



ICAO

# MIDANPIRG/23 & RASG-MID/13

CAIRO - EGYPT

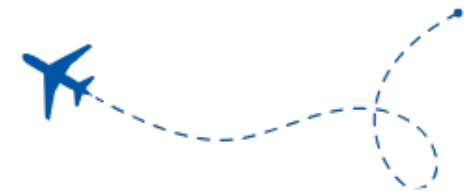
14-18 JUNE 2026



# GNSS Radio Frequency Interference (RFI) in Egypt: Challenges & Mitigation Strategies

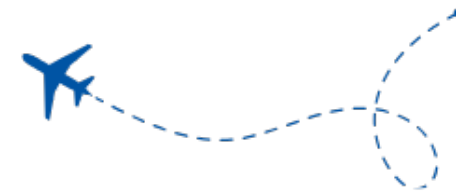
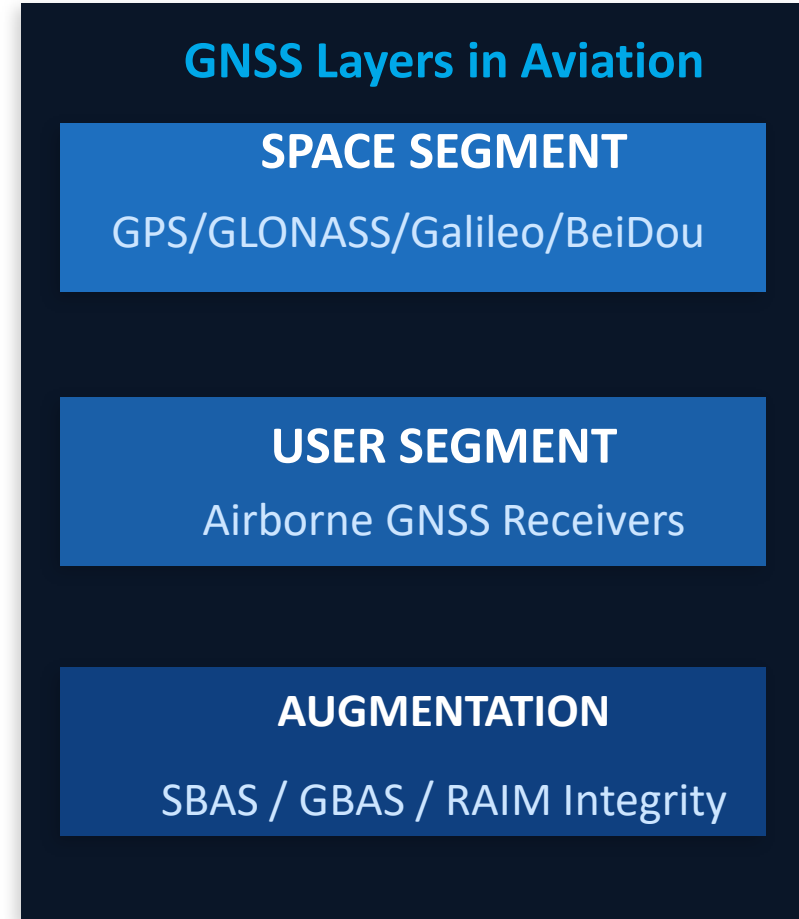
—  
**Eng. Waheed Sulaiman**

**CNS Engineer/ NANSC**





- GNSS is now the primary means of navigation for En-route, terminal area, and approach operations under ICAO Annex 10 & Doc 9849.
- Global aviation infrastructure heavily relies on GNSS as the primary enabler for Performance-Based Navigation (PBN).





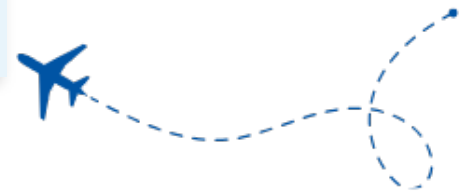
- GNSS vulnerability to low-power interference (Jamming & Spoofing) represents a critical safety and efficiency challenge worldwide.
- GNSS RFIs are expected to remain a persistent challenge in the coming years, despite international efforts by ITU and ICAO to minimize their occurrence and operational impact.

## ‘A’ Jamming

intentional high-power RF transmission that overwhelms GNSS receivers. Can result in complete loss of position, navigation, and timing (PNT).

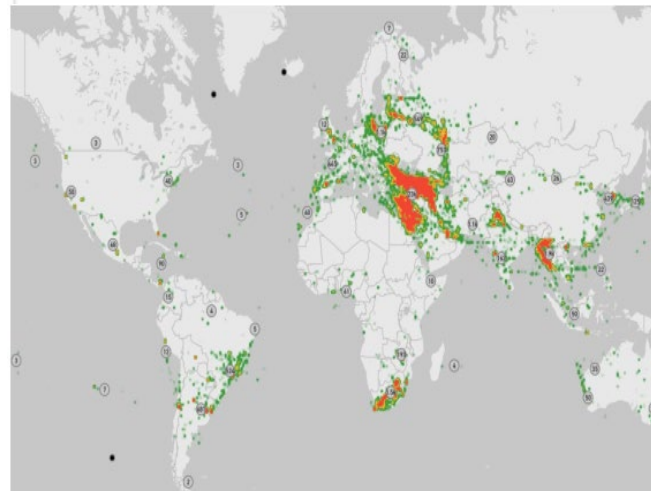
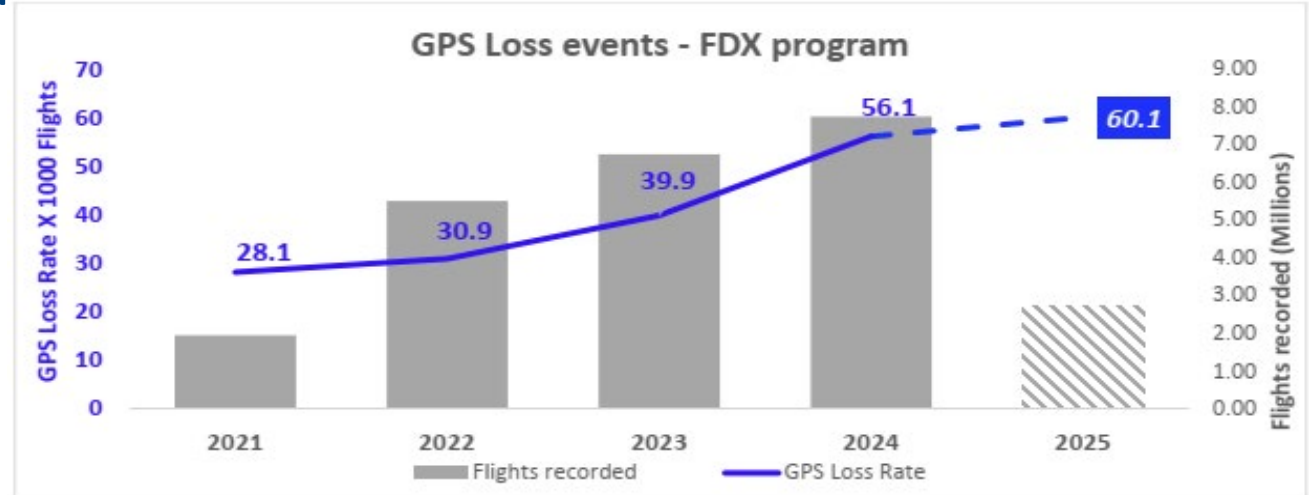
## Spoofing

Broadcast of GNSS-like signals that cause avionics to calculate erroneous positions and provide false guidance. More sophisticated and dangerous than jamming.

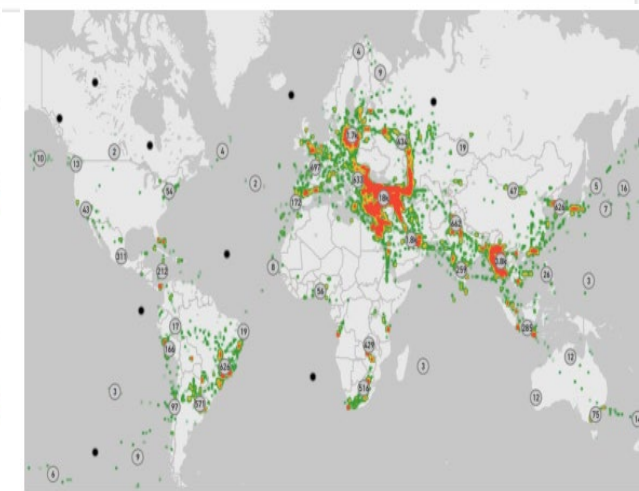


The GPS loss events illustrates that (IATA safety risk assessment):

- **Accelerating Trend:** GPS outages per 1,000 flights doubled from 28.1 (2021) to 56.1 (2024).
- **Historical Peak:** Outages hit a record 60.1 in H1 2025, showing an expanding threat.
- Over the past three years, the picture of RFI hotspots has evolved.



GNSS-RFI Recorded events 2024

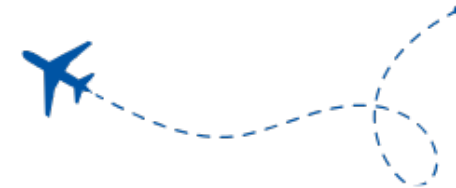
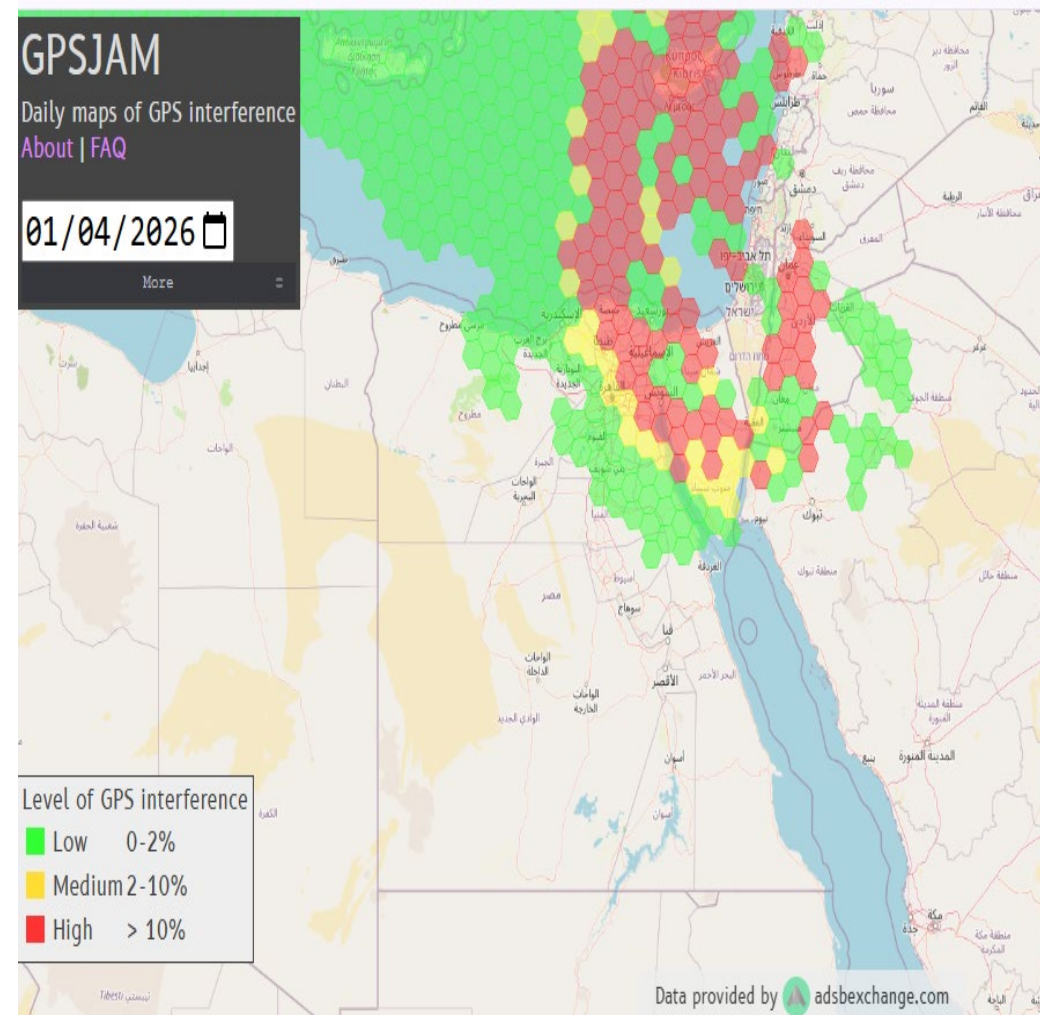


GNSS-RFI Recorded events 2025



Egypt is not immune to this challenge.

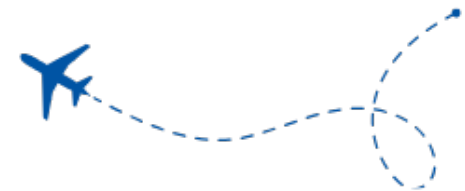
- Egypt’s geographical location adjacent to active conflict zones, GNSS jamming and spoofing events have been detected across the Cairo FIR, with the most significant impact observed in the Sinai airspace.
- GNSS interference events, have been observed during multiple phases of flight and reported by both pilots and ATC.
- The consequences are real. These events have caused aircraft to **deviate from their planned flight trajectories** — deviations that were detected and tracked by ATC radar.





What does this mean for aviation operations?

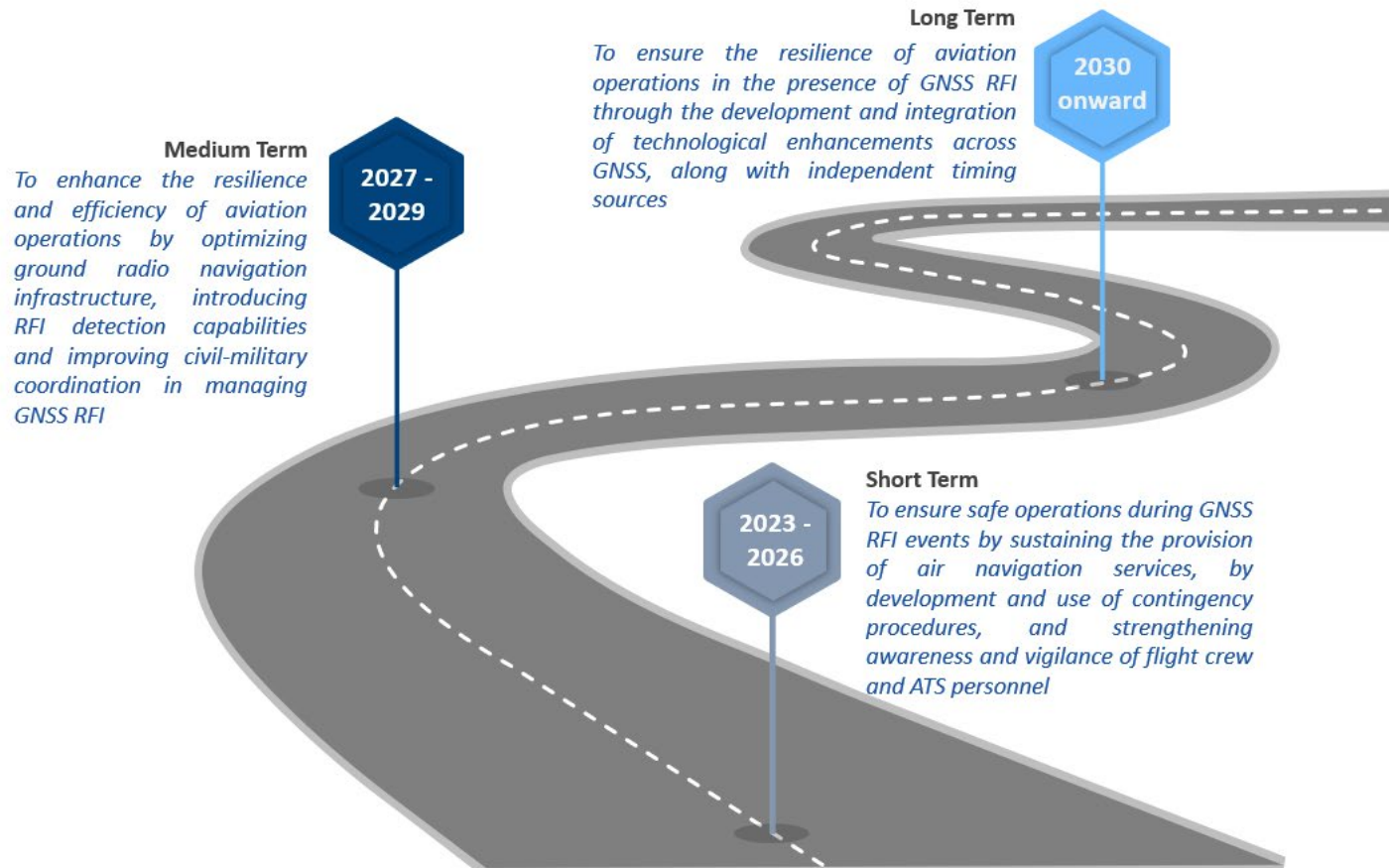
- **En-route Traffic (Over fliers):** Loss of RNAV/RNP capability forces transitions to **tactical Radar Vectoring**, increasing air traffic controller (ATC) and pilot workloads.
- **Terminal procedure:** Jamming and spoofing directly threaten PBN at Sinai airports like Sharm El-Sheikh and Taba and disrupting SIDs, STARs, and RNP approaches.
- **The fundamental message is this:** We must have reliable conventional fallback infrastructure available instantly.



