



ICAO

# MIDANPIRG/23 & RASG-MID/13

CAIRO - EGYPT

14-18 JUNE 2026





**Eng. Amir Aly Mohamed Eid**

[Engineer.amir.aly@gmail.com](mailto:Engineer.amir.aly@gmail.com)



# Roadmap for A-SMGCS Level 4 Implementation at Cairo International Airport



# Agenda

**01- What is A-SMGCS**

**02- A-SMGCS Functions and Levels**

**03- How it works**

**04- A-SMGCS Implementation at HECA**

**05- A-SMGCS Upgrade**

**06- Integrated System Overview**

**07- Where We Are Today**

**08- Expected Challenges**



# WHAT IS A-SMGCS?

A-SMGCS is the abbreviation of **A**dvanced **S**urface **M**ovement **G**uidance and **C**ontrol **S**ystem.

It is an integrated system that provides surveillance, guidance and control of aircraft and vehicles on the movement area to enhance safety and improve operational efficiency.



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ICAO recommends the implementation of A-SMGCS in aerodromes where increased operational safety and efficiency are required.

## A-SMGCS IS REQUIRED IN SOME CONDITIONS SUCH AS:

### ① COMPLEX AERODROME LAYOUT



Multiple runways, parallel taxiways, intersections and aprons increase the risk of runway incursions and require precise monitoring and guidance.

### ② HEAVY TRAFFIC DENSITY



High number of aircraft and vehicles on the movement area require accurate surveillance and efficient management.

### ③ LOW VISIBILITY FOR ATC OR PILOT



Adverse weather conditions such as fog, heavy rain or low cloud reduce visibility and require advanced surveillance and guidance support.

## BENEFITS OF A-SMGCS

- ✓ Enhances safety and reduces runway incursions
- ✓ Improves ground traffic efficiency and capacity
- ✓ Optimizes taxi routes and reduces fuel burn and delays
- ✓ Provides situational awareness in low visibility conditions
- ✓ Supports future airport automation and digital tower operations

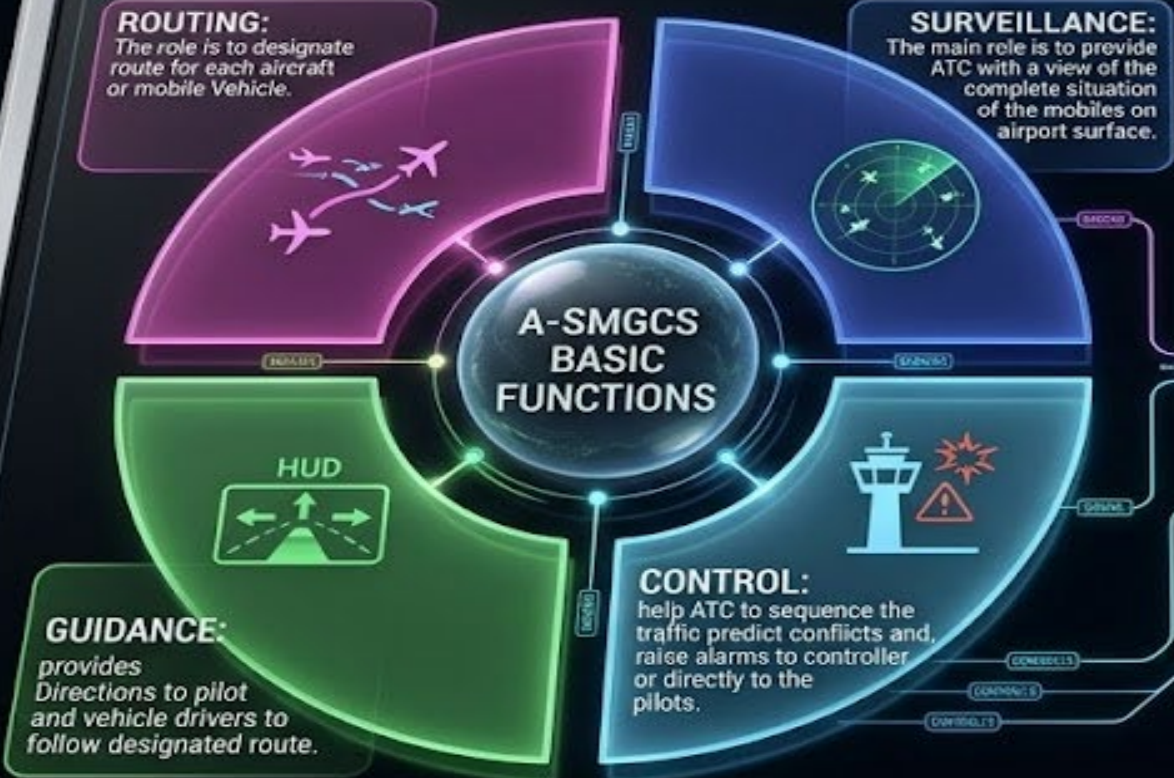
# A-SMGCS (ADVANCED SURFACE MOVEMENT GUIDANCE AND CONTROL SYSTEM) SYSTEM OVERVIEW

