EMMA, a European project

Research activities supporting SESAR and NGATS

Christoph Meier, Jörn Jakobi - DLR

A-SMGCS Forum, Maastricht, 2007-02-12

Internet: http://www.dlr.de/emma2
Overview

- ICAO A-SMGCS Manual as baseline
- Introduction of EMMA & EMMA2
- Performance driven EMMA approach

- Video

- Sample EMMA results
- A-SMGCS implementation roadmap
- Overview to EMMA2

- Summary and discussion
Introduction
A-SMGCS Definition

ICAO A-SMGCS Manual, Doc 9830:

„Advanced surface movement guidance and control system (A-SMGCS).

A system providing routing, guidance and surveillance for the control of aircraft and vehicles in order to maintain the declared surface movement rate under all weather conditions within the aerodrome visibility operational level (AVOL) while maintaining the required level of safety.“
ICAO Manual 9830

- The ICAO A-SMGCS Manual (Document 9830) is the worldwide baseline for the A-SMGCS concept, defining
  - the operational requirements,
  - the necessary A-SMGCS functions,
  - their minimum performance requirements
to allow a safe and expeditious traffic flow on the airport movement area in all weather conditions

- In addition the ICAO A-SMGCS Manual provides guidance to manufacturers and operators on implementation issues, leaving room for local technology choices
ICAO Manual 9830

• ICAO A-SMGCS Manual is based on results of previous European research projects (DEFAMM, BETA,...) and working groups (EUROCAE, AWOP,...)

• EUROCONTROL has been detailing and complementing the ICAO work significantly through their A-SMGCS projects.

• EMMA and EMMA2
  – are based on the ICAO A-SMGCS Manual,
  – take into account EUROCONTROL work,
  – feed-back to ICAO in cooperation with EUROCONTROL.
## A-SMGCS EU-Projects

<table>
<thead>
<tr>
<th>EU-Project</th>
<th>Results</th>
<th>Duration</th>
<th>FP</th>
</tr>
</thead>
</table>
| **DEyamm** Demonstration Facilities for Airport Movement Management | Technology evaluation and demonstration  
  • Cologne  
  • Paris Orly  
  • Bergamo | 1996-1999 |  |
| **Beta** Operational Benefits Evaluation by Testing A-SMGCS | Benefits shown in operational field trials in  
  • Hamburg  
  • Prague  
  **Input to ICAO** Doc 9830.  
  Industry products matured. | 2000-2002 |  |
| **Emma** European airport Movement Management by A-SMGCS Part 2 |  
  • A-SMGCS level 1&2 **concept validated** through operational field trials  
  • **Performance data** for ICAO doc 9830  
  • A-SMGCS **Implementation Roadmap** | 2004-2006 |  |
| **Emma2** |  
  • Definition of **A-SMGCS higher services** (CPDLC, Planning, …) in performance based approach  
  • Validation in simulation and **field trials**  
  • **Feedback to ICAO** | 2006-2008 |  |
<table>
<thead>
<tr>
<th>Aena</th>
<th>AIRBUS</th>
<th>Air Navigation Services of the Czech Republic</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVIATION HAZARD ANALYSIS</td>
<td>BAE SYSTEMS</td>
<td>Athens University of Economics and Business</td>
</tr>
<tr>
<td>AUTO</td>
<td>DLR</td>
<td>dgac</td>
</tr>
<tr>
<td>DIEHL Aerospace</td>
<td>ENAV S.p.A.</td>
<td>DSNA</td>
</tr>
<tr>
<td>EUROCONTROL</td>
<td>EuroTelematik</td>
<td>ERA</td>
</tr>
<tr>
<td>Park Air Systems</td>
<td>Messier-Dowty</td>
<td>RADAR TECHNOLOGY</td>
</tr>
<tr>
<td>softravia</td>
<td>Prague Airport</td>
<td>NLR</td>
</tr>
<tr>
<td>SOFIA</td>
<td>STAR ALLIANCE</td>
<td>RAI</td>
</tr>
</tbody>
</table>
Additional contributors
(in alphabetical order)

AÉROPORTS DE PARIS
AEROPORTI DI MILANO
LINATE E MALPENSA
AIR FRANCE
ČESKÉ AEROLINIE
Lufthansa
POLITECNICO DI MILANO
Field test platforms
Simulation platforms

Airbus Cockpit Simulator

Thales Cockpit Simulator

DLR Cockpit Simulator

TU-D Cockpit Simulator

NLR Tower Simulator

DLR Tower Simulator
Project approach
Performance driven approach

• Workshops with operators
  – analyse recent A-SMGCS concept standardisation,
  – identify current shortcomings and operational needs,
  – jointly define future operational concepts,
  – hypothesise on required performances,
  – improve the concept validation (scenarios, indicators, …).