- ICAO developed a roadmap and EASA have Action plan to address GNSS RFI. The ultimate objective is to ensure the resilience of aviation operations in the presence of GNSS RFI

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## ICAO GNSS RFI Roadmap

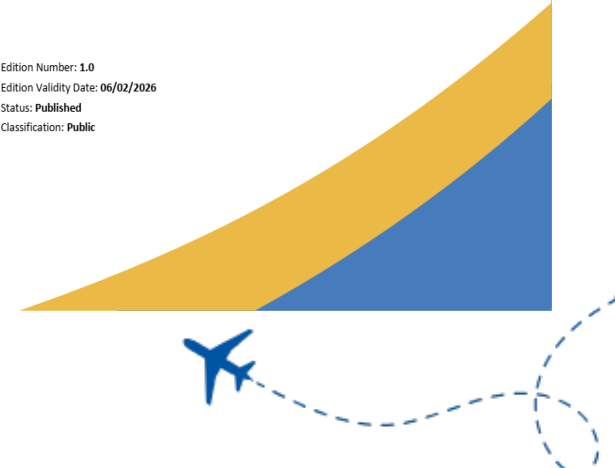



**EASA**  
European Union Aviation Safety Agency

**EUROCONTROL**

European Aviation Action Plan  
for Ensuring Safe Operations  
during GNSS Interferences  
**GNSS RFI Action Plan**

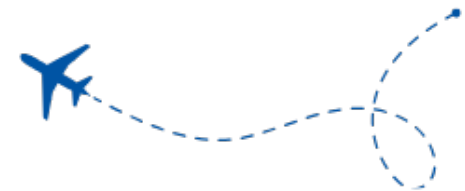
Edition Number: 1.0  
Edition Validity Date: 06/02/2026  
Status: Published  
Classification: Public



The action plan is structured across three phases by priority and timeframe:

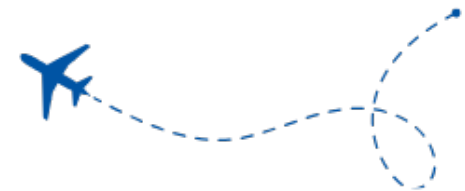
- Short term: sustain navigation services and contingency procedures.
- Medium term: optimise ground infrastructure and introduce RFI detection.
- Long term: integrate advanced GNSS enhancements and independent timing sources.

Egypt is actively delivering the short-term phase right now and start in the medium term.





- **Safety Notices:** raise awareness about the potential risks of (GNSS) Jamming and Spoofing and implementing appropriate mitigation measures, to reduce the potential impact of these threats on aviation safety
- **Operational Readiness:** Continuous optimization of conventional ground-based NAVAIDs (VOR, DME, and ILS) to maintain a robust Minimum Operational Network (MON).
- **Inter-departmental Coordination:** Enhanced synergy between CNS engineering, Air Traffic Control (ATC), and safety oversight sectors. **because** airspace resilience requires everyone working together
- Ensuring airspace resilience requires proactive engineering solutions and robust backup infrastructure.





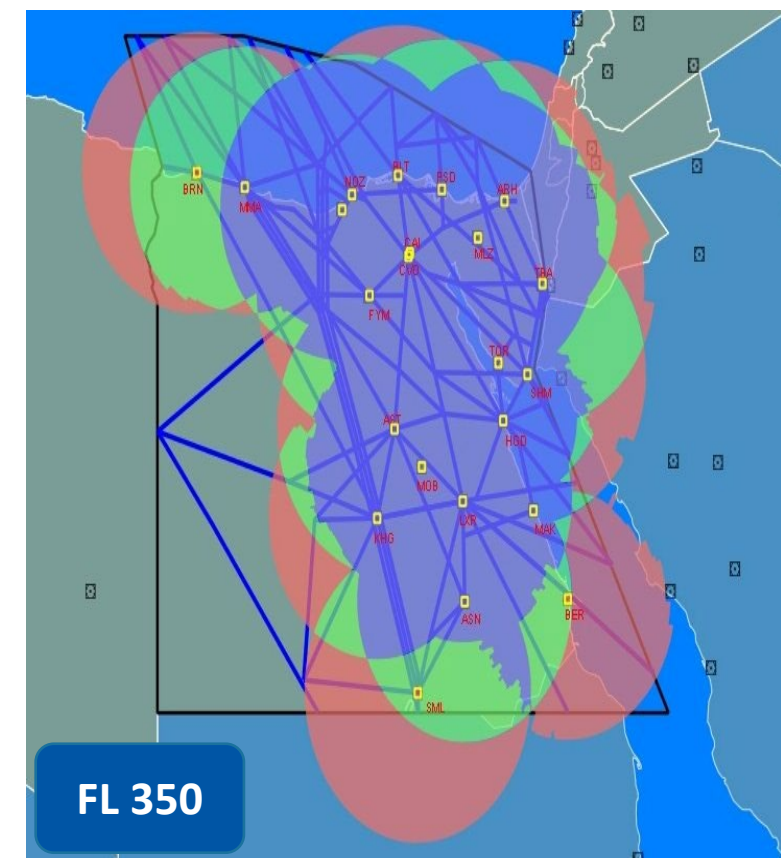
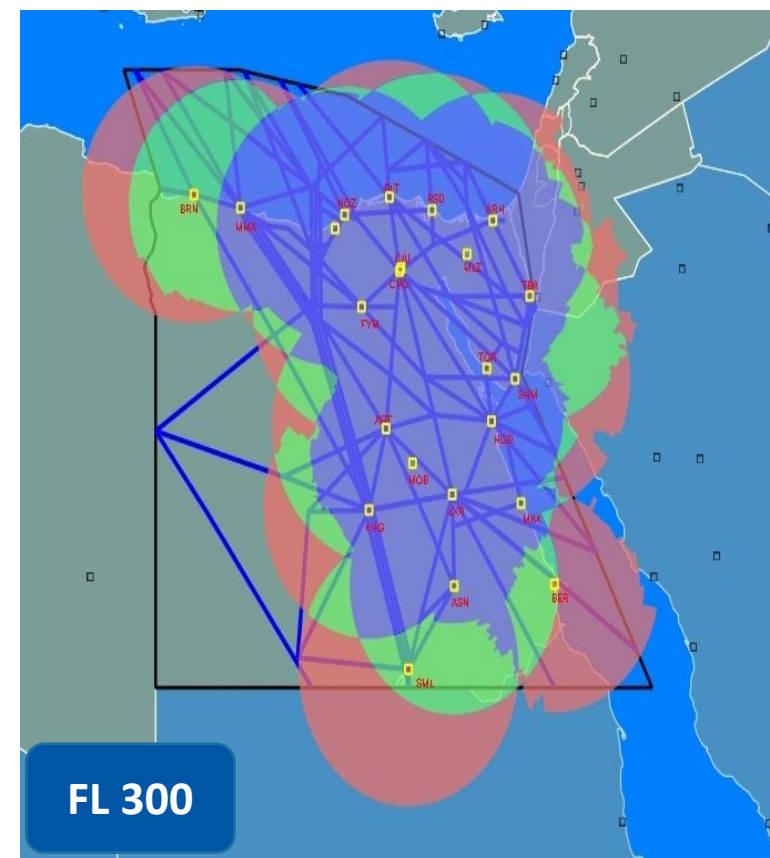
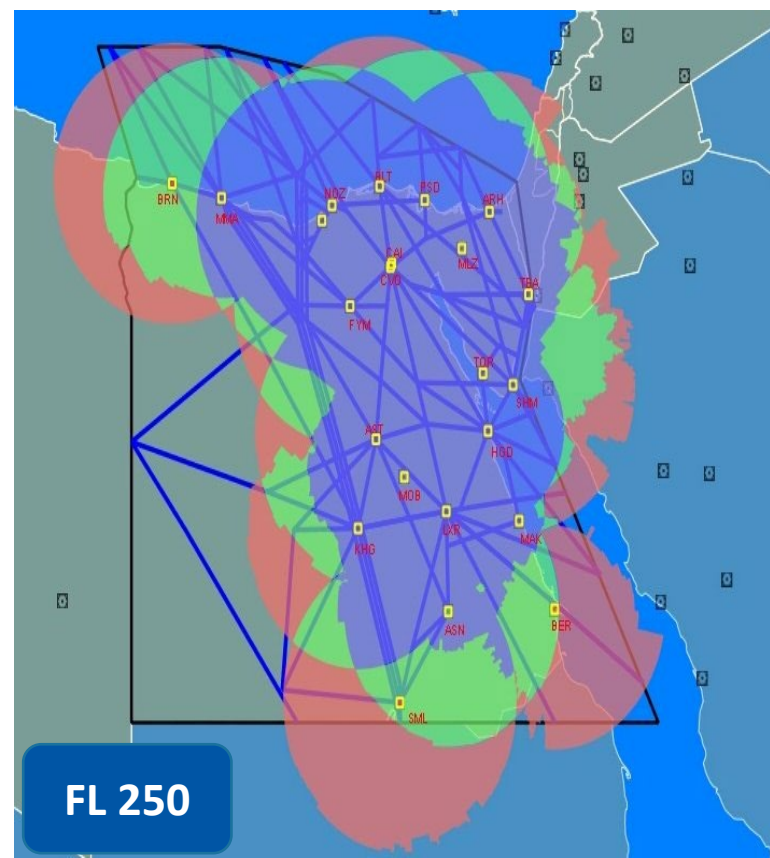
- NAV MON, according to the GANP, aims to rationalize the conventional Navigational aids network through the increased deployment of the satellite based navigation system.
- Review aircraft **minimum equipage lists** to ensure compatibility with implemented minimum operational networks
- Egypt's 22 VOR stations Cover 80% of Cairo FIR, satisfy ICAO MON requirements, providing independent ground-based position reference across the Cairo FIR.
- The VOR network achieves overlapping coverage above FL 250, ensuring redundancy across all published ATS routes.



VOR/DME



22 VOR stations providing full Minimum Operational Network (MON) coverage .



Full / Excessive Redundancy

Limited Redundancy

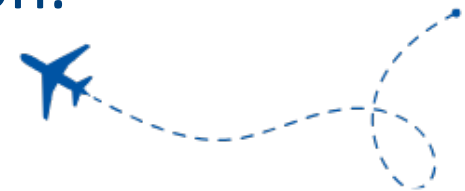
No Redundancy

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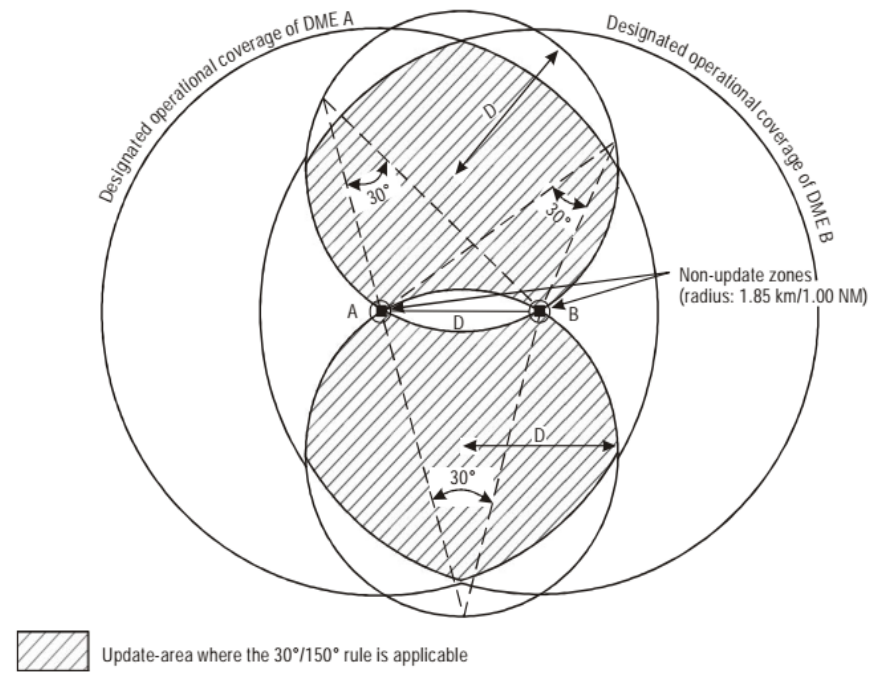




- ICAO's strategy is evolving from a basic Minimum Operational Network ( MON) to a more advanced concept called the Resilient Navigation Operational Network — R-NON.
- The key principle is straightforward: do not rely on a single navigation source. ICAO recommends multi-layered operational environment .
- Optimize deployment of terrestrial navigation aids based on traffic density, operational requirements, and aircraft capabilities
- The technology that enables R-NON is **DME/DME positioning**. By receiving distance signals simultaneously from **two or more DME ground stations**, aircraft can sustain continuous RNAV/PBN operations in the event of a GNSS signal outage or disruption.



