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Validation Plan

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1 Scope of Document

The objective of the EMMA2 Validation process is to assess the potential operational impacts of the proposed A-SMGCS Operational Concept and explore its performance in terms of complying with the relevant requirements and needs of the stakeholders involved in the ATM. This goal is achieved through the implementation of the E-OCVM (European-Operational Concept Validation Methodology). The E-OCVM constitutes a widely accepted Validation Methodology which has been based on the experience gained in ATM R&D activities within the framework of EC and EUROCONTROL funded projects [1]. The EMMA2 generic validation strategy aims to incorporate the E-OCVM steps in to the EMMA2 validation process. In this framework, the EMMA2 Generic Validation Strategy provides a coherent description of the EMMA2 validation steps, activities, and tools emerging from the E-OCVM.

Based on the EMMA2 Technical Annex, the validation exercises of the EMMA2 functions will be performed on four ground sites and one airborne site. The validation process at each site will be based on the corresponding site test plan. In order to assure the maximum compliance of the site test plans with the E-OCVM and the EMMA2 Generic Validation Strategy, two documents are developed: i) 2-D6.1.1a “Validation Plan”, and ii) 2-D6.1.1b “Generic Experimental and Test Plan”. The major objective of both documents is to provide the sites with the essential framework and guidelines for developing the Validation Test Plans in accordance with the EMMA2 Generic Validation Strategy. The former document is mainly focused on presenting the EMMA2 Generic Validation strategy while the latter aims to provide the generic guidelines for the development and implementation of the experimental design and analysis at each site of the project. Due to its nature the 2-D6.1.1a reflects early planning stages of the consortium while 2-D6.1.1b emphasises consolidated validation ambitions. 2-WP 6.2-6.5 and 2-WP 6.6 (green team) will follow this E-OCVM driven strategy while 2-WP 6.6 (blue team) will follow their own / internal methodology. A correlation between EMMA2 objectives and Airbus objectives will be presented in 2-D6.1.1b. Airbus internal assessment methodology is based on Airbus Human Factors know-how and certification guidelines.

The development of the (Site) Validation Test Plans will be based on the customization of the validation activities presented in the EMMA2 generic validation strategy according to the operational, technological, and regulatory limitations and requirements of each site.

The remainder of the document is organized in five sections. Section two presents the objectives of this document while section 3 provides the proposed generic validation strategy (i.e., validation methodology based on the E-OCVM). Sections 4 and 5 provide a description of the first two steps of the proposed generic validation methodology. In particular, section 4 refers to the ATM problem description (including an overview of the EMMA2 Operational Concept), while section 5 addresses the step “set validation strategy”. Finally section 6 provides the concluding remarks and provides an overview of the remaining steps of the Generic Validation Strategy (addressed in 2-D611b).

2 Introduction

2.1 Document Purpose

The development of the EMMA2 validation plan involves a top down approach i.e. a Generic Validation Strategy will be issued at an early stage of the project, and site-specific test plans will be developed by customizing the Generic Validation Strategy within the limitations and requirements of each site. The Generic Validation Strategy includes the presentation of the major validation objectives and the identification of the EMMA2 validation activities emerging from customizing the E-OCVM steps within the EMMA2 context. The E-OCVM consists of six major steps:

- i) step 0 “State Concept and Assumptions”
- ii) step 1 “Set Validation Strategy”
- iii) step 2 “Determine the Experimental Need”
- iv) step 3 “Conduct Experiment”
- v) step 4 “Determine Results”, and
- vi) step 5 “Disseminate Information to Stakeholders”.

In this context, the present document aims to describe the above steps customized for EMMA2, which constitute the generic validation strategy. Furthermore, the document presents the content of the first two steps of the generic validation strategy. Thus, the present document provides an overview of the EMMA2 A-SMGCS functions that will be tested at the sites of the project (based on the EMMA2 SPOR document). Moreover, this document provides a coherent description of the EMMA2 validation stakeholders, objectives, requirements, and tools. Given this information, the set of high and low level objectives and the preliminary set of indicators is also provided. The complete list of indicators and the experimental design and analysis guidelines will be provided in 2-D6.1.1b.

Figure 2-1 presents the role of the Generic Validation Strategy in the EMMA2 Validation process. Both documents (2-D6.1.1.a and 2-D6.1.1.b) will be used by the sites as the basis for developing the local Validation test plans.

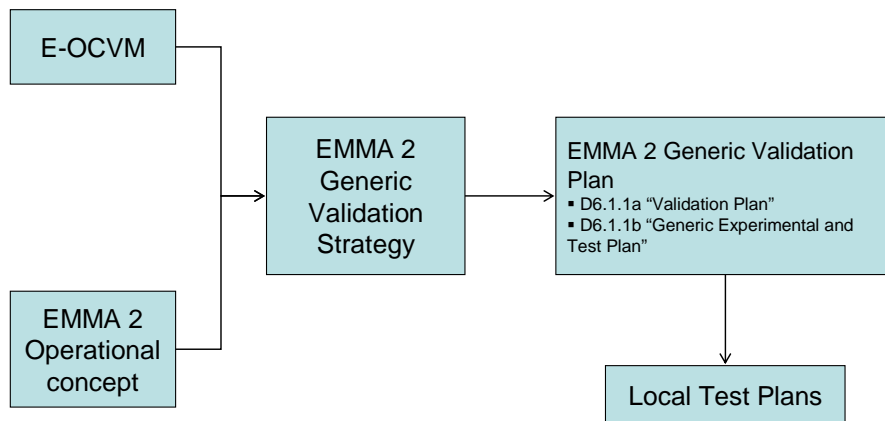


Figure 2-1: Role of the Generic Validation Strategy in EMMA2 Validation Process.

2.2 Document Context

2.2.1 Project Background

The EMMA2 project aims to define and consolidate a harmonised European A-SMGCS concept as prescribed in the ICAO Manual of A-SMGCS [1])i.e. surveillance, control, guidance, and routing and the assessment of their impacts on the performance of the ATM. In this context, the project is divided to six subprojects (2-SP1-6). The subproject 2-SP1 “Concept” provides the EMMA2 A-SMGCS services and identifies the relevant operational and functional concept. Sub-project 2-SP2 “On-board” aims to implement the A-SMGCS services provided to the flight crew, while 2-SP3 “Ground (Prague)”, 2-SP4 “Ground (Toulouse)” and 2-SP5 “Ground (Malpensa)” are focused on the implementation of the ground A-SMGCS services to the following airports: Prague-Ruzyně, Toulouse-Blagnac and Milano-Malpensa respectively. Finally, 2-SP6 aims to assess the performance of the aforementioned A-SMGCS operational concept in terms of complying with the relevant operational and functional requirements and determine the potential impacts of the A-SMGCS services on the ATM. The validation activities and generic guidelines for assessing the implementation of the proposed EMMA2 Operational Concept at the four sites are provided through the Generic Validation Strategy. More information regarding the role of the present document in 2-SP6 is provided in the following sub-section (2.2.2).

2.2.2 Sub-project Background

Based on the technical annex, the sub-project 2-SP6 involves the implementation of the E-OCVM steps for the assessment of the EMMA2 A-SMGCS services implemented at the three ground sites (Prague-Ruzyně, Toulouse-Blagnac and Milano-Malpensa) and the airborne site. Furthermore, higher A-SMGCS services at the ground site Paris Charles de Gaulle will be assessed. A specific validation test plan will be developed at each site of the project, presenting the site-specific validation process

and strategy. In order to facilitate the development of site specific Validation Test Plans compatible with the E-OCVM, the Generic Validation Strategy (i.e. 2-D6.1.1a & 2-D6.1.1b) presents the content of the E-OCVM activities customized along the lines of EMMA2, and the emerging validation activities that will be covered by the site validation test plans. The present document (2-D6.1.1a) constitutes the description of the Generic Validation Strategy.

3 Overall Methodological Approach

The development of the EMMA2 generic validation strategy has been based on customizing the E-OCVM steps and proposed activities for the EMMA2 context, taking into account the experience and information gained through the EMMA validation. Figure 3-1 presents the overall methodological approach for developing the EMMA2 generic validation strategy.

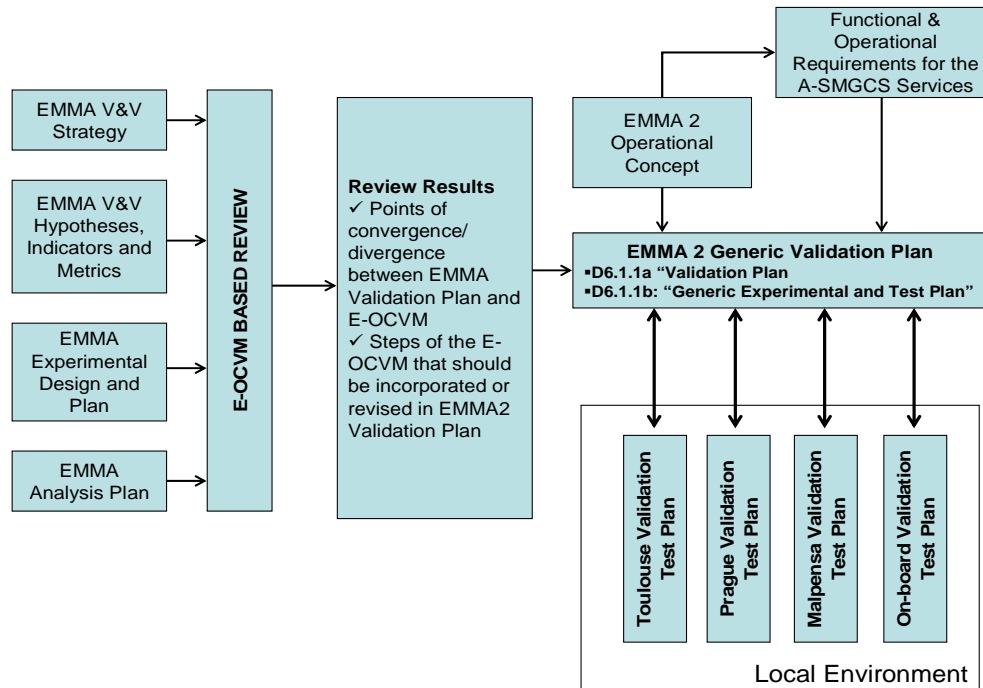


Figure 3-1: Overall methodological framework for developing the EMMA2 Validation Strategy.

