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AIR NAVIGATION SYSTEMS IMPLEMENTATION GROUP

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(Cairo, Egypt, 10 – 12 February 2015)

Agenda Item 4: Performance Framework for Regional Air Navigation Implementation

IMPLEMENTATION OF A-SMGCS (B0-SURF) IN CAIRO AIRPORT

(Presented by Egypt)

SUMMARY

This paper presents the implementation of B0-SURF (A-SMGCS) in Cairo Airport (HECA) and the accumulated experience from 2005 until now.
Action by the meeting is at paragraph 3.

REFERENCES

- ICAO Doc 9830
- EUROCAE ED 78 B
- MID Region Air Navigation Strategy

1. INTRODUCTION

MID Region Air Navigation Strategy was endorsed by the Fourth meeting of the MIDANPIRG Steering Group (MSG/4, Cairo, Egypt, 24-26 November 2014) as the framework identifying the regional air navigation priorities, performance indicators and targets. The Strategy determined that Cairo Airport to implement A-SMGCS level 1 and 2.

2. DISCUSSION

2.1 B0-SURF (Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2) as a priority 1 Module, is the implementation of A-SMGCS. Egypt already implemented A-SMGCS in HECA airport and is willing to share experience with the MID States.
A-SMGCS is required in some conditions such as:

a- Visibility condition 2, 3 or 4

ICAO identifies visual condition in Doc 9830 Appendix A as:

- Visibility condition 1: Visibility sufficient for the pilot to taxi and to avoid collision with other traffic on taxiways and at intersections by visual reference, and for personnel of control units to exercise control over all traffic on the basis of visual surveillance
- Visibility condition 2 :Visibility sufficient for the pilot to taxi and to avoid collision with other traffic on taxiways and at intersections by visual reference, but insufficient for personnel of control units to exercise control over all traffic on the basis of visual surveillance;

- Visibility condition 3 : Visibility sufficient for the pilot to taxi but insufficient for the pilot to avoid collision with other traffic on taxiways and at intersections by visual reference, and insufficient for personnel of control units to exercise control over all traffic on the basis of visual surveillance; and
- Visibility condition 4: Visibility insufficient for the pilot to taxi by visual guidance only.

b- Heavy Traffic Density

ICAO identifies heavy traffic density in Doc 9830 Appendix A as:

- 26 or more movements per runway or typically more than 35 total aerodrome movements.
- According to ICAO traffic density and ATC experience, we could define two thresholds to distinguish the light / medium / heavy airports, as follows:
  - First threshold light / medium: between 40 000 and 60 000 movements per year;
  - Second threshold medium / heavy: between 140 000 and 160 000 movements per year.

c- Complex aerodrome layout

ICAO identifies complex aerodrome in Doc 9830 Appendix A as:
An aerodrome with more than one runway, having many taxiways to one or more apron areas.

A-SMGCS Functions

2.2 A-SMGCS should support the following functions in order to optimize “gate to gate” operation:

a) Surveillance: The basic A-SMGCS is intended primarily to enhance safety and efficiency of ground surface operations through the introduction of an advanced surveillance.
b) Control: this function service aims at complementing the surveillance service with an alerting tool whose objective is to detect potentially dangerous conflicts in order to improve safety of runways and restricted areas.
c) Routing: this function will provide ATCOs with a means of designating and assigning a taxi route to each movement, either manually or, as the system evolves, semi-automatically or even automatically.
d) Guidance: this function is predominantly for pilots and drivers, helping them to implement clearances and instructions given by the ATCO, and preventing them from missing their assigned routes and from intruding into restricted areas.

Note:

ICAO Doc 9830 - AN/452 Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual is appropriate reference and Eurocontrol Document – “Definition of A-SMGCS Implementation Levels, Edition 1.2, 2010”are used to fully understand the A-SMGCS functions

A-SMGCS Levels

2.3 Depending on its function, A-SMGCS can be categorized to levels 1, 2, 3 and 4; A-SMGCS in HECA is categorized as level 2 because of these points:

a) Surveillance function is traditional as in level 1 and is not envisaged to extend the provision of the surveillance function to pilots and drivers as in levels 3and 4 because the required technologies such as ADSB/ TIS-B will not yet be thoroughly available.
b) Control function performed by the present Runway and Incursion Monitoring (RIM) Alerts on air traffic control display; this function isn't included in A-SMGCS level 1 functions.
c) Routing function is not included in this system. Only levels 3 and 4 perform this function.
d) Guidance to drivers can be provided by using static maps, not dynamic ones as in levels 3 and 4.