00:44

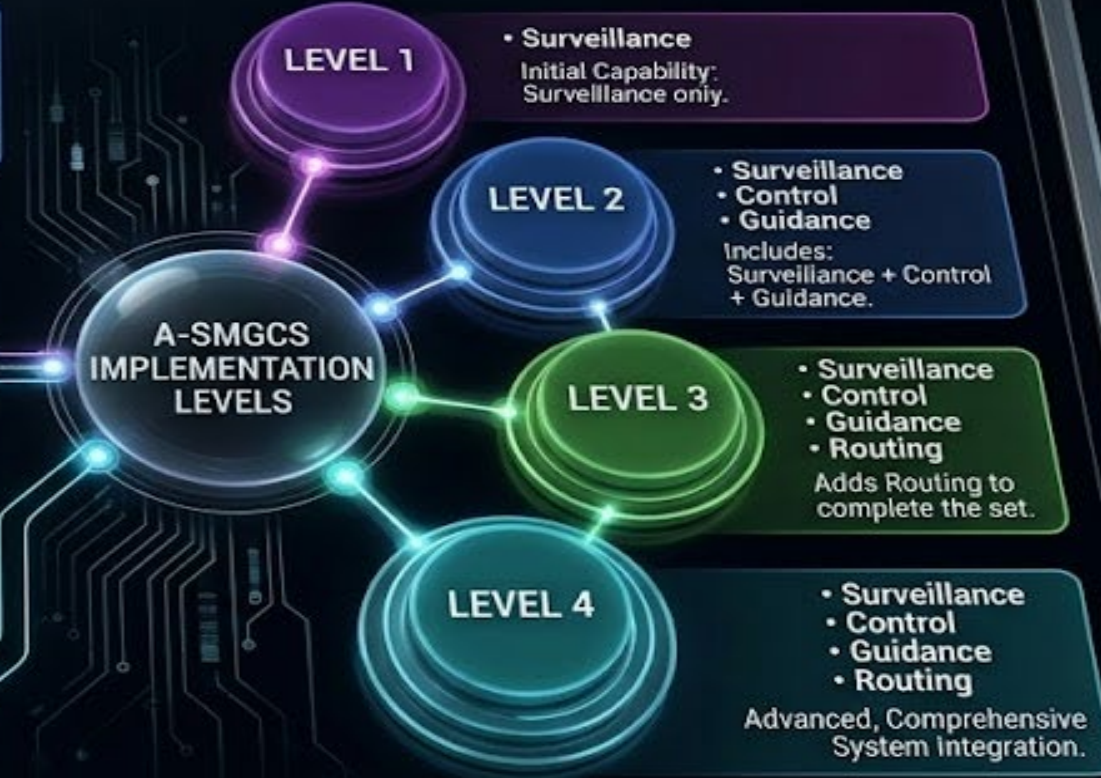
System Clock  
Sensor Status

MIDANPIRG/23 Data Feed Active

## A-SMGCS BASIC FUNCTIONS



## A-SMGCS IMPLEMENTATION LEVELS



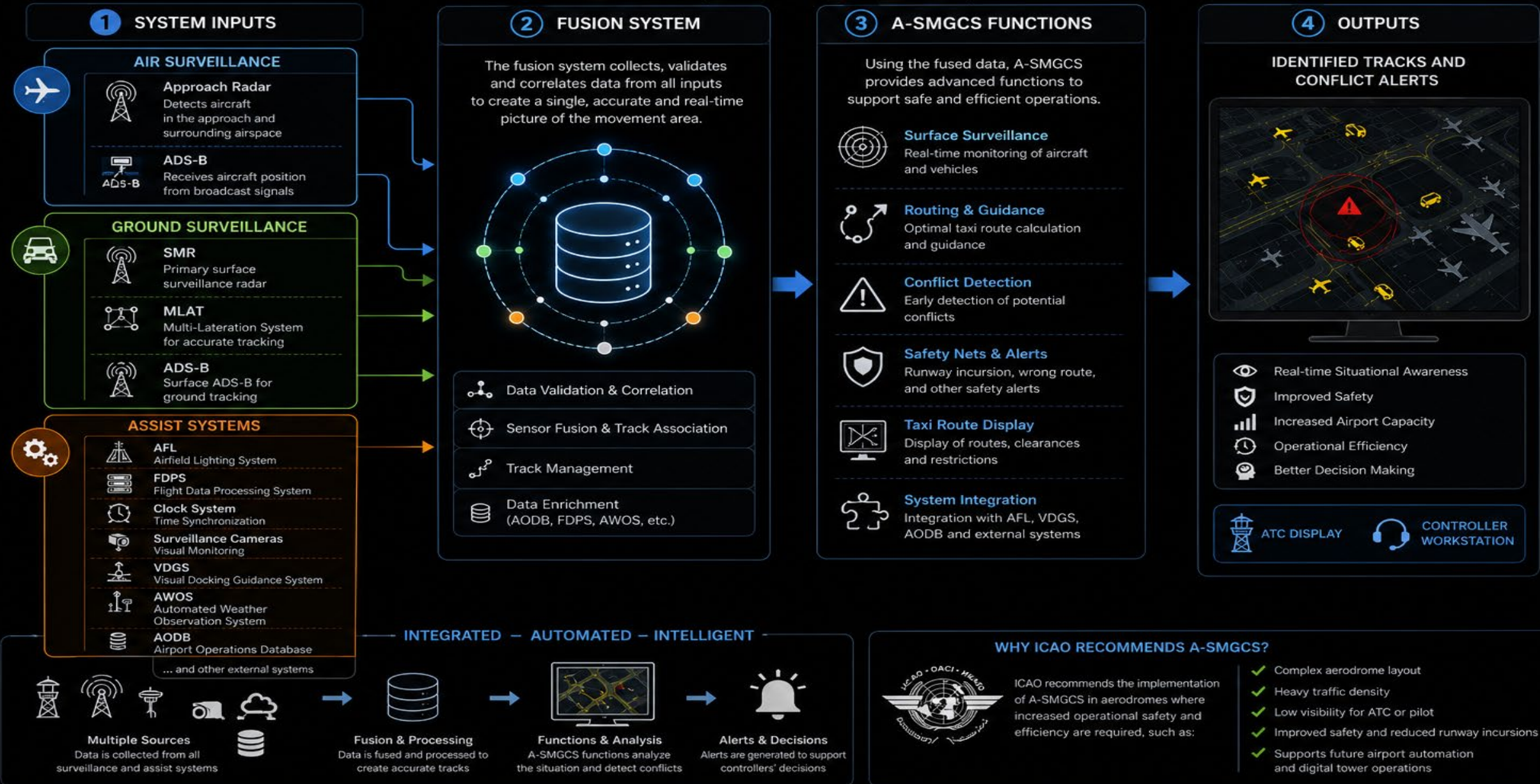
MIDANPIRG/23 Data Feed Active

■ AIRSPACE STATUS 3000R MIDANPIRG/23 7000 00:004 104 DATA 10000 00001

# HOW A-SMGCS SYSTEM WORKS

## A-SMGCS (Advanced Surface Movement Guidance and Control System)

An integrated system that provides surveillance, guidance and control of aircraft and vehicles on the movement area to enhance safety and improve operational efficiency.



