Conclusion of User Feedback

Michael Roeder
DLR

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1 Scope of Document

This A-SMGCS user feedback compilation shall describe the users' conclusion on A-SMGCS; its development, implementation, expected benefit and possible concerns.

2 Introduction

Initially it was intended to gather the users feedback through two independent user forums; the first one was held at Luxembourg on the 15th October 2004,( ref 1).

After having evaluated the rather limited results from this first venue the consortium decided to more directly approach end-users and to get their feedback on site:

- Airport visits
  - Madrid
  - Palma de Mallorca
  - Amsterdam-Schipol
  - Paris CDG (is involved directly into the EMMA Project)
  - London Heathrow

and

- a Demonstration Day together with a Workshop (Prague)

were thought to be a better way how to get first hand feedback from the respective stakeholders. Beside this, this document gathers other A-SMGCS feedback from European and USA projects.

3 EMMA First User Forum Luxembourg

3.1 Purpose

The main objectives of the user forum are to present the work being carried out within the EMMA project to the aeronautical community and to bring together people working on A-SMGCS in order to cross feed experience between various activities and obtain feedback from experts in specific topics. The intention was to have a highly proactive workshop audience during the sessions.

3.2 Organisation

The user forum was structured in two sessions. The first one was devoted to present in detail the EMMA project, providing the audience a global picture and explaining the need for the EMMA project, in addition to show the expected benefits from an ANSP perspective. The second one was devoted to show the benefits for ANSP-airport users and for flight crew that could be obtained thanks to the A-SMGCS, as well as the final conclusions.

After each presentation the attendees raised several comments and questions which might be concluded as follows.

3.3 Conclusions on comments and questions by the audience

A wide area of topics was voiced ranging from technical, functional, operational and legal issues to a more general discussion about the timeframe for implementation which was seen as rather optimistic.
Out of these discussions very limited conclusions could be derived; mainly three areas of concern were voiced.

1. Because the individual CAA/DGAC’s as regulatory authorities are not participating in EMMA and their competence is limited to national issues ICAO will have the saying in almost all aspects of A-SMGCS.

2. In regard to cost benefit considerations imposed on airports and airlines for the equipage of their vehicles and airliners it was emphasized that EMMA 1 as a research project was lacking a sound business model which only could be provided when functionalities were further explored and defined.

3. A-SMGCS and especially the proposals and results of EMMA must be communicated to end-users in a much broader way; this 1st User Forum failed to derive sound conclusions even from the limited number of attendees not adequately representing the end-user community.

4 Airport Visits

These site visits followed two main objectives:

1. Getting feedback about the work carried out in EMMA to support EMMA in adapting to new objectives.
2. Supporting airports by providing solutions to there specific constraints.

4.1 Madrid Barajas

![Figure 4-1: Layout of Madrid Barajas](image)
4.1.1 Reasons for A-SMGCS

- The main reason for wanting A-SMGCS is the high movement rate and the handling of Ground Movements.
- Identification of aircraft is the main problem. A-SMGCS would provide controllers with better situational awareness that could give safety and capacity improvements.
- Low visibility is also an issue (there are 4-5 days a year with these conditions).
- Mr. Sanz explained that there was an accident at Barajas 7 years ago that could have been avoided with A-SMGCS.
- Due to the size and layout of the airport with the 2 new runways and the 2 new terminals, taxing procedures and co-ordination get really complex. There are complex taxi flows and bottlenecks in the central area. As an example of this, an aircraft taxing can cross 3 or 4 different GMC sectors spending just a couple of minutes in some of them. In this case, better surveillance and automatic conflict detection would be very valuable.

4.1.2 Sensors, Technology and Capabilities

- There are two SMRs installed and in operation; one on the Central TWR and one on the South TWR.
- MLAT is not installed at all (and it seems it will not be installed before 18 – 24 months).
- To cover all parts of the apron, cameras are needed.
- 3rd (West) Tower will be opened soon. (Only to cover the new apron at Terminal 4, gates at the back of the terminal are not to be covered by the new tower)
- SACTA (a system that integrates and displays information from different ATC systems) is being extended to cover the needs of APP/TWR. This is part of a project called VICTOR (Integrated Visualisation for Control Tower). It should be ready to incorporate information from MLAT in 1 month.

4.1.3 Procedures

- Currently there are no special procedures for A-SMGCS.
- During night, noise abatement procedures are defined (only use of 36R for departures and 33L for arrivals).
- Procedures for departure management control define a limit of 20 traffics (from start up clearance to take off) in North Configuration and 15 traffics in South Configuration.
- Madrid/Barajas personnel showed great interest in the need for new procedures. They wanted to know about the type of information available about procedures from EMMA or EUROCONTROL. Their intention was to use this in the future to define their own procedures at Madrid/Barajas airport.
- Flight crews often keep the transponder on when it should be in Standby. It seems they are not familiar with the correct procedure, which they should be using even though A-SMGCS is not yet implemented at Madrid/Barajas airport.
4.2 Palma de Mallorca