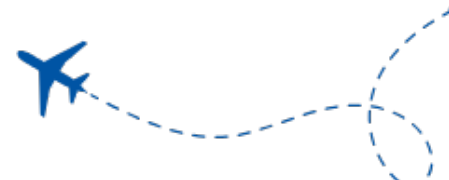
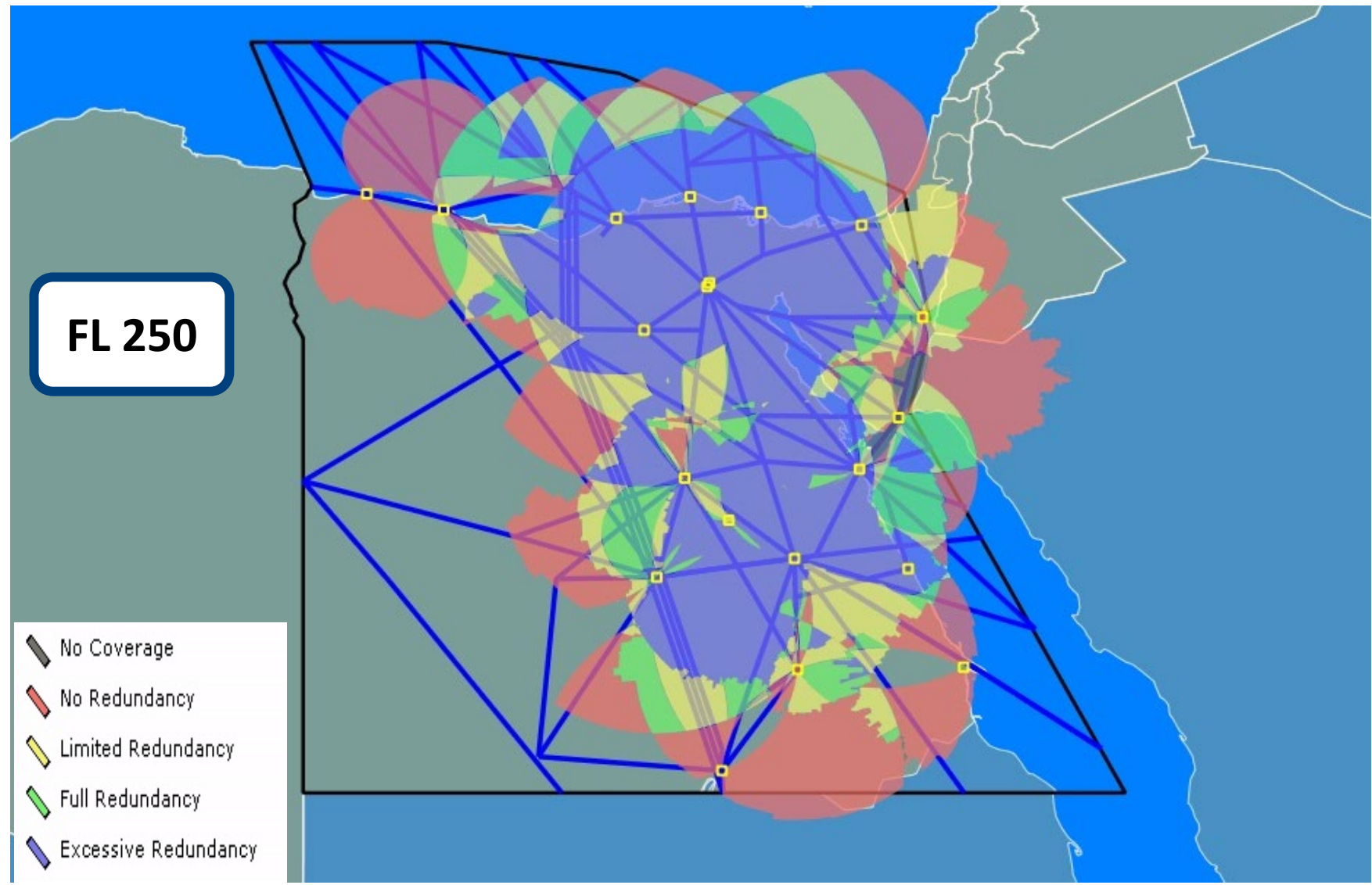
- NANSC CNS engineers conducted a comprehensive technical study to assess DME/DME coverage across the Egyptian airspace at different flight levels. Phase 1 focused on a route-by-route analysis of priority areas, including the Sinai and Cairo sectors.

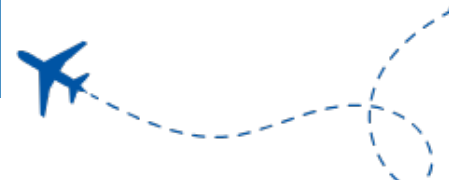
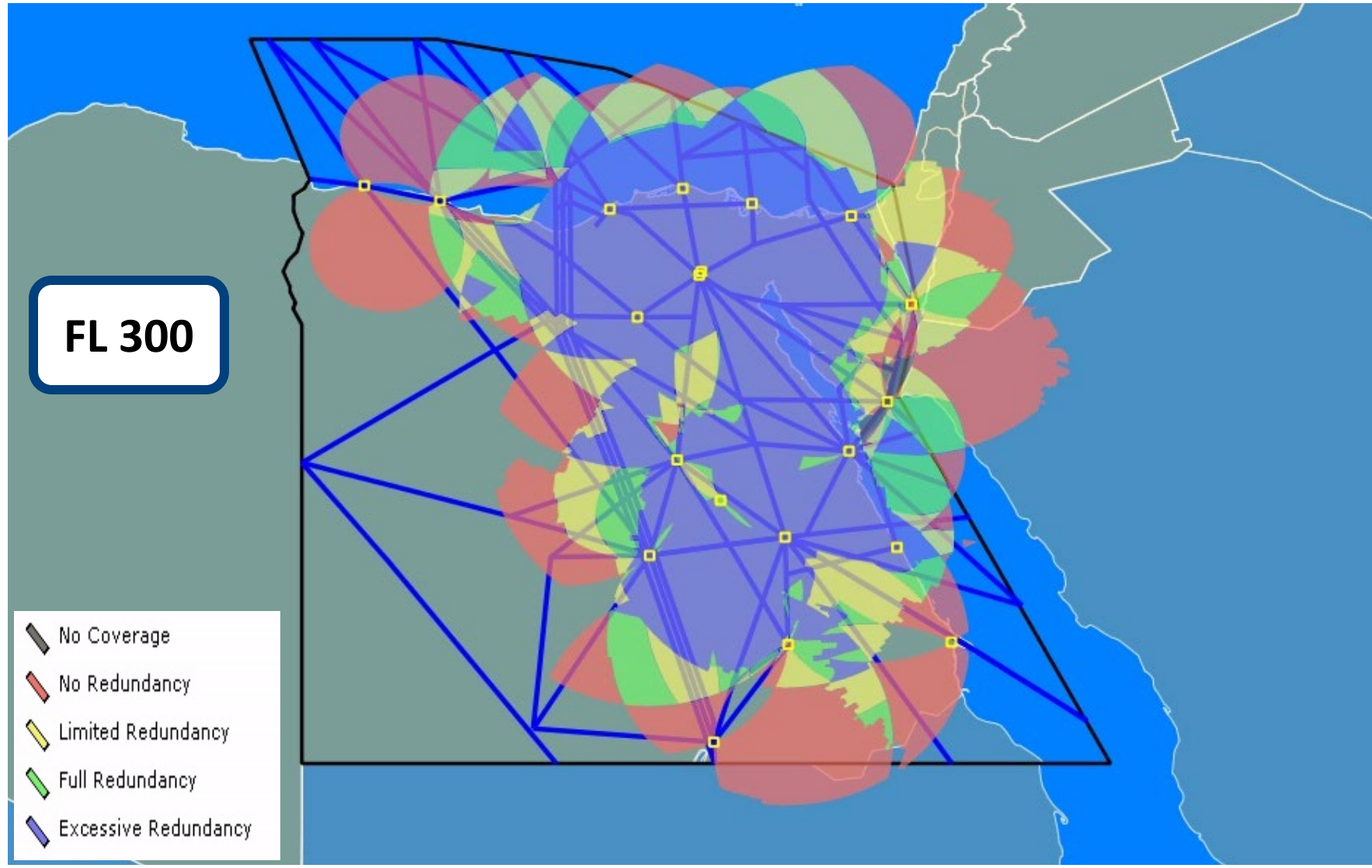


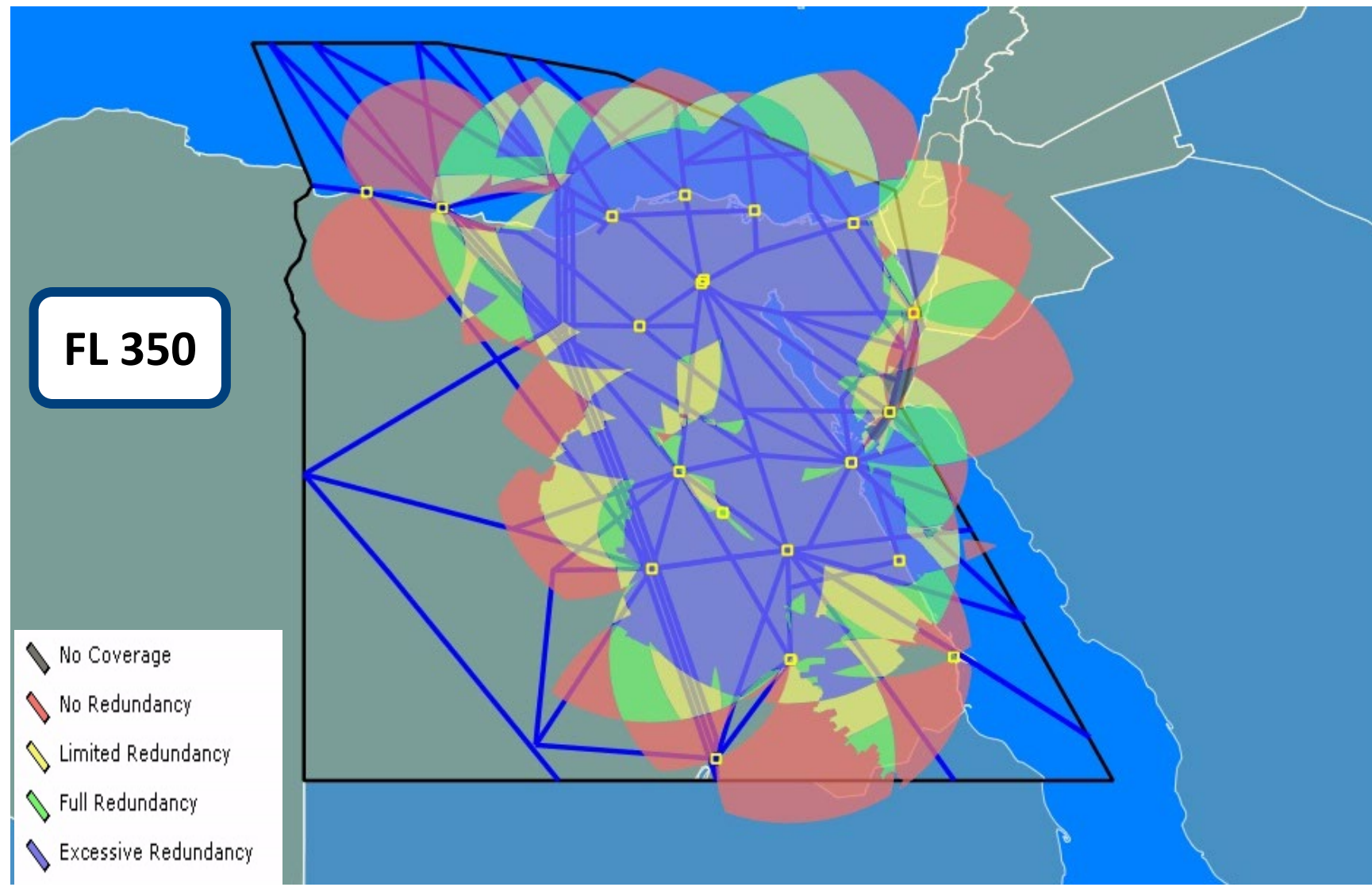
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Navigation specification	Flight phase	NavAids infrastructure
RNAV5	En-Route	VOR/DME, DME/DME
RNAV2, RNAV1	En-Route, SID, STAR	DME/DME, DME/DME/IRU

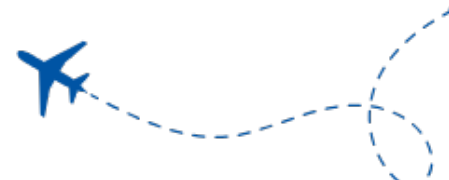






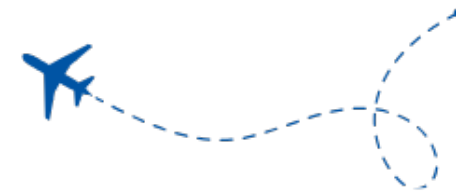
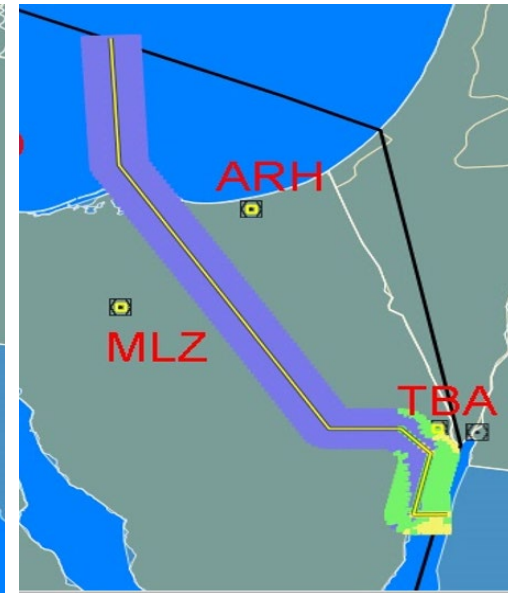
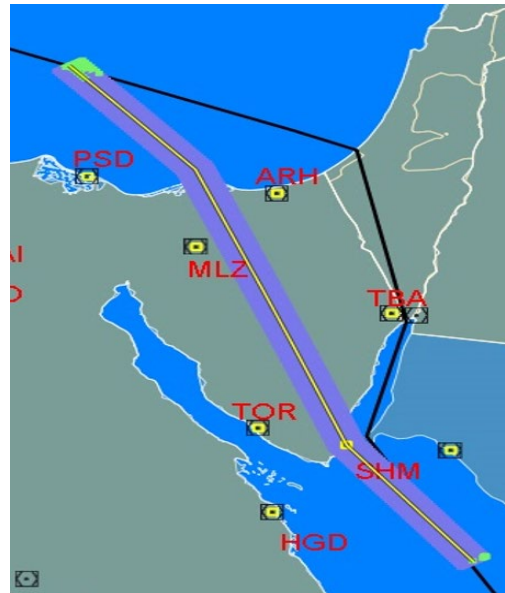
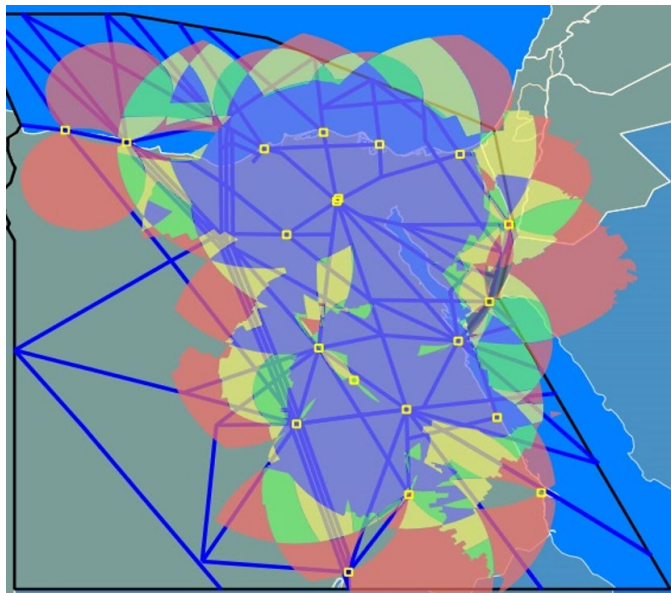


