TITLE
Operational Concept and Requirements for A-SMGCS Implementation Level 2

Abstract
This document is the Eurocontrol specification of the operational requirements for A-SMGCS Level 2 implementation.

In 2006 the EUROCONTROL A-SMGCS project published the latest version of this document that has been agreed by WG41 of EUROCAE. Further developments as well as the integration of the specifications into a European Norm and updated references consequently required an update of this document.

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EXECUTIVE SUMMARY

This document describes the Eurocontrol specification of the operational concept and requirements for the A-SMGCS Implementation Level 2.

Based on the results of validation projects, an update of the initial requirements had been prepared and agreed with EUROCAE WG41 for A-SMGCS and was published in 2006.

The EUROCONTROL and EUROCAE specifications have been incorporated in the creation of a European Norm (EN) for A-SMGCS Level 1 and Level 2 by the European Telecommunications Standardisation Institute (ETSI) based on Mandate 390 of the European Commission to a significant extend. This European Norm is planned to be converted into a European Community Specification (CS) by end of 2010. Both forms are intended as means of compliance to the European Regulation on Interoperability (EC) No 552/2004 being amended by Regulation (EC) No 1070/2009.
CHAPTER 1 – Introduction

1.1 Scope of the document

The Eurocontrol A-SMGCS project aims at defining pragmatic implementation steps for A-SMGCS. The first step named A-SMGCS Level 1 focuses on the implementation of automated surveillance. Level 1 operational concept and requirements are presented in Ref. 2.

A-SMGCS Level 2 aims at complementing surveillance service with a control service which provides a runway safety net and prevents incursions into restricted areas. A guidance service may also be provided to the vehicles driver as an option.

This document defines the operational concept and requirements for A-SMGCS Implementation Level 2, i.e. how ATS is expected to evolve through the introduction of the A-SMGCS surveillance, and control (automated) services.

The surveillance service is identical at Level 1 and Level 2 (description available in Ref. 2). Therefore the document focuses on the control and guidance services.

The Eurocontrol A-SMGCS Definition of Implementation Levels is included in Ref. 1.

Note - The present document contains a revised version of the requirements following the results of validation activities.

1.2 Structure of the document

Introduction

CHAPTER 1 – describes the purpose of this document, its structure, the reference documents, and an explanation of terms used throughout the document.

Operational Concept

CHAPTER 2 – introduces the operational concept and principles associated to A-SMGCS Level 2. Further definition of the concept is provided through the following three chapters:

Services Description

CHAPTER 3 – presents the automated control service for A-SMGCS Level 2.

Runway safety net

CHAPTER 4 – presents the scenarios to be detected by the Runway safety net.

Restricted area incursions
CHAPTER 5 – presents the restricted area incursion scenarios.

Roles of Actors

CHAPTER 6 – presents the role of Level 2 actors in light of provided services

Operational Procedures

CHAPTER 7 – introduces the operational procedures that are associated to Level 2 and being developed by EUROCONTROL in close coordination with ICAO.

Equipment

CHAPTER 8 – presents equipment required for A-SMGCS Level 2.

Operational Requirements

CHAPTER 9 – contains the operational requirements associated to Level 2, i.e. from an A-SMGCS user point of view, the general requirements attached to Level 2 services, the functionalities and interfaces needed (functional requirements) and the corresponding non-functional requirements (performances). Both normal and exceptional conditions (failure) are covered.

Annexes

ANNEX 1 – summaries the conflicts / infringements to be detected by the runway safety net and associated alerts.

1.3 Performance parameters

This section provides the explanation of terms required for a correct understanding of the present document. Most of the following explanations are drawn from the A-SMGCS manual Ref. 4, the ICAO Annex 14 Ref. 5 or the EUROCAE MASPS for A-SMGCS Ref. 7, in that case it is indicated in the definition. Ref. 5 definitions are used as a first option. In general, other definitions are only used where there is no ICAO definition. If not, it is explained why another definition is preferred to the ICAO one.

Alert Response Time (ART)

Ref. 7 definition

The time delay between an alert situation occurring at the input to the Alert Situation Detection Element and the corresponding alert report being generated at its output.

Coverage Volume (CV)

Ref. 7 definition

That volume of space which encompasses all parts of the aerodrome surface where aircraft movements take place together with those parts of the surrounding airspace which affect surface operations.

Display Resolution (DR)

Ref. 7 definition

The number of individually addressed picture elements (pixels) along each axis of the display screen. (For a raster-scan display, the resolution is normally expressed in terms of the number of raster lines and the number of pixels per line.)

Information Display Latency (IDL)

Ref. 7 definition
The maximum time delay between a report, other than a target report, being received by the A-SMGCS HMI and the corresponding presentation on the HMI display of the information contained in the report.

**Position Registration Accuracy (PRA)**

*Ref. 7 definition*

The difference between the co-ordinates contained in the dynamic input data to the HMI and the corresponding geographical position represented on the HMI display.

**Probability of Detection (PD)**

*Ref. 7 definition*

The probability that an actual target is reported at the output of the Surveillance Element of an A-SMGCS.

**Probability of Detection of an Alert Situation (PDAS)**

*Ref. 7 definition*

The probability that the Monitoring/Alerting Element correctly reports an alert situation.

**Probability of False Alert (PFA)**

*Ref. 7 definition*

The probability that the Control service reports anything other than actual alert situations.

**Probability of False Detection (PFD)**

*Ref. 7 definition*

The probability that the Surveillance Element of an A-SMGCS reports anything other than actual targets.

**Probability of False Identification (PFID)**

*Ref. 7 definition*

The probability that the identity reported at the output of the Surveillance Element of an A-SMGCS is not the correct identity of the actual target.

**Probability of Identification (PID)**

*Error! Reference source not found. definition*

The probability that the correct identity of a co-operative target is reported at the output of the Surveillance Element.

**Reported Position Accuracy (RPA)**

*Ref. 7 definition*

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.

**Reported Velocity Accuracy (RVA)**

*Ref. 7 definition*

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

**Response Time to Operator Input (RTOI)**

*Ref. 7 definition*
The maximum time delay between the operator making an input on a data entry device of an A-SMGCS HMI and the corresponding action being completed or acknowledged on the HMI display.

**Surveillance Capacity**

*Ref. 7 definition*

The number of target reports in a given period which the Surveillance Element is able to process and output without degradation below the minimum performance requirements.

**System accuracy**

*Ref. 4 definition*

The term accuracy generally describes the degree of conformance between a platform’s true position and/or velocity and its estimated position and/or velocity.

**System availability**

*Ref. 4 definition*

Availability is the ability of an A-SMGCS to perform a required function at the initiation of the intended operation within an A-SMGCS area.

**System Capacity**

*Ref. 4 and Ref. 7 definition*

The maximum number of simultaneous movements of aircraft and vehicles that the system can safely support within an acceptable delay commensurate with the runway and taxiway capacity at a particular airport.

**System continuity**

*Ref. 4 definition*

Continuity is the ability of an A-SMGCS to perform its required function without non-scheduled interruption during the intended operation in an A-SMGCS area.

**System integrity**

*Ref. 4 definition*

Integrity relates to the trust which can be placed in the correctness of the information provided by an A-SMGCS. Integrity includes the ability of an A-SMGCS to provide timely and valid alerts to the user(s) when an A-SMGCS must not be used for the intended operation.

**System reliability**

*Ref. 4 definition*

Reliability is defined as the ability of an A-SMGCS to perform a required function under given conditions for a given time interval.

**Target Display Latency (TDL)**

*Ref. 7 definition*

The maximum time delay between a target report being received by the A-SMGCS HMI and the corresponding presentation on the HMI display of the target position contained in the report.

**Target Report Update Rate (TRUR)**

*Ref. 7 definition*
The frequency with which target reports are output from the Surveillance Element.
CHAPTER 2 –Operational Concept

2.1 Objectives

A-SMGCS Level 2 aims at complementing surveillance service (Level 1) with a control service whose objective is to detect potentially dangerous conflicts in order to improve safety of runways and restricted areas.

A-SMGCS Level 2 provides to ATCOs a traffic situation picture associated to an automated control service capable of detecting potential conflicts.