Figure 4-2: Layout of Palma de Mallorca

4.2.1 Reasons for A-SMGCS

- Low visibility is the main reason for need of A-SMGCS (there is often fog in the morning from 05:00 to 10:00). This can mean that most of Air Berlin fleet arriving from different German airports has to be diverted as they are arriving in peak hours between 04:00 and 08:00.
- Safety improvement in LVC.
- Severe reduction of capacity in LVC.
- Under LVC aircraft keep landing but they cannot handle them easily due to the shortage of stop bars. There is no guidance lighting on the aprons.
- Situational awareness is not very good with simultaneous take-offs/landings, as from the position in the TWR the ATCo can only see one runway at a time.
- Problems with some pilots that do not speak English or Spanish as their native language. It happens sometimes that they report to be in the wrong stand.
- Many stands are not visible from the TWR

4.2.2 Sensors, Technology and Capabilities

- An SMR has been installed on the Palma control tower but it did not meet the AENA requirements. It has been replaced and is expected to be working in April 06.
- MLAT is installed and working (implemented by ERA), but is not in operational use, because of missing operational displays and approval for use. A total of 20 sensors have been installed.
(18 receivers and 2 transponders). The sensors provide a full coverage of the movement area (stands included).

- It is planned to install a new version (3.5) of the SACTA integrated display system. Until this is completed no further progress towards A-SMGCS implementation can be done.
- It is planned to equip follow me cars with transponders and they should be the only vehicles on the manoeuvring area.

### 4.2.3 Procedures

- Currently, there are no special procedures defined for A-SMGCS.
- There are no procedures defined for departure management control. Pushback and taxi clearances are given as soon as pilots report that they are ready.
- Normally no mixed-mode operations (1 runway for departures, 1 for arrival)
- During night, noise abatement procedures are applied (only use of 06R or 24R for departures). No landings on 06R.
- Use of reverse thrust is not allowed at night.
- Main problems are taxi-procedures in LVC:
- There are long distances to taxi and only 3 stop bars to segment the traffic. Only one movement at a time in each segment is allowed in LVP when RVR<350m. There are fewer than 8 movements per hour in this case (aprox.).
- The movement rate falls to 8 movements per hour under these conditions. During LVPs when RVR>350m traffic is restricted to 8 mov/hour.
- There are problems for the controllers in case of simultaneous departures from both runways.
- Intention is to include transponder-operating procedures in AIP in order to start raising awareness of flight crews in its use when operating in Palma.
4.3 Amsterdam Schipol

Figure 4-3: Layout of Amsterdam Schipol

4.3.1 Reasons for A-SMGCS
- High capacity required in all weather conditions.
- Increase of situational awareness of all sector partners
- Competition with other European airports

4.3.2 Sensors, Technology and Capabilities
- 3 Surface Movement Radars
- Digital SMR plot extraction
- 2 Terminal Approach Radars
- Mode S MLAT sensors provided by SENSIS (1997)
• Use of ≈ 250 vehicle transponders. At the moment the meeting took place, only 60 vehicles were equipped. Estimations from LVNL show that with 250 equipped vehicles there should be no problem of capacity to interrogate, etc
• Airport Surveillance Tracker (ASTRA)
• Runway Incursion Alerting System Schiphol (RIASS)
• Current TWR HMI adapted for A-SMGCS
• Disregard of ADS-B data for aircraft surveillance
  o INS data can be corrupted
• Correlation window technique
  o Automatic algorithm try to prevent false correlation due to Mode-A input errors
• New HMI displays for AAS (Towing control + Airport Operations Management)
  o Label is extracted when the mouse cursor is moved over the target. There is an automatic check of the integrity of the label which shall not overlap.

4.3.3 Procedures
The procedures have been modified in line with the introduction of A-SGMCS level 1. An example of this is the traffic handover; in the past, when an ATCO transferred an aircraft to another ATCO, he had to pass the flight strip physically and to point at the position of the aircraft on the SMR display. Almost the same change has been applied to the handover of traffic between TWRs. In the past explanations about the position of the aircraft had to be given by telephone.

Pilot position report is still expected when vacating the runway.

The reduced separation on the runway procedure is not applied at Schiphol.

Performance of A-SMGCS systems at Schiphol has been checked under adverse weather conditions. This is especially important for SMRs the performance of which can be affected by heavy rain.

4.3.4 Functions and Reliability
Today there are no specific plans in future A-SMGCS functions such us routing, guidance, DMAN, etc. It is preferred to focus on the near future, concerning CDM-like initiatives using A-SMGCS data. However, route deviations, even with familiar pilots, happen rather frequently.

Training on A-SMGCS was composed of a theoretical part (manuals, handbooks, etc) and a practical one. Total time spent per ATCO was 1.5 days.

In case of a system breakdown Schipol would return to current procedures. The transition to these procedures was described in the quick reference manual at the CWP.

4.3.5 Verification and Validation
• A lot of verification is done by involving controllers in the development and acceptance of the systems. Though the original intention of Schiphol was to use EUROCAE and/or ICAO requirements, these requirements were not used because they were considered outdated. Experience and requirements used by Fraport and Heathrow airports served as a basis to produce requirements for Schipol A-SMGCS system.
• There are monitoring tools running continuously. Feedback from ATC about irregularities or encountered problems is a useful way to initiate extra manual checks of the system performance in specific areas.
• Some simulations to evaluate the efficiency, capacity, workload and safety of A-SMGCS had been run.
• Measurement of frequency occupancy has been made by the manufacturer of the MLAT system. An analysis of the impact on taxi time, delays and other parameters has started.