# Surface Movement Radar (SMR) Coverage at Cairo International Airport



## SMR KEY FEATURES



High-resolution surface surveillance



Detection and tracking of aircraft and vehicles



Accurate target positioning



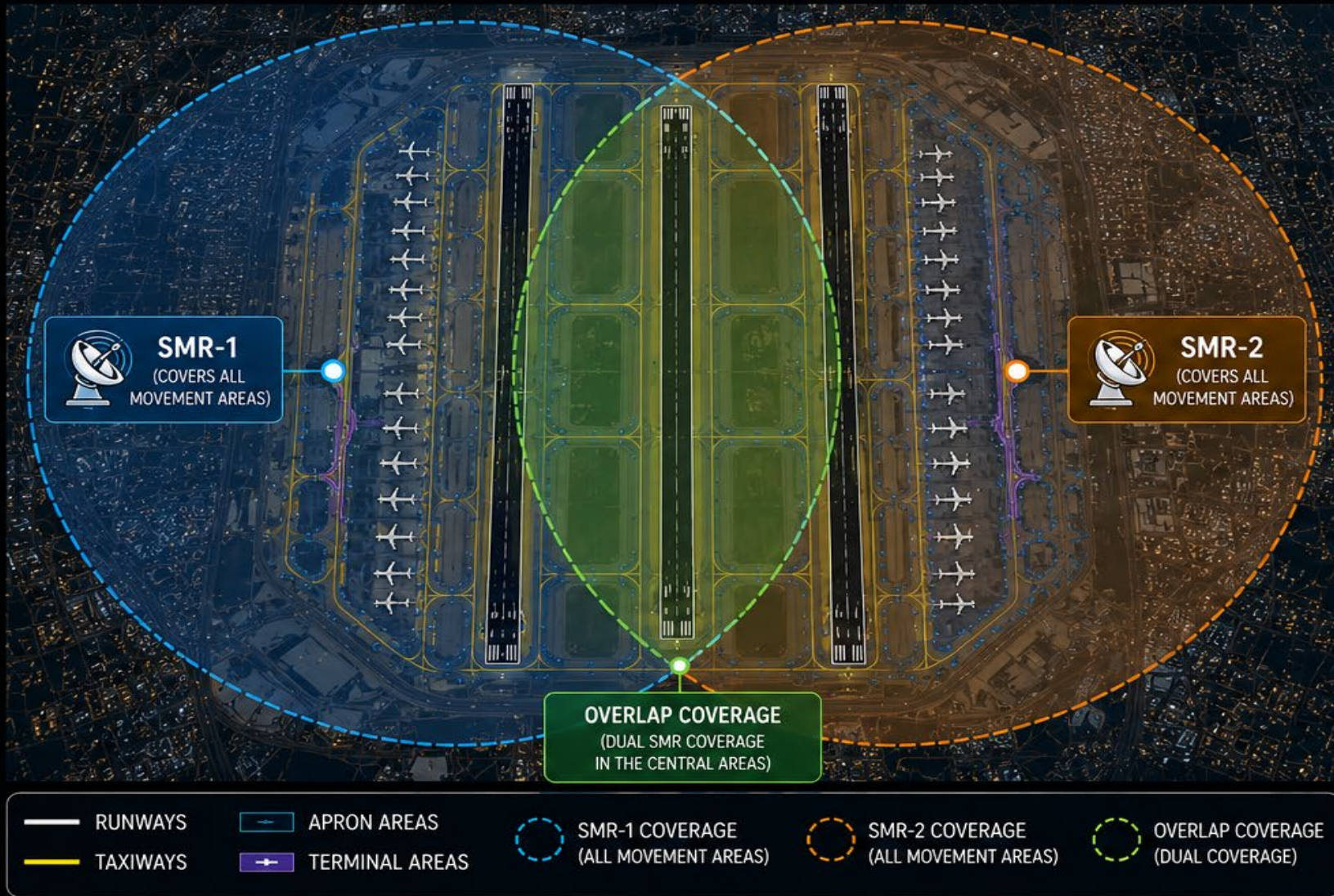
Enhanced situational awareness



Support for low visibility operations



Safety net for runway and taxiway monitoring



## BENEFITS OF DUAL SMR CONFIGURATION



Full maneuvering area coverage



Improved target detection probability



Reduced shadow areas



Increased system availability



Enhanced fail-soft capability



Higher operational safety



Two independent Surface Movement Radars provide comprehensive surveillance coverage of all movement areas, ensuring reliable aircraft and vehicle detection with enhanced safety and operational efficiency.



# MLAT SYSTEM – 37 SENSORS DISTRIBUTION CAIRO INTERNATIONAL AIRPORT



**MLAT SYSTEM**  
**37 SENSORS**  
DEPLOYED



## HOW MLAT WORKS



**1 Aircraft/Vehicle Transmits**  
The transponder on board transmits Mode S/ADS-B signal.



**2 Signals Received**  
Multiple MLAT sensors placed around the airport receive the signal at the same time.



**3 Time Difference of Arrival**  
Each sensor records the exact time the signal was received. The time differences are used to calculate the position.



**4 Position Calculation**  
The MLAT processor calculates the target position by analyzing the time differences from at least 3 sensors.