A-SMGCS Level 2 is fully compliant with ICAO SMGCS provisions (Ref. 4 and Ref. 5) to prevent runway incidents and accidents.

2.2 Services

At Level 2, A-SMGCS consists in the introduction of automated surveillance (identical to Level 1) complemented by an automated service capable of detecting conflicts and infringements of some ATC rules involving aircraft or vehicles on runways and restricted areas. Whereas the detection of conflicts identifies a possibility of a collision between aircraft and/or vehicles, the detection of infringements focuses on dangerous situations because one or more mobiles infringed ATC rules. A-SMGCS Level 2 will not address conflicts between two vehicles, but only between an aircraft and another mobile.

The A-SMGCS control service is available for all weather conditions, traffic density, and aerodrome layout. In particular, an A-SMGCS Level 2 should be able to assist the controller in preventing collisions between aircraft and mobiles especially under reduced visibility conditions.

The conflicts / infringements considered at Level 2 are related to the most hazardous ground circulation incidents or accidents. They could be defined as follows:

- Conflicts / infringements on runway caused by aircraft or vehicles;
- Restricted area incursions caused by aircraft (i.e. incursions on a closed taxiway or runway).

Further extension of conflict detection to cover taxiway intersections has not been retained for Level 2, because it seems technically difficult, at Level 2, to correctly detect these conflicts without providing inappropriate alerts.

When an alert situation is detected the A-SMGCS control service generates an appropriate alert to ATCOs. At Level 2, alerts are provided only to ATCOs.

The targeted A-SMGCS control service is highly dependent on the surveillance data, i.e. the quality of conflict / infringement detection is directly related to the performance (accuracy, availability, continuity, integrity, etc), of
the systems providing the surveillance data and which are also used by the surveillance service.

2.3 Operations

A-SMGCS Level 2 operations are identical to those defined for Level 1 in Ref. 2, plus those linked to the use of the automatic conflict / infringement detection tool. Procedures related to each type of alert shall be defined and applied by ATC controllers.

2.4 Benefits

The main benefits to be accrued from implementation of A-SMGCS Level 2 will be associated with the provision of a safety net for runway operations, i.e. capable of detecting and preventing potential hazards resulting from deviations or errors.

2.5 Implementation Consideration

A-SMGCS Level 2 has to adapt to local needs of different aerodromes concerning the detection of runway safety hazards. In particular for some airports the adequacy between conflict / infringements detected and working methods such as intersection departures, multiple line-up, or conditional clearance shall be ensured in order to avoid unnecessary alerts.

Level 2 will be built upon Level 1 but several improvements need to be implemented, as surveillance data will be used by the runway safety net, the surveillance infrastructure will not be the same. In comparison to Level 1, the traffic information (position, identity) will be completed with other parameters like speed vector, and the performance will be enhanced, i.e. the position accuracy will be better.

In addition, the automated control system shall be robust to failures of other ATC systems (Flight Data Processing System, etc), or other A-SMGCS elements. This will be realised by minimising the interaction with these systems.

Consideration will be put on user workload, by minimising controller inputs.

2.6 Optional service

A-SMGCS Level 2 may also optionally provide a guidance service to vehicle drivers. This service which will be available in the A-SMGCS Level 2 implementation timeframe consists in an airport map showing taxiways, runways, fixed obstacles and the mobile position. With this system, the driver could visualise his position and his destination on a display. This will reduce navigation mistakes which could occur in low visibility conditions.

In any case, vehicles equipped with this guidance service or not, all participating vehicles will normally be co-operative and will provide their identity to ATC on the manoeuvring area.
CHAPTER 3 –Services

In A-SMGCS Level 2, the automated surveillance and control services are provided to ATC controllers, and the guidance service may optionally be provided to vehicle drivers. This section further describes the A-SMGCS control service, the surveillance service being described in Ref. 2.

3.1 Overview

A-SMGCS Level 2 provides an automated control service to ATCOs. This service detects the following conflicts / infringements:

- Conflicts / infringements on runway caused by aircraft or vehicles;
- Restricted areas incursions caused by aircraft.

For each conflict / infringement detected, the A-SMGCS control service provides an appropriate alert to ATCOs.

This service gives assistance to the ATCO in his control tasks by:

- Anticipating potential conflicts;
- Detecting conflicts.

At Level 2 the A-SMGCS control service primarily intends to contribute to operations as a safety net, preventing hazards resulting from pilot or vehicle driver deviations or from operational errors or deviations.

At further A-SMGCS Levels (3 or 4) further developments of the service are envisaged to:

- Provide automatic alerts to pilots / drivers;
- Detect conflict at taxiway intersections, and any other conflict on the airport surface;
- Perform automatic actions following alerts (e.g. trigger stop bars);
- Improve decision support capability provided to ATCOs.

Levels 3 and 4 are not within the scope of this document but a description is provided in Ref. 1.

A-SMGCS Level 2 can optionally provide a guidance service for vehicle drivers. This service consists providing the following information to the driver:

- Vehicle position;
- Traffic context information: static geographic information (layout, reference points)
3.2 **Alerts to ATCOs**

### 3.2.1 Presentation of alerts to ATCOs

When conflicts / infringements are detected, an alert is presented to ATCO using visual and sound processes.

Visual process consists in the provision of alert situation information: type and location of alert situation, identification of the conflicting mobiles. This visual alert is presented on the same HMI used for the surveillance service.

Sound process consists in a sound alert issued when the alert situation necessitates an immediate action. A sound process will always be associated with a visual process in order to provide the controller with the information he needs to understand the situation.

In A-SMGCS implementation Level 2, it is not foreseen to provide the alert with an indication on the procedure the controller must apply. The alert resolution assistance will be provided in the Level 4 (see Ref. 1).

### 3.2.2 Stages of alert

Different levels of severity for alert situations may be distinguished. For each level a different alert stage is defined. Two stages of alerts are recommended.

The number of alert stages should be kept to a minimum (i.e. 1 or 2) in order to decrease the controller disturbances and workload. More than two stages could be too complicated and bewildering.

This recommendation is also based on the experience and practices of current A-SMGCS systems being operational in Europe.

The recommended two stages of alert are defined as follow:

- **Stage 1** alert is used to inform the controller that a situation which is potentially dangerous may occur, and he/she needs to be made aware of. According to the situation, the controller receiving a stage 1 alert may take a specific action to resolve the alert if required. This is called INFORMATION step.

- **Stage 2** alert is used to inform the controller that a critical situation is developing which demands immediate action. This is called ALARM step.

In general, a stage 2 alert is preceded by a stage 1 alert in order to anticipate the conflicts / infringements. However, this is not systematic and depends on the scenario. Depending on the detected situation a prediction will not necessarily be issued and the system will directly trigger an alert.

Controllers have different preferences, some of them want to be alerted only when the situation is critical (only stage 2 alerts), and others wish more anticipation (two stages of alert). As a consequence, some ATS providers may choose to have ALARM only, and not use INFORMATION.

The end of an alert situation can be either manual, controller input, or automated based on local parameters.
3.3 Compliance with ATC Procedures and Working Methods

In order to efficiently assist ATCOs (for building and enhancing confidence), the automated A-SMGCS control service shall be compatible with local procedures and working methods. It could have requirements for additional amended procedures that should be harmonised (i.e. through ICAO).

In particular, the detection of conflict / infringements shall take into account local working methods implemented according to the ICAO relevant provisions e.g. multiple line-ups, intersection departures, conditional clearance (see definitions in Ref. 9).

The (automated) control service shall also take into account that such working methods vary with respect to traffic load or meteorological conditions.

According to given visibility conditions (local parameter) operations such as multiple line-ups, could not be authorised and in such a case appropriate alerts shall be generated.

However, in some cases the runway safety net provided by A-SMGCS Level 2 could allow the ATM providers to perform multiple line-ups and conditional clearances even in reduced visibility conditions, provided that aircrew can see each other (i.e. in visibility condition 2, Ref. 4).

3.4 Protection Areas

As introduced in Ref. 3 section 3.3.3.7 and 3.4.5.11, a solution to detect conflict / infringements is to define virtual areas around runways, restricted areas, or mobiles. These areas are called protection areas.