Note: Eurocontrol Document – "Definition of A-SMGCS Implementation Levels, Edition 1.2, 2010"was used to categorize our system.

A-SMGCS Architecture

2.4 A-SMGCS is a complex system of systems, it is composed of multiple systems used as inputs to Surveillance Data Fusion (SDF) via suitable LAN gateway and the output is one comprehensive surveillance package, Fig 1 describes A-SMGCS architecture.

Note-- EUROCAE Document ED 87A – "MASPS for Advanced Surface Movement guidance and control system" is appropriate document for full understanding A-SMGCS Architecture.

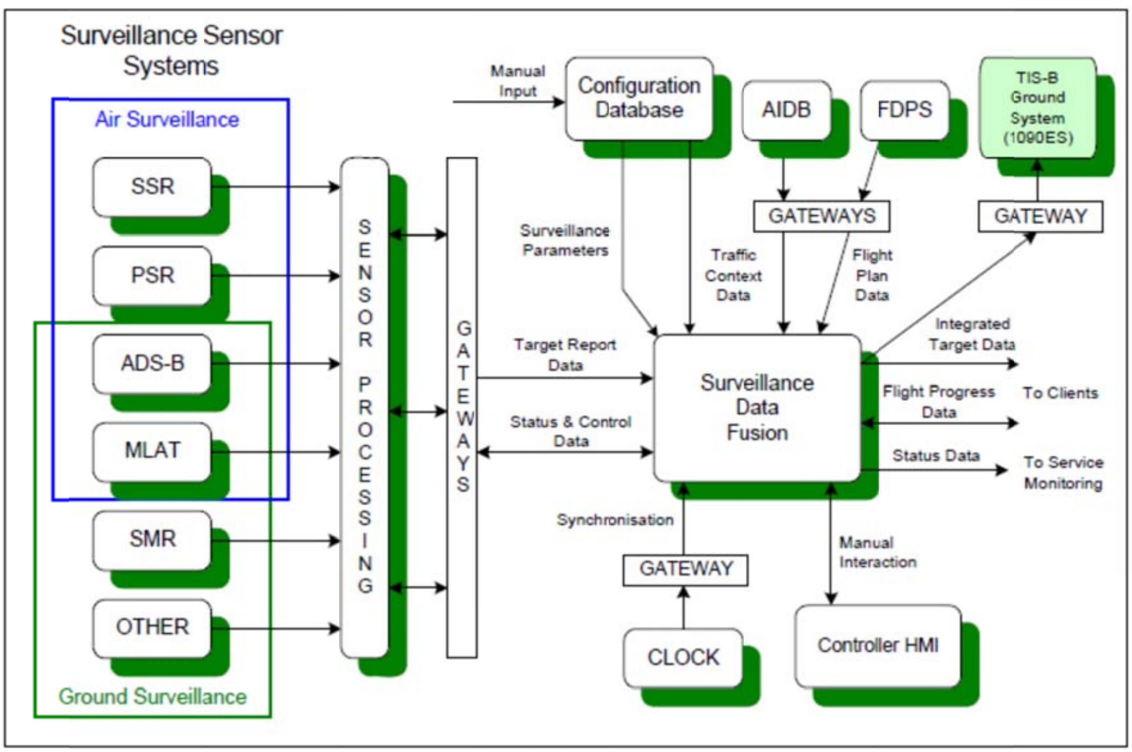

Fig 1 A-SMGCS architecture

2.5 Multiple surveillance sensor systems will normally be required to provide acquisition of traffic information for all traffic on and near the aerodrome. In order to detect all types of aircraft, vehicles and obstacles, the sensor systems should be a mixture of cooperative and non-cooperative types.

