

Supporting
European
Aviation



EUROCONTROL Perspectives on Navigation Capability Evolution

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ICAO EUR / MID Navigation Symposium

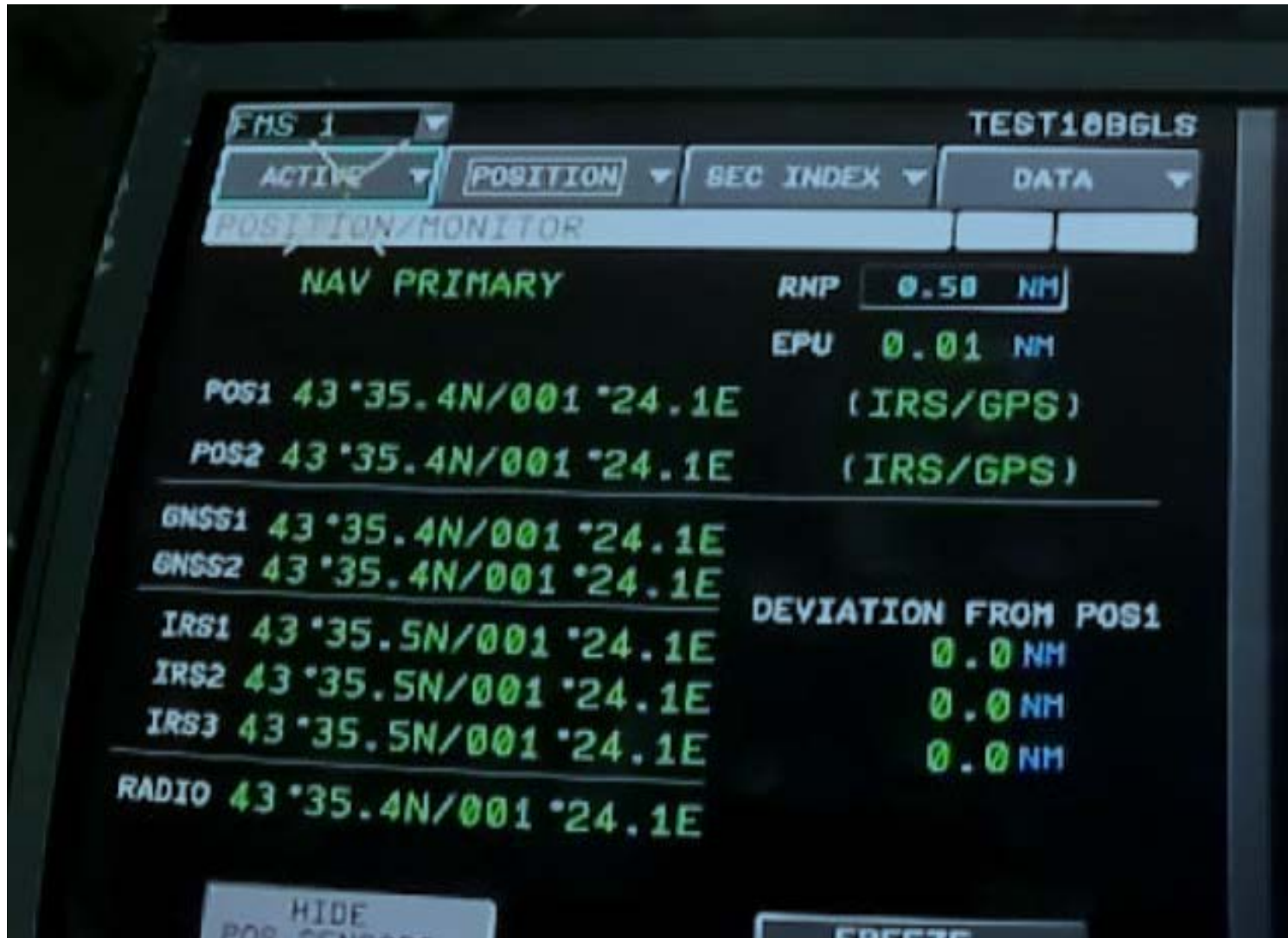
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NETWORK
MANAGER



Introduction: Do You See the Issues?



Path Towards Assured of Complementary PNT ?

- Definitions used by UN ICG:
 - (United Nations International Committee on GNSS)
- **Interoperability**
 - Multiple systems can operate in the same frequency band, free from unacceptable interference
- **Compatibility**
 - Combination of multiple systems achieves a service that is improved over what would be possible with individual systems alone
- Could we take it up a notch? “**System of Systems Integration**”
 - Aviation has been busy introducing common mode dependencies
 - Standardized and non-standardized
 - Analogue CNS Systems have mutual back-up functions (CNS Safety Triangle)
 - This has not propagated to more modern digital systems
 - Exploit multi-mode strengths to mitigate multi-mode weaknesses

CNS System Architecture Considerations: SUR Example

- Modern Cooperative Surveillance built on 3 technical layers
 - SSR (normally fully independent from GNSS, but have to be careful with time)
 - ADS-B (based on GNSS position, should evolve to assured hybrid position!)
 - WAM (using SSR signals, often dependent on GNSS time)
- Most medium to high-capacity airspaces in the world have at least SSR and ADS-B, many also WAM
 - Does SUR sensor fusion systematically compare the different positions?
- Consider the GNSS Spoofing Threat
 - Defending against GNSS Spoofing at GNSS receiver level WITHOUT any other sources – possible but quite difficult...
 - Comparing SSR and ADS-B position already available TODAY – spoofing detection could be MUCH simpler!

Complementary Positioning: Architecture Change?

