



International Civil Aviation Organization

Middle East Regional Monitoring Agency Board

Twenty-first Meeting (MIDRMA Board/21)
(Cairo, Egypt, 14 – 15 January 2026)

Agenda Item 4: Progress Report on the MIDRMA Project

**PROJECT PROPOSAL FOR THE MIDDLE EAST RISK ASSESSMENT SOFTWARE
WITH ADS-B INTEGRATION AND RESPONSE (MIDRAS AIR)**

(Presented by the MIDRMA)

SUMMARY

This working paper presents a project proposal for enhancing the Middle East Risk Assessment Software through the integration of Automatic Dependent Surveillance–Broadcast (ADS-B) technology, resulting in the upgraded system known as MIDRAS-AIR. The proposed enhancement aims to improve the accuracy, timeliness, and operational relevance of collision risk assessments within the ICAO Middle East RVSM airspace by utilizing high-frequency, four-dimensional (4D) trajectory data derived from ADS-B surveillance.

The integration of ADS-B data is expected to significantly reduce reliance on manual traffic data submissions from member States, which are known to contain inaccuracies, omissions, and delays. By leveraging automated and continuous surveillance data, MIDRAS-AIR will enable more precise collision risk calculations and support a proactive approach to airspace safety management.

Recognizing that not all aircraft operating within the Middle East RVSM airspace are continuously represented through ADS-B surveillance — including certain military, State, VIP, private, or non-equipped aircraft — the proposed system is designed to ensure comprehensive traffic coverage. MIDRAS-AIR will therefore incorporate the capability to process multiple traffic data sources, allowing collision risk assessments to be conducted using ADS-B data where available, while maintaining the inclusion of non-ADS-B traffic through conventional flight plan and legacy traffic data.

Action by the meeting is in paragraph 3.

REFERENCES

- Project Proposal for MIDRAS AIR.
- Cost Effectiveness Study for the MIDRAS-AIR Project.

1. INTRODUCTION

1.1 The Middle East Regional Monitoring Agency (MIDRMA) continues to support the safe and efficient operation of RVSM airspace through the application of internationally accepted collision risk assessment methodologies. As air traffic volumes in the ICAO Middle East Region continue to grow in complexity and density, the availability of accurate, timely, and representative traffic data remains a critical factor in maintaining acceptable levels of safety.

1.2 Historically, collision risk assessments within the Middle East RVSM airspace have relied primarily on traffic data samples submitted by member States. While this approach has enabled MIDRMA to meet its safety monitoring obligations, experience has shown that manually collected traffic data may be subject to limitations, including missing records, data inconsistencies, and processing delays, which can affect the precision of risk calculations.

1.3 In response to these challenges, MIDRMA proposes the enhancement of its existing Middle East Risk Assessment Software (MIDRAS) through the integration of Automatic Dependent Surveillance–Broadcast (ADS-B) technology, resulting in the upgraded system referred to as ADS-B Integration and Response (MIDRAS AIR). The integration of ADS-B will enable the use of high-frequency, four-dimensional (4D) trajectory data, providing a more accurate and operationally representative basis for collision risk assessment in RVSM airspace.

1.4 At the same time, MIDRMA recognizes that the surveillance environment within the Middle East Region is diverse, and that not all aircraft operating in RVSM airspace are continuously represented through ADS-B transmissions. Certain categories of traffic, including State, military, VIP, private, or non-equipped aircraft, may not be fully captured through ADS-B surveillance alone. A comprehensive safety assessment framework must therefore ensure that all relevant air traffic is appropriately represented, irrespective of the surveillance source.

1.5 Accordingly, the proposed MIDRAS-AIR solution is designed to support the use of multiple traffic data sources. While prioritizing ADS-B data where available for its superior accuracy and timeliness, the system will retain the capability to incorporate conventional flight plan and legacy traffic data to ensure complete traffic representation. This integrated approach enables MIDRMA to enhance risk assessment accuracy while preserving the completeness, resilience, and regulatory integrity of RVSM safety monitoring activities.

2. DISCUSSION

2.1 The proposed MIDRAS-AIR project represents a significant advancement in the way collision risk assessments are conducted within the Middle East RVSM airspace. By integrating Automatic Dependent Surveillance–Broadcast (ADS-B) data into MIDRMA's existing risk assessment framework, the system will enable the use of high-frequency, four-dimensional (4D) trajectory data, thereby improving the accuracy, timeliness, and operational relevance of collision risk calculations. This approach supports a transition from periodic, manually assembled traffic samples toward a more automated and data-driven safety monitoring capability.

2.2 ADS-B technology provides continuous, GPS-based aircraft position, altitude, and velocity information at a significantly higher update rate than conventional traffic data samples. The use of such data allows MIDRAS-AIR to model aircraft trajectories with greater precision, reduce uncertainty in collision risk parameters, and improve the identification of potential risk hotspots within RVSM airspace.

In addition, the automation of data ingestion reduces dependency on manual submissions by member States, mitigating known issues related to data incompleteness, formatting errors, and processing delays.

2.3 While ADS-B offers substantial safety and operational benefits, the surveillance environment within the ICAO Middle East Region is not uniform. It is recognized that certain categories of aircraft operating in RVSM airspace may not be continuously represented through ADS-B transmissions. These include, inter alia, State, military, VIP, private, or non-equipped aircraft, as well as aircraft operating with ADS-B intentionally deactivated. Exclusive reliance on ADS-B data could therefore result in incomplete traffic representation and potentially affect the comprehensiveness of collision risk assessments.

2.4 To address this operational reality, MIDRAS-AIR is designed to support an integrated, multi-source traffic data environment. The system will prioritize ADS-B data where available, benefiting from its high accuracy and temporal resolution, while retaining the capability to process conventional flight plan data and legacy traffic information for aircraft not captured by ADS-B surveillance. This approach ensures that all relevant RVSM traffic is included in collision risk assessments, regardless of surveillance equipment or operational status.

2.5 The incorporation of multiple data sources enhances the resilience and robustness of the risk assessment framework. By avoiding reliance on a single surveillance technology, MIDRAS-AIR ensures continuity of safety monitoring in the presence of equipment outages, signal interference, or operational constraints. This redundancy aligns with ICAO safety principles and supports MIDRMA's responsibility to maintain a complete and representative safety picture of RVSM operations across the region.

2.6 In addition to improved accuracy and completeness, MIDRAS-AIR will enable more frequent and responsive collision risk assessments. The availability of high-resolution traffic data supports enhanced analytical capabilities, including improved hotspot identification, trend analysis, and the potential for predictive safety assessments. These capabilities will allow MIDRMA to proactively monitor evolving traffic patterns and better support States in managing increasing air traffic complexity.

2.7 Overall, the proposed MIDRAS-AIR project provides a balanced and future-oriented solution that combines the advantages of modern surveillance technologies with the continued inclusion of conventional traffic data sources. This integrated approach strengthens MIDRMA's collision risk assessment capability, enhances confidence in safety outcomes, and positions the Agency to meet current and future ICAO RVSM safety monitoring requirements in a sustainable and operationally realistic manner.

2.8 In order to ensure transparency, shared understanding, and effective engagement of all MIDRMA Member States, the detailed project proposal prepared by the software developers has been made available for review, at **Appendix A**. Member States are encouraged to examine the proposed scope, technical approach, implementation plan, and associated cost elements, and to provide comments or observations to MIDRMA to support informed consideration and decision-making by the Board.

2.9 In parallel with the technical proposal, a Cost-Effectiveness Study has been prepared to assess the financial, operational, and safety benefits associated with the implementation of the MIDRAS-AIR project, at **Appendix B**. The study demonstrates that the integration of ADS-B-based automation, combined with reduced reliance on manual traffic data submission, is expected to deliver long-term operational efficiencies, cost savings, and enhanced safety outcomes for MIDRMA and its Member States. The findings of the study support the technical justification for the project and provide an additional basis for informed consideration by the MIDRMA Board.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- a) note the proposed enhancement of the Middle East Risk Assessment Software (MIDRAS) through the integration of ADS-B technology, including the use of an integrated approach that combines ADS-B data with conventional flight plan and legacy traffic data to ensure complete and representative RVSM collision risk assessments within the ICAO Middle East Region;
- b) invite MIDRMA Member States to review the detailed project proposal and the associated Cost-Effectiveness Study, at **Appendix A** and **B**, respectively. And to submit any comments or observations to MIDRMA within a timeframe to be determined by the meeting; and
- c) agree that MIDRMA may proceed with the necessary preparatory steps for the implementation of the MIDRAS-AIR project, in accordance with the guidance and decisions of the MIDRMA Board.

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Middle East Risk Assessment Software with ADS-B Integration

Project Proposal

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Author	Dr Sameer Alam

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Issued to:

Mr. Fareed Al-Alawi
Manager, Middle East Regional Monitoring Agency
Tel: +973 17 329054
Email: [midrma\(@\)midrma.com](mailto:midrma(@)midrma.com)
P.O. Box 50468
Kingdom of Bahrain

Issued by:

Dr Sameer Alam
Singapore

Contact:

Dr Sameer Alam
Tel: +65 84290661
Email: alamsam@yahoo.com
Project Manager and Consultant, Singapore

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MIDRAS-AIR

Middle East Risk Assessment Software with ADS-B Integration

Executive Summary

This proposal outlines a strategic upgrade of the **MIDRAS** software to a next-generation platform—**MIDRAS-AIR**—integrating **Automatic Dependent Surveillance–Broadcast (ADS-B)** technology into its collision risk assessment framework. By harnessing real-time, four-dimensional (4D) trajectory data, the enhanced system will enable the **Middle East Regional Monitoring Agency (MIDRMA)** to conduct faster, more accurate, and data-driven **Reduced Vertical Separation Minimum (RVSM)** airspace safety assessments.

Beyond ADS-B integration, MIDRAS-AIR introduces a **dual-mode data processing capability**. In scenarios where aircraft are unequipped with or have disabled ADS-B transponders, the system will seamlessly revert to using **flight plan data**, ensuring comprehensive surveillance coverage and operational continuity across all RVSM operations.

