EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

Validation Master Plan for A-SMGCS Implementation Level I

DSA / AOP

Edition	:	1.0
Edition Date	:	02/10/2003
Status	:	Released Issue
Class	:	General Public

EUROPEAN AIR TRAFFIC MANAGEMENT PROGRAMME

DOCUMENT IDENTIFICATION SHEET

DOCUMENT DESCRIPTION

Document Title

Validation Master Plan for A-SMGCS Implementation Level I

EWP DELIVERABLE REFERENCE NUMBER:

PROGRAMME REFERENCE INDEX:	**EDITION:**	1.0
	EDITION DATE:	02/10/2003

Abstract

Keywords

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DOCUMENT STATUS AND TYPE

STATUS		CLASSIFICATION	
Working Draft	☐	General Public	☑
Draft	☐	EATMP	☐
Proposed Issue	☐	Restricted	☐
Released Issue	☑		

ELECTRONIC BACKUP

INTERNAL REFERENCE NAME:

HOST SYSTEM	MEDIA	SOFTWARE
Microsoft Windows	Type: Hard disk	
	Media Identification:	

DOCUMENT APPROVAL

The following table identifies all management authorities that have successively approved the present issue of this document.

AUTHORITY	NAME AND SIGNATURE	DATE
A-SMGCS Project Manager	Paul Adamson	

DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION	DATE	REASON FOR CHANGE	SECTIONS PAGES AFFECTED
0.a	20/05/2003	Initial template proposed by ADVS	
0.b	28/05/2003	Template updated with CENA comments	All
0.c	24/06/2003	First draft	All
0.d	08/07/2003	Comments from Progress Meeting 1	All
0.e	23/07/2003	Inputs from CENA	7 to 9
0.f	18/08/2003	Comments from Progress Meeting 2	
0.g	21/08/2003	Comments from CENA	
1.0	02/10/2003	Released Issue	

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1. INTRODUCTION

1.1 Background

Despite implementation of SMGCS (Surface Movement Guidance and Control System) in the ECAC area, some European airports have faced severe runways incursions lately which ended up as major incidents or accidents. The increasing number of accidents and incidents on airports movement areas has now become the biggest concern in terms of airport safety.

As a consequence, EUROCONTROL recognised the need of “Improved Traffic Management on the Movement Area” through the ATM Strategy for the Years 2000+. This direction for change includes four Operational Improvements as follows:

1. Improvement of Aerodrome Control Service on the manoeuvring Area;
2. Improvement of Conflict Detection and Alert for all Traffic on the Movement Area;
3. Improvement of Planning and Routing on the Movement Area;
4. Improvement of Guidance and Control on the Movement Area.

The application of the Advanced Surface Movement Guidance and Control System concept is considered essential to achieve this objective. A-SMGCS has been considerably developed in Europe through working groups of ICAO, EUROCAE, the European Commission which launched several projects (BETA, DEFAMM,…), and major airports which are already equipped with A-SMGCS.

The approach to the implementation of the A-SMGCS technologies and the new procedures needs to be coordinated and harmonised in Europe. This coordination will make the ECAC members concentrate their efforts in aiming at the same objectives so as to faster achieve the A-SMGCS. The harmonisation will reduce the diversity of both embedded and ground equipment for A-SMGCS. It should have a considerable impact on costs. In that sense, EUROCONTROL launched the A-SMGCS project which proposes an evolutionary implementation of A-SMGCS. The successive levels of implementation form a coherent series that :

- Recognises operational needs;
- Reflects the evolution of technologies and procedures;
- Enables airports to equip according to local requirements.

The EUROCONTROL A-SMGCS project focuses on the A-SMGCS implementation levels I and II. The first phase of the project defined theses levels in terms of operational concept, procedures, and functional specification. Now, the next step is to validate all the requirements and procedures identified for A-SMGCS implementation levels I and II. The validation of the concept, requirements and procedures for A-SMGCS Implementation levels I and II will be performed in accordance with an agreed Validation Master Plan.

1.2 Scope of the document

This document aims at defining the Validation Master Plan for A-SMGCS implementation Level I. The Validation Master Plan identifies the objectives and the steps of the validation process. It provides for each step a full description (resources, timeframe, training etc.) and identifies its prerequisites.

This documents also identifies the techniques of evaluation (fast time and real time simulations, pre-operational trials at representative airports,…) to assess, demonstrate and confirm that A-SMGCS fulfil the Operational Concept with respect to the airport manoeuvring area, for all visibility conditions, times of the day and traffic densities.

At the end of the validation activity, the different documents about A-SMGCS procedures [A-SMGCS Proc], concepts [D3] and requirements [D5] developed within EUROCONTROL A-SMGCS Project will be updated according to the conclusions of the validation.

A particular emphasis is placed upon the validation of A-SMGCS related procedures, with the view to providing the data necessary to support their submission to ICAO. Once validated, the operational concepts for A-SMGCS implementation level I may be submitted to ICAO for updating the A-SMGCS manual [ICAO-A-SMGCS].

The present document only addresses A-SMGCS Implementation Level I, the Validation Master Plan for Level II is developed in [VMP II].

1.3 Methodology

To develop the Validation Master Plan, we applied the MAEVA methodology [MAEVA] which has been especially designed for this kind of exercise by the Master ATM European Validation Plan (MAEVA) project. This project is sponsored by the European Commission's Directorate General for Energy and Transport within its Fifth Framework Programme (5th FP) for research and development.

MAEVA establishes a uniform framework for the validation of ATM concepts such as A-SMGCS. This methodology is not only helpful to define a coherent Validation Master Plan but also to provide guidelines along the entire validation process. This methodology allows to ask the good questions related to validation and presents concrete examples of applications of the methodology. Its step-by-step approach helps the validation team to address the validation activity in an exhaustive way.

In the MAEVA's Validation Guideline Handbook (VGH) [MAEVA], it is proposed a five-step process for conducting validation exercises. These steps are as follows:

- Step 1: Define validation aims, objectives and hypotheses.
- Step 2: Prepare the validation plan and exercise runs.
- Step 3: Execute the exercise runs and take measurements.
- Step 4: Analyse results.
- Step 5: Develop and disseminate conclusions.

The Validation Master Plan is the result of the step 1 of the MAEVA methodology. It will allow to prepare the next validation steps from 2 to 5.

The Step 1 is devoted to obtaining an understanding of the ATM problem that needs to be solved and the operational concept to address this problem. The process related to step 1 is described Figure 1-1 provides information required for the detailed design of the exercise in step 2.

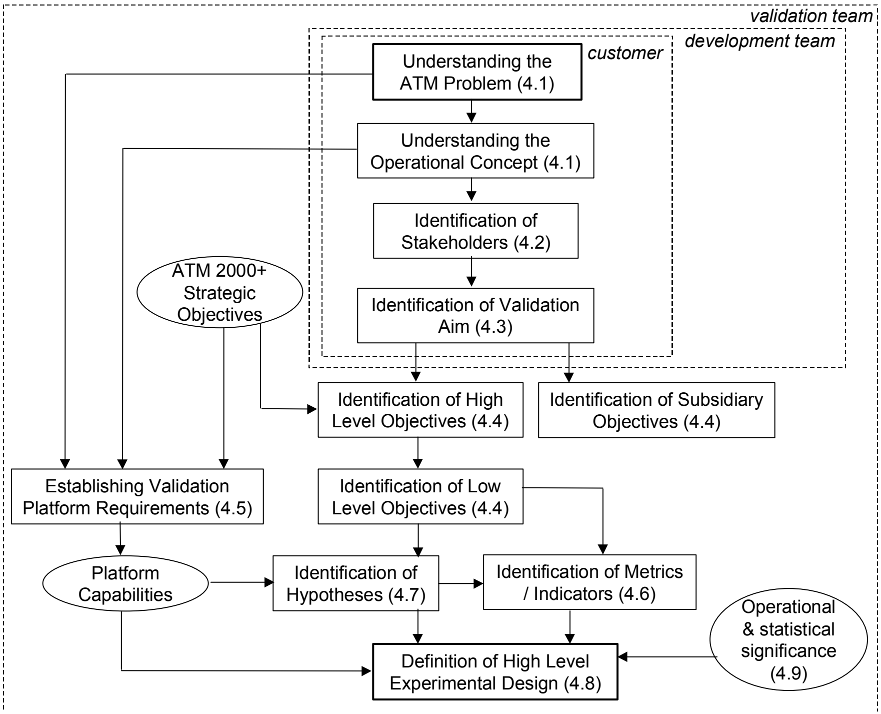

Figure 1-1 : Process Diagram for Step 1

During this step the ATM problem is decomposed into quantifiable high-level and lower level objectives. Hypotheses associated with the lower level objectives are set-up and metrics/indicators are identified, including the required measurements. This step can be seen as the requirement specification of the validation exercise; everything is known to plan and prepare the validation exercise in detail. It is an important step to prevent obtaining results that do not help evaluating whether the operational concept contributes to solving the ATM problem (garbage in, garbage out).

1.4 Structure of the document

Introduction

Describes, in Chapter 1, the purpose of this document, its structure, the reference documents and gives an explanation of terms used throughout the document.

Issues of the current situation

Are presented in chapter 2, in terms of degradation of safety, airport capacity shortfall, ATC procedures, technology deficiencies, technology cost, and aerodrome activities coordination.

Operational concept for A-SMGCS implementation level I

Describes, in chapter 3, the objectives, services, roles of actors, operational procedures, benefits, and level of maturity for A-SMGCS level I.

Identification of stakeholders

Lists, in chapter 4, the stakeholders involved in the acceptance of A-SMGCS level I.

Identification of validation aims

Describes, in chapter 5, the aims of the validation activity planned in this document.

Identification of high-level, low-level and subsidiary validation objectives

Derives, in chapter 6, the validation aims the high and low levels objectives of the validation.

Identification of metrics and indicators

Presents in chapter 7, the metrics and indicators that will be used to validate each low-level objective of the validation.

Identification of hypotheses

Described, in chapter 8, are used in the statistical techniques of validation.

Definition of high-level experimental design

Presents, in chapter 9, the different exercises of validation.

