EUROPEAN AIRPORT MOVEMENT MANAGEMENT BY A-SMGCS, Part 2

Contract No. TREN/04/FP6AE/SI2.374991/503192

A-SMGCS Technical Requirements - Ground

A. Gilbert

Park Air Systems AS

Document No:	**2-D1.1.2a**
Version No.	**1.0**
Classification:	**Public**
Number of pages:	**168**

Project Funded by
European Commission, DG TREN
The Sixth Framework Programme
Strengthening the competitiveness
Contract No. TREN/04/FP6AE/SI2.374991/503192

Project Manager
M. Röder
Deutsches Zentrum für Luft und Raumfahrt
Lilienthalplatz 7, D-38108 Braunschweig, Germany
Phone: +49 (0) 531 295 3026, Fax: +49 (0) 531 295 2180
email: fp6-emma@dlr.de
Web page: http://www.dlr.de/emma

Distribution list

Member Type	No.	Name	POC	Distributed
Web		Internet	http://www.dlr.de/emma2	
		Intranet	https://extsites.dlr.de/fl/emma	X
Contractor	1	DLR	Jörn Jakobi	X
	2	AENA	José Félix Dominguez Porras	X
	3	AIF	Marianne Moller	X
	4	SELEX	Giuliano D'Auria	X
	5	ANS_CR	Jan Kubicek	X
	8	DSNA	Philippe Montebello	X
	9	ENAV	Antonio Nuzzo	X
	10	NLR	Jürgen Teutsch	X
	11	PAS	Alan Gilbert	X
	12	TATM	Corinne Heinrich	X
	13	THAV	Marc Fabreguettes	X
	15	AUEB	Konstantinos G. Zografos	X
	16	CSL - Prague Airport	Libor Kurzweil	X
	17	DAS	Benno Petersen	X
	18	DFS	Klaus-Rüdiger Täglich	X
	19	EEC	Stéphane Dubuisson	X
	20	ERA	Tim Quilter	X
	21	ETG (FAV)	Thomas Wittig	X
	23	SICTA	Mariacarmela Supino	X
	24	TUD	Christoph Vernaleken	X
	25	SOF	Lionel Bernard-Peyre	X
Sub-Contractor		CSA	Karel Mündel	X
		Körte	Max Körte	X
Customer		EC	Doris Schröcker	X

Document control sheet

SP1 Project Manager	Jörn Jakobi	
Responsible Author	A. Gilbert	Park Air Systems
Additional Authors	K. Werner	DLR
	A. Lebbink	DLR
	M. Moller	AIF
Subject / Title of Document:	A-SMGCS Technical Requirements - Ground	
Related Task('s):	WP1.1	
Deliverable No.	2-D1.1.2a	
Save Date of File:	2009-07-14	
Document Version:	1.0	
Reference / File Name	2-D112a_ATR-GND_V1.0.doc	
Number of Pages	168	
Dissemination Level	Public	
Target Date	2008-10-31	

Change control list

Date	Release	Changed Items/Chapters	Comment
2006-07-19	0.01		First draft, based on EMMA D142a TRD-GND.
2006-08-24	0.02	Expanded functional architecture description in Ch.2. Added ADS-B and TIS-B requirements in Ch.4. Expanded CPCLC requirements in Ch.7.	Relevant sections from EMMA D141 AGFA.
2006-08-28	0.03	Minor changes throughout.	Internal review
2007-03-02	0.04	Changes Ch.5-9.	Partner inputs
2007-03-20	0.05	Changes Ch.5-9.	Update by PAS
2007-05-25	0.06	Changes Ch.5-9. Added Ch.10	Update by PAS Interoperability requirements
2007-08-01	0.07	Minor changes throughout.	THAV review Update by PAS
2008-01-17	0.08	Changes Ch.5-10. Additional high-level requirements. Renaming of all requirements.	Update by PAS
2008-02-05	0.09	Changes to Ch.1, 4, 6, 7, 8 and 10.	SP3 review Comments from DLR and DFS Update by PAS
2008-02-21	0.10	Added Departure Management definition in 1.5.1. Additions to 6.2.2.	SP3 review Contribution from DLR Update by PAS
2008-06-02	0.11	No GA comments received	Version sent to EC for their review
2008-08-14	0.12	Minor changes to Ch.2, 3, 4, 5, 6, 7, 8, 9, 10 and Annex A.	EC review
2009-07-14	1.0	approved	

Table of contents

1 Introduction

This document is a deliverable produced under work package WP1.1 of the EMMA2 Project.