Leveraging the high frequency and precision of ADS-B data, MIDRAS-AIR overcomes the inherent limitations of legacy **Traffic Sample Data (TSD)**, notably in data latency and fidelity. A redesigned **software architecture** and **advanced analytical algorithms** will support continuous 4D trajectory ingestion, real-time collision risk computation, and proactive identification of evolving **airspace hotspots**.

Together, these innovations will establish a **resilient, scalable, and future-ready safety framework** for Middle Eastern airspace—empowering MIDRMA to anticipate risks, optimize operational efficiency, and uphold world-class standards in regional airspace safety management.

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Middle East Risk Assessment Software with ADS-B Integration

1. INTRODUCTION

Given the continued growth in air transportation, one of the key challenges faced by Air Navigation Service Providers (ANSPs) and airlines is how to increase airspace capacity without compromising safety. ICAO's new air traffic management (ATM) paradigms target a doubling of airspace capacity (2x) while enhancing safety by a factor of 10 by 2030.

Achieving these ambitious goals necessitates the development of new operational concepts, safety measures, and safety performance indicators within the air traffic system. For instance, Reduced Vertical Separation Minimum (RVSM) airspace, which spans vertically from 29,000 feet (FL290) to 41,000 feet (FL410), reduces the vertical separation from 2000 feet to 1000 feet, thereby adding six extra flight levels. ICAO has implemented stringent procedures to uphold the safety and integrity of this airspace.

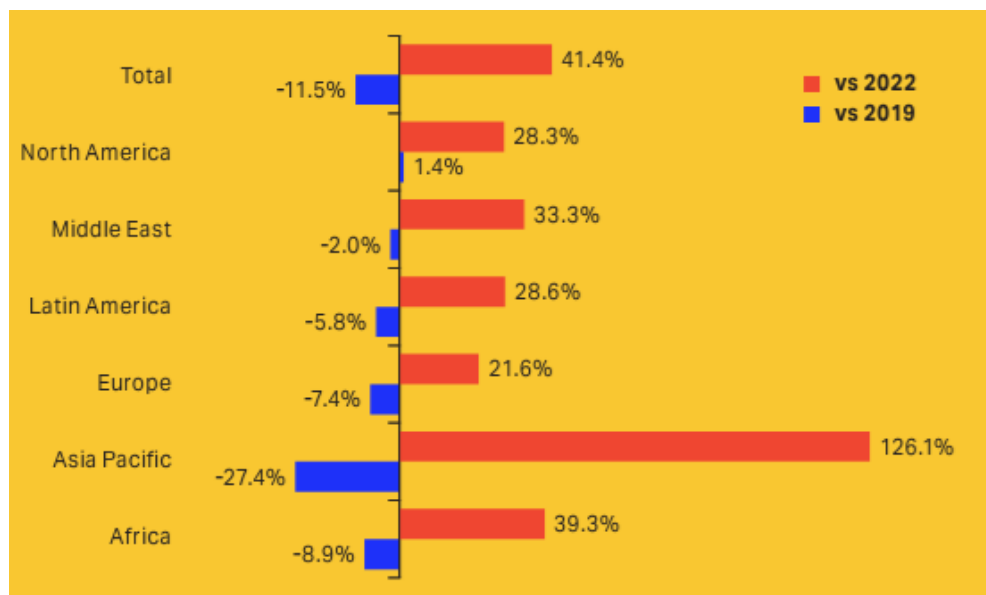


Figure 1: International PRK growth by airline region of registration: Industry-wide international RPKs increased 41.5% YoY, reflecting strong results for all regions with Middle East up by 33% YoY evolution in international traffic.

MIDRMA has developed MIDRAS software for collision risk assessment of Middle East airspace. This software system uses ICAO RGCSP Vertical Collision Risk Model for collision risk computation. The ICAO model is based on knowledge of the traffic flows along a given route structure.

The software computes Collision Risk equation parameters and process flight data for each member state and computes Collision Risk. The MIDRAS software also provides an interactive interface for collision risk visualization, simulation, modelling of scenarios and Hot-Spot analysis.

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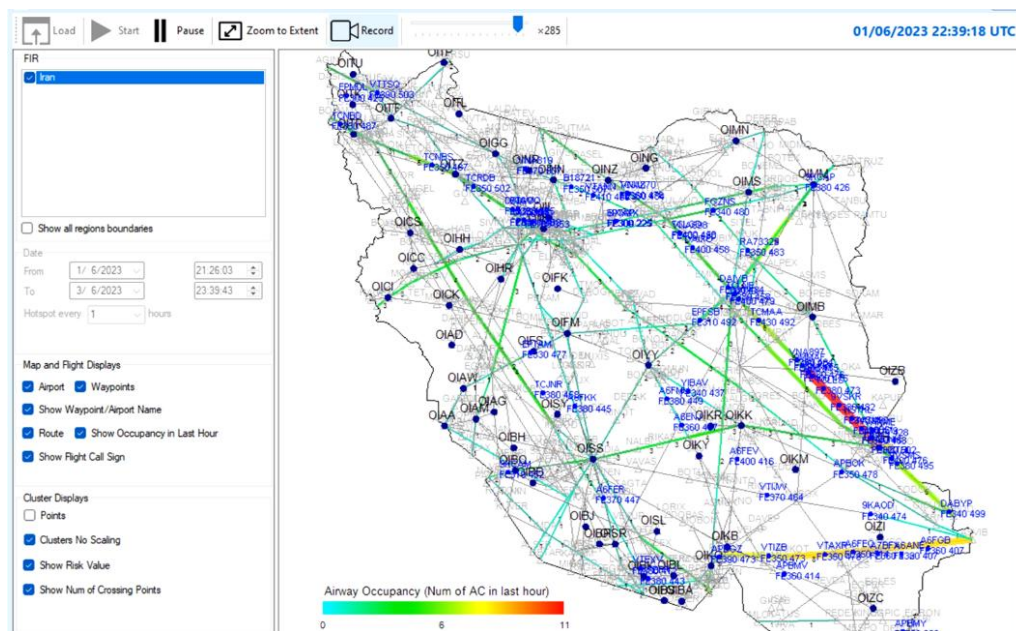


Figure 2: Visual Interface of MIDRAS software

A key challenge in the current air traffic risk assessment process is the reliance on manual data collection, which is often slow, error-prone, and resource-intensive. Manual data entry not only introduces the risk of inaccuracies, such as missing or misaligned data, but also contributes to issues like missing waypoints and incorrect aircraft speed information. These problems, combined with data maintenance issues, can lead to incomplete datasets and data loss, ultimately compromising the accuracy of collision risk assessments. Moreover, the computation of crossing frequency is approximated due to the nature of Traffic Sample Data (TSD) which may lead to errors in computations which need to be manually corrected.

The integration of ADS-B technology into MIDRAS addresses these challenges by providing automated, real-time data that eliminates the need for manual input and data corrections. Unlike manual collection, ADS-B delivers precise aircraft positional data continuously and without delay, ensuring data accuracy and integrity. This real-time nature of ADS-B data minimizes the risk of data loss and significantly improves data maintenance, as the system automatically records and updates traffic information. By leveraging ADS-B, MIDRAS can enhance its collision risk assessments, eliminates manual intervention in data entry and collection, ensuring that the insights are based on timely and accurate data, which is essential for effective management of airspace safety.

Incorporating ADS-B into MIDRAS will elevate the integrity and accuracy of air traffic data, enabling precise collision risk assessments, comprehensive data analytics, and enhancing MIDRAS's operational capabilities in airspace management and safety analytics.

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Middle East Risk Assessment Software with ADS-B Integration

2. BACKGROUND

One of the critical challenges faced in the current air traffic risk assessment process is the collection and accuracy of air traffic data. Traditional data collection methods rely heavily on manual data collection and entry, which is both time-consuming and prone to errors. The manual nature of these processes often results in missing data, misaligned information, missing waypoints, and inaccuracies in recorded aircraft speeds. These issues are particularly prevalent with data provided by various air traffic system providers, where inconsistencies and errors are common.

These inaccuracies significantly impact the reliability of collision risk assessments. Without precise and timely data, the ability to compute crossing frequency and analyze collision risk, if not carefully monitored, may be compromised. The integration of ADS-B technology within MIDRAS addresses these challenges by offering automated, high frequency data feeds that improve the accuracy, timeliness, and completeness of air traffic trajectory data. ADS-B reduces dependency on manual data entry, mitigates errors related to speed, distance, time and provides highly accurate aircraft positional data, ultimately leading to more reliable and precise 4D trajectory-based risk assessments.

The proposed upgrade will leverage ADS-B data to enhance MIDRAS's capabilities in several key areas:

- a) **Enhanced Accuracy and Frequency:** ADS-B offers updates as frequently as every second, compared to Traffic Sample Data (TSD) that is based on Waypoint entry records from Flight Data Processing system. This increase in update frequency and removal of reliance on secondary data feed will allow for more granular data and precise computational accuracy of collision risk models in MIDRAS.
- b) **Collision Risk Hot-Spot Assessment:** ADS-B data integration in MIDRAS will provide highly accurate collision risks hot-spots through detailed positional data, offering a more reliable basis for safety analysis.
- c) **Predictive Analytics:** Enabling MIDRMA to anticipate and mitigate collision risk by predictive modelling of traffic flows and congestion based on ADS-B data, including potential future traffic scenarios and frequent airspace closures.