Figure 3-1 implies that the development of the EMMA2 generic validation strategy has been based on the following activities:

- i) Specifying the content that should be provided for each of the E-OCVM steps based on the A-SMGCS functions implemented in the EMMA2 Operational Concept.
- ii) Tracing the above mentioned content for each E-OCVM step in the corresponding validation issues addressed in EMMA Validation Strategy. Revise or enhance this information (if necessary).
- iii) Elaborating the E-OCVM steps poorly or not addressed at all within EMMA.

The EMMA2 generic validation strategy is provided in two documents 2-D6.1.1a and 2-D.6.1.1b. Table 3-1 presents the generic validation activities, and provides the corresponding sections of 2-D6.1.1a and 2-D6.1.1b which address each of these issues.

Step	Activity	Description	2-D6.1.1a & b sections
<i>Step 0 “State Concept and Assumptions”</i>	0.1	Understand the problem	Section 4.1, 2-D6.1.1a
	0.2	Understand the proposed solution(s)	Section 4.2, 2-D6.1.1a
<i>Step 1 “Set Validation Strategy”</i>	1.1	Identify the stakeholders, their needs, and involvement	Section 5.1, 2-D6.1.1a
	1.2	Identify the existing information, including current and target levels of maturity	Section 5.2, 2-D6.1.1a
	1.3	Describe validation expectations and outline cases – outcomes, products, what will success look like	Section 5.3, 2-D6.1.1a
	1.4	Identify programme validation objectives in key performance areas	Section 5.4, 2-D6.1.1a
	1.5	Establish initial validation requirements, and draft validation strategy	Section 5.5, 2-D6.1.1a
	1.6	Select validation tools or techniques	Section 5.5, 2-D6.1.1a
	1.7	Define validation strategy	Section 5.6, 2-D6.1.1a
<i>Step 2 “Determine the Experimental Needs”</i>	2.1	Identify stakeholders’ acceptance criteria and performance requirements	Guidance for specific validation test plans in: Section 3.1, 2-D6.1.1b
	2.2	Identify project and exercise validation objectives	Section 3.2, 2-D6.1.1b
	2.3	Refine validation strategy	Section 3.3, 2-D6.1.1b
	2.4	Identify indicators and metrics	Section 3.4, 2-D6.1.1b
	2.5	Specify validation scenarios	Section 3.5, 2-D6.1.1b
	2.6	Produce validation exercise plan	Section 3.6, 2-D6.1.1b Section 3.7, 2-D6.1.1b Section 3.8, 2-D6.1.1b
	2.7	Prepare the platform or facility	Section 3.9, 2-D6.1.1b
	2.8	Conduct pre-exercise testing and training	Section 3.10, 2-D6.1.1b
<i>Step 3 “Conduct the Experiment”</i>	3.1	Conduct validation experiment	Section 4, 2-D6.1.1b
	3.2	Assess for unexpected effects or behaviours	Section 4, 2-D6.1.1b
<i>Step 4 “Determine the Results”</i>	4.1	Perform analysis specified in the analysis plan	Guidance for validation reports in: Section 5.1, 2-D6.1.1b
	4.2	Prepare analysis contributions	Section 5.2, 2-D6.1.1b
	4.3	Prepare validation report	Section 5.2, 2-D6.1.1b
<i>Step 5 “Information for Dissemination to Stakeholders”</i>	5.1	Disseminate information to stakeholders and decision makers	Section 6.1, 2-D6.1.1b
	5.2	Draw conclusions and decide on actions feedback to validation strategy	Section 6.2, 2-D6.1.1b

Table 3-1: The 2-D6.1.1a & 2-D6.1.1b sections which describe each of the E-OCVM-based steps and activities

Both documents provide substantial information regarding the validation activities that should be addressed by the sites and prescribed in their validation test plans, including:

- i) the identification of high level validation objectives and the corresponding low level validation objectives
- ii) the determination of validation hypotheses, indicators, and metrics
- iii) the development of the experimental design
- iv) the development of the experimental plan that will be developed by the site
- v) the development of the analysis plan

As mentioned before, the specification of the major validation issues and activities of the EMMA2 generic validation strategy have been based on the review of the EMMA Validation Strategy in terms of covering the E-OCVM steps. The Validation issues included in EMMA Validation Strategy which are compatible with E-OCVM were customized, when necessary, for the EMMA2 Operational Concept. Furthermore, any E-OCVM validation activities not addressed within the EMMA Validation Strategy have been explicitly incorporated in EMMA2 generic validation strategy. In what follows, there is an overview of the results of the relevant review process.

Step 0 “State Concept and Assumptions” of the E-OCVM consists of two activities: i) Understand the problem, and ii) Understand the proposed solutions. This step implies the definition of the ATM problem and the corresponding operational concept. In EMMA, this issue was covered within SP1 where the ATM problem was defined and the EMMA operational concept was developed. An overview of the problem and the operational concept was also included in D6.1.1. Concerning EMMA2 project, this step of E-OCVM implies the specification of the actual EMMA2 operational concept provided in 2-SP1.

Step 1 “Set Validation Strategy” involves the following activities:

- 1) *Identify the Stakeholders, their needs and involvement.* This activity includes the identification of the stakeholders i.e. actors involved or affected by the EMMA2 A-SMGCS. For each stakeholder the following information is essential: i) the area of expertise and role in the ATM, ii) the relevant impacts of the proposed operational concept, iii) the involvement in the validation process, and iv) the expectations from the validation process. In EMMA, deliverable D6.1.1 provided a description of the stakeholders and their role in the proposed Operational Concept covering the aforementioned issues. However, limited information was provided regarding the role of each stakeholder in the validation process. Therefore, in EMMA2 Generic Validation Strategy this description will be revised and enhanced in order to conform with respect to the EMMA2 operational concept while addressing the role of each stakeholder in the validation process. It should be emphasized that the full list of the above mentioned issues will be addressed for every category of stakeholders.
- 2) *Identify the level of maturity.* This activity refers to the identification of the stage of maturity of the EMMA2 A-SMGCS functions. In EMMA, this issue has been covered through the provision of the major functionalities associated with the EMMA operational concept (see D6.1.1). In the context of EMMA2 Validation Strategy, a similar description of the major functionalities of the EMMA2 operational concept will cover this issue.
- 3) *Describe (Validation) Expected Outcomes.* This activity refers to the specification of the scope and aims of the validation process. Section 2.1.3 of D6.1.1 addresses the Verification and Validation aims for the EMMA 1 operational concept. EMMA2 will refine the relevant verification and validation aims taking into account the EMMA2 Operational Concept.
- 4) *Identify High Level Validation Objectives and Key Performance Areas.* The high level Verification and Validation objectives described in D6.1.1 (section 2.1.4) refer to the major benefits expected from the EMMA operational concept. These objectives will be updated accordingly in order to account for the scope and functionalities of the EMMA2 Operational Concept.
- 5) *Establishing Initial Validation Needs and draft plan.* The identification of the validation needs and the development of the draft plans were achieved in EMMA through a bottom-up process involving: i) the preliminary assessment of the validation limitations and requirements at each site, ii) the production of draft validation site plans, iii) the review of the site plans in terms of complying with the Validation objectives, and iv) the production of the revised validation site plans. This process will be adopted within the validation process of EMMA2. Therefore, the EMMA2 validation strategy will provide guidelines for determining the validation needs emerging from each A-SMGCS function implemented at the sites. The experience gained in EMMA implies that the corresponding process requires the feedback of the sites regarding the validation needs per A-SMGCS function and therefore it will be performed at an early stage of the validation process.

- 6) *Selection of Validation Tool type and technique.* The selection of the validation tools and techniques for EMMA was specified through the process of establishing the validation needs described in the previous paragraph. A similar approach will be adopted for the EMMA2 Validation tools and techniques.
- 7) *Define Validation Strategy and Plan.* The specification of a Validation Strategy and Plan involves: i) the determination of the major validation activities to achieve the Validation objectives, ii) a Validation Schedule and a management plan for the associated activities and resources required, iii) the selection of experiments , and iv) interaction between experiments. The EMMA Validation Strategy addressed this type of information through developing a generic strategy (D6.1.1) [4] and a Validation Methodological framework (D6.2.1)[6]. The EMMA2 Generic Validation Strategy will also address the aforementioned issues through revising the validation methodology in order to comply with EMMA2 operational concept and provide guidelines for developing the site test plans of the emerging Validation activities.

Step 2 “Determine the Experimental Needs” refers to the determination of the Experimental design and plan. In particular it involves the following activities:

- 1) *Identify Acceptance Criteria and Performance Requirements.* This activity pertains to the definition of the hypotheses i.e. specify what can be considered as success of the operational concept in addressing the performance expectations with the required level of confidence. The EMMA Validation Strategy addressed this issue through providing the corresponding Validation Hypotheses. In EMMA2 Validation Strategy these hypotheses will be enhanced and modified in order to cover the expectations of the stakeholders from the EMMA2 operational concept.
- 2) *Identify Low level Validation Objectives.* Given the High Level Validation objectives specified in Step 1, the scope of this activity aims to determine in more detail the expected impacts of the system. In EMMA Validation Strategy, the high level objectives were further decomposed to a set of specific low level objectives. The same process will be performed in the case of EMMA2. Upon determination of the high level validation objectives, they will be decomposed to more detailed objectives expressing the expected benefits from the EMMA2 operational concept.
- 3) *Refine Validation Strategy.* This activity refers to refining the strategy specified in step 1. The EMMA Validation Strategy was refined based on the feedback received from the sites through the development of the sites draft plan. This process of getting feedback from the sites will be repeated in refining the EMMA2 Validation strategy. However, this activity should be performed at an earlier stage of the EMMA2 Validation process.
- 4) *Identify Indicators and Metrics.* This activity implies the determination of the indicators and their associated metrics for measuring the performance of the system. EMMA Validation Strategy included a wide range of indicators and metrics expressing the low level verification and validation objectives. This set of verification and validation indicators which were reported in EMMA (D6.2.2), will be revised and enhanced based on the additional functionalities proposed in the EMMA2 operational concept.
- 5) *Specify Validation Scenarios.* Each Validation scenario involves a description of the actors, events and interactions that take place in a simulated operational concept scenario. The EMMA Validation Strategy addressed this issue by including an outline of the validation scenario in the site validation plan reports. The Validation scenarios for EMMA2 will also be included in the site plan reports while generic guidelines for describing the scenario will be provided in the EMMA2 Generic Validation Strategy. It should be stressed that the specification of the actual validation scenarios will be performed by the sites based on the site specific experimental environment.
- 6) *Produce the experimental plan.* This type of activity refers to issuing a management plan for conducting the relevant experiments. In EMMA the associated management plans were prepared by the sites and were reported in the revised site validation plans. In this context, the EMMA2 Generic Validation Strategy will provide specific guidelines on the content and structure of the corresponding management plans. However, the development of the

experimental plans will be performed by the sites and will be reported in the corresponding site Validation Plans.

