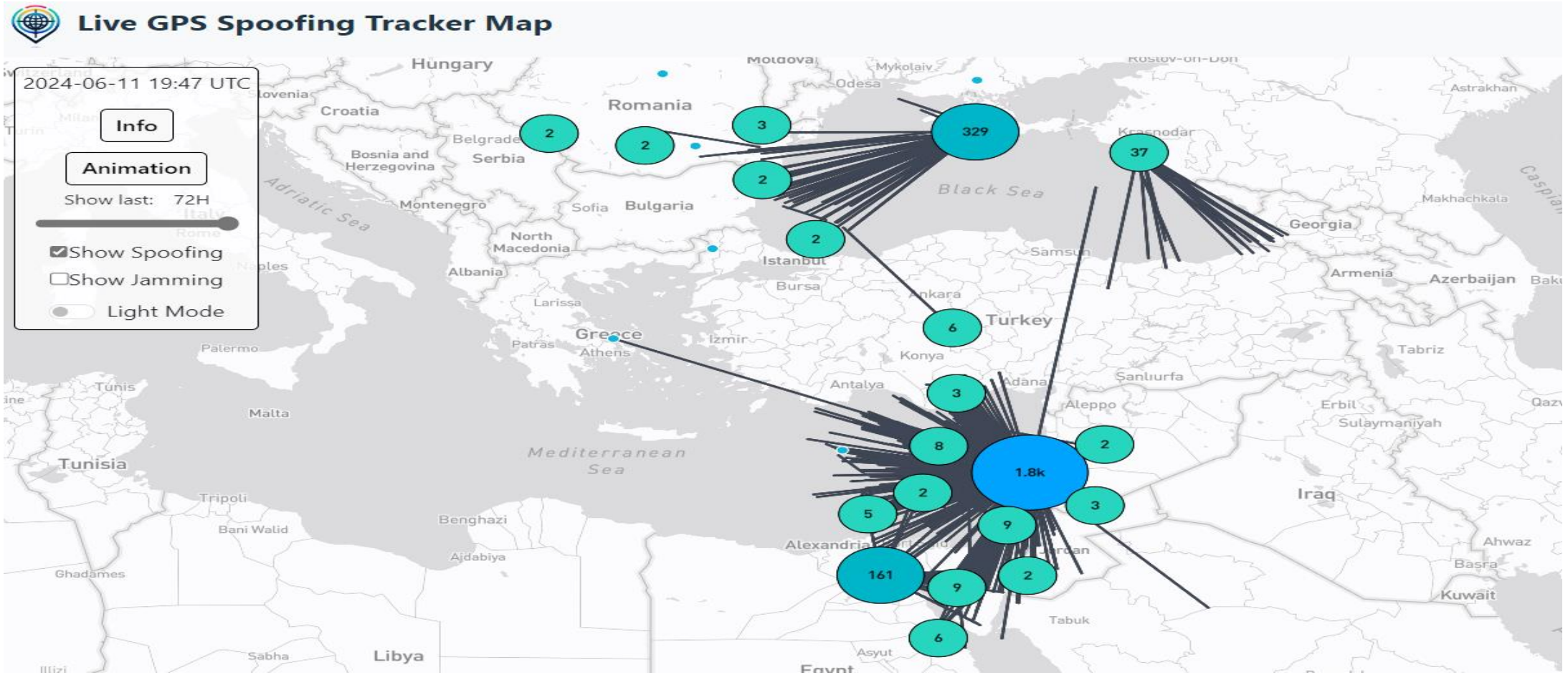
GNSS Jamming



Not all GPS jamming activities were detected, as this tool's capability is contingent upon ADS-B coverage and the presence of flights in the respective areas.

Areas of potential **GPS jamming** are indicated by colored hexagons.