1.5 Reference Documents

[VMP II]	Validation Master Plan for A-SMGCS Implementation Level II
[MAEVA]	MAEVA Validation Guideline Handbook
[D1]	A-SMGCS Project Strategy
[D2]	Definition of A-SMGCS Implementation Levels
[D3]	A-SMGCS Level I Operational Concept and Requirements
[D4]	A-SMGCS Level II Operational Concept and Requirements

[D5]	Functional Specification for A-SMGCS Implementation Level I
[D6]	Functional Specification for A-SMGCS Implementation Level II
[A-SMGCS Proc]	Current ATC Ground Procedures & the use of A-SMGCS Surveillance Data
[ATCO Training]	Implementation of A-SMGCS – ATCO Training and Licensing Requirements.
[ATM-2000+]	EUROCONTROL Air Traffic Management Strategy for the Years 2000+, Volume 1 and 2, January 2000
[SRC]	Safety Regulation Commission, Aircraft Accidents/Incidents and ATM contribution: Review and Analysis of Historical Data, Edition 2.0, 19 October 2001.
[ICAO-A-SMGCS]	ICAO European Manual on Advanced Surface Movement Control and Guidance Systems (A-SMGCS) AOPG, Final Draft, Nov 2001
[EUROCAE-MASPS]	EUROCAE WG-41, MASPS for A-SMGCS, Edition ED-87A, January 2001
[ICAO-Annex14]	ICAO Annex 14, Volume I, Chapter 8
[ICAO-4444]	ICAO Doc 4444-RAC/501 RULES OF THE AIR AND AIR TRAFFIC SERVICES

1.6 Acronyms

ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance Broadcast
AOP	Airport Operations Unit
AOPG	ICAO Aerodrome Operations Group
AOT	Airport Operation 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
AVOL	Aerodrome Visibility Operational Level
CDG	Charles De Gaulle
CDM	Collaborative Decision Making
ECAC	European Civil Aviation Conference
ESARR	Eurocontrol Safety Regulatory Requirements
EUROCAE	European Organisation for Civil Aviation Equipment
GNSS	Global Navigation Satellite System
HMI	Human Machine Interface
ICAO	International Civil Aviation Organisation
LVP	Low Visibility Procedures

MASPS	Minimum Aviation System Performance Specification
R/T	Radio Telephony
SMGCS	Surface Movement Guidance and Control Systems
SMR	Surface Movement Radar
SRC	Safety Regulation Commission

1.7 Explanation of terms

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 [ICAO-A-SMGCS], the ICAO Annex 14 [ICAO-Annex14] or the EUROCAE MASPS for A-SMGCS [EUROCAE-MASPS], in that case it is indicated in the definition. [ICAO-A-SMGCS] 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)

[ICAO-A-SMGCS] 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

[ICAO-Annex14] and [ICAO-A-SMGCS] 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

[ICAO-A-SMGCS] definition addresses only aircraft movement, we extended the definition to all mobiles.

The movement of a mobile (aircraft or vehicle) on the movement area.

Airport authority

[ICAO-A-SMGCS] definition

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

Alert

[ICAO-A-SMGCS] 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

[EUROCAE-MASPS] definition

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

Apron

[ICAO-Annex14] and [ICAO-A-SMGCS] 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

[ICAO-A-SMGCS] 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

[ICAO-A-SMGCS] definition

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

Control

[ICAO-A-SMGCS] definition

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

Cooperative mobile

"Cooperative target" [EUROCAE-MASPS] 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 to collect 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.

False Alert

[EUROCAE-MASPS] 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

[ICAO-A-SMGCS] 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

[ICAO-A-SMGCS] 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" [ICAO-4444] 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

[ICAO-A-SMGCS] 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

[ICAO-Annex14] and [ICAO-A-SMGCS] 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.

Movement area

[ICAO-Annex14] , [ICAO-4444] and [ICAO-A-SMGCS] 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" [EUROCAE-MASPS] 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 to determine 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 (correspond to visibility condition 1 defined by ICAO [ICAO-A-SMGCS]).

Nuisance Alert

[EUROCAE-MASPS] definition

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

Obstacle

[ICAO-Annex14] and [ICAO-A-SMGCS] 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.

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 [ICAO-A-SMGCS]).

Restricted Area

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

Route

[ICAO-A-SMGCS] definition

A track from a defined start point to a defined endpoint on the movement area.

Runway Incursion

EUROCONTROL Runway Incursion Task Force definition

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

Stand

[ICAO-A-SMGCS] definition

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

Surveillance

[ICAO-A-SMGCS] definition

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

Target

[ICAO-A-SMGCS] definition (this definition has been preferred to the [EUROCAE-MASPS] definition)

An aircraft, vehicle or other obstacle, which 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.

Validation (System)

EATMP Glossary document

The process of determining whether the requirements for a system or component are complete and correct, the product of each development phase fulfil the requirements or conditions imposed by the previous phase, and the final system or component complies with specified requirements.

Verification

EATMP Glossary document

Confirmation by examination of evidence that a product, process or service fulfils specified requirements.

VIS1, VIS2, VIS3, VIS4

[ICAO-A-SMGCS] definition

VIS1, VIS2, VIS3, VIS4 are the four visibility conditions defined by ICAO in [ICAO-A-SMGCS].

2. ISSUES OF THE CURRENT SITUATION

The objective of this section is to give a clear understanding of the ATM problem that needs to be solved by the implementation of A-SMGCS. The ATM problem is already presented in the “Strategy for A-SMGCS Implementation” document [D1] by a description of the current issues in airport operations such as degradation of safety, all visibility operation, capacity optimisation, ATC procedures,… These issues are summarised hereafter.

2.1 Introduction

Despite implementation of SMGCS in the ECAC area, some European airports have faced severe runways incursions lately which ended up as major incidents or accidents. The escalating number of accidents and incidents on surface movements has now become the biggest concern in terms of airport safety. The progressive growth in traffic, the complexity of aerodrome layouts and the increasing number of operations which take place in low visibility conditions are amongst the contributing factors in the increasing number of ground incidents. The existing systems demonstrate weaknesses in coping with the present situation and the future systems should tackle the following concerns and needs.

2.2 Degradation of Safety

The Safety Regulation Commission (SRC) has recently carried out a study giving an overview of safety data, aircraft accidents and incidents that have occurred in the European Civil Aviation Conference region (ECAC) area over the last twenty years, see [SRC].

As an indicative figure, this study shows that the number of ATM related incidents collected by EUROCONTROL (referring to runway incursions) in the year 2000 were more than double the ones recorded in 1999. The doubling of reported incidents is perhaps also to be related to an increase in the incursion reporting rate (due to the implementation of ESARR2).

Safety data for the year 2001 have not yet been published, but are expected to follow the same trend, even if the 11th September events have produced a temporary decrease in traffic. This document also highlights the relative importance of accidents occurring during the taxi phase. Accidents during this phase in Western Europe and North America represent two thirds of the world-wide number of accidents.

2.3 Airport Capacity shortfall

Due to the current capacity shortfall in all the major ECAC airports, it is necessary to generates efficient flows of aircraft from/to the runway to allow optimum arrival and departure streams. By planning the traffic, it is possible to optimise aircraft routes on the airport surface, and thus make a more efficient use of the airport capacity.

Moreover, in adverse meteorological conditions, the airport capacity is decreased by the implementation of Low Visibility Procedures. Those procedures imply to reduce the number of mobiles on the manoeuvring area and to close several taxiways. Therefore, those procedures curtail the airport capacity in reducing the aircraft throughput under reduced visibility conditions.

2.4 ATC procedures

In order to cope with the increasing traffic and to enable airports to make the best use of possible capacity set up by the aerodrome infrastructure, current ATCO working practices have evolved. Those local practices such as multiple line-up or conditional clearance have not yet been standardised. Consequently, they are not always taken into account by the current SMGCS. For instance, in a multiple line-up situation cleared by the controller, some conflict detection tools generate alarms. To avoid being continually disturbed by these inappropriate alarms, controllers tend to shut down this function in order to cope with the traffic.

The new procedures should allow controllers to issue clearances and instructions on the basis of surveillance data alone. A-SMGCS will permit the implementation of these new procedures and shall be aware of them in order to generate alarms only in appropriate situations.

2.5 Technology Deficiencies

The major airports in the ECAC area comply with chapter 8.9 of [ICAO-Annex14] which mentions that SMGCS shall be installed in airports according to the traffic density, operation visibility conditions, layout complexity and ground vehicle traffic.

The most developed SMGCS in operation are currently based on a Surface Movement Radar to monitor ground traffic movements (see requirements concerning the provision of SMR [ICAO-Annex14]). This technology has presented some deficiencies (loss of the target due to masking, plot clutter due to rain or grass reflection, flight label overlap, etc.) and only a very small number of airports exploit the fusion of data from other surveillance sensors. An even smaller number benefits from flight tracking and correlation with flight plan data.

Those elements render the SMGCS surveillance function not very effective which, combined with false alarms from any associated conflict detection and alerting system, cause the ATCO to express a lack of confidence in the system.

2.6 Technology Cost

Equipment which tracks and displays non co-operative targets currently on the markets is expensive and ATM providers or airports operators tend to reserve such equipment for major airports.

Mid-size airports are usually not equipped with a SMGCS which means that controllers and pilots should prevent runways incursions using visual observations and complying with RT reports. The technology cost puts a brake on SMGCS implementation and ATM providers or airports operators expect less expensive A-SMGCS. They have high expectations in the actual experimentations, in particular concerning the average cost of marine radar as a non cooperative surveillance sensor.

2.7 Aerodrome Activities Coordination

The improvement of coordination between all aerodrome activities requires the sharing of operations data between the ATC and all airport operators. In particular, there is a need from the flight dispatch/apron control service perspective to know the availability of stands/parking areas in order to reduce taxi delays to a minimum. A better coordination between ATCOs in charge of the manoeuvring area and the apron area operators will contribute to optimising the airport resources and the flows between both areas.

