EUROPEAN AIRPORT MOVEMENT MANAGEMENT BY A-SMGCS

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Executive Summary

In its first phase, the European FP6 project EMMA has evaluated the EUROCONTROL A-SMGCS Levels 1 & 2 concept and related procedures in field trials at four representative European airports: Prague - Ruzyne, Toulouse - Blagnac, Milan - Malpensa and Paris - Charles de Gaulle. The operational requirements that were validated were derived from the ICAO A-SMGCS Manual [3].

For Level 1, automated Surveillance, based mainly on primary Surface Movement Radar (SMR) in combination with secondary Mode S Multilateration (MLAT), has been implemented and studied. For Level 2, a Control function has been added to provide alerts to the controller in cases of runway incursion or possible conflicts on runways. In addition, initial on-board pilot assistance functions for the higher levels of A-SMGCS have been successfully tested on several aircraft platforms.

It was shown in simulations, as well as in field trials, that the A-SMGCS Levels 1 & 2 functions are technically and operationally feasible, that they are accepted by controllers and pilots, and that they lead to significant operational improvements. It was proven that efficiency and safety of airport surface operations can be significantly improved by these initial A-SMGCS concept elements. Controller situational awareness is increased and reaction times in case of critical situations are reduced. Taxi times are reduced and the traffic runs more smoothly, which saves fuel and reduces environmental impact.

EMMA further led to significant recommendations regarding the implementation of A-SMGCS Levels 1 & 2. These recommendations were submitted to ICAO by a coordinated EC and EUROCONTROL initiative.

Within EMMA, an A-SMGCS service and implementation roadmap was developed as part of the A-SMGCS harmonisation process. This roadmap was recommended to be included in the SESAR Master Plan by the ATM community. The roadmap will be used in the successor project, EMMA2, to be approved or - if necessary - improved and updated following the operational tests that will be performed.

This report describes the work performed so far, the results achieved, and the on-going progress of optimising the efficiency of aerodrome movements.

1 Project Execution

1.1 Introduction

The European Commission White Paper "*European transport policy for 2010: Time to decide*" [1] focuses on an efficient transport system offering a high level of quality and safety, referring also to airport capacity and use. In addition, the authors of "*Vision 2020*" [2] forecast that today's traffic volume will double within the next 15 years.

How will airports cope with this additional traffic? Most of the existing ones will not be able to extend their infrastructure. Therefore, more and more airports strive to increase the efficiency of surface movements by means of modern technology while maintaining a consistently high level of safety.

For years, airports, ATC providers, civil aviation authorities, airlines, industry and research institutes worldwide have been working on the development of technologies and processes for the optimisation of aerodrome surface movement management. **A**dvanced **S**urface **M**ovement **G**uidance and **C**ontrol **S**ystems (**A-SMGCS**) aim at satisfying these objectives and allow using existing infrastructure more efficiently in all weather conditions. A-SMGCS will improve capacity usage, efficiency, and safety, and maintain this in different visibility conditions. The environmental impact of fuel consumption and pollution will decrease, the service efficiency for passengers will increase due to less idle time at the airports. So far, the approaches adopted by some airports have resulted in non-standard solutions that address only part of the complex objective.

The basis for European A-SMGCS was laid down some time in the early 1990s. In that period, the main components of the A-SMGCS concept and its draft standard specifications were defined in terms of surveillance, control, planning and guidance functions. At the same time European air traffic authorities worked together to specify what later became the ICAO A-SMGCS manual [3] and guidance material. Industries joined with Air Navigation Service Providers and research institutes in the EUROCAE working group 41 to identify the technical user needs. These needs were converted into Minimum Aviation System Performance Specifications (MASPS) [4] with the associated test procedures.

The A-SMGCS defined in ICAO [3] consists of four main functions embedded in the overall ATM system, which can be summarised as follows:

a) Surveillance: Provides the controller with accurate position and identification information of (authorized) movements at the airport.
b) Routing: Enables to designate a route for each aircraft or vehicle either manually or automatically.
c) Guidance: Supports the pilot and vehicle driver to follow the instructions and clearances from the controller
d) Control / Alerting: Alerts the controller when critical situations may occur. Helps the controller to monitor the execution of clearances.

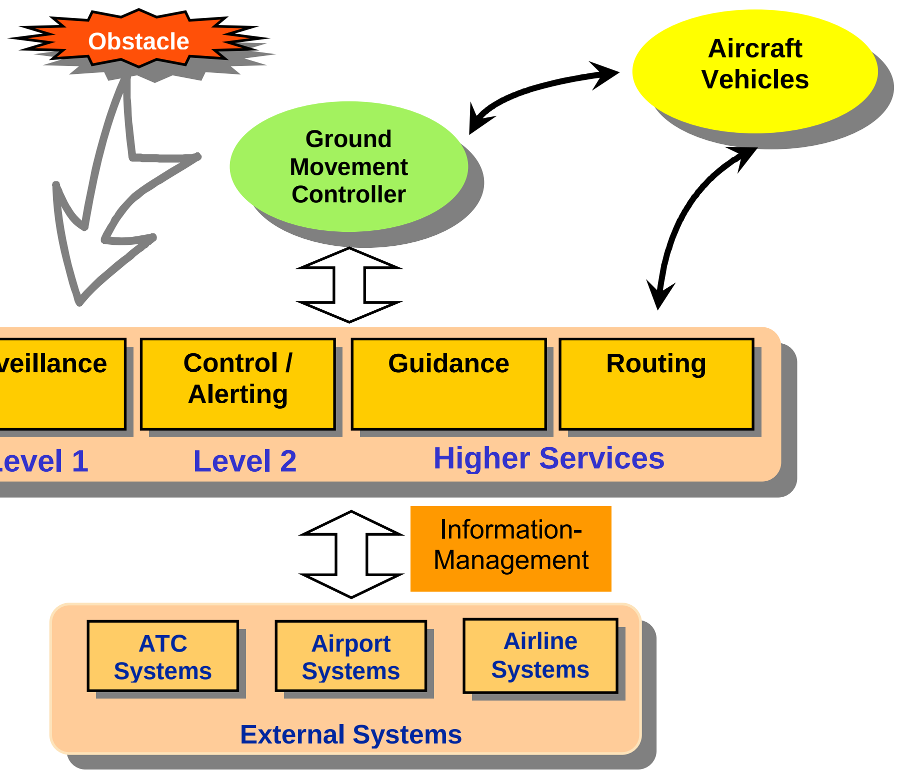

Figure 1-1: A-SMGCS environment

In previous Framework Programmes (FP) the European Commission initiated several A-SMGCS research projects to develop concepts, prototypes and operational application variants. An all-encompassing solution has been strived for, which can be applied to airports worldwide.

In March 2004, as part of the 6th FP, the European Commission officially launched the **EMMA** Project **(E**uropean Airport **M**ovement **M**anagement by **A**-SMGCS) with the objective of providing concept harmonisation and validation through extensive operational field trials and integration of on-board and ground systems. The project involves 24 partners encompassing

EUROCONTROL, airport operators, ATC providers, industrial enterprises, airlines and research institutes from 10 European countries, coordinated by the German Aerospace Center (DLR). EMMA focuses on harmonisation and consolidation, with a long-term objective being to support ICAO standardisation of A-SMGCS. This approach should ensure that manufacturer-specific implementations will be in line with ICAO specifications for A-SMGCS. Improved efficiency can only be achieved by means of aim-oriented cooperation of all stakeholders involved.

Since its conception, EMMA was scheduled to have a successor project called EMMA2. While EMMA mainly focused on the A-SMGCS Levels 1 & 2 (surveillance and runway incursion alerting), EMMA2 will continue to consolidate and implement the higher-level services of A-SMGCS (planning, routing, control and guidance). This shared approach has ensured that the first results of the basic A-SMGCS (Levels 1 & 2) were fed into the standardisation bodies in a timely manner (November 2006 to ICAO [3]).

1.2 From SMGCS to A-SMGCS

Currently, airports are considered as the main bottleneck of the Air Traffic Management (ATM) system. According to the EUROCONTROL Performance Review Commission report [5], airport delays make up a growing proportion of the total ATM delays. An extension of existing airport infrastructures, e.g., by building new runways, is very difficult. Therefore, the optimal usage of existing infrastructure becomes more and more important. Despite the importance of optimal resource usage, operations on the airport airside are still managed more or less “manually”.

At many airports, pilots have to navigate using paper maps, and air traffic controllers (ATCOs) perform the surveillance task visually by looking out of the window. Radio voice transmission is still used as the primary communication means. When the visibility conditions degrade, the controller may make use of primary airport radar, SMR, which provides an analogue display that may be cluttered, particularly during heavy rain or snow conditions. In order to ensure safety, special low visibility procedures are used to help overcome the poor technology support, compromising airport capacity and increasing delays – with repercussions for the approach areas and introducing network effects to the overall air transport system.