As an example a conflict / infringement is detected when a mobile crosses the runway protection area boundary.

The form and size of the protection areas may vary depending on airport layout and ATC procedures.

The runway protection area is composed of two boundaries:

- A ground boundary to detect the mobiles on the surface,
- An air boundary to detect airborne aircraft.

Around the same runway several “layers” of protection areas may be defined, each one corresponding to an alert situation severity level (and associated to alert stages, see section 3.2).

The boundaries of the runway protection area must be as close as possible to the runway to avoid unnecessary alerts, but must be carefully determined to allow time for immediate action / reaction in order to prevent any mobile from entering the runway after having been detected as a potential hazard.

3.4.1 Ground boundary

The length of the ground boundary must at least include the runway strip. The width could be defined, and different, according to the meteorological conditions, e.g. Non-LVP or LVP.

As an example based on today ILS holding positions:

- In Non-LVP - ground boundary defined by Cat I holding position
- In LVP - ground boundary defined by Cat II / III holding position
This ground boundary will be used for both prediction and alert stages.

Figure 1: Ground boundary of runway protection area

Note - In order to avoid unnecessary predictions or alerts to the controllers, current systems wait until the mobile has crossed the boundary. Subject to further development, if the runway protection is ensured by an algorithm which could predict that a mobile is able or not to stop before entering the protection area, i.e. the ground boundary, a prediction/alert could be generated before the mobile crosses the boundary. Such algorithms, based on the speed and position of a mobile, may already exist but they have to be evaluated.

3.4.2 Air boundary

The air boundary is defined as a flight time to threshold and would take into account the two stages of alert, prediction and alert, as well as the meteorological conditions:

- Non-LVP - INFORMATION around T1 = 30”, ALARM around T2 = 15”
- LVP - INFORMATION around T1 = 45”, ALARM around T2 = 30”

According to Ref. 3, 3.4.5.12 and 3.4.5.13, these times of the two alert stages outlined above should be configurable, depending upon optimisation at the aerodrome.

Figure 2: Air boundary of runway protection area
3.5 **Guidance Service to Vehicle Drivers (Optional)**

At Level 2, the optional guidance service to vehicle drivers will provide basic information that allows drivers to visualise their position on the movement area.

Two main types of information have to be provided:

- Vehicle position;
- Traffic context information - static geographic information (layout, reference points, holding positions).

At Level 2 the service is not intended to provide direct guidance instructions, for instance for crossing of holding positions.

This reduced service primarily intends to reducing navigation errors which may occur in reduced visibility conditions or with un-experimented drivers.

At further A-SMGCS Levels (3 and 4) the guidance service will also be provided to aircrew and enhanced by visualising dynamic traffic context information - status of runways and taxiways, obstacles.
CHAPTER 4 – Runway Safety net

A-SMGCS Level 2 will provide runway safety net by detecting potentially dangerous scenarios dealing with runway. It is not intended to provide an exhaustive list of the cases to be monitored at Level 2. These cases remain specific to each aerodrome.

Firstly, the cases depend on the aerodrome layout: the definition of runway incursions could be different in an airport with only one runway to the one of an airport with two crossing runways.

Secondly, the conflicts / infringements cases are closely related to ATC local procedures. For instance, in order to increase the departure rate, some airports apply multiple line-up departures under which several aircraft may be lined-up at the same time on the same runway. In such an airport, two lined-up aircraft are not considered as a conflict. Therefore, in that case, the A-SMGCS runway safety net should deal with two aircraft in the same protection area without issuing an immediate alert. This implies the use of A-SMGCS safety net whose algorithm goes further and deeper than the traditional algorithm.

At other airports where multiple line-ups are not in operation, this two lined-up aircraft case may be recognised as a runway incursion case.

Consequently, conflict/infringements cases have to be specifically determined for each airport. In A-SMGCS Level 2, the control service shall detect all the conflicts/infringements on a runway with respect to each airport’s particularities and definitions.

However, we provide in the following sections some general cases which should be addressed by A-SMGCS Level 2.

4.1 Scope of conflicts / infringements on runway

Runway Incursion is defined by the ICAO Manual on the Prevention of Runway Incursions, Ref. 18:

“The unintended presence of an aircraft, vehicle or person on the runway or runway strip”.

In A-SMGCS Level 2, it is proposed to detect runway incursions caused only by aircraft or vehicles, not person.

Conflicts between 2 vehicles are out of the scope of A-SMGCS Level 2. It means A-SMGCS Level 2 will detect only conflicts between an aircraft and another mobile which may be another aircraft or a vehicle.

The analysis of conflicts involving more than two mobiles may be done by considering each pair of mobiles. Consequently, this case is covered by the two-mobile case.
The detection of conflicts / infringements on runway must take into account the specific runway configuration of each aerodrome. An aerodrome may have one, two, or more runways. The analysis of conflicts / infringements on an aerodrome with more than two runways may be done by considering each pair of runways. Consequently, this case is covered by the two-runway configuration.

The scope of conflicts / infringements on runway in A-SMGCS Level 2 is summarised in the following table:

<table>
<thead>
<tr>
<th>Runway configuration</th>
<th>Conflicts / infringements involving a person</th>
<th>Conflicts / infringements involving a single mobile</th>
<th>Conflicts / infringements involving two mobiles</th>
<th>Conflicts / infringements involving more than two mobiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>One runway</td>
<td></td>
<td>A-SMGCS Level 2 scenarios</td>
<td></td>
<td>These scenarios are covered by considering each pair of runways.</td>
</tr>
<tr>
<td>Two runways</td>
<td>Not detected by A-SMGCS Level 2.</td>
<td></td>
<td></td>
<td>These scenarios are covered by the conflicts involving two mobiles in considering each pair of mobiles.</td>
</tr>
<tr>
<td>More than two runways</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Table 1: Scope of conflicts/infringements on runway

According to this scope, the different conflicts / infringements on runway scenarios are defined in the following sections. The different runways configurations (one or two runways) and the different mobiles configurations (a single mobile or conflicts between an aircraft and another mobile) are addressed. It is important to notice that A-SMGCS Level 2 will not address all the scenarios within the scope defined above, but only those relevant and technical feasible.

### 4.2 One Runway

#### 4.2.1 Conflicts / infringements involving a single mobile

##### 4.2.1.1 The mobile is an aircraft

The objective is to prevent aircraft from using the runway without authorisation. As the controller gives his authorisation to the aircraft by voice, A-SMGCS cannot automatically know if the aircraft is authorised or not. The only way to do it, is to manually enter each authorisation in the system. This will highly increase the controller workload, and it is not acceptable. In the future, when authorisations may be given by data-link (e.g. departure, pushback, and taxi clearances) A-SMGCS will be able to automatically use these data-link clearances to detect unauthorised incursions.

Consequently, A-SMGCS Level 2 shall not be able to detect unauthorised aircraft using the runway. Anyway, if an aircraft is using the runway without authorisation and is in conflict with another mobile, this will be detected (see section 4.2.2).

In some particular cases it is possible to detect unauthorised aircraft by using the status of the runway, for instance when the runway is closed, or when the aircraft does not respect the runway orientation.
Aircraft proceeding to a closed runway will trigger the following alerts:

Figure 3: Aircraft on runway protection area surface => INFORMATION

Figure 4: Aircraft lining-up or taking-off => ALARM

Figure 5: Arriving aircraft (< T1 from threshold) => ALARM

Figure 6: Aircraft lining-up on the centre line in the wrong direction => INFORMATION

(Aircraft arriving on the runway in the wrong direction will not trigger an alert except if another mobile is on the runway (see conflicts aircraft / mobile)).
Figure 7: Aircraft taking off in the wrong direction => ALARM

In order to avoid nuisance alerts, the runway protection area must be carefully defined when runway is also used for other purposes such as crossing runway, or taxiing.