GNSS Spoofing



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Towards Resilient PNT

Complementary PNT (C-PNT

- The concept was introduced through A41-8C
- Inertial sensors and DME considered to be the most suitable near-term technologies for mitigating GNSS RFI (ANConf/12, Rec 6/8 e-f)

Alternative PNT (A-PNT)

- Provide guidance as appropriate to maintain safe and efficient operations in case of GNSS ***outages***
- Amend DME and other provisions as necessary to optimize APNT functions while preparing for an efficient transition

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Assembly Resolution A41-8/C

The 41st Assembly, Resolution A41-8, Appendix C, ICAO policy on GNSS (and more generally CNS systems) resilience, directly addresses both jamming and spoofing

APPENDIX C

Ensuring the resilience of ICAO CNS/ATM systems and services

Whereas the CNS/ATM systems are evolving and so are the associated CNS threats and vulnerabilities;

Whereas the occurrences of interferences against satellite-based CNS systems and global navigation satellite system (GNSS), in particular, have significantly increased;

Whereas CNS resiliency to interference needs to be addressed at a global level with a holistic approach, ensuring an efficient and coordinated evolution between the infrastructure architecture, improved technological capabilities, civil and military operational procedures, radio regulatory authorities and civil-military coordination;

Recognizing that resiliency to interference needs to be improved by maximizing the integration of all suitable ground infrastructure, space infrastructure and airborne components in a complementary and cooperative manner, to be as robust as possible to cases of satellite-based service disruption or environments where false or deceptive signals are present;

Recognizing that both the aircraft on-board and ground infrastructure complementing the satellite-based CNS systems need to be adapted to include, where appropriate, interference detection, mitigation and reporting functions to support the resolution of operationally encountered performance anomalies;

Believing that, combined with the use of the appropriate legal framework, such capabilities and measures will allow for the relevant authorities to act upon harmful interferences caused by the illegal operation of transmitters and avoid the proliferation and the use of such illegal transmitters and the misuse of test and maintenance equipment;

Believing that, with appropriate coordination and application of best practices, military and State authorities can conduct GNSS-related testing and other interventions using radio equipment as necessary and without causing an undue impact on civil aviation;

Believing that civil-military coordination should facilitate the sharing of relevant information with airspace users, especially when flying in the vicinity of a conflict zone; and

Acknowledging that loss of crew's situational awareness from malicious origin is classified as a cybersecurity threat and cannot be tolerated in civil aviation; and that intentionally sending misleading signals to replace the accurate signal is a far more serious threat to flight safety than the loss of this signal.

The Assembly:

1. *Encourages* States to transition towards optimized, secure CNS systems based on complementary integration of suitable and independent aircraft capabilities, satellite- and ground-based infrastructure which maximize resiliency and robustness to any type of interference;

2. *Encourages* standardization bodies and industry to develop appropriate interference detection, mitigation and reporting capabilities for the aircraft on-board, satellite- and ground-based CNS system components, in order to ensure higher CNS resiliency, continuity of operations and prevent any cascading effects from the use of compromised position, velocity or time data;

3. *Encourages* States to ensure that sufficient terrestrial CNS capabilities remain available to ensure safe operations and complement aircraft-level integration of position, velocity and time with independent surveillance information;

4. *Invites* ICAO to develop high-level principles on how to integrate CNS ground, space and on-board systems and capabilities to obtain more resilient positioning and timing services;

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Build a Framework for GNSS & Aviation Resiliency

- Need to know where aircraft are affected by Interference, Jamming and/or Spoofing
- Need to understand what GNSS-based services can no longer be used
- Need to understand aircraft operational impacts (capability limitations & safety considerations)
- Must work together to:
  - Address aviators' and flying publics' safety, security, and economic needs
  - Address each individual Interference, Jamming and/or Spoofing event/location to restore normal operations

ICNSS and Evolving Standardization

- *Innovation* starts on the flight deck, at the control position and on the tarmac
  - People using the tools are the first to know how they can be improved