To improve this situation, a modular A-SMGCS concept has been defined in the ICAO A-SMGCS Manual [3] aiming at providing adequate capacity and safety in relation to specific weather conditions, traffic density and aerodrome layout. With A-SMGCS, ATS providers and flight crews are assisted in terms of surveillance, routing, guidance and control.

Today, some major airports have already implemented A-SMGCS technology Levels 1 & 2 (surveillance and runway incursion/conflict alerting), and some have also started to adapt the operational procedures. However, due to missing operational procedures and / or inadequate technical performance, these systems are not sufficiently mature to fully support operations in low visibility conditions. To stimulate development, the European Commission has co-financed a number of A-SMGCS projects within the different Framework Programmes (FP) over the past decade:

- FP4: DEFAMM (**De**monstration **F**acilities for **A**irport **M**ovement **M**anagement) to demonstrate the technology.
- FP5: BETA (operational **B**enefit **E**valuation by **T**esting an **A**-SMGCS) for first implementations under operational conditions at two airports
- FP6: EMMA (**E**uropean airport **M**ovement **M**anagement by **A**-SMGCS), which will pave the way to harmonising the implementation of A-SMGCS in a two step approach: Levels 1&2 and higher level under adapted operational procedure

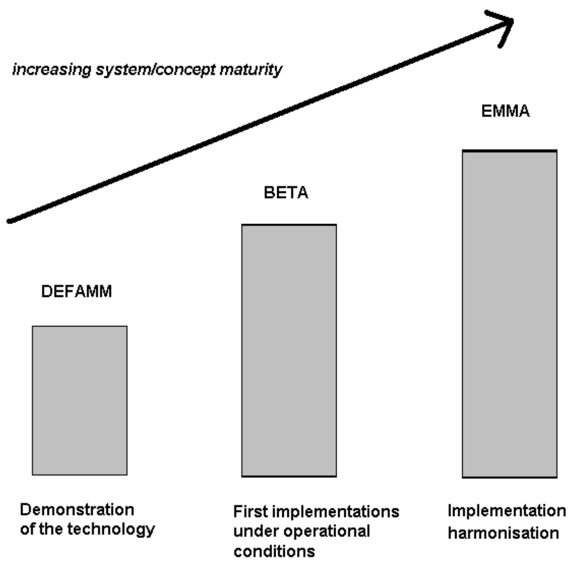

Figure 1-2: Evolution of EC-initiated A-SMGCS Projects

While the European Commission projects in this domain have been devoted to research – extending the current state of the art – a EUROCONTROL project, run in parallel, has been successfully tackling the operational implementation issues, especially the adaptation of procedures. The EUROCONTROL and European Commission projects have been successfully coordinated.

The European industry has developed mature products to support A-SMGCS implementation. A few airports in Europe have already implemented the first two levels of A-SMGCS operationally and the trend is increasing as the operational (and economic) improvements become increasingly obvious.

The necessity for A-SMGCS has also been understood on other continents. In the USA, the FAA is currently implementing A-SMGCS Levels 1 & 2 functionality in their ASDE-X programme and the implementation of A-SMGCS is on-going at major airports in Asia and Australia. The success rate of European industry in providing the necessary equipment in these countries is without doubt due to the important joint R&D project work, carried out in Europe these last years. Amongst other collaborative activities, an FAA-EUROCONTROL Action Plan 21 has been established to support the coordination of A-SMGCS and CDM research between the two communities of both continents.

EMMA research and development covered two main aspects in coherence with the A-SMGCS implementation strategy:

- Harmonisation and consolidation of Levels 1 & 2 in terms of installed technology, procedures and regulations and
- Preparation of higher-level applications in terms of on-board and ground functions development, active controller and pilot involvement, as well as technical and operational implementation preparation.

An advantage of EMMA has been the clustering of European A-SMGCS expertise into one project. This has offered the chance to transfer current A-SMGCS solutions into a harmonised European system, which was EMMA's most innovative goal. This goal was supported by widespread A-SMGCS implementation and its validation against a common set of requirements.

1.3 Objectives

Knowing about the benefits that can be expected from A-SMGCS is a key factor for deciding on A-SMGCS implementation. Only if these benefits are identified and quantified, and if the technological and operational feasibility is sufficiently demonstrated, will decision makers include A-SMGCS in their investment plans.

To overcome the drawbacks of the current situation as described above (section 1.2), the EMMA project pushed A-SMGCS one step further towards the final goal: the harmonised European implementation of A-SMGCS. Within EMMA, '*harmonisation*' has been defined as: *Common A-SMGCS interoperable Air-Ground co-operation concept and benefit expectation in Europe.*

To achieve this superior goal, tactical sub-goals were defined, as shown in the following picture:

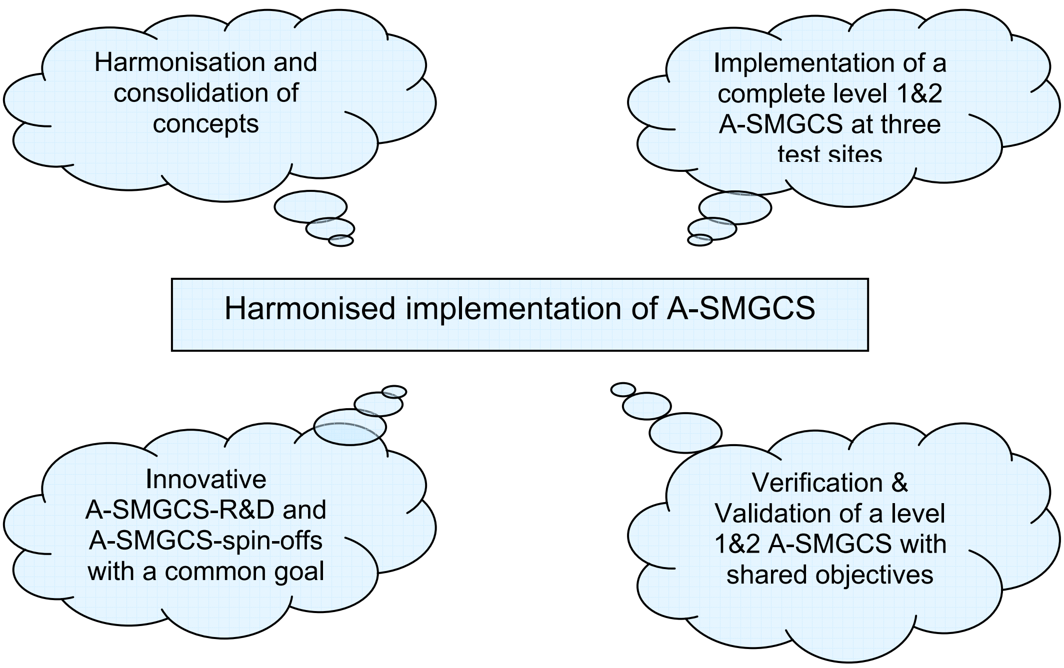

Figure 1-3: Main Objectives

Based on an advanced operational concept, A-SMGCS Levels 1 & 2 has been implemented at three European airports, and studied in operational use over a significant time. In addition, trials have been carried out at Paris - CDG to evaluate the long-term performance of the existing operational A-SMGCS. The systems implemented have been verified and validated against the predefined operational and technical requirements. On-site long-term trials have been performed to ensure the assessment of operational benefits. The issues of this test phase have been fed back to the concept of operations and are intended to fix standards for future implementation in terms of:

- Common operational procedures
- Common technical and operational system performance
- Common safety requirements
- Common standards of interoperability with other ATM systems

These standards were fed into the relevant documents of international organisations involved in the specification of A-SMGCS (ICAO [3], EUROCAE [4], EUROCONTROL [6, 7, 8]) and are to be recommended for all future implementations. Furthermore, the results have been used to generate public guidelines for the certification of an A-SMGCS. Additionally, the experience gathered at the test sites has been used to produce technical and operational transition guidelines for users when they decide for certain A-SMGCS level implementation. As pre-requisite for the ‘European licensed controller’, the tower working environment was defined in harmonised levels thanks to EMMA.

In addition to the harmonisation objective, the maturity of the higher A-SMGCS levels has been an important objective. The work conducted in this area has focussed on the integration of air and ground A-SMGCS functions and the planning support to the controllers, which will be studied further in the successor project EMMA2, where operational trials with these functions are planned.

A main extension of the A-SMGCS concept developed by EMMA is the holistic, integrated air-ground approach, considering aircraft equipped with advanced systems for pilot assistance in a context where tower and apron controllers are supported by A-SMGCS ground systems. A mature technical and operational concept, as developed in EMMA, should ensure consistency of traffic information given to controllers and pilots. This is the basis for a common situational awareness and safe ground operations. The associated operational concept defines the roles and tasks of the onboard and ground stakeholders and the procedures from an overall, holistic point of view.

1.4 Approach

EMMA was executed between March 2004 and April 2006. The project was organised into eight different sub-projects (GP0, GP7, SP1-SP6), which were co-ordinated by different partners (Figure 1-3). There were three ground-related sub-projects (SP3-SP5) and one onboard-related sub-project (SP2), representing the three different test sites and the onboard test-'site'.