Description of the encountered implementation problems:
• Non-ICAO compliant transponders
• False APP radar-tracks
  o 30-50% of the aircraft reply on the ground to SSR A/C interrogations
  o 15% of the aircraft reply on the ground to Mode S all-call interrogations
  o Special radar-filters required
• No MLAT tracks
  o Wrong wiring of most SAAB-2000 aircraft
  o Individual cases of wrong wiring of other aircraft types
  o Reliability of vehicle transponders.
• Previous generations failed performance requirements
• Latest models under evaluation
• Low compliancy to transponder procedures
  o Deviations:
    ▪ Use of the “old procedure” at runway
    ▪ Transponder is active all the time
    ▪ Mode A code set to 2000 after leaving the runway
    ▪ Procedures published in AIC, AIP and NOTAM
    ▪ Corrections via addressing of individual airlines
    ▪ Now increasing through R/T feedback
• MLAT-stability at gates and hangars
  o Caused by active transponders of parked aircraft
  o Initiates an oscillating effect
  o Lot of MLAT tuning required

It was explained that no cost benefit analysis had been made prior to the decision to develop the system, but that there were strong arguments in support of its implementation. Schiphol wants to remain one of the most important airports in Europe that needs to be ready to compete with other European airports.
4.4 Paris CDG

Figure 4-4: Layout of Paris CDG

4.4.1 Reasons for A-SMGCS

Following data will explain the reasons to go with A-SMGCS:

- Paris–Charles-de-Gaulle is the largest airport in France, and the first in Europe for aircraft movements.
- It is the 8th airport in the world for passenger traffic.
- In 2001 it had 48 million passengers, and 592 000 aircraft operations.
- Peak day in 2000: August 31: 1662 aircraft movements (departures and arrivals).
- Paris–Charles-de-Gaulle is located in the North-East of Paris City, at about 40 km.
- Very near this airport, stands Le Bourget airport, which specialises in general aviation (corporate travel) and taxi flights: 50 000 IFR and 10 000 VFR flights in 2001.
- In the south of the city is Paris’ other large commercial airport: Orly.
  - 25 million passengers
  - 250 000 flights
- They are all part of the large Paris TMA, and the ATC operations are handled by two approach centres, one in each airport.

4.4.2 Sensors, Technology and Capabilities

1. Installed systems/components

- **A-SMGCS Level 2**: surveillance functions + SCA functions
- **ASR**: 3 STR installed (Flight Radar Data Processing Systems)
- **SMR**: 4 SMR installed
M-Lat (Mode-S): 18 transceivers and antennas
Electronic Flight Strips (TWR and Apron): Discus system
SCA system: RIMCAS system
Vehicle tracking system (Mode-S): Syletrack system

2. Functional Architecture

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\caption{Functional Architecture at CDG}
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4.4.3 Procedures

- Paris–Charles-de-Gaulle is made of 2 pairs of parallel runways. Independent operations are conducted between both pairs, and within each of them, one runway is dedicated to departures, and the other to arrivals. However, the northernmost runway is not yet operational, so its neighbour is operated in mixed mode since summer 2002.
- This configuration allows a peak capacity of 121 flights per hour.
- This layout can explain the high taxi-times on the airport in an average of around 20 minutes.
- There are two main terminals:
  - Terminal 2 is dedicated to Air France’s hub, and its partners
  - Terminal 1 handles most other airlines
- Three different centres control air Traffic in the Paris area:
  - the Paris ATCC in charge of flights between the TMAs and the en-route phase
  - the Paris-Charles-de-Gaulle Approach control centre, responsible for the northern part of Paris TMA, dealing with approach for Charles-de-Gaulle and Le Bourget airports
  - the Orly Approach control centre, responsible for the southern part of Paris TMA, dealing with approach for Orly, Toussus and Villacoublay airports
- The two approaches, being closely linked, have to assume control for some flights that pass through their airspace coming from or going to airports on the other side.
- Charles-de-Gaulle airport is made of 4 runways. They are all east-west oriented, and organized as 2 sets of 2 parallel runways. Both sets are completely independent.
  - Within each set, the inner runway is dedicated to departures; the outer runway is dedicated to arrivals.
- Operations around the airport tend to be more and more separated between two geographical independent parts. The northern part is made of north runways, north arrivals, terminal 1 and its
taxiways. The southern part is made of south runways, south arrivals, terminal 2 and its taxiways (see figure 1).

- On Paris-Charles-de-Gaulle airport, one approach room and two control towers, north and south, share responsibility for the area.
  - In each of them, several Air Traffic Controllers working positions can be found.

### 4.4.4 Functions and Reliability

**Proofed/certified systems/functions**

At the present time, there is no certification process for ATC tools. However, all systems have verified and validated by ADP and STNA (DNA technical services) before use in an operational context.

**Reliability**

All systems are reliable: it is one of the criteria in the V&V process performed by ADP and STNA. All systems are available 24h a day. The redundancy of the system and of the sensors guarantees their availability.