- Many of TODAY's Aircraft, FMS NAV Integration: **“availability switch”**
 - IF GPSavailable THEN use GPS
 - IF GPSnotavailable THEN use INS or RADIONAV
 - unless forced through GPS outage, RADIONAV position gets ignored
 - systems today are trimmed to deliver high availability / continuity
- TOMORROW's Aircraft FMS NAV Integration: **“improved consideration of all sources”**
 - We need to forget the term “Alternative PNT”
 - Not interesting to carry another system on the aircraft just in case the other one does not work
 - Service provision: need to push for DME network to provide GNSS-like navigation service
- Current supporting developments:
 - RTCA DO384, MOPS for GNSS-aided Inertial Systems
 - Update of RNP/RNAV MASPS, DO236E / ED75F and MOPS, DO283C / ED323
 - EUROCAE WG107, DME Supporting PBN, new MASPS to cover DME Positioning for RNP
 - Update of ED57A, DME Transponder MOPS

ITU WORLD RADIO CONFERENCE 2023 DUBAI

Resolution on Prevention and mitigation of harmful interference to the radionavigation-satellite service in the frequency bands 1 164-1 215 MHz and 1 559-1 610 MHz

resolves to urge administrations

1 to apply necessary measures to avoid the proliferation, circulation and operation of unauthorized transmitters that cause or have the potential to cause harmful interference to RNSS systems ...

2 to take the following actions to prevent and mitigate harmful interference affecting RNSS operating in the frequency bands 1 164-1 215 MHz and 1 559-1 610 MHz ***without prejudice to the right of administrations to deny access to RNSS, for security or defence purposes:***

2.1 to encourage collaboration between spectrum regulators, enforcement authorities and RNSS stakeholders, in particular in the aeronautical and maritime domains;

2.2 to encourage cooperation between aeronautical, maritime and security authorities, as well as spectrum regulators, as appropriate, to address interference risks to RNSS systems that may stem from the activities of these security authorities;

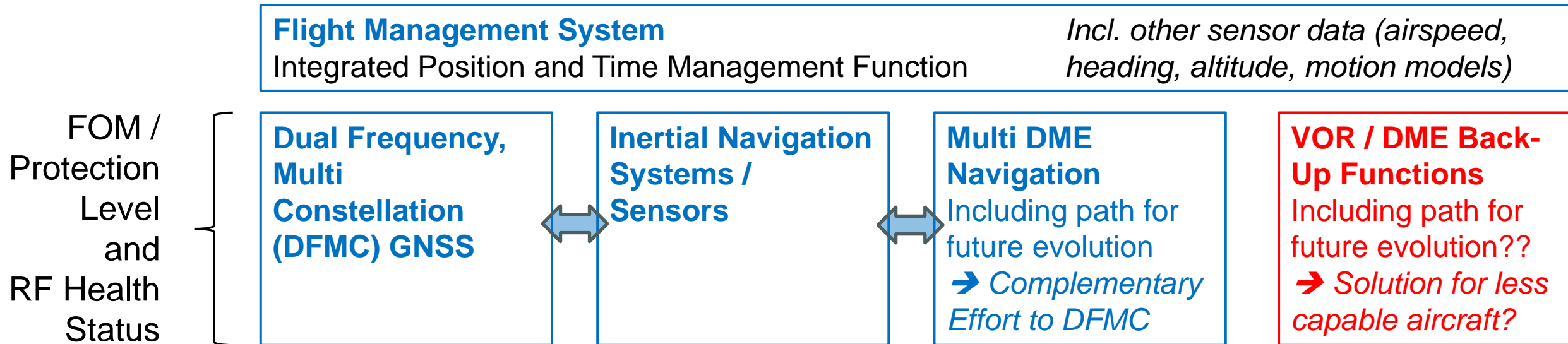
ICAO Assembly Resolution 41-8C

(Excerpt) 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;

“High Level Integration Principles”

- Avionics Integration: Industry / Avionics / Aircraft OEM Job
- SUR position integration: ATM System Industry / ANSP Job
 - **So far this is not prescribed or regulated – should stay that way**
 - But need a suitable framework for performance objectives
 - “Modular Integrity” is a key concept for future navigation
 - Safety / Security Trade-Offs need to be considered



Short Term Priorities

- Make sure that Inertial Navigation Systems work when required
 - Avionics Integrators must ensure that GPS is disconnected as soon as receiver outputs become unstable to ensure that faulty GPS outputs do not pollute INS coasting
 - All cascading effects from GNSS issues should be reduced or eliminated
- Make sure that Multi-DME Positioning works when required
 - Ensure DME Updating is Enabled
 - ANSP to provide DME RNAV SID/STAR whenever possible
 - Test DME positioning capabilities
- Improve provisions for contingency operations
 - Ensure alternative approach procedures can be used in case of GNSS outage (e.g., provide non-GNSS means for ILS intercept)

Summary

- Multi-DME Navigation can make a significant contribution for resilient navigation
 - Not the same as DME/DME (single pair) broadly known today
 - INS and DME can and should support ADS-B
 - DME is not the solution for all environments or all aircraft
 - Needs harmonized “integration upgrades” with FMS, DFMC GNSS and INS
 - “DME Forever” will not work for spectrum reasons, need evolution path
- Avionics integration needs to become more resilient and take better advantage of available complementary sensors, reduce CNS interdependencies
 - Need to overcome “magic is in the box” mentality
 - Similar efforts required at CNS ground system level
 - Need improved cooperation and common performance language
- ANSP need to improve service provision for GNSS contingency
 - Aircraft operators need clarity on available level of service