**5 Track Output**  
The system outputs accurate position, speed and track to the A-SMGCS system.

## MLAT SYSTEM ADVANTAGES

- Full Surface Surveillance**  
100% coverage of runways, taxiways and aprons.
- High Accuracy**  
Accurate position updates with high update rate.
- Independent Surveillance**  
Doesn't need special Avionics on the aircraft.
- All Weather & All Light Conditions**  
Operates in all weather conditions day/night.
- Cost Effective**  
Lower infrastructure cost compared to radar.
- Enhanced Safety**  
Improves situational awareness and reduces runway incursions and ground incidents.



**37**  
MLAT Sensors  
Deployed



**100%**  
Maneuvering Area  
Coverage



**Up to 1 sec**  
Update Rate



**< 10 meters**  
Typical Position  
Accuracy



**99.9%**  
System  
Availability

# ADS-B (AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST) AND ITS USE IN A-SMGCS

ADS-B is a surveillance technology where aircraft periodically broadcast their **position, velocity and other data** derived from **GNSS**, enabling **accurate, real-time** situational awareness without secondary radar.

## WHAT IS ADS-B?



**Automatic**  
Aircraft automatically broadcasts information with no pilot or operator input required.



**Dependent**  
Positioning and velocity vectors are derived from GNSS.



**Surveillance**  
A method of determining the position of aircraft and vehicles.



**Broadcast**  
The transmitted information is available to any user with an appropriate receiving system.

## HOW ADS-B WORKS



## ADS-B IN A-SMGCS – ENHANCING AIRPORT SURFACE SURVEILLANCE



## KEY BENEFITS



**High Accuracy**  
High update rate position and velocity information.



**Independent Surveillance**  
Does not rely on radar; complements other systems.



**All Weather & Day/Night**  
Reliable performance in all weather and lighting conditions.



**Wide Coverage**  
Large area coverage with fewer ground installations.



**Cost Effective**  
Lower infrastructure and operational costs.



**Enhanced Safety**  
Improves situational awareness and reduces runway incursions.

## ADS-B MESSAGE CONTENT

- Aircraft Identification
- Position (Latitude, Longitude, Altitude)
- Velocity (Ground Speed, Track Angle, Vertical Rate)
- Time & Integrity
- Status Information
- Aircraft Category



## USE IN A-SMGCS

ADS-B provides accurate, real-time surveillance data of all ADS-B equipped aircraft and vehicles on the movement area. The data is integrated into the A-SMGCS system to support:



Surface Movement Monitoring



Runway Incursion Prevention



Taxi Guidance Support



Capacity & Flow Management



Safety Nets & Alerts

## KEY FACTS



**ADS-B Out:** Broadcast from aircraft



**ADS-B In:** Received by ground stations



**Update Rate:** Up to 1 second



**Typical Accuracy:** < 10 meters



**1090 MHz Extended Squitter (ES)**



ADS-B is a key enabler for A-SMGCS, providing **accurate, reliable** and **cost-effective** surveillance of airport surface operations, enhancing **safety, efficiency** and **situational awareness**.

## A-SMGCS INPUTS (CURRENT SYSTEM AT CAIRO)



**SMR – Surface Movement Radar**  
Provides accurate surveillance of aircraft and vehicle movements on the surface



**PSR / SSR – Primary / Secondary Surveillance Radar**  
Provides aircraft detection and identification



**MLAT – Multilateration System**  
Provides precise position of aircraft and vehicles



**ADS-B – Automatic Dependent Surveillance – Broadcast**  
Provides position and velocity information from equipped aircraft and vehicles



**GNSS – Global Navigation Satellite System**  
Provides time synchronization and position reference



**SYSTEM TIME**  
Accurate time source for synchronization of all system components



**AERONAUTICAL DATA**  
Airport layout, runways, taxiways, aprons, stop bars, stand and ground routes



**INFRASTRUCTURE & IT**  
Servers, network, storage and communication infrastructure

# A-SMGCS IMPLEMENTATION AT HECA

## PROVIDING SURVEILLANCE AND CONTROL SERVICE TO THE ATC

### A-SMGCS SYSTEM

Data Fusion, Processing, Tracking & Monitoring



DATA STORAGE & ARCHIVING

### SURVEILLANCE & CONTROL SERVICE TO THE ATC CONTROLLER



- ✓ Real-time Situational Awareness
- ✓ Airport Surface Monitoring
- ✓ Traffic Flow & Guidance
- ✓ Conflict Detection & Alerts
- ✓ Safe & Efficient Movement
- ✓ Improved Decision Making

### 24/7 SYSTEM SUPPORT & MAINTENANCE BY ATSEP ENGINEERS



Round-the-Clock Monitoring



- ✓ System Monitoring
- ✓ Preventive Maintenance
- ✓ Fault Management
- ✓ Software & Hardware Support
- ✓ On-site & Remote Assistance

ATSEP – Ensuring System Availability & Reliability

### A-SMGCS ALARMS



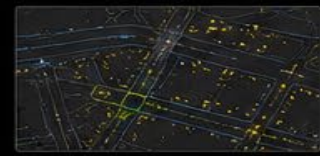
#### Stop bar Violation Monitoring (SVM)

Detects and alerts when an aircraft/vehicle crosses a stop bar without clearance



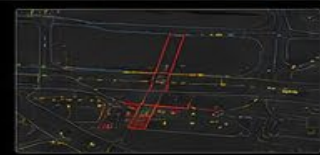
#### Restriction Violation Monitoring (RVM)

Detects and alerts when an aircraft/vehicle enters a restricted area



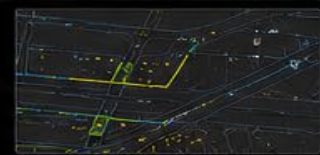
#### Area Penetration Monitoring (APM)

Detects and alerts when an aircraft/vehicle enters a non-movement area



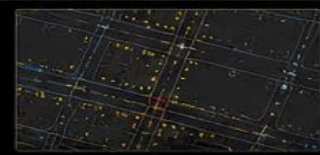
#### Taxiway Collision Monitoring (TCM)

Detects potential collisions between aircraft/vehicles on taxiways



#### Runway Incursion Monitoring (RIM)

Detects and alerts any unauthorized presence on the runway



### BENEFITS OF A-SMGCS



Enhanced Safety



Situational Awareness



Operational Efficiency



Cost Effective



Regulatory Compliance



24/7 System Availability



A-SMGCS INTEGRATES MULTIPLE SURVEILLANCE SOURCES TO PROVIDE ACCURATE, REAL-TIME SURFACE AWARENESS, SUPPORTING THE ATC CONTROLLER WITH ADVANCED MONITORING, ALARMS, AND DECISION-MAKING TO ENSURE A SAFE, EFFICIENT AND WELL-MANAGED AIRPORT MOVEMENT ENVIRONMENT.