3. OPERATIONAL CONCEPT FOR A-SMGCS IMPLEMENTATION LEVEL I

The growing occurrence of runway incursions combined with the relentless traffic increase, the need to improve airport activities in low visibility conditions, the emergence of new ATC procedures associated with the evolution of technology lead to the necessary improvement in the current SMGCS. This improvement sets up the Advanced SMGCS (A-SMGCS).

Aiming at coordinating and harmonising A-SMGCS implementation in Europe, EUROCONTROL defined several levels of A-SMGCS implementation. The purpose of the following sections is to describe the operational concept for A-SMGCS implementation level I, and how this concept intends to address the ATM problem describe in the previous chapter. This operational concept has been defined in [D3], and is summarised hereafter.

3.1 Objectives

The A-SMGCS level I intends primarily to enhance safety and efficiency of ground surface operations through the introduction of the surveillance service.

The main objective is to enhance ATM operations, in particular visual surveillance (performed in SMGCS) by an automated system capable of providing the same level of service in all-visibility operations.

Level I surveillance forms a pragmatic and basic first step in A-SMGCS implementation, allowing the progressive introduction of other A-SMGCS services such as Control and Guidance.

3.2 Services

At level I, A-SMGCS consists in the introduction of an automated system capable of providing airport traffic situational awareness through the automated identification and positioning of aircraft and vehicles within a predefined area of interest.

The area of interest considered at Level I is defined as follows :

- manoeuvring area for vehicles;
- movement area for aircraft.

At level I, situational awareness is provided only to ATCOs.

A-SMGCS level I will differ from an SMGCS in that it provides a surveillance service that is effective over a much wider range of visibility conditions, traffic density and aerodrome layout.

In particular, an A-SMGCS Level I should be able to assist the controller in preventing collisions between all moving aircraft and vehicles especially in conditions when visual contact cannot be maintained.

The application of A-SMGCS Level I will lead to reallocation of responsibilities for positioning the mobiles when the controller cannot establish visual contact. Less reliance is placed on the ability of the pilot or control authority to provide a visual surveillance function.

3.3 Roles of Actors

Actors take part in A-SMGCS operations as user or contributor. In A-SMGCS level I, the main actor is the controller, as user of the surveillance service. The pilots and the drivers will not be users of the system, but only contributor, and their role will be impacted by the A-SMGCS implementation. Operators will also be needed for configure the system. The role of all these actors is described in the following sections.

3.3.1 Controllers

In the SMGCS current situation, the role of ATCO is to manage aircraft and vehicles movements in the manoeuvring area with respect to safety requirements and planning constraints.

With the implementation of A-SMGCS level I, the role of the controller will evolve in the sense that the surveillance service will provide to the controller a new source of data about the traffic situation in all visibility conditions. This new source of data will complement and could even replace the usual sources of traffic data (Visual means, Mobiles R/T reports).

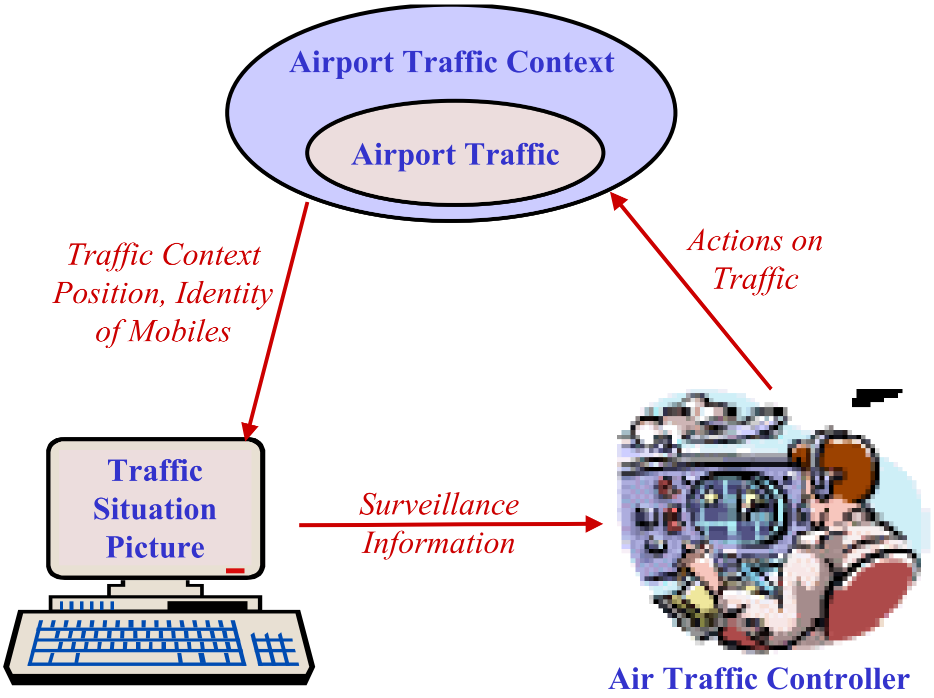

Figure 3-1 : ATCO role

As illustrated by the Figure 3-1, the traffic situation picture, containing traffic context, position and identity of the mobiles, is 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 this surveillance information as following :

- The controller analyses the global view of the traffic situation;
- The controller focuses on particular airport areas (runway for instance) or mobiles (landing aircraft for instance) requiring his attention;
- The position of all the mobiles allows the controller to detect intruders, or participating mobiles without authorisation;
- The identification of the mobile through its label allows the controller to communicate with the mobile by R/T;
- The mobiles positions with respect to airport layout help the controller to set up a traffic planning and provide guidance to the pilots / drivers;
- The controller monitors on the display that mobiles apply the clearances he issued;
- Mobile position compared with airport layout allows the controller to check the mobile is on the right way and to provide guidance to the pilot / driver;
- Mobile position compared with airport areas status allows the controller to anticipate incursions in restricted areas and to alert the mobile;
- Mobile position compared with other mobiles position allows the controller to inform the mobile on its surrounding traffic and to anticipate collisions with other mobiles and to alert the mobile;
- Information on A-SMGCS status (failures,…) which could affect safety allows the controller to apply the appropriate procedure.

3.3.2 Pilots and drivers

In the SMGCS current situation, the role of the pilot / driver is to navigate / drive his aircraft / vehicle following ATCO instructions and clearances provided through R/T, with the help of visual aids and ATCO. The use of a A-SMGCS level I by the controllers will have the following impact on the pilot / driver role :

Reduction of R/T report

Since the controller knows the position and identity of mobiles provided by A-SMGCS, it is possible that some mobile position reports not be necessary anymore. This statement has to be confirmed by the definition of the procedures related to the use of A-SMGCS.

Cooperative sensor checking

Since mobile are supposed to provide their identity through cooperative surveillance sensors (see [D3]), aircrew and drivers should check that this piece of equipment operates satisfactorily on board and should use it in the correct manner.

3.3.3 Other operators

If not automatic, one or more operators are needed to update the traffic context required by A-SMGCS, this includes :

- MET data, visibility conditions (including transition between visibility 1,2,3 and 4), …
- Airport Configuration : runway in use, open taxiways,…
- List of participating mobiles,…

The role of these operators is essential to configure the system, and provide up-to-date information to the controller.

3.4 Operational Procedures

The implementation of A-SMGCS level I requires the review of SMGCS procedures and the definition of a new set of operational procedures to be applied by ATC controllers, pilots and vehicle drivers.

In addition, procedures benefiting from A-SMGCS surveillance service are being harmonised on a European level. The activities on procedures are carried out by EUROCONTROL in close cooperation with ICAO. The following section purpose is to present the categories of procedures associated to A-SMGCS Level I.

3.4.1 Controller

The ATC ground procedures are defined in [A-SMGCS Proc]. This document aims at establishing the chronological and operational practice currently in use by Airport ATC, and how they are adapted or changed by applying future and expected A-SMGCS surveillance capability. All the procedures from the initial clearance delivery to the holding position and from clearing the runway to engine stop at the gate for arrival are described :

- Pre-departure
- Push-back, Power back and Towed-out Clearance
- Taxi Clearance
- Control of taxiway intersection
- TAXIING on the runway
- LINE-UP Procedure from threshold
- LINE UP Procedure from intersection
- MULTIPLE line up
- TAKE-OFF Clearance
- INTERSECTION Take-off clearance
- LANDING Clearance
- CONDITIONAL Clearance

The above procedures will not change in VIS 1 and VIS 2 from the present procedures (Pre-departure, push back or towed out, taxi clearance and control of taxiway intersection, taxiing on runway) in the sense that the pilot will remain in charge of visual ”separation”. The approved surveillance tool given to the controller will increase his situational awareness and decrease its workload in VIS 2 conditions but the present sharing of responsibility will remain the same.

Under VIS1 and VIS 2 conditions, as far as the flight crew is concerned the present ruling conditions "see and avoid" continue to be applied. To assume that clearances can be executed with no potential conflict on the manoeuvring area, the ATC controller can rely on the identified aircraft and vehicles positions on the surveillance display under VIS 2, as he does in VIS 1 when the traffic is visible outside.

3.4.2 Pilots

In A-SMGCS level I, there will be limited changes to pilot responsibilities. As explained in section 3.3.2, the pilot must check if the equipment operates correctly. A-SMGCS category of each airport, defining its A-SMGCS level, and the aircraft equipment required to interoperate, is expected to be determined in, for example, the aeronautical publications. Procedures will be written to describe the use of the A-SMGCS equipment in the aircraft.

3.4.3 Vehicle Drivers

In A-SMGCS level I, there will be limited changes to vehicle drivers responsibilities. The driver must check if the A-SMGCS equipment of its vehicle operates correctly in case it is equipped. Procedures will be written to describe the use of the A-SMGCS equipment in the vehicle.

3.4.4 Other procedures

- Procedures to determine the A-SMGCS category of each airport (A-SMGCS level, cooperative sensors,…). Aircraft will operate on different aerodromes, not equipped with the same kind of A-SMGCS. Therefore, to facilitate aircrew operations, A-SMGCS categories need to be defined corresponding to the implementation levels (I / II / III / IV), as well as potentially required aircraft equipment. A formal agreement that aircraft will be equipped to provide cooperative surveillance (e.g. carriage of mode S transponder) may be needed. Airport A-SMGCS category will be notified to airspace users in order to allow aircrews to anticipate provided services and applicable procedures.
- Procedures to provide A-SMGCS surveillance data to other users. Even if Collaborative Decision Making is not expected to be implemented at level I, surveillance data can be provided to other users such as airport operators, airlines, handling agencies to support them in managing their fleets.
- Procedures for users training and licensing.