• Real time simulation setups are integrated
  – to initially check the operational feasibility,
  – to evaluate the potential for operational improvements,
  – to assess new functions in safety critical situations.

• So far: technology independent!
Performance driven approach

- Field trial setups are integrated
  - to check the feasibility of alternative technological options,
  - to check the applicability to diverse airport environments,
  - to prove the operational feasibility in real life conditions.

- EMMA / EMMA2 results and conclusions
  - populate parameters of existing A-SMGCS standards,
  - add, modify and abandon requirements in A-SMGCS standards,
  - evaluate technological options to implement the concept,
  - validate the A-SMGCS concept.

- EMMA / EMMA2 follows E-OCVM
EMMA results
EMMA V&V methodology

1. Technical tests
2. Operational feasibility
3. Operational improvements
4. Operational benefits

Validation

Verification
Verification

• EMMA technical requirements refer to:
  – EUROCAE MASP for A-SMGCS, ED-87A
  – ICAO A-SMGCS Manual, Doc 9830
  – EUROCONTROL Operational Concept & Requirements for A-SMGCS implementation levels 1&2

• But improved with:
  – new indicators,
  – long-term tests,
  – more clear test procedures.

4. Operational benefits

3. Operational improvements

2. Operational feasibility

1. Technical tests
Validation

• “Is the technical performance sufficient to cover the needs of the users?”

• Assessment via
  – questionnaires - “Can you work with the new system properly?”
Validation

- “Yes, we can work with the new system properly, but does it improve something?”
- Key performance areas
  - safety,
  - efficiency (incl. capacity, environment),
  - human factors.
Validation

• “Oh yes, we can work safely and more efficient, but how many Euros do we save?”
Validation methodology

Validation

Operational benefits

Operational improvements

Operational feasibility

Technical tests

Verification
### Short-term

<table>
<thead>
<tr>
<th>Performance requirement</th>
<th>Required</th>
<th>Short-term Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported position accuracy</td>
<td>≤ 7.5 m</td>
<td>3.2 m – 7.5 m</td>
</tr>
<tr>
<td>Probability of detection</td>
<td>≥ 99.90%</td>
<td>99.65% – 99.98%</td>
</tr>
<tr>
<td>Probability of false detection</td>
<td>≤ 0.001%</td>
<td>0% – 0.070%</td>
</tr>
<tr>
<td>Probability of identification</td>
<td>≥ 99.90%</td>
<td>99.72% – 100%</td>
</tr>
<tr>
<td>Probability of false identification</td>
<td>≤ 0.001%</td>
<td>0%</td>
</tr>
<tr>
<td>Target report update rate</td>
<td>≤ 1s</td>
<td>0.47s – 1s</td>
</tr>
<tr>
<td>Probability of detection of an alert situation</td>
<td>≥ 99.9%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Long-term

• A software, MOGADOR, has been matured in EMMA to continuously assess the performances of the surveillance function

2 missing reports
3 s.

PD
Technical performance monitoring

Long Term Measurements for the Probability of Detection - PD %


90,00%
Validation methodology

- Operational benefits
- Operational improvements
- Operational feasibility
- Technical tests

Validation

Verification
Examples of debriefing questions – field trials Prague

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Item</th>
<th>Mean</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA-3</td>
<td>When visual reference is not possible, the displayed position of the <strong>aircraft</strong> on the <strong>taxiways</strong> is accurate enough to exercise control in a safe and efficient way.</td>
<td>5,4</td>
<td>0,00*</td>
</tr>
<tr>
<td>VA-6</td>
<td>When visual reference is not possible, a <strong>wrong label</strong> is not a problem to exercise control in a safe and efficient way.</td>
<td>1,9</td>
<td>0,00*</td>
</tr>
<tr>
<td>VA-22</td>
<td>I experienced that aircraft have failed to comply with the transponder operating procedures.</td>
<td>4,7</td>
<td>0,00*</td>
</tr>
<tr>
<td>VA-...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