**75%**  
Upper Airspace  
Coverage Achieved

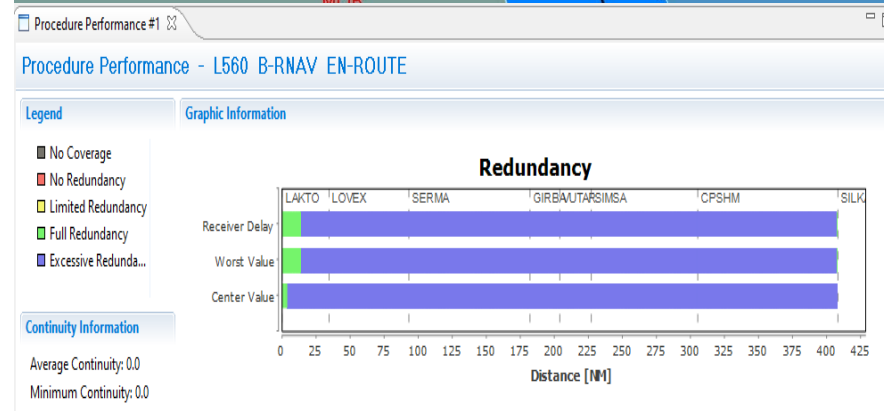
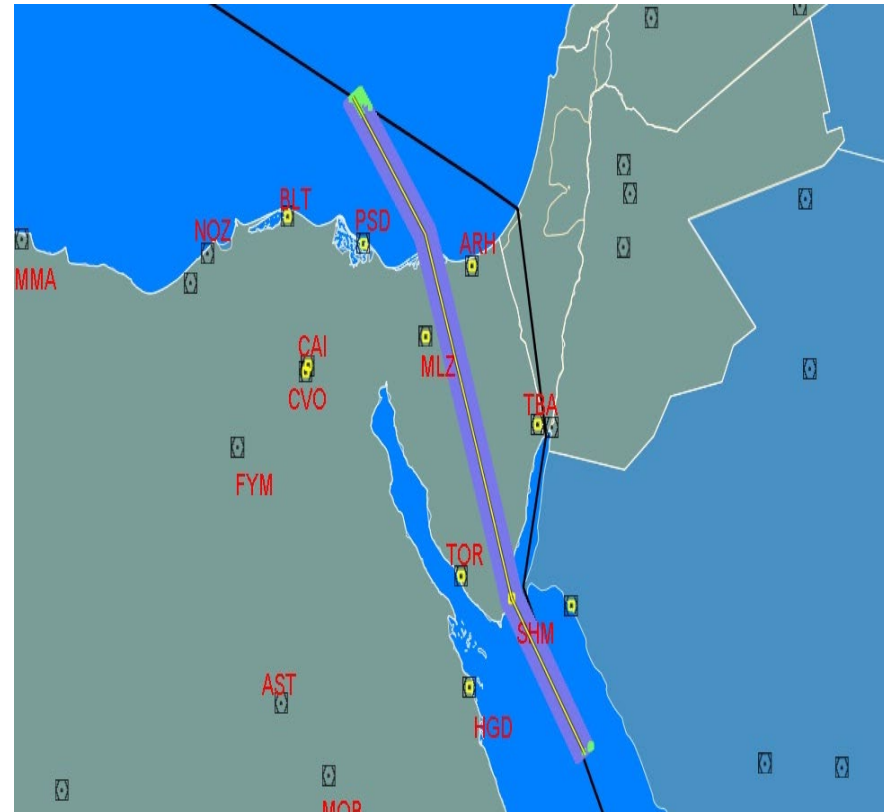
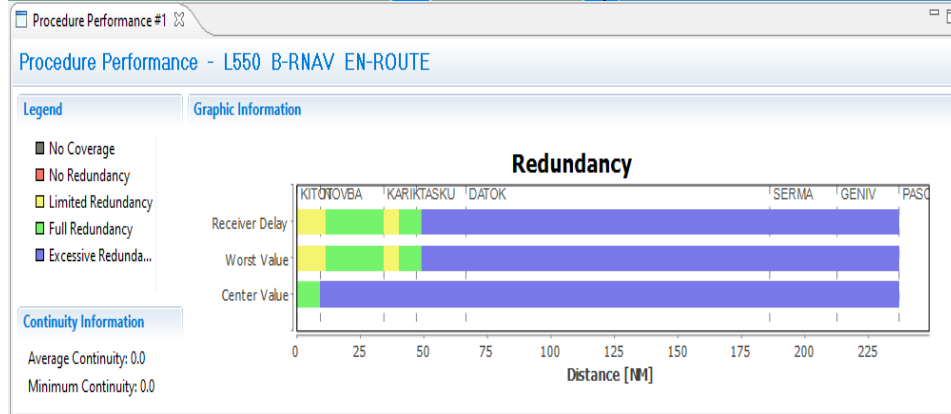
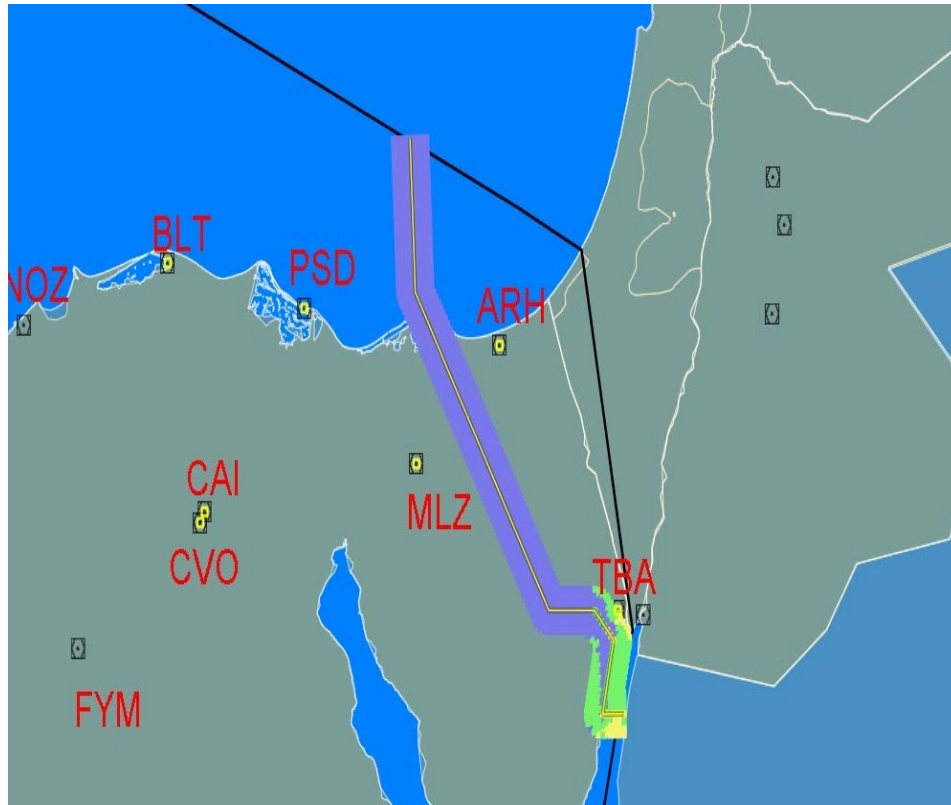




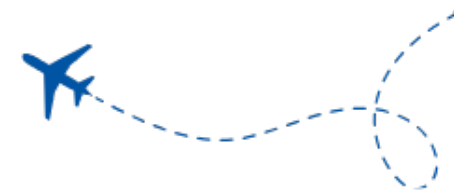
- **Route-Specific Methodology:** To achieve valid DME/DME airspace coverage, each ATS route must be analysed individually, strictly based on the designated flight levels published in **Egypt AIP**
- **Phase 1 Execution:** The initial phase of this DME/DME coverage study has been successfully completed, focusing on the high-priority affected regions: **Sinai airspace sector**

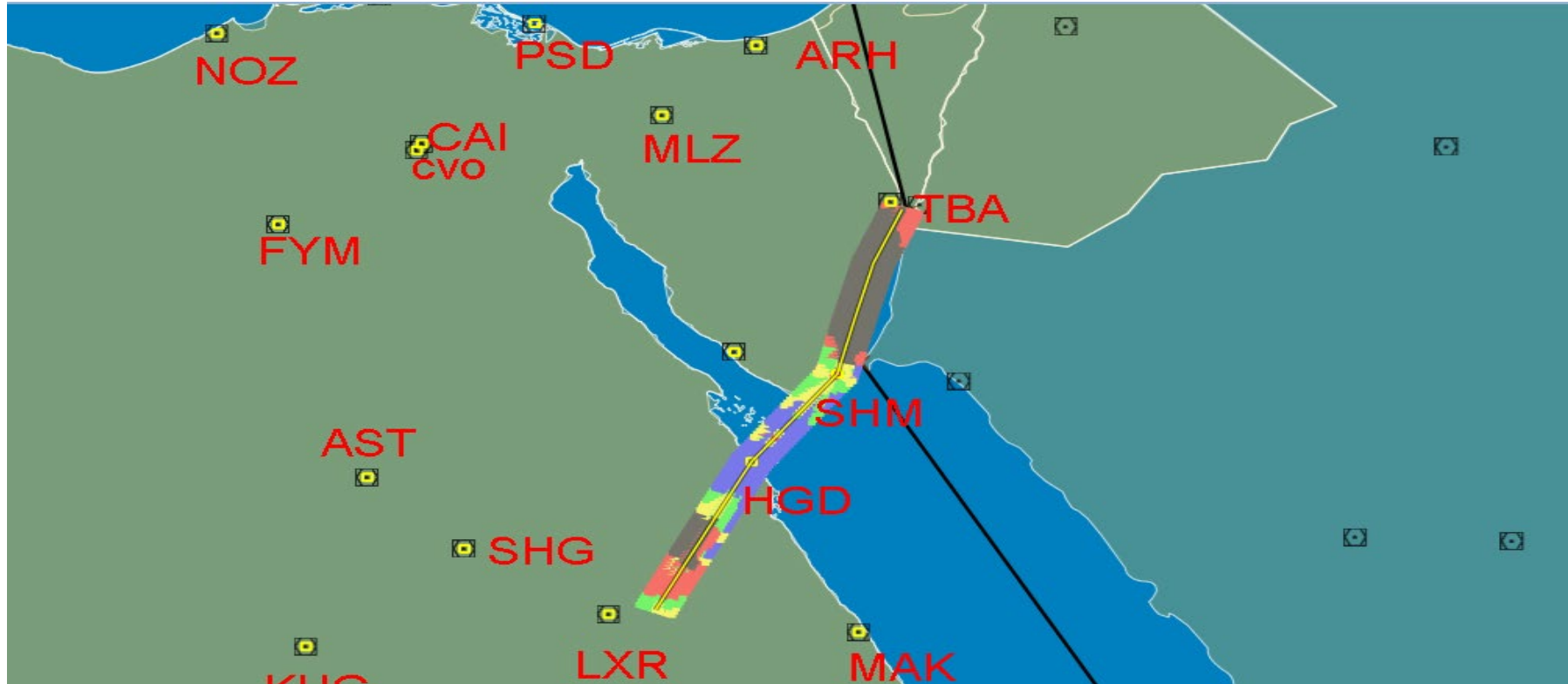


# ATS route (L550, L560)

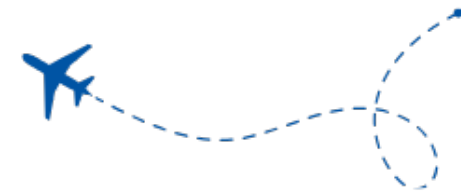
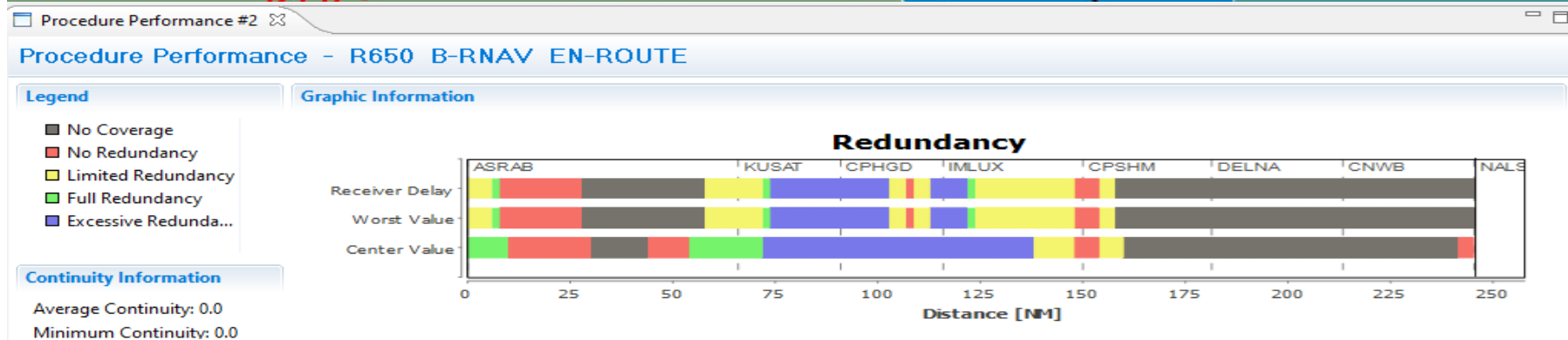


The simulation confirm full DME/DME redundancy across the entire route length. Existing infrastructure is sufficient. No new stations needed.

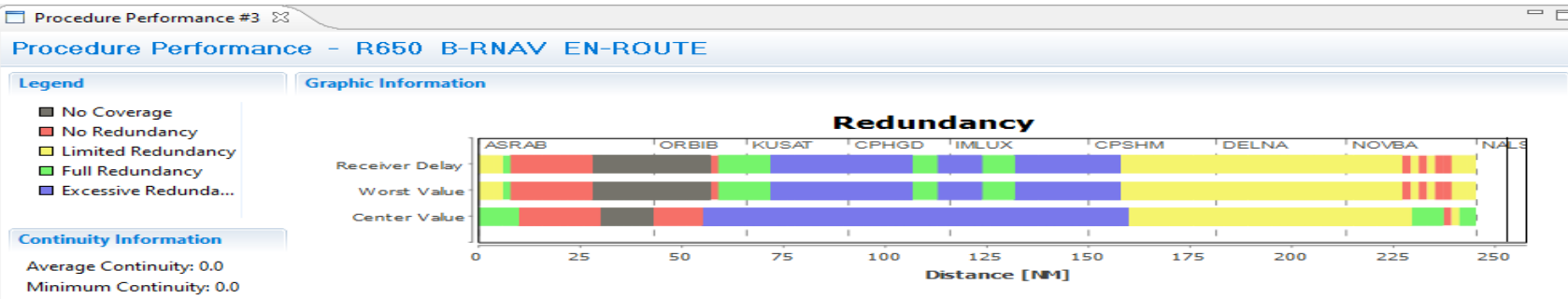
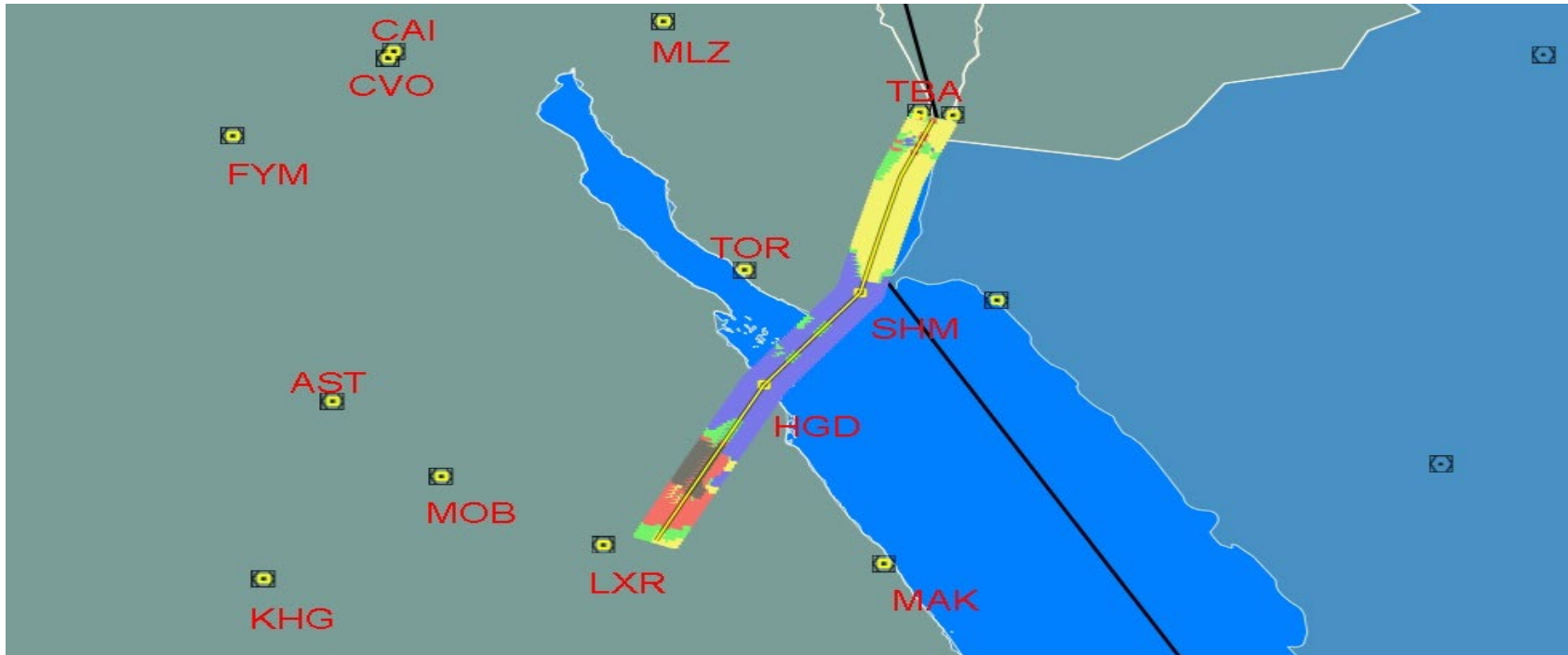