4.2.1.2 The mobile is a vehicle

The objective is to detect vehicles entering the runway without authorisation according to the ICAO rule: “The movement of pedestrians or vehicles on the manoeuvring area shall be subject to authorization by the aerodrome control tower. Persons, including drivers of all vehicles, shall be required to obtain authorization from the aerodrome control tower before entry to the manoeuvring area. Notwithstanding such an authorization, entry to a runway or runway strip or change in the operation authorized shall be subject to a further specific authorization by the aerodrome control tower.” (Ref. 6, 7.6.3.2.1).

Prior to delivering an authorisation, the controller must identify the vehicle. In A-SMGCS Level 2, all participating vehicles (those likely to enter the manoeuvring area) are cooperative, which means able to provide their identity to A-SMGCS. As a consequence, for the system, any vehicle unable to provide its identity is considered an intruder.

4.2.1.2.1 The vehicle is not identified by A-SMGCS

Unidentified vehicles are intruders and not authorised to enter not only the runway but the whole manoeuvring area. Consequently, provided that the system makes sure that the unidentified vehicle does not correspond to a false detection, the system will trigger an alert when an unidentified vehicle enters the runway protection area. As previously, the A-SMGCS could be equipped with a predictive algorithm which issues an alert before the vehicle enters the manoeuvring area.

**Note** - The system could be enhanced by using the vehicle speed to anticipate its incursion in the runway protection area. It also could be extended to the detection of unidentified vehicles on the whole manoeuvring area.
Vehicles which have already been authorised and are temporarily unable to provide their identity for any reason (e.g. transponder break-down) will also trigger alerts that the controller will manage through R/T.

**Note** - The detection of intruders relies on non-cooperative sensors such as Surface Movement Radar (SMR). Some difficulties are encountered with the use of SMR which could generate false detection and consequently causing false alerts. It is important that A-SMGCS makes sure that the detected intruder does not correspond to a false detection before alerting the controller.

### 4.2.1.2.2 The vehicle is identified by A-SMGCS

Although the vehicle is identified, A-SMGCS doesn’t know if the vehicle is authorised or not. One way to do it, is to manually enter each authorisation in the system. This will highly increase the controller workload, and it is not acceptable. Consequently, the system will not know whether or not a vehicle is authorised and it will never alert when an unauthorised identified vehicle enters the runway or the manoeuvring area. However, in any case the conflict between a vehicle entering the runway and an aircraft will be detected (see section 4.2.2).

### 4.2.2 Conflicts / infringements involving an aircraft and another mobile

In order to trigger the appropriate alerts to the controllers, the position of the mobiles should be analysed according to the set time-parameters, their relative speeds and positions when entering the runway protection area:

- Aircraft / vehicle
- Arrival / Arrival
- Arrival / Departure
- Departure / Departure
- Including aborted takes-off and go-around

Consideration should be given to the working methods of every airport and the local parameters like reduced separations on the runway when approved by the ATS authorities.

The following scenarios are recommended for A-SMGCS Level 2. They are based on ICAO rules and experience from existing A-SMGCS. They will be assessed during the validation activities.

#### 4.2.2.1 Arriving Aircraft

If a mobile (aircraft or vehicle) is on the runway protection area surface and:

1. The arriving aircraft < T1 from threshold => INFORMATION
2. The arriving aircraft < T2 from threshold => ALARM, until the arriving aircraft has passed the mobile (mobile behind the arriving aircraft)

![Figure 9: Aircraft or vehicle on the protected area](image-url)
If there is a slower preceding departing aircraft which has not crossed the end of the runway-in-use or has not started a turn (Ref. 6 7.9.2), and:

1. The arriving aircraft $< T_1$ from threshold => INFORMATION
2. The arriving aircraft $< T_2$ from threshold => ALARM

The system could be enhanced, as some existing systems do, by using the acceleration difference between both aircraft. It will allow to predict with more accuracy if there is a risk of collision or not, and so avoid unnecessary alerts.

![Figure 10: Slower preceding departure aircraft](image1.png)

If there is a preceding arriving aircraft which has not cleared the protection area (Ref. 6 7.9.2), and:

1. The arriving aircraft $< T_1$ from threshold => INFORMATION
2. The arriving aircraft $< T_2$ from threshold => ALARM

![Figure 11: Preceding arrival aircraft not clear](image2.png)

### 4.2.2.2 Departing aircraft

If a mobile (aircraft or vehicle) is on the runway protection area surface and not behind the departing aircraft:

1. The departing aircraft is not yet taking-off (speed $< 50$ knots) => INFORMATION
2. The departing aircraft is taking-off (speed $> 50$ knots) => ALARM

![Figure 12: Mobile on the runway protected area and not behind](image3.png)
If multiple line-up is applied, the system shall trigger a ALARM, only if the departing aircraft which is behind has started its take-off and not when it is lining-up. The use of INFORMATION in this case is left to local decision.

4.3 Two Runways

The runways may be:

- Parallel:

![Parallel Runways Diagram](image1)

Figure 14: Example of parallel runways at Paris CDG airport
• Converging:

Figure 15: Example of converging runways at Frankfurt airport (18 and 07/25)

• Intersecting:

Figure 16: Example of intersecting runways at Zurich airport (10/28 and 16/34)
4.3.1 Parallel or converging runways

When operations are conducted on two parallel or converging runways, the only incursion hazard happens if one aircraft enters the protection area of the other runway while this one is engaged.

In order to avoid this situation, the A-SMGCS should analyse the position of the mobile according to the protection area of the active runway.

A design encompassing both runways in a large protection area would create too high a number of unnecessary warnings, especially when conducting simultaneous operations.

For that reason each runway will be considered with its own protection area and as a consequence two parallel or converging runways are considered as two individual runways.

At most major airports the distance between the runways centrelines is such that the runway protection areas will not overlap.

Nevertheless, in order to avoid unwanted warnings, consideration should be given to the layout of the taxiways / runways (see ICAO Annex 10) when deciding about the parameters for the ground boundaries of the runway protection areas.

The position of the mobile will be analysed according to the protection areas of both runways then depending on the mode of operations (mixed or segregated) the A-SMGCS will issue, if need be, the prediction or/and alert warnings already defined for the same configuration (landing or taking-off aircraft) for the one-runway scenarios.

In a further step, as an improvement, the analysis could be based on the predicted position of the mobile instead of its actual position.

4.3.2 Intersecting runways

As there are no standard operating procedures for simultaneous operations on intersecting runways, we will only analyse some different scenarios for non-simultaneous operations.

Although the only incursion hazard happens if one aircraft enters the protection area of the other runway while this one is engaged, unlike the previous case both runways share a common part and the controller has to be alerted if there is a risk that any two mobiles, one being an aircraft, are to be in this common part at the same time.

In order to avoid this critical situation, the A-SMGCS should analyse the position of any mobile according to the protection areas of both runways at the same time.

For that reason the protected area will encompass 3 protection areas: each runway protection area and the common part of the protection areas.

---

1 Procedures for simultaneous dependent operations on intersecting runways are applied at some airports, but they are not standard.
The A-SMGCS will analyse the position of the mobile according to each runway protection area and to the runway protection areas common part.

4.3.2.1 Same runway

If a mobile is detected in the same protection area as the one of an already engaged runway: the single runway scenario cases will apply.

E.g. aircraft on final runway 2, mobile entering runway protection area 2 or aircraft lined-up runway 1, mobile entering runway protection area 1

4.3.2.2 Different runways: not aiming at the common part

If a mobile is detected in a protection area different from the one of an already engaged runway => no warning

E.g. aircraft runway 2, mobile runway 1

4.3.2.3 Different runways: aiming at the common part

4.3.2.3.1 Arriving aircraft

If a vehicle enters the runway protection area common part and:
1. The arriving aircraft < T1 from threshold => INFORMATION
2. The arriving aircraft < T2 from threshold => ALARM

If an aircraft is lined-up on the other runway => INFORMATION
If an aircraft is taking off on the other runway => ALARM

4.3.2.3.2 Departing aircraft

If a vehicle enters the runway protection area common part and:
1. The departing aircraft is lined-up => INFORMATION
2. The departing aircraft is taking off => ALARM
   If an aircraft is lined-up on the other runway => INFORMATION
   If an aircraft is taking off on the other runway => ALARM
   In a further step, as an improvement, the analysis could be based on the predicted times of both aircraft in the runway protection area common part and a comparison of their respective position when the first one enters this part.
Chapter 5 – Restricted Area Incursions

The restricted area incursions only concern incursions by an aircraft (not vehicles) into an area where the presence of an aircraft or a vehicle is permanently or temporarily forbidden. Closed TWY, ILS, or MLS critical areas are examples of restricted areas. When closed, runways may be considered as restricted areas. The case of incursion on a closed runway is covered separately by the runway safety net (section 4.2).