- 7) *Produce Analysis Plan.* Given the experimental plan, this activity refers to the specification of the data collection methods, the training requirements, the analysis methods, the statistical hypotheses and significance, and the outline of the results report. The EMMA Validation Strategy provided part of this information through the documents D6.1.1, D6.2.2 [7] and D6.2.1. These issues will also be fully covered in EMMA2 Generic Validation Strategy utilizing the information and data collection experience gained in EMMA.
- 8) *Produce Detailed Experimental Plan.* The detailed experimental plan involves the specification of the activities for the preparation, management, and execution of the experiments. In EMMA, this plan was conducted by the sites and reviewed by the actors responsible for the Validation plan in order to ensure compliance with the validation requirements and objectives. In EMMA2, the detailed experimental plan will be prepared for each site separately based on the specifications presented in the EMMA2 Generic Validation Strategy and the relevant experiments and validation scenarios. Specific guidelines will be provided within the EMMA2 Generic Validation Strategy for assuring the robustness of the measurements.
- 9) *Identify Assessment Requirements.* This activity refers to the identification of the platform, analysis and validation scenario requirements. The EMMA Validation Strategy covered this issue through providing the hypothesis tests, statistical methods, and the validation platforms/tools description for the corresponding experiments. This type of information will be revised and included in the EMMA2 Generic Validation Strategy.
- 10) *Prepare the Platform of Facility.* The aim of this activity is to configure the real time and fast time simulation platforms in order to represent the ATM problem. In EMMA this activity was performed during the experiments. The EMMA2 Generic Validation Strategy will provide a set of guidelines for preparing the platform or any other facility for implementing the alternative Validation Scenarios.
- 11) *Conduct Pre-exercise Testing and Training.* This activity was not included in the EMMA Validation Strategy. However, specific guidelines will be included in the EMMA2 Validation Strategy in order to account for this activity.

Step 3 “Conduct Experiment” of the E-OCVM includes a set of activities for executing the Validation experiments. Although missing from EMMA 1 Validation Plan, the EMMA2 Validation Strategy will include a set of guidelines for executing the validation exercises, and dealing with unexpected results or behaviours based on the relevant experience gained on EMMA. Step 4 “Determine the Results” pertains to the implementation of the analysis plan. EMMA Validation Plan did not include any guidelines regarding this task. In this context, EMMA2 Validation Strategy will provide guidelines on the development of the analysis report (i.e. preliminary table of contents or generic structure and statement of the scope of the analysis report). Step 5 refers to the dissemination of the emerging information to the stakeholders. EMMA Validation Plan did not make any reference to this issue. The EMMA2 Validation Strategy will provide guidelines regarding the expected outcome of the validation process and the way of presenting them to the stakeholders.

The above analysis outlines the support of the Generic Validation Plan to the development of the Site Validation Test Plans. The remainder of this report (2-D6.1.1a) presents the information required to the sites for performing step 0 and step 1 of the E-OCVM. More specifically, the remainder of this report is devoted to:

- i) An overview of the EMMA2 A-SMGCS functionalities
- ii) Stakeholders involved in the Validation process, their area of expertise and role in ATM, their relation to the A-SMGCS operation, their involvement in the validation process and expected outcome.
- iii) Determination of the degree of maturity of the A-SMGCS functionalities based on the sites feedback
- iv) Determination of the validations aims (i.e. expected outcome of the validation process)

- v) Determination of the high level objectives
- vi) Identification of the validation needs based on the EMMA2 A-SMGCS functionalities
- vii) Overview of the major issues that will be covered by the Site Validation Test Plans
- viii) Description of the major validation tools and techniques

More over the present document provides preliminary information regarding the validation low level objectives, acceptance criteria and indicators. The relevant information required for steps 2-5 of the E-OCVM is provided in 2-D6.1.1b “Generic Experimental and Test Plan”.

4 EMMA2 Concept and Assumptions

4.1 ATM Problem Description

A major task in the ATM relates to the management and monitoring of the ground movements within the runways and taxiways of an airport. Concerning ground movements, the ATCO is responsible for:

- i) detecting and identifying any mobile on the movement area,
- ii) providing navigation and clearance information for the aircraft and vehicles within the movement area,
- iii) monitoring the movement of any aircraft and vehicle, and
- iv) alerting the flight crew and vehicle drivers in case of detecting a potential hazard (collision or runway incursion) and resolving the situation.

On the other hand the flight crew and the vehicle drivers are responsible for the movement of the aircraft/vehicles on the ground according to the prevailing safety rules and the guidance provided by the ATCO. A major feature of the current surface movements' ground control system is that the navigation of the aircraft and the vehicles relies on the visual observation of the traffic situation in the movement area. In this context, the low visibility conditions and/or the increased traffic in the movement area tend to:

- i) increase the workload of the ATCO (increased voice communication between the ATCO and the flight crews or vehicle drivers, increased number of communication)
- ii) decrease the situation awareness of the ATCO regarding the traffic on the movement area (under visibility conditions 2 and 3, the control provided by the ATCO is heavily based on the visual observations and reports of the flight crew (without an basic A-SMGCS level 1))

Based on the current operational framework of the control and guidance services provided by the ATCO, the efficiency of ATM is affected by the prevailing visibility conditions. Low visibility conditions, increase the safety precautions taken by the ATCO in controlling the aircraft and vehicles thus decreasing the efficiency of their operations and the capacity of the airport.

Moreover, other major constraints of the current SMGCS encountered by the ATCO are the following:

- the detection for runway incursions or infringements of protected area is heavily based on visual observation of the airfield and the surveillance equipment, thus increasing the ATCO workload
- sequencing of departures becomes a difficult task in complex runway and taxiway layouts
- Communication problems between the ATCO and the flight crew (in R/T communications) especially at congested airports, due to lack of language proficiency, improper or non-standard phraseology, and frequency congestion
- Increased workload due to performing multiple tasks
- Lack surveillance equipment at the tower

The flight crews encounter the following difficulties:

- Potential risk for route deviations in complex runway and taxiway layouts due to insufficient airport signing and marking
- Communication problems with the ATCO e.g., read-backs errors due to frequency congestion
- Increased head-down times high affect crew workload, e.g. in cases of last minute runway changes
- Insufficient familiarity with the airport

Finally, the existing SMGCS creates the following constraints to the vehicle drivers:

- Drive and trace their position in the movement area at the same time. This is very difficult under low visibility conditions
- Simultaneous operation of more than one radio in the car makes it difficult for the driver to receive the instruction provided by the ATCO.

The EMMA2 operational concept covers A-SMGCS surveillance, control, routing, and guidance functionalities for facilitating the operations performed by the ATCO, flight crew, and vehicle drivers, especially under low visibility conditions and/or heavy traffic conditions. The proposed EMMA2 A-SMGCS functionalities relate to the following aspects:

- 1) Detection and identification of any vehicle or aircraft in the movement area is provided to the flight crew and the vehicle drivers in addition to the ATCOs.
- 2) Conflict prediction, detection, and alerting to ATCO/flight crew, for potential or actual incursions and infringements, and actions for resolving these situations (for the ATCO only).
- 3) Routing of the aircraft and vehicle on the movement area.
- 4) Guidance provided to the flight crew and the vehicle drivers.

The next sub-section is devoted to the presentation of the associated A-SMGCS services provided to ATCO, flight crew, and the vehicle drivers. A detailed description of the EMMA2 A-SMGCS services can be found in the SPOR document [8].

4.2 Operational Concept Description

Based on the 2-SPOR (2-D1.1.1) [8] document², each actor (ATCO, Flight crew, and Vehicle drivers) receives A-SMGCS services customized to its specific needs, expectations, and operational requirements. In the remainder of this section, there is an overview of the services implemented for the ATCO, Flight crew, and the vehicle drivers separately.

4.2.1 Services to ATCO

The A-SMGCS services provided to the ATCO are the following: i) Surveillance i.e. detection and identification of any aircraft, vehicle, or obstacle within the movement area (taxiways and runways), ii) Conflict prediction, detection of potential hazard situations (collisions, incursions) and alerting, iii) Routing and planning, i.e., manual, semi automatic or automatic determination and assignment of routes to aircraft and/or vehicles, iv) TAXI-CPDLC, v) Sectorisation, Transfer of Control, and Coordination, and vi) Integrated Human Machine Interface. The remainder of this sub-section is devoted to the presentation of the major functionalities of the A-SMGCS services provided to the ATCOs.

The surveillance functions provided to the ATCO aim to present the traffic situation of the movement area, on an airport map display. The objective of these services is to enhance the situation awareness of the ATCO especially under low visibility conditions. The major services included are:

- Detection of all aircraft, vehicles, and obstacles on the movement area
- Identification of all cooperative aircraft and vehicles
- Approach surveillance for all airborne aircraft in the vicinity of the airport
- Flight information for all identified movements
- Data fusion i.e. merging of information regarding the location of the aircraft/vehicle received from different sources)
- Airport traffic context provision i.e. runways, taxiways, apron areas, gates, buildings, guidance equipment (holding points, stop bars, airfield lighting), status of the runways and taxiways, fixed obstacles
- Human Machine Interface, providing a graphical display of the airport context and the actual traffic situation
- Provision of surveillance information to the Flight crews and the vehicle drivers.

² This section presents an overview of the A-SMGCS functions included in the EMMA2 Operational Concept, as they are described in 2-D1.1.1. For more information regarding the EMMA2 A-SMGCS services, consult 2-D1.1.1.

