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**Agenda Item 4: Emerging technologies, new business models and other associated aspects**
**4.3: Leveraging air transport data and the digital ecosystem for seamless, secure and resilient operations**

## DIGITAL INNOVATIONS IN SURVEY AND CHARTING PROCEDURES FOR ENHANCED EFFICIENCY IN AERODROME SAFEGUARDING

(Presented by India)

**EXECUTIVE SUMMARY**

This working paper presents a digital initiative by the Airports Authority of India (AAI) to modernize and automate survey, cartography, and charting procedures for aerodrome safeguarding in accordance with the International Civil Aviation Organization (ICAO) Annex 14 – *Aerodromes,* (Chapter 4) recommendations and Directorate General of Civil Aviation (DGCA) guidelines.

To overcome the bottlenecks of legacy manual processes—such as email-reliant data handling, processing delays, and human error—AAI has developed a centralized, web-based automated portal. The portal enables daily multi-format data uploads (CSV, Excel, RINEX), automated Differential Global Positioning System (DGPS)/Total Station processing via Geographic Information System (GIS) similarity transformations without specialized third-party software, real-time obstacle penetration evaluations, and single-click generation of 19 ICAO/DGCA-compliant aerodrome charts. Incorporating side-by-side comparative dashboards, visual change detection, and Terrestrial Laser Scanning (TLS)/Structural Slab Level (SSL) security, the system significantly reduces turnaround times, enhances data integrity, and establishes a scalable benchmark for aerodrome safeguarding.

## 1. INTRODUCTION

1.1 This paper provides an overview of digital innovations in compliance for safeguarding aerodrome operations.

1.2 In accordance with the International Civil Aviation Organization (ICAO) Annex 14 – *Aerodromes,* (Chapter 4) Recommendations, the Airports Authority of India (AAI) has undertaken a transformative project to digitize and automate survey and charting processes critical for aerodrome safeguarding. In response to growing operational demands and the need for rapid, error-free data processing, this initiative replaces legacy manual methods with an integrated, workflow-driven portal. This

paper outlines the project's objectives, the current challenges in manual data handling, the proposed automated system architecture, and the anticipated benefits in compliance, operational efficiency, and data integrity.

1.3 Rapid expansion across India's aviation sector has substantially increased the volume and complexity of survey data required to maintain aerodrome safety. Traditional manual processes have led to processing delays, data inconsistencies, and operational inefficiencies. With regulatory frameworks from ICAO and the Directorate General of Civil Aviation (DGCA) mandating strict compliance, AAI seeks to modernize its survey ecosystem by introducing a comprehensive digitization platform. This platform streamlines data collection, processing, and single-click electronic chart (e-chart) generation—thereby drastically reducing turnaround time, supporting safe airport operations, and facilitating international best practices.

## 2. CURRENT CHALLENGES IN SURVEY AND CARTOGRAPHY

Existing aerodrome survey and cartographic practices present significant operational hurdles that compromise processing speed and data accuracy:

2.1 **Manual Dependency**: Existing processes rely heavily on manual data sharing via email and physical file handling, leading to processing delays and increased risk of data corruption. Email-based communication creates severe difficulties in data tracking and auditability, while placing heavy reliance on skilled individuals for routine tasks.

2.2 **Data Processing Bottlenecks**: Inaccuracies frequently arise during Differential Global Positioning System (DGPS) and Total Station data processing, requiring manual intervention for coordinate calculations, reference point removal, and height adjustments. Data can only be processed once a survey is fully completed (taking several days); if survey inconsistencies are detected, physical site re-visits are required to rectify errors.

2.3 **Time-Consuming Charting**: The preparation of aerodrome charts and Obstacle Limitation Surface (OLS) analysis is labor-intensive and highly subject to human error, impacting the timely availability of critical safety information.

2.4 **Limited Scalability**: Legacy processes are ill-suited to handle the rapidly increasing volume of aerodrome surveys across expanding airport networks.

2.5 **Legacy Core Functions**: Despite major technological advances in other aviation domains, core survey and cartography functions have remained largely manual.

2.6 **Non-Standardized Formats**: A lack of uniform, standardized data formats further complicates manual verification and cross-departmental coordination.

## 3. PROPOSED AUTOMATED WORKFLOW SYSTEM & ARCHITECTURE

3.1 The initiative establishes a centralized, web-based portal to automate survey data processing and charting for aerodromes. The portal eliminates email-based communication bottlenecks, enforces audit trails, enhances data integrity, and automates raw survey data conversion into compliance-ready OLS charts. Key system modules include:

3.2 **Centralized Data Ingestion and Upload**

3.2.1 **Survey Data Upload Interface:** The platform supports multiple file formats (CSV, Excel, RINEX, etc.) and enables daily uploads of Differential Global Positioning System (DGPS) and Total Station data directly from survey sites. Once uploaded, automated processing commences immediately, allowing early detection and rectification of survey inconsistencies without requiring surveyors to perform physical site re-visits.

