



The European Organisation for Civil Aviation Equipment  
L'Organisation Européenne pour l'Équipement de l'Aviation Civile

# **GUIDELINES FOR SURVEILLANCE DATA FUSION IN ADVANCED SURFACE MOVEMENT GUIDANCE AND CONTROL SYSTEMS (A-SMGCS) LEVELS 1 AND 2**

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**ED-128**

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## CHAPTER 1

### INTRODUCTION

#### 1.1 INTRODUCTION

Aerodrome ATC is a service to airside users to provide a safe, expeditious and orderly flow of air traffic. On the ground, the aims are to prevent collisions between aircraft and aircraft and aircraft and vehicles on the airport manoeuvring area and collisions between aircraft and obstructions on the manoeuvring area.

To avoid collisions, two methods have been agreed by ICAO: Spacing (apply a standard separation) or Traffic Information and Clearances (inform the pilot of conflicting traffic and using ATC clearances, e.g. priority order, let him decide where or when to accelerate, decelerate or stop in order to operate his aircraft in the interests of safety).

On the taxiways, there are currently no separation standards defined for ATC, and ICAO requires that the Aerodrome control service should be performed by the use of “visual observation”. Traffic information and clearances are therefore the only means available to the Aerodrome ground controllers to assist in preventing conflicts. On the runway, a combination of agreed separation standards and traffic information are used.

When the manoeuvring area cannot be visually monitored from the Control Tower, ICAO require to set up low visibility operations, operationally known as “Procedural Control” for which the ICAO Doc 9476 “SMGCS Manual” provides guidance and procedures. This method greatly decreases the declared surface movement rate to a level that is not compatible with the expected movement rate of major airports. The use of SMR, as an “adjunct” gives significant benefit in respect of safety but does not significantly improve the movement rate.

##### 1.1.1 Strategy

The solution is to build an advanced system that can replace the ATC visual observation with the same (or higher) level of accuracy, efficiency and safety; this has led to state a general objective for that new system:

***The general objective of an Advanced Surface Movement Guidance and Control System (A-SMGCS) is to ensure the safety and efficiency of airport surface traffic with the increasing density of traffic and in all weather conditions (visibility and cloud ceiling) down to Cat III landing and LVTO.***

For that purpose, the ATC service provided by the controller has been shared out in sub-tasks (functions) that will correspond to individual advanced tools replacing the ATCO lack of vision, in the field of Surveillance, Routing and Guidance. Associated together they will create the A-SMGCS as defined in the ICAO Manual:

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

*A system providing routing, guidance and surveillance for the control of aircraft and vehicles in order to maintain the declared surface movement rate under all weather conditions within the Aerodrome Visibility Operational Level (AVOL) while maintaining the required level of safety.*

The ICAO Doc 9830 A-SMGCS Manual develops generic operational requirements (irrespective of the technology used) that provide guidelines for the analysis and development of local guidelines).

### 1.1.2 EUROCONTROL A-SMGCS Objectives

The present EUROCONTROL A-SMGCS project (up to December 2006) aims to harmonise through the ECAC area, the operational implementation of the A-SMGCS surveillance function (known as Level 1) limited to some visibility conditions, and an A-SMGCS safety net (known as Level 2), both functions using existing technology.

The initial requirements come from ICAO (Doc 9830 “A-SMGCS Manual”) and EUROCAE WG-41. They will be verified/validated through real time simulation and “in situ” operational tests. Additional studies, like Safety Case, Human Factor Case and Regulatory Impact Assessment will support the implementation of ATC operational procedures to be included in ICAO Doc 4444 and Doc 7030.

In parallel, dedicated Mode S transponder operations have been set up in accordance with ATC procedures, published through airports’ AIC/AIP and finally introduced in the ICAO PANS-OPS (Doc 8168).

The EUROCONTROL A-SMGCS project will have a follow on starting January 2007 (with early results expected in December 2009) looking at further integration of tools like DMAN and AMAN, further studies on low visibility procedures and improvement of existing concepts and requirements.

### 1.1.3 Other A-SMGCS Input

The European Commission through its 6<sup>th</sup> Framework Research Programme is undertaking a parallel and complementary A-SMGCS project, EMMA (European Airport Movement Management by A-SMGCS). In its first phase (EMMA 1, 2004-2006), EMMA aims at further validating the concepts contained in the ICAO Manual. As a research project, EMMA also aims at further developing the A-SMGCS Levels 1 and 2 concepts beyond those of Eurocontrol, focusing research in areas such as improved conflict detection and resolution on the movement area and the use of advanced surveillance technologies. This work will lay the foundation of more advanced research and development in support of higher levels of A-SMGCS during the second phase of EMMA (EMMA 2, 2006-2008).