MAINTAINING SAFETY, ENSURING AVAILABILITY

# A-SMGCS UPGRADE PROGRAM

SMR UPGRADE – NEXT GENERATION SURFACE SURVEILLANCE RADAR



## CURRENT SMR

MAGNETRON TECHNOLOGY



-  Magnetron-Based Radar
-  Single Frequency Operation
-  Lower Accuracy
-  Limited Fail-Soft Capability
-  Higher Maintenance Requirements

TECHNOLOGY UPGRADE

## NEXT GENERATION SMR

SOLID-STATE (SEMICONDUCTOR-BASED) TECHNOLOGY



-  Solid-State (Semiconductor-Based) Technology
-  Multi-Frequency Operation (More than Two Frequencies)
-  Improved Detection Probability
-  Higher Accuracy & Better Tracking
-  Enhanced Fail-Soft Capability
-  Increased Reliability & Availability
-  Reduced Maintenance Requirements

## SMR UPGRADE

The existing Surface Movement Radar (SMR) system will be upgraded to a modern solid-state (semiconductor-based) system, replacing the current magnetron technology. The new radar employs an advanced **multi-frequency architecture**, operating on more than two frequencies to **improve detection probability**, **enhance positional accuracy**, and **increase system resilience** with improved fail-soft performance in case of partial system degradation.



A KEY ENABLER FOR THE TRANSITION FROM A-SMGCS LEVEL 2 TO LEVEL 4 AT CAIRO INTERNATIONAL AIRPORT

# A-SMGCS UPGRADE

## NEW ENABLERS: SURVEILLANCE CAMERAS



As part of the A-SMGCS enhancement program, **HD, thermal, and PTZ surveillance cameras** are being installed to achieve comprehensive coverage of the airfield, particularly blind spots that cannot be observed directly by air traffic controllers from the tower.



The camera network will serve as an additional sensor input to the A-SMGCS, **increasing system resilience and continuity of service.**



It will support airport operations by providing **supplementary surveillance data** whenever other enablers are unavailable due to maintenance or unexpected outages.



HD CAMERA



THERMAL CAMERA



PTZ CAMERA



WIDE COVERAGE



SURVEILLANCE  
CAMERAS



A-SMGCS  
INTEGRATION



ENHANCED AIRFIELD  
AWARENESS



INCREASED RESILIENCE  
& CONTINUITY



SAFE & EFFICIENT  
AIRPORT OPERATIONS



# A-SMGCS upgrade

## New Fusion System With New Inputs

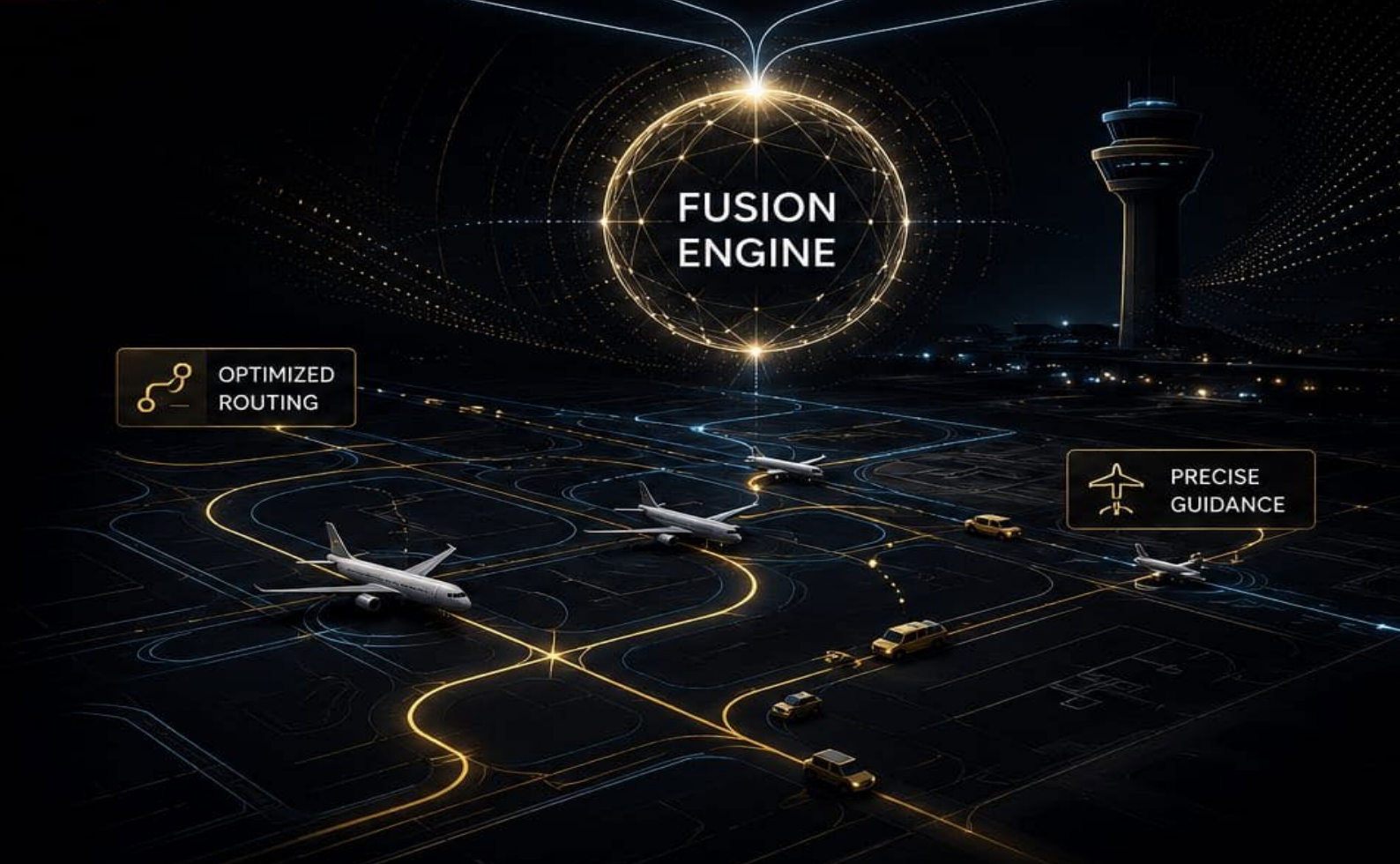
To support the transition towards **A-SMGCS Level 4**, the fusion engine will be enhanced to integrate multiple operational systems, such as AODB, AFL, VDGS, and AWOS.