3.5 Benefits

The benefits expected from implementation of A-SMGCS level I will be mainly associated with, but not limited to, safety and capacity issues at airports.

Significant improvements of aerodrome safety can be achieved under all visibility conditions through enhanced ATCO's situation awareness.

Usually airports declare 2 capacities. E.G, sample for one airport :

- Normal ARRIVAL Capacity : 70 movements / hour
- ARRIVAL Capacity in LVP : 39 movements / hour

The number of movements cannot be reduced in one shot from 70 to 39. In reality, there is a transition phase when evolving from good visibility conditions to LVP. LVP is anticipated and the capacity is progressively reduced from 70 mvt/h to 39 mvt/h. A controller provided with a surveillance service will have a better traffic situation awareness, especially when the visibility is degrading. Therefore, it could be able to better optimise the traffic and manage a maximum of movements when evolving from good visibility conditions to LVP.

A-SMGCS implementation level I will also provide a basis for aerodrome activities coordination. A-SMGCS will participate in the CDM process by sharing useful information such as position and identity of mobiles. In particular, it will help in a better coordination between ATCOs in charge of the manoeuvring area and the apron area operators in order to optimise airport resources and the flows between both areas. This is more part of the Collaborative Decision Making (CDM) concept than A-SMGCS concept, and will not be addressed in the validation activity.

A-SMGCS level I will also have to take up a technical challenge in using efficient technologies for a reasonable cost. It is essential to overcome the technology deficiencies and reduce their cost (see chapter 2), to allow the implementation of A-SMGCS in the ECAC area.

3.6 Level of maturity

A-SMGCS is currently being implemented at some major European airports such as Heathrow and Roissy. However, the functions, performances and procedures may differ from an airport to another one. EUROCONTROL intends to harmonise them, that is why they need to be validated.

It is not the objective here to favour a specific technology supporting A-SMGCS level I. However, to illustrate the operational A-SMGCS level I, here are some examples of technologies :

- One or several Surveillance Movement Radars to detect any mobile, including intruders ;
- Mode S multilateration as cooperative surveillance sensor to also collect the identity of cooperative mobiles (most of aircraft are already equipped with Mode S transponders).

Other technologies such as ADS-B / GNSS are also candidate for cooperative surveillance in A-SMGCS.

A-SMGCS level I is a mature concept. This should benefit to the validation activity addressed by the present document. The validation should concentrate its effort on which has not been validated yet.

4. IDENTIFICATION OF STAKEHOLDERS

ATM is a complex system involving many agencies, services and countries. If any change in the operational concept is to be successfully brought into operation, it is critical that all the actors who will be involved in its implementation and its use are fully committed to its success. Validation exercises are frequently used as one of the means to provide these actors with the necessary confidence in the concept.

These actors, or stakeholders, will be different according to the nature of the operational concept and its intended role. If the stakeholders are identified at an early stage in the validation exercise, and their needs considered at critical points, the eventual outcome is more likely to be acceptable and convincing to all, thereby minimising the problems for the eventual operational implementation of the concept.

The stakeholders identified in A-SMGCS implementation level I are ordered in the following table, with their respective role related to A-SMGCS level I, according to their level of involvement in A-SMGCS level I.

Stakeholders	Role related to A-SMGCS level I
Airport Air Traffic Controllers	Users of services provided by A-SMGCS.
Air Traffic Service Provider	Train Air Traffic Controllers to use services provided by A-SMGCS, provide and maintain Ground Equipment for A-SMGCS.
Pilots	Actors that are part of the system
Vehicle drivers	Actors that are part of the system
Other A-SMGCS Operators	Actors that are part of the system
Airlines	Train aircrew. Equip and Operates aircraft
Airport Operators	Train vehicle drivers. Equip and Operates vehicles
Population living in the vicinity of airports	Impacted by aircraft noise and gaseous emissions.
EUROCONTROL	Coordinate and harmonise implementation of A-SMGCS technologies and the associated procedures in Europe.

Table 1 – Role of Stakeholders

The ATM Problem and performance shortfalls will be understood and judged differently according to these viewpoints, so it is important that these are all taken into account in setting the aims of the validation exercise. This can be presented in a table giving for each stakeholder its acceptance / rejection criteria.

Stakeholders	Acceptance / rejection criteria
Airport Air Traffic Controllers	Usable HMI, compatible with other ATCO tools Confidence in information provided on the HMI Workload remains acceptable Relevance of notifications of degraded mode
Air Traffic Service Provider	Feasibility of equipment integration in existing ground systems Cost of equipment Cost of maintenance Cost of ATCO training Gains in safety Increased ground movement throughput
Pilots	Simple, well defined, harmonised procedures Workload remains acceptable Gains in safety
Vehicle drivers	Simple, well defined, harmonised procedures Workload remains acceptable Gains in safety
Other A-SMGCS Operators	Simple, well defined, harmonised procedures Workload remains acceptable
Airlines	Cost of aircraft equipment Cost of maintenance Gains in safety Cost / Time savings
Airport Operators	Feasibility of equipment integration in vehicles Cost of vehicles equipment Cost of maintenance Gains in safety Cost / Time savings
Population living in the vicinity of airports	Aircraft noise Gaseous emissions
EUROCONTROL	Validation of A-SMGCS concept (procedures + operational requirements)

Table 2 – Stakeholders Acceptance / rejection criteria

As a conclusion, Identification of Stakeholders is necessary to ensure that all parties relevant to the validation of the A-SMGCS concept are known so that they can provide information and develop confidence in the proposed A-SMGCS concept in meeting the operational needs.

5. IDENTIFICATION OF VALIDATION AIMS

The ATM Problem, the Operational Concept and the Stakeholders, described in the previous chapter, will set the context for the Identification of Validation Aims. The purpose of this activity is to clarify what is to be achieved from the validation exercise.

The validation aim is an unambiguous, qualitative definition of what is to be achieved through the conduct of the validation exercise. In the context of A-SMGCS validation, it is to provide information that demonstrates the feasibility of the operational concept and that the concept provides a solution to the specific ATM problem.

Before starting any validation exercise, the aim has to be clearly understood, agreed and stated unambiguously. It will reduce the risk that the validation exercise will not deliver what was expected.

The validation aims are to assess, demonstrate and confirm the :

- Ability of the technical system to fulfil the Operational Concept for A-SMGCS level I ;
- Ability of the procedures to fulfil the Operational Concept for A-SMGCS level I ;
- Ability of the A-SMGCS Operational Concept to efficiently address the issues of the current situation.

Validation will be with respect to the airport manoeuvring area, for all visibility conditions, times of the day, aerodrome layouts and traffic densities.

EUROCONTROL also planned to perform a common Safety / Human Factors Case for A-SMGCS implementation levels I and II. This activity is out of the scope of the present document but linked to the Validation results. Indeed, the results of the simulations and operational trials performed in the frame of the validation activity should feed the Safety / Human Factors Case.

6. IDENTIFICATION OF HIGH-LEVEL, LOW-LEVEL AND SUBSIDIARY VALIDATION OBJECTIVES

6.1 Introduction

The purpose of this activity is to convert the Validation Aims, couched in qualitative terms, into quantitative objectives that can be measured in a validation exercise.

From the validation aims defined in the previous chapter, high-level objectives may be derived. Related to these strategic objectives are questions that contribute to the validation aim. A question related to "safety" could be for example "will the new operational concept reduce safety?".

Since it usually proves difficult to answer these questions immediately, lower level objectives need to be derived. The lowest level objectives need to be parameters that can be measured using a known technique. This may mean that more than one detailing step is required. The decomposition should continue until the lowest level objectives are measurable and related to elementary ATM items. This is when feasible metrics and indicators can be identified (defined in chapter 0).

Through this, the objectives of the validation exercises will be clearly defined and the parameters to be measured, that will address the high-level objectives, will be specified. This is illustrated in the following figure :

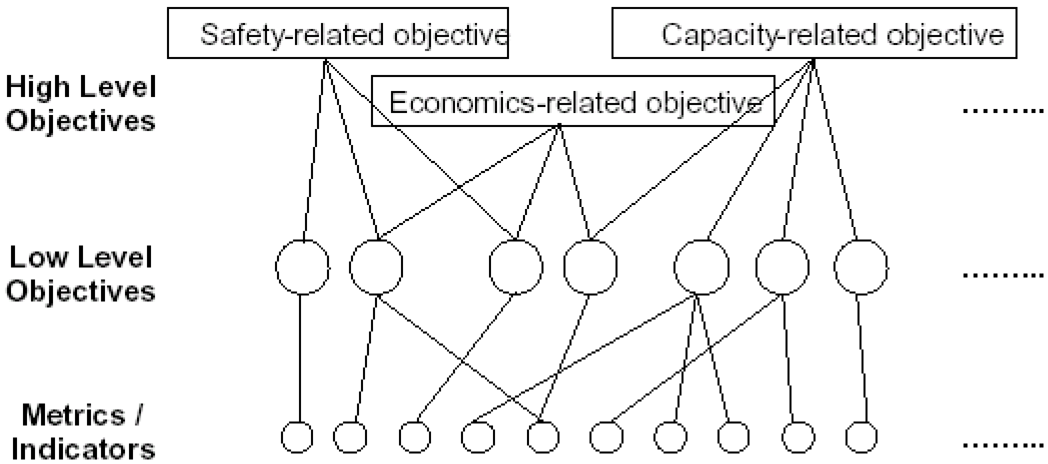

Figure 6-1 : Relationship between Higher Level Objectives, Lower Level Objectives and Metrics/Indicators

This activity aims at providing a structured hierarchy of objectives for A-SMGCS level I validation. These objectives are presented in the following sections.