## 1.2 PURPOSE AND SCOPE OF THE DOCUMENT

The purpose of this document is to inform A-SMGCS suppliers and users about the concepts and issues surrounding the fusion of data in the Surveillance element of an A-SMGCS.

This guidance applies to Data Fusion within the context of Level 1 and Level 2 A-SMGCS as defined in the EUROCAE document ED-87A “MASPS for Advanced Surface Movement Guidance and Control Systems”, and further expanded by the Eurocontrol document “Definition of A-SMGCS Implementation Levels”.

The information in this document is a collection of best engineering practices drawn from the experience and lessons learned during system implementations and research.

This guidance is not intended to be a development standard, a process document, nor a means of compliance against any regulation.

### 1.2.1 Document Structure

This document is divided into 4 chapters.

- Chapter 1 contains the purpose and scope, definition of terms, and lists of abbreviations and references.
- Chapter 2 gives a background to A-SMGCS, extracted from the MASPS.
- Chapter 3 provides practical design considerations for Data Fusion.
- Chapter 4 provides general reliability and maintainability requirements for Data Fusion equipment.

## 1.3 DEFINITIONS AND ABBREVIATIONS

### 1.3.1 Definitions

The following defined terms are used within the context of this document:

#### Advanced Surface Movement Guidance and Control System

A system providing routing, guidance and surveillance for the control of aircraft and vehicles in order to maintain the declared surface movement rate under all weather conditions within the Aerodrome Visibility Operational Level (AVOL) while maintaining the required level of safety.

#### Aerodrome

A defined area (including any buildings, installations, and equipment) intended to be used either wholly or in part for arrival, departure and surface movement of aircraft.

#### Apron

A defined area, on a land Aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fuelling, parking or maintenance.

#### Availability

The probability that a system or an item is in a functioning state at a given point in time.

#### Classification

A function which groups Targets into various types (e.g. large, medium, small).

#### Continuity of Service

The ability of a system or an item to perform its required function without unscheduled interruption throughout the duration of the intended operation.

#### Cooperative Surveillance

Surveillance that relies on the Target being equipped with a system capable of automatically and continuously providing information enabling the Target's position and identity to be determined by the A-SMGCS.

#### Data Fusion

A generic term used to describe the process of combining Surveillance information from two or more sensor systems or sources.

#### Integrity

An attribute of a system or an item indicating that it can be relied upon to perform correctly on demand. (It includes the ability of the system to inform the user in a timely manner of any performance degradation.)

#### Manoeuvring Area

That part of an Aerodrome to be used for take-off, landing and taxiing of aircraft, excluding Aprons.

#### Movement Area

That part of an Aerodrome to be used for take-off, landing and taxiing of aircraft, consisting of the Manoeuvring area and Apron(s).

**NOTE:** For A-SMGCS, the Movement Area does not include passive stands, empty stands and those areas of the Apron(s) that are exclusively designated to vehicle movements.

#### Non-Cooperative Surveillance

Surveillance that is able to detect and locate a Target without relying on the Target being specifically equipped.

Obstacle

All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.

Reliability

The ability of a system or an item to perform a required function under specified conditions, without failure, for a specified period of time.

Reported Position Accuracy (RPA)

The difference, at a specified confidence level, between the reported position of the Target and the actual position of the Target at the time of the report.

Requirement

An identifiable element of a function specification that can be validated and against which an implementation can be verified.

Target

Any aircraft, vehicle or obstacle, whether stationary or moving, which is located within the intended coverage area of the A-SMGCS and which is of sufficient size to be operationally significant.

Target Report

A data record containing all relevant information pertaining to a Target detected by the surveillance sensor system.

Track

A progressive series of estimates of a Target position.

Update

A renewal of Target Reports relating to all Targets under surveillance.

**1.3.2****Abbreviations**

|                  |                                                               |
|------------------|---------------------------------------------------------------|
| <b>ADEP/ADES</b> | Aerodrome of Departure/Destination                            |
| <b>ADS-B</b>     | Automatic Dependent Surveillance - Broadcast                  |
| <b>AFTN</b>      | Aeronautical Fixed Telecommunications Network                 |
| <b>AIC</b>       | Aeronautical Information Circular                             |
| <b>AIP</b>       | Aeronautical Information Publication                          |
| <b>AMAN</b>      | Arrival Manager                                               |
| <b>ARP</b>       | Aerodrome Reference Point                                     |
| <b>A-SMGCS</b>   | Advanced Surface Movement Guidance and Control System         |
| <b>ASTERIX</b>   | All Purpose Structured Eurocontrol Radar Information Exchange |
| <b>ATC</b>       | Air Traffic Control                                           |
| <b>ATCO</b>      | Air Traffic Control Officer                                   |
| <b>ATM</b>       | Air Traffic Management                                        |
| <b>BITE</b>      | Built-in Test Equipment                                       |
| <b>CTOT</b>      | Calculated Take-Off Time                                      |
| <b>DMAN</b>      | Departure Manager                                             |
| <b>ECAC</b>      | European Civil Aviation Conference                            |
| <b>EGNOS</b>     | European Geostationary Navigation Overlay Service             |