Figure 3: Middle East airspace flight tracks from ADS-B data (source: Flight radar 24)

3. BENEFITS OF COLLISION RISK ASSESSMENT WITH ADS-B INTEGRATION IN MIDRAS

The integration of ADS-B technology into the MIDRAS software brings numerous advantages to the accuracy and reliability of collision risk assessment, enhancing overall air traffic safety in the MID RVSM airspace. The key benefits include:

a) Enhanced Data Accuracy

- **Real-Time Positional Data:** ADS-B provides highly accurate, GPS-based positional data at frequent intervals. This real-time data significantly reduces errors caused by manual data entry, such as missing waypoints or misaligned flight paths, and ensures that risk assessments are based on the most current and precise information.
- **Automated Data Collection:** Unlike manual data collection, which can be prone to data loss and inaccuracies, ADS-B automatically captures and transmits aircraft positions, altitudes, and speeds directly into the MIDRAS system. This automation reduces human error and enhances data completeness and integrity.

b) Improved Situational Awareness

- **Comprehensive Traffic Monitoring:** ADS-B allows for continuous 4D trajectory data of aircraft across the airspace, providing a complete and real-time data of all flights. This enhanced data helps collision risk modelling with high accuracy.
- **Timely Detection of Conflicts:** The high-frequency updates provided by ADS-B enable MIDRAS to detect Collision Risk Hotspots as they arise, allowing for proactive risk mitigation and reducing the likelihood of collision risk.

c) Efficient Risk Management

- **Rapid Data Processing:** ADS-B data can be processed in real-time, which facilitates quick assessment and analysis of traffic conditions. This efficiency allows air traffic managers to make timely and informed decisions, particularly in complex airspace scenarios such as airspace closure or major traffic diversions in the MID RVSM airspace.
- **Reduction in Manual Data Maintenance:** With ADS-B, there is a significant reduction in the need for manual data maintenance. This not only lowers operational costs but also reduces the time required to update and verify data, allowing manpower resources to be focused on risk assessment and mitigation.

d) Enhanced Predictive Capabilities

- **Reliable Trajectory Prediction:** With accurate, high-frequency data from ADS-B, MIDRAS can generate reliable 4D trajectory predictions, which are crucial for assessing potential Hot-Spots and identifying traffic flows that may lead to higher collision risks.
- **Improved Model Accuracy:** The integration of ADS-B data enhances the accuracy of MIDRAS's collision risk models, as it enables the system to account for real-time variations in aircraft speed and trajectory, providing more robust and precise assessments.

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e) Compliance with International Standards

- **Alignment with Global Best Practices:** ADS-B is recognized globally as a key component of modern air traffic management systems. Integrating ADS-B with MIDRAS ensures that the system aligns with international safety standards and best practices, supporting MIDRMA's mission to maintain and enhance airspace safety in the Middle East RVSM airspace.
- **Support for Regulatory Requirements:** ADS-B data supports compliance with aviation regulatory requirements by providing transparent and verifiable data for collision risk assessments, which is essential for reporting and audit purposes.

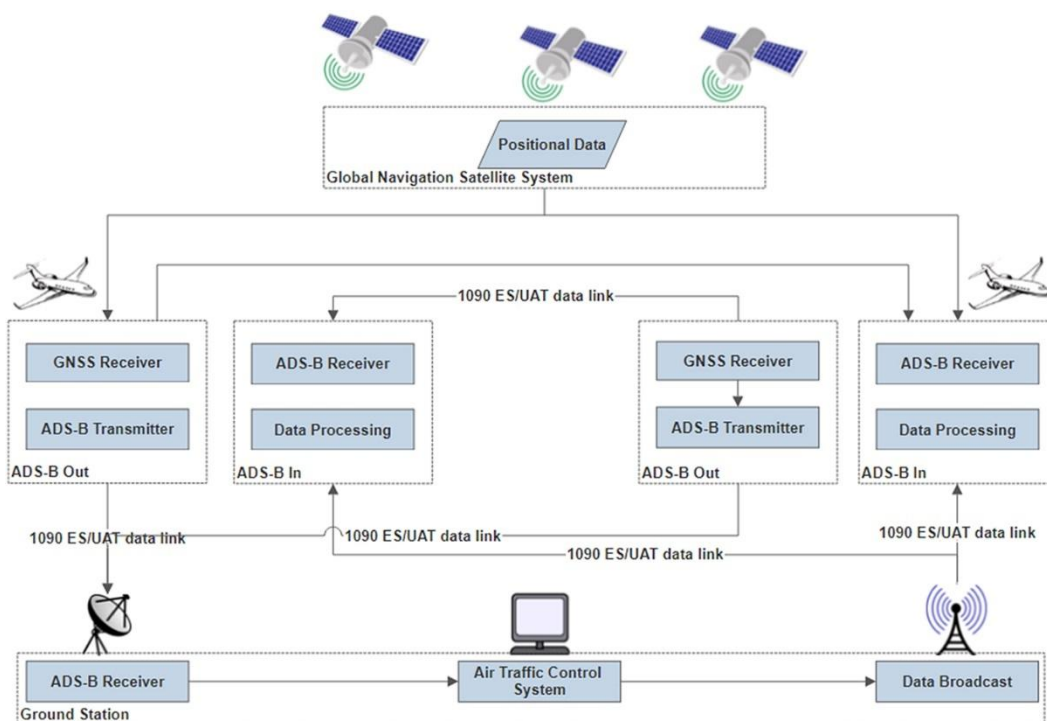


Figure 4: ADS-B data collection process.

The integration of ADS-B technology into MIDRAS significantly enhances the accuracy, timeliness, and reliability of collision risk assessments, providing valuable benefits for air traffic safety and efficiency in the Middle East region. By leveraging real-time data, automated processes, and predictive analytics, MIDRAS with ADS-B capabilities positions MIDRMA at the forefront of air traffic risk management and safety.

4. NEED FOR A NEW ARCHITECTURE AND ADVANCED ALGORITHMS FOR ADS-B INTEGRATION IN MIDRAS

The integration of ADS-B data into MIDRAS requires a fundamental redesign of the software architecture to accommodate the advanced features and capabilities enabled by this technology. Unlike the traditional

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Traffic Sample Data (TSD), which has limited fields and static values, ADS-B data provides a continuous stream of dynamic, four-dimensional (4D) data, including latitude, longitude, altitude, speed, and time. This necessitates new approaches in both data processing and collision risk assessment.

a) New Software Architecture Requirements

- **Scalability and Real-Time Processing:** The existing MIDRAS architecture is designed to handle periodic updates from simpler data formats like Traffic Sample Data (TSD), which are less frequent and contain basic information. In contrast, ADS-B data requires a scalable, high-performance architecture capable of processing real-time data from multiple sources simultaneously. The upgraded architecture must support continuous data ingestion, data processing, and deep analysis, ensuring MIDRAS can handle the increased data volume and complexity.
- **Data Storage and Management:** ADS-B data streams are substantially larger and more detailed than traditional data sources. Therefore, the new architecture needs to incorporate advanced data storage solutions that can manage the high-frequency data while ensuring data integrity and accessibility. This includes optimizing data indexing, retrieval, and archiving to support both current and historical analyses.

b) Development of Advanced 4D Data Processing Algorithms

- **4D Trajectory Prediction and Monitoring:** Traditional algorithms for Traffic Sample Data (TSD) were limited to basic parameters and were not designed to handle the complexities of 4D data (spatial dimensions plus time) that ADS-B provides. New algorithms will be required to process ADS-B data, enabling precise 4D trajectory construction and data analytics. These algorithms will consider variables like speed, heading, and altitude changes, allowing for a more accurate representation of aircraft 4D trajectories and crossing frequencies.
- **Automated Data Correction and Error Handling:** Unlike Traffic Sample Data (TSD), which offers a simpler and more predictable data set, ADS-B data can be prone to various types of errors, such as signal interference or erroneous readings. New algorithms must be developed to automatically detect, correct, or compensate for these errors to ensure the reliability and accuracy of the data used for collision risk assessments.
- **Geospatial Analysis and Real-Time Visualization:** With the added detail of ADS-B, MIDRAS will require advanced geospatial algorithms to analyze aircraft positions in relation to airways, waypoints, and other airspace constraints. This will enable enhanced visualization capabilities such as airway occupancy analytics and fast-time simulation of air traffic, which are critical for identifying potential risk scenarios and Hot-Spot identification.

c) Addressing the Limitations of Traffic Sample Data (TSD)

- **Expanding Data Fields and Parameters:** TSD provides limited fields, primarily focusing on basic flight plan information and waypoint position. In contrast, ADS-B includes a broader range of parameters, such as velocity, heading, rate of climb or descent, and more. The new

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architecture and algorithms will be designed to fully leverage this expanded data set, providing a richer and more detailed basis for analysis.

- **Real-Time Data vs. Static Snapshots:** Unlike the static nature of TSD, ADS-B provides a real-time, dynamic view of air traffic. This capability enables MIDRAS to continuously monitor and update its assessments, as opposed to relying on periodic snapshots that may not accurately reflect current conditions. Real-time processing algorithms will ensure that MIDRAS can identify and respond to emerging collision risks.
- **Enhanced Accuracy and Predictive Capabilities:** The static and limited nature of TSD restricts the ability to make accurate and forward-looking assessments. With ADS-B integration, MIDRAS will benefit from highly accurate, 4D trajectory data that supports sophisticated predictive models. This enhancement will improve the system's ability to anticipate future traffic scenarios and proactively mitigate risks.

