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Evolving GNSS Resilience in Saudi Arabia: From Monitoring Limitations to a Future-Ready Mitigation Strategy

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01

GNSS in Saudi Arabia's Aviation Evolution

Balancing innovation and safety in a complex airspace

GNSS in Saudi Arabia’s Aviation Evolution

Balancing innovation and safety in a complex airspace

- Rapid integration of GNSS in national CNS modernization
- Strategic redesign of airspace and navigation procedures
- Safety-first approach with retained ground-based layers
- Addressing regional challenges with balanced infrastructure

02

The Threat of GNSS RFI: Global Surge, Local Impact

Growing vulnerabilities demand a proactive national response

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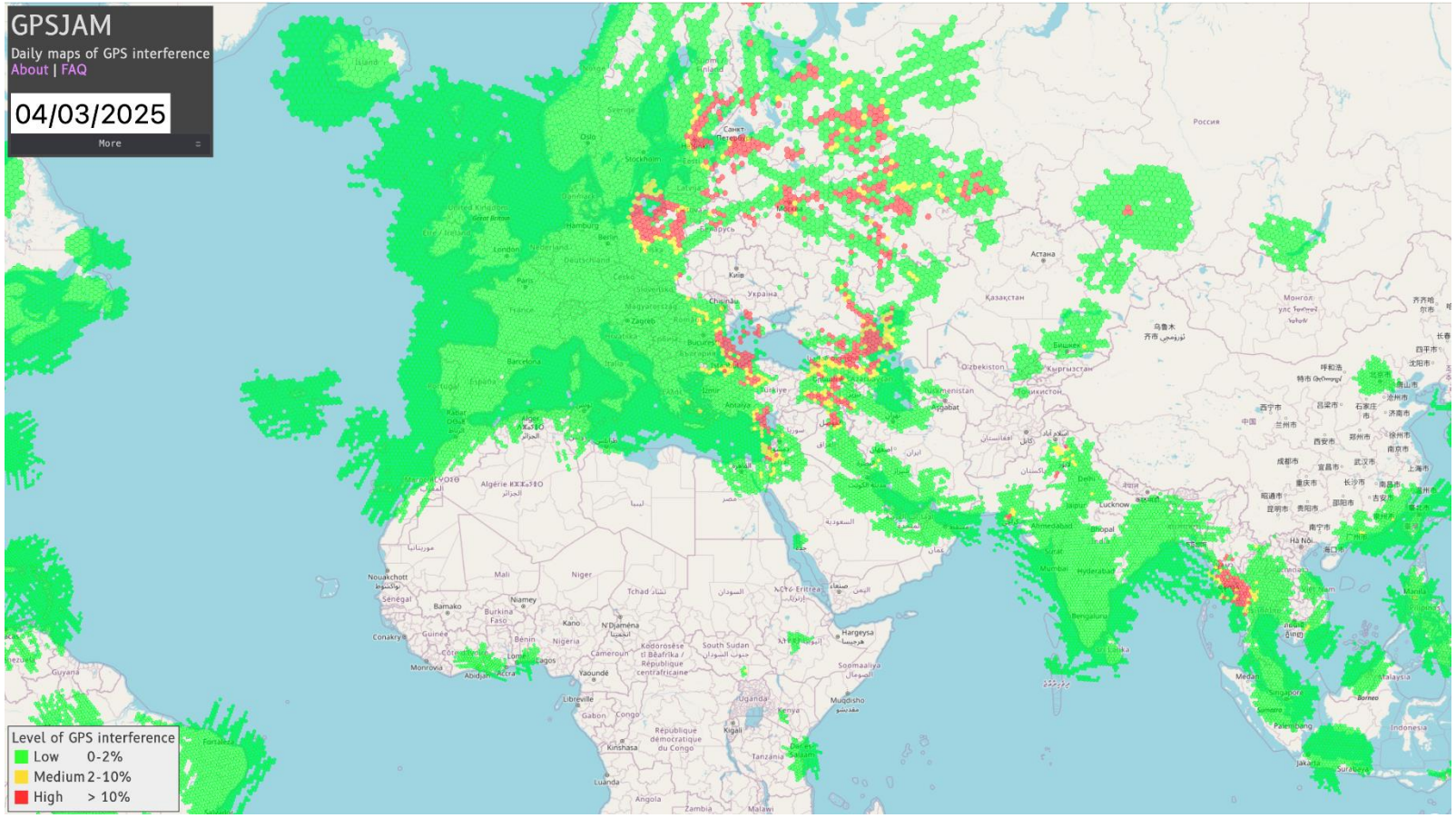
Growing vulnerabilities demand a proactive national response