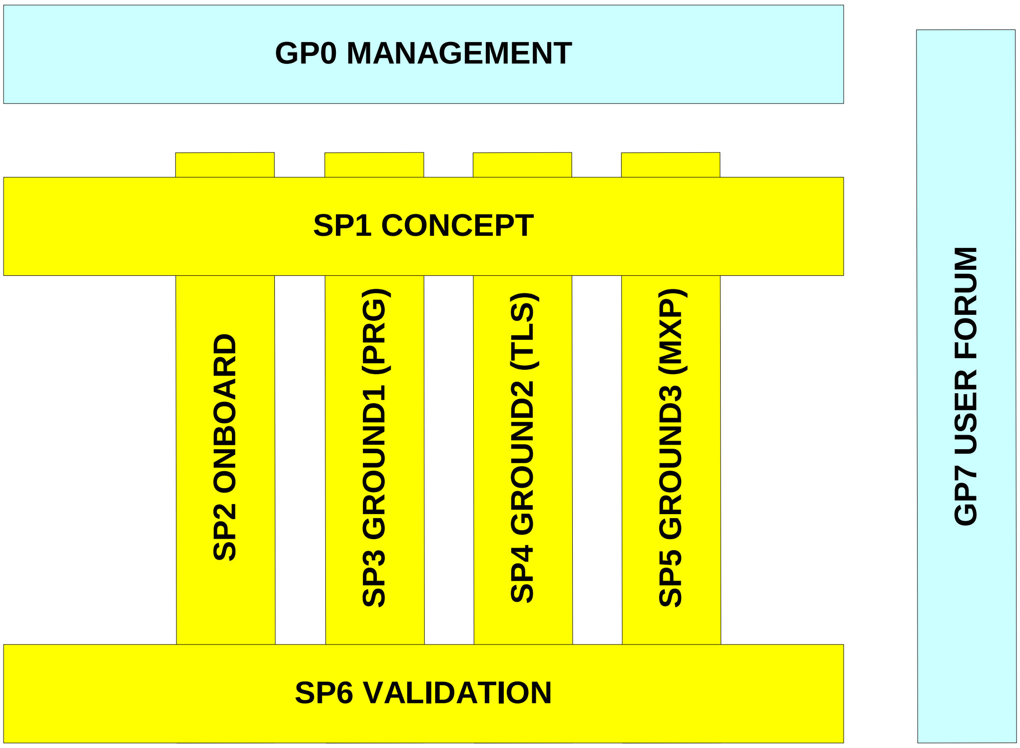

Figure 1-4: Project Structure

The four vertical sub-projects were, to a certain degree, independent of each other. This structure was used to minimise frictional losses, to have small, efficient sub-project-teams and to enable them to use existing site-specific systems or components. However, these four sub-projects were inter-linked with the horizontal sub-projects '*concept*' and '*validation*', to guarantee that the different test-site systems were based on a common concept and that all were validated with the same criteria. SP1 '*concept*' must be seen as the fundamental part paving the way forward, so that all other EMMA sub-projects shared a common, harmonised A-SMGCS concept, starting from the existing documents and work. SP6 '*validation*' provided a systematic step towards the verification and validation of A-SMCGS. It described a framework for the verification and validation of concepts, systems and procedures, and collated the results of the vertical sub-projects. The sub-project '*User Forum*' (GP7) provided a platform bringing A-SMGCS users (controllers, pilots and their organisations) together with the EMMA partners. Two public 'User Events' were carried out giving users outside of the consortium the possibility to contribute to the outcome of EMMA. In addition to this, some airport visits were performed as part of GP7. Last, but not least, the task of the Management sub-project (GP0) was the one of overall coordination.

The project followed an iterative development process with system maturing phases, followed by functional and operational testing phases.

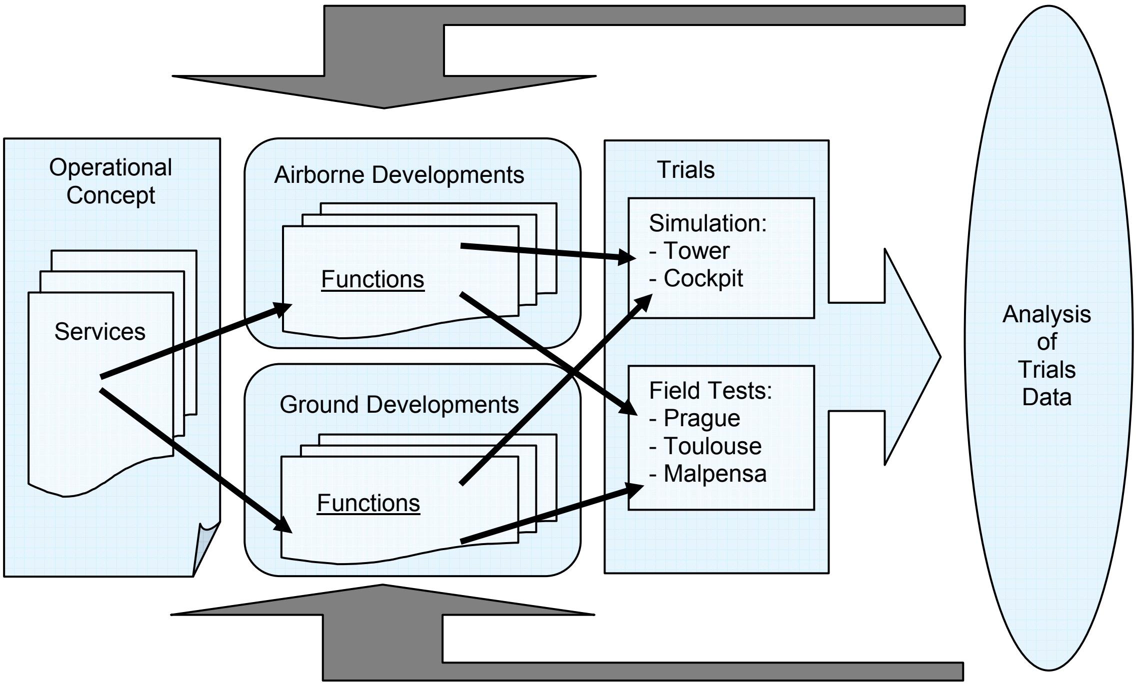

Figure 1-5: Iterative Approach

1.4.1 A-SMGCS Functions

The A-SMGCS main functions (Figure 1-6) were implemented in EMMA focusing on the surveillance and runway incursion alerting functions. More advanced functions like guidance and planning have been prepared for EMMA2 where they will finally be implemented.

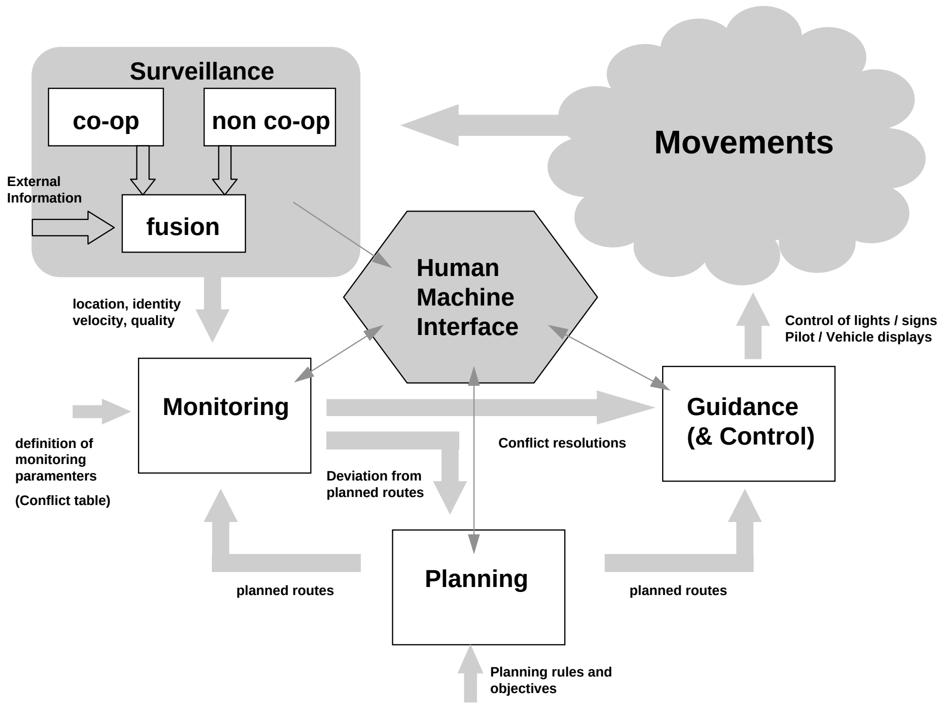

Figure 1-6: Principle A-SMGCS Structure, as defined in [4]

Surveillance:

At each of the ground system test sites the A-SMGCS main function '*Surveillance'* has been provided by cooperative sensors (ASR, Mode S Multilateration – MLAT, ADS-B via 1090MHz, Vehicle Localisation & Identification), non-cooperative sensors (SMR, cameras) and sensor data fusion (SDF). State-of-the-art arrangements from different manufacturers have been used.