1.1 Scope of Document

This document builds upon the work done in the predecessor project EMMA, where technical and requirements for Level 2 A-SMGCS, as well as some preliminary material on higher level implementations and air-ground interoperability, were specified in deliverable documents D141 AGFA [3], D142a TRD-GND [4] and D142b TRD-AIR [5].

The present document combines relevant material from D141 AGFA and D142a TRD-GND and strengthens the high level requirements using as input additional operational requirements being developed in WP1.1 and recent work in other research projects. Operational requirements derive where possible from existing international standard documents on A-SMGCS. This document attempts to develop further the set of technical requirements and describes the generic A-SMGCS equipment architecture and its major components. It also draws upon the specifications of current A-SMGCS implementations and earlier European research projects. Requirements for the development of interfaces between the EMMA2 components and external systems are identified. Where existing specifications are lacking, these have been supplemented by additional technical requirements for specific items of equipment, as appropriate.

In this document, all requirements are kept as generic as possible in order to allow the systems described to be implemented at any airport with only minor adaptations. Individual adaptations to local site infrastructure or other specific local requirements at the EMMA2 test sites are not addressed here. These are covered separately in the respective documents of the sub-projects SP2, SP3, SP4 and SP5.

Since A-SMGCS is a modular and scalable concept, airports may decide to implement only a subset of the available services, according to their operational requirements and expected benefits. The EMMA2 deliverable document D111 Services, Procedures and Operational Requirements (SPOR) describes the A-SMGCS concept and the various services available.

The present document addresses only the ground system components of an A-SMGCS. The technical requirements for airborne equipment are contained in a separate companion document, D112b ATR-AIR.

Requirements are presented at the unit functional level. No attempt is made to address design details of hardware and software components, i.e. the document describes the technical requirements for each item of equipment, not the means by which the requirements shall be met.

1.2 Document Context

This ATR D112a and its companion D112b are mainly derived from the SPOR document [2]. The requirements in this document establish the basis for specific adaptations for the implementation of EMMA2 at each of the airport test sites and on-board the test aircraft.