This integrated environment will enable the system to generate **optimized routing and guidance information** for aircraft and vehicles, supporting safer and more efficient airport surface operations.



### LEVEL 4

THE NEXT LEVEL OF  
SURFACE MANAGEMENT



# A-SMGCS UPGRADE

## NEW LEVEL, NEW SERVICES



### ROUTING SERVICE



Automatically generates the **most suitable taxi route** for aircraft and vehicles across the airport movement area.

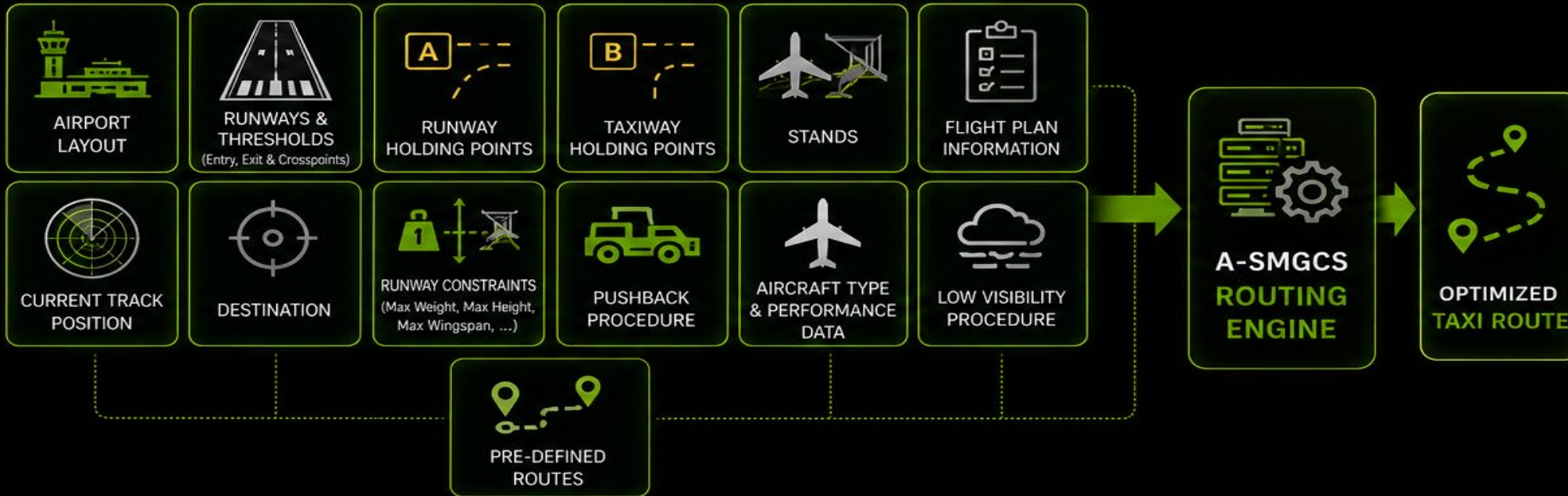


Supports controllers by providing the **safest and most efficient** route based on real-time operational conditions.



Allows controllers to **review, approve, or modify** the proposed route whenever necessary.

#### HOW DOES THE SYSTEM CALCULATE THE ROUTE?



#### BENEFITS

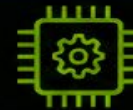
- Reduced Controller Workload
- Optimized Surface Movements
- Reduced Taxi Time
- Improved Situational Awareness
- Enhanced Safety
- Increased Airport Capacity



The Routing Service automatically recommends the **most operationally efficient route** while ensuring compliance with airport rules, aircraft limitations, and current traffic conditions.



DATA INPUTS



ROUTING ENGINE



OPTIMIZED ROUTE



CONTROLLER  
REVIEW & APPROVAL



CALLSIGN	TYPE	FROM	TO	CLEARANCE	STATUS
MSR874	A320	RWY 23L	STAND 24	TAXI TO STAND 24	ROUTED

## ROUTING FUNCTION

The Routing Function of A-SMGCS Level 4 calculates and assigns the optimal taxi route for aircraft from their current position to the assigned destination.

### HOW IT WORKS

- 1 The controller selects the destination (e.g., Stand 24).
- 2 A-SMGCS calculates the optimal taxi route based on airfield status, restrictions, and traffic.
- 3 The selected route is displayed on the radar screen.
- 4 The system monitors the aircraft and provides route conformance alerts.
- 5 The route can be updated dynamically if conditions change.