The control services should include automated support for helping the release of ATC clearances and the transfer of coordination among different ATC sectors. The services provided are the following:

- Conflict prediction, detection, alerting
- TAXI-CPDLC
- Sectorisation, Transfer of Control and Co-ordination

The routing service is solely provided to the ATCO and pertains to the determination of the route of the departing/landing aircraft between the runway exit and relevant stand allocated to it. Given the level of automation producing the aircraft routes, the routing service may involve:

- **Manual Routing.** The route of each aircraft is created manually by the ATCO and it is manually inserted in the system. Alternatively the functionality determines a valid route given the origin and destination points inserted manually by the ATCO.
- **Semi-automatic routing.** The shortest route complying with the local routing constraints is created automatically while the ATCO has the option to modify or rebuild manually the route.
- **Automatic Routing.** The route is built and assigned to the aircraft automatically based on a set of optimization criteria. In addition to the route, the departure time and the off-block time of the relevant aircraft is calculated by a planning functionality (Departure Management) operating complementarily to the routing function. Manual intervention of the ATCO is also permitted.

Finally, the Integrated Human Machine Interface refers to the development of an A-SMGCS HMI that could facilitate the new A-SMGCS services, like those mentioned above. This is achieved by an integrated HMI solution providing a surveillance display and an electronic flight strips display.

4.2.2 Services to Flight Crews

The objective of the A-SMGCS services provided to the flight crew is to increase the situation awareness of the pilots regarding the position/ direction of the aircraft and the surrounding traffic situation. The on-board A-SMGCS services are the following:

- **Airport Moving Map function:** it displays the horizontal position, heading, and velocity of the aircraft on the airport layout.
- **Ground Traffic Display:** it displays the position and direction of the surrounding vehicles and aircraft on the movement area. In addition, it displays any potential conflicts with the surrounding traffic.
- **Ground-air Database Upload:** it updates the airport mapping data of the on-board aeronautical database regarding the layout and configuration of the airport.
- **Surface Movement Alerting function:** it detects any potential incursion to restricted areas and alerts the flight crew.
- **Traffic Conflict Detection function:** it generates alerts to the flight crew when a potential conflict with the surrounding traffic is detected.
- **Taxi-CPDLC:** it replaces the voice communication between the flight crew and the ATCO for non time-critical messages, e.g., departure, start-up, push-back and taxi clearances request and response messages.
- **HUD Surface Guidance Symbology:** it provides the flight crew with guidance cues path (with stop information), awareness information with respect to the aircraft situation on taxiway, and braking and steering cues.

4.2.3 Services to Vehicle Drivers

These services are optional in EMMA2 and will not be validated at all sites.

Services provided to the vehicle drivers aim to increase the situation awareness of the driver regarding the position and direction of the vehicle on the manoeuvring area. The services to vehicle drivers are the following:

- Airport Moving Map function: it displays the position of the vehicle on the airport layout (with respect to the aerodrome geographic locations).
- Ground Traffic Display: it displays the surrounding traffic of the vehicle and detects any potential conflicts of the vehicle with any other aircraft or vehicle on the movement area.
- Surface Movement Alerting service, providing the driver with alerts in possible risk situations for the vehicle.
- Vehicle Dispatch and Guidance by Data Link function refers to the provision of vehicle dispatch and specific guidance information through a data link communication.

5 Set Validation Strategy

This section presents the major activities required for defining the validation strategy at each site of the project, while it provides the essential information that facilitates this task. In this context, the present section identifies and describes the stakeholders involved in the EMMA2 validation process, the level of maturity of the A-SMGCS functions implemented within EMMA2, the associated validation needs, the expected outcome, and the high / low level validation objectives. The level of maturity of each EMMA2 A-SMGCS functions was checked and certified by the sites. Note that the information provided in this section aims solely to propose the issues that should be included in each site-specific validation strategy. The actual site validation strategies will be produced by the corresponding site-specific validation partners. The content of this section could facilitate each of the sites in developing its validation strategy.

5.1 List of stakeholders and their needs

A major objective of the EMMA2 Validation process is to provide sufficient evidence for convincing the stakeholders involved in the ATM problem that the proposed system covers their requirements and needs. This target may be achieved by identifying the complete set of EMMA2 stakeholders and specifying their objectives, needs, expectations from the system and the validation process, and the information required in order to assess the performance of the EMMA2 system. This section presents the stakeholders that are involved in or affected by the EMMA2 validation process. The identification of the EMMA2 stakeholders was based on the enhancement of the corresponding list of stakeholders provided in EMMA Generic Validation Plan (D6.1.1) [4]. For more information on the involved stakeholders see [5].

5.1.1 Air Traffic Controllers

The Air Traffic Controllers (ATCOs) constitute a major user group of the system proposed within the EMMA2 Operational Concept. The categories of ATCOs involved in the EMMA2 Operational Concept are:

- i) the clearance delivery controller who is responsible for authorising any movement of the aircraft from the stand it occupies
- ii) the ground controller who is responsible for guiding the aircraft through the taxiway and the apron
- iii) Tower or Runway controller, who is responsible for providing take-off and landing clearances to the aircraft and checking that the aircraft arriving and/or departing are separated according to the safety rules.

The tasks performed by the ATCO are ultimately based on the visual monitoring of the movements in the airport. Under low visibility conditions and/or increased traffic conditions, the operations performed by the ATCOs are significantly slowed down in order to secure safe movements on the ground. The emerging inefficiencies in monitoring the movements on the ground by the ATCO, may be mitigated by the introduction of the EMMA2 A-SMGCS. In particular, the expectations of the ATCOs from the EMMA2 A-SMGCS relate to the: i) reduction of the R/T communication load with the flight crew, ii) improvement of their situation awareness regarding the traffic situation in the movement area especially under low visibility and increased traffic conditions, iii) shorter response times to conflict situations (due to the alerting service), and iv) workload reduction due to the automated provision of services such as clearances and guidance.

It should be emphasized that the expectations of the ATCO from the corresponding EMMA2 Validation relates to the provision of evidence that the system would improve their performance under low visibility and heavy traffic conditions (i.e. increase situation awareness and decrease workload) without affecting (or rather improving) the safety of their operations.

5.1.2 Aircraft Operators

A major feature of the EMMA2 operational concept is the provision of the surveillance, alerting, and guidance services to the flight crew. The objective of the flight crew and the associated airlines with respect to the aircraft movements on the ground relates to the safe and efficient transfer of the aircraft from the runway to a stand at the apron and the opposite so as to achieve punctuality in departures and arrivals (i.e. decrease delays on the ground) and reduction in the taxiing time to and from the apron. Evidently, under low visibility conditions and heavy traffic conditions, the aircraft movements are significantly delayed causing additional cost for the airlines while creating increased workload to the flight crew. Thus, the surveillance and guidance services provided to the flight crew are expected to: i) increase the situation awareness of the pilots regarding the aircraft position on the runway, taxiway or apron and the surrounding vehicles, aircraft, and obstacles under low visibility conditions, and ii) expedite the aircraft movements on the ground without deteriorating safety, thus leading to cost reduction under low visibility and/or heavy traffic conditions.

5.1.3 Ground Handling Operators

The ground handling operators are responsible for managing the vehicles that provide ground handling services (e.g. passenger transportation on the ground). The performance of the vehicle drivers deteriorates under low visibility and heavy traffic conditions. The implementation of the EMMA2 system aims to improve the performance of the ground handling vehicles operations in terms of safety and efficiency. In particular, the EMMA2 services aim to accommodate the movement of the vehicles under low visibility conditions in order to: i) reduce the workload of the drivers, and ii) improve the situation awareness regarding the surrounding traffic.

5.1.4 Airport Emergency Units

This category of stakeholders includes the emergency service providers that are responsible for any type of safety-threatening incident within the movement area of the airport. The position of the incident, the dynamic status of the runways, and the position of any aircraft or vehicle on the movement area constitute critical information for the airport emergency providers. In this context, the detection and identification of an incident on the movement area by the surveillance and alerting functions provided by the proposed EMMA2 A-SMGCS may attract the interest of this type of actors. The expectation of these stakeholders from EMMA2 relates to the improvement of the situation awareness of the traffic situation and the position of the safety-threatening incident.

5.1.5 Regulators

As a key part in the facilitation of A-SMGCS implementation, regulators should be informed (even

participate) in the definition of the EMMA2 validation process. Their inputs would be used to design the validation process in such a way that apart from conforming to the technical and functional issues, it would also cover (or advance) the regulatory ones. Furthermore, the regulators could gain further knowledge in the system that will enable them to better regulate on it in the future. Several organisations are identified in this cluster:

- ICAO: As the main responsible for aircraft and airport operation and global regulator almost universally accepted.
- Civil Aviation Authorities: As the final regulators in each country. At least the CAA of the European Union Members should be aware of EMMA results. FAA is also to be considered since similar projects are running in USA and certain communality could be desirable.
- European Commission: Though it has not regulatory responsibilities, it acts as Consultancy Body for the European Parliament, and sponsors the project.

The expectations of the above organisations from the EMMA2 systems relate to the:

- i) safety improvement for the ground movements despite the traffic increase, and
- ii) reduction of environmental impacts.

5.1.6 Other Organisations

Representative organisations are identified as means to broadcast the EMMA2 results but also as consultative bodies to support or corroborate EMMA2 approaches. Due to their own nature, these kind of organisations grouping and representing industry, airports, ATCOs, pilots, ANSPs could provide some kind of 'official' support to EMMA2 activities.

The following organisations are identified as interesting to be aware of the EMMA validation process and results:

- ACI: Airport Council International is an organisation in charge of representing airports' interests and representing them around the world. Due to its function, it is interesting to count with them as a mean to broadcast EMMA2 results to those airports not directly participating in the EMMA project, and also getting some sort of official acknowledgement from airports to EMMA activities.
- AEA: Association of European Airlines represents a wide number of European airlines. A means of disseminating EMMA2 project to those airlines not directly involved in it.
- AECMA: Since major European aircraft and component manufacturers are included in the European Association of Aerospace Industries, this association can be used as a reference to broadcast and agree on the EMMA2 results.
- CANSO: Civil Air Navigation Services Organisations is a council of the Air Navigation Service Providers. Since they are affected by EMMA activities, it would be interesting to involve CANSO to get dissemination of and commitment to EMMA2 results.
- EUROCAE: It is in charge of creating standards for the development of aeronautical equipment. Due to its role in developing standards for A-SMGCS equipment it would be interesting to keep a continuous feedback with this organisation.
- EUROCONTROL: It develops European policy regarding safety, among others. It is essential to keep them involved in EMMA2 activities for the role they can play in supporting EMMA2 results. Possible synergy with EUROCONTROL activities needs to be assessed.
- Flight Safety Foundation (or similar European associations): Since A-SMGCS aims to improve safety in the airport manoeuvres, their opinion would be relevant to EMMA2. Furthermore they can promote EMMA2 activities.

