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SAFE SKIES.
SUSTAINABLE FUTURE.

Massimiliano Ferla

Product Line Manager for Navigation Aids and
Non Radar Surveillance - Thales

Innovation embedded in new Navaids & Surveillance systems

Context

PBN and A-PNT needs

GNSS reversion & Navaids innovation

Navaids innovation sustaining safe and resilient navigation

GNSS RFI monitoring

RFI monitoring and identification to protect Navigation operations

Context

The growing complexity of operational and environmental requirements for civil and military operations necessitates innovative, compact, resilient, deployable, and energy-efficient systems to support safe and effective **Performance-Based Navigation** (PBN) and landing operations in times of peace, crisis, or conflict.

While RNAV and RNP operations, enabled by Global Navigation Satellite Systems (GNSS), support efficient operations, the increasing threats of GNSS jamming and spoofing demand **Alternate Position, Navigation and Timing** (A-PNT) systems to ensure continuity in PBN operations and requires means for issues detection.

The optimization and rationalization of ground infrastructure, known as **Minimum Operational Network** (MON) implementation, guarantee efficient and resilient secured operations while minimizing the cost impact of the infrastructure.

Key technologies such as **Tactical Air Navigation (TACAN), Instrument Landing Systems (ILS), Distance Measuring Equipment (DME), cybersecurity** measures, and enhanced capabilities are essential to meet these new operational requirements.

Key capabilities to detect GNSS jamming and spoofing are key to safely manage airplane navigation and surveillance

International Organizations recommendations

How ANSP have to deal with GNSS issue

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- ICAO, in October 2022, issued a resolution paper including (ICAO ASSEMBLY – 41st SESSION) a CNS/ATM strategy recommendation (resolution A41-8) Ensuring the resilience of ICAO CNS/ATM systems and services in case of interference to the Global Navigation Satellite System (GNSS)..
- ICAO, in April 2024, issued a Aviation Safety Concern on interference to the Global Navigation Satellite System (GNSS) recalling both ICAO resolution A41-8, FAA Safety Alert for Operators (SAFO) and EASA Safety Information Bulletins (EASA SIB) to be followed.

EASA

- EASA, in July 2024, issued a Safety Information Bulletins (EASA SIB) in which recognize the issue on GNSS jamming and spoofing and recommends an appropriate Navaids infrastructure in order to secure the operations:
- **CAs should: Ensure that contingency procedures are established in coordination with ATM/ANS providers and airspace users, and that existing non-GNSS based navigation infrastructure, ILS, DME stations and Very High Frequency VOR and kept operational as required**

FAA

- FAA, in January 2024, issued a Safety Alert for Operators (SAFO) **recommending operators to check, before departure, on reported GNSS outages and availability of conventional Navigational Aids (Navaids) as an alternative.** Furthermore, **FAA recommends, during the flight, to ensure that Navaids are available**

AIRSPACE DESIGN CONCEPT

Navaids infrastructure rationalization strategies

Air Navigation Conferences (ANC), ANC 12, to optimize the overall navigation infrastructure investments, also provided recommendation for rationalization of terrestrial navigation aids while implementation of performance-based navigation:

a) Assess the opportunity for realizing economic benefits by reducing the number of navigation aids through the implementation of performance-based navigation

b) Ensure that an adequate terrestrial navigation and air traffic management infrastructure remains available to mitigate the potential loss of global navigation satellite system service in their airspace

c) Align performance-based navigation implementation plans with navigation aid replacement cycles, where feasible, to maximize cost savings by avoiding unnecessary infrastructure investment

A-PNT - GNSS Reverse benefitting of Civil/Military cooperation

Following recommendations, to ensure ANSPs' contingency plan, the following Alternative Positioning, Navigation and Timing (A-PNT) systems can be used:

ILS systems, to provide final approach and landing capabilities

DME systems, to provide distance to the point and **supporting DME-DME** network to provide similar RNAV performances -> DME-DME navigation

VOR/DME, providing Navaids waypoints to Civil aircraft to Navigate

TACAN, providing Navaids waypoints to Military aircraft to Navigate and **supporting ILS/DME, VOR/DME or DME-DME navigation for Civil aircraft** -> TACAN to follow same performances and certifications of civil applications (ICAO Annex 10, EUROCAE ED-57, EMC, SAFETY and R&TTE ("CE" marking), MIL-STD 461F, STANAG 5034 ISSUE 1989 (ed.3), MIL STD 291-C)

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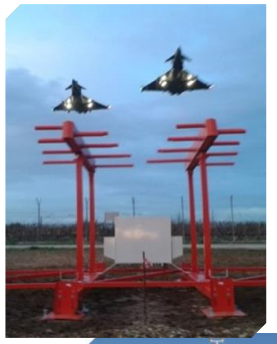
Additional Thales innovation to support recommendations

To increase the resilience of the A-PNT systems, new functionalities or operational capabiliites can be implemented



Mobile solutions with high reliability, flexibility and modularity to support emergency, crisis or temporary Navaids disruption

Increased system adaptability to the various sites, like:

- Coverage extension to support large areas
- Coverage reduction to reduce system to system interferences
- Increased spectrum efficiency

Systems evolutions to support additional and future services

System integrity level increase to support extended operations

NAVAIDS INFRASTRUCTURE PLAN AND CAPABILITIES EVOLUTION

Navaids product Evolution supporting efficient deployment and rationalization

While planning for the Navaids infrastructure, new features are under development on DME (Enhanced DME) within the frame of SESAR project and including:

- DME/DME passive ranging: interrogation reductions thanks to spontaneous synchornization signals emission from the ground to allow airplanes to calculate their positions in the space
- DME Z-channel introduction, on top of the used X and Y channel cos