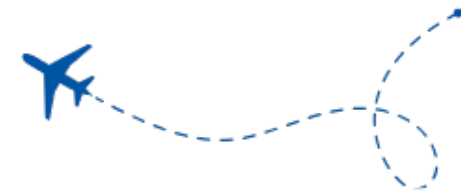
Simulation results highlight a noticeable coverage gap (indicated in grey) across a significant segment of the evaluated ATS route

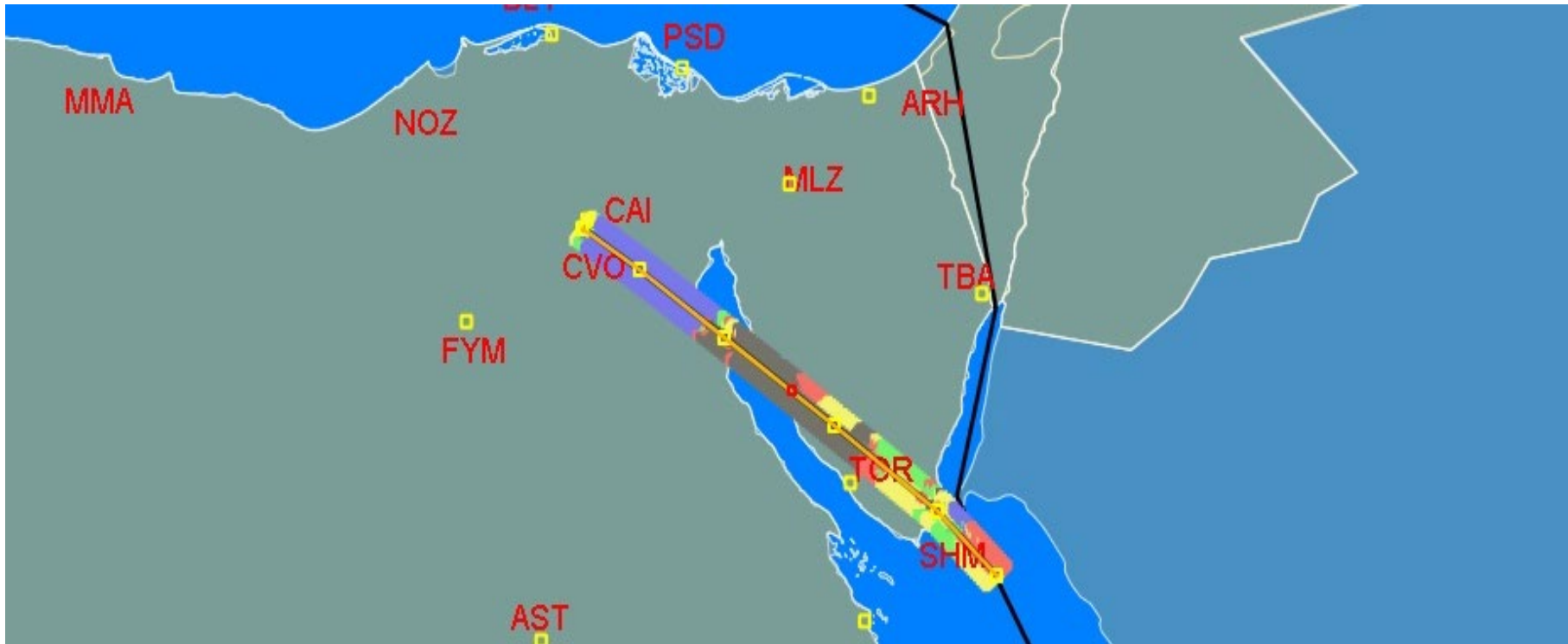


This is regional cooperation in practice — a clear demonstration that cross-border DME sharing is both practical and effective.

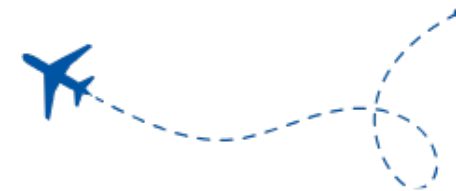
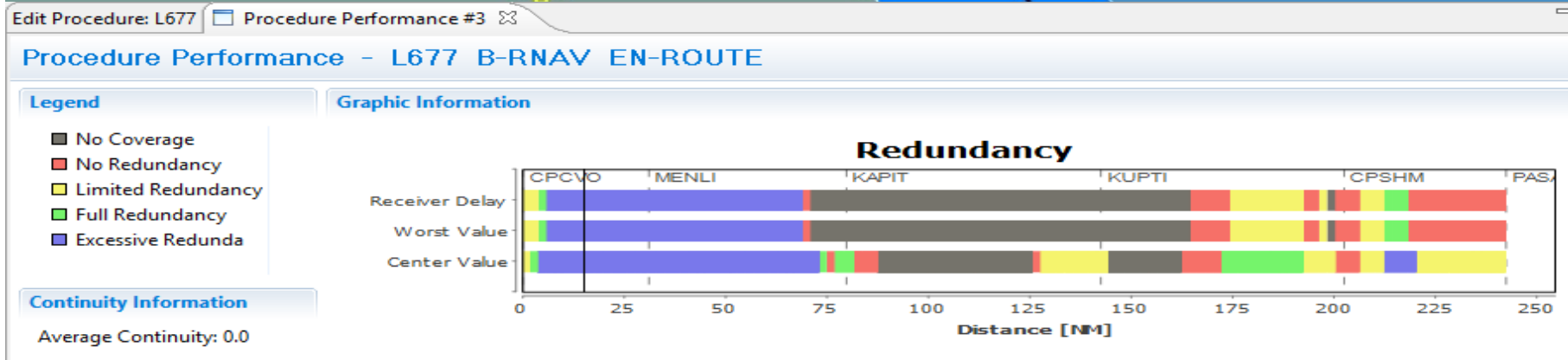


By utilizing DME systems from neighbouring regions (NEOM in Saudi Arabia and Aqaba in Jordan), coverage can be improved."

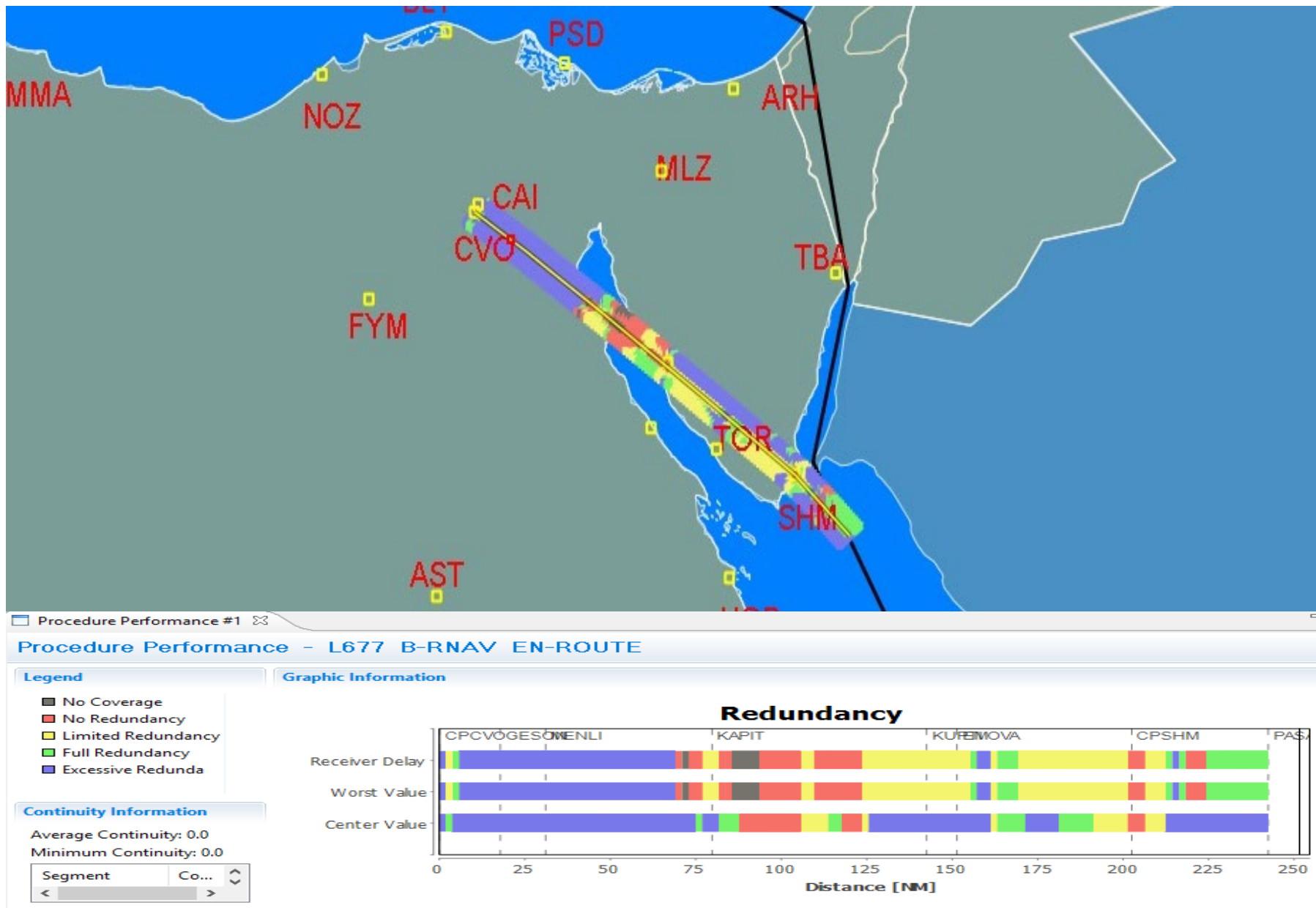




Simulation results reveal a noticeable coverage gap (indicated in grey) across a significant segment of the evaluated ATS route

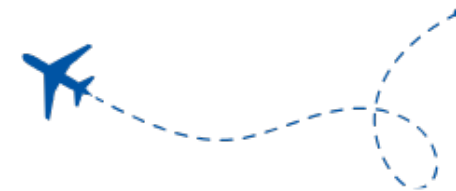


# Mitigation scenario for L677 (FL90 : FL120 )



To resolve the coverage deficiency on Airway L677, installing two new DME stations is proposed at:

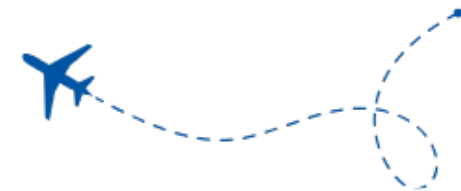
- 28°22'20.69"N, 33°03'17.11"E and
- 28°53'26.94"N, 33°12'49.19"E



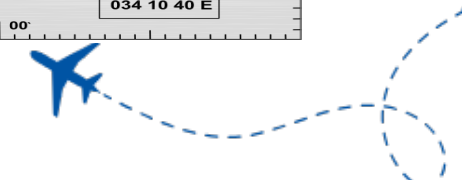
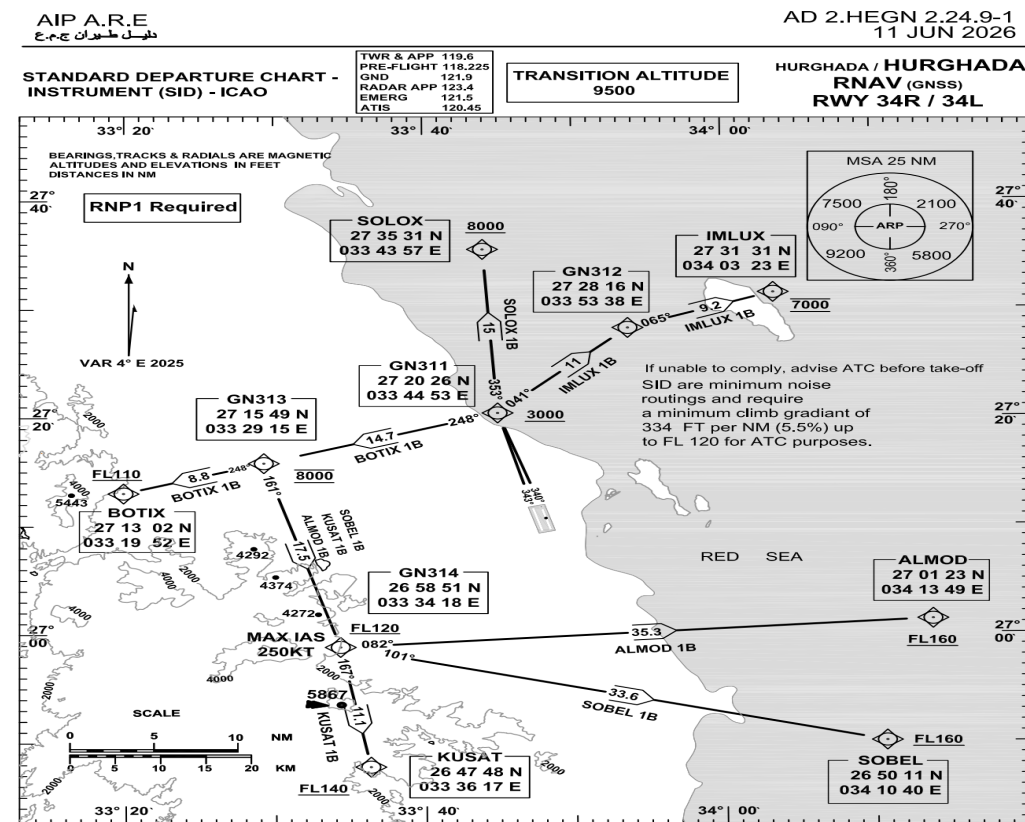
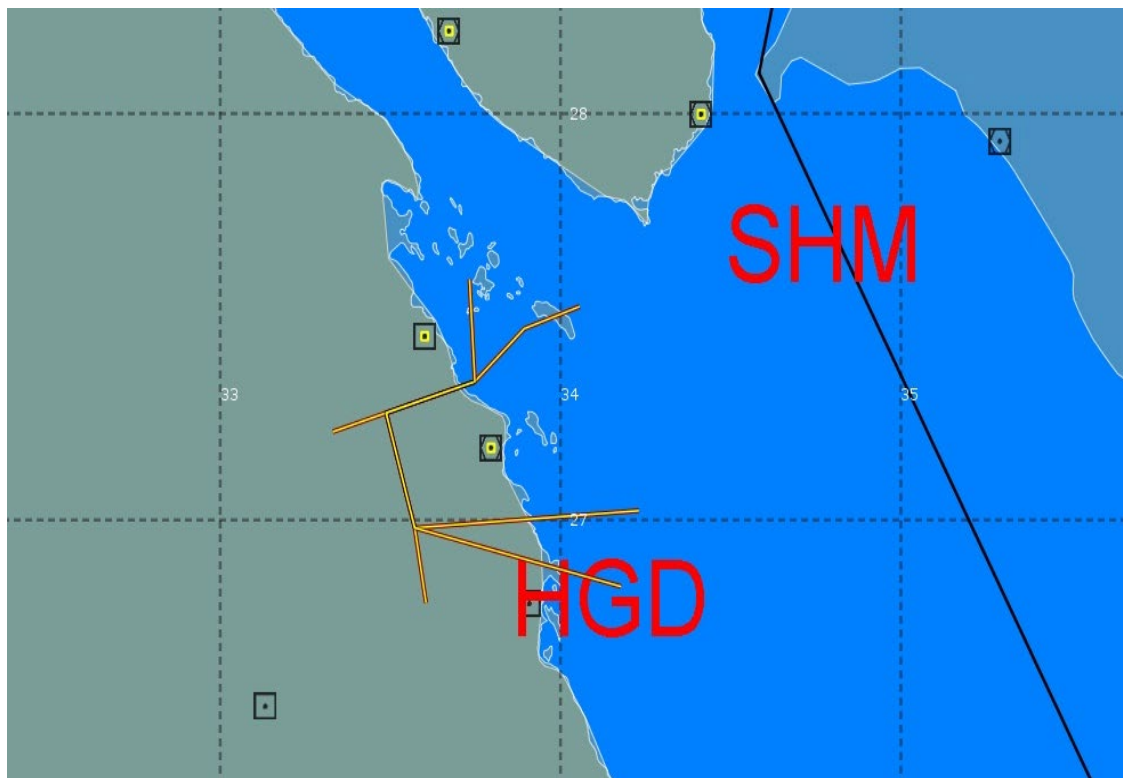