6.2 High-level objectives of the validation process

The high-level objectives of the validation process could be grouped in three categories:

- Feasibility

- Benefits
- Cost efficiency

6.2.1 Feasibility

The validation process will demonstrate the feasibility of A-SMGCS Implementation Level I. Both technical and human aspects of the feasibility will be assessed. The validation will confirm that A-SMGCS level I correctly works according to the operational and functional requirements.

The feasibility of the integration of A-SMGCS level I in existing ATC systems, vehicles and aircraft has already been demonstrated at operational airport platform such as Heathrow or Roissy airports. Therefore, it will not be an objective of the validation, but simply verified.

The Human Factors (procedures, workload, training, situational awareness etc. for controllers) will be evaluated to ensure that the A-SMGCS services are acceptable by the users : ATCOs. Other A-SMGCS actors (pilots, and vehicles drivers) have a minor contribution to A-SMGCS level I, thus it does not seem necessary to evaluate their human factors. It is out of the scope of the present validation activity.

A particular emphasis will be placed upon the validation of A-SMGCS related procedures, with the view to providing the data necessary to support their submission to ICAO. Therefore, the validation will confirm the ability of the system and the procedures to fulfil the A-SMGCS Operational Concept.

Technical feasibility :

- To validate the functional requirements
- To validate the operational requirements

Human Factors :

- To validate the controller procedures (including training,…)
- To assess acceptance from actors

6.2.2 Benefits

The validation shall not only demonstrate that A-SMGCS works, but also it brings benefits. The strategic objectives of the A-SMGCS are to optimise the airport capacity in maintaining or even increasing safety of operations, minimizing the costs and the impact on environment.

6.2.2.1 Safety

The objective is to minimise the air navigation services' contribution to the risk of an aircraft accident as far as it is reasonably practicable. The target will be to improve safety levels by ensuring that ATM induced accident and incident rates do not increase and, wherever possible, will even decrease. It will be achieved through the assessment and mitigation of the risks associated with the introduction of changes in technology and operations.

The improvement of safety could be monitored by the occurrence of runway incursions which is, by far, the most dangerous and hazardous situations for airplanes and passengers. The occurrence of runway incursions represents an efficient and reliable key performance indicator for ground safety management.

6.2.2.2 Capacity

As stated in the EUROCONTROL ATM 2000+ Strategy [ATM-2000+], capacity is a complex mix of access to airports, airspace and services, predictability of schedules, flexibility of operations, flight efficiency, delay and network effects. The strategic objective regarding airport capacity is stated so as to enable airports to make the best use of possible airside and landside capacity, as determined by the infrastructure in place, political/environmental restrictions and the economic response to the traffic demand.

The measurement of airport delay due to ground taxiing and operations, especially during reduced visibility conditions, will constitute an efficient key performance indicator of the A-SMGCS impact on capacity.

6.2.2.3 Environment

The steady growth in air travel demand leads to more intense aircraft operations at and around airports, where they are most noticeable to the public. Even though aircraft have become less noisy over the past two decades, the compounded effects of more movements over longer periods of the day and night have increased the disturbance. This has fuelled the resistance in the population living in the vicinity of an airport to further expansion of the facility and its operations.

At the same time there is greater awareness of citizen's rights and political influence through action groups. This trend is expected to become stronger in the near future. At a local level, this may turn into a volatile mix bearing a substantial risk for the sustainability of further airport expansion and traffic growth. If not handled with political skill, great care, courage and sincerity, the environmental factor will stand in the way of further growth until the advent of newer and quieter aircraft/engine combinations. It is important in this context that airports actively address the environmental issue before it becomes a real problem. Once the confidence and goodwill of those living within the vicinity of the airport have been lost it will take a long and costly battle to restore them. The environmental protection requirements are expected to become the most important constraint to the further growth of commercial aviation.

The strategic objective is to sustain the expansion of airport airside capacity despite more stringent environmental requirements through :

a) new technology application;

b) improved procedures;

c) better utilisation of improved aircraft operational capabilities.

A-SMGCS will contribute to attaining the overall environmental target. The surveillance service provided to ATCO by A-SMGCS level I should help him to optimise each ground movement. This will participate to mitigate the environmental impact of noise and gaseous emissions per aircraft operation at and around airports. The key performance indicators shall be, for instance, the average taxiing time and the average holding time.

6.2.3 Economics/Cost-effectiveness

It is not enough to demonstrate the benefits of the A-SMGCS, its implementation will only be performed if its cost is acceptable. The economic strategic objective is to minimise the direct and indirect airport and mobile A-SMGCS-related costs per aircraft operation. In particular, it means that each airport will not implement the same A-SMGCS in terms of cost according to the number of aircraft operations. The cost-effectiveness is the ability to provide an agreed level of service at the least cost over the long term, given safety and environmental constraints. The coordination and harmonisation of the A-SMGCS implementation in Europe will contribute to its cost-effectiveness.

However, the cost analysis is out of the scope of the validation activity addressed in the present document. The results of such a study rely on each aerodrome specificities. Therefore, ATS providers have the responsibility to perform a cost assessment and balance it against the expected benefits before implementing A-SMGCS level I at each airport.

6.3 Low-level objectives of the validation process

6.3.1 Technical feasibility

6.3.1.1 To validate functional requirements

The functions and associated functional requirements defined in [D5] shall be validated.

Each functional requirement should be derived in low level validation objectives in order to determine the metrics / indicators to be measured in order to validate the requirement.

This activity is obvious for performance requirements. For instance, for the “Fn_Perf-10-Response Time to Operator Input” requirement, the metric to be measured will be the Response Time to Operator Input, and it shall be demonstrated that the value required (250ms) is achieved.

This is less trivial for other types of requirements. For instance, for a “pure” functional requirement such as “Fn-16-Display Airport traffic situation : This function shall display the complete airport traffic situation.”, it shall be verified that the function “Interface with user” displays all the elements of the airport traffic situation.

For each functional requirement, the metrics / indicators will be determined when preparing the validation exercise(s) addressing the validation of functional requirements.

6.3.1.2 To validate operational requirements

The operational requirements defined in [D3] shall be validated. The operational requirements are broken down into the following categories :

Operational Requirements Categories	Definitions	Abbreviations Op_
Services	They define the services to be provided to the users	Serv

requirements		
Operational range	These requirements define the operational range covered by the systems, they fix the operational limits of the system	Range
Responsibilities	Requirements related to assignment of responsibilities when using A-SMGCS	Resp
Interfaces	Requirements related to interfaces between A-SMGCS and users or other systems	If
Performances	These requirements define the performances to be fulfilled by A-SMGCS at an operational level	Perf
Monitoring	Requirements related to monitoring of A-SMGCS equipment, Quality of Service, Performances,…	Mon
Environmental constraints	Requirements related to interference between A-SMGCS and its environment	Env
Design	They are not "pure" operational requirements but more general principles on system design	Ds
System evolution	They are not "pure" operational requirements but more general principles on future evolutions of the system	Evo

Table 6-1: Categories of Operational Requirements

Each operational requirement should be derived in low level validation objectives in order to determine the metrics / indicators to be measured in order to validate the requirement. This activity is obvious for performance requirements. For instance, for the "Op_Perf-05-Position Accuracy" requirement, the metric to be measured will be the position accuracy, and it shall be demonstrated that the value required (12m) is achieved. This is less trivial for other types of operational requirements. For each one, the metrics / indicators will be determined when preparing the validation exercise(s) addressing the validation of operational requirements.

The operational requirements rely on assumptions which will also have to be validated.

6.3.2 Human Factors

6.3.2.1 To validate the ATC ground procedures

The ATC ground procedures defined in [A-SMGCS Proc] shall be validated. These procedures will be applied during representative scenarios in order to check whether they are applicable and safe. Each procedure will be tested separately and through sequences of procedures for representative aircraft movement scenarios (e.g. a typical arrival from approach to gate and a typical departure from gate to take-off). These procedures are very sensitive to visibility conditions and thus will have to be assessed during all visibility conditions.

Possibly these procedures could be improved. This will be also assessed. In particular, procedures such as line up from intersection, multiple line up, and conditional clearance could be less constrained in their applications. For instance, it will give the opportunity to go through the constraint of "visual observation" imposed by ICAO DOC4444 7.1.1.2.

Moreover, the impact of A-SMGCS breakdown on procedures will be assessed. During validation and in particular under reduced visibility conditions, it will be observed how the ATCO manage the transition period from a situation when using the A-SMGCS surveillance service to a situation when this service is not available anymore.

6.3.2.2 To validate the training and licensing procedures

Procedures for A-SMGCS actors training and users licensing will have to be written before the validation activity in order to be validated. Concerning the controller, these procedures will be based on the requirements described in [ATCO Training].

6.3.2.3 To verify acceptance from ATCO

To verify acceptance from ATCO, the ATCO participating to the validation will be provided with an efficient and usable Human Machine Interface (HMI). This is a prerequisite to :

- To verify the procedures are acceptable ;
- To verify the workload decreases or remains acceptable ;
- To asses the transition between VIS1 to VIS2 ;
- To assess other negative effects of A-SMGCS equipment on ATCO.

6.3.3 Safety

6.3.3.1 To assess the improvement of ATCO's Situational Awareness

The A-SMGCS aptitude of displaying on a screen the exact picture of the ground traffic provides the ground controller with an accurate traffic situation. This capability enhances the controller's situation awareness and improves overall ATC safety.

In normal visibility conditions, the A-SMGCS can be used as a backup to what the ground controller sees from the tower window. It allows the ground controller to spot more easily the vehicles which could sometimes be difficult to detect with the naked eye especially when the taxiway and runway layouts are very intricate.

In reduced visibility conditions, the use of a A-SMGCS allows the ground controller to provide the same quality of control as in normal visibility conditions.

6.3.3.2 To assess the reduction of the number of incidents on the manoeuvring area

There are reported cases of reduced visibility conditions during which collisions between aircraft and vehicles were or could have been prevented thanks to the use of an A-SMGCS.