- GA Associations: As final user, General Aviation should be informed on the EMMA activities and participate (if possible) in the design and validation activities due to the special particularities of this type of aviation.
- IATA: Representing airlines all over the world, IATA will serve as broadcast and evaluator of EMMA2 activities to one of the most important final users of A-SMGCS.
- IFATCA: The International Federation of Air Traffic Controllers' Associations plays an equivalent role to IATA and ACI on the ATCOs' side. Their point of view in HMI and functionality issues is of high interest.
- Military: Co-operation with military is needed not only because they are final users of A-SMGCS, but also because of the relevance of security in the future and the role they play in some airports. Civil-Military interoperability panels can be contacted. EUROCONTROL's Military Business Division can play the communication channel role.
- Passenger Associations: As the real final user, passengers could be consulted on how much comfortable they feel with such systems intended to increase the airport operations' safety. Surveys could be conducted through passenger associations.
- Research Institutes: European research institutes, mainly those from the new Associated States and those not participating in EMMA2 activities can be informed on EMMA2 activities to gather their opinion and looking for possible co-operation in dissemination or sharing of expertise.
- RTCA: Same as for EUROCAE
- Unions: Workers (e.g., pilots, drivers, airlines staff, handling staff) are also users of the system. Their point of view, mainly in HMI issues is key for EMMA2 success. A first contact could be performed with those belonging to the organisations (airports, ANSPs) participating in EMMA2.

Air Traffic Service Providers, Airport Authorities and Airlines benefit directly from the EMMA2 A-SMGCS services. Other Stakeholders don't have direct benefit from A-SMGCS. Aircraft Manufacturers and ATM Systems Providers may have a role in the overall validation.

5.1.7 Overview of Stakeholders Expectations covered by EMMA2 Operational Concept

This section aims to provide an overview of the needs covered by the EMMA2 operational concept per category of stakeholders.

<i>Stakeholder</i>	<i>EMMA2 A-SMGCS Service</i>	<i>Expectations Addressed</i>
ATCO	Surveillance ³	– improve situation awareness on the movement area under low visibility conditions and heavy traffic scenarios
	Conflict Prediction, Detection, and Alerting	– promptly and efficiently determine the short-term or medium-term conflicts and infringements on the movement area – improve the response time of the ATCO to incidents
	TAXI-CPDLC	– decrease the workload of R/T communication between the ATCO and the flight crew

³ The surveillance service received by the ATCOs will play only a subordinated role within the EMMA2 validation activities. It must be seen as the basic A-SMGCS service that enables higher-level services. However, it must be ensured during EMMA2 V&V that this service is fully working, meeting the operational requirements but this service is not focus of the EMMA2 HLO since this service has already been fully validated in EMMA and other European A-SMGCS V&V activities, e.g. EUROCONTROL A-SMGCS Project.

<i>Stakeholder</i>	<i>EMMA2 A-SMGCS Service</i>	<i>Expectations Addressed</i>
	Routing/ Planning	<ul style="list-style-type: none"> – improve efficiency of surface movements in terms of punctuality – supports the ATCO to prepare an optimal taxi route for each movement and to input it into the machine
	Sectorisation, transfer of Control, and Coordination	<ul style="list-style-type: none"> – facilitates the transfer of control between controller working positions and supports the coordination between them
	Integrated Human Machine Interface in terms of Electronic Flight Strips	<ul style="list-style-type: none"> – increase situation awareness – enables the ATCO working efficiently with the new A-SMGCS services (e.g. TAXI-CPDLC, route conformance monitoring, planning, etc.) – supports the ATCO to share and receive relevant information in the right time
Flight Crews	Airport Moving Map function	<ul style="list-style-type: none"> – improve the situation awareness of the flight crew under low visibility conditions – enable navigation under low visibility conditions
	Ground Traffic Display	<ul style="list-style-type: none"> – avoid collisions under low visibility and /or heavy traffic conditions – improve the situation awareness of the flight crew under low visibility conditions
	Surface Movement Alerting Function	<ul style="list-style-type: none"> – improve the reaction time of the flight crew to safety-threatening situations (collisions) – avoid collisions
	Traffic Conflict Detection Function	<ul style="list-style-type: none"> – improve the reaction time of the flight crew to safety-threatening situations (collisions) – avoid collisions
	TAXI-CPDLC	<ul style="list-style-type: none"> – avoid collisions due to pilot read back errors – decrease workload of communication between the ATCO and the pilot – safely guide the aircraft on the movement area by ground-based means or by transferring information to the pilot
	Braking and Steering Cues function	<ul style="list-style-type: none"> – efficient navigation of the aircraft based on the assigned route
	HUD Surface Guidance Symbology function	<ul style="list-style-type: none"> – efficient navigation of the aircraft based on the assigned route
Vehicle Drivers	Airport Moving Map function	<ul style="list-style-type: none"> – improve situational awareness of the vehicle drivers under low visibility conditions
		<ul style="list-style-type: none"> – improve the situational awareness of the emergency response units regarding the locations of an incident under low visibility conditions
	Ground Traffic Display function	<ul style="list-style-type: none"> – avoid potential collisions of the vehicles with surrounding traffic under low visibility conditions
	Surface Movement Alerting function	<ul style="list-style-type: none"> – avoid potential incursion of the vehicles to restricted areas

<i>Stakeholder</i>	<i>EMMA2 A-SMGCS Service</i>	<i>Expectations Addressed</i>
	Vehicle Dispatch and Guidance by Data link	<ul style="list-style-type: none"> – avoid collisions due to drivers’ read back errors – decrease workload of communication between the ATCO and the vehicle driver

Table 5-1: Overview of the stakeholders’ needs covered by EMMA2 A-SMGCS functions

5.2 Validation Life Cycle Model (E-OCVM)

5.2.1 Introduction

The European Operational Concept Validation Methodology (E-OCVM) describes several levels of maturity along the life cycle of ATM concept validation (Ref. [1]). The assumption is that an ATM concept will take time to develop into an application and that the validation process should allow for this ‘maturing’ process. Too much rigor at an early stage will stop a good idea whereas too little rigor late in the development will allow a poor idea to go forward. As the concept matures programme managers should be aware of what can be expected in terms of results and the reliability of those results in order to set realistic programme and project objectives. The E-OCVM proposes a 6 level concept validation maturity scale ranging from V0 (ATM Needs) to V5 (Operational). At each of the stages the validation scope is likely to mature in line with the advancing maturity of the concept (see Figure 5-1). As the concept becomes more mature, the validation activity must become more rigorous. Validation exercises may be larger and the focus of these exercises and their objectives are likely to mature.

The maturity model described above can be applied for the purposes of EMMA2 in order to determine the type of validation exercises and assessments that should be performed. The focus of ATM concept R&D is most applicable to phases V1 to V3 of the E-OCVM maturity model (i.e. from the establishing of the scope of concept validation to integrated performance validation). The last two phases concern industry activities in which the validated concept and related system prototypes will be brought into operation.

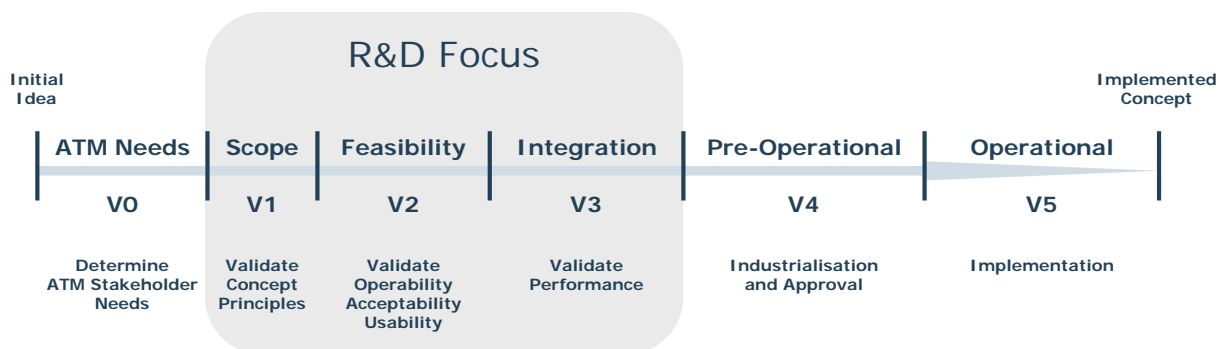


Figure 5-1. Validation stages throughout the life cycle of an operational concept (E-OCVM).

5.2.2 Verification versus Validation

In EMMA-1 the following definitions for verification and validation were given:

Verification is testing against predefined *technical specifications*, technical functional testing ('did we build the system right?').

Validation is testing against *operational requirements* (as defined by stakeholders and written down in the OSED document of EMMA-1), man-in-the-loop, ATM procedure testing, case studies ('did we build the right system?').

In general, these definitions still apply, although even operational requirements can be verified simply by performing a site acceptance test, looking at whether an operational requirement is part of the system or not, without giving an indication of whether the requirement is reasonable or not. Thus, simply arguing that an introduced system complies with an operational requirement is not enough for validation. Instead, validation of operational requirements must clearly be linked to the objectives formulated for the project. In general, these objectives will be linked to the key performance areas that address specific stakeholder issues and are therefore directly linked to the needs expressed by stakeholders.

If there is a desire to validate concept principles, the set of operational requirements might not even be detailed enough to present an operational expert with a prototype. In that case, it is sufficient to find evidence that the proposed solution, however detailed it is, will be able to address the stakeholder needs and promises to lead to operational improvements.

If the feasibility of a certain prototype or concept idea is to be shown then operational requirements should be detailed enough to be validated and after the necessary verification activities (functional testing) validation of the feasibility of the proposed concept and system, including acceptability and usability of operations and system implementation, can take place. The result of such testing should be evidence that the behavioural capabilities of concept and prototype system are such that operational requirements, which should be driven by the need to improve a defined key performance, are complied with and lead to the expected acceptance levels. Validating different system implementations in that way can lead to the selection of one or more promising candidates for pre-operational implementation.