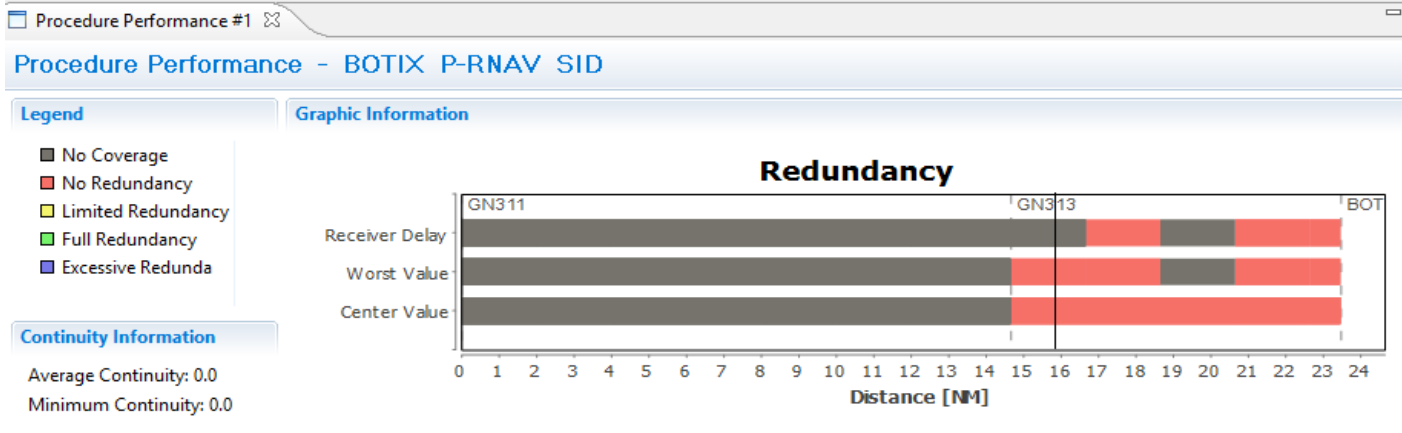
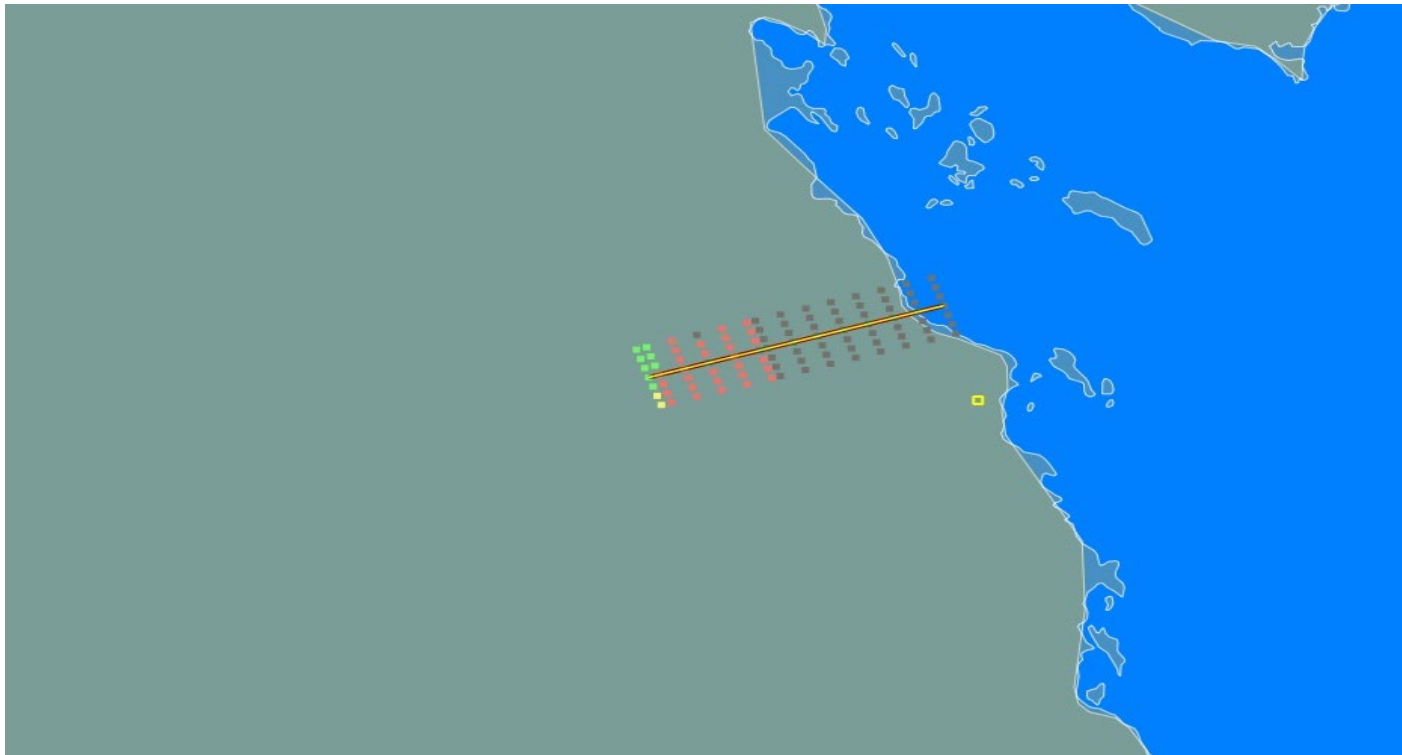
- The DME is no longer merely a conventional navigation aid; it has become an important component of the future backup navigation infrastructure. It is regarded as one of the most practical alternatives for supporting RNAV/PBN operations in the event of a GNSS signal outage or disruption.

Ser.	Airway	FL	The status of current NAVAIDS coverage	Mitigation strategy
1	L550	255	Fully Covered	
2	L560	305	Fully Covered	
3	R650	120	noticeable coverage gap	By utilizing DME systems from neighbouring regions (NEOM in Saudi Arabia and Aqaba in Jordan), coverage can be improved."
4	L677	90:120	noticeable coverage gap	Installation of two new dedicated DME stations at: 28 22 20.69 N 33 3 17.11 E and 28 53 26.94N 33 12 49.19E

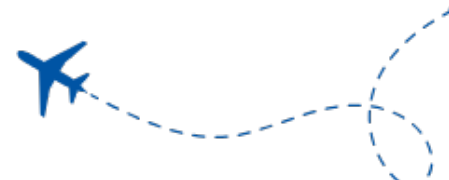


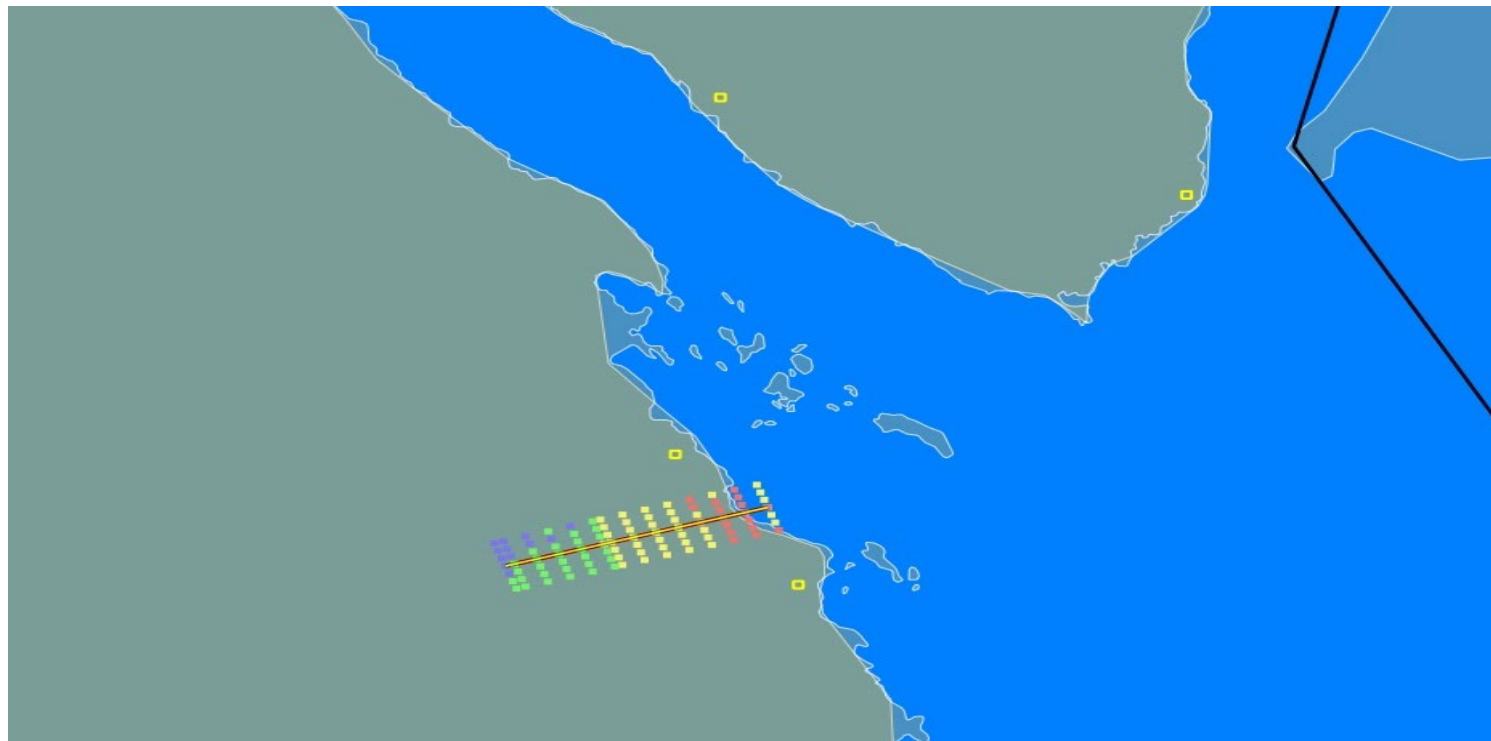
- Evaluating DME/DME coverage for Hurghada Airport terminal procedures (SID & STAR) to support uninterrupted PBN operations and enhance navigation resilience.



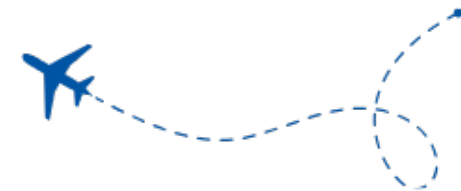
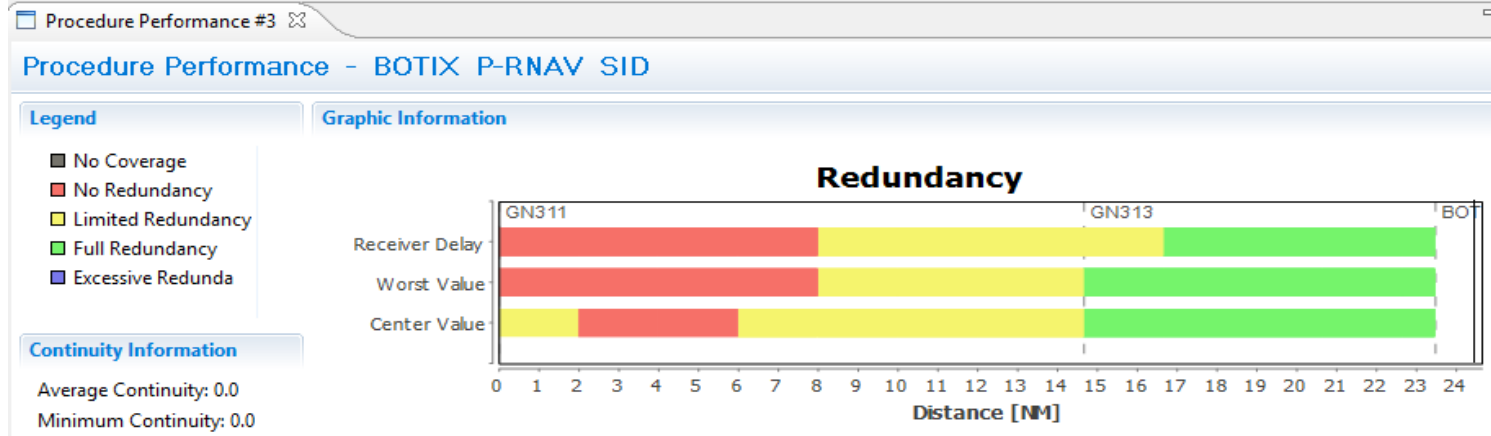