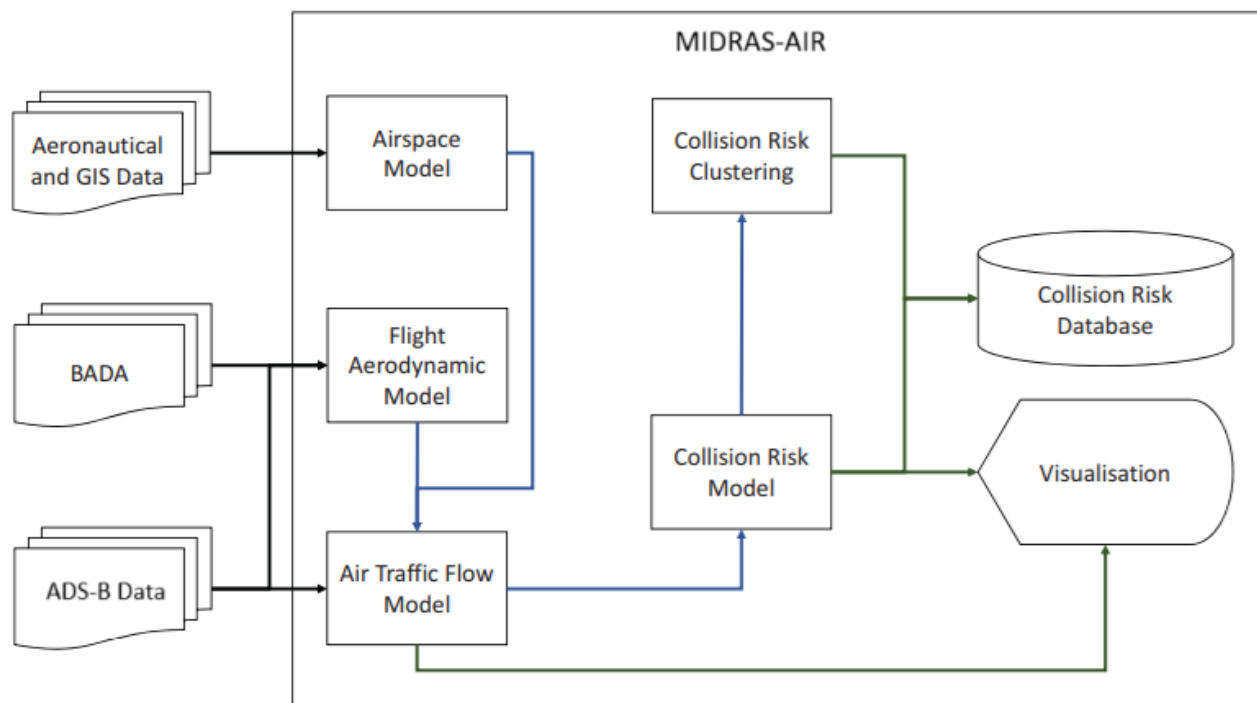


Figure 5: Architecture of the MIDRAS-AIR

5. Dual Data Processing Capability in MIDRAS-AIR

To address the limitations of relying solely on ADS-B data, MIDRAS-AIR will incorporate a dual data processing capability, enabling robust and resilient air traffic management within Reduced Vertical Separation Minimum (RVSM) airspace. This feature is critical for managing scenarios where aircraft

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either lack ADS-B equipment or have their ADS-B transponders switched off, thereby presenting gaps in surveillance coverage if only ADS-B data is used.

a) Flight Plan Data Integration for Non-ADS-B Equipped Aircraft

- While ADS-B integration provides real-time, four-dimensional trajectory data that enhances the precision of collision risk assessment, MIDRAS-AIR will not solely depend on ADS-B. For aircraft without ADS-B transmitters, MIDRAS-AIR will utilize flight plan data, enabling the system to track and assess collision risk based on scheduled trajectories and other pertinent information. This approach ensures that every aircraft operating within RVSM airspace can be included in the airspace collision risk assessment, regardless of its onboard surveillance equipment.

b) Adaptive Processing Based on Surveillance Availability

- MIDRAS-AIR's dual capability enables adaptive processing. When ADS-B data is available, the system prioritizes it for its higher accuracy and frequency of updates. However, in the absence of ADS-B data, MIDRAS-AIR seamlessly transitions to processing collision risk based on flight plan data, supported by legacy surveillance systems when available. This flexibility provides MIDRAS-AIR with an adaptable operational model, ensuring comprehensive coverage without interruption.

c) Enhanced System Resilience and Redundancy

- By supporting both ADS-B data and flight plan data, MIDRAS-AIR introduces a resilient framework that minimizes reliance on a single data source. This redundancy is essential for sustaining operations under diverse conditions, such as equipment outages, signal interference, or intentional deactivation of ADS-B transponders by aircraft. The dual-processing approach bolsters MIDRAS-AIR's ability to manage traffic safely in all circumstances, supporting continuous monitoring and risk assessment in RVSM airspace.

d) Ensuring Seamless Compliance with ICAO Standards and Safety Goals

- Incorporating both ADS-B and flight plan data processing aligns MIDRAS-AIR with ICAO standards for surveillance and safety in RVSM airspace. By providing comprehensive surveillance coverage through multiple data sources, MIDRAS-AIR enhances MIDRAS-AIR's compliance with international safety standards and its capability to meet evolving airspace safety demands.

Upgrading MIDRAS to integrate ADS-B technology will require a new software architecture capable of real-time data processing and storage, as well as the development of advanced 4D data processing algorithms. These enhancements will allow MIDRAS to leverage the full capabilities of ADS-B data, overcoming the limitations of traditional Traffic Sample data form and delivering a more robust, accurate, and responsive collision risk assessment system.

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6. SCOPE OF WORK AND WORK PACKAGES

The MIDRAS-AIR will involve **four primary work packages** (WPs), each addressing specific technical aspects of ADS-B integration and enhanced functionality. Detailed descriptions of each WP are provided below.

WP1: ADS-B Data Integration and 4D Trajectory based Collision Risk Assessment

- **Objective:** Integrate ADS-B data into MIDRAS to facilitate 4D Trajectory based, high-fidelity collision risk assessments.
- **Tasks:**
 - **Data Processing Algorithms:** Develop robust algorithms to handle ADS-B data streams, including decoding, filtering, and error correction.
 - **Risk Calculation Models:** Implement enhanced collision risk models that exploit the improved accuracy and frequency of ADS-B data. These models will consider trajectory prediction, altitude monitoring, and spatial separation.
- **Outcomes:**
 - Enhanced 4D Trajectory based Collision Risk Assessment.
 - High precision in risk assessments due to frequent position updates.
 - An enriched database for analytical and historical trend analysis.

WP2: Dual Data Processing Capability for Collision Risk Assessment

- **Objective:** Establish resilient, dual-data processing in MIDRAS-AIR to ensure continuous collision risk assessment, even when ADS-B data is unavailable.
- **Tasks:**
 - **Data Integration:** Enable MIDRAS-AIR to use both ADS-B and flight plan data, ensuring compatibility across data sources.
 - **Model Calibration:** Adapt collision risk models to work effectively with either data source, ensuring accurate assessments.
 - **Validation:** Test the system under mixed data conditions to verify consistent performance.
- **Outcomes:**
 - Maintains full collision risk assessment capabilities regardless of data source.
 - Enables MIDRAS-AIR to dynamically switch data inputs as needed.
 - Models calibrated for both ADS-B and flight plan data for robust risk predictions.

WP3: Advanced Traffic Analysis and Simulation with ADS-B Data

- **Objective:** Enable dynamic traffic simulation capabilities by utilizing ADS-B data for predictive analysis.

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- **Tasks:**
 - **Traffic Flow Modelling:** Develop predictive models to assess current and forecasted air traffic congestion, incorporating ADS-B data for high accuracy.
 - **Scenario-based Simulations:** Implement tools for real-time scenario simulation, allowing users to adjust parameters (such as traffic volume) and evaluate potential outcomes.
 - **3D Visualization Tools:** Create advanced 3D visualization capabilities for air traffic flows, including altitude, speed, and trajectory information, to provide users with intuitive, interactive monitoring.
- **Outcomes:**
 - A predictive framework for managing traffic flows and identifying congestion points.
 - Real-time capability for conducting “what-if” analyses and planning.
 - Improved situational awareness through immersive 3D visualization.

WP4: User Interface and System Performance Enhancements

- **Objective:** Enhance the MIDRAS interface to improve user experience and optimize system performance for handling large volumes of ADS-B data.
- **Tasks:**
 - **User Interface (UI) Redesign:** Develop a responsive, intuitive interface with streamlined navigation and customization options tailored to risk analysts.
 - **Data Handling Optimization:** Implement improvements in data storage and retrieval, including indexing and caching mechanisms to enhance performance.
 - **Enhanced Architecture:** Introduce advanced architecture features, such as robustness, scalability and automatic error handling to ensure data integrity.
- **Outcomes:**
 - A user-friendly, efficient, and secure interface, providing enhanced operational insights.
 - Improved data processing speeds to manage real-time ADS-B data streams effectively.
 - Increased system reliability and reduced downtime through optimized backend processes.

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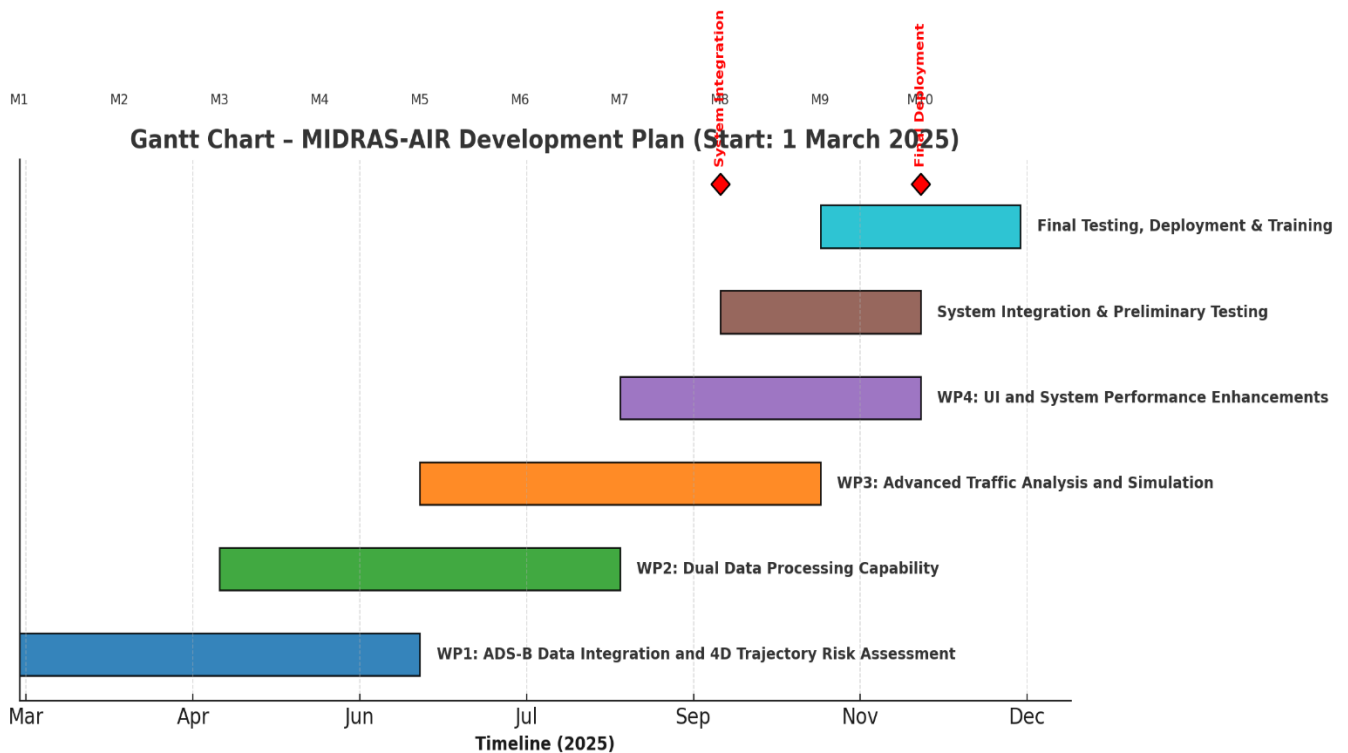
Middle East Risk Assessment Software with ADS-B Integration