Each sensor system will include pre-processing and plot extraction.
Outputs from the sensor systems should be target reports in the ASTERIX data format. Each target report should be time stamped.

Egypt A-SMGCS configuration

2.6 SSR/PSR systems: Position and identity of airborne aircraft are provided to the HECA A-SMGCS by existing approach surveillance radars. To ensure both cooperative and non-cooperative surveillance, the approach surveillance system will normally comprise both primary and secondary surveillance radars (PSR and SSR) feeding a multi-sensor Radar Data Processing System (RDPS).

2.7 Surface Movement RADAR (SMR): At least one non-cooperative surveillance sensor will be needed to detect mobiles and obstacles; including intruders, on the aerodrome surface, in HECA A-SMGCS we use two SMR sensors to cover three runways.

More information about SMR sensors in EUROCAE Document ED 116 – "MOPS for Surface Movement RADAR sensors systems for use in A-SMGCS.

2.8 Multilateration System (MLAT) At least one cooperative surveillance sensor will be needed to provide the position and identity of the participating mobiles on the surface. The participating mobiles are those known by the aerodrome authority, and likely to move on the maneuvering area. In the longer term, all the participating mobiles are required to be cooperative, allowing the cooperative surveillance sensor to collect information about them, at least their position and identity.

MLAT is the main cooperative sensor system for the HECA ground surveillance because it can utilize the Mode A/C/S transponders that are already standard equipment on aircraft. MLAT ground stations are also capable of receiving and decoding 1090ES ADS-B transmissions.

- MLAT system in HECA composed of (19) Receiver stations, (13) Transmitter/Receiver stations and (3) transponders to check the accuracy of the operation in addition of the core system Central target processor (CTP).
- Motorola wireless networking system (Canopy) is used to connect all the stations to the (CTP). There is a remote terminal for monitoring and control of the system. Fig. 2 describes the architecture of MLAT system.

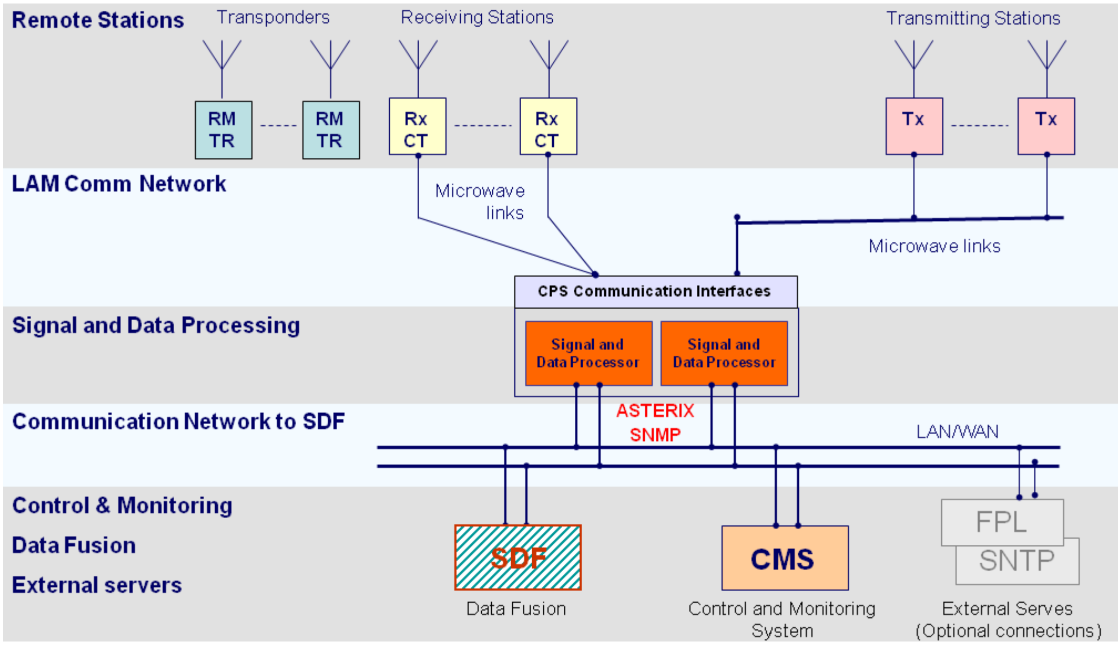

Fig 2 MLAT system architecture

- Data of MLAT is used for reliable automatic identification for transponder-equipped aircrafts or vehicles. Fig. 3 describes the distribution of MLAT sensors through the 3 runway

  (More Information about MLAT in EUROCAE Document ED 117 – "MOPS for MLAT system for use in ASMGCS" is appropriate document to determine MLAT components and requirements.)