The restricted areas and their associated protections used to detect incursions should be defined locally with respect to each airport particularity. However, since restricted areas incursions deal only with ground traffic, the definition of the corresponding protection areas is easier than for runways. The protection area will be composed of only a ground boundary to detect aircraft incursions and the protection area boundary will be defined by the boundary of the restricted area (closed TWY, ILS critical area, etc).

An alert will be provided to the controller when an aircraft enters a restricted area or before the entrance if a predictive algorithm is used.
CHAPTER 6 –Roles of Actors

A-SMGCS actors take part in A-SMGCS operations as a user or contributor. The roles of actors described in A-SMGCS Level 1 (Ref. 2) remain similar at Level 2, except for ATCOs, and vehicle drivers equipped with the optional guidance service as explained in the following sections.

6.1 Controller

As for Level 1, the role of the controller does not really change by the implementation of A-SMGCS Level 2, but the controller tasks evolve in the sense that the A-SMGCS control service provides the controller with a dedicated source of alert information in all visibility conditions, and the controller must apply the procedures related to each type of alert.

This new source of data complements the conflict / infringement detection performed by the controller in analysing the traffic visually or using surveillance data.

The table below summarises conflict / infringement detection in A-SMGCS:

<table>
<thead>
<tr>
<th>Visibility Conditions</th>
<th>Conflict / infringement Detection with SMGCS</th>
<th>Conflict / infringement Detection with A-SMGCS Level 1</th>
<th>Conflict / infringement Detection with A-SMGCS Level 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Analysis of traffic data:</td>
<td>Analysis of traffic data:</td>
<td>Analysis of traffic data:</td>
</tr>
<tr>
<td></td>
<td>• Visual means</td>
<td>• Surveillance Service</td>
<td>• Surveillance Service</td>
</tr>
<tr>
<td></td>
<td>• Mobiles R/T reports</td>
<td>• Visual means</td>
<td>• Visual means</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mobiles R/T reports</td>
<td>• Mobiles R/T reports</td>
</tr>
<tr>
<td>Reduced</td>
<td>Analysis of traffic data:</td>
<td>Analysis of traffic data:</td>
<td>Analysis of traffic data:</td>
</tr>
<tr>
<td></td>
<td>• Mobiles R/T reports</td>
<td>• Surveillance Service</td>
<td>• Surveillance Service</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mobiles R/T reports</td>
<td>• Mobiles R/T reports</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• A-SMGCS control service</td>
</tr>
</tbody>
</table>

Table 2: Conflict / infringement Detection for the Controller
As illustrated by the Figure 18, the traffic situation picture and the conflict / infringements detection are provided by A-SMGCS to the controller to help him performing its Control task by actions on the traffic via R/T. The controller uses the alerts to:

- Resolve conflict / infringements and give essential traffic information;
- Anticipate incursions into runways and restricted areas, and alert the mobiles;
- Anticipate risk of collision between mobiles on the runways, and alert the mobiles.

When alerted by a conflict / infringement detection, the surveillance information also provided to the controller allows him to have a good awareness and understanding of the alert situation by identifying on his screen the area of alert situation and the mobiles implicated in the alert situation. Therefore, the controller is able to quickly take the appropriate action to resolve the conflict / infringement.

Even if provided with the A-SMGCS control service, the controller shall not rely on it to detect conflicts / infringements, but shall continue the monitoring of the traffic situation to identify potential conflicts / infringements as in SMGCS or A-SMGCS Level 1 operations.

![Figure 18: ATCO role](image-url)

### 6.2 Other operators

A pre-requisite for an efficient detection of conflicts / infringements is the correct configuration of the automated tool, i.e. through the provision of the following information:

- Airport Configuration: runways in use, runways status, restricted areas, etc;
• Applied procedures and working methods: LVP, multiple line-ups.

If not automatic, the configuration of the tool providing the automatic A-SMGCS control service may be allocated to one or more operators of the ATC team.

6.3 Vehicle driver

In A-SMGCS Level 2, the vehicle driver may optionally be provided with a guidance service. The role of the vehicle driver will not really change when equipped with the guidance service. Its tasks will evolve in the sense that the guidance service will provide to the driver a new source of data about its position related to the airport layout and fixed obstacles in all visibility conditions. This new source of data will complement the usual visual observation outside the vehicle. The guidance service does not require any inputs neither from the driver, nor from the controller.

The driver will use this new information (position of its vehicle, airport map, reference points on the map, visualised on a display) for the navigation of its vehicle. For instance, when he is lost, there are no indications about its position outside, or he cannot see them because of reduced visibility conditions, he will be able to use the information provided by the guidance service to know exactly where he is on the airport platform.
CHAPTER 7 – Operational Procedures

The procedures applying in A-SMGCS Level 1 Ref. 2, remain in Level 2.

However, the introduction of the A-SMGCS control service will require new procedures defining the controller actions (acknowledgement) when the control service generated an alert.

These actions must be appropriate to each alert situation. An example of controller action when alerted by the A-SMGCS control service could be to contact by radio a mobile involved in the alert situation, using the appropriate phraseology.

Concerning the guidance service provided to the vehicle drivers, emphasis should be put on the training and licensing of the drivers. Contrary to the ATC controllers who are familiar with the use of a display in their job, the use of a display is completely new for the drivers. Consequently, new procedures could define the way to use the guidance service for vehicle drivers and the associated training and licensing activities.
CHAPTER 8 –Equipment

The aim of this section is to present the equipment required by A-SMGCS Level 2 without pre-empting any technology.

Figure 19: Surveillance and Control services

In A-SMGCS Level 2, the same equipment required for Level 1 may be used for the surveillance service. However, the A-SMGCS control service will not only use the Position and Identity of mobiles but also the speed vector and other mobile parameters if needed in order to detect the conflicts / infringements. Therefore, the cooperative surveillance sensors shall be able to collect these parameters. Moreover, enhanced performances will be required for A-SMGCS Level 2 as surveillance data will be used by the runway safety net. For instance, it will require a better accuracy for mobiles position.

The A-SMGCS control service will also use a module of conflict / infringement detection which will compute the data provided by the Data Fusion module and the traffic context to provide alerts to the controller HMI, if necessary.
CHAPTER 9 – Operational Requirements

9.1 Methodology

The methodology introduced for Level 1 is also applied for Level 2 (see Ref. 2).

9.2 Pre-requisite for A-SMGCS Level 2

All A-SMGCS Level 1 operational requirements are pre-requisite for A-SMGCS Level 2.

The following section specifies the operational requirements specific to the Control and Guidance services.

9.3 Control Service

9.3.1 Service Requirements

Op_Serv-14-Service
A-SMGCS Level 2 shall provide the control service to the users.

Op_Serv-15-Usersp
The users of the A-SMGCS control service shall be all control authorities concerned in the manoeuvring area of the aerodrome.

Op_Serv-16-Conflicts/infringements on runway
The control service shall detect the conflicts/infringements on runway:

1) Aircraft arriving to, or departing aircraft on, a closed runway;
2) Arriving or departing aircraft with traffic on the runway (including aircraft beyond the runway holding positions);
3) Arriving or departing aircraft with moving traffic to or on a converging or intersecting runway;
4) Arriving or departing aircraft with opposite direction arrival to the runway;
5) Arriving or departing aircraft with traffic crossing the runway;
6) Arriving or departing aircraft with taxiing traffic approaching the runway (predicted to cross the runway-holding position);
7) Arriving aircraft exiting runway at high speed with converging taxiway traffic;
8) Arriving aircraft with traffic in the sensitive area (when protected);
9) Aircraft exiting the runway at unintended or non-approved locations;
10) Unauthorised traffic approaching the runway, and;
11) Unidentified traffic approaching the runway;

Source: Ref. 4 3.4.5.7 (a)

Op_Serv-17-Restricted area incursions
The control service shall detect the restricted area incursions caused by an aircraft (not vehicles) into an area such as closed TWY, ILS, or MLS critical area, to be defined locally for each aerodrome.