One-Sample T-Test expected mean value = 3,5, answers from 1 (disagreement) to 6 (agreement), N = 15 ANS_CR controllers, $\alpha = 0.05$
EUROPEAN AIRPORT MOVEMENT MANAGEMENT BY A-SMGCS, Part 2

Validation methodology

Validation

Operational benefits

Operational improvements

Operational feasibility

Technical tests

Verification
Real-time simulation

ATCO reaction time in case of conflict (sec)

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>A-SMGCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6</td>
<td>5.3</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

difference: 0.69 sec
df: 12
t-value: -0.56
p-value: 0.28 (not significant)
Real-time simulations

mean taxi time (min)

Baseline
A-SMGCS

difference: -30 sec
df: 178
t-value: -1.973
p-value: 0.03* (significant)
Real-time simulations

R/T communication

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>A-SMGCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tower Planner</td>
<td>20.3</td>
<td>14.7</td>
</tr>
<tr>
<td>Tower Control</td>
<td>47.5</td>
<td>46.2</td>
</tr>
<tr>
<td>Ground Control</td>
<td>53.6</td>
<td>46.7</td>
</tr>
</tbody>
</table>

Percent R/T load of overall time

- df: 1
- F-value: 3.675
- p-value: 0.06 (not significant)
Real-time simulations

situation awareness
(SASHA Q Item 12)

difference: 0.51
df: 10
T-value: 2.965
p-value: 0.01*

Baseline
A-SMGCS
## Operational field trials

<table>
<thead>
<tr>
<th>VA</th>
<th>Safety</th>
<th>Mean</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA-28</td>
<td>When procedures for LVO are put into action, A-SMGCS helps me to operate safer.</td>
<td>5,4</td>
<td>0,00*</td>
</tr>
<tr>
<td>VA-50</td>
<td>A-SMGCS is helpful for better monitoring aircraft commencing its take off roll.</td>
<td>4,7</td>
<td>0,02*</td>
</tr>
<tr>
<td>VA-61</td>
<td>I think A-SMGCS can help me detect or prevent runway incursions.</td>
<td>5,0</td>
<td>0,01*</td>
</tr>
<tr>
<td>VA-...</td>
<td>...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Operational field trials

<table>
<thead>
<tr>
<th>VA</th>
<th>Efficiency / capacity</th>
<th>Mean</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA-9</td>
<td>When visual reference is not possible, I think <em>identifying</em> an aircraft or vehicle is <em>more efficient</em> when using the surveillance display.</td>
<td>5,2</td>
<td>0,01*</td>
</tr>
<tr>
<td>VA-10</td>
<td>I think, also in <em>good visibility</em> conditions, <em>identifying</em> an aircraft or vehicle is even <em>more efficient</em> when using the surveillance display.</td>
<td>5,2</td>
<td>0,00*</td>
</tr>
<tr>
<td>VA-122</td>
<td>The A-SMGCS enables me to handle more traffic when visual reference is not possible.</td>
<td>4,3</td>
<td>0,01*</td>
</tr>
</tbody>
</table>
# Operational field trials

<table>
<thead>
<tr>
<th>VA</th>
<th>Human factors</th>
<th>Mean</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA-125</td>
<td>The A-SMGCS helps me to improve my <strong>situation awareness</strong>.</td>
<td>5,1</td>
<td>0,00*</td>
</tr>
<tr>
<td>VA-59</td>
<td>When procedures for LVO are put into action, A-SMGCS helps me to reduce my <strong>workload</strong>.</td>
<td>5,2</td>
<td>0,00*</td>
</tr>
<tr>
<td>VA…</td>
<td>….</td>
<td>…</td>
<td>…</td>
</tr>
</tbody>
</table>
Implementation Roadmap
EMMA approach

• EMMA workshops with partners from
  – industry (Airbus, PAS, TATM, SELEX)
  – R&D (DLR, NLR, EUROCONTROL)
  – users
    • ANSPs (ANS_CR, AENA, DSNA, ENAV, DFS)
    • Airlines (DLH, CSA)
    • Airports (CSL, AENA)