|                 |                                                                                                                                                                                    |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>EUROCAE</b>  | European Organisation for Civil Aviation Equipment                                                                                                                                 |
| <b>ETA/ETD</b>  | Estimated Time of Arrival/Departure                                                                                                                                                |
| <b>FDPS</b>     | Flight Data Processing System                                                                                                                                                      |
| <b>FMS</b>      | Flight Management System                                                                                                                                                           |
| <b>GDOP</b>     | Geometric Dilution of Precision                                                                                                                                                    |
| <b>GPS</b>      | Global Positioning System                                                                                                                                                          |
| <b>GNSS</b>     | Global Navigation Satellite System                                                                                                                                                 |
| <b>HDOP</b>     | Horizontal Dilution of Precision                                                                                                                                                   |
| <b>HMI</b>      | Human Machine Interface                                                                                                                                                            |
| <b>ICAO</b>     | International Civil Aviation Organisation                                                                                                                                          |
| <b>ID</b>       | Identity                                                                                                                                                                           |
| <b>INS</b>      | Inertial Navigation Systems                                                                                                                                                        |
| <b>IRTOP</b>    | Identification Renewal Time-Out Period                                                                                                                                             |
| <b>LVTO</b>     | Low Visibility Take Off                                                                                                                                                            |
| <b>MASPS</b>    | Minimum Aviation System Performance Specification                                                                                                                                  |
| <b>MLAT</b>     | Mode S Multilateration                                                                                                                                                             |
| <b>MOPS</b>     | Minimum Operational Performance Specification                                                                                                                                      |
| <b>MSL</b>      | Mean Sea Level                                                                                                                                                                     |
| <b>PANS-OPS</b> | Procedures for Air Navigation Services - Aircraft Operations                                                                                                                       |
| <b>PD</b>       | Probability of Detection                                                                                                                                                           |
| <b>PFA</b>      | Probability of False Alarm                                                                                                                                                         |
| <b>QNH</b>      | Atmospheric Pressure at Nautical Height: Q-code designation for atmospheric pressure at mean sea level.<br><br>Altimeter sub-scale setting to obtain elevation when on the ground. |
| <b>PRTOP</b>    | Position Renewal Time-Out Period                                                                                                                                                   |
| <b>PSR</b>      | Primary Surveillance Radar                                                                                                                                                         |
| <b>RDPS</b>     | Radar Data Processing System                                                                                                                                                       |
| <b>RF</b>       | Radio Frequency                                                                                                                                                                    |
| <b>RPA</b>      | Reported Position Accuracy                                                                                                                                                         |
| <b>R/T</b>      | Radio Telephony                                                                                                                                                                    |
| <b>RWY</b>      | Runway                                                                                                                                                                             |
| <b>SARPS</b>    | Standards and Recommended Practices                                                                                                                                                |
| <b>SID</b>      | Standard Instrument Departure                                                                                                                                                      |
| <b>SDF</b>      | Surveillance Data Fusion                                                                                                                                                           |
| <b>SMGCS</b>    | Surface Movement Guidance and Control System                                                                                                                                       |
| <b>SMR</b>      | Surface Movement Radar                                                                                                                                                             |
| <b>SSR</b>      | Secondary Surveillance Radar                                                                                                                                                       |
| <b>STAR</b>     | Standard Terminal Arrival Route                                                                                                                                                    |
| <b>TWY</b>      | Taxiway                                                                                                                                                                            |

|               |                                                             |
|---------------|-------------------------------------------------------------|
| <b>UAT</b>    | Universal Access Transceiver                                |
| <b>VDL</b>    | VHF Data Link                                               |
| <b>VHF</b>    | Very High Frequency                                         |
| <b>WAAS</b>   | Wide Area Augmentation System                               |
| <b>WGS-84</b> | World Geodetic Survey (1984)                                |
| <b>WTC</b>    | Wake Turbulence Category (also called Wake Vortex Category) |

## 1.4

### REFERENCES

The following documents are incorporated by reference. The latest issue in effect shall be the one that will apply.