The most frequently quoted incidents related to reduced visibility conditions are :

- Planes backtracking or crossing on a runway (without informing air traffic control) when others are cleared to land or takeoff,
- Aircraft and airport service vehicles lost on the runways, thus requiring the airport to close down for a time,
- Runway confusion by the pilots,

- Runway vehicle intrusion as a result of a mistake or a control misunderstanding.

6.3.4 Capacity

A controller provided with a surveillance service will have a better traffic situation awareness, especially when the visibility is degrading. Therefore, it could be able to better optimise the traffic and manage a maximum of movements when evolving from good visibility conditions to LVP.

6.3.4.1 To assess whether each control unit can take in charge a greater number of aircraft

Under specific circumstances, mainly when the ground controller encounters difficulties in establishing visual contact (night, degrading visibility conditions, hidden areas, etc.) with taxiing aircraft, the use of an A-SMGCS allows the ground controller to track aircraft on the manoeuvring area. This increases controllers' awareness of traffic situation and consequently allows them to handle more aircraft.

6.3.4.2 To assess aircraft delay reduction, diversion avoidance

For a fixed demand from the airlines, the provision of extra capacity brings about a reduction in total delays. This reduction of total delays would be particularly substantial in reduced visibility conditions during which ATC capacity is curbed. In some cases, it could even prevent some aircraft from flying in holding patterns and would thus reduce the risk of diversion.

6.3.5 Environment

The aircraft operations at airport impact the environment through noise and gaseous emissions. A-SMGCS level I is expected to contribute to reduce this environmental impact. This will be assessed during the validation activity :

6.3.5.1 To assess the reduction of noise impact on environment

The surveillance service provided to ATCO by A-SMGCS level I should help him to optimise each ground movement and reduce the traffic congestions especially when the visibility conditions are degrading. Therefore, each aircraft is expected to spend less time on the airport platform with its engines on, and thus reducing its noise impact.

6.3.5.2 To assess the reduction of gaseous emissions

As for noise, each aircraft being expected to spend less time on the airport platform and on holding paths with its engines on, the gas emissions per aircraft operation are supposed to be reduced.

7. IDENTIFICATION OF METRICS AND INDICATORS

The purpose of this activity is to convert the low level objectives defined in section 6.3 into metrics and indicators that can be measured on a validation platform. For each validation objective, a set of relevant metrics is established. For each metric, it is interesting to qualify it by attributes:

- <u>Objective metrics</u>: relate directly to the performance of the A-SMGCS system, or part of it. They are derived from measurements.
- Or <u>Subjective metrics</u>: Opinion requested and response based on subjective viewpoint of the data provider.
- <u>Quantitative</u>: numerically expressed values.
- Or <u>Qualitative</u>: text based descriptions or opinions (e.g. opinion about perceived workload).

For each validation objectives, the metrics are presented in the following table.

High level objectives	Low-level objectives	Metrics / Indicators	Attributes
To validate functional requirements	For each requirement, the low level objectives and metrics / indicators will be determined when preparing the validation exercise(s) addressing the validation of functional requirements. For instance, for a performance requirement, the metric is the associated performance parameter.		
To validate operational requirements			
To validate the procedures	To validate the ATC ground procedures	Metrics to validate procedures cannot be identified at this stage. The procedures have firstly to be written and then tested during operational scenarios.	
	To validate the other operators procedures		
	To validate the training and licensing procedures		

High level objectives	Low-level objectives	Metrics / Indicators	Attributes
To verify acceptance from ATCO	To verify the procedures are acceptable	Verbal description on what the participant do and why (after exercise) Opinion requested after the exercise	Subjective, Qualitative
	To verify the workload decreases or remains acceptable	Measured User Workload Global feeling of workload Communications Time on R/T for each aircraft	Objective, Quantitative Subjective, Qualitative Objective, Quantitative
	To assess other negative effects of A-SMGCS equipment on ATCO	Questionnaire about other negative effects	Subjective, Qualitative
To assess the benefits in terms of safety	To assess the improvement of ATCO's Situational Awareness	User feeling on his situational awareness	Subjective, Qualitative
	To assess the reduction of the number of incidents on the manoeuvring area	Number of incidents on the manoeuvring area	Objective, Quantitative
To assess the benefits in terms of capacity	To assess whether each control unit can take in charge a greater number of aircraft	Maximum number of aircraft taken in charge by a control unit during reduced visibility conditions Maximum number of aircraft taken in charge by a control unit during good visibility conditions Number of Aircraft movements at peak hours Peak hour demand realised / Scheduled peak hour capacity	Objective, Quantitative Objective, Quantitative Objective, Quantitative Objective, Quantitative
	To assess aircraft delay reduction, diversion avoidance	ATC delay (only Departure?) per aircraft Holding time per aircraft Number of diversions	Objective, Quantitative Objective, Quantitative Objective, Quantitative
To assess the benefits in terms of environment	To assess the reduction of noise impact on environment	Holding time / optimum holding time (%)	Objective, Quantitative
	To assess the reduction of gaseous emissions	Holding time / optimum holding time (%) Taxi time / optimum taxi time (%)	Objective, Quantitative Objective, Quantitative

Figure 7-1 : Metrics and Indicators

8. IDENTIFICATION OF HYPOTHESES

The purpose of this activity is to convert the low-level objectives into a rigorous mathematical framework that can be tested using statistical techniques.

The effect of introducing the A-SMGCS application and the operational procedures they support will be examined in the context of the exercise 2 (section 9.3) by comparing a Baseline organisation (SMGCS environment) with the Advanced organisation (A-SMGCS environment) in different visibility conditions.

8.1 Statistical analysis aims

Statistical analysis embodies both descriptive and inferential statistics:

- o Descriptive statistics enables to describe the gathered measurements by their average, variance, with the help of graphs and histograms.
- o Inferential statistics enables to draw conclusion about a large group of subjects on the basis of measurements from a small sample.

Inferential statistics enable to draw conclusion with a specified level of confidence, that a particular measurement made under the baseline experimental conditions really differs from a measurement made under the advanced experimental conditions.

This confidence level relates to the fact that there is always the possibility that a difference between the measurements simply occurred by chance. Hence, conclusions are stated with an associated probability. This is the probability that the observed difference between the measurements of the two systems would have occurred by chance if there was, in reality, no difference between the systems. The level of statistical significance chosen for each test will be set at $p < 5\%$, as usually accepted in the ATM validation community.

Formally, the statement that there is no statistically significant difference between two sets of measurements is stated as a « null hypothesis » (H0). An « alternative hypothesis » (H1) describes a contradiction of the null hypothesis, i.e. that there is a statistically significant difference between the two sets of measurements. The process of statistical inference either accepts the null hypothesis or rejects it in favour of the alternative hypothesis.

The effect of introducing the A-SMGCS application and related procedures will be examined by comparing Baseline environment with Advanced (Adv.) environment in different visibility conditions (visibility conditions 1,2 and 3)[1].

The effect of different visibility conditions will be examined by comparing Advanced V1 (visibility 1) vs. Advanced V2 (visibility 2) vs. Advanced V3 (visibility 3) environments. This further comparison between different visibility conditions into the Advanced environment aims to refine results obtained through the first set of hypotheses (comparing Baseline environment with Advanced environment).

[1] Four visibility conditions have been defined by ICAO. However, as the fourth one correspond to a situation in which control and mobiles movements are no more possible, only the first three visibility conditions will be simulated.

The low-level objectives studied below are those allowing to measure potential difference between Baseline and Advanced environments. It excludes low-level objectives such as technical feasibility, other operators procedures and training and licensing procedures.

8.2 Human Factors Investigation

- Does the A-SMGCS application decrease ATCOs' workload (per aircraft) or remain acceptable ?
- Are the procedures related to the use of A-SMGCS application acceptable (appropriate) for ATCOs ?

In order to examine the controller workload, subjective and objective measurements will be conducted. The following null hypotheses (H0) will be stated to statistically test the data, using data pooled across controller rotation and traffic volumes. H1 refers to the alternative hypothesis which will be accepted if the H0 is rejected.

8.2.1 Workload

Baseline vs. Adv.

- H0 : There is no difference of workload between the Baseline and the Advanced environments.
- H1 : The workload is different as an effect of introducing the A-SMGCS application and related procedures.

Adv. (V1) vs. Adv. (V2) vs. Adv. (V3)

- H0 : There is no difference of workload between different visibility conditions.
- H1 : Workload is different, depending on visibility conditions.

The statistical tests will be applied separately for low, medium and high traffic load for each of the workload measurements described in Chapter 7. Separate analyses will be conducted for each controller working position.

8.2.2 Acceptance of procedures

The hypotheses of acceptance will apply to the distributions of controller responses to the individual questionnaire items. For each item, the following hypotheses will be tested:

Baseline vs. Adv.

- H0 : There is no difference in the frequency of positive and negative controller responses between the Baseline and the Advanced environments.
- H1 : There is a difference in the frequency of positive and negative controller responses.

Adv. (V1) vs. Adv. (V2) vs. Adv. (V3)

- H0 : There is no difference in the frequency of positive and negative controller responses between different visibility conditions.

- H1 : The frequency of positive and negative controller responses is different, depending on visibility conditions.

The test will be applied using the subjective indicators of acceptance of procedures as described in Chapter 7.

8.3 Safety Investigation

- o Does the aptitude of A-SMGCS application to provide an accurate traffic situation enhance the ATCOs' situation awareness ?
- o Does the use of A-SMGCS application induce a significant reduction of number of incidents on the manoeuvring area ?

The following set of hypotheses will be tested, using data pooled across the controller rotation and the traffic volumes.

8.3.1 ATCOs' situation awareness

Baseline vs. Adv.

- H0 : There is no difference in terms of ATCOs' situation awareness between the Baseline and the Advanced environments.
- H1 : The ATCOs' situation awareness is different as an effect of introducing the A-SMGCS application and the related procedures.

Adv. (V1) vs. Adv. (V2) vs. Adv. (V3)

- H0 : There is no difference of ATCOs' situation awareness between different visibility conditions.
- H1 : ATCOs' situation awareness is different, depending on visibility conditions.

The tests will be applied using the subjective and objective indicators of situation awareness as described in Chapter 7.