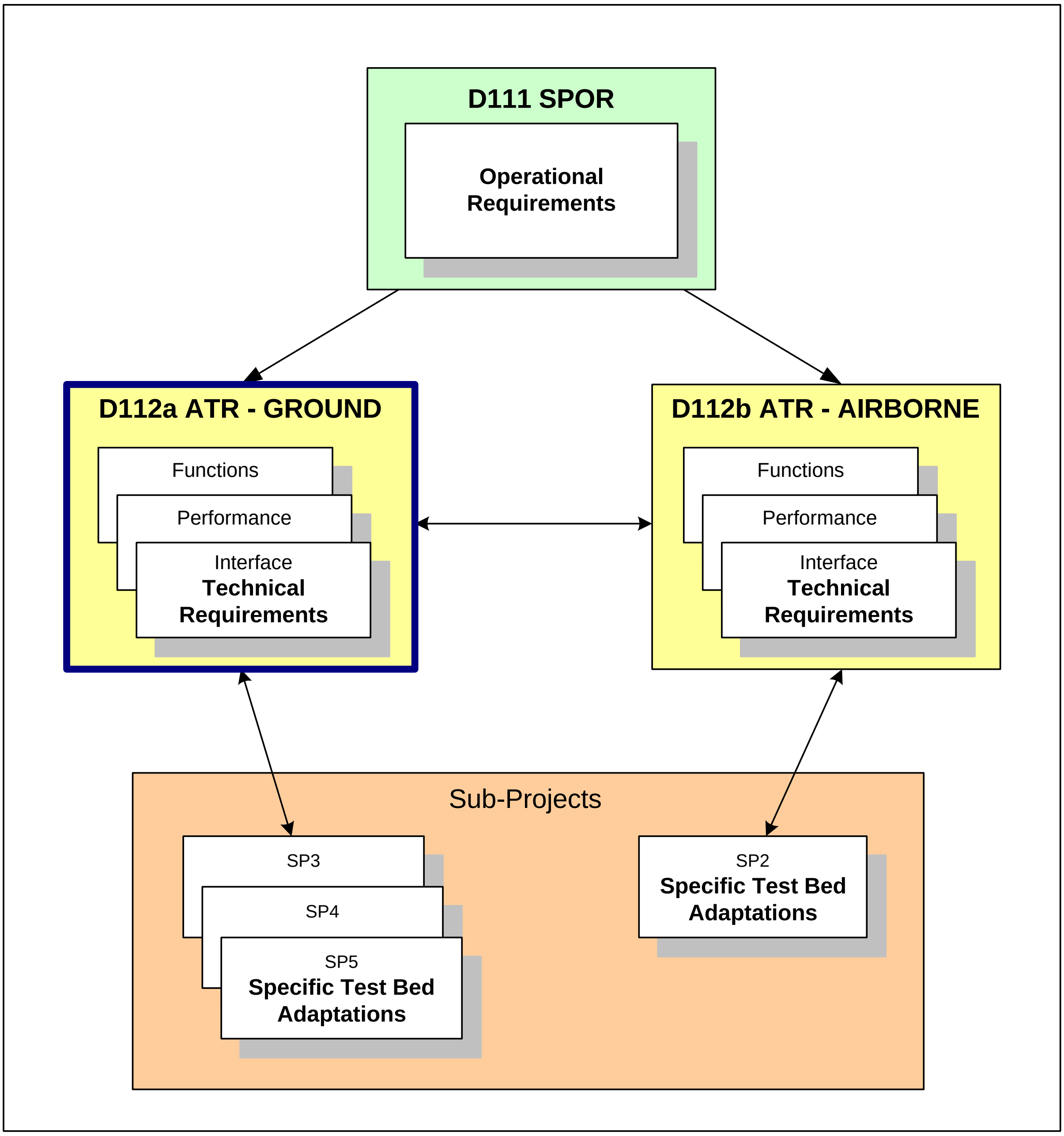

Figure 1-1: Context of D112a ATR - GROUND

1.3 Document overview

1.3.1 Purpose

The document aims to establish a minimum set of concise technical requirements upon which testing of A-SMGCS equipment will be based, in order to verify its performance. It should provide the baseline and serve as input for the development and adaptation of the A-SMGCS airport and simulator test beds for the EMMA2 operational verification and validation studies in SP6.

Since A-SMGCS is a concept under evolution, the generic requirements derived from current published standards and recommendations and listed herein have not been fully validated. Therefore, all performance figures are purely indicative. A primary objective of EMMA2 is to validate these requirements and provide feedback to the appropriate international organisations to assist in the further refinement of the respective A-SMGCS specifications.

1.3.2 Intended audience

The dissemination of this document is public.

1.3.3 Document structure

This document is divided into ten chapters.

Chapter 1	is this introduction. It describes the purpose and scope of the document, the document structure and context, and the methodology used to derive the requirements.
Chapter 2	gives an overview of the complete A-SMGCS, describes the generic architecture, identifies the major building blocks of the ground equipment and describes how the blocks fit together.
Chapter 3	lists overall requirements such as environment, electromagnetic compatibility, and reliability, which are common to all elements of the system. Subsequent chapters allocate specific technical design requirements to each element.
Chapter 4	describes the Surveillance function and its main components and establishes the appropriate technical design requirements.
Chapter 5	describes the Control function and its main components and establishes the appropriate technical design requirements.
Chapter 6	describes the surface movement Routing/Planning function and the component parts for taxi route planning, departure management, sequencing, and runway occupancy planning. Appropriate preliminary technical design requirements are listed.
Chapter 7	describes the Guidance function including Air-Ground Data Link communications. Appropriate preliminary technical design requirements are listed.
Chapter 8	lists technical design requirements pertinent to the controller HMI
Chapter 9	lists the technical design requirements for the supporting functions, such as configuration databases, control and monitoring of equipment, and recording facilities. The required data exchanges with the other A-SMGCS functions are discussed.
Chapter 10	provides an overview of Air-Ground Interoperability and lists the generic interoperability requirements for ADS-B, TIS-B and CPDLC in EMMA2.
Chapter 11	is an annex containing lists of references, figures, tables, acronyms and abbreviations used in the document.

1.4 Methodology

The methodology employed to obtain the technical requirements has been to extract operational, functional and performance requirements from the relevant ICAO, EUROCAE and EUROCONTROL documents and higher level EMMA2 documents, and map them onto an architectural framework. As a first step the requirements were sorted and allocated to the airborne or ground systems, as appropriate.