As things have just become more complicated

The list of stakeholders is growing…and fast

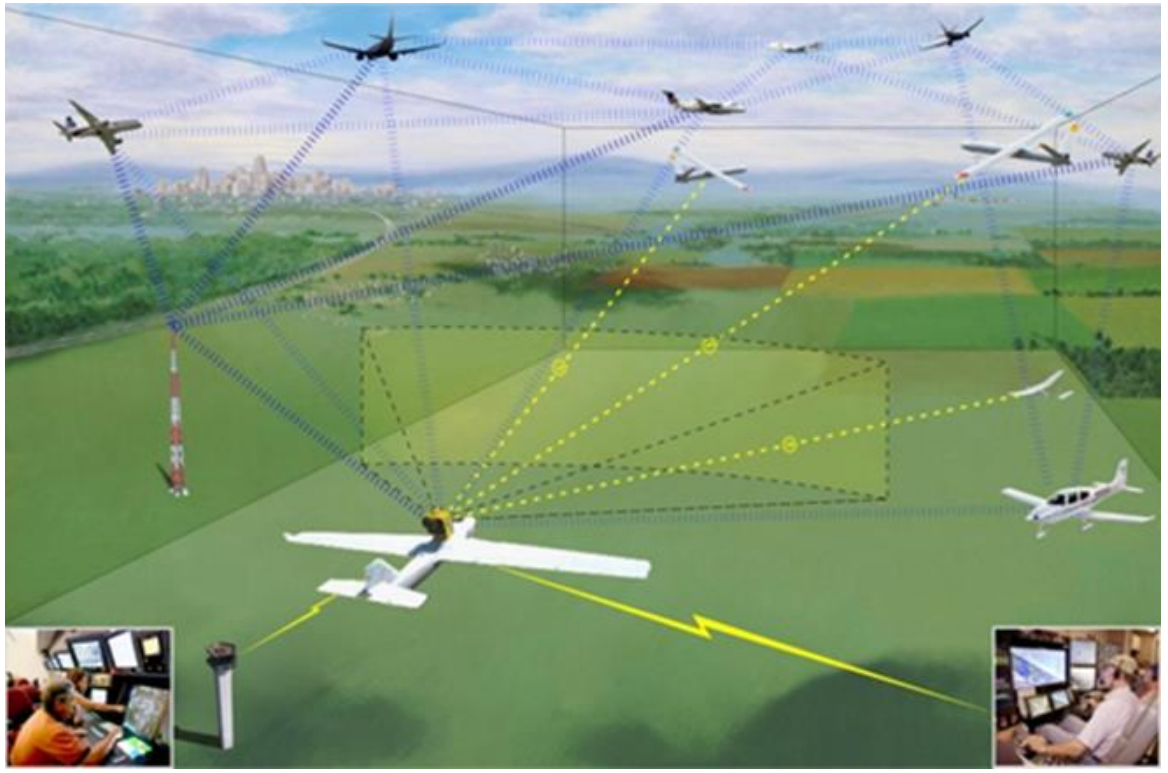
- Drones!
- Urban Air Mobility!!
- Near Space Vehicles!!!
- Space Tourism!!!!

Can we keep up?

These new entrants introduce unique operational and regulatory challenges that must be addressed to ensure safe and efficient airspace integration.

New Entrants, Diverse Needs, Global Challenges

Safe, secure co-existence



ICNSS and Challenges

- **The evolution of the CNS systems will require aviation to face two main challenges:**

  - **Spectrum challenge**
    - **Limited spectrum resource**
    - **Increasing pressure from non-aviation users**