- [1] EUROCAE: Minimum Aviation System Performance Specification for Advanced Surface Movement Guidance and Control Systems (ED-87A, Interim Document, January 2001)
- [2] ICAO: Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (Doc 9830)
- [3] ICAO: SARPS Annex 14 Aerodromes
- [4] ICAO: Aerodrome Design Manual (Doc 9157)
- [5] ICAO: PANS OPS (Doc 8168)
- [6] ICAO: PANS ATM (Doc 4444)
- [7] ICAO: Annex 10 Volume IV (Radar of surveillance systems and anti-collision systems)
- [8] EUROCONTROL: Standard Document for Surveillance Data Exchange - Part 7 Transmission of Monosensor Surface Movement Data, SUR.ET1.ST05.2000-STD-07-01
- [9] EUROCONTROL: Definition of A-SMGCS Implementation Levels, Edition 1.0, September 2003
- [10] EUROCAE: MOPS for SSR Mode S Transponder (ED-73B, January 2003)
- [11] EUROCAE: MOPS for 1090 MHz for ADS-B (ED-102, November 2000)
- [12] EUROCAE: MOPS for VDL Mode 4 Aircraft Transceiver (ED-108A, September 2005)
- [13] RTCA: MOPS for Universal Access Transceiver ADS-B (DO-282A, August 2004)
- [14] EUROCAE: MOPS for MLAT for use in A-SMGCS (ED-117, November 2003)
- [15] EUROCAE: MOPS for SMR for use in A-SMGCS (ED-116, January 2004)
- [16] EUROCAE: User Requirements for Aerodrome Mapping Information (ED-99A, October 2005)

## CHAPTER 2

### BACKGROUND

#### 2.1 A-SMGCS OVERVIEW

##### 2.1.1 Basic Functional Elements of an A-SMGCS

In order to analyse the requirements of an A-SMGCS and provide an evolutionary modular concept, it is necessary to split the system into its logical functional elements. The proposed basic elements are Surveillance, Monitoring/Alerting, Guidance and Route Planning, together with the necessary communications.

It should be noted that while these basic technical functions do not align directly with the functions Surveillance, Routing, Guidance and Control as described in the ICAO A-SMGCS Manual [2], they are nevertheless consistent with the provision of systems to meet the operational requirements therein defined.

In particular, the use of the term Control, which in the ICAO Manual embraces instructions given by ATC or by the system, does not have a direct technical counterpart. Control may be exercised in a technical implementation by mandating directions given through the medium of the Guidance element, which in turn may have been processed by the Route Planning element. Route Planning, within the technical implementation is a function which includes both the allocation of a route and the associated timing and sequencing. At a tactical level, the route provided by the Route Planning element may well be dynamic during the course of an aircraft's progress, dependent on other factors, such as weather conditions, runway usage, etc.

The Monitoring/Alerting element, which has no direct counterpart in the ICAO functions, comprises the processing of the information gathered by the Surveillance element against a set of rules which characterise the particular requirements of A-SMGCS at the Aerodrome concerned.

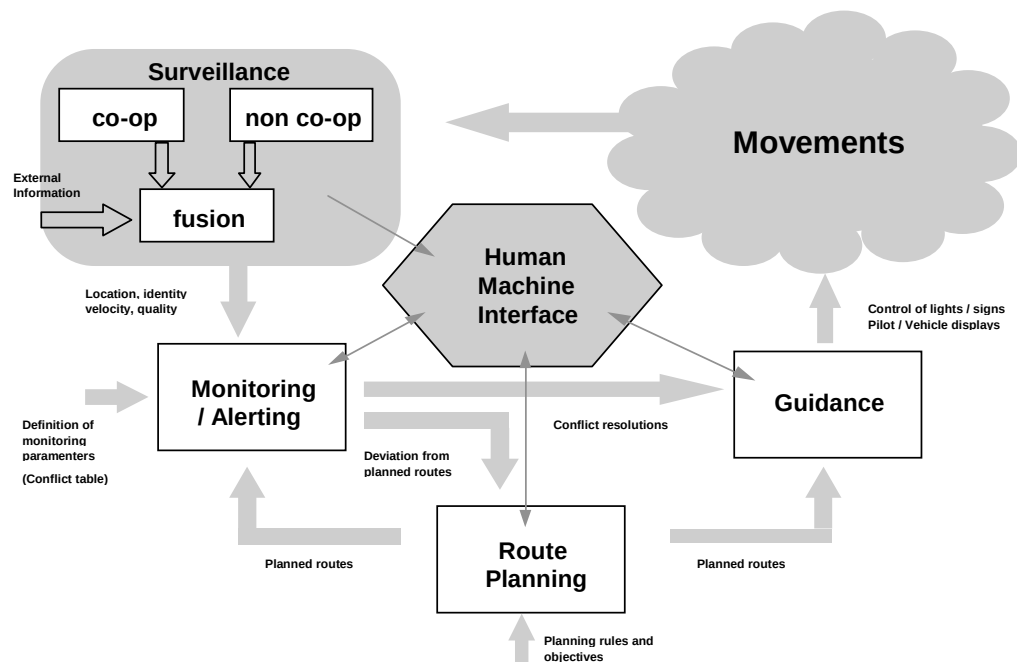


FIGURE 2-1: CONCEPTUAL BLOCK DIAGRAM FOR A-SMGCS