**Existing Problems**

In order to improve RIMCAS system, it is necessary to make the input surveillance data more reliable. False detection (fixed plot, grass, etc.) generate false alerts, which may have an impact on controller workload. EMMA project WP1.1 will help identify the main causes of false detection and false alerts and give recommendations for the improvement of the system.

### 4.5 London Heathrow

![Layout of London Heathrow](image)

**Figure 4-6: Layout of London Heathrow**

#### 4.5.1 Reasons for A-SMGCS

Following data will explain the reasons to go with A-SMGCS:
This complex airport has 10 controller working positions:

- two Tower Controller (TC1 + TC2),
- two Ground Movement Controller (GMC1 + GMC2),
- two Ground Movement Planner (GMP1 + GMP2),
- two Light Board Assistant (LB1 + LB2),
- one Flight Strip Printer Assistant (FS), and
- one Supervisor Position

In accordance to the runway configuration the TC positions can be adapted easily. With runway 27R/27L in use the TC facing eastwards and with 09L/09R they are facing westwards by simply rotating their chairs by 180 degrees. This is easily manageable because there are two redundant CWP for each Tower Controller. TC1 is responsible for 09L/27R and TC2 is in charge either for 09R or 27L.

With the Ground Movement Controller (GMC) and also the Light Board Assistants (LB) share the responsibility of the movements on the aerodrome: GMC1 and LB1 are responsible for northwest part whereas GMC2 and LB2 are responsible for the southeast part. With this work share it could happen that for a single flight 6 handover have to be performed. However, NATS controllers are used to it and estimate it very uncritical.

The Ground Movement Planner (GMP) grants the departure clearance including SID, SSR Code, ATIS, RWY, and Start up Clearance. The GMP aims to establish the best sequence by granting the start-up clearance by close co-ordination with the Ground Movement Controller.

All positions, except of LB and FS are equipped with A-SMGCS display.

**Gate Management**

The aerodrome movement control is completely performed by NATS from their Control Tower. There is a local Gate Management Centre that is managed by the Airport itself. The Gate Management has very close contact to the airlines to enable a very flexible gate allocation. Co-operations between NATS and the Gate Management are very loose as NATS is only interested in the result of the gate allocation process.

**Approach Control**

The Approach Centre is not situated at the airport but 1,5km away the airport. The arrival flight strips are printed out at the Tower 40 minutes in advance. They have no access to A-SMGCS information.

**Departure Control**

They are connected to the A-SMGCS – they are provided with the pushback event that helps them to manage the real capacity demand more in advance.

The predominating runway use is a single mode with runway 27L and 27R. Arrival runway and departure runway are equally alternated over the day to prevent noise concentrations to the surrounding airport areas. RWY23 is not used anymore as a runway but as a taxiway. Runway 09L is not used for departures because of noise restrictions with an adjacent residential area.

**4.5.2 Sensors, Technology and Capabilities**

There are following systems installed (July/2004):

- 2 x ASR: There are two different ASR in the centre of the airport very close to each other. The radars are working with different wave length, range and accuracy.
1 x SMR: There is one Surveillance Movement Radar on top of the Tower building in the centre of the airport. 2 additional SMR outside the runways planned for 2005

15 x M-LAT antennas: 9 antennas outside of the runways, 6 inside, operational since November 2000

Electronic Flight Strips: There are no EFS for the time being. However, printed flight strips are aimed to be replaced by EFS when moving to the new Tower building. Software will be taken from NAV Canada, because London Stansted uses this software too.

SDS: The output of the surveillance data server is one position report per second. The incoming sensor information is weighted differently, e.g. MLAT is more significant than SMR information and SMR information are even suppressed with the alerting function. The SMR information is displayed to the ATCO without any filtering. The SDS is operational since November 2002.

Vehicle tracking system (Mode-S): Very less vehicles equipped, i.e. there are also unequipped vehicles on the runway. At the moment they investigate the performance and the potential benefit of vehicles equipped with co-operative sensors. In case of positive results they want to equip more vehicles

RIMCAS: For the moment the system is only used as an additional assistance system or an additional safety net. The system is not adapted to different visibility conditions.

4.5.3 Procedures by using A-SMGCS Level II

NATS still applies usual SMGCS procedures by using the A-SMGCS as an additional monitoring means to support them with their control task. However, the system performance is rated as rather high and they could imagine using the system as the primary means for detection and identification.

Labels on the gate are suppressed to prevent confusion by too many labels on the A-SMGCS screens. Too many labels are caused by plenty of movements and by pilots who forget to switch of their transponder after reaching the parking position. Further on, the probability of identification at the gate area is not as good as needed to rely on. If the aircraft is pushed out of the suppression area it is labelled automatically.

4.5.4 Functions and Reliability

Surveillance

Surveillance performance has not been measured objectively but it is estimated very high by the controllers. With the A-SMGCS display an algorithm has been established that prevents an overlapping of labels what is absolutely needed with the mass of departures.

There is only one SMR on the top of the Tower building, so that the surrounding terminals cause shadows which impair the detection of non-cooperative target. With these areas only detection of co-operative targets is possible (MLAT). Further on, buildings and parking aircraft cause shadows on the runways that appear as false targets occasionally. These surveillance lacks shall be treated with two additional SMRs that are built up in the centre outside the runways in 2005.