Finally, if the performance of an integrated concept and system needs to be validated, full-blown man-in-the-loop exercises should be performed. This can only happen if it is guaranteed that the system complies with all requirements that were refined in the previous feasibility validation. This verification step is necessary to ensure that all conceptual or procedural and technical improvements suggested during the previous validation phase were indeed integrated in the prototype system. Performance validation then needs to find the evidence that the proposed final concept is able to lead to the desired improvements in the key performance areas while complying with all identified requirements. Regarding the latter it is important to especially look at approval, certification, safety and political regulations and legislation applicable to both operation and system from the beginning.

The following sections again describe the different levels of maturity as defined in the E-OCVM and will identify the EMMA2 systems and their corresponding maturity levels.

5.2.3 Description of the Levels of Maturity

5.2.3.1 Maturity Phase V0: ATM Needs

As a prerequisite of concept validation, the ATM performance needs and barriers must be identified. To complete the validation of the concept, the concept must show that it can alleviate these barriers enough thus enhancing ATM performance to the anticipated required level.

5.2.3.2 Maturity Phase V1: Scope

This is the phase where the concept should be described in sufficient detail to enable identification of the potential benefits mechanism (i.e. the change to operational procedures that will enable the known barrier to be alleviated). Some aspects of the concept will be unknown or unclear at this stage. They may exist as a number of options to be assessed during the further validation process.

5.2.3.3 Maturity Phase V2: Feasibility

The feasibility phase is the phase to develop and explore the concept until it can be considered operationally feasible. During this phase system prototypes will be used that make assumptions about technical aspects in order to avoid platform engineering which can be costly and lengthy. The main focus is on operability and the acceptability of operational aspects. It is during this phase that operational procedures and requirements emerge. The number of iterations depends on the complexity of the concept and how often unexplained situations occur that need to be explained. At the end of this phase HMI, operating procedures (for normal and key non-normal conditions) and phraseology should be thoroughly tested. This stage will establish the behaviours of the new system.

5.2.3.4 Maturity Phase V3: Integration

This is the phase to integrate any required functionality into pre-industrial prototypes. Engineering processes can be explored to provide experience that will be useful to building the end-system. This phase is focused on integrating operating procedures by using realistic scenarios that are representative of what the concept must be able to manage in the target end-system. The focus is therefore on system level behaviour, performance and establishment of standards and regulations necessary to build and operate the required technical infrastructure. This work will enable costs and benefits to be clearly identified and provide information about the potential performance of the overall ATM system.

5.2.3.5 Maturity Phase V4: Pre-operational

Pre-operational preparation takes place during this phase. Pre-operational prototypes will be transformed into industrial products ready for implementation and all institutional issues concerned with procedures approval should be addressed. This phase is out of the direct scope for ATM R&D.

5.2.3.6 Maturity Phase V5: Operational

This is the phase when products and procedures are combined to create an operational system at a specific site. Implementation is a complex and risky procedure and it can be expected that many pragmatic 'fixes' will be required to complete implementation successfully. This phase again is out of the direct scope for ATM R&D.

5.2.4 EMMA2 Concepts and their Level of Maturity

The following table indicates the level of maturity of the A-SMGCS concepts tested in the context of the EMMA2 Integrated Project. The tables reflect a global EMMA2 view and should not be read as mandatory for each test site or airborne activities.

The allocation of the maturity levels to the functions is result of an acute discussion between the EMMA2 partners. As direct consequence SP6 trials should focus first on checking the **operational feasibility** of requirements and procedures, but also testing different options of procedures. Also technical failures and their respective fall back procedures could be tested – the focus depends on the resources of the test sites (time and ATCOs / Pilots available) – not all can be tested in one test run. If system maturity is sufficient also **operational improvements** should be derived.

	On ground						
	Surveillance	Conformance Monitoring	TAXI-CPDLC	Routing	Electronic Flight Strips	Planning	Sectorisation, Transfer of Control, and Co-ordination
Description	- providing fused surveillance data from non-cooperative and cooperative sensors display the actual traffic situation to the ATCO (position and identification)	- service for the ATCO to check the adherence of aircraft to clearances	- area communication service that uses the medium data link instead of R/T - to be used for routine and less time and safety critical communication in order to reload the current R/T channel	- assisting the ATCO to plan optimised routes	- reproducing the paper strips to a certain extend. The EFS data is used by other ground based services. The ATCO has to maintain an EFS, e.g. when giving clearances, the ATCO needs to give extra inputs to the EFS.	- giving advice to ATCO for an optimised departure scheduling. Possibly optimising the turn-around and flight preparation at the gate, the taxi-out phase, the optimised sequence of departing aircraft, the optimal utilisation of the SID and any combination of these. ROP serves the ATCO for optimum use of the runway.	the coordination and transfer of control of a flight between successive ATC units and control sectors shall be effected by a process comprising the following stages: 1. announcement of the flight and the proposed transfer of control conditions 2. coordination of and agreement on the transfer of control conditions 3. transfer of control to the accepting ATC unit or control sector.
A-SMGCS	Surveillance	Control	Control	Routing	HMI	Planning	Control
Maturity	V4-V5 already pre-operational or operational	V1-V2 Establish concept principles / proof of concept	V1-V2 Establish concept principles / proof of concept	V1-V2 Est. concept principles / proof of concept	V1-V5 Establish concept principles // operational (very airport dependent)	V1-V2 Est. concept principles / proof of concept	V1-V2 Est. concept principles / proof of concept
EMMA2 Validation	already validated – not part of EMMA2	Validate concept principles and feasibility	Validate concept principles and feasibility	Validate concept principles & feasibility	Validate performance; pre-operational trials	Validate concept principles and feasibility	Validate concept principles

Table 5-2 EMMA2 On ground A-SMGCS functions – descriptions and level of concept maturity

	On-board					
	Ground Traffic Display	Air Database Upload	Head Up Navigation	Surface Movement Alert (SMA)	Traffic Conflict Detection	TAXI-CPDLC
Description	The On-Board moving map and situation display provides a surveillance picture of all surrounding aircraft and vehicles. Both direct ADS-B from the surrounding traffic are received and traffic broadcasts from a ground TIS-B server (includes also non-cooperative movements detected by the SMR or other non-cooperative sensors)	On-Board moving map and situation display needs accurate and up to date air data base information. This function takes care of the safe and secure up load of air databases.	The HUD enables the pilot to look outside and see at the same moment and in the same observing direction the flight data as projected on the HUD.	The Surface Movement Alert function has the following main goals: Assist and alert the pilot, to avoid collision of own aircraft with fixed obstacles, to avoid own aircraft runway incursions, to avoid usage of unsuitable taxiways, to avoid deviation from taxi guidance line or centre line, avoid deviation from the pre-defined route and to avoid take-off from taxiways	This on-board function tries to raise the awareness of the flight crew about potential conflicts with other traffic as a complement to the runway situation awareness and/or to the traffic situation awareness	- area communication service that uses the medium data link instead of R/T - to be used for routine and less time and safety critical communication in order to reload the current R/T channel - taxi route information can be received and displayed alphanumerical or even graphical on the on-board moving map display
A-SMGCS	Surveillance	Surveillance	Surveillance	Control	Control	Control + Guidance
Maturity	V2-V3 Integration and Pre-Ops trials	V1-V2 Establish concept principles / Proof of Concept	V2-V3 Integration and Pre-Ops trials	V1-V2 Establish concept principles / Proof of Concept	V1-V2 Establish concept principles / Proof of Concept	V1-V2 Establish concept principles / Proof of Concept
EMMA2 Validation	Validate concept feasibility and performance	Validate concept principles and feasibility	Validate concept feasibility and performance	Validate concept principles and feasibility	Validate concept principles and feasibility	Validate concept principles and feasibility

Table 5-3 EMMA2 On-board A-SMGCS functions – descriptions and level of concept maturity

The level of maturity of the equipage is different for the participating airports. More details can be found in the chapter on Validation Needs (Section 5.5) and the Validation Strategy and Plan (Section 5.6).

5.3 Validation Expected Outcomes

The scope of the EMMA2 Validation process relates to the investigation of the operational feasibility of the proposed A-SMGCS functions in terms of complying with the relevant operational (i.e., service and performance) requirements, and the assessment of the operational improvements in the ATM due to the introduction of the proposed EMMA2 operational concept. In this context, the EMMA2 Validation involves the following types of assessment:

- i) Verification of the accuracy, reliability, and robustness of the functionalities provided by the EMMA2 system. This type of assessment is performed by examining each of the functionalities of the system in terms of covering the associated technical specifications. The objective of this type of assessment is to provide evidence that the EMMA2 system provides the intended A-SMGCS functionalities. Based on the Technical Annex, this type of assessment will be performed within SP2-5. Therefore, Verification is not included in the Validation process.
- ii) Operational Feasibility, referring to the examination of the EMMA2 A-SMGCS system in terms of complying with the operational requirements provided in the SPOR document and the new operational procedures. The objective of this type of assessment is to provide sufficient evidence that the proposed A-SMGCS services may be operationally integrated and used within the ATM given the existing local technological and regulatory limitations, and propose relevant amendment in case of success of the trials.
- iii) Evaluation of the Operational Improvements. The objective of this type of evaluation is to determine and assess the potential impacts of the proposed EMMA2 system in the major key performance areas of the ATM operations.
- iv) Operational Benefits, referring to the quantification of the above operational improvements. This type of assessment will not be performed in EMMA2.

In particular, concerning the operational improvements assessment, the EMMA2 Validation process aims to examine the proposed EMMA2 system in comparison with the existing SMGCS under the following expected impacts:

- User Acceptance of the EMMA2 system. The EMMA2 Validation process should investigate the impacts of the alerting, guidance, routing, and surveillance services on the behaviour and performance of the users of the proposed system (i.e. ATCO, pilots, and vehicle drivers)
- Safety. The Validation process should investigate the impact of the EMMA2 A-SMGCS on the probability of conflicts, collisions, and infringements of the aircraft/ vehicles on the movement area under alternative visibility and traffic conditions. Furthermore, the following issues should be examined:
 - the contribution of the proposed conflict resolution plans in improving safety
 - the timely detection of potential non-nominal situations
 - the expected time required for resolving a conflict
- Capacity. The aim of the Validation process relates to the investigation of the throughput changes (with EMMA2 system) and their significance under alternative visibility and traffic

conditions. It is also important to examine the changes in throughput due to the route plans proposed by the EMMA2 routing function.