### BENEFITS

- ✓ Improves surface traffic efficiency
- ✓ Reduces taxi time and fuel burn
- ✓ Enhances situational awareness
- ✓ Supports safe and reliable operations
- ✓ Reduces controller workload

**1 DESTINATION SELECTED**

The controller selects the destination (Stand 24).

**2 ROUTE CALCULATED**

A-SMGCS calculates the optimal taxi route.

**3 ROUTE DISPLAYED**

The assigned route is displayed on the radar.

**4 ROUTE MONITORING**

The system monitors the aircraft on the assigned route.

**5 ARRIVAL AT DESTINATION**

Aircraft reaches the destination safely and efficiently.

# A-SMGCS UPGRADE

## NEW LEVEL, NEW SERVICES



CAIRO INTERNATIONAL AIRPORT  
TRANSITIONING FROM LEVEL 2 TO LEVEL 4

### GUIDANCE SERVICE



Guidance services can **automatically direct aircraft** based on routes issued by the routing function, supporting the pilot in the situation with **low visibility** or at **large airport**.



The function is based on **Follow The Greens (FTG) Concept** where the **Automatic Ground Lighting (AGL)** provides ground-based guidance through enhanced automation coupled with route planning.



AGL lights guide the aircraft along the cleared route, **improving safety, situational awareness** and reducing pilot workload.



#### FOLLOW THE GREENS (FTG)

Automatic ground lighting (AGL) provides clear, intuitive guidance for pilots to follow the planned route safely and efficiently.

#### GUIDANCE SOFTWARE NEEDS THE FOLLOWING INFORMATION



**CLEARANCE AND CLEARED ROUTES**  
Routes and clearances issued to aircraft.



**AIRPORT CONFIGURATION**  
Runways, taxiways, aprons, stands, and intersections.



**IDENTITY AND CURRENT POSITION OF EACH MOBILE**  
Real-time position and identity of aircraft and vehicles.



**STATES OF STOP BARS**  
Status (open/closed) of stop bars and runway holding points.

#### BENEFITS



**SUPPORTS PILOTS**  
Especially in low visibility and complex airport environments.



**IMPROVES SAFETY**  
Through clear and consistent guidance.



**INCREASES EFFICIENCY**  
Optimized routes and reduced taxi time.



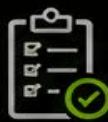
**REDUCES WORKLOAD**  
For both pilots and controllers.



**ENHANCES CAPACITY**  
Better traffic flow and movement management.



Guidance Service uses advanced automation and intelligent ground lighting to guide aircraft **safely and efficiently** along the intended route.



**ROUTING SERVICE**  
Generates the best route



**GUIDANCE SERVICE**  
Guides aircraft along the route (FTG)



**SAFE & EFFICIENT MOVEMENT**  
Enhanced safety, efficiency and capacity



## FOLLOW THE GREEN (FTG)

FTG is an advanced A-SMGCS Level 4 function that uses dynamic taxiway lighting to guide aircraft along the cleared route.



- 1 The controller issues a taxi clearance.



- 2 A-SMGCS calculates the optimal route.



- 3 The system sends commands to the Airfield Lighting (AFL).



- 4 Only the lights on the cleared path illuminate in green.



- 5 As the aircraft moves, the lights behind turn off, and the lights ahead turn green.

## BENEFITS

- ✓ Reduces taxi route errors
- ✓ Enhances safety and runway incursion prevention
- ✓ Improves efficiency and reduces taxi time
- ✓ Supports low visibility operations
- ✓ Reduces controller workload

**SMR 1**  
Surface Movement Radar (Primary)

**SMR 2**  
Surface Movement Radar (Secondary)

**MLAT**  
Multi-Lateration System

**ADS-B**  
Automatic Dependent Surveillance – Broadcast

**FDPS**  
Flight Data Processing System

**CLOCK SYSTEM**  
Time Synchronization

**SURVEILLANCE CAMERAS**  
HD / Thermal / PTZ

**AFL**  
Airfield Lighting System

**VDGS**  
Visual Docking Guidance System

**AWOS**  
Automated Weather Observation System

**AODB**  
Airport Operations Database

**A-SMGCS FUSION ENGINE**

DATA COLLECTION

DATA VALIDATION & CORRELATION

SENSOR FUSION TRACKING

DATA ENRICHMENT (AODB, AFL, VDGS, AWOS, FDPS)

ROUTING & GUIDANCE ALGORITHMS

ALERTS & SAFETY NETS

**REDUNDANT INFRASTRUCTURE**  
High Availability | Fail-Soft Design

**A-SMGCS OPERATIONAL DISPLAY**

SURFACE MAP ALERTS 2 TOOLS HISTORY

OVERVIEW FILTERS

**DLH456**  
A321  
HOLD SHORT  
RWY 23L

**UAE123**  
B738  
TAXIING

**MSR874**  
A320  
TAXI TO  
STAND 24

**LEGEND**

- Aircraft
- Vehicle
- Assigned Route
- Alternative Route
- Stop Bar
- Stand
- Taxiway Edge Light
- Centerline Light

**AWOS**  
Wind 180° / 12 kt  
Visibility 6000 m  
QNH 1013 hPa

**AODB INFO**

Flight: MSR874  
Type: A320  
From: CAI  
To: RUH  
EOBT: 14:45 UTC  
Stand: 24  
Status: Taxiing

ROUTING FOLLOW THE GREEN CONFLICT DETECTION SAFETY NETS ALERTS 2 METEO HISTORY REPORTS



INTEGRATED BENEFITS

**ENHANCED SAFETY**  
Improved situational awareness and conflict prevention

**INCREASED EFFICIENCY**  
Optimized routing and reduced taxi time

**HIGH SYSTEM AVAILABILITY**  
Multiple sensors and redundancy ensure continuity of service

**BETTER VISIBILITY**  
All-weather and low-visibility operation support

**INFORMATION INTEGRATION**  
Operational data improves decision making

**REDUCED WORKLOAD FOR CONTROLLERS**  
Automation and intelligent guidance support

# WHERE WE ARE TODAY

## Cairo International Airport – A-SMGCS Level 4 Upgrade Program

1



### TECHNICAL SPECIFICATION COMPLETED

A comprehensive technical specification has been developed, defining the requirements and target architecture for the transition from A-SMGCS **Level 2** to **Level 4**.