At the functional level, the analysis of operational requirements has defined the internal building blocks of the A-SMGCS. At the technical level, the requirement analysis defines the physical components of the A-SMGCS system needed to perform the various defined functions: the functions are mapped onto the physical architecture. At this level, the specification goes deeper into the details of the system design and the functional requirements are developed into technical requirements. In particular, interfaces between physical units are expressed in technical terms.

In this document, the technical requirements are kept at the unit level in order to permit manufacturers a large degree of flexibility in the internal design of system components.

Throughout the document, requirements are presented in the form of tables. Requirements are numbered and grouped under appropriate headings for each system element or unit. Comments to the requirements indicate how the system element contributes towards satisfying the operational requirement and identify weaknesses or anomalies in the source material. Traceability between the requirements will be used during the verification and validation of the A-SMGCS.

1.5 Explanation of Terms

This section provides an explanation of the terms required for a correct understanding of this document.
Most of the following explanations are drawn from ICAO documents, from EUROCAE ED-87B MASPS for A-SMGCS [7], or from EUROCONTROL; in each case, it is indicated in the definition.
ICAO Doc 9830 definitions [14] are used as a first option. In general, other definitions are only used where it is necessary to have a more precise technical definition than the ICAO definition or if an ICAO definition for a term used in this document does not exist.

1.5.1 General

Advanced Surface Movement Guidance and Control Systems (A-SMGCS) *[ICAO Doc 9830]*
Systems providing routing, guidance, surveillance and control to aircraft and affected vehicles in order to maintain movement rates under all local weather conditions within the Aerodrome Visibility Operational Level (AVOL) whilst maintaining the required level of safety.

Aerodrome *[ICAO Doc 9830]*
A defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for arrival, departure and surface movement of aircraft.

Aerodrome movement *[ICAO Doc 9830]*
The movement of a mobile (aircraft or vehicle) on the movement area.

Aerodrome Visibility Operational Level (AVOL) *[ICAO Doc 9830]*
The minimum visibility at or above which the declared movement rate can be sustained.

Airport Authority *[ICAO Doc 9830]*
The person(s) responsible for the operational management of the airport.

Alert *[ICAO Doc 9830]*
An indication of an existing or pending situation during aerodrome operations, or an indication of abnormal A-SMGCS operation, that requires attention/action.

Alert Situation *[EUROCAE ED-87B]*
Any situation relating to aerodrome operations which has been defined as requiring particular attention or action.

Apron *[ICAO Doc 9830]*
A defined area on a land aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fuelling, parking or maintenance.

A-SMGCS Capacity *[ICAO Doc 9830]*
The maximum number of simultaneous movements of aircraft and vehicles that the system can safely support within an acceptable delay commensurate with the runway and taxiway capacity at a particular aerodrome.

Conflict *[ICAO Doc 9830]*
A situation when there is a possibility of a collision between aircraft and/or vehicles.

Control *[ICAO Doc 9830]*
Application of measures to prevent collisions, runway incursions and to ensure safe, expeditious and efficient movement.

Cooperative Target *[EUROCAE ED-87B]*
A target which is equipped with systems capable of automatically and continuously providing information including its identity to the A-SMGCS.
Note: as several cooperative surveillance technologies exist, a target is cooperative on an aerodrome only if the target and the aerodrome are equipped with cooperative surveillance technologies which are interoperable. A target is only cooperative if its equipment is switched on and operating correctly.

Coverage Volume (CV) *[EUROCAE ED-87B]*
That volume of space which encompasses all parts of the aerodrome surface where aircraft movements take place together with those parts of the surrounding airspace which affect surface operations.

Data Fusion *[EUROCAE ED-87B]*
A generic term used to describe the process of combining information from two or more sensor systems or sources.

Departure Management *[EMMA2 based on ICAO Doc 9830]*
The planning of the most efficient departure sequence for aircraft departing at an airport, and of optimal departure times for each aircraft, in order to ensure minimum delay and maximum utilization of the available capacity of the aerodrome.

Direction of Movement
The direction in which a tracked target is progressing at the instant of the calculation of its position.

Fail Safe *[ICAO Doc 9830]*
A term meaning that sufficient redundancy is provided to carry data to the display equipment to permit some components of the equipment to fail without any resultant loss of data displayed.

Fail Soft *[ICAO Doc 9830]*
A term meaning that the system is so designed that, even if equipment fails to the extent that some loss of data occurs, sufficient data remain on the display to enable the controller to continue operations.