A number of airport ground vehicles have been equipped with transponders for the vehicle localisation. Different products were used at the different test sites.

In addition to the aircraft equipped with Mode S transponders, one test aircraft and one test van were adapted to send out 1090 Extended Squitter messages (ADS-B).

Note: Based on a user requirement analysis performed by an airline, the consortium decided to use the 1090MHz ADS-B. This has been installed by the airframe manufacturers, starting in 2004. The VDL4 ADS-B application was taken into account through theoretical studies.

Monitoring/Alerting:

Conflict detection and alerting met the Control function requirements. The detection of runway incursions and of intrusion into prohibited areas was implemented by adequate alerting procedures.

Guidance:

Guidance was implemented on ground by the use of stop bar lights (Ground Based Guidance Means) and on-board by the use of a display. The onboard system consisted of an Electronic Moving Map (EMM) and in addition of a Head-Up Display in the simulation environment. For EMMA2, this will be extended with TIS-B and CPDLC.

Beside these main functions, the following supporting functions were implemented:

Information Management:

The A-SMGCS had to be integrated into the general ATM environment. This included interfaces to Flight Plan Data Processing Systems (FDPS), Radar Data Processing Systems (RDPS) on the ATC side and Gate Allocation Processing Systems on the Airport side.

The information management is responsible for

- Data collection
- Merging of data and their consistency
- Completeness of data
- Distribution of data
- Synchronisation (common time base)

Air Traffic Controller Human Machine Interface (HMI):

An additional surveillance display was integrated at each CWP providing the controller with position and identification of all mobiles on the manoeuvring area (partially also the movement area). In addition, this HMI presented the controller with alerts for abnormal events.

Onboard Human Machine Interface (HMI)

Various cockpit mock-ups have been equipped with the following systems:

- Airport moving maps providing pilots with basic information on their position on the airport surface, and new functions of traffic display, surface movement alerting and virtual taxi routing as proposed by the ground controller;
- a Braking and Steering cues display system;
- a Head Up Display with a surface guidance symbology function.

Recording System:

All traffic data and the status of the technical systems had to be recorded continuously. The ATC recording system was used for validation purposes. The ASTERIX data format was used to ensure a standard interface to analysis tools. (EMMA focused on this by a special tool named MOGADOR; see chapter 1.6(e))

Technical System Control:

Engineering control of the A-SMGCS was performed using a dedicated ATC technical workstation allowing set-up/shut-down of the system and adaptation of parameters.

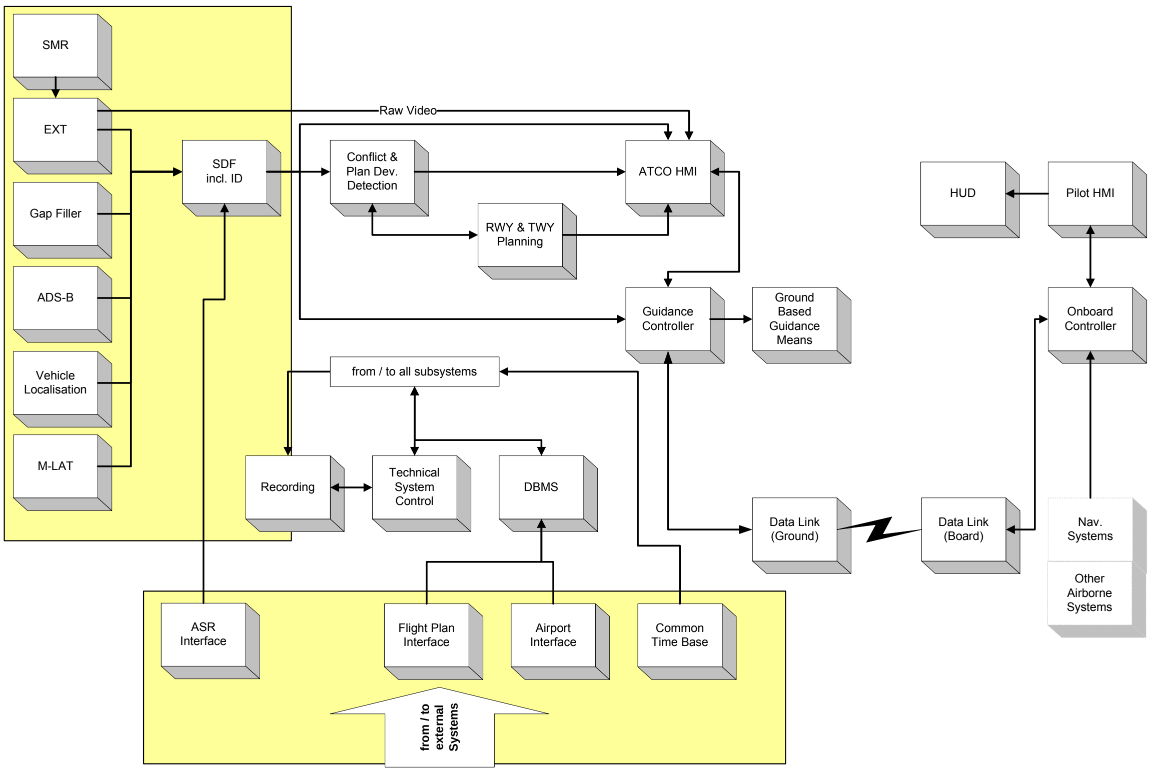

Figure 1-7: EMMA System architecture

1.4.2 Harmonisation and Standardisation

Although all EMMA ground test sites had their own specific functional focus, the above-mentioned principal A-SMGCS structure was basically always the same. In order to meet the project goals '*harmonisation'* and '*consolidation'*, the technical solutions at the test sites were in line with standard requirements but also able to consider local constraints. Although different products from several manufacturers were used, a definite level of standardisation was maintained.

In the EMMA project, A-SMGCS systems have been installed at the three mid-size airports Prague Ruzyne, Milano Malpensa and Toulouse Blagnac. These were used to control the regular airport traffic. Appropriate testing methodologies concerning functional and operational testing were defined to ensure comparable results. EMMA first consolidated the surveillance and ATC runway conflict alert functions while the successor project EMMA2 will focus on advanced onboard guidance support to pilots and planning support to controllers. The results of the performed tests were intended to propose standards for future implementation in terms of:

- Concept of an A-SMGCS Levels 1 & 2
- Technical and operational requirements
- Operational procedures
- Implementation issues (e.g. safety assessment, training and licensing)
- Detailed recommendations for a harmonised A-SMGCS V&V methodology

In order to meet the aforementioned objectives, EMMA was built upon previous work – especially from the ICAO Doc. 9830 [3] and from the EUROCONTROL document [6, 7, 8].

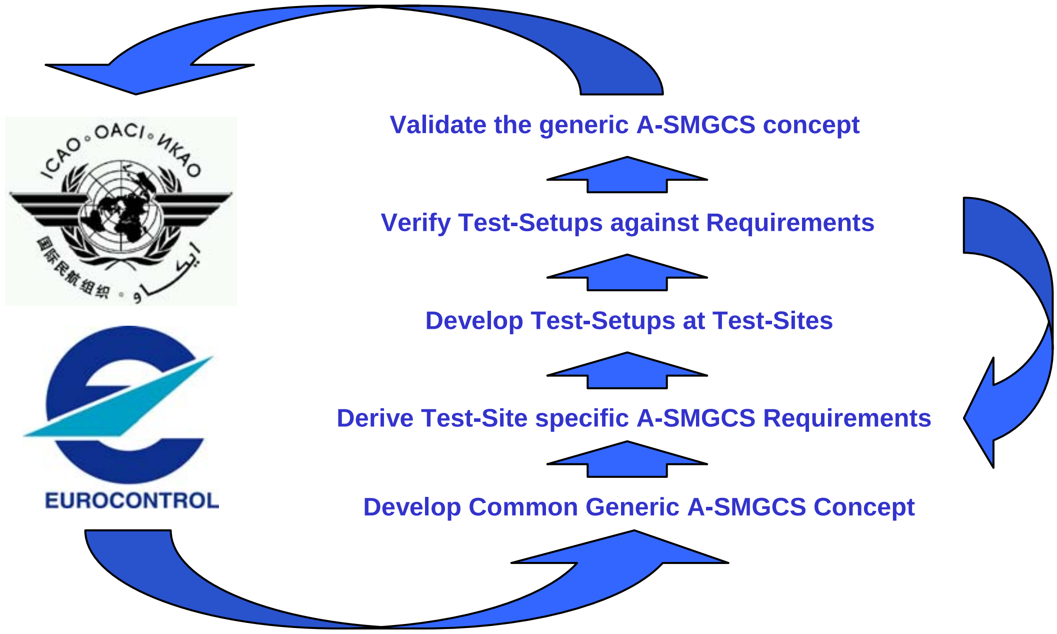

Figure 1-8: Harmonisation Loop

The harmonised concepts of operations were applied and validated thanks to functional and operational testing under real operational conditions. To achieve these goals, the active participation of licensed controllers and pilots from different countries was essential. These operators were trained in advance both in simulation and on-site.