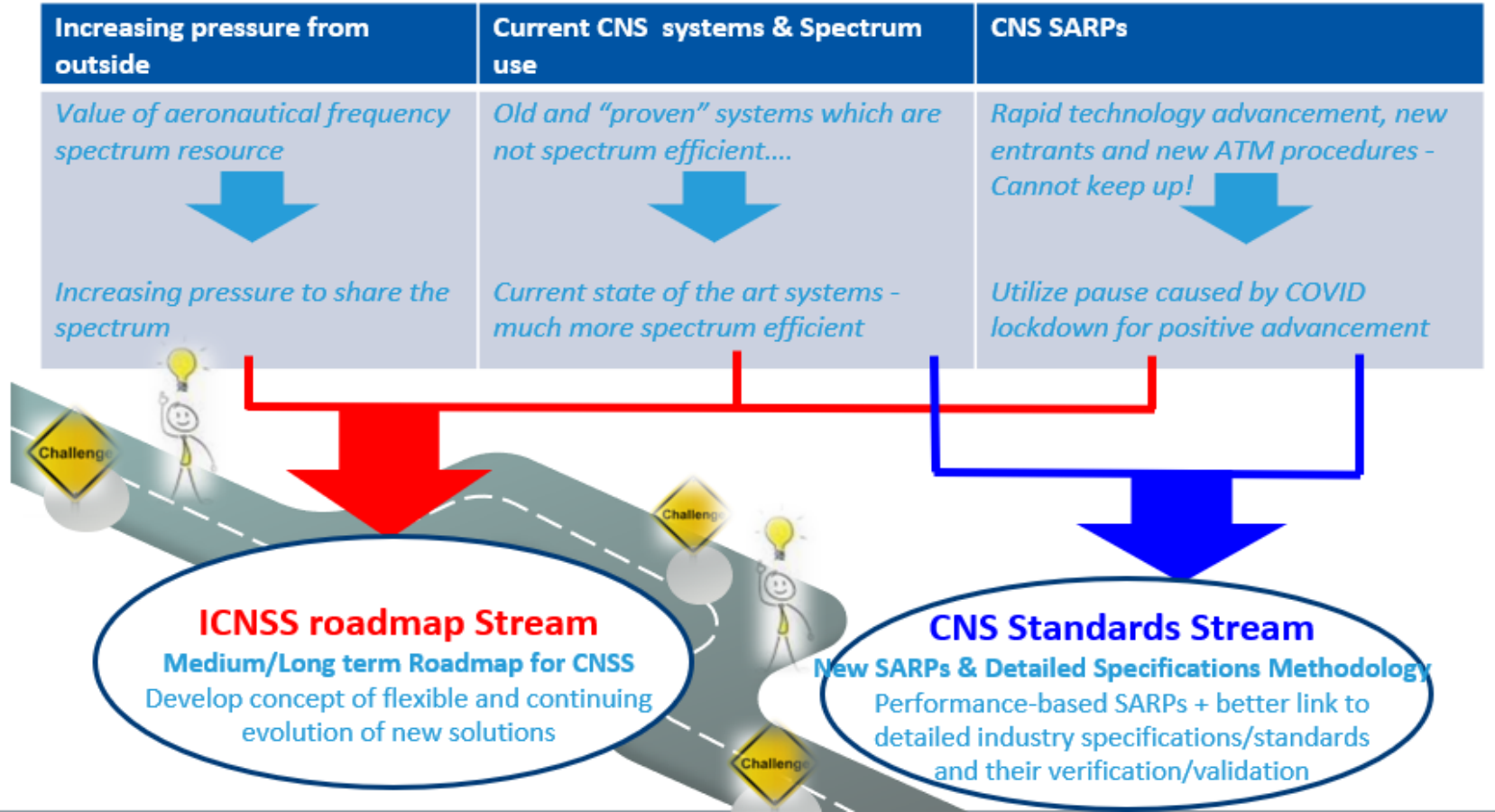
  - **Institutional challenge**
    - **Slow adoption of new technology across the globe**
    - **Regulatory framework needs to accommodate the accelerating pace of innovation**

ICNSS Road Ahead

- **As a first step facing these challenges, ICAO established the ICNSS Task Force with two main objectives:**