7. IMPLEMENTATION PLAN AND MILESTONES

The project will be executed over a ten-month period, with concurrent development across work packages. Major milestones include:

- **Month 1-4:** Completion of ADS-B data integration framework and dual data processing capabilities (WP1 and WP2)
- **Month 3-5:** Development of enhanced collision risk models and visualization tools (WP2& WP3)
- **Month 5-7:** Implementation of predictive traffic flow models and UI redesign (WP3 & WP4)
- **Month 8-9:** System integration and preliminary testing with simulated ADS-B data
- **Month 9-10:** Final testing, deployment, documentation, and user training

Table 1: Project Activities – GANTT Chart for 10 Months of Development Phase



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Middle East Risk Assessment Software with ADS-B Integration

8. PROJECT DELIVERABLE

The MIDRAS-AIR project will result in the following key deliverables, ensuring the successful integration of ADS-B capabilities for enhanced collision risk assessment and air traffic management:

1. ADS-B Integration Module:

- A fully developed and integrated ADS-B module within the MIDRAS-AIR system, enabling real-time data collection and processing of 4D aircraft trajectories.

2. Traffic Analysis and Simulation Tools:

- Advanced traffic analysis tools that leverage ADS-B data for dynamic traffic simulations, supporting proactive collision risk assessment.
- Simulation results and reports demonstrating the effectiveness of the tools in managing air traffic within Middle Eastern airspace.

3. Enhanced User Interface (UI) and Performance Upgrades:

- A redesigned and optimized user interface for MIDRAS-AIR, featuring enhanced visualization of real-time traffic data and collision risk scenarios.
- Performance improvements to support real-time data processing and interactive analysis.

4. System Integration and Testing Documentation:

- Comprehensive system integration reports detailing the implementation of ADS-B into the MIDRAS-AIR framework.
- Testing documentation including test plans, results, and validation reports confirming system functionality and reliability.

5. Technical Documentation and User Manuals:

- Detailed technical documentation covering the architecture, algorithms, and methodologies used in the system upgrade.
- User manuals for operational guidance, detailing system features, user interface navigation, and troubleshooting procedures.

6. Final Project Report:

- A comprehensive project report summarizing the scope, methodology, outcomes, and future recommendations.
- Includes insights on potential areas for further research and development based on the project findings and ADS-B integration results.

MIDRAS-AIR

Middle East Risk Assessment Software with ADS-B Integration

9. BUDGET BREAKDOWN FOR MIDRAS-AIR DEVELOPMENT AND MAINTENANCE

The total estimated budget (**Development and Maintenance**) for the MIDRAS-AIR project is

\$340,000 (Three hundred and forty thousand USD Only)

which include system design, development and integration over a ten-twelve-month period and a subsequent two-year maintenance period. Below is the detailed budget breakdown:

a) Development Phase (10 – 12 months) - Cost: \$240,000

The development phase comprises four key work packages, with detailed costs based on estimated hours and rates. This phase will conclude within nine months, covering the integration of ADS-B, traffic analysis, user interface enhancements, and system testing.

b) Maintenance Phase (24 months) - Cost: \$100,000

After the completion of the development phase, the project will enter a two-year maintenance period, covering ongoing support, updates, and bug fixes for MIDRAS-AIR. This maintenance phase ensures continued reliability and functionality for stakeholders.

Table1: Budget breakdown for Development & Maintenance

Project Phase	Work Package	Cost (USD)
Development Phase	WP1: ADS-B Integration	\$60,000
	WP2: Dual Data Processing Capability	\$43,200
	WP3: Traffic Analysis & Simulation	\$60,000
	WP4: UI & Performance Enhancements	\$36,000
System Integration & Deployment	System Integration and Testing	\$24,000
	Final testing and Deployment	\$16,800
Development & Integration	10-12 Months	\$240,000
Maintenance	Two Years (24 months)	\$100,000
Total Project Cost		\$340,000

MIDRAS-AIR

Middle East Risk Assessment Software with ADS-B Integration

10. PROJECT INCLUSIONS & EXCLUSIONS

- **Key Inclusions:**

- Full development of the software, covering all work packages and system integration.
- A two-year maintenance plan post-development, ensuring continuous support and updates.
- Necessary hardware and software to support the project's objectives.
- Travel Costs: Any travel costs related to the project, including training or software installation, is covered in the proposal.

- **Key Exclusion:**

- Provision of ADS-B Data: For the purposes of this project, one critical exclusion pertains to the provision and cost of ADS-B data. The ADS-B (Automatic Dependent Surveillance-Broadcast) data, which is essential for real-time positional tracking and collision risk assessment within the MIDRAS-AIR system, will be supplied directly by the Middle East Regional Monitoring Agency (MIDRMA).
- ADS-B Decoder and any Third-Party Software Licenses: Licensing fees for any required decoder for raw ADS-B data and third-party software is excluded from the project cost and will be supplied directly by the Middle East Regional Monitoring Agency (MIDRMA).

11. PROJECT TIMELINE

The project is scheduled to span **10-12 months**, with an anticipated start date of **March 1, 2026**, and an expected completion date of **Dec 31, 2026**, with a two-month buffer period to account for uncertainties.

Table 2: Project Timeline

Project Phase	Duration	Start Date	Completion Date
Project Admin / Planning	1 month	Mar 1, 2026	Mar 31, 2025
Design and Development	7 months	Apr 1, 2026	Oct 31, 2026
System Integration	2 months	Sep 1, 2026	Nov 30, 2026
Testing & Deployment	1 month	Dec 1, 2026	Dec 31, 2026

This timeline allows for structured progression through the phases of project initiation, development, system integration, and final testing, ensuring a comprehensive approach to delivering the MIDRAS-AIR project on time.

MIDRAS-AIR

Middle East Risk Assessment Software with ADS-B Integration

12. PAYMENT TERMS

The Consultant will invoice MIDRMA according to the schedule outlined in the agreement or the relevant Statement of Works.

The total project cost is inclusive of GST. Please note that any transaction-related fees, such as bank charges and currency exchange fees, will be borne by MIDRMA.

There will be one full and final invoice of **USD 340,000** (Three Hundred Forty Thousand US Dollars). This invoice will cover the **Development Cost** of USD 240,000 (Two Hundred Forty Thousand US Dollars) and the **Maintenance Cost** of USD 100,000 (One Hundred Thousand US Dollars), to be invoiced and paid at the start of the project in the following account.

Account Details	
Account Name	Sameer Alam
Account Number	537462392001
Bank Name	Oversea-Chinese Banking Corporation Limited Singapore
Bank Address	OCBC CENTRE, FLOOR 9, 65 CHULIA STREET. ZIP Code: 049513
Intermediary Bank	JP Morgan Chase Bank, New York, USA
SWIFT BIC code:	CHASUS33

13. REFERENCES (Consultant in **Bold**)

- **Alam, S.**, Lokan, C., & Abbass, H. (2012). What can make an airspace unsafe? Characterizing collision risk using multi-objective optimization. In *Proceedings of the 2012 IEEE Congress on Evolutionary Computation (CEC)*, Brisbane, Australia, 1-8.
- Symon, F., **Alam, S.**, Hossain, M. M., & Blom, H. (2012). Airspace network characterization for effect of intermediate waypoints on collision risk assessment. In *Proceedings of the 6th International Conference on Research in Air Transportation (ICRAT)*, Istanbul, Turkey.
- **Alam, S.**, Hossain, M., Lokan, C., Barry, S., Aldis, G., Butcher, R., & Abbass, H. (2013). Real-time prediction of worst-case air traffic sector collision risk using evolutionary optimization. In *Proceedings of the 2013 IEEE Symposium on Computational Intelligence in Vehicles and Transportation Systems (CIVTS)*, Singapore.
- Purton, L., Abbass, H., & **Alam, S.** (2014). Identification of ADS-B system vulnerabilities and threats. *Australian Transport Research Forum*, Canberra, Australia, 1-16.
- Hossain, M. M., **Alam, S.**, Symon, F., & Blom, H. (2014). A complex network approach to analyze the effect of intermediate waypoints on collision risk assessment. *Air Traffic Control Quarterly*, 22(2), 87-114.
- **Alam, S.**, Hossain, M., Al-Alawi, F., & Al-Thawadi, F. (2016). Optimizing lateral airway offset for collision risk mitigation using differential evolution. *Air Traffic Control Association Institute Inc.*, 23(4), 1-24.
- Nguyen, M. H., & **Alam, S.** (2016). Airspace collision risk hot-spot identification using clustering models. *IEEE Transactions on Intelligent Transportation Systems*, 19(1), 48-57.
- Pham, D. T., Ngo, M. M., Tran, N. P., **Alam, S.**, & Duong, V. (2019). Conflict Prediction Using Generative Model from ADS-B Data. In *Proceedings of the 2019 Integrated Communications, Navigation, and Surveillance Conference (ICNS)*, Herndon, VA, USA.
- Schultz, M., Post, J., & **Alam, S.** (2019). Concept of a data-driven airport management using ADS-B data. In *Proceedings of the EIWAC Conference*, Tokyo, Japan.
- Tang, J., Abbass, H., & **Alam, S.** (2019). An airspace collision risk simulator for safety assessment. In *Proceedings of the 2019 Winter Simulation Conference (WSC)*, National Harbor, MD, USA, 3160-3171.
- Pham, D. T., **Alam, S.**, & Duong, V. (2020). An Air Traffic Controller Action Extraction-Prediction Model Using Machine Learning Approach. *Complexity*, 2020(1), 1659103.
- Schultz, M., Olive, X., Rosenow, J., Fricke, H., & **Alam, S.** (2020). Analysis of airport ground operations based on ADS-B data. In *Proceedings of the 2020 International Conference on Artificial Intelligence and Data Analytics in Air Transportation (AIDA-AT)*, Singapore.
- Ma, C., Cai, Q., **Alam, S.**, & Duong, V. N. (2020). Airspace capacity overload identification using collision risk patterns. In *Proceedings of the 2020 International Conference on Artificial Intelligence and Data Analytics in Air Transportation (AIDA-AT)*, Singapore.
- Cai, Q., Ang, H., & **Alam, S.** (2021). A multi-objective optimization approach for reducing air traffic collision risk. In *Proceedings of the 2021 IEEE Congress on Evolutionary Computation (CEC)*, Kraków, Poland, 1759-1766.
- Cai, Q., Ang, H., & **Alam, S.** (2023). Collision risk assessment of reduced aircraft separation minima in procedural airspace using advanced communication and navigation. *Chinese Journal of Aeronautics*, 36(4), 315-337.