ADS-B receiver is installed but not used due to interferences with ASR und SMR when processed by the SDS. Further on, inaccuracy with the sensor is assumed. NATS would estimate that 10 to 15 percent of aircraft operating on London Heathrow are ADS-B equipped.
The correct transponder operating procedures of the aircraft, as described with the Eurocontrol AIC, is regarded by the pilots by nearly 100%. If the transponder has not been set correctly, the controllers request the right transponder setting via radio.

**Alerting System**
Controllers are very satisfied with the RWY incursion alerting function (RIMCAS). The alerts are bounded to runway incursions only; there is neither a prediction nor taxiway conflict detection.

Since the alerting performance is dependent on the quality of the surveillance they have also many false/unwanted targets that evoke unwanted alerts. False alerts are very disturbing at night and in LVC because they can hardly be verified or falsified by looking out of the window. Also double targets during take off that are caused by the same aircraft, are observed and release false alerts. That’s why NATS decided that the alerting function only bases on co-operative targets.

Missed alerts, that is, a real conflict situation that has not been detected by the alert function, has never been observed.

**Ground Guidance Means**
There are green taxiway centre lines that can be switch from segment to segment. A segment is framed by two red stop bars. When a stop bars is set on to red, the green centre lights are illuminated automatically reaching from the local aircraft position up to the red stop bar. This kind of guidance is only used at night and in LVC. It is operated by two Light Board assistant whereas each of them monitors the GMC radio frequency northwest and southeast, respectively.

**Current Constraints and Plans for the Future**
NATS stated that there are no current constraints in terms of traffic demand and capacity for the time being. Higher levels of A-SMGCS are not considered for the near future. The airport layout is judged as too complex to be coped by an automatic planning function. The same to CPDLC: It is not judged to be necessary for the near future.
5 Demonstration Day and Workshop in Prague

Figure 5-1: Layout of Prague Ruzyně

5.1 Purpose
The main objectives of this two day event are to present the work being carried out within the EMMA project to the aeronautical community and to bring together people working on A-SMGCS in order to cross feed experience between various activities and obtain feedback from experts in specific topics.

Mr. Hubert from ANS-CR expressed how important that type of projects and initiatives are for the aviation community and said that one of the main reasons to go for the implementation of A-SMGCS in Prague were the results of the BETA project.
Ms. Hana Černochová from CSL said that due to the increasing demand in Prague, the airport needed to search for new solutions and thanked EC for their support to achieve this.

5.2 Organisation
At the first day the main focus was laid to the site visit of the EMMA installations at the Prague Tower and Apron Control. On the second day the EMMA results were presented to the audience for starting a discussion. These presentations were structured in three main aspects:
- Concept and requirements
- Safety aspects
- Introduction of the continuing project EMMA2
5.3 Conclusions on comments and questions by the audience

A wide area of topics was voiced ranging from technical, functional and operational to legal issues. After each presentation the attendees raised several comments and questions which might be concluded as follows:

- **EMMA’s methodology** can be used by any airport and that the same questionnaires were used to better compare the results between different test sites. Interviews were also used to complement and validate the results from the questionnaires.
- **Briefing sessions** took place before the questionnaire was given to ATCOs. The objective of these sessions was mainly to inform them about the objectives and avoid misunderstanding of the questionnaires.
- **During the trials, it was checked that** alerts were correct in different situations and that they appeared at the right time.
- **Monitoring and alerting service** must be well tuned to fulfil the user’s requirements and that this tuning process takes time. When the alert performance drops (e.g. unwanted alerts due to false targets caused by snow reflections for instance) a supervising controller decides to switch them off.
- **A tool for continuous monitoring** is very useful. For future phases (EMMA 2), it would be interesting to distinguish between results for different areas (apron, taxiways, etc) and for different sensors.
- **It was highlighted leaving to users the definition of target values, such as the level of accuracy required, is ambiguous and could bring problems due to different interpretations.**
- **Validate technical standards** are the supreme goal. They would allow installing an A-SMGCS without an effortful proving whether the requirements are valid or not. However, the EMMA results do not say if lower accuracy performances would also be sufficient to fulfil the user requirements. This bears the risk that too rigid performance requirements can prevent cheaper installations with smaller airports for instance. However EMMA recommends keeping the 7,5m reported position accuracy to guarantee a solid surveillance performance that supports the implementation of additional A-SMGCS services like control or onboard surveillance.
- **The transponder operating procedures and transponder technical requirements already exist and referred to ICAO Annex 10 volume 4.** All pilots would follow transponder operating procedures if they were part of the airlines checklist. Some airlines have been informed but are reluctant to do it. It is needed to make airlines aware of the benefit applying this procedure would bring. IATA has made airlines aware of this and that it is being co-ordinated.
- **The level of safety should be increased by the introduction of A-SMGCS rather than maintained. With the increasing level of traffic, not improving safety would imply having accidents every day.** ICAO sets a target level of safety but does not specify that this value need to be improved. These target values were set 20 years ago and are now obsolete. The first step is to consider that the safety level is not reduced, and that EMMA-2 will allow to make measurements (SSA) to know were we are currently in terms of safety. In addition, setting too hard requirements could imply killing the development of certain products that would bring benefits. EUROCONTROL’s safety case proved that A-SMGCS together with other initiatives such as CDM can serve to increase the current level of safety.
- **EMMA proposes (and Prague already does it) that only co-operative targets should enter the manoeuvring area, particularly in low visibility conditions.** With such a procedures controllers could also live with one non-identified movement. To prevent a label swapping EMMA recommends to drop the label information when the system does not get a valid update of the MLAT – this setting would rarely reduce the severe safety impact of a wrong label. It is better to have no label than a wrong one.
- **It is a good idea to use different service levels but it will be needed to pack and set priorities in order to be PAN EUROPEAN. It will take a long time to implement and that it is a task that cannot be carried out within 2 years.**
• EMMA should approach not only airports but also airlines, and get them on board by justifying that behind A-SMGCS there is an economical benefit for them. For instance in Australia all airlines need to prove and certify their transponders, otherwise they would not be allowed to fly under ADS-B procedures. IATA is looking forward to the results of the cost benefit analysis. A small reduction of the taxiing time implies a big reduction of costs for airlines but they need to see clear facts about the benefits.