• D131u EMMA OSED-update document,
  www.dlr.de\emma
### ICAO implementation levels

<table>
<thead>
<tr>
<th>Aerodrome Types</th>
<th>User</th>
<th>Surveillance</th>
<th>Control</th>
<th>Routing</th>
<th>Guidance</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ground</td>
<td>On</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Board</td>
<td>Board</td>
</tr>
<tr>
<td>T-1: (1)(7)(L)</td>
<td>Controller</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>T-2: (1)(7)(M)</td>
<td>Pilot/Vehicle driver</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>T-5: (1)(5)(L)</td>
<td>System</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-3: (1)(7)(L)</td>
<td>Controller</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>II</td>
</tr>
<tr>
<td>T-4: (1)(5)(L)</td>
<td>Pilot/Vehicle driver</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-7: (1)(7)(L)</td>
<td>System</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-6: (1)(5)(M)</td>
<td>Controller</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>III</td>
</tr>
<tr>
<td>T-9: (1)(7)(L)</td>
<td>Pilot/Vehicle driver</td>
<td>X</td>
<td>X^{1)}</td>
<td>X^{1)}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-9: (1)(7)(L)</td>
<td>System</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>IV</td>
</tr>
<tr>
<td>T-8: (1)(3)(M)</td>
<td>Controller</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>V</td>
</tr>
<tr>
<td>T-12: (2)(7)(H)</td>
<td>Pilot/Vehicle driver</td>
<td>X</td>
<td>X^{1)}</td>
<td>X^{1)}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-14: (2)(3)(H)</td>
<td>System</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>T-16: (2)(5)(L)</td>
<td>Controller</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-18: (2)(5)(H)</td>
<td>Pilot/Vehicle driver</td>
<td>X</td>
<td>X^{1)}</td>
<td>X^{1)}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-19: (3)(7)(L)</td>
<td>System</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>T-20: (3)(5)(M)</td>
<td>Controller</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-21: (3)(5)(H)</td>
<td>Pilot/Vehicle driver</td>
<td>X</td>
<td>X^{1)}</td>
<td>X^{1)}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-22: (3)(5)(L)</td>
<td>System</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>T-23: (4)(7)(H)</td>
<td>Controller</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-24: (4)(5)(L)</td>
<td>Pilot/Vehicle driver</td>
<td>X</td>
<td>X^{1)}</td>
<td>X^{1)}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-25: (4)(5)(H)</td>
<td>System</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

### SMGCS

- **SMGCS**: Specialized Mobile Ground Collision Avoidance System

### A-SMGCS

- **A-SMGCS**: Automatic SMGCS
Definition of A-SMGCS services

• **Service description** is allocated to the user who receives it and not to a primary function.
  – 3 main users: **ATCOs, pilots, vehicle drivers.**

• **Functions** and their **technical enablers.**

• **Evolutionary implementation steps** for each service.
Service vs. technical enabler

- When defining a service, their **technical enablers** have to be regarded.

- It is an iterative process
  - service ↔ technical enablers
  - (ATM problem) ↔ (technical possibilities)
# Technical Enablers for the ATCO’s surveillance service

<table>
<thead>
<tr>
<th>Function</th>
<th>On-board enabler</th>
<th>Ground enabler</th>
</tr>
</thead>
</table>
| provide traffic information | • MODE-S transponder  
   • ADS-B transponder | • cooperative sensors (SSR, Mode-S, ADS-B, GNSS)  
   • non-cooperative sensors (SMR)  
   • sensor data fusion  
   • FDPS |
| provide traffic context   |                                       | • aeronautical info server  
   • meteo data |
| interface with ATCOs      |                                       | • HMI component |
# Implementation Steps for the surveillance service

<table>
<thead>
<tr>
<th>Service Steps</th>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>• detection and position of all movements &amp; obstacles</td>
<td>manoeuvring area</td>
</tr>
<tr>
<td></td>
<td>• identification of all cooperative movements</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>• step1 + detection and identification of <strong>all aircrafts</strong></td>
<td>movement area</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>• step2 +</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• detection and identification of <strong>all vehicles</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• detection of <strong>obstacles</strong></td>
<td></td>
</tr>
</tbody>
</table>
Logical interdependencies between the services