To ensure a strong position, EMMA worked in close cooperation with EUROCONTROL and relevant working groups, providing all experience and results, which were collected, consolidated and submitted as recommendations to ICAO.

1.5 Activities performed

Two operational on site campaigns were performed with preparatory training phases. Licensed controllers and pilots, as well as aircraft and ground vehicles, were involved in the testing in order to gain realistic results. Controllers and pilots were trained in real time simulation (RTS) and on-site to prepare them to cope with a Level 1 or 2 A-SMGCS under real operational conditions.

In EMMA, only the surveillance and alerting functions were implemented and used operationally. The exception to this was the switched stop-bar lighting and the on-board part: EMMA provided the pilot with visual information on own-ship's position and on the airport surface by means of a Moving Map Display. This display is the basis for the on-board A-

SMGCS services such as guidance and an autonomous on-board conflict detection system that will be followed up in EMMA2.

The test site selection for EMMA took into account that real operational tests had to be performed there, necessitating:

- available resources for installations and testing,
- the possibility to install additional equipment on ground, and
- the possibility to install fully equipped EMMA controller working positions.

According to the ICAO Manual [3] regarding surveillance, "*it is expected that more than one type of surveillance sensor will be needed to meet the surveillance requirements*".

The A-SMGCS surveillance equipment at each of the test airports consisted of at least one non-cooperative sensor (SMR) and one cooperative sensor (ASR, MLAT). At Prague and Toulouse there was an additional cooperative sensor based on ADS-B technology. Also at Prague, gaps in the SMR surveillance due to blind spots were covered by a camera system. All data were combined by a sensor data fusion process and presented to the controller. Each airport provided real operational working positions and a test bed for shadow mode trials. The necessary number of working positions depended on the specific operational requirements of the airport.

Type	Prague	Toulouse	Malpensa
ASR stations	1	1	1
SMR stations	1	1	1
EXT for SMR	✓		✓
MLAT stations	15	5	10
Data Fusion	✓	✓	✓
ATCO HMI	4	1	4
Runway Conflict Detection	✓	✓	✓
Gap Filler	Camera		
Vehicles ADS-B equipped	80	10	5
Ground based Guidance	✓		
Onboard MMD tested	✓		✓
ADS-B (*)	✓	✓	
Recording system	✓	✓	✓

Figure 1-9: Equipment used in EMMA

(*) The results of ADS-B trials showed that it was currently not usable for ground applications because of unreliable positional accuracy. In the case of vehicles, ADS-B could be used because the ADS-B position was based on differential GPS navigation data.

Validation is the last step in the development and integration process of ATM systems before taking them into every day operational control. After assuring an adequate performance in the verification phase of the ATM system, the validation completes the cycle by including the user's judgement about the correct operation of the system.

At three test sites, Prague - Ruzyně, Toulouse - Blagnac, and Milano – Malpensa, Levels 1 & 2 A-SMGCS have been implemented and tested. On-site trials were used to verify that the implemented A-SMGCS fulfilled the technical and operational requirements and to get feedback from the operators with respect to its operational feasibility.

Toulouse - Blagnac and Milano - Malpensa evaluated the A-SMGCS in shadow-mode trials, which provided important feedback to the technical and operational performance. After the FP5 BETA project, Prague-Ruzyně had already started to implement an A-SMGCS and ran an operational A-SMGCS in parallel to EMMA. Thus Prague - Ruzyně could rely on a matured system.

On the airborne side, the following support functions were implemented and tested in different environments:

- The airport moving map display was tested in a real aircraft at Prague and Malpensa in addition to simulation trials in cockpit mock-ups. This function aims at supplementing the out-of-the window visual assessment of own-ship situation (horizontal position, heading and velocity) on airport layout. It displays the own-ship position with respect to aerodrome geographic locations (i.e. geographic features, or ground based facility locations in proximity of the aircraft).
- The ground traffic display function was tested in a vehicle (i.e. simulated aircraft) at Frankfurt, Prague, and in a cockpit mock-up. It aims at reducing the potential for traffic conflicts, errors and collision by providing enhanced situation awareness to the flight crew operating on the airport surface especially in all weather conditions. It provides the flight crew with the surrounding traffic information on the airport moving map.
- The Surface Movement Alerting (SMA) function was tested in a vehicle at Frankfurt, Prague and in a cockpit mock-up. It aims at preventing hazardous surface movements of the aircraft such a runway incursions. It provides flight crew with aural and/or visual information or alerts in case of a conflict situation risk due to the own movements of the aircraft (there are no alerts linked to other traffic movement). The visual information is displayed on the airport moving map.

The CPDLC (Controller Pilot Datalink Communication) Ground Clearances function was tested in cockpit mock-ups, with simulation of datalink exchanges with the ground control. It aims at enabling easier and safer surface movements, by assisting the crew to guide the aircraft as per taxi clearances given by the controller. Exchanges between the aircraft and the ground control are done via datalink, an alternative way of communication to voice. Taxi instructions and clearances are displayed on the Airport Moving Map (graphical information) and on the appropriate datalink exchange display (textual information).The Head-Up Display (HUD) surface guidance function was tested in a concept demonstrator. It aims at supporting the flight crew of an aircraft with tactical navigation information during taxi operations. It provides the pilot with cues for the instantaneous trajectory on taxiways and navigation on the airfield.The Braking and Steering Cues (BSC) display functions were tested in a cockpit mock-up. Braking cues display function aims at improving the reliability of runway occupancy times during the landing roll. It provides assistance to the pilot to control aircraft deceleration in order to exit the runway as planned, or to warn the pilot as early as possible if actual braking performance is not sufficient to exit as planned. The additional steering cues display function aims at helping the pilot in the speed control.

- SMA, CPDLC ground clearances and HUD surface guidance functions will be validated in more details during EMMA2 as being part of the higher A-SMGCS services.

1.6 Results achieved

1.6.1 Methodology

The experience and knowledge obtained during the EMMA project verification and validation (V&V) process led to the development of the following main V&V recommendations:

a) The use of the MAEVA VGH [9] with its stepped evaluation view contributed substantially to the production of reliable validation results. In future validation projects, the European Operational Concept Validation Methodology (E-OCVM [10]) should be used instead. The E-OCVM builds on the MAEVA stepped validation approach, adding, amongst others, a lifecycle view to the validation process that helps to determine the necessary validation activities in each of the concept lifecycle phases. However, as the methodology does not describe verification, these activities have to be integrated into the validation approach.

b) The development of a V&V master plan [D611] at an early stage of the project constitutes an essential prerequisite for organising and effectively managing the V&V process. Ideally the V&V master plan should be part of the proposal itself.

c) With EMMA, V&V has been split into four stages (Figure 1-9), which proved very useful to organise V&V objectives.

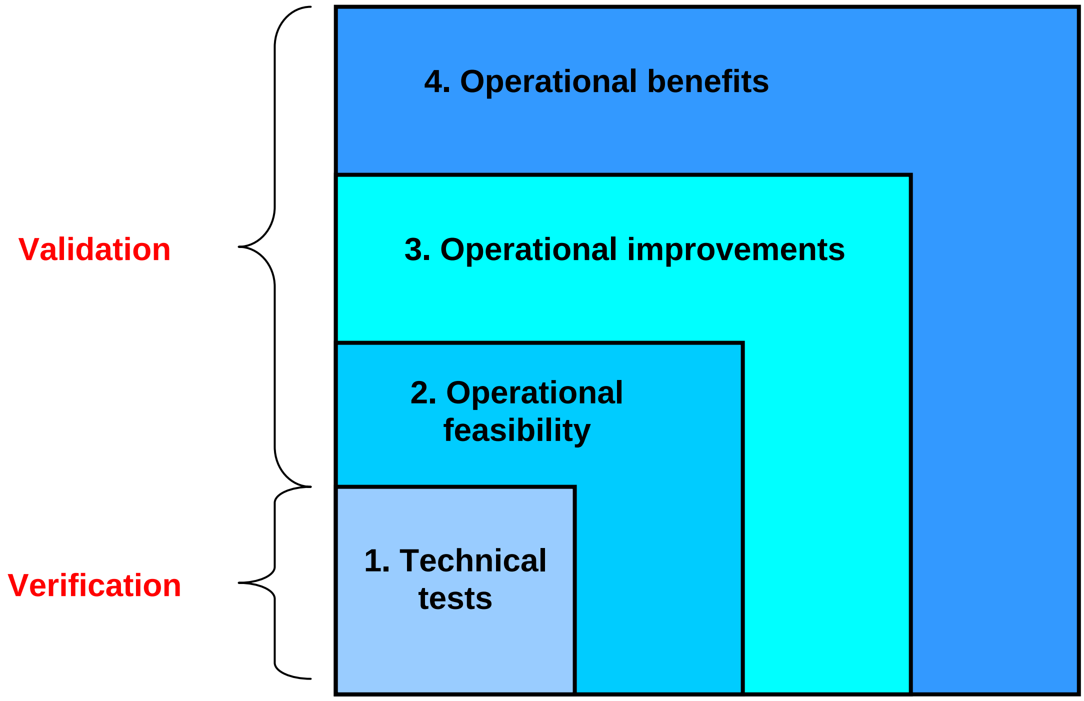

Figure 1-10: EMMA V&V methodology

d) Real-time simulation platforms proved to be appropriate means for testing non-nominal and safety-critical events, adapting technical parameters to the users' needs, and substantiating operational improvements in real experimental conditions. Field trials, on the other hand, are the irreplaceable means for proving the technical and operational feasibility of a new system.

e) EMMA recommends using automatic long-term system performance assessment tools in the field to get support for verifying and tuning the new level 1 & 2 system to meet the specific local requirements of an aerodrome.