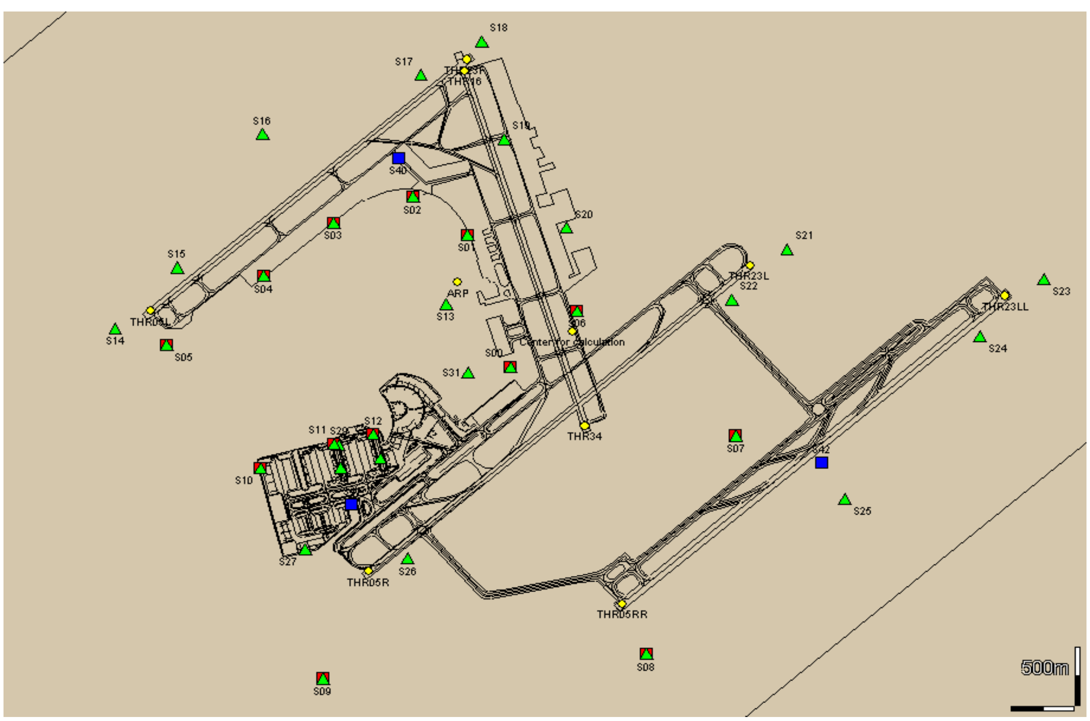

Fig. 3 MLAT distribution sensors on the three runways

2.9 Some other data sources are used as inputs to Surveillance Data Fusion (SDF); such as:

- FDBS Data: Necessary for automatic identification of arriving and departing aircraft and presentation in the identification lists.
- Air Field Lighting (AFL) Data: Connected to monitor (and possibly control) utilities like stop bars for example.
- Runway Occupation System (ROS) Data: Connected to monitor each runway status which can be: ARR; DEP; MIXED; NU; or CLOSED.
- Time Reference system: External source for a reliable reference time. Data is used for synchronization of the components of the A-SMGCS system and presentation on the operational traffic display.

2.10 There are supporting systems to enhance the operation A-SMGC S system like remote control and monitoring system (RCM) and recording and replay system RRS.