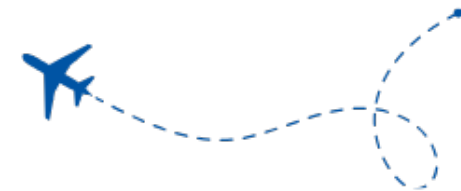
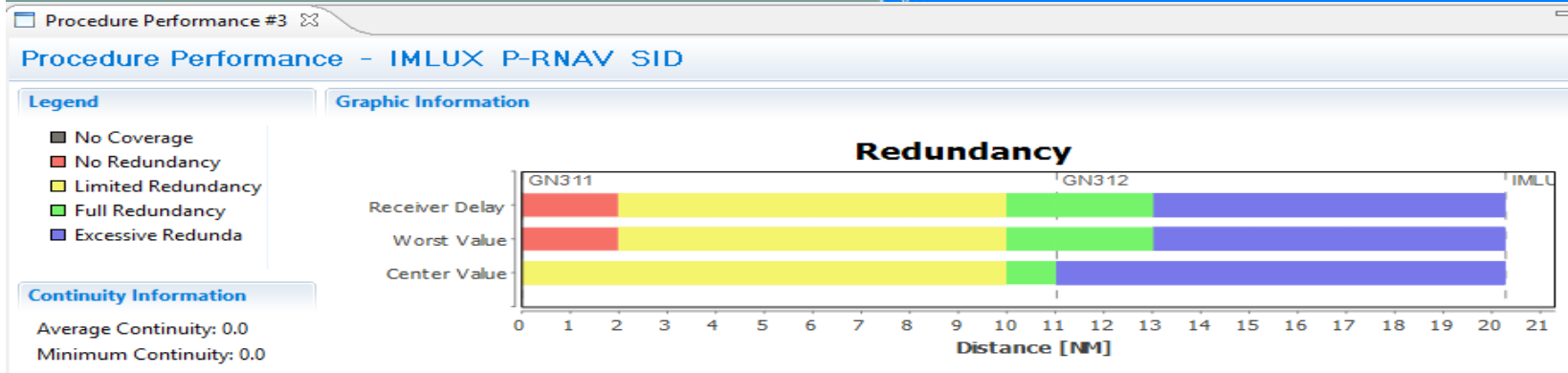
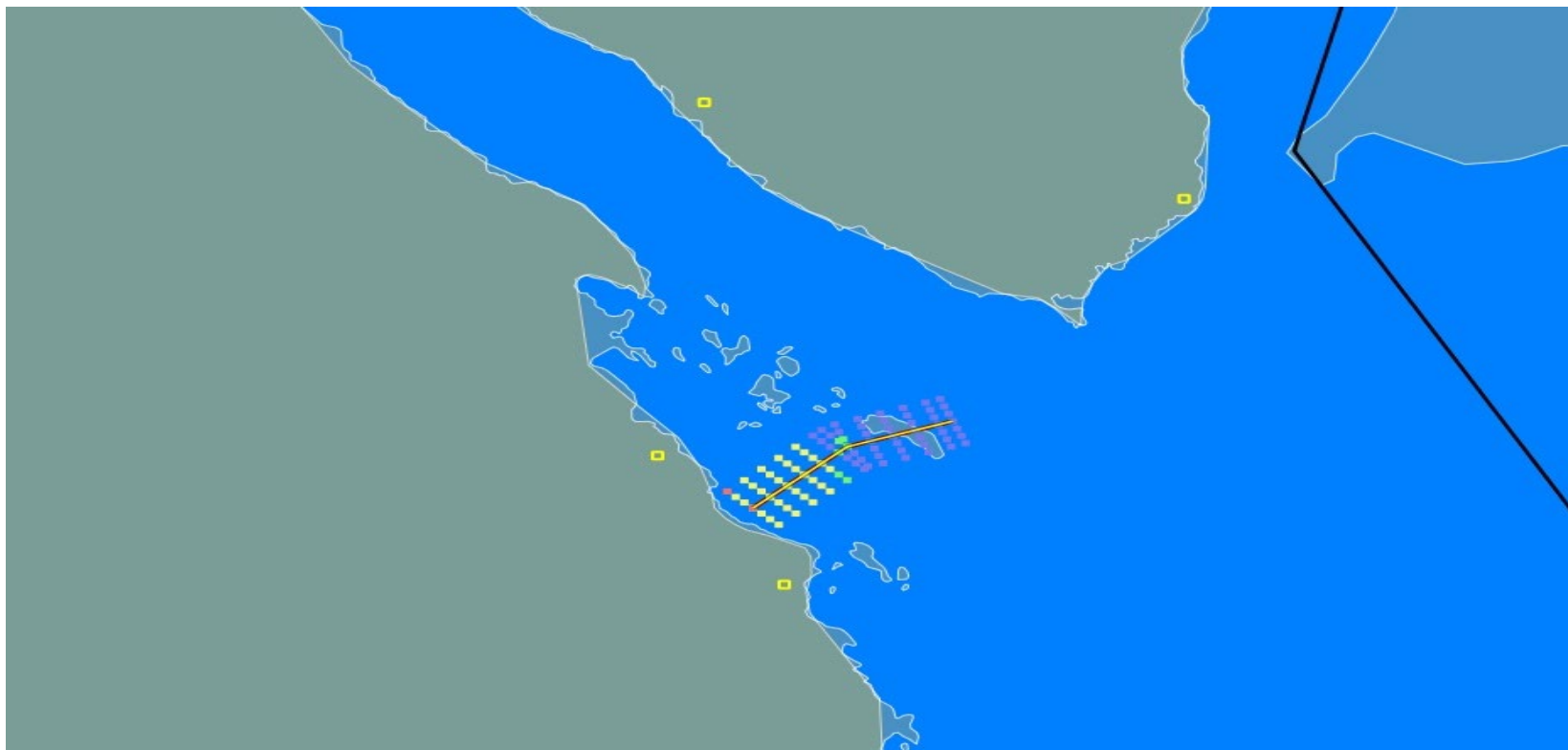
- There are only one operational DME station within the Hurghada airport
- A single DME source is insufficient to support DME/DME Coverage.
- Simulation results highlight a noticeable coverage gap (indicated in grey) across a significant segment of the Path .

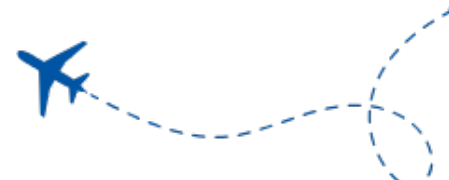
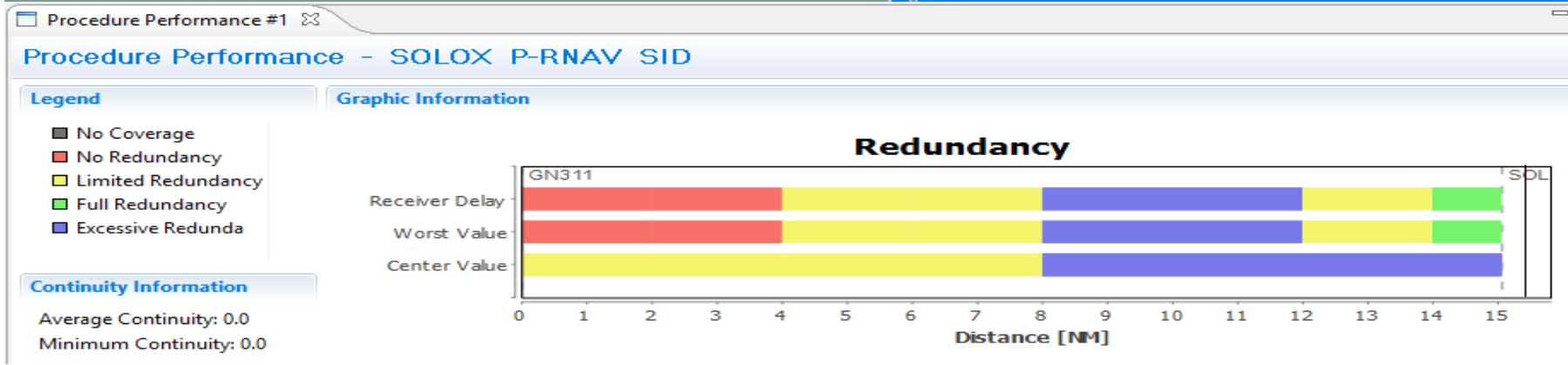
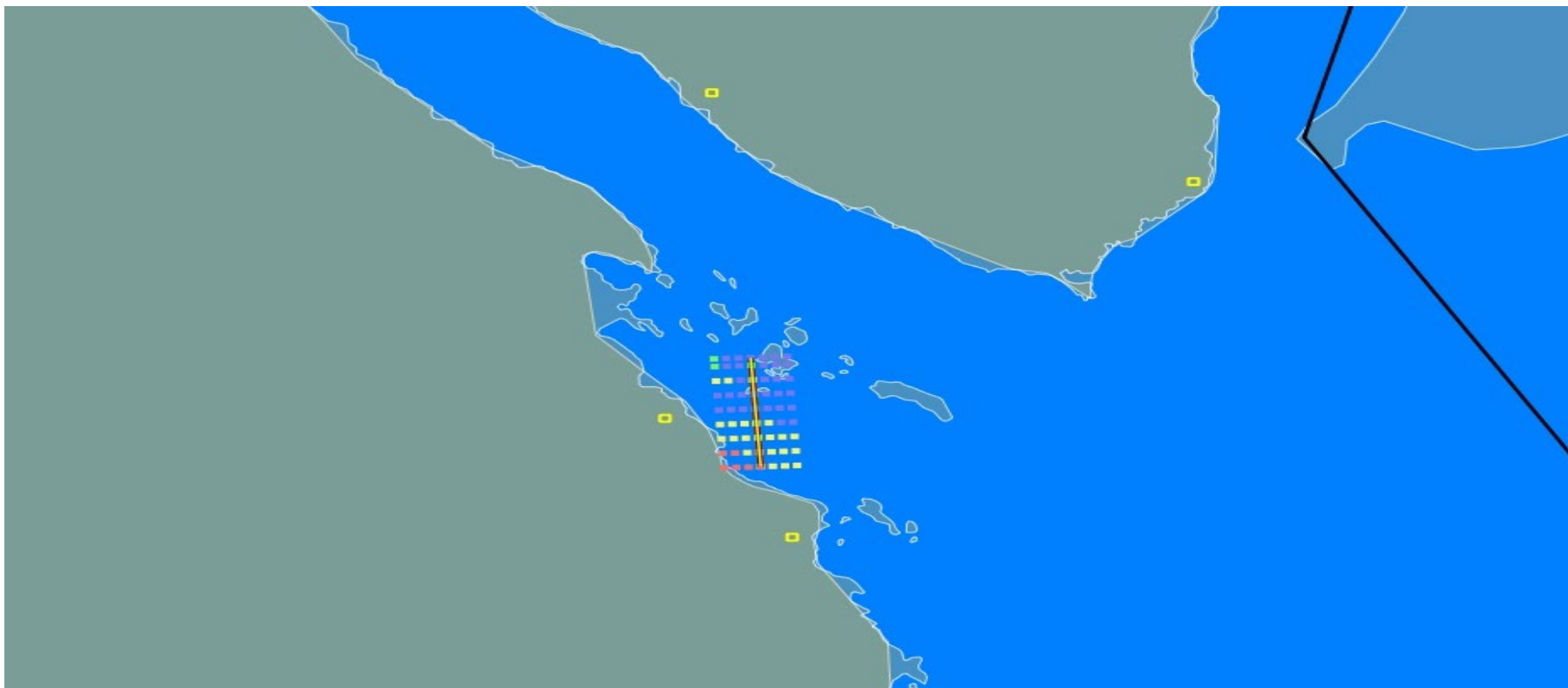


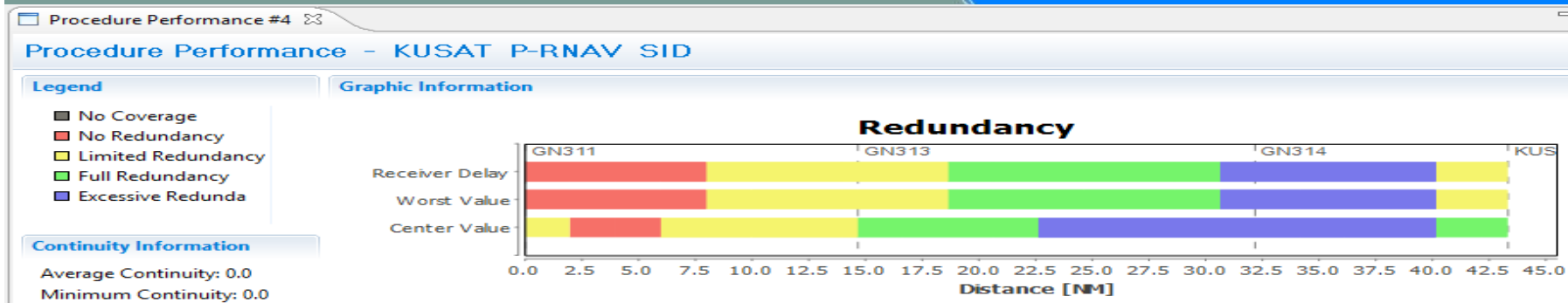
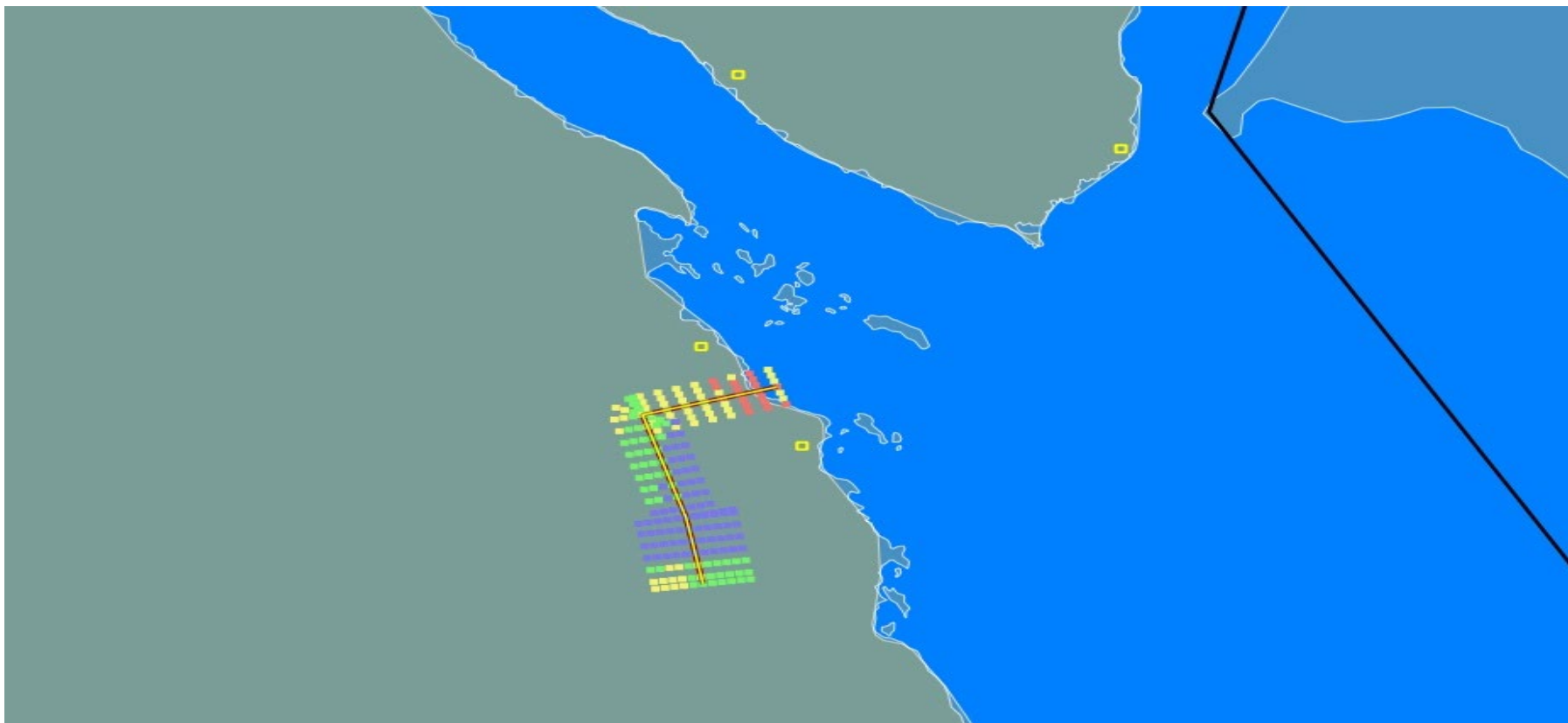