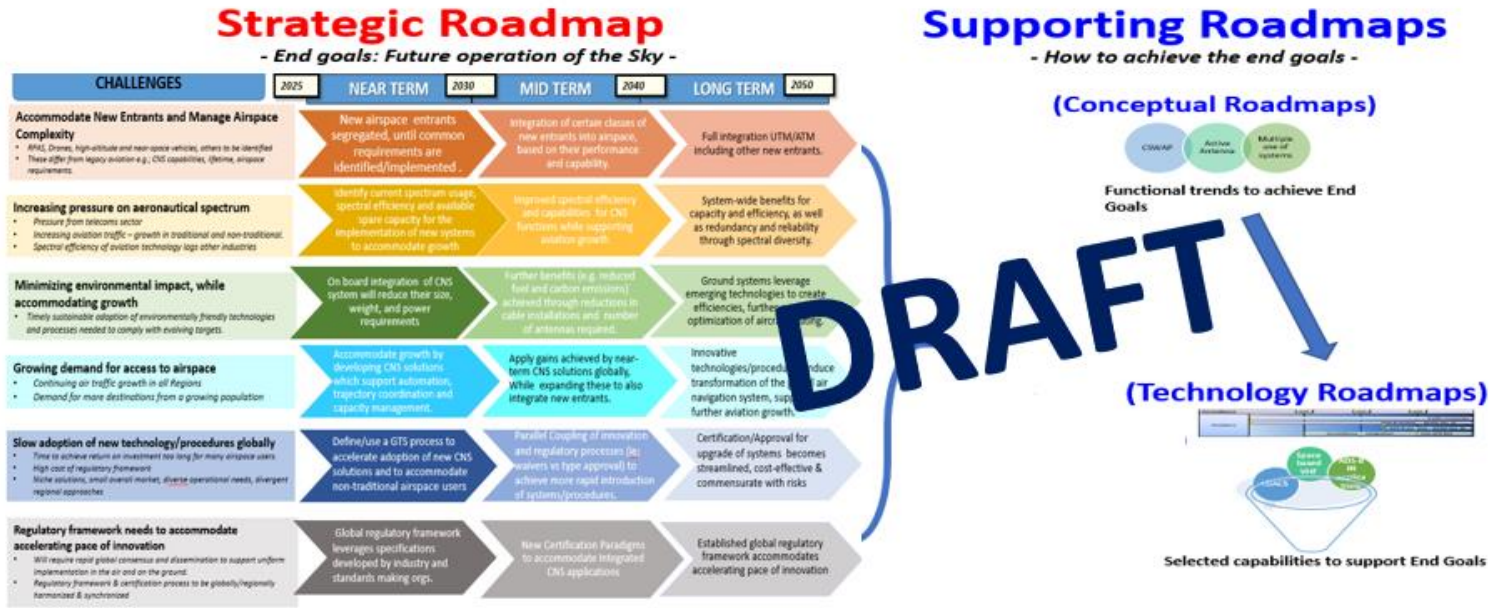
  - **Develop roadmaps for CNS in the near, medium and long terms; and**