False Alert *[EUROCAE ED-87B]*
An alert which does not correspond to an actual alert situation.
Note: It is important to understand that it refers only to false alerts and does not address nuisance alerts (i.e. alerts which are correctly generated according to the rule set but are inappropriate to the desired outcome).

Guidance *[ICAO Doc 9830]*
Facilities, information and advice necessary to provide continuous, unambiguous and reliable information to pilots of aircraft and drivers of vehicles to keep their aircraft or vehicles on the surfaces and assigned routes intended for their use.

Heading *[ICAO]*
The direction in which the longitudinal axis of a mobile is pointed, expressed in clockwise degrees from North. Usually *magnetic* heading (with respect to magnetic north pole).

Identification *[ICAO Doc 9830]*
The correlation of a known aerodrome movement callsign with the displayed target of that mobile on the display of the surveillance system.

Identity *[ICAO 4444]*
A group of letters, figures or a combination thereof which is either identical to, or the coded equivalent of, the mobile call sign to be used in air-ground communications, and which is used to identify the mobile in ground-ground air traffic services communications.

Incursion *[ICAO Doc 9830]*
The unauthorized entry by an aircraft, vehicle or obstacle into the defined protected areas surrounding an active runway, taxiway or apron.

Low Visibility Procedures (LVP) *[ICAO EUR Doc 013]*
Specific procedures applied at an aerodrome for the purpose of ensuring safe operations during Category II and III approaches and/or departure operations in RVR conditions less than a value of 550m.

Manoeuvring Area *[ICAO Doc 9830]*
That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

Mobile
A mobile is either an aircraft or a vehicle.
Note: when referring to an aircraft or a vehicle, the term "Mobile" will be preferred to "Target". The term "Target" will only be used when considering an object under surveillance by the A-SMGCS. The term "Mobile" is equivalent to the ICAO term "Movements" that also includes aircraft and vehicles on the movement area.

Modularity *[ICAO Doc 9830]*
Capability of a system to be enhanced by the addition of one or more modules to improve its technical or functional performance.

Movement Area *[ICAO Doc 9830]*
That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and apron(s), but excluding passive stands, empty stands, and those areas of the apron(s) which are exclusively designated to vehicle movements.

Non-Cooperative Target *[EUROCAE ED-87B]*
A target which is not equipped with systems capable of automatically and continuously providing information including its identity to the A-SMGCS.

Non-Cooperative Surveillance
The surveillance of mobiles is non-cooperative when a sensor, named non-cooperative surveillance sensor, detects the mobiles, without any action on their behalf. This technique allows determining the position of any mobile in the surveillance area and in particular to detect intruders. Examples of non-cooperative surveillance sensors are the Primary Surveillance Radars.

Normal Visibility
Visibility conditions sufficient for personnel of control units to exercise control over all traffic on the basis of visual surveillance (corresponding to visibility condition 1 defined by ICAO *[ICAO Doc 9830]*).

Nuisance Alert *[EUROCAE ED-87B]*
An alert which is correctly generated according to the rule set but inappropriate to the desired outcome.

Obstacle *[ICAO Doc 9830]*
All fixed (whether temporary or permanent) and mobile obstacles, or parts thereof, that are located on an area intended for the surface movement of mobiles or that extend above a defined surface intended to protect aircraft in flight.

Protection Area
A protection area is a virtual volume around a runway, a restricted area or a mobile. This protection area is used to detect an alert situation. For instance, an alert situation is detected when a mobile is on a runway and one or more mobiles enter the runway protection area.

Reduced Visibility
Visibility conditions insufficient for personnel of control units to exercise control over all traffic on the basis of visual surveillance (corresponding to visibility conditions 2, 3, and 4 defined by ICAO *[ICAO Doc 9830]*).

Reported Target *[EUROCAE ED-87B]*
An aircraft, vehicle or other object which is reported by the Surveillance Element of an A-SMGCS.

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

Route *[ICAO Doc 9830]*
A track from a defined start point to a defined endpoint on the movement area.

Routing *[ICAO Doc 9830]*
The planning and assignment of a route to individual aircraft and vehicles to provide safe, expeditious and efficient movement from its current position to its intended position.

Runway Incursion *[EUROCONTROL]*
The unintended presence of an aircraft, vehicle or person on the runway or runway strip.

Stand *[ICAO Doc 9830]*
A stand is a designated area on an apron intended to be used for the parking of an aircraft.