- Efficiency. This type of improvement relates to the reduction of the aircraft taxiing time due to the improvement in departure planning and optimal aircraft route assignment.
- Environment. An additional expected improvement relates to the reduction of the environmental impacts due to the airport operations.
- Operator Training and Licensing. Results from the EMMA2 Validation will be a significant source when training needs for the ATCO, pilots, and the vehicle drivers are determined in order to efficiently and safely use higher A-SMGCS services.

5.4 High Level Validation Objectives in Key Performance Areas

The high level validation objectives⁴ express the major goals of the assessment of the operational feasibility and the operational improvements of the proposed A-SMGCS. Thus, the high level validation objectives for the **operational feasibility** assessment are the following [4]:

- *High Level Objective 1 (HLO 1: Verification of EMMA2 Operational Requirements and Procedures)*: Assessment of the new A-SMGCS services provided by the EMMA2 system in terms of covering the SPOR operational requirements. This objective also includes: i) the identification of the barriers and enablers in implementing and using the new A-SMGCS services, ii) the associated operational procedure changes that would underpin the use of the services, and iii) the validation that adequate procedures exist in order to recover from the possible failures of A-SMGCS equipment.

The determination of the high level validation objectives associated to the substantiate EMMA2 **operational improvements** was based on the expected validation outcome of the EMMA2 A-SMGCS mentioned in the previous section, the ICAO Manual on A-SMGCS [2], and the ATM objectives stated in the ATM 2000+ Vol. 2 [3]. The relevant high level objectives are the following:

- *High Level Objective 2 (HLO 2: Increase of Safety)*: referring to the assessment of the EMMA2 functions in terms of preserving (or even increasing) the level of safety at the airport especially under low visibility conditions and in congested traffic situations. This type of assessment will be focused on investigating the contribution of the use of the system in mitigating the risk of incursions or collisions on the movement area.
- *High Level Objective 3 (HLO 3: Increase of Capacity and Efficiency)*. HLO 3 refers to the assessment of the impact of the system on the capacity and efficiency of the airport. This type of assessment involves the verification of the maintenance (or improvement) of apron, taxiway, runway, and approach capacity due to the use of the proposed A-SMGCS functions, especially under low visibility conditions and in congested traffic situations. In addition, the proposed EMMA2 functions are envisaged to improve the accuracy and facilitate the effective planning of the ground operations. These impacts are expected to increase the overall ATM network capacity in line with traffic demand, to ensure that ATM-induced delays are not a significant constraint, and that the percentage of traffic delayed by ATM is less than today.
- *High Level Objective 4 (HLO 4: Suitability of Behaviour and Working Performance)*. HLO 4 involves the assessment of the impact of the EMMA2 functions on the behaviour and working performance of the staff involved in ATM. The EMMA2 functions are expected to preserve or improve the situation awareness of the ATM actors (pilots, ATCO, vehicle drivers) and reduce the workload and stress, especially under low visibility conditions and in congested traffic situations. This high level objective aims to ensure human involvement and commitment in

⁴ EMMA2 will continue to use the self-explanatory term “High Level (Validation) Objective” (HLO) instead of the new E-OCVM (Version 2) term “Programme Validation Objective”

making possible the changes in future ATM, so that operational, technical and support staff can operate effectively, efficiently and safely within their capabilities, and obtain challenge and job satisfaction.

- *High Level Objective 5 (HLO 5: Reduction of Environmental Impact)*. The improvement of capacity and efficiency expected by the use of the EMMA2 A-SMGCS will mitigate the negative environmental impacts of the airport operations.

5.5 Initial Validation Needs and Draft Plan

This sub-section covers the E-OCVM activity (of Step 1) “Initial Validation Needs and draft Validation strategy” and “Validation Tools or Techniques”. The EMMA2 Ground and On-board A-SMGCS functions have been identified in Table 5-2 and Table 5-3. The two overview tables reflect the overall impressions about what test sites are going to validate. In what follows, more detailed tables per A-SMGCS function are specified. Each table is devoted to a specific A-SMGCS function providing the following type of essential information for performing the corresponding validation exercises:

- Type of test (RTS for Real Time Simulation, OST for On Site Testing)
- High Level Objective(s) (most important ones)
- ATM scope (tells roughly the ATM context for the validation tests)
- A-SMGCS context (this is called Geo context in E-OCVM, see the E-OCVM definitions)
- Realism (gives a rough indication how close to reality the test (model, concept, prototype) is expected to be)
- Platform fidelity (gives an indication about the degree to which a collection of integrated tools and inputs matches the characteristics of the real ATM system and ATM procedures it represents)
- Duration (indication on fore-hand about the size of the experiments; has to be further specified in local Test Plan(s) and the Duration specified could be the sum of several tests)
- Resources required (specifies the most important resources required, like the number of participating controllers, pilots, other ATM functions, special test items)
- Dependencies (specifies the minimum required conditions, tools, milestones-reached before this validation can happen. Be aware that some EMMA2 tests might benefit from other projects!)

This document (2-D6.1.1a) will only specify global (i.e. not-site specific) EMMA2 validation activities. It does not exclude site-specific validation activities. The specific validation test plan (2-D6.1.2 to 2-D6.1.6) is the place to specify these local activities and it would be very valuable to integrate the results also in the final document of EMMA2.

	On ground					
	Conformance Monitoring	TAXI-CPDLC	Routing	Electronic Flight Strips	Planning	Sectorisation, Transfer of Control, and Co-ordination
A-SMGCS	Control	Control	Routing	HMI	Planning	Control
Maturity	V1-V2 Establish concept principles / proof of concept	V1-V2 Establish concept principles / proof of concept	V1-V2 Establish concept principles / proof of concept	V1-V5 Integration and Pre-Ops trials	V1-V2 Est. concept principles / proof of concept	V1-V2 Est. concept principles / proof of concept
Type of test (and test site)	D RTS (TLS, MXP) OST (MXP)	D RTS (PRG, TLS, MXP) OST ⁵ (PRG, TLS, MXP)	D RTS (PRG, MXP) OST (PRG, MXP)	D RTS (PRG, MXP ⁶) OST (PRG,TLS,MXP)	RTS (PRG, CDG, TLS) OST (PRG, TLS)	RTS (CDG)
Assumption	Safety improvement	Improvement of airport throughput	Improvement of airport throughput, efficiency	more efficient information access and sharing	Improve of runway throughput, taxi duration and queue length	more efficient information access and sharing
ATM scope	Runway and ground control ⁷	Taxiing, take-off and landing	Landing, taxi, parking and vice versa Runway and ground control	Tower control	Departure management in coordination with arrivals	Aerodrome Control adjacent sectors (Departure, Approach), AOC, AOCC
A-SMGCS context	Runways and taxiways	Busy airport	Complex airport; Runways and taxiways	Complex airport	Runway, Taxiway	Airport and adjacent sectors
Realism	Medium	Medium	Medium	High	Medium (Low in CDG RTS)	Low (High in CDG RTS)

⁵ Ground system and procedures lack except for pre-departure clearance

⁶ Vigiestrips will be used in RTS CDG but will not be validated (since it was already 3 years ago).

⁷ This function serves as monitoring and alerting process

	On ground					
	Conformance Monitoring	TAXI-CPDLC	Routing	Electronic Flight Strips	Planning	Sectorisation, Transfer of Control, and Co-ordination
Platform fidelity	Medium	Medium	Medium	Medium	Medium	Medium
Duration	Phase 1: about 1 day of demonstration to controller (Focus: HMI) Phase 2: about 3 days of RTS Phase 3: about 1 or 2 days OST (Focus Phase 2&3: proof of concept)	About 3 days (1 for each type)	Few days with demonstration to pilots SMAN: Phase 1: half day of demonstration to controller (focus HMI) Phase 2: about 3 days of RTS trials (focus: airport throughput & capacity enhancement) Phase 3: about 1 day of RTS trials (Focus: safety assessment) Phase 4: about 4 days OST ⁸	About 10 days Phase 1: 0.5 day D Phase 2: about 1 week RTS Phase 3: about 1 week RTS Phase 4: about 1 week OST	About one week RTS About 1 day OST ⁹	About 1 day D, about 5 days with different scenarios and controller exposure
Resources required	ATCO team to evaluate traffic situation display in RTS and OST Traffic situation display with alerting capabilities Conformance monitoring module	ATCO team, ATTAS team, Airbus team	Sufficient number of pilots for performing an evaluation, data link, SMAN (RP), CDTI SMAN: ATCO team, SMAN (RP) and HMI functionality	ATCO team, EFS, data recording	Controller team, DMAN, EFS	Controller team
Dependencies	Needs route allocation per aircraft, e.g. from SMAN / Route Planner (RP) ¹⁰	CPDLC airborne standards, Test Aircraft (ATTAS and Airbus platform) ¹¹	Route generation from SMAN Test Aircraft ¹²			Other functions needed to feed the Safety Net (EFS, TRCM,...)

Table 5-4 Validation Strategy and Plan for on ground functions

⁸ 4 phases for Malpensa, 3 for Prague

⁹ OST in shadow mode in close cooperation with EFS

¹⁰ This monitor function can be tested in combination with SMAN (RP) taxi route generation

¹¹ Use CASCADE and D-Taxi results

¹² If no SMAN, use table for route generation

	On-board					
	Ground Traffic Display	Air Database Upload	Head Up Navigation	Surface Movement Alert (SMA)	Traffic Conflict Detection	TAXI-CPDLC
A-SMGCS	Surveillance	Control	Control	Control	Control	Control
Maturity	V2-V3 Feasibility and Integration	V1-V2 Establish concept principles / Proof of Concept	V2-V3 Feasibility and Integration	V1-V2 Establish concept principles / Proof of Concept	V1-V2 Establish concept principles / Proof of Concept	V1-V2 Establish concept principles / Proof of Concept
Type of test (and test site)	RTS (DLR, TUD Sim) OST ¹³ (ATTAS, GA, TUD Van)	RTS (TUD Sim) OST (TUD Van)	RTS (THAV Sim)	RTS (DLR, TUD Sim) OST (TUD Van)	RTS ¹⁴ (DLR, TUD Sim) OST ? (TUD Van)	RTS(Sim THAV,AIF,DLR) OST (ATTAS)
Assumption	The traffic display is assumed to improve pilot situation awareness and thus safety	Develop and test procedures such that the pilots shall always work with the most recent airport database.	The head up navigation is assumed to improve pilot situation awareness.	Improvement of pilot situational awareness	Improvement of pilot's situation awareness and thus safety	Improvement of pilot's situation awareness
ATM scope	Landing/taxi-in /parking/ taxi-out/ crossing/ take-off ¹⁵	Correct and complete upload of database in a reasonable time	Landing/taxi-in /parking/ taxi-out/ crossing/ take-off	Taxiing / landing / take-off	Landing / crossing/ take-off ¹⁶	Airport taxiing, take-off and landing
A-SMGCS context	Busy and complex airport	Busy and complex airport	Busy and complex airport	Runways and taxiways	Busy and complex airport	Busy airport
Realism	Required for RTS: excellent cockpit visuals; OST: ATTAS	Medium	Excellent cockpit visuals required	High	Excellent cockpit visuals required	High ¹⁷
Platform fidelity	Medium	Medium	Medium	Medium	High ¹⁸	Medium
Duration	RTS: 5 days OST: about 5 days ¹⁹	about 3 days	about 5 days	about 10 days ²⁰	1 week	3 days

¹³ RTS on avionics platform tests

¹⁴ RTS on avionics platform tests

¹⁵ Suggest to take at least 3 visibility conditions and compare situational awareness with and without TIS-B (6 conditions)

¹⁶ Compare with and without alerting

¹⁷ Use of real CPDLC messages in ATTAS

¹⁸ Because of accurate and realistic aircraft modeling required

¹⁹ Combination with on-board conflict alert?