6 Further A-SMGCS developments in Europe and USA

This chapter describes some examples of surface-related research efforts in Europe and the US. In addition, the Surface Management System (SMS), a tool developed jointly by NASA and the FAA [16] with the focus of the discussions related to US surface tools. Other US work like AMASS, ASDE-X, etc. is referenced; however, this chapter does not attempt to address the entire body of research for those tools. There is much more work on A-SMGCS worldwide thus, results from following different projects
• the EUROCONTROL A-SMGCS project
• the NASA SMS project
are taken as representative samples.

A previous comparison [4] of US and European airports, found airports and runways on both sides of the Atlantic are managed with sufficient similarity to be compared. There, it is shown that the considered approaches from Europe and the US fit together into the ICAO A-SMGCS concept and that considerable operational benefits can be expected in terms of enhancing efficiency and safety for airport operations.

Results from two different projects in the US and in Europe are reported, analysed and compared. As stated previously, these results reflect data collected from examples of the A-SMGCS work in Europe and in the US, and do not represent all relevant surface research efforts. Especially in Europe the A-SMGCS development was and is driven by additional projects and also by the users themselves. More and more airports and ANSPs becoming aware of the necessity of A-SMGCS and are pushing this development. Further information can be found in [17] wherein following projects are summarised in more detail:
• BETA
• ATOPS
• DEFAM
• LEONARDO

The conclusions and outlook in chapter 7 based also on these projects.

As the benefit of an A-SMGCS is dependent on the specific situation of the individual airport and the numerical values measured, these tests are not fully comparable with regard to the indicators mentioned. However, the comparison of the qualitative findings shows that a certain trend is observable.

6.1 Europe

6.1.1 EUROCONTROL A-SMGCS

The real-time A-SMGCS simulations for the two airports, Paris Orly and Charles de Gaulle (CDG), were conducted on the SALSA-SALADIN platform, developed by the CENA. The aim of the real-time simulation sessions was to assess the benefits and/or difficulties associated with the implementation of A-SMGCS level I (automatic multi-sensor surveillance including positive
identification) and II (additional alerting e.g., of runway incursions) in comparison with a baseline system (SMR only, without identification). Five simulation sessions (20 days) were organized, involving 15 air traffic controllers from CDG and Orly airports in total.

In order to compare A-SMGCS level I and II [5,6,7] and baseline system (i.e., SMR), different experimental conditions were included during each simulation session, namely: the rotation of the ATCOs on three working positions, the visibility conditions (VIS1, VIS2 and VIS3), the traffic samples, and the insertion of disruptive events. Training sessions prepared the ATCOs and pilots for the A-SMGCS procedures.

- In total, 45 real-time exercises were run, representing 34 control hours (11h30 in VIS1, 15h in VIS2, 7h30 in VIS3).
- During each session, three ATCOs (runway, Ground and Ground Assistant) were presented with nine scenarios (45 minutes each).
- More than 25,000 radio communication exchanges took place between ATCOs and pilots, representing 2300 managed aircraft (about 1900 landings and take-offs). When level I or II was in operation, about 650 identification procedures (in VIS2/VIS3 conditions), 50 multiple line-up in VIS2 conditions, 600 line-up procedures, and 5500 traffic information and air traffic control instructions were issued by ATCOs (e.g., sequencing and handling taxiway conflicts in VIS2/VIS3).
- During reduced visibility conditions, ATCOs were presented with a total of 150 special events (runway inspection triggering a go-around, aircraft lining-up before take off, arriving aircraft crossing departure runway without clearance, aircraft and vehicle problems, aircraft lost, etc.).

Relevant data were collected during and after the real-time simulations, but it should be kept in mind that as realistic as the SALSA-SALADIN platform is, it presents some limits for analysis. Conclusions from real time simulations should be generally validated through field trials. The data collection method was either performed by automated means (e.g., the record of the taxi time), or gathered through observations and questionnaires (e.g., the errors committed by ATCOs).

### 6.2 USA

The following sections presents the test conditions from the US related to SMS, AMASS and ASDE-X systems’ development. Results of these tools are reported in later portions of this paper.