MIDRAS-AIR

Middle East Risk Assessment Software with ADS-B Integration

APPENDIX

CONSULTANCY SERVICES TERMS AND CONDITIONS

These Terms and Conditions shall apply to the provision of the Software Development and Consultancy Services by Sameer ALAM (referred to as CONSULTANT hereafter) as stipulated in Annex (Project Work Details) wherein MIDRMA has requested for ADS-B Integration within MIDRAS software and, unless CONSULTANT has agreed otherwise in writing, they shall also apply to any other services of whatever nature which may be provided by CONSULTANT to the Client in the future.

DEFINITIONS

In this Agreement, unless the context otherwise requires, the following expressions have the following meanings:

"Agreement" means the Client Communication in conjunction with these Terms and Conditions.

"Client" means any individual, firm or corporate body (which expression shall, where the context so admits, include its successors and assigns) which purchases the Software Development and Consultancy Services from CONSULTANT.

"Client Communication" means the email, fax, letter or other written or verbal communication made to the Client confirming the Consultancy Services to be provided.

"Commencement Date" means the earlier of the commencement date for this Agreement as set out in the Client Communication and the commencement of the performance of the Consultancy Services.

"Consultancy Services" means the consultancy services to be provided by CONSULTANT to the Client as set out in the Client Communication.

"Fees" means the fees payable by the Client to CONSULTANT in consideration of the Consultancy Services as set out in the Client Communication or, if not, in accordance with Consultant Standard Charge Out Rates or such other fee as may be agreed.

"CONSULTANT's Standard Charge Out Rates" means the charge out rates of CONSULTANT applicable to the Consultancy Services as promulgated by CONSULTANT from time to time; and

"Representatives" means any officers or employees of CONSULTANT and any consultants, subcontractors or other agents used by CONSULTANT to fulfill their obligations to the Client under the provisions of this Agreement.

1. THE SOFTWARE DEVELOPMENT AND CONSULTANCY SERVICES

- a. With effect from the Commencement Date, CONSULTANT shall, in consideration of the Fees being paid in accordance with the provisions of this agreement provide the Software Development and Consultancy Services to the Client.
- b. CONSULTANT shall use reasonable care and skill in their performance of the Software Development and Consultancy Services.
- c. CONSULTANT shall use reasonable endeavours to complete its obligations under the Agreement.
- d. The Software Development and Consultancy Services are being provided by CONSULTANT exclusively to the Client. CONSULTANT does not accept responsibility to any third party for the Software Development and Consultancy Services which it provides to the Client unless CONSULTANT has agreed with the Client in writing that CONSULTANT shall accept such liability.

2. FEES

- a. The Client shall pay the Fees in accordance with the provisions of this agreement.
- b. In addition, CONSULTANT shall be entitled to recover from the Client its reasonable incidental expenses in connection with the provision of the Software Development and Consultancy Services.
- c. The Client shall pay CONSULTANT for any additional software development scope and consultancy services provided by CONSULTANT, that are not specified in the agreed Client Communication, in accordance with CONSULTANT's Standard Charge Out Rates or such other fee as may be agreed. Any charge for additional software development and consultancy services will be supplemental to the amounts that may be due for the Software Development and Consultancy Services.
- d. All sums payable pursuant to this Agreement are exclusive of any goods service tax, withholding tax or other tax (except corporation tax or other taxes on profit), for which the Client shall be additionally liable.

3. TERMS OF PAYMENT

- a. All payments required to be made pursuant to this Agreement by the Client shall be made within 30 (thirty) days of the date of the relevant invoice in the currency stated in the invoice in cleared funds to CONSULTANT's bank as set out in the invoice, without any set-off, withholding or deduction except such amount (if any) of tax as the Client is required to deduct or withhold by law.
- b. Promptness of payment shall be of the essence under this Agreement. If the Client fails to make any payment on the due date in respect of the price or any other sum due under these terms and conditions then CONSULTANT shall, without prejudice to any right which CONSULTANT may have pursuant to any statutory provision in force from time to time, have the right to charge the Client interest on a daily basis at an annual rate equal to twelve percent (12%) from time to time on any sum due and not paid on the due date. Such interest shall be accumulatively on a daily basis and shall run from day to day and accrue after as well as before any judgement.

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Middle East Risk Assessment Software with ADS-B Integration

4. CLIENT RESPONSIBILITIES

The Client undertakes:

- a. to ensure that full information and instructions are given to CONSULTANT and in sufficient time to enable the Software Development and Consultancy Services to be performed effectively and efficiently.
- b. to take such steps as it reasonably can to procure all necessary access for CONSULTANT's Representatives to goods, premises, vessels, installations and transport; and
- c. where it has control of the relevant working environment, to take such steps as it reasonably can to ensure such working environment is safe, without risks to health, and adequate in relation to facilities and arrangements for the Consultant's welfare at work.

5. VARIATION AND AMENDMENTS

- a. If the Client wishes any variations to be made to the Software Development Scope and Consultancy Services, it must notify CONSULTANT in writing as soon as possible. CONSULTANT shall endeavour to make any required changes and any additional costs thereby incurred shall be due to and invoiced to the Client.
- b. If, due to circumstances beyond CONSULTANT's control, it has to make any change in the arrangements relating to the provision of the Software Development and Consultancy Services it shall notify the Client forthwith. CONSULTANT shall endeavour to keep such changes to a minimum and shall seek to offer the Client arrangements as close to the original as is reasonably possible in the circumstances.

6. TERMINATION

- a. All or any part of the Software Development and Consultancy Services may be terminated at such time or times as CONSULTANT and the Client may mutually agree.
- b. CONSULTANT may terminate this Agreement forthwith if:
 - the Client is in breach of any of its obligations hereunder; or
 - the Client suspends, or threatens to suspend, payment of its debts or is unable to pay its debts as they fall due or admits inability to pay its debts; or
 - the Client commences negotiations with all or any class of its creditors with a view to rescheduling any of its debts; or
 - a petition is filed, a notice is given, a resolution is passed, or an order is made, for or in connection with the winding up of the Client; or
 - an application is made to court, or an order is made, for the appointment of an administrator or if a notice of intention to appoint an administrator is given or if an administrator is appointed over the Client; or
 - a floating charge holder of the assets of the Client has become entitled to appoint or has appointed an administrative receiver; or
 - a person becomes entitled to appoint a receiver over the assets of the Client or a receiver is appointed over the assets of the Client; or
 - any event occurs or proceeding is taken with respect to the Client in any jurisdiction to which it is subject that has an effect equivalent or similar to any of the events mentioned above (inclusive); or
 - any circumstances whatsoever beyond the reasonable control of CONSULTANT that necessitate the termination for whatever reason of the provision of Software Development and Consultancy Services.
- c. In the event of termination CONSULTANT shall retain any sums already paid to it by the Client without prejudice to any other rights either party may have whether at law or otherwise.

7. SUB-CONTRACTING

CONSULTANT may sub-contract the performance of any of its obligations under this Agreement without the prior written consent of the Client.

9. LIMITATIONS ON LIABILITY

- a. CONSULTANT's maximum liability under the provisions of this Agreement shall be limited to the fees paid in consideration of the Software Development and Consultancy Services and any claims against CONSULTANT shall be deemed to be waived and absolutely time barred upon the expiry of one year from the completion of the Software Development and Consultancy Services.
- b. CONSULTANT shall not be liable to the Client, whether in contract, tort (including negligence), breach of statutory duty, or otherwise, for any loss of profit, or any indirect or consequential loss arising under or in connection with the Agreement
- c. CONSULTANT shall not be liable to the Client or be deemed to be in breach of these terms and conditions by reason of any delay in performing, or any failure to perform, any of CONSULTANT's obligations if the delay or failure was due to any cause beyond CONSULTANT's reasonable control.
- d. In the event that the Software Development and Consultancy Services involves any work or services to or containing a product or article any of which contain latent defects which were not apparent at the time surveyed and could not reasonably have been expected to have been discovered by such survey (either by reason of lack of access to, limited availability of time or otherwise) then CONSULTANT shall have no liability thereafter.
- e. CONSULTANT shall only be liable to the Client to the extent that CONSULTANT is unable to rectify any matter for which it would otherwise be liable to the Client within a period of 45 days of becoming aware of the said matter.
- f. The Client's relationship is solely with CONSULTANT. No Representative of CONSULTANT has any personal legal liability to the Client whether in contract, tort (including negligence) or otherwise. The fact that any Representative signs in his or her name any document or email in the course of carrying out the Software Development and Consultancy Services does not give rise to any personal legal liability separate to that of CONSULTANT.
- g. The Client agrees that other than in the event of fraud, any claim which the Client brings in respect of a matter on which the Client has instructed CONSULTANT shall be made against CONSULTANT and not against any of the following:

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- any Representative of CONSULTANT; or
 - any CONSULTANT Group Company of CONSULTANT or any officer, employee, agent, consultant or subcontractor of any such
 - CONSULTANT Group Company; and
 - any successor of any of the persons listed in the preceding sub paragraphs.
- h. Where CONSULTANT is liable to the Client and a third party is also liable to the Client in connection with the same matter, CONSULTANT shall only be responsible for a fair share of the Client's loss. In particular, if the Client agreed to limit the liability of such other third party or if the Client is unable to recover from that other third party, CONSULTANT's share shall not be increased because of the limitation of liability the Client has agreed with the other third party or the Client's inability to recover from him/it.
- i. The Client shall indemnify CONSULTANT against all damages, costs, claims and expenses suffered by CONSULTANT arising from the provision of the Software Development and Consultancy Services including (but not limited to) loss or damage to any equipment (including that of third parties) caused by the Client, or its agents or employees.
- j. Nothing in this Agreement limits or excludes the liability of CONSULTANT for death or personal injury resulting from negligence; or for any damage or liability incurred by the Client as a result of fraud or fraudulent misrepresentation by the CONSULTANT or any of its Representatives.