The MOGADOR tool developed by DSNA has been refined within EMMA. The MOGADOR tool is an automatic system performance assessment tool that needs to know about local regulations and the airport environment in order to match the measured system surveillance output with the actual traffic. For this reason, the tool needs considerable adaptation to suit the airport specifics and the specifications of the used surveillance equipment in order to enable a correct automatic assessment of the system performance.

f) For the purpose of analysis and to progressively update and improve the safety net settings, it proved useful to retain electronic records of the alerts and the traffic situation.

g) Various trials of cockpit functions confirmed the relevance of the operational concept for situation awareness, safety enhancement and workload decrease. At the functions level, limitations of the respective cockpit mock-ups and of the operational context of real aircraft trials should be kept in mind in the assessments.

1.6.2 Operational Concept

In close cooperation with EUROCONTROL [6, 7, 8], based on ICAO [3], the operational concept for A-SMGCS Levels 1 & 2 was proven and strengthened by the implementation of Levels 1 & 2 A-SMGCS and extensive validation and verification activities at three different European airports: Milano-Malpensa, Prague-Ruzyně, and Toulouse-Blagnac. Controllers went as far as to work with the system in low visibility conditions, although this was not expected within the time-frame of the EMMA project. Measurement indicators and test procedures were defined and a significant amount of data was collected during the functional and operational tests. Controllers and pilots actively participated and contributed to the results.

In an additional innovative study, a preliminary concept and an implementation roadmap (details in chapter 1.7) for a complete A-SMGCS, considering higher-level services like routing, planning, and the air-ground integration, has been proposed to prepare the successor project EMMA2.

The EMMA A-SMGCS concept is described in the following EMMA documents:

- the Operational Service and Environment Description (OSED) [D136u]
- the Operational Requirement Document (ORD) [D135u]

All these documents make extensive references to the ICAO A-SMGCS Manual [3] and the EUROCONTROL A-SMGCS concept documents [6, 7, 8]. The EMMA A-SMGCS implementations and V&V activities focussed on EUROCONTROL's levels 1 & 2 concept, although EMMA outlined a more comprehensive concept that also considers higher-level A-SMGCS services (e.g. planning, routing, and on-board services).

The EMMA A-SMGCS concept, which includes both operational requirements and associated procedures, has been set out in document D135u (ORD). The EMMA concept states:

> "*The objective of an A-SMGCS is to optimise the efficiency, capacity and safety of operations at an aerodrome. The surface movement infrastructure existing at many airports today can be enhanced by providing positive identification of traffic, improving all weather situational awareness, improving communications and navigation aids, and by providing route planning tools.*" [D135u] (Compare also ICAO doc 9830, [3]).

Except for the "*improving communications and navigation aids by providing route planning tools"* aspects, which are higher-level A-SMGCS services to be covered in EMMA2, the above objective was proven with the EMMA A-SMGCS implementations in the simulator and on-site at the test airports. For instance, **the simulation trials revealed that A-SMGCS is able to reduce the average taxi time, the load of the R/T communication, and the controller's reaction time in case of a conflict situation.**

These operational improvement objectives, which were collected on a real-time simulation test platform, could also be confirmed with controllers' subjective statements in the field. Controllers were asked to estimate their perceived safety and efficiency when they work with A-SMGCS compared to earlier times when they did not use an A-SMGCS. Their positive answers showed that **A-SMGCS provides significant operational improvements that will result in operational benefits for all stakeholders of an A-SMGCS (see [D671] for more details). These results validated the levels 1 & 2 concept of an A-SMGCS.**

In addition to that, real-time simulations were carried out with Prague ANS CR and Malpensa ENAV controllers by using traffic scenarios of their own airport environment. These simulation trials were mainly used to substantiate operational improvements with respect to safety and efficiency.

All the main technical and operational requirements could be verified [D671]. For this purpose, technical short-term and long-term measurements were conducted. The three systems implemented by EMMA could not always meet the levels of performance published in international standards (e.g. 99.90% probability of detection), but the controllers felt that the observed level of performance (e.g. 99.65% probability of detection measure in Prague-Ruzyně) was acceptable anyway.

For the long-term system performance measurements, the MOGADOR tool was used to analyse the surveillance performance parameters automatically (for more details see [D112u]). This analysis tool could also be used to tune and adapt the A-SMGCS to meet operational needs.

The on-site trials revealed that controllers who have worked operationally with the A-SMGCS fully accept the A-SMGCS and thus approve its "operational feasibility". Statements like:

- "When visual reference is not possible, the displayed position of the aircraft on the taxiways is accurate enough to exercise control in a safe and efficient way.", and
- "I think that the A-SMGCS surveillance display could be used to determine that an aircraft has vacated the runway.", and
- "The information displayed in the A-SMGCS is helpful for avoiding conflicts.", and
- "The A-SMGCS provides the right information at the right time.", and
- "When visual reference is not possible I think the A-SMGCS surveillance display can be used to determine if the runway is cleared to issue a landing clearance."

have been significantly confirmed by controllers. The statements given above mainly refer to the surveillance service of the A-SMGCS, because ATCOs have not used the full scope of the monitoring and alerting function operationally. However, real-time simulations and real flight tests were used to create additional conflict situations (e.g. runway incursions, arrival-arrival conflicts, etc.). Results show that the controllers also accept the performance of the other alerts.

Validation of operational improvements was mainly performed through real-time simulations (RTS). The most important unexpected result of the RTS was that **A-SMGCS is able to reduce the average taxi time**. In total, the average taxi time was reduced by 5.5% and showed to be statistically highly significant with 358 total movements [D631]. Up to 18% taxi time reduction was measured in dense traffic scenarios. These results need to be confirmed in the field.

Furthermore, **A-SMGCS reduces the load of the R/T communication**. With Prague RTS, a statistically significant reduction of 16.0% was measured [D671]. This result needs to be confirmed in the field.

An additional operational improvement can be assumed with the **"controller's reaction time in case of a conflict situation": 5.3 seconds with A-SMGCS instead of 6.0 seconds** without A-SMGCS. The improved reaction time showed an interesting trend but was found to be statistically not significant. Further tests with a bigger sample size should reduce the ambiguity.

Controllers were also asked to estimate their perceived safety and efficiency when they worked with A-SMGCS compared to earlier times when they did not use an A-SMGCS. The following main results were gained:

- “When procedures for LVO are put into action, A-SMGCS helps me to operate safer.”
- “I think A-SMGCS can help me to detect or prevent runway incursions.”
- “When visual reference is not possible, I think identifying an aircraft or vehicle is more efficient when using the surveillance display.”
- “I think, also in good visibility conditions, identifying an aircraft or vehicle is even more efficient when using the surveillance display.”
- “The A-SMGCS enables me to execute my tasks more efficiently.”
- “The number of position reports will be reduced when using A-SMGCS (e.g. aircraft vacating runway-in-use).”
- “The A-SMGCS enables me to handle more traffic when visual reference is not possible.”
- “The A-SMGCS display gives me a better situational awareness.”
- “When procedures for LVO are put into action, A-SMGCS helps me to reduce my workload.”

Significant and positive results were obtained both from live and shadow-mode field trials [D671]. All those examples further support the hypothesis that A-SMGCS provides significant operational improvements that will result in operational benefits for all stakeholders of an A-SMGCS.