8.3.2 Incidents on the manoeuvring area

Baseline vs. Adv.

- H0 : There is no difference in terms of number of incidents on the manoeuvring area between the Baseline and the Advanced environments.
- H1 : The number of incidents on the manoeuvring area is different as an effect of introducing the A-SMGCS application and the related procedures.

Adv. (V1) vs. Adv. (V2) vs. Adv. (V3)

- H0 : There is no difference of number of incidents between different visibility conditions.
- H1 : The number of incidents is different, depending on visibility conditions.

The statistical tests will be applied in the same way on low, medium and high traffic load for the objective indicators described in Chapter 7.

8.4 Capacity Investigation

- o Does the use of A-SMGCS application allow the airport to maintain throughput in all visibility conditions ?
    - Can each control unit take in charge a greater number of a/c without discomfort or impairing safety due to the A-SMGCS environment and concept ?
- o Does the use of A-SMGCS application induce a significant reduction of total delays (particularly in reduced visibility conditions) ?

First, the capacity measures of each organisation within the same traffic sample and controller will be compared. The following null hypotheses (H0) will be stated to test statistically the capacity data, using data pooled across the controller rotation and the traffic volumes. H1 refers to the alternative hypothesis which will be accepted if the H0 is rejected.

8.4.1 Airport throughput

Baseline vs. Adv.

- H0 : There is no difference in terms of airport throughput between the Baseline and the Advanced environments.
- H1 : The airport throughput is different as an effect of introducing the A-SMGCS application and related procedures.

Adv. (V1) vs. Adv. (V2) vs. Adv. (V3)

- H0 : There is no difference of airport throughput between different visibility conditions.
- H1 : Airport throughput is different, depending on visibility conditions.

The statistical tests will be applied in the same way on medium and high traffic load for the objective indicators described in Chapter 7.

8.4.2 Delays

Baseline vs. Adv.

- H0 : There is no difference in terms of total delays between the Baseline and the Advanced environments.
- H1 : Total delays are different as an effect of introducing the A-SMGCS application and related procedures.

Adv. (V1) vs. Adv. (V2) vs. Adv. (V3)

- H0 : There is no difference of total delays between different visibility conditions.
- H1 : Total delays are different, depending on visibility conditions.

The statistical tests will be applied in the same way on medium and high traffic load for the objective indicators described in Chapter 7.

8.5 Environment Investigation

- o Does the use of A-SMGCS application induce a significant reduction of noise impact on environment ?
- o Does the use of A-SMGCS application induce a significant reduction of gaseous emissions at and around the airport ?

The following set of hypotheses will be tested, using data pooled across the controller rotation and the traffic volumes.

8.5.1 Noise impact

Baseline vs. Adv.

- H0 : There is no difference in terms of noise impact on environment between the Baseline and the Advanced environments.
- H1 : The noise impact on environment is different as an effect of introducing the A-SMGCS application and the related procedures.

Adv. (V1) vs. Adv. (V2) vs. Adv. (V3)

- H0 : There is no difference of noise impact on environment between different visibility conditions.
- H1 : Noise impact on environment is different, depending on visibility conditions.

The tests will be applied using the objective indicators of noise impact as described in Chapter 7.

8.5.2 Gaseous emissions

Baseline vs. Adv.

- H0 : There is no difference in terms of gaseous emissions between the Baseline and the Advanced environments.
- H1 : Gaseous emissions are different as an effect of introducing the A-SMGCS application and the related procedures.

Adv. (V1) vs. Adv. (V2) vs. Adv. (V3)

- H0 : There is no difference of gaseous emissions between different visibility conditions.
- H1 : Gaseous emissions are different, depending on visibility conditions.

The tests will be applied using the objective indicators of gaseous emissions as described in Chapter 7.

9. DEFINITION OF HIGH-LEVEL EXPERIMENTAL DESIGN

This step identifies the evaluation exercises and validation environments required to validate A-SMGCS level I.

9.1 Validation techniques

This section justifies the choice of the validation techniques and of a coherent set of validation exercises which should offer a quite complete coverage of all the validation objectives.

It is deemed obvious that validation of operational requirements requires shadow mode trials or live trials in a real operational environment. On the other hand, an assessment of overall efficiency of the procedures should benefit from real-time human-in-the-loop simulations.

9.2 Validation exercises

Three validation exercises are proposed, comprising a fast-time simulation, a real-time simulation and an operational trial. These exercises can be carried out sequentially or in parallel for some of them. They can also be performed extensively from the first to the last one, but they do not necessarily have to. The fast-time simulation can be considered as optional. On the other hand, given the maturity of the operational concept, it seems advisable to plan a real-time simulation and an operational trial. It is also recommended to have the real-time simulation preceded by a pre-experimental phase (i.e. pre-exercise testing) in order to pre-test the whole environmental simulation platform in terms of reliability, quality of the systems, training and procedures.

9.2.1 Fast-time simulation (optional)

Fast-time simulation (exercise 1) is suitable for a preliminary assessment of great number of options. Its aim is to evaluate the performance related to the introduction of A-SMGCS application through a mathematically model. This exercise enables to assess ideal throughput of a given airport and to correlate the data collected with those obtained through the real-time simulation. Provided the models used are representative for the conditions being investigated, it could give an indication of the possible gain margin between an ideal throughput in a flawless environment (in which all systems and operators always respond in the most efficient way) and the throughput obtained in a real-time simulation environment.

The results obtained by fast-time simulation for A-SMGCS level I could be used in the future for comparison with A-SMGCS level III and IV when validating these implementation levels in the future.

9.2.2 Real-time simulation

Real-time simulation (exercise 2) involves the participation of actors (controllers, pilots…) performing their operational tasks in a realistic environment. Hypotheses related to human factors objectives can be tested in addition to safety, capacity and environment objectives. This exercise uses a baseline system to carry out a relative type of analysis. Two environments are used, a baseline (SMGCS) and an advanced one (i.e. without and with A-SMGCS application), so as to compare both results and determine whether there is a difference between them, i.e. whether the introduction of A-SMGCS application brings some benefits or not. In the SMGCS baseline, the ATC controllers are only provided with the display of mobiles' position without their identity (e.g. Surface Movement Radar without labels providing targets' identity)

This exercise is intended to assess the following issues:

- A-SMGCS related procedures
- A-SMGCS transition from VIS1 to VIS2
- A-SMGCS breakdown and in particular the transition from a situation with the surveillance service to a situation without the surveillance service in visibility conditions 2.

9.2.2.1 ATM platform

The validation platform to be used in real-time simulation should use a test-bench which offers a realistic environment of simulation. It should be an airport test-bench dedicated to aeronautical control system and addressing airport events (e.g. aircraft and vehicles movements, aircraft states, some meteorological parameters…).

The airport simulator should be equipped with a system capable of reproducing the external view that controllers have in tower. This system enables the controllers to have a direct access to information from the airport platform[2].

9.2.2.2 Airspace and platform model

Several configurations (e.g. two for Roissy airport: face to East and face to West) will allow to assess a wide range of operational situations.

For example, for an airport like Roissy Charles-de-Gaulle, composed of two sets of two mixed-mode runways, only the south area of the airport will be concerned. The north area of the airport comprising the north set of runways will not be simulated.

9.2.2.3 Simulated traffic data

Scenarios will be build from real traffic samples which will be modelled so as to obtain medium to high traffic loads. Towed aircraft and vehicles will be added. Events such as runway incursions will be included.

Among these scenarios, some of them will be planned to be used as exercises for training.

9.2.3 Operational trial

Operational trial (exercise 3) is an important exercise, the closest to real operations. It implies that previous simulations have already assessed and validated the new concept and its related procedures. The operational trials will mainly validate the

[2] This proposal stems from the experience of the CENA about real-time simulations on the airport simulator it has developed: the SALSA – SALADIN platform settled in a 3D simulation environment.

technical feasibility of A-SMGCS (technical feasibility implies the system is able to fulfil the required operational performances, which can only be validated during operational trials).

9.3 Focus of Validation Exercises

The tables below present the validation objectives studied in the validation exercises. To stress to which extent the objectives will be studied, the level of focus of each validation objective is specified.

Exercise 1 : Fast-time Simulation (optional)		
Technique	Fast-time simulation	
Objective	To assess an optimal throughput of a representative airport (or more) through the use of appropriate models (airport and controller activity) in order to compare the data collected with those of real-time simulation.	
High level validation objectives		Level of focus
To provide information about airport throughput.		Collect information

Exercise 2 : Real-time Simulation (Comparison Baseline/Adv.)			
Technique		Real-time simulation	
Objective	Pre-experimental phase	To assess the reliability of the whole system and the applicability and effectiveness of A-SMGCS related procedures.	
	Experimental phase	To consolidate the A-SMGCS related procedures and to measure benefits of introducing A-SMGCS application through the use of two simulation environments - SMGCS (Baseline) and A-SMGCS (Advanced Organisation). To assess A-SMGCS transition from VIS1 to VIS2. To assess A-SMGCS breakdown and transition issues from a nominal situation (with surveillance service) to a non nominal situation (without surveillance service).	
Validation point of view		ATC Controllers	
High level validation objectives			Level of focus
To ensure that the A-SMGCS related procedures are applicable and effective.			Focus
To assess the increase of safety in ground operations specially in reduced visibility conditions (e.g. number of runway incursions).			Focus
To assess the increase of throughput in reduced visibility conditions.			Focus
To assess the reduction of noise and gaseous emissions in reduced visibility conditions.			Focus
To provide information about ATCO workload.			Collect information

To provide information about situational awareness.	Collect information

Exercise 3 : Operational Trials		
Technique	Operational trials in a large airport (Roissy, Heathrow…)	
Objective	To consolidate A-SMGCS related procedures in a real environment in all expected operational situations (including a variety of visibility conditions, technical and human factors events).	
Validation point of view	ATC Controllers, Pilots, Vehicle Drivers	
High level validation objectives		Level of focus
To verify technical feasibility of A-SMGCS level I.		Focus
To ensure that the A-SMGCS application and related procedures are acceptable by ATCO.		Focus
To verify that the application fulfil performance and safety requirements.		Collect information
To assess the increase of safety in ground operations specially in reduced visibility conditions (e.g. number of runway intrusions).		Collect information
To assess the increase of throughput in reduced visibility conditions.		Collect information
To assess the reduction of noise and gaseous emissions in reduced visibility conditions.		Collect information

Focus: this objective is a target objective so that hypotheses and related indicators or metrics will be defined and analysed to try to provide response.