Source: Ref. 4 3.4.5.2 and 3.4.5.11

Op_Serv-18-Runway protection area
The runway protection area shall be composed of two boundaries: A ground boundary to detect the mobiles on the surface, an air boundary to detect airborne aircraft.

Op_Serv-19-Ground boundary
The length of the ground boundary must at least include the runway strip. The width could be defined, and different, according to the meteorological conditions, e.g. Non-LVP, LVP.

As an example based on today ILS holding positions:
- In Non-LVP: ground boundary defined by Cat I holding position
- In LVP: ground boundary defined by Cat II / III holding position

This ground boundary will be used for both INFORMATION and ALARM stages.

Note: In order to avoid unnecessary INFORMATION or ALARM alerts to the controllers, current systems wait until the mobile has crossed the boundary.

Subject to further development, if the runway protection is ensured by an algorithm which could predict that a mobile is able or not to stop before entering the protection area, i.e. the ground boundary, an INFORMATION / ALARM could be generated before the mobile crosses the boundary.

Such algorithms, based on the speed and position of a mobile, may already exist but they have to be evaluated.

Op_Serv-20-Air boundary
The air boundary shall be defined as a flight time to threshold and would take into account the two stages of alert, INFORMATION and ALARM, as well as the meteorological conditions:
- Non-LVP: INFORMATION around T1 = 30", ALARM around T2 = 15"
- LVP: INFORMATION around T1 = 45", ALARM around T2 = 30"

Note - Theses times should be configurable, depending upon optimisation at the aerodrome.

Source: Ref. 4 3.4.5.12 and 3.4.5.13

Op_Serv-21-Traffic Context Update
For the Conflict/Infringement detection, additional updated and correct traffic context information shall be provided to the system as required for the detection.
Examples:
- Airport Configuration: runways in use, runways status, restricted areas,
- Applied procedures: e.g. LVP
- ATC working methods: e.g. multiple line-ups.

Source: Ref. 15

**Op_Serv-22-Alert**
The control service shall alert the users in case of conflict/infringement detection.

Source: Ref. 4 3.4.5.8

**Op_Serv-27-Stages of alert**
The control service shall provide 2 stages of alert:

The Stage 1 alert is used to inform the controller that a situation which is potentially dangerous may occur, and he/she needs to be made aware of. According to the situation, the controller receiving a stage 1 alert may take a specific action to resolve the alert if needed. This is called INFORMATION step.

The Stage 2 alert is used to inform the controller that a critical situation is developing which needs immediate action. This is called ALARM step.

**Note** - Controllers have different preferences, some of them want to be alerted only when the situation is critical (only stage 2 alerts), and others wish more anticipation (2 stages of alert). This is confirmed by the evaluations performed in the BETA project. As a consequence, some ATS providers may choose to have ALARM only, and not use INFORMATION. The choice of having several stages of alerts presented to the controller, according to the conflict / infringement, should be left to the ATS providers.

**Op_Serv-28-Alert priority**
Priorities should be established so as to ensure system logic performs efficiently. Conflict alerting priorities should be as follows:

a) Runway incursions.

b) Restricted area incursions.

Source: Ref. 4 3.4.5.10

**Op_Serv-29-Adaptation to local procedures**
In order to efficiently assist ATCO, the automated A-SMGCS control service should be configurable to adapt to local ATC procedures and working methods.

Source: Ref. 15

**Op_Serv-30-Traffic Information Update**
For the Conflict/Infringement detection, additional updated and correct traffic information shall be provided to the system such as mobiles velocity.

9.3.2 Quality of Service Requirements

**Op_Perf-15-Position Accuracy**
The allowable error in reported position used for conflict/infringement (within runway protection area) shall be consistent with the requirements set by the Control service:
7.5m at 95% level of confidence on the manoeuvring area, and;
12m at 95% level of confidence on the apron.

*Note* - The required position accuracy may be specifically defined at each airport by the ATS authority on the basis of local safety analysis.

Source: Ref. 4 2.7.1, 3.4.1.12, and 4.2.3; Ref. 7 3.2.3.2 and 3.2.4, and Ref. 15

**Op_Perf-16-Reported Velocity Accuracy**

The velocity shall be determined to the following accuracy:

- Speed: <5m/s
- Direction of movement: <10°.

*Note*

The velocity shall be determined to the following accuracy:

- Speed: <5m/s
- Direction of movement consistent with alerting algorithms

*Note* - For reported velocity accuracy, ICAO specification recommends the following values:

- Speed: +/- 1 Kt (0.5m/s)
- Direction of movement: +/-1°.

According to the performance of existing tracking systems studied in other projects these values do not seem to be achievable.

Therefore, we recommend the values required by Ref. 7, 3.2.4: <5 m/s for speed and for direction of movement consistent with alerting algorithms.

Source: Ref. 4 4.1.1.8 and 4.1.1.10; Ref. 7 3.2.4

**Op_Perf-17-Target Report Velocity Resolution**

The target report velocity resolution shall be:

- Speed: ≤0,25m/s

Source: Ref. 7 3.2.4

**Op_Perf-18-Alert latency**

The alert resulting of conflict / infringement detection shall be provided to the user well in advance within a specified time frame, to enable the appropriate remedial action with respect to:

a) Conflict / infringement prediction;

b) Conflict / infringement detection, and;

c) Conflict / infringement resolution.

Source: Ref. 4 2.5.4.4

**Op_Perf-19-Alert Continuity**

The Conflict/Infringement Alert should be displayed continuously while the conflict is detected.

Source: Ref. 4 3.4.5.14

**Op_Perf-20-False and Nuisance alert number**

The number of 3 false alerts (stage ALARM) should not be exceeded on a weekly basis.
9.4 Guidance Service for Vehicle Drivers (Optional)

9.4.1 Service Requirements

**Op_Serv-23-Service**
A-SMGCS Level 2 may optionally provide the guidance service to the users.

**Op_Serv-24-User**
The users of the guidance service shall be the vehicles drivers.

**Op_Serv-25-Display Items**
The guidance service of an A-SMGCS Level 2 shall display the following items to the user:

- Vehicle position;
- Airport layout: geographical representation of various airport areas (TWY, RWY, etc);
- Reference points: holding points, stop bars (and other airfield lighting), RWY thresholds, etc;
- Fixed obstacles;
- Other vehicle information (heading, etc), if required by the user.

**Op_Serv-26-Position**
The vehicle shall be seen in the correct position with respect to the aerodrome layout.

**Note** - It means for instance, if a mobile is on the runway, it must be seen on the runway and not outside the runway. The position accuracy is given in another requirement.

**Op_Mon-7-Equipment Status**
The operational status of all guidance service equipment shall be monitored by the system, and alerts shall be provided when the system must not be used for the intended operation.

Source: Ref. 4 2.5.1.2

**Op_Mon-8-Performance**
Monitoring of the performance of the guidance service should be provided such that operationally significant failures are detected and appropriate remedial action is initiated to restore the service or provide a reduced level of service.

Source: Ref. 4 2.7.4.3

**Op_Mon-9-Data**
The A-SMGCS shall perform a continuous validation of data provided to the user and timely alert the user when the system must not be used for the intended operation.

Source: Ref. 4 2.7.3.2
**Op_Mon-10-Back-up**
The system shall allow for a reversion to adequate back-up procedures if failures in excess of the operationally significant period occur.

Source: Ref. 4 2.7.5.3

**Op_Mon-11-System Failures**
Operationally significant failures in the system shall be clearly indicated to any affected user.

Source: Ref. 4 2.7.5.3 and 2.7.4.4

**Op_Mon-12-Failure Alerts**
All critical elements of the system should be provided with audio and visual indication of failure given in a timely manner.

Source: Ref. 4 2.6.9.3

### 9.4.2 Quality of Service Requirements

**Op_Perf-22-Position Accuracy**
For the guidance service, the allowable error in reported position shall be consistent with the requirements set by the task of the user: 12m at a confidence level of 95%.