2.11 Egypt installed some MLAT sensors above frangible masts beside runway according to ICAO Doc 9157 part 6 frangibility

Interface requirements

2.12 Surveillance data exchange should use the ASTERIX data format. ASTERIX is a data format originally developed as an efficient means of packaging radar data, for transmission over narrow-band communication links such as analogue telephone lines.
Surveillance sensor systems, such as SMR and MLAT, which are specifically intended for airport surface movement applications, should use the ASTERIX Category 010 standard.
ASTERIX Category 011 or the newer Category 062 should be used as the data format for exporting data-fused A-SMGCS surveillance data to other users.
Note—Eurocontrol standard documents for RADAR data exchange -part 1and part 2- All Purpose Structured Eurocontrol Radar Information Exchange (ASTERIX) are appropriate documents to describe ASTERIX message structure

Development stages of HECA A-SMGCS system

2.13 Implementation of A-SMGCS system in Cairo had begun in 2006 to cover only runways 1 and 2. The inputs of SDF were RDPS, FDPS, SMR1, time reference and 4 sensors of Vehicle Tracking System (VTS).

In 2010, the control tower was constructed and there was an uncovered area behind the tower. So, we installed SMR 2 on top of the new tower and increased the VTS sensors to 6. Having done so, the input sensors were RDPS, FDPS, SMR1, VTS, time reference, SMR2, AFL and ROS.

In 2013, terminal 3 was constructed, so there became another uncovered area. We mitigated that by using a Local Area Multilateration system (LAM), and ever since the input sensors have been RDPS, FDPS, SMR1, time reference, MLAT, SMR2, AFL and ROS.

In 2015, and after finishing the rebuilding of terminal 2, we will increase MLAT sensors by 5 sensors to have full coverage on taxiways behind terminal 2.

2.14 There are two concepts that have to be taken into consideration before approving A-SMGCS design; the first is the “fail safe” concept—it means that sufficient redundancy is provided to carry data to the display equipment so as to permit some components of the equipment to fail without any resultant loss of data displayed.

2.15 The second concept is “fail soft”—this term means that the system is designed in such a way that even if equipment fails to the extent that some loss of data occurs, sufficient data remains on the display to enable the controller to sustain operation.

System requirements

2.16 There are general requirements related to Design, Evolution, Operational Range, Environmental Constraints and Interfaces applicable to the overall A-SMGCS ground system and its components. Also, there are specific requirements for surveillance function, control function, guidance function, routing function, control HMI and supporting functions (RCMS, Recording).

These requirements are valid at all levels of implementation of an A-SMGCS, the references of most of these requirements are described in EUROCAE ED 78B and ICAO Doc 9830.

Implementation Challenges

2.17 Lack of experience in the beginning of A-SMGCS implementation back in 2005.

2.18 The main challenge was the need for coordination with various suppliers due to the nature of A-SMGCS (system of systems), as no single company can supply all the components. So, we had the SDF supplied by one company, the SMRs by another, and the MLAT by a third. Therefore, care should be taken to ensure that all systems can be integrated.

2.19 The need for coordination with various institutions and companies to fix the sensors on their buildings, and some of those buildings may be belong to military institution.

2.20 Sometimes it is difficult to connect logistics (electricity and ventilation) to sensor locations.

2.21 It is difficult to dig under runways to extend fibre cable to connect MLAT Transmitters and Receivers with processing unit. So we use microwave links to connect them.

2.22 The variety of operating systems used, we use Linux for SDF system, Windows XP for MLAT Receivers, Windows server 2003 for MLAT processor. This requires additional training

2.23 With any change in airport topography there may a need to redistribute the sensors on the run ways.

Future Mitigations:

2.24 Increasing the numbers of MLAT sensors by 5 after rebuilding terminal 2 to have full coverage with high accuracy.

2.25 Now we are applying N-1 concept on MLAT system. That means if two sensors fail out of 31 sensors, all the MLAT system stop introducing output to save the accuracy of the system. But that is a hindrance knowing that we have 3 runways. So, we are considering making that mitigation by applying the N-1 concept for each runway separately, not for the system as a whole.

2.26 Taking into consideration the implementation status, targets set by the MID Region Air Navigation Strategy and the Egypt do not have no proposal to change the targets.

3. ACTION BY THE MEETING

3.1 The meeting has invited to:

a) note Egypt experience;

b) request to update the implementation of the B0-SURF status for Egypt being implemented; and

c) take any other action as appropriate.

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