3.2.2 **User-Defined Data Selection:** Surveyors can seamlessly link daily data uploads to specific airports using intuitive dropdown selection tools and standardized metadata tags.

3.3 **Automated Data Processing & Transformation**

3.3.1 **DGPS & TS Data Refinement:** The processing engine filters DGPS data by isolating points with 'fixed' status. It automatically flags and removes temporary TS reference points, calculates actual elevations, and converts local survey coordinates into standard geographic coordinate formats (Latitude and Longitude) using embedded Geographic Information System (GIS) similarity transformation modules—eliminating reliance on third-party specialized software.

3.3.2 **Runway Profiling & Automatic Universally Unique Identifier (UUID) Assignment:** Integrates runway profiling algorithms and automatically assigns UUIDs to survey datasets to guarantee data traceability and uniformity across master records.

3.4 **Obstacle Analysis & Single-Click Chart Generation**

3.4.1 **Obstacle Analysis & AGA Surface Drafting:** Leveraging regulatory guidelines from ICAO Annex 14 – *Aerodromes* and DGCA, the system automatically calculates permissible obstacle heights and evaluates obstacle penetration against critical limiting surfaces. Draft Aerodrome Ground Aids (AGA) surfaces, line-of-work annotations, and standard object representations are rendered automatically upon finalizing the master dataset.

3.4.2 **19 ICAO/DGCA Standardized Aerodrome Charts:** From the verified master dataset, the portal automatically generates 19 standardized e-charts with a single click, as detailed in Table 1 below:

| | |
|---|---|
| 1. Airport Map (Base Map) | 11. Precision Approach Terrain Chart |
| 2. Approach Chart (Both Runway Ends) | 12. Zoning Map (20 km from ARP) |
| 3. Contour Map (Up to 900 m from Threshold) | 13. PAPI Protection Surface Chart (Both Ends) |
| 4. Vertical Significance Map (20 km around ARP) | 14. 30 NM Chart (Digital NOC Obstacle Scale 1:250k) |
| 5. Grid Map | 15. Laser Beam Protection Surface Map |
| 6. Type A Chart (Both Sides) | 16. Colour Coded Zoning Map (CCZM) |
| 7. Type B Chart (Scale 1:20,000) | 17. Obstacle Free Zone (OFZ) Chart (CAT II/III ILS) |
| 8. Take-Off Climb Surface Chart (Both Ends) | 18. Longitudinal Profile Chart |
| 9. Parking and Docking Chart | 19. Aerodrome Chart (ADC) |
| 10. Aerodrome Vicinity Map (Scale 1:50,000) | |

*Table 1: Standardized 19 ICAO/DGCA electronic aerodrome charts generated on a single click.*

3.5 **Comparative Analysis Dashboard & Interactive Visualizations**

3.5.1 **Side-by-Side Comparative Analysis:** The portal features an interactive dashboard allowing side-by-side comparative views of charts for the same runway. Users can adjust Nav-Aid facilities, runway codes, and operational parameters in real time. Obstacle penetration changes across historical datasets are visually highlighted to assist cartographers in rapidly identifying physical environmental changes. Automated alerts are generated prior to survey due dates.

3.5.2 **Interactive Visualizations:** Provides dynamic data filtering, 3D/2D spatial obstacle views, and manual override controls when specialized decision-making is warranted.

## 4. ADMINISTRATIVE, SECURITY & IMPLEMENTATION MODULES

4.1 **User & Configuration Management:** Implements granular role-based access control (RBAC), configurable airport profile settings, and strict input validation rules.

4.2 **Security & Infrastructure:** Ensures end-to-end Terrestrial Laser Scanning (TLS)/ Structural Slab Level (SSL) encrypted data transmission, continuous vulnerability monitoring, and hosting on secure AAI-provided infrastructure equipped with disaster recovery and automated backup routines.

4.3 **System Integration:** Facilitates seamless interoperability with external civil aviation databases (e.g., Digital NOC portals) via secure Representational State Transfer Application Programming Interface (REST APIs).

4.4 **Testing & Deployment:** Underwent rigorous functional, performance, and security testing—including User Acceptance Testing (UAT) and independent third-party vulnerability assessments—prior to operational deployment.

## 5. ANTICIPATED BENEFITS

a) **Efficiency & Turnaround Time:** Drastic reduction in survey data processing and charting cycles from weeks to single-click generation.

b) **Data Integrity & Auditability:** Automated workflows and built-in validation rules eliminate human calculation errors and maintain end-to-end audit trails.

c) Compliance & Safety: Automated evaluation against ICAO Annex 14 – Aerodromes standards guarantees strict regulatory adherence, bolstering aerodrome operational safety.

d) **Operational Scalability:** The microservices architecture effortlessly accommodates new airport developments and increased survey frequencies without system performance degradation.

## 6. CONCLUSION

The Conference is invited to note the information contained in this paper.

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