Furthermore, considering the opportunity to benefit of commonalities and dual use of Military forces' Navigation Aids infrastructure, cooperation with them can increase the rationalization principle, in particular:

- Re-assess the TACAN coverage to better plan and use the DME signal that can be generated by the TACAN equipment
- Possibility to introduce Enhanced DME capabilities in TACAN equipment can strengthen the seamless use of the global Navaids infrastructure

Enhance systems resilience: ILS new features and future innovation

More compact and low power consumption

Using the new technologies it is expected to:

- **Drastically simplify the installation and setting up time**
- **Improve the adaptability** to the various environment
- Applicability to **new air traffic typology like drones, air taxis and helicopters** on helipads, helistops and vertiports

Cyber-secured equipment to support asset protection

More resilient operations

Increasing the flexibility in adaptation to the specific airport layout

Reducing the reflections from nearby obstacles

Increasing the flexibility in glide slope angle definition to support different approach and landing operations

Enhance systems resilience eDME

Improving DME spectrum utilization to add value to your future navigation

1 **DME spectrum issues!**

- DME is criticized as being spectrum utilisation inefficient

2 **How e-DME can contribute to better spectrum utilization?**

- Introduction of passive ranging reduces the overall load on both downlink and uplink directions
- e-DME can introduce the Z-channel coding

3 **Frequency re-use by Y and Z channels**

- It can be used to increase the number of DME channels
- It can be used to free part of the current frequencies used by X-channels

Enhance systems resilience: TACAN new features and future innovation

INNOVATIONS on TACAN can follow DME innovations

Enhanced TACAN (e-TACAN)

- **Similar approach,** spectrum optimization thanks to higher digital signal generation control and monitoring, higher accuracy, re-use of Z-channels coding **can be transferred to TACAN to implement TACAN/TACAN navigation, other than supporting the cooperation of in between civil and military providing DME-DME enhanced capabilities.**
- **Cyber-secured equipment to support asset protection**

Introducing data on the TACAN & DME transmission channel allows an increased pilot awareness and optimize the communications air – ground

- **Passive ranging capability**
- **Allows a reduction of the probability of interception of the aircraft during missions**, other than optimizing / reducing the overall channel load

Innovative Business Model

DRONE BASED INSPECTIONS

EFFICIENT DELIVERIES OF THALES ILS IN CIVIL AND MILITARY MISSIONS

- Greater correlation with flight checks than handheld or vehicle mounted methods
- It provides all necessary parameters required to perform the different checks and measurements
- Reducing inpection and measurement time and risk of flight check failures

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RFI Monitoring

Interference and Spoofing

Both interference and spoofing might affect the PNT performances and availability: Air Navigation Conferences (ANC), ANC/13, highlighted the need for CNS spectrum protection and access.

Two main categories of action can be envisaged:

- Regulatory: assign and coordinate frequency allocation for old, existing and new / emerging technologies to avoid overlaps and keep appropriate separations
- Monitoring & Identification: monitor the spectrum usage over the PNT systems frequency band and identify the source of the disturbance

RFI Monitoring & Identification

To protect the Navigation operations, RFI monitoring and identification can be planned.

Spectrum Monitoring initiatives can be taken to monitor the spectrum used by the PNT and A-PNT networks:

Use of **wide band RF spectrum scanners** placed in strategic positions to identify spectrum mis-use and alert the community in case of interferences

Use of drones equipped with either wide band RF spectrum scanners or specific frequency monitoring systems, to be used on a periodic interval of time or on specific areas of interest (sensitive targets or areas)

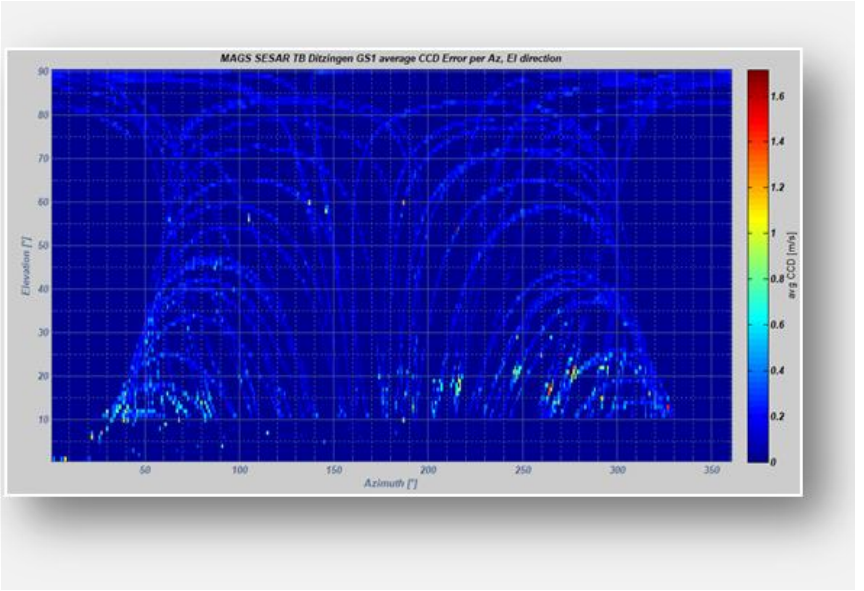
Use of ground network sensors to monitor the status of GNSS signal (i.e. ADS-B or MLAT systems) against pre-defined reference target

Use of multiple sensor sources can support spoofing detection and isolation

RFI source identification can support intervention and system recovery to normal conditions

Use of Direction Finder systems can point the RFI source

Use of specific aircraft for RFI detection can support protection and identification of RFI sources



Thank You

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