*Note -*

For the Guidance service the position accuracy doesn’t need to be better than for surveillance service.

If the same equipment is used to provide the position both to the control and the guidance service, the position accuracy must be consistent with the Position Accuracy requirement set for the control service.

Source: Ref. 4 2.7.1.2; Ref. 7 3.2.4, and Ref. 15

**Op_Perf-23-Position Resolution**
The mobile position resolution shall be ≤1m.

Source: Ref. 7 3.2.4

**Op_Perf-24-Update rate**
Where appropriate, the update rate of the reported mobile position shall be consistent with the requirements set by the task of the driver: approximately 1 per second.

*Note -* EUROCAE and ICAO-A-SMGCS require an update rate of at least 1 per second. For example, in one second, a vehicle at 35 km/h will move of 10 metres. In that case, the position displayed to the user can differ of 10 metres from the actual position before being updated with the new reported value. If we take the maximum speed of 150 km/h (80 kt) for vehicles on the movement area, the displayed position can differ by 40 metres.

Source: Ref. 4 4.2.4, and Ref. 7 3.2.4

**Op_Perf-25-Integrity**
A-SMGCS shall preclude failures that result in erroneous data provided to the users.

Source: Ref. 4 2.7.3.1, Ref. 7 3.1.1.1

**Op_Perf-26-Reliability**
A failure of equipment shall not cause:
- A reduction in safety (fail soft), and;
- The loss of basic functions.

Source: Ref. 4 2.7.5.2, and Ref. 7 3.1.1

**Op_Perf-27-Continuity of Service 1**

An A-SMGCS shall provide a continuous service.

**Note** – The provisions of Ref. 4 are extended to vehicle drivers.

Source: Ref. 4 2.7.4.2, Ref. 7 3.1.1.2

**Op_Perf-28-Continuity of Service 2**

Any unscheduled break in continuity shall be sufficiently short or rare as not to affect the safety of mobiles.

**Note** – The provisions of Ref. 5 are extended to vehicle drivers.

Source: Ref. 4 2.7.4.2, Ref. 7 3.1.1.2

**Op_Perf-29-Recovery time**

When restarting, the recovery times of the guidance service shall be compatible with user operations (a value of 1 minute would be reasonable as a maximum).

Source: Ref. 4 2.6.9.4 and 2.7.4.4
### ANNEX 1 –Summary of Conflicts / infringements to be detected by the runway safety net

<table>
<thead>
<tr>
<th>Reference Aircraft</th>
<th>Conflicting Mobile</th>
<th>Stages of Alert</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Reference aircraft</td>
<td>Unidentified vehicle on the runway protection area</td>
<td>INFORMATION: No; ALARM: Yes</td>
</tr>
<tr>
<td></td>
<td>Aircraft proceeding to a closed runway</td>
<td>INFORMATION: No; ALARM: Departing aircraft lining-up or taking-off or arriving aircraft (&lt; T1 from threshold)</td>
</tr>
<tr>
<td></td>
<td>Aircraft on runway protection area surface</td>
<td></td>
</tr>
<tr>
<td>Arriving aircraft</td>
<td>Aircraft departing on the runway in the wrong direction</td>
<td>INFORMATION: No; ALARM: Yes</td>
</tr>
<tr>
<td></td>
<td>A mobile (aircraft or vehicle) is on the runway protection area surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arriving aircraft &lt; T1 from threshold</td>
<td>INFORMATION: Arriving aircraft &lt; T1 from threshold; ALARM: The arriving aircraft &lt; T2 from threshold, until the arriving aircraft has passed the mobile (mobile behind the arriving aircraft)</td>
</tr>
<tr>
<td></td>
<td>A slower preceding departing aircraft which has not crossed the end of the runway-in-use or has not started a turn</td>
<td>INFORMATION: Arriving aircraft &lt; T1 from threshold; ALARM: Arriving aircraft &lt; T2 from threshold</td>
</tr>
<tr>
<td>Reference Aircraft</td>
<td>Conflicting Mobile</td>
<td>Stages of Alert</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>INFORMATION</td>
</tr>
<tr>
<td>A preceding arriving aircraft which has not cleared the protection area</td>
<td>Arriving aircraft &lt; T1 from threshold</td>
<td>Arriving aircraft &lt; T2 from threshold</td>
</tr>
<tr>
<td>Departing aircraft</td>
<td>A mobile (aircraft or vehicle) is on the runway protection area surface and not behind the departing aircraft</td>
<td>Departing aircraft is not yet taking-off (speed &lt; 50 knots)</td>
</tr>
</tbody>
</table>

Table 3: Conflicts / infringements to be detected at each individual runway

<table>
<thead>
<tr>
<th>Reference Aircraft</th>
<th>Conflicting Mobile</th>
<th>INFORMATION</th>
<th>ALARM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arriving aircraft</td>
<td>an aircraft is lined-up on the other runway</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>an aircraft is taking off on the other runway</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Departing aircraft</td>
<td>an aircraft is lined-up on the other runway</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>an aircraft is taking off on the other runway</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 4: Additional conflicts / infringements to be detected when two runways are intersecting
REFERENCES

Ref. 1 EUROCONTROL definition of A-SMGCS Implementation Levels, Edition 1.2, 30/06/2010

Ref. 2 A-SMGCS Level 1 Operational Concept and Requirements, Edition 2.1, 30/06/2010


Ref. 7 EUROCAE Minimum Aviation System Performance Specifications (MASPS) for A-SMGCS (Level 1 and 2), Edition ED-87B, January 2008, including ED-87B amendment No 1 of January 2009


Ref. 9 ICAO Doc 7030 - European Supplementary Procedures, Fifth Edition 2008

Ref. 10 ICAO – Approval of a Proposal for Amendment of Regional Supplementary Procedures – Doc 7030/5 (Serial No.: EUR/NAT-S 08/08 – EUR 6-5) of 12/06/2009; and

Open Proposal for Amendment to the Regional Supplementary Procedures – Doc 7030/5 (SUPPs) (Serial No: EUR/NAT-S 08/09 – EUR 6-5) related to low visibility procedures.

Ref. 11 EUROCONTROL Airport Operations Team, A-SMGCS Concept Justification and User Requirements, AOT/10 WP3, June 2002

Ref. 12 EUROCONTROL Preliminary Safety Case for A-SMGCS Levels 1 and 2, Edition 2.1, 30/06/2010

Ref. 13 EUROCONTROL Human Factor Case for A-SMGCS Levels 1 and 2, Edition 1.2,
30/06/2010


GLOSSARY

This section provides the explanation of terms required for a correct understanding of the present document. Most of the following explanations are drawn from the A-SMGCS manual Ref. 4, the ICAO Annex 14 Ref. 5, or the EUROCAE MASPS for A-SMGCS Ref. 7 in that case it is indicated in the definition. Ref. 4 definitions are used as a first option. In general, other definitions are only used where there is no ICAO definition. If not, it is explained why another definition is preferred to the ICAO one.

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

Ref. 4 definition

Systems providing routing, guidance, surveillance and control to aircraft and affected vehicles in order to maintain movement rates under all local weather conditions within the Aerodrome Visibility Operational Level (AVOL) whilst maintaining the required level of safety.

**Aerodrome**

Ref. 4 and Ref. 5 definition

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

**Aerodrome movement**

Ref. 4 definition addresses only aircraft movement, we extended the definition to all mobiles. The movement of a mobile (aircraft or vehicle) on the movement area.

**Aerodrome Visibility Operational Level (AVOL)**

Ref. 4 definition

The minimum visibility at or above which the declared movement rate can be sustained.

**Airport authority**

Ref. 4 definition

The person(s) responsible for the operational management of the airport.

**Alert**

Ref. 4 definition

An indication of an existing or pending situation during aerodrome operations, or an indication of abnormal A-SMGCS operation, that requires attention/action.

**Alert Situation**

Ref. 7 definition

Any situation relating to aerodrome operations which has been defined as requiring particular attention or action.

Ref. 4 and Ref. 5 definition

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.