1.6.3 Safety Assessment

Before an A-SMGCS is actually made operational, a safety assessment should take place in order to provide a good understanding of the safety impact caused by the application of the system but also the safety impact in case of failure of elements of the system. The EMMA functional hazard assessment (FHA) (cf. the EMMA FHA report [D139]) was started when the EUROCONTROL safety assessment methodology (SAM) was still in its release 1.0. At that time, the split between equipment, people and procedures was unclear, so the EMMA FHA also includes some equipment-related analysis, closer to the preliminary system safety assessment (PSSA) steps of the current SAM (version 2.0). The FHA established a survey of existing A-SMGCS safety analysis, then identified hazards for each A-SMGCS level, focusing on hazards originating from equipment failures. For each of the identified hazards, severity indicators (i.e. hazard effects at aerodrome ATC level, exposure, and mitigation means that are external to the system) have been analysed in order to assign a severity. Two hazards were assessed as catastrophic (i.e. severity 1). The two hazards are similar but apply to different A-SMGCS implementation levels: "*in visibility condition 3, the controller does not detect the corruption of equipment surveillance data, and continues to use this corrupted surveillance data to ensure separation*". After the second FHA workshop (including representatives from all EMMA ANSPs), the severities were confirmed by drafting concrete outcomes. The FHA concluded on the specification of safety objectives, which were crosschecked with EUROCONTROL's generic A-SMGCS safety case. The FHA results will be integrated into the EMMA2 safety case, which will include a complete preliminary system safety assessment (PSSA) and system safety assessment (SSA) for high-level A-SMGCS.

1.7 Conclusions and recommendations

EMMA has made a further step to promote the use of A-SMGCS in all weather conditions by proposing adapted procedures [D135]. Within the EMMA project, A-SMGCS test-bed systems were installed, verified and validated at three different airports, in several real time simulations and by on-board installations in simulation. In addition, long-term testing was carried out on the operational A-SMGCS at Paris-CDG airport.

The EMMA consortium specified a comprehensive A-SMGCS concept incorporating surveillance, control, routing and guidance services as well as new onboard-related A-SMGCS services. EMMA delivered recommendations for A-SMGCS ‘*implementation packages*’ that are tailored to the user’s needs. A-SMGCS Levels 1 & 2 were implemented and tested at Prague - Ruzyně, Toulouse - Blagnac and Milano - Malpensa. Even if measured results did not always reach the ICAO requirements, the three A-SMGCS implementations demonstrated operational benefits. The three A-SMGCS implementations will be used as baseline for the follow-up project, EMMA2, during which more advanced A-SMGCS features will be added and validated. The specified concept supports the stepwise implementation of a complete A-SMGCS. This concept for the higher levels of A-SMGCS has to be given careful consideration due to the changing of operational procedures, shifting responsibilities from human to equipment, necessary harmonization between airports, appropriate qualification/certification of both ground control and onboard equipment, and latency of technical deployment on aircraft fleet

1.7.1 EMMA implementation steps for A-SMGCS services

The EMMA operational concept approach started with breaking down the existing EUROCONTROL Levels 1 & 2 concept [6, 7, 8] to a more detailed description of all individual A-SMGCS services including guidance, routing, planning, and on-board services, as well as an extension of surveillance and control services. This was done for each of the three main users of an A-SMGCS: air traffic controllers (ATCO), flight crews, and vehicle drivers:

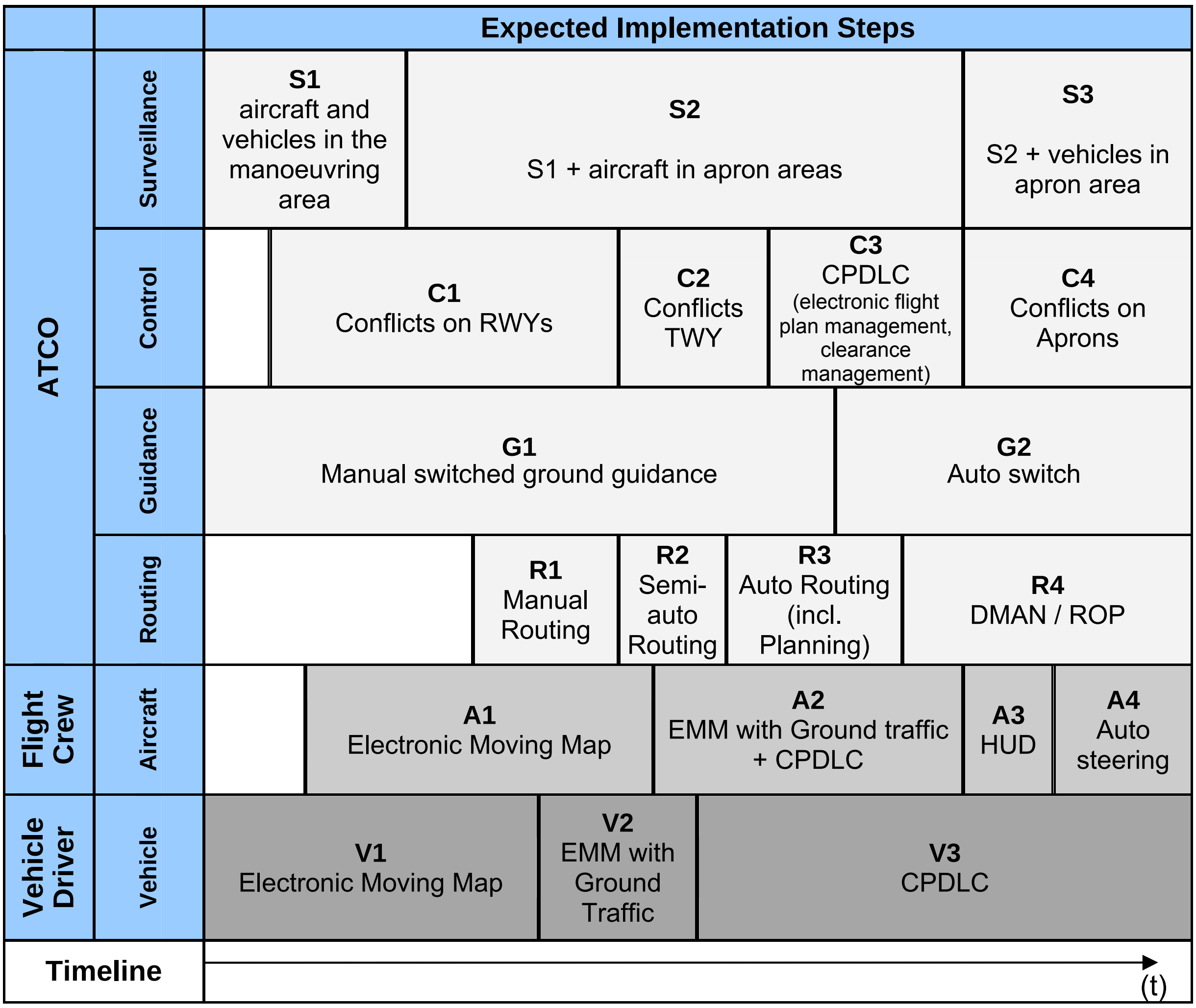

Figure 1-11: A-SMGCS services and implementation steps

ROP	Runway Occupancy Planning
EMM	Electronic Airport Moving Map
HUD	Head-Up Display
S1	Surveillance Service for ATCOs step 1
C1	Control Service for ATCOs step 1
G1	Ground guidance means Service for ATCOs step 1
R1	Routing Service for ATCOs step 1
A1	Onboard Services for flight crews step 1
V1	Onboard Service for Vehicle Drivers step 1

Figure 1-12: A-SMGCS services and implementation steps: Agenda

1.7.2 From implementation steps to implementation packages

Having defined evolutionary implementation steps for each A-SMGCS service the users can cluster them into implementation packages, which exactly meet their operational needs at the specific airport. To support this process, EMMA recommends special implementation packages in accordance to the specific airport needs, considering the airport complexity, traffic volume, and prevailing visibility conditions (OSED D131u).

Implementation of innovative systems at airports is driven by a number of factors, amongst which are the budget available, political pressure, and image. Several innovative systems have been site-accepted but never used due to a lack of consistency with other tools and the environment, a lack of procedures and training, or inadequate performance to the real needs. However, for the situations in which operational needs for an A-SMGCS are the main driving factor for its implementation, the implementation packages defined in EMMA (OSED D131u) are recommended so as to build up an acceptable equilibrium between equipment, procedures, and interoperability with adjacent systems.

The Integrated Project **EMMA** has lead to comprehensive results that supported the regulation and standardisation bodies, as well as the industry, in the early and efficient implementation of A-SMGCS. Significant progress in maturation of technical equipment and on operational issues such as proper transponder operating procedure was made.

EMMA and EMMA2 are important milestones towards a Europe-wide introduction of A-SMGCS in order to increase the safety, the throughput and the efficiency of airports in compliance with EUROCONTROL and in view of a worldwide ICAO standardisation. Both projects will support the SESAR initiative by close cooperation during the definition phase.