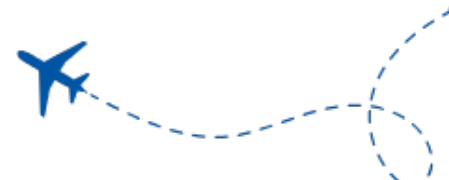
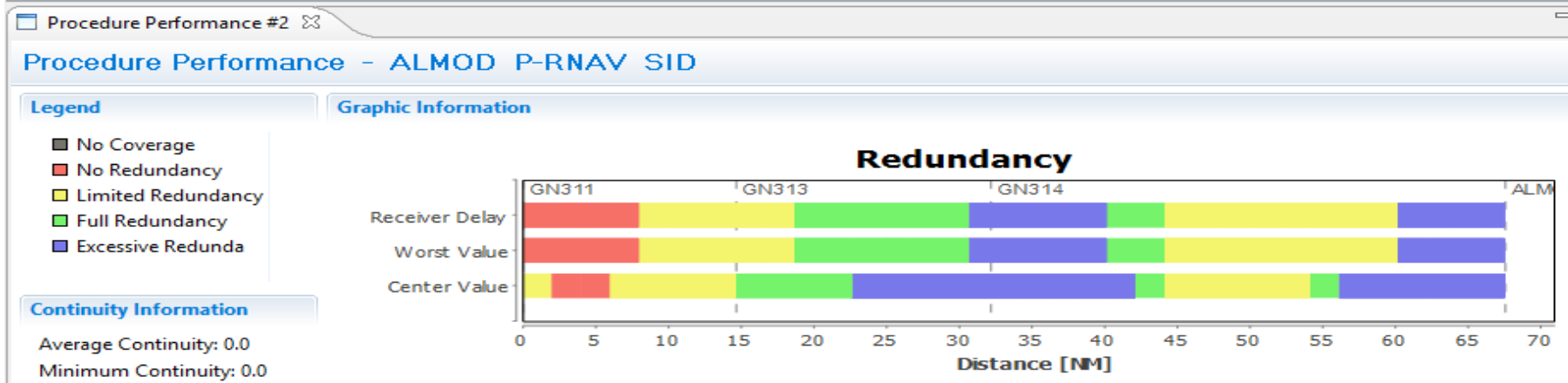
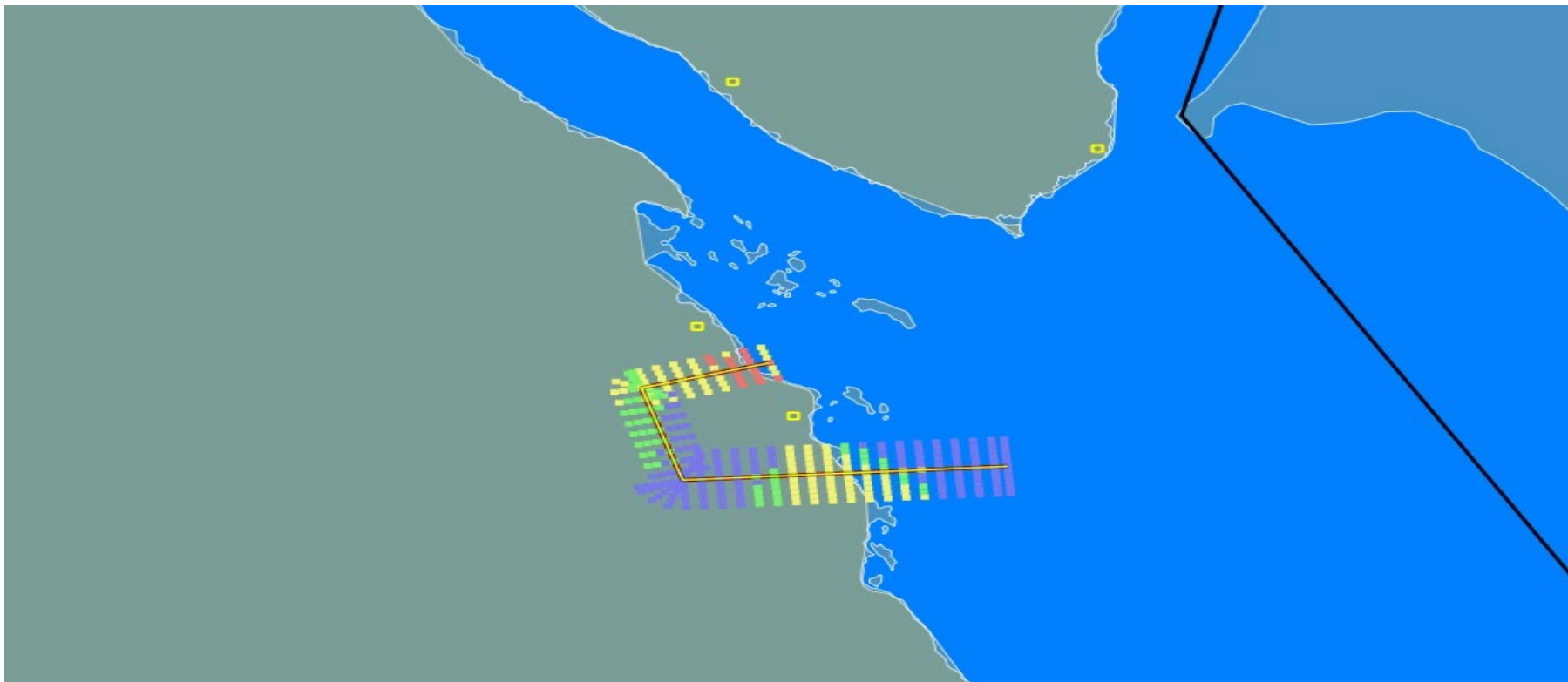
The proposed mitigation integrates current operational NAVAIDs with the installation of one new dedicated DME stations at (27 27 7.63N 33 36 3.64E )

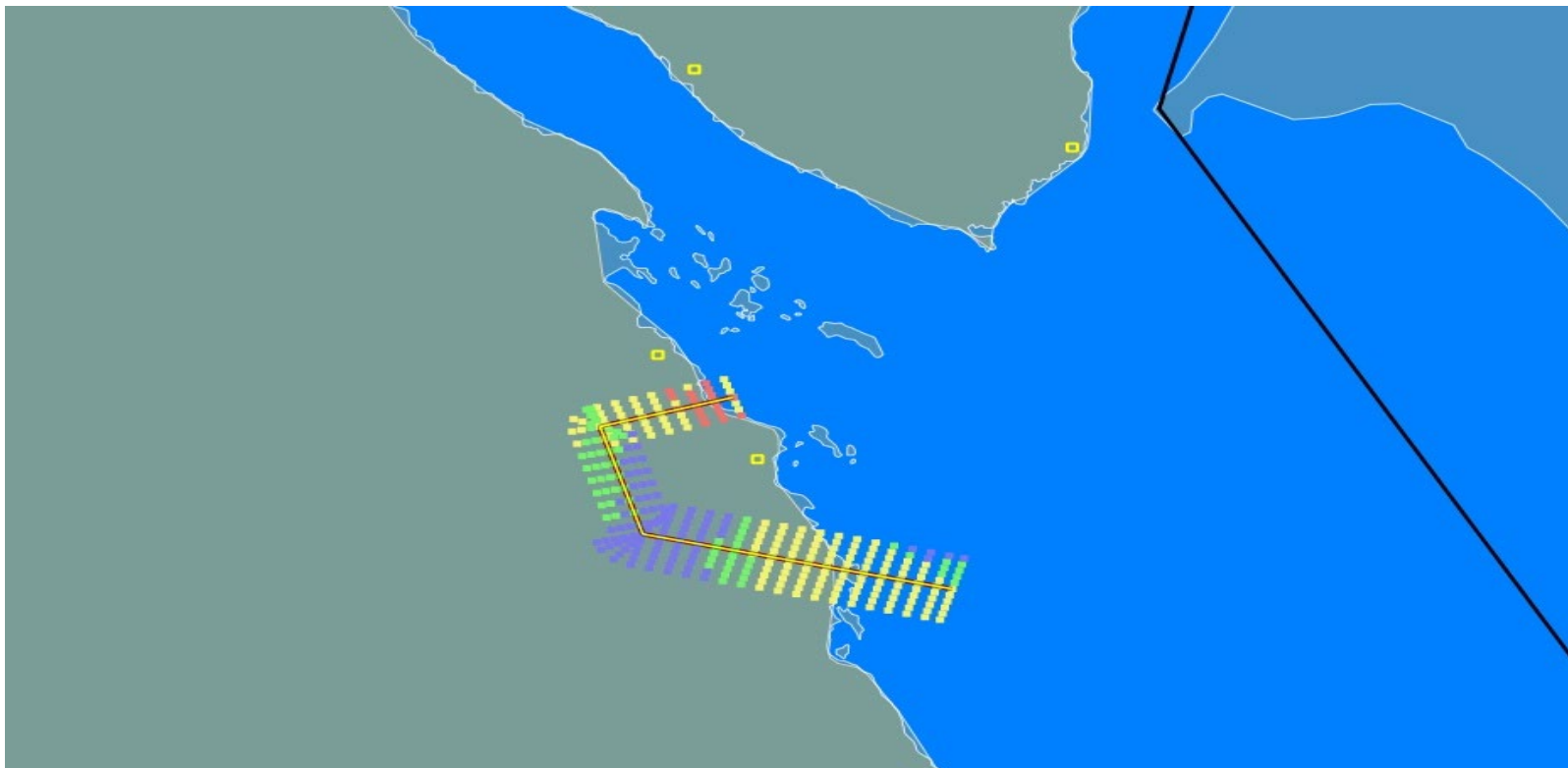




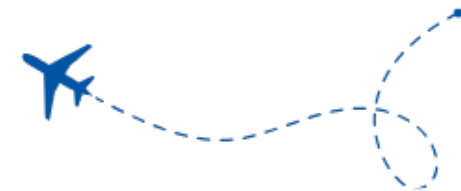
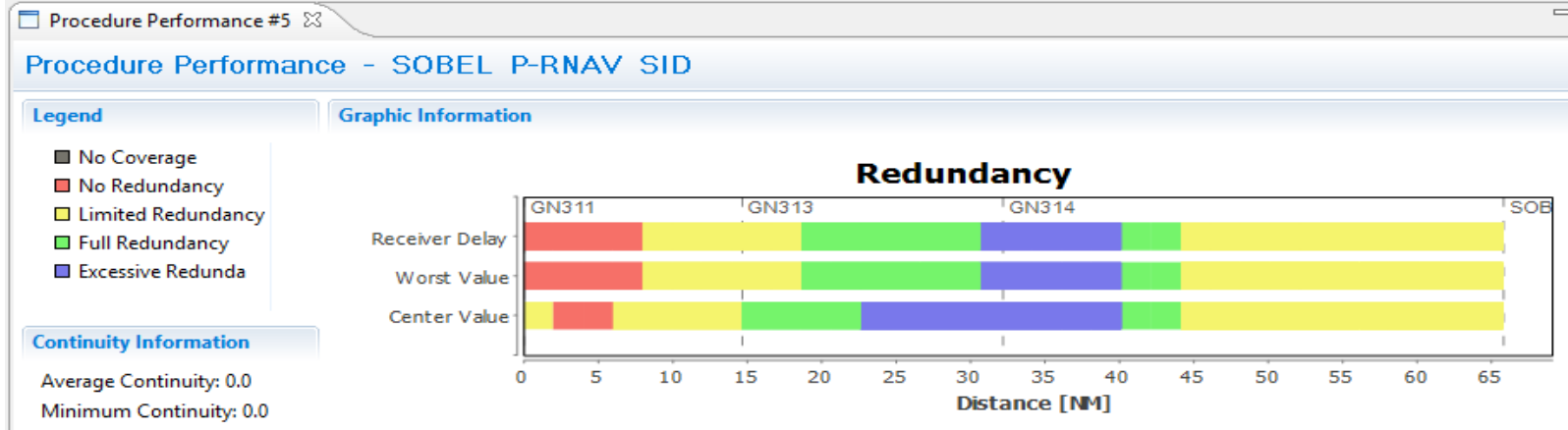








DME is the most practical and proven alternative for sustaining RNAV and PBN operations when GNSS fails



**29** | **ATS Routes**  
*analysed in Sinai sector*

**6** | **New DME Stations**  
*proposed for Airway*

**2** | **New DME Station**  
*proposed for Hurghada terminal*

**75%** | **Upper Airspace**  
*DME/DME coverage achieved (FL350)*

## Operational Impact



## Egypt as Regional Model

*"Egypt's DME/DME study is the first comprehensive coverage verification of its kind in the MID region."*

## Methodology

ICAO Doc 8168 + Doc 9613 compliant — directly transferable to any MID State airspace.

## Data & Tools

Full simulation outputs, redundancy maps, and gap analysis available for sharing.

## Capacity Building

Supports ICAO's call for specialised DME/DME-based PANS-OPS training (Doc 8168).





## Dual-Layer Strategy:

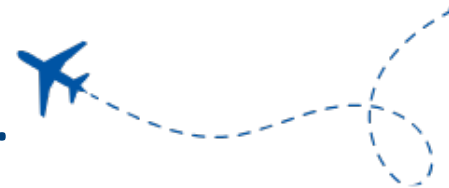
Global aviation experience confirms that GNSS is the main enabler for efficient PBN operations; however, it cannot be used as the only source of navigation. An independent conventional backup system is required to ensure operational continuity.

## Proactive Threat Mitigation:

Moving from short-term solutions for GNSS RFI events toward a permanent and resilient navigation structure by continuously optimizing the DME/DME network to maintain operations during large-scale interference.

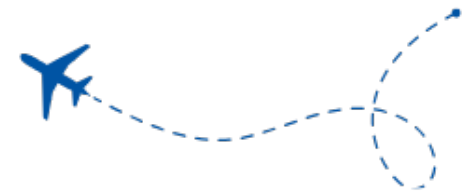
## Regional Standardization:

Working with ICAO MID Region to develop common R-NON implementation criteria, using Egypt's DME/DME analysis and optimization approach as a potential regional reference model.

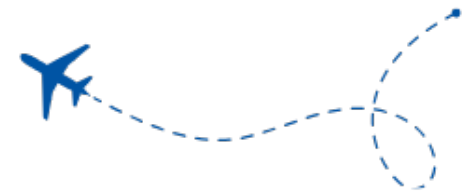




- Establish data-sharing mechanisms among ICAO MID States to support the identification, monitoring, mapping, and recording of coordinated GNSS RFI and spoofing events.
- Encourage States to maintain and strategically enhance DME/DME infrastructure as a resilient Alternative Positioning, Navigation, and Timing (A-PNT) backup solution.
- Invest in specialized training programs for flight procedure designers on DME/DME-based PANS-OPS criteria in accordance with ICAO Doc 8168.



- ICAO PBN Manual (Doc 9613)
- ICAO GNSS Manual (Doc 9849)
- ICAO PANS OPS Manual (DOC 8168)
- GNSS RFI Safety Risk Assessment (IATA)
- IATA Releases 2025 Safety Report
- EASA and IATA Publish Comprehensive Plan to Mitigate the Risks of GNSS Interference
- CNS/SG 15 Meeting : Minimum Navigation Operational Network (NAV MON)



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Thank You