**A-SMGCS capacity**

Ref. 4 definition
The maximum number of simultaneous movements of aircraft and vehicles that the system can safely support within an acceptable delay commensurate with the runway and taxiway capacity at a particular aerodrome.

Conflict
Ref. 4 definition
A situation when there is a possibility of a collision between aircraft and/or vehicles.

Control
Ref. 4 definition
Application of measures to prevent collisions, runway incursions and to ensure safe, expeditious and efficient movement.

Cooperative mobile
“Cooperative target” Ref. 7 definition in which “target” is replaced by “mobile” (see mobile definition)
Mobile which is equipped with systems capable of automatically and continuously providing information including its identity to the A-SMGCS.
Note: as several cooperative surveillance technologies exist, a mobile is cooperative on an aerodrome only if the mobile and the aerodrome are equipped with cooperative surveillance technologies which are interoperable.

Cooperative surveillance
The surveillance of mobiles is cooperative when a sensor, named cooperative surveillance sensor, collects information about the mobiles from an active element of the transponder type which equips the mobiles. This technique allows collecting more mobile parameters than the non-cooperative surveillance, for instance the mobiles identity.
The cooperative surveillance may be:
- Either dependant on the cooperative mobile, when the mobile automatically generates the information and transmits it to the surveillance sensor, for instance via ADS-B;
- Or Non-dependant on the cooperative mobile, when the mobile is interrogated by the surveillance sensor, for instance Mode S Multilateration.

Data Fusion
Ref. 7 definition
A generic term used to describe the process of combining surveillance information from two or more sensor systems or sources.

False Alert
Ref. 7 definition
Alert which does not correspond to an actual alert situation.

Note - It is important to understand that it refers only to false alerts and does not address nuisance alerts (i.e. alerts which are correctly generated according to the rule set but are inappropriate to the desired outcome).

Guidance
Ref. 4 definition
Facilities, information and advice necessary to provide continuous, unambiguous and reliable information to pilots of aircraft and drivers of vehicles to keep their aircraft or vehicles on the surfaces and assigned routes intended for their use.

Identification
Ref. 4 definition
The correlation of a known aerodrome movement callsign with the displayed target of that mobile on the display of the surveillance system.

Identity
“Aircraft identification” Ref. 6 definition extended to all mobiles.
A group of letters, figures or a combination thereof which is either identical to, or the coded equivalent of, the mobile call sign to be used in air-ground communications, and which is used to identify the mobile in ground-ground air traffic services communications.

Incursion
Ref. 4 definition
The unauthorized entry by an aircraft, vehicle, or obstacle into the defined protected areas surrounding an active runway, taxiway, or apron.

Intruder
Any mobile which is detected in a specific airport area into which it is not allowed to enter.

Manoeuvring area
Ref. 4 and Ref. 5 definition
That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

Mobile
A mobile is either an aircraft or a vehicle.

Note - when referring to an aircraft or a vehicle, and not another obstacle, the term “Mobile” will be preferred to “Target”. The term “Target” will only be used when considering an image of a mobile or other obstacle displayed on a surveillance screen.

Modularity
Ref. 4 definition
Capability of a system to be enhanced by the addition of one or more modules to improve its technical or functional performance.

Movement area
Ref. 4, Ref. 5 and Ref. 6 definition
That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and apron(s).

Non-Cooperative mobile
“Non-cooperative target” Ref. 7 definition in which “target” is replaced by “mobile” (see mobile definition)
Mobile which is not equipped with systems capable of automatically and continuously providing information including its Identity to the A-SMGCS.

Non-Cooperative surveillance
The surveillance of mobiles is non-cooperative when a sensor, named non-cooperative surveillance sensor, detects the mobiles, without any action on their behalf. This technique allows determining the position of any mobile in the surveillance area and in particular to detect intruders. Examples of non-cooperative surveillance sensors are the Primary Surveillance Radars.

Normal Visibility
Visibility conditions sufficient for personnel of control units to exercise control over all traffic
on the basis of visual surveillance (corresponds to visibility condition 1 as defined by ICAO Ref. 4).

**Nuisance Alert**

Ref. 7 definition

Alert which is correctly generated according to the rule set but are inappropriate to the desired outcome.

**Obstacle**

Ref. 4 and Ref. 5 definition extended to all mobiles.

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

**Participating mobile**

Mobile whose identity is known by the aerodrome authority, and likely to move on airport movement areas. As illustrated in Figure 20, a participating mobile is either cooperative or non-cooperative.

![Figure 20: Types of Mobiles](image)

**Protection area**

A protection area is a virtual volume around a runway, a restricted area or a mobile. This protection area is used to detect an alert situation. For instance, an alert situation is detected when a mobile is on a runway and one or more mobiles enter the runway protection area.

**Reduced Visibility**

Visibility conditions insufficient for personnel of control units to exercise control over all traffic on the basis of visual surveillance (correspond to visibility conditions 2, 3, and 4 defined by ICAO Ref. 4).

**Restricted Area**

Aerodrome area where the presence of an aircraft or a vehicle is permanently or temporarily forbidden.

**Route**

Ref. 4 definition

A track from a defined start point to a defined endpoint on the movement area.
Ref. 4 definition
The planning and assignment of a route to individual aircraft and vehicles to provide safe, expeditious and efficient movement from its current position to its intended position.

Runway Incursion
Ref. 18 definition
Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and take off of aircraft

Stand
Ref. 4 definition
A stand is a designated area on an apron intended to be used for the parking of an aircraft.

Surveillance
Ref. 4 definition
A function of the system which provides identification and accurate positional information on aircraft, vehicles, and obstacles within the required area.

Target
Ref. 3 definition (this definition has been preferred to the Ref. 7 definition)
An aircraft, vehicle, or other obstacle, of which an image is displayed on a surveillance display.

Note - when referring to an aircraft or a vehicle, and not another obstacle, the term “Mobile” will be preferred to “Target”. The term “Target” will only be used when considering an image of a mobile or other obstacle displayed on a surveillance screen.
ABBRÉVIATIONS

ADS  Automatic Dependent Surveillance
ADS-B Automatic Dependent Surveillance Broadcast
ANSPs Air Navigation Service Provider
AMAN Arrival Manager
AOP  Airport Operations Programme
AOPG ICAO Aerodrome Operations Group
AOT  Airport Operations Team
A-SMGCS Advanced Surface Movement Guidance and Control Systems
ATC  Air Traffic Control
ATCO ATC Controller
ATM  Air Traffic Management
ATS  Air Traffic Services
ATSU Air Traffic Service Unit
AVOL Aerodrome Visibility Operational Level
CDM  Collaborative Decision Making
CFMU Central Flow Management Unit
CNS  Communication Navigation Surveillance
CS Community Specification
DMAN Departure Manager
EC European Commission
ECAC European Civil Aviation Conference
EN European Norm
ESARR Eurocontrol Safety Regulatory Requirements
ETSI European Telecommunication Standardisation Institute
EUROCAE European Organisation for Civil Aviation Equipment
FAA Federal Aviation Administration
GBAS Ground based Augmentation System
GNSS Global Navigation Satellite System
GPS Global Positioning System
HMI Human Machine Interface
ICAO International Civil Aviation Organisation
LVO Low Visibility Operations
LVP Low Visibility Procedures
MASPS Minimum Aviation System Performance Specification
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLS</td>
<td>Microwave Landing System</td>
</tr>
<tr>
<td>MOPS</td>
<td>Minimum Operational Performance Specification</td>
</tr>
<tr>
<td>Ref.</td>
<td>Reference</td>
</tr>
<tr>
<td>R/T</td>
<td>Radio Telephony</td>
</tr>
<tr>
<td>RVR</td>
<td>Runway Visual Range</td>
</tr>
<tr>
<td>SMGCS</td>
<td>Surface Movement Guidance and Control Systems</td>
</tr>
<tr>
<td>SMR</td>
<td>Surface Movement Radar</td>
</tr>
<tr>
<td>SRC</td>
<td>Safety Regulation Commission</td>
</tr>
<tr>
<td>TMA</td>
<td>Terminal Manoeuvring Area</td>
</tr>
</tbody>
</table>