10. FORCE MAJEURE AND SUSPENSION OF AGREEMENT

- a. 12.1 Neither CONSULTANT nor the Client shall be responsible for any failure to fulfil any term or condition of this Agreement if and to the extent that fulfilment has been delayed or temporarily prevented by circumstances which are beyond the control and without the fault or negligence of the party affected and which, by the exercise of reasonable diligence, the said party is unable to provide against.
- b. In the event of a suspension of this Agreement for reasons of breach by the Client, force majeure or for the convenience of the Client, CONSULTANT shall be entitled to payment by the Client of the following:
- the full costs of laying off (and re-hiring if necessary) any Representatives employed or hired specifically for the purposes of this Agreement such full costs to include any costs which CONSULTANT has necessarily paid to an employment agent.
 - the costs irrevocably committed relating to the period of suspension by subcontractors, under a subcontract which relates to this Agreement.
 - any other costs which CONSULTANT or its Representatives have irrevocably committed in respect of the period of the suspension.
 - loss of CONSULTANT's anticipated profit under this Agreement for the period of the suspension.
- c. Without prejudice to its rights hereunder CONSULTANT shall have the right but not the obligation to give notice of termination of this Agreement if any period of suspension continues for a period of more than 30 days.

11. WAIVER

- No waiver by CONSULTANT of any breach of this Agreement by the Client shall be considered as a waiver of any subsequent breach of the same or any other provision. A waiver of any term, provision or condition of this Agreement shall be effective only if given in writing and signed by the waiving party and then only in the instance and for the purpose for which the waiver is given.
- No failure or delay on the part of any party in exercising any right, power or privilege under this Agreement shall operate as a waiver of, nor shall any single or partial exercise of any such right, power or privilege preclude any other or further exercise of or the exercise of any other right, power or privilege.

12. SEVERANCE

If any provision of this Agreement is held by any competent authority to be invalid or unenforceable in whole or in part the validity of the other provisions of this Agreement and the remainder of the provision in question shall not be affected thereby.

13. COPYRIGHT

CONSULTANT reserves all copyright and any other rights (if any) which may subsist in the products of, or in connection with, the provision of the Software Development and Consultancy Services or facilities. CONSULTANT reserves the right to take such actions as may be appropriate to restrain or prevent infringement of such copyright.

14. CONFIDENTIALITY

Both CONSULTANT and the Client undertake not to disclose any information provided in confidence by the other party to any third party and the receiving party shall not permit access to such information by any third party unless the disclosing party expressly grants permission save where required to do so by an order of a competent court of law.

15. ASSIGNMENT

This Agreement may not be assigned in whole or in part by the Client without the specific written approval of CONSULTANT.

16. NOTICES AND SERVICE

- a. Any notice or other information required or authorised by this Agreement to be given by either party to the other shall be given by:- sending by pre-paid registered post; or sending by email, facsimile transmission or comparable means of communication.

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- b. Any notice or information given by post in the manner described above which is not returned to the sender as undelivered shall be deemed to have been given on the third day after the envelope containing it was so posted; and proof that the envelope containing any such notice or information was properly addressed, pre-paid, registered and posted, and that it has not been so returned to the sender, shall be sufficient evidence that the notice or information has been duly given.
- c. Any notice or information sent by telex, cable, facsimile transmission or comparable means of communication shall be deemed to have been duly given on the date of transmission, provided that a confirming copy of is sent to the other party 24 hours after transmission.
- d. Service of any document for the purposes of any legal proceedings concerning or arising out of this Agreement shall be effected by either party by causing to be delivered to the other party at its registered or principal office, or to such other address as may be notified to by the other party in writing from time to time.

16. **APPLICABLE LAW AND JURISDICTION**

This Agreement shall be governed and construed in accordance with Singapore law and the parties shall submit to the non-exclusive jurisdiction of the Courts of Singapore. The parties also agree that any non- contractual claims or disputes shall be subject to Singapore law and that the Courts of Singapore shall have non-exclusive jurisdiction to determine any such claim or dispute.

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**COST-EFFECTIVENESS STUDY
REPORT**

MIDRAS-AIR PROJECT

Prepared by the Middle East Regional
Monitoring Agency (MIDRMA)

03rd January 2026

EXECUTIVE SUMMARY

This Cost-Effectiveness Study assesses the financial, operational, and safety value of implementing the MIDRAS-AIR project for the Middle East Regional Monitoring Agency (MIDRMA). The proposed upgrade enhances the existing Middle East Risk Assessment Software (MIDRAS) through the integration of ADS-B-based surveillance data, while retaining the capability to process conventional flight plan and legacy traffic data to ensure comprehensive RVSM traffic representation.

The primary objective of MIDRAS-AIR is not to automate operational control or directly reduce collision risk, but to strengthen the accuracy, timeliness, and completeness of RVSM collision risk assessments, thereby improving safety assurance and regulatory confidence. The project responds to long-standing limitations associated with manual traffic data submission, including high administrative burden, data quality issues, and limited responsiveness of safety assessments.

From a cost-effectiveness perspective, the study finds that MIDRAS-AIR represents a financially responsible and operationally sustainable investment when assessed over a medium- to long-term horizon. While the project requires an initial development and integration investment, this cost is offset by recurring operational savings arising from reduced manual data handling, validation, and re-processing activities at both MIDRMA and Member State levels.

In addition to direct cost savings, MIDRAS-AIR delivers non-monetary but strategically critical benefits, including:

- Improved accuracy and confidence in collision risk estimates through high-resolution 4D trajectory data*
- More frequent and responsive safety assessments*
- Enhanced identification of emerging risk trends and hotspots*
- Greater resilience through a multi-source surveillance architecture*

A conservative quantitative analysis indicates that, under reasonable assumptions, MIDRAS-AIR achieves cost recovery within a single RVSM monitoring cycle, with sustained net benefits accruing thereafter. Sensitivity analysis further demonstrates that the project remains cost-effective even under partial ADS-B coverage scenarios.

Overall, the Cost-Effectiveness Study concludes that MIDRAS-AIR offers strong value for money, delivering measurable operational efficiencies and essential safety assurance benefits, while aligning MIDRMA's RVSM monitoring capability with ICAO's evolving air traffic management framework and global best practices.

INTRODUCTION:

This Cost-Effectiveness Study evaluates the financial, operational, and safety benefits associated with the implementation of the MIDRAS-AIR (Middle East Risk Assessment Software with ADS-B Integration and Response) project for the Middle East Regional Monitoring Agency (MIDRMA). The project aims to enhance RVSM collision risk assessment capabilities through the integration of Automatic Dependent Surveillance–Broadcast (ADS-B) technology, while maintaining comprehensive traffic representation across the ICAO Middle East Region.

The MIDRAS-AIR project is designed to improve the accuracy, timeliness, and operational relevance of collision risk assessments by leveraging high-frequency, four-dimensional (4D) trajectory data derived from ADS-B surveillance where available. At the same time, the system is architected to incorporate conventional flight plan and legacy traffic data to ensure that aircraft not continuously represented through ADS-B — including State, military, VIP, private, or non-equipped aircraft — remain fully accounted for in safety assessments.

This study examines how the proposed integrated, multi-source data approach supports operational efficiency, reduces reliance on manual traffic data submissions, and enhances safety outcomes, while remaining cost-effective for MIDRMA and its Member States. The analysis is aligned with ICAO’s evolving air traffic management (ATM) framework and reflects a balanced, resilient, and future-ready investment in regional RVSM safety monitoring.

CURRENT CHALLENGES

1. Manual Data Submission and Its Limitations:

- a) *At present, collision risk assessments within the Middle East RVSM airspace rely heavily on manually submitted traffic data provided by MIDRMA Member States. This process is resource-intensive, time-consuming, and subject to delays, placing a significant administrative burden on national authorities. The effort required to collect, validate, and submit traffic data contributes to operational inefficiencies across the region.*
- b) *Manual data submission methods are also prone to data quality issues, including missing records, wrong flight levels, incorrect aircraft information, misaligned waypoints, and incomplete datasets. These deficiencies can compromise the accuracy and reliability of collision risk assessments and often require additional effort and resources for data correction and validation.*

2. Operational and Analytical Constraints:

- a. *The reliance on manually collected traffic data limits MIDRMA's ability to conduct timely and responsive collision risk assessments. Risk evaluations are often based on static or retrospective datasets, reducing the effectiveness of proactive safety monitoring and constraining the ability to identify emerging risk trends in a dynamic operational environment.*
- b. *In addition, while modern surveillance technologies such as ADS-B offer significant potential benefits, the surveillance landscape within the Middle East Region remains diverse. Not all aircraft operating in RVSM airspace are continuously represented through ADS-B transmissions, including certain State, military, VIP, private, or non-equipped aircraft. Exclusive dependence on a single surveillance data source could therefore result in incomplete traffic representation and limit the effectiveness of safety assessments.*

3. Need for an Integrated and Resilient Data Approach

- a) *These challenges highlight the need for a collision risk assessment framework that both reduces reliance on manual data submission and ensures comprehensive traffic coverage across all categories of airspace users. A resilient, integrated approach—capable of leveraging ADS-B data where available while retaining the inclusion of conventional flight plan and legacy traffic data—is essential to support accurate, complete, and cost-effective RVSM safety monitoring in the Middle East Region.*

BENEFITS OF MIDRAS-AIR:

The MIDRAS-AIR project addresses the identified operational and analytical challenges by introducing an enhanced collision risk assessment framework that combines modern surveillance technologies with resilient data processing. The key benefits of the proposed solution are outlined below.