- GNSS Radio Frequency Interference (RFI) is growing at an alarming rate:
  - → Jamming: +175%,
  - → Spoofing: +500% (globally)
- Most disruptions are detected through **pilot reports**, not automated systems
- These events affect **en-route navigation**, **FMS**, **ADS-B**, and **approach phases**
- Unaddressed RFI may compromise situational awareness and safety margins

The Threat of GNSS RFI: Global Surge, Local Impact



Daily GPS interference heatmap – 3 April 2025

Source: gpsjam.org | Red = >10% interference, Yellow = 2–10%, Green = <2%

03

SANS GNSS Monitoring System: Foundation for Future Readiness

A necessary first step in understanding and responding to GNSS threats
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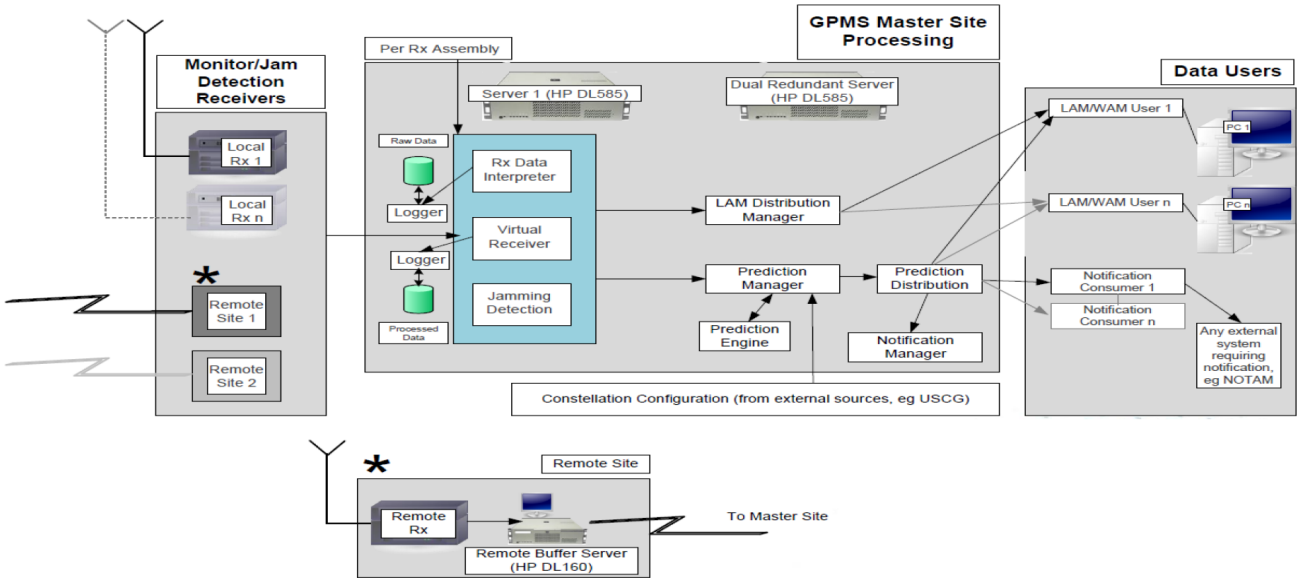
SANS GNSS Monitoring System: Foundation for Future Readiness

A necessary first step in understanding and responding to GNSS threats

- Initial deployment of GNSS Performance Monitoring System (GPMS)
- Five receiver sites across major operational regions
- Visual monitoring, basic prediction, and NOTAM proposal
- Operational integration with ATCO and engineering support
- Provided valuable insights, but has reached its technical limits

SANS GPMS Architecture & Receiver Setup



GPMS Overview:

SANS GPMS uses NovAtel GNSS receivers and antennas to collect signal data across multiple sites.

Data is centralized for basic integrity checks, jamming alerts, and semi-automated NOTAM proposals.