  - **Develop a new, streamlined framework for CNS & Spectrum standardization.**



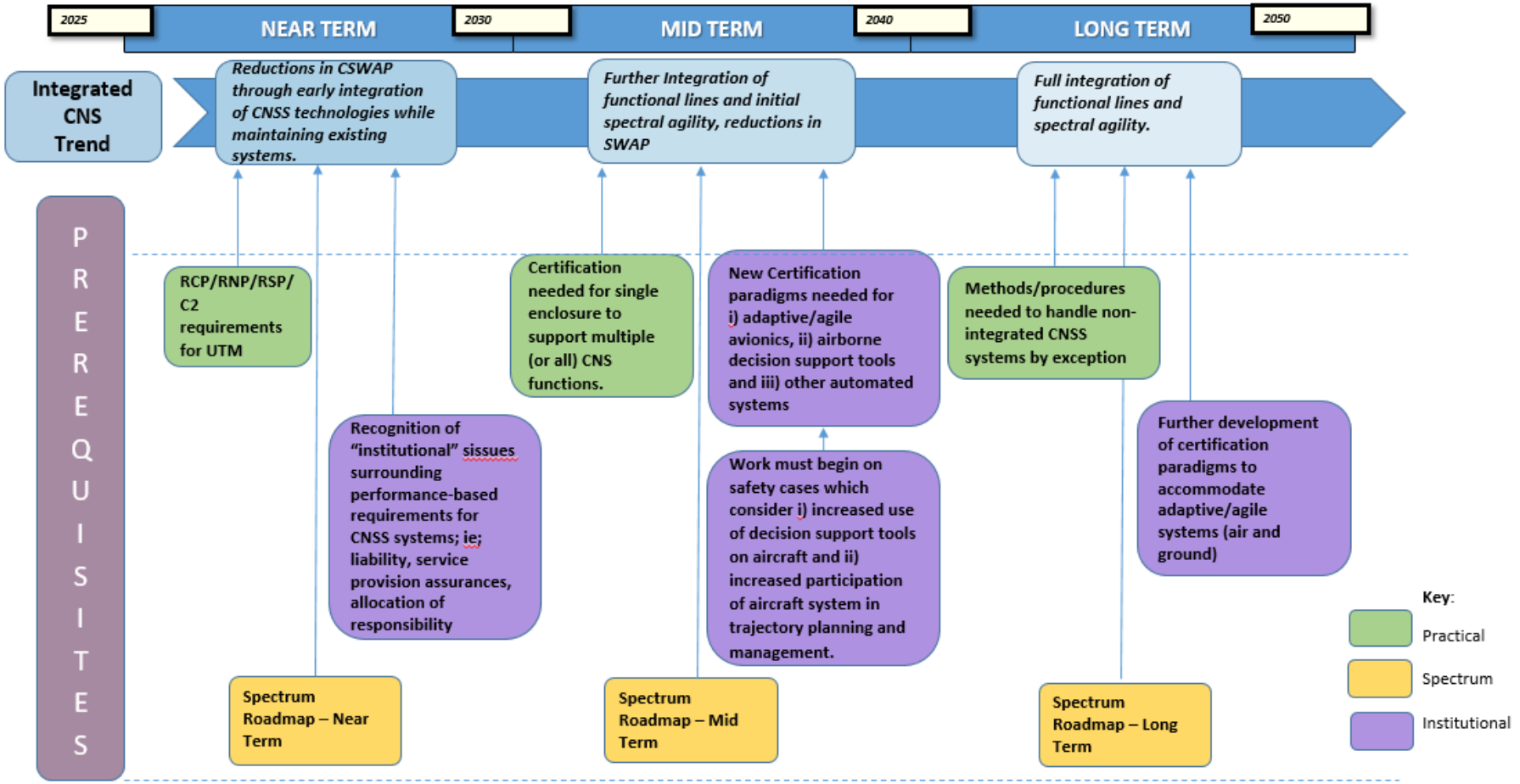
ICNSS Roadmap

- **Leverage recent state-of-the-art advances in CNS technologies**
- **Ensure aviation remains a responsible user of spectrum**
- **Focus on Safety, Security, Efficiency and Sustainability of global aviation**
- **Benefits of the Roadmap**
  - Be a common vision, shared between States and aeronautical industry, of CNS and Spectrum evolution in the medium and long term;
  - Realize more efficient and cost-effective CNS solutions; and
  - Extend the planning horizon of the GANP.



High-Level Roadmaps and Detailed roadmaps:
- see https://www.icao.int/airnavigation/ICNSS_project

The required prerequisites to progress the ICNSS concept



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Streamlined CNS Standardization Framework

- **A new approach for the development of SARPs and Detailed Technical Specifications**
- **Leverage a more performance-based approach**
- **Ensure interoperability**
- **Expected Benefits include, but not limited to:**
  - Less frequent amendments required for Annex 10;
  - Better link to aerospace specifications/standards outside ICAO;
  - Support speedy implementation of new technologies; and
  - Close coordination between SMO's to facilitate timely deliver of all provisions.

Minimal essential SARPs framework

Global Technical Specification (GTS) framework

CONCLUSION

- Collaboration among states, industry stakeholders, and regulatory bodies is essential to creating unified strategies for CNS security.
- Aviation must remain agile and capable of continuing operations during both planned and unplanned outages affecting GNSS Position, Navigation, and Timing (PNT) services, ensuring resilience and adaptability, and adopt A-PNT and C-PNT strategies once developed or defined by the experts group.
- Promotion of interoperable digital trust frameworks via common policies, methods and technical requirements.
  - Allows resilient and secure civil aviation data exchange
- Addressing challenges posed by drones, urban air mobility platforms, and other emerging technologies ensures safe integration into global airspace.
- Developing roadmaps for CNSS evolution.
- Streamlining the framework for CNS standardization to foster innovation while maintaining interoperability.

Thank You

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