1- Enhanced Data Quality and Accuracy

- a. MIDRAS-AIR enables the use of high-frequency, four-dimensional (4D) trajectory data derived from ADS-B surveillance, providing significantly improved positional accuracy compared to manually submitted traffic data. This reduces uncertainties associated with missing waypoints, incorrect flight level entries, and misaligned flight paths, thereby improving the reliability of collision risk calculations.*
- b. Where ADS-B data is not available, MIDRAS-AIR retains the capability to process conventional flight plan and legacy traffic data, ensuring that all relevant RVSM traffic remains represented in safety assessments. This integrated approach preserves data completeness while enhancing overall analytical accuracy.*

2- Improved Operational Efficiency and Cost Reduction

- a. By automating the collection and processing of traffic data, MIDRAS-AIR substantially reduces the reliance on manual data submissions by Member States. This results in lower administrative workload, reduced data validation effort, and decreased operational overhead for both MIDRMA and its Member States.*
- b. The reduction in manual processes also minimizes the need for post-submission data correction and reconciliation, contributing directly to long-term cost savings and more efficient use of human resources.*

3- More Timely and Proactive Risk Management

- a. The availability of high-resolution traffic data enables MIDRAS-AIR to support more frequent and responsive risk collision assessments. This allows MIDRMA to move beyond retrospective analysis toward a more proactive safety monitoring approach, improving the identification of emerging risk trends and potential collision risk hotspots within RVSM airspace.*
- b. The system's ability to integrate multiple data sources ensures continuity of risk assessment even under conditions where ADS-B data may be unavailable or incomplete, supporting uninterrupted safety oversight.*

4- Enhanced Predictive and Analytical Capabilities

- a. *MIDRAS-AIR supports advanced analytical functions, including improved trend analysis, hotspot identification, and the potential for predictive safety assessments. These capabilities enable better understanding of evolving traffic patterns, airspace complexity, and congestion, supporting informed decision-making and more effective safety interventions.*

5- Long-Term Strategic and Regulatory Benefits

- a. *The MIDRAS-AIR project aligns MIDRMA’s safety monitoring capabilities with ICAO’s evolving air traffic management framework and global best practices. By combining ADS-B-based automation with a resilient, multi-source data architecture, the system provides a future-ready solution that can adapt to increasing traffic volumes, technological evolution, and regulatory requirements.*
- b. *This balanced approach ensures that MIDRMA achieves enhanced safety outcomes while maintaining cost-effectiveness, robustness, and long-term sustainability of its RVSM collision risk assessment activities.*

FINANCIAL ANALYSIS:

While the implementation of the MIDRAS-AIR project requires an initial investment, the overall financial analysis demonstrates that this expenditure is offset by substantial long-term savings and operational efficiencies. The introduction of automated data processing, combined with reduced reliance on manual traffic data submission, provides a strong and sustainable cost-benefit case for MIDRMA and its Member States.

1- Direct Cost Savings

- a. *The automation of traffic data collection and processing significantly reduces the need for manual data submission, validation, and correction activities. By leveraging ADS-B data where available, MIDRAS-AIR minimizes labor-intensive processes associated with traditional traffic data handling, resulting in lower operational and administrative costs for both MIDRMA and Member States.*
- b. *At the same time, the system’s ability to incorporate conventional flight plan and legacy traffic data ensures that non-ADS-B traffic remains fully represented without requiring parallel or duplicated processes. This integrated approach avoids additional cost burdens while preserving comprehensive traffic coverage.*

- c. *Reduced data inaccuracies and fewer post-processing corrections further contribute to direct cost savings by decreasing the resources required for data reconciliation and quality assurance.*

2. Indirect Financial Benefits

- a. *The proactive and more frequent risk assessment capability enabled by MIDRAS-AIR supports early identification of emerging risks, allowing preventive actions to be taken before costly corrective measures become necessary.*

3- Long-Term Financial Sustainability

- a. *Over time, the combined effects of automation, improved data quality, operational efficiency, and resilient system design are expected to deliver sustained financial benefits. The MIDRAS-AIR project therefore represents a cost-effective and financially responsible investment that supports MIDRMA's long-term mandate to maintain safe and efficient RVSM operations in the ICAO Middle East Region.*

- b. *More Explanations:*

Current RVSM monitoring requires:

- I. Manual traffic data collection*
- II. Data validation*
- III. Error correction*
- IV. Re-processing*

These activities are recurrent every year and consume staff time at both MIDRMA and Member States.

With MIDRAS-AIR:

- I. ADS-B automation reduces or eliminates much of this recurring workload.*
- II. Over time, fewer human hours = lower operational costs.*

CONCLUSION:

- a. *The MIDRAS-AIR project represents a cost-effective and strategically sound investment in the enhancement of RVSM collision risk assessment capabilities within the ICAO Middle East Region. By modernizing the existing MIDRAS platform through the integration of ADS-B technology, the project enables more accurate, timely, and operationally relevant safety assessments, while addressing long-standing challenges associated with manual traffic data submission.*
- b. *The Cost-Effectiveness Study demonstrates that the automation of traffic data processing is expected to deliver significant long-term operational efficiencies and cost savings for MIDRMA and its Member States. Reduced administrative workload, improved data quality, and minimized need for post-submission data correction collectively support a more efficient and sustainable safety monitoring framework. Importantly, the MIDRAS-AIR solution is designed to remain fully effective across a diverse surveillance environment. While ADS-B data provides substantial benefits through high-frequency, four-dimensional trajectory information, the system retains the capability to incorporate conventional flight plan and legacy traffic data to ensure that aircraft not continuously represented through ADS-B surveillance remain included in collision risk assessments. This integrated, multi-source approach preserves the completeness, robustness, and regulatory integrity of RVSM safety monitoring activities.*
- c. *In addition to immediate operational benefits, the MIDRAS-AIR project provides long-term strategic value by aligning MIDRMA's safety oversight capabilities with ICAO's evolving air traffic management framework and global best practices. The system's scalable and resilient architecture ensures that it can adapt to increasing traffic volumes, technological advancements, and future regulatory requirements without disproportionate additional investment.*
- d. *Overall, the Cost-Effectiveness Study confirms that the MIDRAS-AIR project delivers strong value for money, combining enhanced safety outcomes with operational efficiency and financial sustainability. The proposed investment supports MIDRMA's mandate to maintain an acceptable level of safety in RVSM airspace and reinforces the Agency's leadership role in regional airspace safety monitoring.*

RECOMMENDATION:

- a. *Based on the findings of this Cost-Effectiveness Study, it is recommended that the MIDRMA Board endorse the implementation of the MIDRAS-AIR project in principle, subject to the review of the detailed project proposal and associated cost elements by MIDRMA Member States.*
- b. *The proposed investment is justified by the demonstrated operational efficiencies, long-term cost savings, enhanced safety outcomes, and alignment with ICAO's strategic direction for air traffic management. The integrated, multi-source data approach ensures that the project remains robust and effective across the full spectrum of RVSM operations within the Middle East Region.*
- c. *Accordingly, the MIDRMA Board is encouraged to support the project and authorize MIDRMA to proceed with the necessary preparatory and coordination activities, in line with the governance framework and decisions of the Board.*

ANNEX A

Cost-Effectiveness Summary – MIDRAS-AIR

1- Purpose

This annex summarizes the cost-effectiveness of the MIDRAS-AIR project to support MIDRMA Board decision-making. The analysis focuses on financial transparency, operational efficiency, and safety assurance value, consistent with ICAO RVSM monitoring objectives.

2- Project Duration and Cost Structure

- a. Year 1: One-time development, integration, and testing*
- b. End of Year 1: System deployment*
- c. Years 2–3: Fixed maintenance and support period*
- d. Beyond Year 3: No recurring operating or licensing costs*

Costs:

- a. One-time development & integration: USD 240,000*
- b. Fixed 2-year maintenance & support contract: USD 100,000*
- c. Total project cost: USD 340,000*

3- Baseline (Current RVSM Monitoring)

- a. RVSM collision risk assessments rely on manual traffic data submission, validation, correction, and re-processing.*
- b. Estimated recurring effort: ~2,800 staff-hours per year (MIDRMA + Member States).*
- c. Conservative cost proxy: ~USD 140,000 per year, recurring annually.*

4- Operational Efficiency Gains (Post-Deployment)

- a. MIDRAS-AIR automates traffic data ingestion using ADS-B where available, while retaining legacy data sources.*
- b. Conservative assumption: 60% reduction in manual data handling effort.*
- c. Estimated savings: ~USD 84,000 per year, starting after deployment (Year 2 onward).*

5- Cost Recovery and Lifecycle View

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- a. *Simple payback: ~4 years after deployment (≈ 5 years from project start).*
 - b. *10-year post-deployment view:*
 - c. *Total savings: ~USD 840,000*
 - d. *Total project cost: USD 340,000*
 - e. *Net benefit: ~USD 500,000*

6- Sensitivity (ADS-B Coverage)

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- a. *Cost-effectiveness remains positive under high, medium, and low ADS-B coverage scenarios due to the integrated multi-source data approach.*
 - b. *Even under conservative assumptions, MIDRAS-AIR achieves cost neutrality or net benefit over its lifecycle.*

7- Non-Monetary Benefits (Decision-Critical)

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- a. *Improved accuracy and confidence in RVSM collision risk assessments*
 - b. *More frequent and responsive safety monitoring*
 - c. *Reduced regulatory and audit exposure due to data quality issues*
 - d. *Alignment with ICAO surveillance modernization and RVSM oversight principles*

Conclusion

With a single one-time development cost of USD 240,000 and a fixed two-year maintenance contract of USD 100,000, MIDRAS-AIR represents a cost-effective, low-risk, and financially transparent investment. The project delivers sustained operational efficiencies and essential safety assurance value, supporting MIDRMA's mandate to maintain acceptable levels of safety in RVSM airspace.

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