Surveillance

Control

Routing

Guidance

Aircraft

automation - complexity – new procedures

enables
## A-SMGCS services & implementation steps

<table>
<thead>
<tr>
<th>Ground</th>
<th>Expected Implementation Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surveillance</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>S1 aircraft and vehicles in the manoeuvring area</td>
</tr>
<tr>
<td>C1 Conflicts on RWYs</td>
<td>C2 Conflicts TWY</td>
</tr>
<tr>
<td>C3 CPDLC (electronic flight plan management, clearance management)</td>
<td>C4 Conflicts on Aprons</td>
</tr>
<tr>
<td><strong>Routing / Planning</strong></td>
<td></td>
</tr>
<tr>
<td>R1 Manual Routing</td>
<td>R2 Semi-auto Routing</td>
</tr>
<tr>
<td>R3 Auto Routing (incl. Planning)</td>
<td>R4 DMAN</td>
</tr>
<tr>
<td><strong>Ground Guidance</strong></td>
<td></td>
</tr>
<tr>
<td>G1 Manual switched ground guidance</td>
<td>G2 Auto switch</td>
</tr>
<tr>
<td><strong>Aircraft</strong></td>
<td></td>
</tr>
<tr>
<td>A1 Electronic Moving Map</td>
<td>A2 EMM with Ground traffic + CPDLC</td>
</tr>
<tr>
<td>A3 HUD</td>
<td>A4 Auto steering</td>
</tr>
<tr>
<td><strong>Vehicle</strong></td>
<td></td>
</tr>
<tr>
<td>V1 Electronic Moving Map</td>
<td>V2 EMM with Ground Traffic</td>
</tr>
<tr>
<td>V3 CPDLC</td>
<td></td>
</tr>
</tbody>
</table>
ICAO A-SMGCS categorisation

1. Visibility conditions
   - Vis 1: no impact
   - Vis 2: ATCO cannot see
   - Vis 3: pilots cannot see and avoid (400m < Vis 3 < 75m)
   - Vis 4: pilots cannot taxi (< 75m)

2. Traffic density
   - Light (L): 0 < movements < 20
   - Medium (M): 20 < movements < 35
   - Heavy (H): 35 < movements ∞

3. Aerodrome layout
   - basic (B): = 1 RWY = 1 TWY = 1 Apron
   - simple (S): = 1 RWY > 1 TWY > 1 Apron
   - complex (C): > 1 RWY > 1 TWY > 1 Apron
### Initial implementation packages for different airports

<table>
<thead>
<tr>
<th>Layout Density</th>
<th>Vis 1</th>
<th>Vis 2</th>
<th>Vis 3</th>
<th>Vis 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## A-SMGCS services & implementation steps

<table>
<thead>
<tr>
<th>Surveillance</th>
<th>S1 aircraft and vehicles in the manoeuvring area</th>
<th>S2 S1 + aircraft in apron areas</th>
<th>S3 S2 + vehicles in apron area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>C1 Conflicts on RWYs</td>
<td>C2 Conflicts TWY (electronic flight plan management, clearance management)</td>
<td>C4 Conflicts on Aprons</td>
</tr>
<tr>
<td>Ground Guidance</td>
<td>G1 Manual switched ground guidance</td>
<td>G2 Auto switch</td>
<td></td>
</tr>
<tr>
<td>Aircraft</td>
<td>A1 Electronic Moving Map</td>
<td>A2 EMM with Ground traffic + CPDLC</td>
<td>A3 HUD</td>
</tr>
<tr>
<td>Vehicle</td>
<td>V1 Electronic Moving Map</td>
<td>V2 EMM with Ground Traffic</td>
<td>V3 CPDLC</td>
</tr>
</tbody>
</table>

**Onboard**

**Ground**

**Expected Implementation Steps**
### Initial implementation packages for different airports

<table>
<thead>
<tr>
<th>LAYOUT COMPLEX</th>
<th>Traffic Density</th>
<th>Vis 1</th>
<th>Vis 2</th>
<th>Vis 3</th>
<th>Vis 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>S1 + C1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Initial implementation packages for different airports