04

System Gaps and Challenges: Bridging the Limitations

Lessons learned from the first generation of GNSS monitoring

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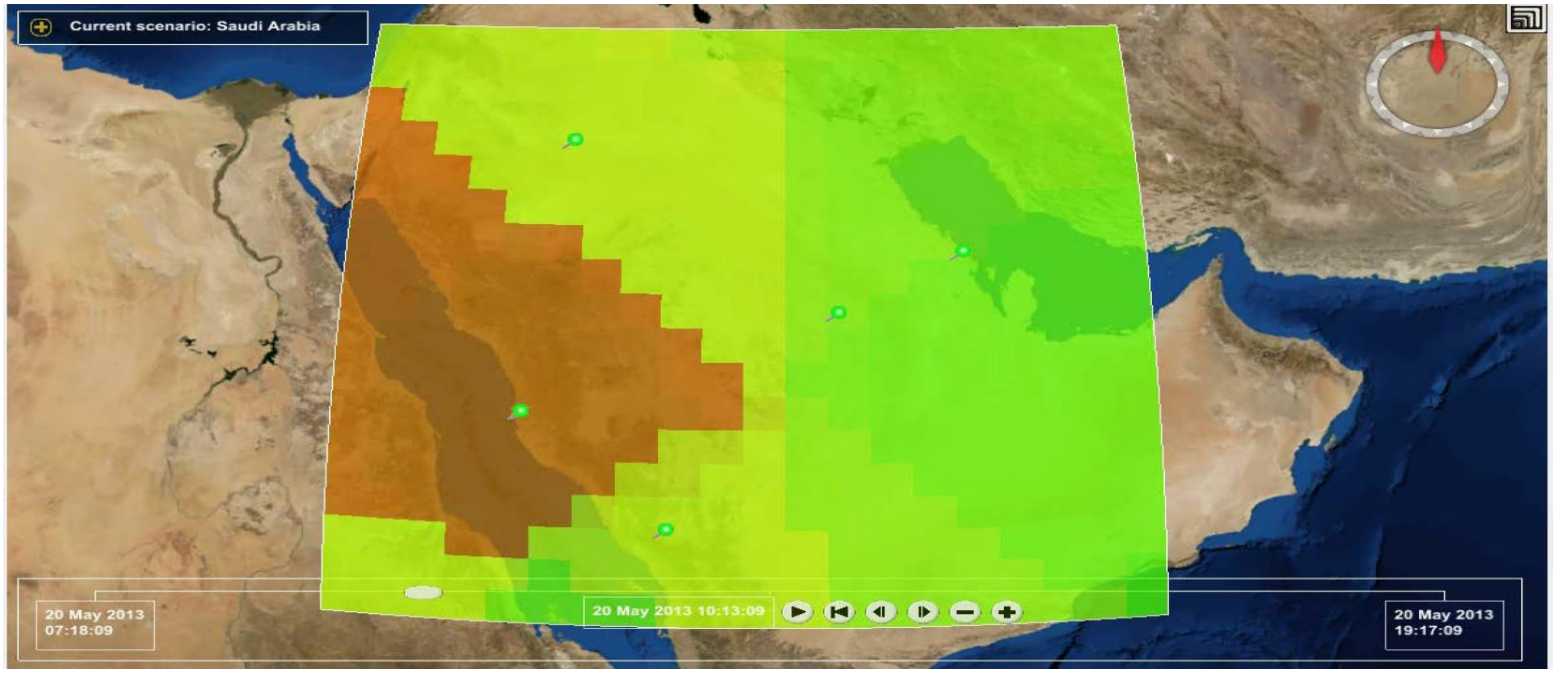
Lessons learned from the first generation of GNSS monitoring

- Coverage limited to receiver site proximity
- No spoofing or jamming detection capabilities
- Outdated software and limited prediction scope
- GPS-only monitoring; lacks multi-constellation support
- No remote access or interoperability with other systems

System Gaps and Challenges: Observed GNSS Signal Degradation



Simulation output showing GNSS signal availability

Data highlights significant signal degradation across central and western Saudi Arabia, particularly in zones beyond the direct line of sight from monitoring sites.

Orange = Severe degradation

Yellow/Green = Acceptable signal quality

05

Building the Future: A Vision for Integrated GNSS Resilience

Toward a predictive, scalable, and collaborative monitoring architecture

Building the Future: A Vision for Integrated GNSS Resilience

Toward a predictive, scalable, and collaborative monitoring architecture

- Distributed, low-cost GNSS sensors for wide-area coverage
- Integration with ADS-B (NIC/NUC) for air-ground performance data
- Satellite-based interference mapping and spoofing detection
- Real-time prediction algorithms and health monitoring
- Inter-agency data sharing and standardized interfaces