2 Contact and information

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2.2 Public Deliverables

Deliverables can be downloaded from the project website www.dlr.de/emma

No.	Deliverable name
D012	Database about gender aspects of EMMA human resources
D013	Final Public Activity Report
D031	Internet presentation of project
D032	CD-ROM containing all public deliverables
D033	Professional Video
D034	Final Plan for using and disseminating the knowledge
D111	State of the Art in A-SMGCS
D112u	CDG A-SMGCS data analysis
D121	ATM interoperability document, including Terminal co-ordination system, feasibility report
D121u	ATM interoperability document, including Terminal co-ordination system, feasibility report (UPDATE)
D131	Air-Ground Operational Service and Environmental Description (OSED)
D131u	Air-Ground Operational Service and Environmental Description (OSED) (UPDATE)
D133	General Safety Concept
D135	Operational Requirements document
D135u	Operational Requirements document (UPDATE)
D136	Human Factors HMI Requirements
D136u	Human Factors HMI Requirements (UPDATE)
D137	Training Concept for the Users
D139	Functional Hazard Assessment and very Preliminary System Safety Assessment Report
D141	High Level Air-Ground Functional Architecture document
D141u	High Level Air-Ground Functional Architecture document (UPDATE)

D142a	Technical Requirements document – Ground
D142au	Technical Requirements document – Ground (UPDATE)
D142b	Technical Requirements document – Airborne
D142bu	Technical Requirements document – Airborne (UPDATE)
D143	A-SMGCS related certification aspects
D151	Transition Guidelines for A-SMGCS
D161	Test site operations document for Prague Ruzyně, Toulouse-Blagnac and Milan Malpensa
D171a	A-SMGCS Data Link Situation 2008+
D171b	A-SMGCS Starter Kit for Regional Airports
D441	Report on the format, quality and quantity of raw system performance results for the Toulouse-Blagnac airport
D442	Specification of the measurement tools and assessment of their performance at Toulouse-Blagnac
D611	V&V Strategy document
D612	V&V test plan for Prague (simulation and on-site)
D616	Generic test and analysis plan for V&V of A-SMGCS
D621	V&V methodology for A-SMGCS
D622	V&V Indicators and Metrics for A-SMGCS
D631	Prague A-SMGCS V&V results
D641	Toulouse A-SMGCS V&V results
D651	Malpensa A-SMGCS V&V results
D671	V&V Analysis Report
D681	V&V Recommendations Report
D711	User Forum Meeting Minutes of Workshop1
D713	Meeting Minutes of Demonstration Day
D721	Conclusion of User Feedback
D731	Cross Recommendations to and from other Projects

2.3 Major dissemination events

Beside the events listed in the following table much coordination work took place in EMMA regarding the A-SMGCS activities, within:

- EUROCONTROL CCOM
- EUROCONTROL AOP
- EUROCONTROL Coordination Group
- EUROCAE: WG41

Date	Event	Place
2006-04-20	EMMA2 public launch	Malpensa
2006-04-17	SPIE Defence and Security Symposium	Orlando, Florida
2006-03-22	A-SMGCS Workshop: 2nd user forum	Prague
2006-03-21	EMMA Demo Day	Prague
2006-02-16	CAATS Workshop	Lanzarote
2006-02-14	ATC Maastricht	Maastricht
2006-01-30	C-ATM Meeting	Brussels
2005-10-24	A-SMGCS course	Luxembourg
2005-10-13	NASA / DLR / FAA Workshop	Braunschweig
2005-10-10	EUROCONTROL ATM Symposium	Braunschweig
2005-09-22	Airlines Feedback Meeting	Bratislava
2005-09-21	CPDLC Seminar	London
2005-09-20	ICAS Meeting	Prague
2005-09-15	FHA Meeting	Brussels
2005-07-20	EMMA – Flysafe Coordination Meeting	Toulouse
2005-06-27	FAA / EUROCONTROL conference	Baltimore (USA)
2005-06-24	FHA II Workshop	Prague
2005-06-22	ORD Workshop	Prague
2005-06-20	JISSA2005 Conference	Paris
2005-06-07	A-SMGCS Action Plan Meeting	Brussels
2005-06-05	SMA Workshop II	Toulouse
2005-05-19	OSED Workshop II	Toulouse
2005-04-05	FHA Workshop	Paris
2005-03-30	ACARE	Brussels
2005-02-01	ATC Maastricht	Maastricht
2004-12-16	Association European Airline	Brussels
2004-12-14	User Workshop to higher A-SMGCS levels	Toulouse
2004-11-30	Cross IP Meeting	Bretigny
2004-11-24	SESAME	Heathrow
2004-11-03	SESAME	Brussels
2004-10-26	DGLR Symposium: ATM Impact	Bremen
2004-10-15	1st EMMA User Forum	Luxembourg

2004-10-11	EUROCONTROL A-SMGCS Course and Exhibition	Luxembourg
2004-09-20	DGLR Symposium	Dresden
2004-06-21	ICAO / EUROCONTROL	Brussels
2004-06-14	ATM Symposium	Aronsborg
2004-06-06	LEONARDO	Brussels

2.4 References

[1] EUROPEAN TRANSPORT POLICY FOR 2010: *Time to decide*, White paper, Luxembourg 2001, ISBN 92-894-0341-1

[2] Busquin et. al.*: European aeronautics*: *A vision for 2020, meeting society's needs and winning global leadership*, Report of the Group of Personalities, Luxembourg, January 2001, ISBN 92-894-0559-7

[3] ICAO Doc. 9830, *Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual*, First Edition, ICAO Montreal, Canada 2004

[4] EUROCAE: *ED-87A Minimum aviation system performance specification for Advanced Surface Movement Guidance and Control Systems (A-SMGCS)*, Paris, January 2001

[5] EUROCONTROL (2004). *PRR8 An Assessment of Air Traffic Management in Europe during the Calendar Year 2004, Performance Review Report*, April 2005, Performance Review Commission, http://www.eurocontrol.int/prc

[6] Adamson P., *Definition of A-SMGCS Implementation Levels*, EUROCONTROL Brussels, Belgium 2003

[7] EUROCONTROL, *Operational Concept and Requirements for A-SMGCS implementation Level 1*, Edition Number 2.0, Brussels 2006

[8] EUROCONTROL, *Operational Concept and Requirements for A-SMGCS implementation Level 2*, Edition Number 2.0, Brussels 2006

[9] A Master ATM European Validation Plan (MAEVA**)**, *Validation Guideline Handbook (VGH)*, Issue 3.0, Isdefe, Madrid, April 2004.

[10] EUROCONTROL EXPERIMENTAL CENTRE, *EUROPEAN Operational Concept Validation Methodology (E-OCVM)*, Version 1.0, Makins, N., Brétigny, June 2005.

2.5 Figures

2.6 Abbreviations

Abbreviation	Meaning
ADS-B	Automatic Dependant Surveillance – Broadcast
AIP	Aeronautical Information Publication
ANS CR	Air Navigation Services Czech Republic
ANSP	Air Navigation Services Providers
A-SMGCS	Advanced Surface Movement Guidance and Control System
ASR	Airport Surveillance Radar
ASTERIX	All purpose Structured Eurocontrol Radar Information eXchange
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
AUEB	Athens University of Economics and Business
BETA	operational Benefit Evaluation by Testing an A-SMGCS
BSC	Braking and Steering Cue
CPDLC	Controller Pilot Data Link Communication
CWP	Controller Working Position
DEFAMM	Demonstration Facilities for Airport Movement guidance control and Management
DSNA	Direction des Services de la Navigation Aérienne (French Air Navigation Services)
EASA	European Aviation Safety Agency
EMM	Electronic Moving Map
ENAV	Italian Company for Air Navigation Services
E-OCVM	European Operational Concept Validation Methodology
ESARR	EUROCONTROL Safety Regulatory Requirement
EUROCAE	European Organisation for Civil Aviation Equipment manufacturers
EUROCONTROL	European Organisation for the Safety of Air Navigation
ETG	EuroTelematik AG
FAA	Federal Aviation Authority

Abbreviation	Meaning
FCL	Flight Crew Licensing
FHA	Functional Hazard Assessment
FP	Framework Programme
GND	Ground
GTD	Ground Traffic Display
HMI	Human Machine Interface
HUD	Head Up Display
ICAO	International Civil Aviation Organization
JAA	Joint Aviation Authority
JAR	Joint Aviation Requirement
LVO	Low Visibility Operation
LVP	Low Visibility Procedures
MAEVA	Master ATM European Validation Plan
MLAT	Multilateration
MMD	Moving Map Display
NOTAM	Notice To Airman
OSED	Operational Service And Environmental Description (EMMA)
RTS	Real-Time Simulation
RVR	Runway Visual Range
SAM	Safety Assessment Methodology
SDF	Sensor Data Fusion
SESAR	Single European Sky ATM Research
SMA	Surface Movement Alerting
SMR	Surface Movement Radar
TATM	Thales Italia
THAV	Thales Aerospace
TIS-B	Traffic Information Service - Broadcast
TREN	Transport and Energy

Abbreviation	Meaning
TUD	Technische Universitaet Darmstadt
TWR	Tower
TWY	Taxiway
V&V	Verification and Validation
VGH	Validation Guideline Handbook

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