#### 6.2.1 SMS

The phase-1 build of SMS was developed through a series of studies, simulations and shadow mode trials, involving potential users throughout the research process. Two real-time simulations in NASA Ames’ Future Flight Central simulator, of an air traffic control tower (ATCT), in 2001 and 2002 allowed assessments of ATCOs information requirements and guided the development of SMS. The system was refined during trials at an airline ramp tower in 2002. The testing culminated with an operational trial that took place at Memphis International Airport, in September 2003, which had been the focal development airport for SMS due to its advanced surface surveillance capabilities.

The operational trial sessions were conducted simultaneously at four locations around the airport: the Memphis ATCT, Memphis TRACON, Memphis Air Route Traffic Control Center (ZME), and an airline ramp tower. SMS displays were set up on the operational floors of these FAA facilities and at the participating airline. Three ATCOs from the Memphis ATCT/TRACON facility, three Memphis ARTCC (ZME) Traffic Management Coordinators (TMCs), and the on-duty ramp controllers from the airline (10 controllers over all the sessions) took part in the operational trial sessions. Five eight-hour trial sessions were run over five consecutive days.

The focus of the trial was on the SMS traffic management tools. ATCT participants, using the SMS prediction and planning tools, supplied traffic management suggestions to the on-position controller,
who had the authority to reject or accept the same. ZME participants used SMS in conjunction with their other tools, as did the TRACON and ramp tower controllers. Data were collected through the system, questionnaires, and interviews in a similar manner to the BETA project. These last two methods covered research questions listed as 1, 6-8, 11-13, 19 and 20 above, and asked for participants’ subjective response to the items.

SMS was officially transferred from NASA Ames Research Center to the FAA in July of 2004. The FAA is continuing to investigate possibilities for implementation of the STMS (Surface Traffic Management System) as it is now called. In parallel, work is continuing at NASA Ames to enhance the functionality and predictive ability of the SMS under the Special Airspace Usage project.

6.2.2 AMASS.

The first field validations of AMASS involved an Automated Terminal Radar System with an uncommissioned ASDE-3 system (and the prototype AMASS) [8] at the San Francisco International Airport (SFO). Live traffic was used for the demonstration but the AMASS was off-line to prevent any interference with operations. Testing addressed system functional parameters and controller acceptance.

A further trial demonstrated AMASS [9] as part of an integrated system with four other technologies (one of which was ASDE-3). The demonstration took place at the Atlantic City International Airport (ACY). The airborne technologies (i.e., moving map, global positioning system, and data link) were installed on a NASA research aircraft (TSRV), the ground technologies were installed in the old tower at ACY.

Further work was undertaken [10] to look into, and prevent, multi-paths from entering into the safety logic algorithms of the AMASS, thereby preventing AMASS from issuing false alerts to air traffic controllers. It is planned that 40 AMASS will be installed in control towers and facilities around the US. To date, AMASS has been installed, and is currently operational, at all of the sites that have ASDE-3 systems (34 sites) [11]. The FAA is continuously enhancing the system, currently, for example, work in progress includes improved recognition of real targets, interface improvements and an ability to use runway status light messages.

6.2.3 ASDE-X.

ASDE-X was field tested at Milwaukee General Mitchell International Airport (MKE) and, later, at Norfolk Airport [12]. MKE was chosen as the participating airport due to the severe fog conditions it experiences and to increases in its runway incursion rate during the early nineties. The system was installed and tested in a series of stages, first as an off-the-shelf Raytheon marine radar unit at MKE (DOT, 1996). The phase II system was a modification of the marine radar as a result of the phase I testing. This was installed for testing, also at MKE, during 1996. The phase II system was tested mainly in January 1997, with some secondary testing continuing to July 1997. The ASDE-X Program began in August 2000 and the system achieved operational readiness in October 2003. Testing and development since this date has included investigating remote unit capability, data distribution and Safety Logic system enhancement (AXSL), which is the most recent testing and development work.

There are four operational ASDE-X systems in the US National Airspace System (including MKE). Until September 2005, ASDE-X was being deployed only to airports with no surface surveillance systems and those with ASDE-3/AMASS systems. In September 2005, the FAA approved a baseline change to the ASDE-X Program. On the basis of an alternatives analysis, that considered safety and efficiency benefits for the 59 top tier US airports, the FAA is planning to deploy ASDE-X to 35 operational sites and three support systems.
7 Conclusion

Currently airports are considered as the one main bottleneck of the Air Traffic Management (ATM) system. Following the EUROCONTROL Performance Review Commission report [13], airport delays are a growing proportion of the total ATM delays. An extension of existing airport infrastructures, e.g., 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 more or less managed “manually”.

Although many stakeholders like Airports, Airlines, legal bodies and users associations were participating during the public events of several projects, this conclusion presents more the feedback of users. This is due to a simple fact: During the test trials the controllers and pilots were directly involved, they were asked systematically by questionnaires, their behaviour was analysed by statistical means and last but not least their conclusions based on the experience of the today daily work compared to new systems and procedures, as tested in the different A-SMGCS projects.

One main question concerning the cost benefit analysis (CBA) was developed by EUROCONTROL on a generic basis and stated in clear words: The return of investment for an A-SMGCS level II system should be within three to five years depending on the type of airport [18].

7.1 ATCOs

In general, ATCOs expressed their appreciation for the surveillance function. It was considered an important improvement over the current radar information. The HMI surveillance function was also liked. ATCOs could even imagine working completely head-down if the surveillance data could be proven to be absolutely reliable.