<table>
<thead>
<tr>
<th>Layout Density</th>
<th>Traffic Density</th>
<th>Vis 1</th>
<th>Vis 2</th>
<th>Vis 3</th>
<th>Vis 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>S1 + C1</td>
<td>S2 + C1</td>
<td>S2 + C4 + V2 + R3</td>
<td>S2 + C2 + A3 + V2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A1 + V1</td>
<td>A2 + V2</td>
<td>R4 + A2</td>
<td>C4 + A4 + R3/R4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R3/R4 + A2 + V1</td>
<td>C2+R3/R4+A2+V1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy</td>
<td>S2 + C3 + R4</td>
<td>S2 + C3 + R4</td>
<td>S2 + C4 + V2 + R4</td>
<td>S2 + C3 + A3 + V2 + R4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A2 + V2</td>
<td>A2 + V2</td>
<td>A2 + V3</td>
<td>A4 + V3</td>
<td></td>
</tr>
</tbody>
</table>

© EMMA2, A-SMGCS Forum, Maastricht, 2007-02-12
EMMA2 overview
EMMA2 approach

• We will continue to work on
  – operational concept for higher-level A-SMGCS services, including procedures and requirements
  – evaluating technological options
  – maturing technological enablers
  – validating the concept

• We would welcome your contribution in
  – user forums, work shops discussing the operational concept
  – participation of pilots and controllers in work shops and trials
  – cross-meetings with your projects in FP6, FP7, SESAR
  – dissemination event in 2008
Summary
Opportunities for SESAR & EMMA

• EU A-SMGCS projects are a **coordinated series** of projects leading to **significant results**, already discussed in the ATM-community. EMMA and SESAR should be well aligned!

• EMMA results are relevant for SESAR!
  – Consolidated **operational concept** aligned with ICAO doc 9830.
  – Verification results show sufficient technology readiness.
  – Validation results show operational feasibility and improvements.
  – **A-SMGCS roadmap** could be part of the ATM „Master Plan“.

• SESAR advice to EMMA2 is welcome!
  – Set priorities in investigating specific A-SMGCS options.
  – Selection of options for trial-setups (field and simulation).
  – Alignment of **terminology, key performance areas** & indicators.
Relation to NGATS

• ICAO

• Publication of EMMA / EMMA2 results
  – www.dlr.de/emma
  – www.dlr.de/emma2

• FAA-EUROCONTROL CCOM Action Plan 21
  – mutual visits between the two Airport R&D Communities
  – biannual Conferences on Surface Operations since 2003
  – scientific analysis of published results from US and EU

• Through bilateral SESAR-NGATS contacts
Contact

http://www.dlr.de/emma/

http://www.dlr.de/emma2/
Backup
Prague Ruzyne

Installations:
- Multilateration
- ADS-B
- DMAN
- vehicles equipped
- Surface Conflict Alert
- camera system (gap filler)

Trials:
- Real time simulation
- operational trials
- operational use in regular shift

- 2 RWY
- 61 stands
- 9.7 million passengers in 2004
- 145.000 aircraft movements
Toulouse Blagnac

**Trials:**
- Shadow mode trials

**Installations:**
- Multilateration
- ADS-B
- **Surface Conflict Alert**
- Vehicles equipped

- **2 RWY**
- 28 stands
- 5.6 million passengers in 2004
- 95,000 aircraft movements
Milan Malpensa

Trials:
- Real time simulation
- Shadow mode trials

Installations:
- Multilateration
- Surface Conflict Alert
- ADS-B
- Vehicles equipped (M-LAT, WLAN)

- 2 RWY
- 115 stands
- 17.6 million passengers in 2003
- 213,000 aircraft movements
Problems with current technical tests

• How to ensure that the performances are stable?

• How to take into account the whole traffic mix (equipped/not equipped aircraft/vehicle)?)

• How to assess the performances during adverse environmental conditions (strong rain, snow, long grass)?

• How to assess the performances in a non intrusive way?
Operational improvements

Shadow mode

• Examples:
  – The controllers have an overall positive feeling about the ability of A-SMGCS to improve operations.
  – Increase of runway capacity due to the possibility to use of both runways in vis 2 in Toulouse-Blagnac.
Operational improvements

Onboard Moving Map System

SITUATION AWARENESS

✓ MMS significantly increases situational awareness, especially on complex airfields and in low visibility conditions

MENTAL WORKLOAD

✓ Workload is significantly lower in scenarios with the function

SATISFACTION LEVEL

✓ Most pilots would like to have the system in their aircraft as soon as possible