2



### SITE SURVEYS COMPLETED

The participating vendors successfully conducted site surveys to assess the existing infrastructure, operational environment, and integration requirements.

3



### TECHNICAL PROPOSALS RECEIVED

- Three vendors have submitted technical proposals for the project implementation.
- The technical evaluation process is currently underway.

4

### STAKEHOLDER COORDINATION MEETINGS

Several coordination meetings have been conducted with key stakeholders to ensure successful system integration:



Cairo Airport Company (AFL, AODB and VDGS)



Egyptian Meteorological Authority (AWOS / Weather Data)



Surveillance Camera System Administration

These meetings helped identify integration requirements and operational responsibilities.

5



### CURRENT STATUS



### Technical Evaluation Phase

Careful review of all proposals to select the best solution for HECA.



Target: **A-SMGCS Level 4 Implementation**

# EXPECTED CHALLENGES

Key challenges that need to be addressed for a successful transition from A-SMGCS Level 2 to Level 4

1

## INTEGRATION OF MULTIPLE SYSTEMS AND INTERFACES



A-SMGCS requires the integration of various surveillance, functional and assist systems from multiple vendors, using different protocols and data formats.

2

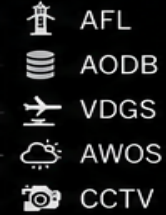
## DATA CONSISTENCY AND SYNCHRONIZATION



Ensuring accurate, real-time and consistent data between different surveillance sensors and systems is critical for safe decision-making and system performance.

3

## INTERFACE DEVELOPMENT WITH EXTERNAL SYSTEMS



Developing and testing robust interfaces with AFL, AODB, VDGS, AWOS and CCTV systems is essential for smooth information exchange and operational efficiency.

4

## MAINTAINING OPERATIONAL CONTINUITY DURING IMPLEMENTATION



The system upgrade must be implemented without disrupting daily airport operations. Phased implementation and careful change management are essential.

5

## VALIDATION OF ROUTING AND GUIDANCE FUNCTIONS



All routing, monitoring and guidance functions must be thoroughly tested and validated to ensure accuracy, reliability and compliance with ICAO requirements.

6

## CYBERSECURITY AND NETWORK SEGREGATION REQUIREMENTS



Protecting critical systems and data from cyber threats and ensuring proper network segregation between operational, corporate and external networks is a major challenge.

7

## STAKEHOLDER COORDINATION ACROSS MULTIPLE ORGANIZATIONS



Successful implementation requires effective coordination and alignment among all stakeholders, including airport operators, ANSP, system owners and supporting agencies.

8

## TRAINING OF OPERATIONAL AND TECHNICAL PERSONNEL



Comprehensive training programs are needed to ensure that controllers, engineers and support staff are fully prepared to operate, maintain and manage the new system.

9

## MIGRATION FROM LEVEL 2 OPERATIONS TO LEVEL 4 CAPABILITIES



Transitioning from the current Level 2 environment to Level 4 capabilities involves process changes, system enhancements and organizational adaptation.



Addressing these challenges effectively will ensure a safe, efficient and successful implementation of A-SMGCS Level 4 at Cairo International Airport.



# EXPERIENCE SHARING REQUEST



We would appreciate learning from States and ANSPs that have transitioned from **A-SMGCS Level 2 to Level 4**.



What were the main **technical** and **operational** challenges?



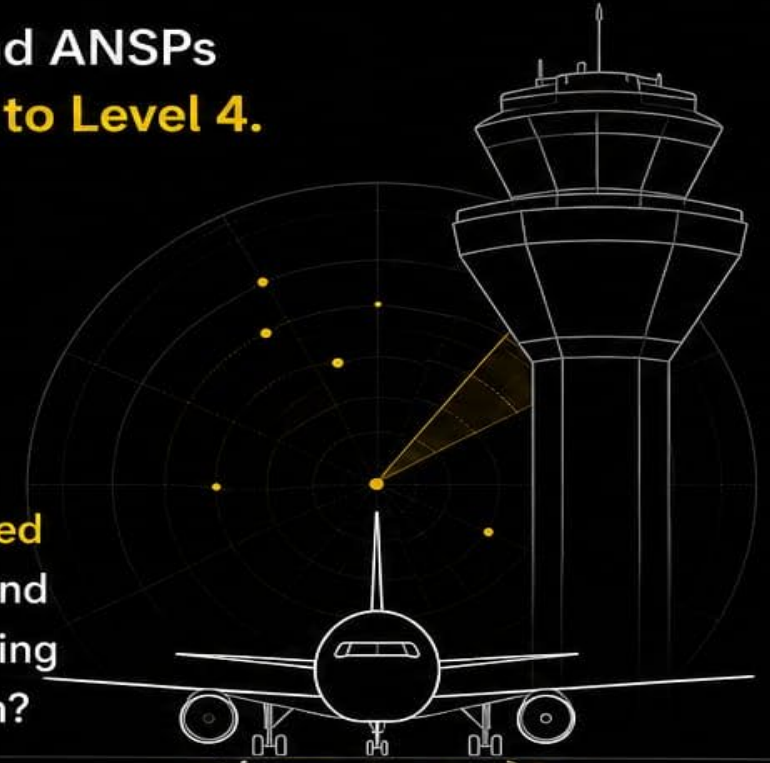
How were **integration** and **interoperability** issues resolved?



Which **lessons learned** would you recommend for projects undergoing the same transition?



Your experiences can help shape **the future** of airport surface management.



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Thank You