The most relevant aspect concerning A-SMGCS implementation at the airport is the acceptability of the HMI by the end-users of the system. Any improvements/modifications of new HMIs should be evaluated by the end-users throughout the development cycle prior to operational implementation.

A clear understanding provided by more than one previous research activities is that the performance of the Surveillance function has to be tested accurately before starting the implementation of A-SMGCS higher levels, avoiding limitations on the performance and usability of the other components of the system. An assessment would then be required to determine whether the level of surveillance is adequate for the type of A-SMGCS being implemented or whether the extension or addition of another sensor system is necessary.

One of the major conclusions is that an A-SMGCS implementation needs to be flexible and to allow for future system developments to be introduced progressively as regulations and operational specifications become defined and that the integration of on-board capabilities/performances into the A-SMGCS operational requirements is really necessary. This aspect is particularly significant for the second phase of the EMMA project during which activities should be focused on the integration of new components both On-ground and On-board. Systems’ flexibility and compatibility is a major aspect to be taken into account implementing higher A-SMGCS levels.

Implementation of an operational A-SMGCS is also closely associated with developments in other areas of Air Traffic Management, most notably where the A-SMGCS functions are dependent on the equipment status of the aircraft and vehicles. This includes aspects such as the use of data link for clearances and the application of Automatic Dependent Surveillance - Broadcast (ADS-B). The Stockholm-Arlanda airport can be considered a valid example for this kind of implementation especially concerning Vehicle Management Systems.
7.2 Pilots

In general, pilots would prefer to get the most safety critical clearances, like take-off clearances and landing clearances from both media: via data link and via R/T. That should also help other aircraft, as they can monitor all clearances concerning a runway. Additionally, they would prefer to perform handoffs via R/T to guarantee the R/T works with the new controller, thereby ensuring the opportunity to fall back to R/T in case of breakdown of the data link. Furthermore, they suggest the provision of an aural signal with an incoming data link clearance. Otherwise a lot of time is consumed by watching the screen. In addition, they wish to have the opportunity to send a “Shut Down” message once they have reached the stand or gate, in order to inform the ATCO that they are leaving the frequency.

All in all, a ground onboard HMI with a well-integrated data link solution was presented to the pilots, who stated that they would like to see this type of aid in use today rather than sometime in the future.

Airlines should be encouraged to modify their Standard Operating Procedures (SOPs) for the use of Mode-S transponders on the ground. Issuing NOTAMs at individual airports is not enough to ensure that pilots adopt the correct procedures.

7.3 Outlook

As a result of extensive testing in real time simulations and in field trials in the US and in Europe, it becomes evident that even the first implementation steps of an A-SMGCS – the surveillance function and incursion alerting – will give significant benefits to airlines, Air Navigation Service Providers and airports, as well as to the acting operators, the ATCOs, pilots and vehicle drivers.

First, safety benefits can be expected from increased situational awareness and an improved safety net through incursion alerting. Subjective assessment methods have shown in simulations that ATCOs will more easily be able to identify and locate aircraft and vehicles. Hard numerical values of safety improvements are not yet available, but it has become obvious that severe accidents, like the one in Milan-Linate, will become more unlikely.

Second, efficiency is improved by A-SMGCS. It was shown in simulation that ATCOs might be able to handle more (in certain cases up to 30%) traffic in reduced visibility conditions using A-SMGCS. Even in good visibility the throughput can be increased in demanding traffic situations (in certain cases up to 20%). Mean taxi-out-times were significantly reduced in the order of 1 min to 5 min – depending, of course on various conditions. Initial field trials in the US indicate the same potential. Furthermore, holding times for line-up, runway crossing and taxiing are reduced in the order of 15%. Queues at holding points were reduced from 11 to 9 aircraft.

Environmental damage reductions can be derived in general from the increased efficiency (e.g., shorter holding times) analytically. It will be important to distinguish between environmental damage per aircraft (A-SMGCS will help) and the total environmental damage (A-SMGCS will perhaps not help due to increased movement rates).

The subject of A-SMGCS should be developed in more than one direction. Higher level functions have to be further explored, developed and validated, e.g., routing and planning support to ATCOs or onboard guidance support to pilots. Many operational questions with respect to operating procedures and responsibilities are open in this context of a higher degree of automation, looking forward to EMMA2. The full integration of A-SMGCS into an overall Airport Airside Management System includes collaborative decision-making as a necessary next step. Exploration of the potential of integrating A-SMGCS into a network begins with the SMS development to enable more accurate and comprehensive predictions that will assist in strategic planning well beyond the airport.
‘Blue Sky’ Research is looking at one example of the long term future of A-SMGCS, the so called ‘Virtual Tower’, where no physical tower building is required due to even more advanced technology and appropriate procedures. A fully reliable surveillance function could finally enable significant changes in the organisation of the work at airports – e.g., physically clustering tower and apron control or clustering the control of several airports in one location. A core challenge will remain in defining the role of the human in such highly automated scenarios.
8 Annex

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Further information of the workshops, user forums, site visits, demo days and public launch of EMMA2 can be found on the public web page: www.dlr.de/emma www.dlr.de/emma2