²⁰ Phase 1: focus on HMI Phase 2: focus on airport throughput and capacity enhancement

Resources required	Sufficient number of pilots to perform validation ²¹	Sufficient number of pilots to perform validation	Sufficient number of pilots to perform validation	Sufficient number of pilots to perform validation OST: ATTAS or TUD van	Sufficient number of pilots to perform validation	Sufficient number of pilots to perform validation
Dependencies	- Moving Map display - ADS-B-in - traffic generator required			Needs route allocation per aircraft, e.g. from SMAN ²²	Moving Map display required ²³	Should line up with CPDLC airborne standards

Table 5-5 Validation Strategy and Plan for on-board functions

²¹ One full landing, taxi-in, parking followed by taxi-out, crossing and take off would last about 30 minutes

²² This monitor function can be tested in combination with SMAN taxi route generation

²³ Step up with Runway Conflict Alert programme (EMMA and EMMA2)

5.6 Define Validation Strategy

This sub-section provides the essential information required for the development of the validation strategy at each site of the project. In particular, the focus is placed on an outline of the major validation activities that should be included in the validation strategy of each site. The major features of the EMMA2 validation process at the different test sites are as follows:

- The different technological and operational constraints at the sites imply that not all A-SMGCS functions will be implemented at each site. Even the common A-SMGCS functions at the sites will be implemented with different degree of maturity.
- The operational requirements for the proposed EMMA2 A-SMGCS functions are similar at every site. However, the priorities assigned by the users to these requirements may vary across the sites.
- The EMMA2 A-SMGCS services are provided to multiple users i.e. ATCO, vehicle drivers, and flight crew
- The assessment of the proposed A-SMGCS services can be achieved by the following types of validation techniques: i) Real time simulation, ii) Fast time simulations, iii) Shadow mode trials, platforms, and iv) operational trials.

The validation strategy at each test site outlines a sequence of major activities for achieving the EMMA2 validation objectives taking into account the aforementioned features of the validation process.

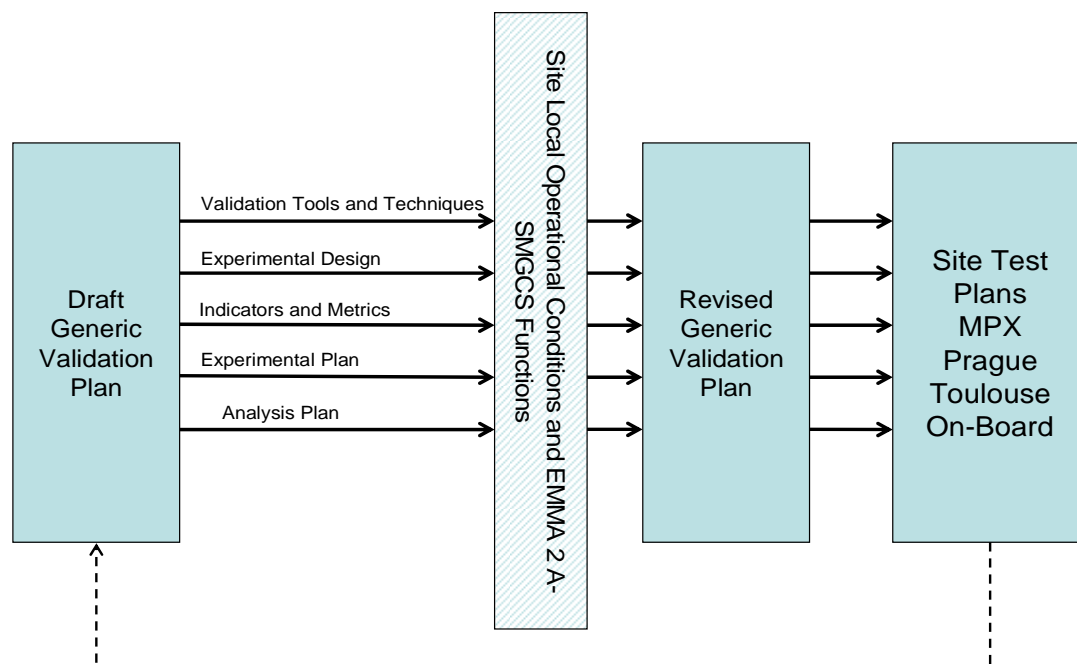


Figure 5-2: Development of the EMMA2 Validation Test Plans

Thus, based on the A-SMGCS functions developed at each site and the corresponding high-level validation objectives, the associated validation strategy should address the following issues:

- Experimental Design. The experimental design refers to the specification of the experimental factors and the description of the experiments that should be performed in order to assess the performance of the proposed system.
- Specification of the indicators and metrics that will be measured
- Validation Management Plan and Schedule. This test plan should cover the experimental design issues while it should also facilitate the management and organization of the validation activities at each site.
- Description of the preparatory work for executing the site specific experiments
- Development of an Analysis Plan
- Execution of the validation exercises
- Analysis of the collected data according to the Analysis Plan and provision of the validation results.

Guidelines for performing these activities are provided in 2-D6.1.1b. The proposed list of activities should be comprehensively described in the Validation Site Test Plans based on the associated guidelines provided in 2-D6.1.1b. The development of each site Test Plan is based on the process that is outlined in Figure 5-2.

6 Concluding Remarks

The EMMA2 Validation process is based on the customization of the E-OCVM for assessing the EMMA2 Operational Concept. The incorporation of the E-OCVM philosophy into the EMMA2 Validation process has led to a set of methodological steps that should be followed at each site of the project. In order to provide a uniform approach for assessing the EMMA2 operational concept at each site, the EMMA2 Generic Validation Strategy has been developed covering the following objectives: i) present the E-OCVM based methodology, and ii) provide the essential guidelines for implementing the proposed steps and activities at the sites of the project. The present document (2-D6.1.1a: “EMMA2 Validation Plan”) constitutes the first part of the EMMA2 Generic Validation Strategy.

The Validation of EMMA2 functions at each site involves a set of major activities which will be described in the Site Validation Test Plan. In this context, this document outlines the major validation activities that should be performed at the sites and provides the associated essential guidelines. The objective of the report is to provide the E-OCVM based methodology developed for the EMMA2 Validation process, and provide the essential guidelines for performing Step 0 “State Concept and Assumptions” and Step 1 “Set Validation Strategy” of the proposed methodology. Step 0 is addressed by providing an overview of the A-SMGCS functions implemented at the site. The present document provides an overview of the EMMA2 A-SMGCS functions based on the description included in the SPOR document. Step 1 involves the determination of validation environment, objectives and needs. In this context, the present document outlines the major stakeholders involved in or affected by the EMMA2 Validation process, presents the high level validation objectives, and determines the validation needs per A-SMGCS function. Finally, the present report provides a tentative list of low level objectives and indicators. Guidelines for measuring and assessing the proposed will be provided in D6.1.1b. Moreover, the second document 2-D6.1.1b: “Generic Experimental and Test Plan” aims at presenting the guidelines for implementing the remaining EMMA2 methodology.

7 Annex I

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7.2 Abbreviations

Abbreviation	Description
ACI	Airport Council International
ADS-B	Automatic Dependent Surveillance – Broadcast
AEA	Association of European Airlines
AECMA	The European Association of Aerospace Industries
AMAN/DMAN	Arrival / Departure Manager (EUROCONTROL)
ANSP	Air Navigation Service Provider
AP	Action Plan
A-SMGCS	Advanced Surface Movement Guidance and Control (ICAO)
ASR	Airport Surveillance Radar
ATTAS	Advanced Technologies Testing Aircraft System
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
CAA	Civil Aviation Authorities
CANSO	Civil Air Navigation Services Organisations
CDTI	Cockpit Display of Traffic Information
CPDLC	Controller-Pilot Datalink Communication
DG TREN	Directorate General Transport and Energy of EC
DLR	Deutsches Zentrum für Luft und Raumfahrt e.V., German Aerospace Center
E-OCVM	European-Operational Concept Validation Methodology
EC	European Commission
EFS	Electronic Flight Strips
EMMA	European airport Movement Management by A-SMGCS
EUROCAE	European Organisation for Civil Aviation Equipment
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAA	Federal Aviation Administration
RTS	Real Time Simulation
HLO	High Level Objectives
HMI	Human Machine Interface
HUD	Head Up Display
IATA	International Air Transport Association
IFATCA	International Federation of Air Traffic Controllers' Associations
ICAO	International Civil Aviation Organisation
NLR	Nationaal Lucht- en Ruimtevaart Laboratorium
KPA	Key Performance Areas
MLAT	Mode-S Multilateration

Abbreviation	Description
OBCA	On-board Conflict Alerting
OCVSD	Operational Concept Validation Strategy Document
OSD	Operational Services & Environmental Definition
OST	On Site Testing
ROP	Runway Occupancy Planning
RP	Route Planner
RTCA	Radio Technical Commission for Aeronautics
RTS	Real Time Simulation
SMAN	Surface Manager
SMR	Surface Movement Radar
SN	Safety Net
SP	Sub-Project
TIS-B	Traffic Information Service – Broadcast

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