Collect information: this validation objective is not a target objective of the exercise but it will be partially studied. Some data will be collected to provide first results (i.e. tendency).

Warning: Focusing on a validation objective does not mean that it is easy to find relevant indicators or metrics. Therefore, the table does not prejudge on the quality of the results and on the level of confidence to be given to the answer to the related hypothese(s). It is particularly true for the safety objectives.

Each exercise is further detailed in Annex, specifying how the steps are to be undertaken, when they will be performed and the responsibilities in the exercise.

9.4 Planning

The validation timeframe is expected to be from 01/11/2003 to 31/07/2005. The following chart present the planning for A-SMGCS level I Validation within this time frame. This is just an example based on the validation exercises provided in Annex.

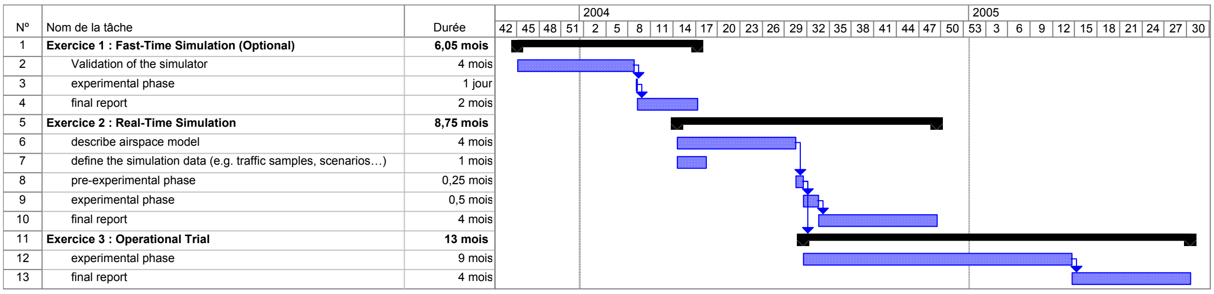

Figure 9-1 : VMPI planning

Appendix A Example of Validation Exercises

Exercise 1 (optional)

How the steps could be undertaken	
Approach, method(s), technique(s) and tool(s) used	Fast-time technique Factors to be varied: - Traffic load - ATCO model Quantitative data analyses
Runs	Series of fast-time assessments
Procedures to ensure quality of the work	Validate data and analyse output of the model used so as to verify representativeness for the conditions being investigated
When the steps could be performed	
Planning of tasks	- Definition of a baseline - Definition of the number of scenarios
Key decision points	
The milestones in the project	- Validation of the simulator (assumed to be already developed) : minimum 4 months - Execution of the exercise : 1 day simulation - Delivery of the final report 2 months (full-time effort) after the end of the exercise
Responsibilities in the exercise	

Resources	- 1 technical manager responsible for the mathematical model design of the fast-time simulator - 1 expert having an in-depth knowledge of A-SMGCS developments, requirements and familiar with contemporary A-SMGCS surveillance systems and procedures
Input and/or co-operation expected from third parties	1 or 2 controllers to assess realism and suitability of the model according to the validation objectives
Prerequisites for each step of the validation process	The fast-time simulator is assumed to be already developed To carry out a comparison between theoretical throughput obtained in fast-time simulation including A-SMGCS, throughput measured in real-time simulation with A-SMGCS and real throughput in real environment, same airport environment has to be used in the model

Exercise 2

How the steps could be undertaken	
Approach, method(s), technique(s) and tool(s) used	Real-time simulation Comparison between Baseline and Advanced environments Factors to be varied: - Traffic load - Visibility conditions - Roles on controllers positions (Ground and Local positions) - Disturbing events (e.g. runway incursion, towed aircraft with gate problem) Qualitative and quantitative analyses - Qualitative data : observations, verbalisations, briefings, questionnaire - Quantitative data : automatic data logging of events related to the use of the available functions Traffic samples : 24 traffic samples could be defined : - 4 low loaded samples for training purposes - 20 simulation exercises meant for validation runs - Each sample lasts 30 to 45 minutes Number of experimental sessions : - 1 experimental session of 10 days (1 to 4 days for training[3] and 5,5 days for simulation runs) - 1 set of 3 controllers
Training	Pilots' training[4]: 2 days before the simulations - Experimental context - Pilots' role - Airport map - HMI - Training exercises Controllers' training: 4 days training - Project presentation - Experimental and environmental context - HMI principles - Controller's role - HMI training - Procedures - Training exercises

[3] Training time will depend on the familiarity the controllers will have with HMI and whether they are experienced with SMGCS or not.
[4] Pilots (pseudo-pilots) are in charge of several aircraft each. They are trained to the Human-Machine Interface allowing them to guide aircraft according to ATCO instructions.

Runs	- 2 controllers rotate on control position to assess the different scenarios (at least one Local and one Ground controllers are required to participate to the validation, even if the simulation run focuses on one of the controller. This is important because local and ground controllers interact during the procedures, and so it could have an impact on the validation results). - The runs could take place during 5,5 days, preceded by the 4 days of training phase.
Procedures to ensure quality of the work	- Evaluate the products of system development activity to determine correctness and consistency with respects to the specifications provided as input to that activity. - Implement a pre-experimental phase before the experimental phase to assess realism and technical quality of the test-bench (response times, bugs, restarting, traffic levels, scenarios, pilots' behaviour…): o 1 week for training and simulation runs o 3 weeks to make and test the changes (ahead the experimental phase) o participation of some controllers involved in the project team and aware of the objective of this pilot phase, pilots, 1 expert controller, 1 ergonomics and technical engineers
When the steps could be performed	
Planning of tasks	- 4 months to describe the airspace model - 3 days/scenario (e.g. traffic samples). Total time to define simulation data depending on the number of scenarios - 1 week for the pre-experimental phase preceding the experimental phase (3 weeks ahead at least) - 10 days for the experimental phase, comprising the training phase (4 days) and the simulation phase (5,5 days with 2 runs per half day)
Key decision points	Validation of procedures during pre-experimental phase
The milestones in the project	- Acceptance of the validation platform - Execution of the exercise : 1day for pilots training + 10 days for simulation - Delivery of the final report 4 months (full-time effort) after the end of the exercise
Responsibilities in the exercise	

Resources	- 3 controllers (2 Ground controllers + 1 Local controller) - 5 pilots (4 could be necessary per run) - Experimental team: o 1 technical manager responsible for the test-bench supervision o 1 or 2 computer engineer responsible for pilot environment design o 1 computer engineer responsible for controller environment design o 1 human factors (ergonomics) expert responsible for preparation, training and follow up of the experiment o 1 expert controller with good knowledge of simulation context (responsible for the definition of traffic samples and related scenarios) and playing the role of Wizard of Oz[5] o 1 expert having an in-depth knowledge of A-SMGCS developments, requirements and familiar with contemporary A-SMGCS surveillance systems and procedures
Input and/or co-operation expected from third parties	1 or 2 controllers to assess realism and suitability of traffic samples according to the validation objectives
Prerequisites for each step of the validation process	- Preliminary assessment of the procedures. - Representative prototype system is tested in a relevant environment.

[5] The Wizard of Oz is in charge of generating some events described in validation scenarios such as incidents on the manoeuvring area. He/she is equipped with tools and HMI allowing him/her to guide vehicles on airport platform.

Exercise 3

How the steps could be undertaken	
Approach, method(s), technique(s) and tool(s) used	Operational trial: - Small scale trial[6] (one airport, delimited areas of the airport, limited to specific flights…) and/or full implementation in order to gain experience and collect data on how the A-SMGCS application and associated procedures work in the real environment. Conditions of trial: - All visibility conditions - Normal conditions to bad conditions (i.e. controlled failure of equipment) Qualitative and quantitative analyses - Qualitative data : observations, verbalisations, briefings, questionnaire - Quantitative data
Training	Necessary, except if participants are already familiar with the system and concepts. Drivers' training if not familiar with the system. Controllers' training: time devoted to training depends on the difference between the current system and the new one. Also depends on whether controllers already participated to previous real-time simulation exercises on the system
Runs	The runs could take place for several months (to be defined), preceded by a training phase.
Procedures to ensure quality of the work	Preliminary phase of technical feasibility validation for verification of functional and operational requirements. Then, involvement of ATCO for a full system validation.
When the steps could be performed	
Planning of tasks	At least 6 months for the operational trial, including the training phase
Key decision points	Acceptance of the preliminary phase of technical validation
	- Acceptance of the validation platform - Execution of the exercise : 6 months for operational trial - Delivery of the final report 4 months (full-time effort) after the end of the exercise
Responsibilities in the exercise	

[6] Small-scale trial is optional in case airport platform is not already equipped with A-SMGCS application. Transition to full operational implementation is made after smaller scale trials proved beneficial.

Resources	- Controllers (all or some selected ones) - Experimental team: o 1 technical manager responsible for the test-bench supervision o 1 or 2 computer engineer responsible for pilot environment design o 1 computer engineer responsible for controller environment design o 1 human factors (ergonomics) expert responsible for preparation, training and follow up of the experiment o 1 expert controller with good knowledge of simulation context o 1 expert having an in-depth knowledge of A-SMGCS developments, requirements and familiar with contemporary A-SMGCS surveillance systems and procedures
Input and/or co-operation expected from third parties	- 1 or 2 controllers to assess realism and suitability of traffic samples according to the validation objectives
Prerequisites for each step of the validation process	- Actual system prototype near, or at, planned operational system. - Preliminary assessment of the procedures. - Implementation of one or more validation exercises (real-time and possibly fast-time) demonstrating that the system is workable from a technical, safety, human factors and benefits viewpoint. - Safety and human factors assessment demonstrates no major non solved problems.