06

DME/DME Navigation – Saudi Arabia's Contingency Layer

A strategic layer aligned with national and regional resilience efforts

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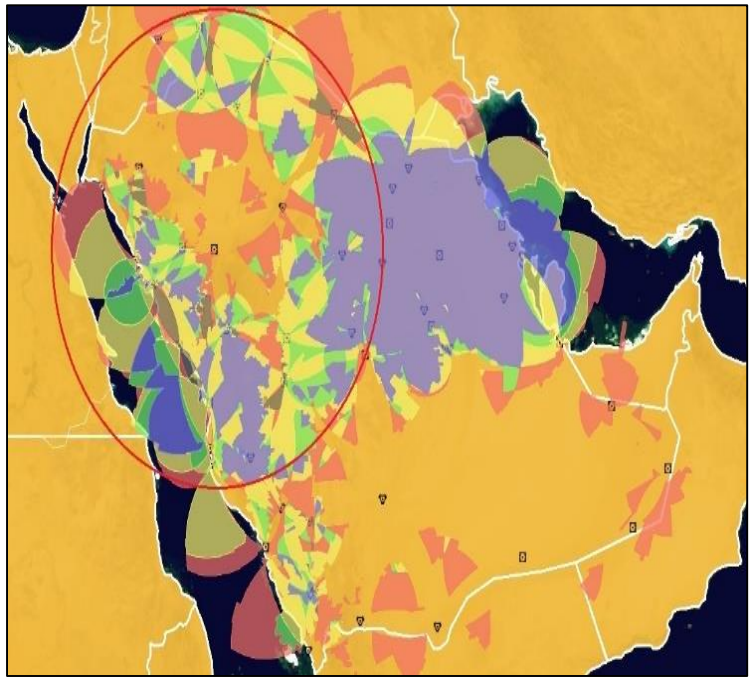
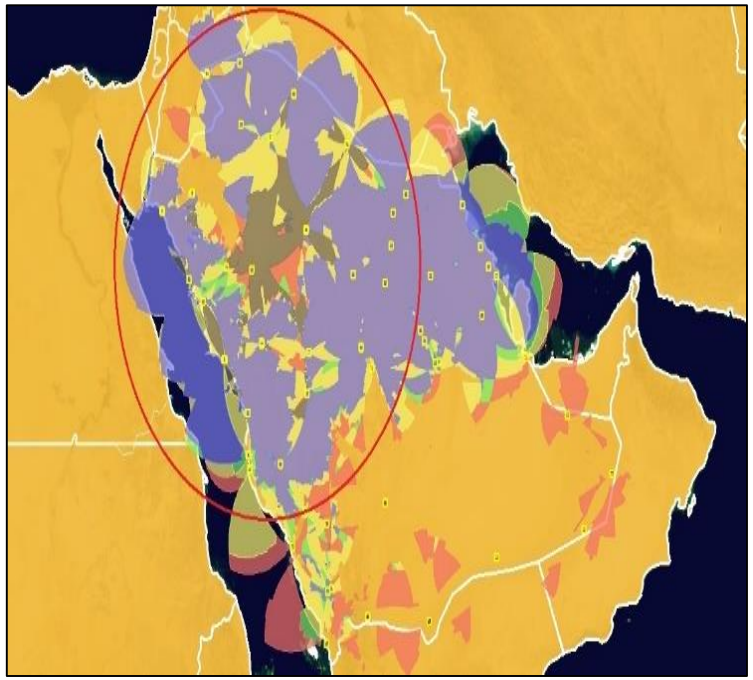
A strategic layer aligned with national and regional resilience efforts

- DME/DME provides GNSS-like positioning with built-in redundancy
- ILS/DME upgrades: high-power omni-DME for extended FL160 coverage
- Supports PBN continuity and resilience during GNSS outages
- Part of national navigation planning under SNAP
- SANS supports the regional MON task force to ensure MID-wide CNS robustness

DME/DME Navigation – Saudi Arabia's Contingency Layer





National DME/DME Coverage at FL160 – Before (left) and After (right) the ILS/DME Upgrade Transition from Low-Power Directional DMEs to High-Power Omnidirectional Units Significantly Expands En-Route Coverage and Strengthens Saudi Arabia's GNSS Contingency Navigation Layer.

07

Saudi Arabia's Commitment to GNSS Resilience

Driving innovation, safety, and collaboration across CNS systems

Saudi Arabia’s Commitment to GNSS Resilience

Driving innovation, safety, and collaboration across CNS systems

- Building a future-ready, data-driven GNSS monitoring framework
- Balancing innovation with operational resilience
- Investing in sovereign infrastructure and layered continuity
- Open to collaboration and knowledge exchange with ICAO States

Thank You

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