Surveillance *[ICAO Doc 9830]*
A function of the system which provides identification and accurate positional information on aircraft, vehicles and obstacles within the required area.

Target *[EUROCAE ED-87B]*
Any aircraft, vehicle or obstacle, whether stationary or moving, which is located within the Coverage Volume of the A-SMGCS and which is of sufficient size to be operationally significant.

Track *[EUROCAE ED-87B]*
A progressive series of estimates of a target position.

Unit
A physical item of equipment that performs a specified function, for instance an SMR or a data fusion unit.

Update *[EUROCAE ED-87B]*
A renewal of target reports relating to all targets under surveillance by the A-SMGCS.

1.5.2 Performance Parameters

Alert Response Time (ART) *[EUROCAE ED-87B]*
The time delay between an alert situation occurring at the input to the Alert Situation Detection Element and the corresponding alert report being generated at its output.

Display Resolution (DR) *[EUROCAE ED-87B]*
The number of individually addressed picture elements (pixels) along each axis of the display screen. (For a raster-scan display, the resolution is normally expressed in terms of the number of raster lines and the number of pixels per line.)

Information Display Latency (IDL) *[EUROCAE ED-87B]*
The maximum time delay between a report, other than a target report, being received by the A-SMGCS HMI and the corresponding presentation on the HMI display of the information contained in the report.

Position Registration Accuracy (PRA) *[EUROCAE ED-87B]*
The difference between the position contained in the dynamic input data to the HMI and the corresponding geographical position represented on the HMI display.

Probability of Detection (PD) *[EUROCAE ED-87B]*
The probability that each actual target is reported at each update at the output of the Surveillance Element of an A-SMGCS.

Probability of Detection of an Alert Situation (PDAS) *[EUROCAE ED-87B]*
The probability that the Monitoring/Alerting Element correctly reports an alert situation.

Probability of False Alert (PFA) *[EUROCAE ED-87B]*
The probability that the Control service reports anything other than actual alert situations.

Probability of False Detection (PFD) *[EUROCAE ED-87B]*
The probability that the Surveillance Element of an A-SMGCS reports anything other than actual targets.

Probability of False Identification (PFID) *[EUROCAE ED-87B]*
The probability that the identity reported at the output of the Surveillance Element of an A-SMGCS is not the correct identity of the actual target.

Probability of Identification (PID) *[EUROCAE ED-87B]*
The probability that the correct identity of a target is reported at the output of the Surveillance Element.

Reported Position Accuracy (RPA) *[EUROCAE ED-87B]*
The difference, at a specified confidence level, between the reported position of the target and the actual position of the target at the time of the report.

Reported Velocity Accuracy (RVA) *[EUROCAE ED-87B]*
The difference, at a specified confidence level, between the reported target velocity and the actual target velocity at the time of the report.

Response Time to Operator Input (RTOI) *[EUROCAE ED-87B]*
The maximum time delay between the operator making an input on a data entry device of an A-SMGCS HMI and the corresponding action being completed or acknowledged on the HMI display.

Surveillance Capacity *[EUROCAE ED-87B]*
The number of target reports in a given period which the Surveillance Element is able to process and output without degradation below the minimum performance requirements.

System Availability *[ICAO Doc 9830]*
Availability is the ability of an A-SMGCS to perform a required function at the initiation of the intended operation within an A-SMGCS area.

System Capacity *[ICAO Doc 9830]*
The maximum number of simultaneous movements of aircraft and vehicles that the system can safely support within an acceptable delay commensurate with the runway and taxiway capacity at a particular airport.

System Continuity *[ICAO Doc 9830]*
Continuity is the ability of an A-SMGCS to perform its required function without non-scheduled interruption during the intended operation in an A-SMGCS area.

System Integrity *[ICAO Doc 9830]*
Integrity relates to the trust which can be placed in the correctness of the information provided by an A-SMGCS. Integrity includes the ability of an A-SMGCS to provide timely and valid alerts to the user(s) when an A-SMGCS must not be used for the intended operation.

System Reliability *[ICAO Doc 9830]*
Reliability is defined as the ability of an A-SMGCS to perform a required function under given conditions for a given time interval.

Target Display Latency (TDL) *[EUROCAE ED-87B]*
The maximum time delay between a target report being received by the A-SMGCS HMI and the corresponding presentation on the HMI display of the target position contained in the report.

Target Report Update Rate (TRUR) *[EUROCAE ED-87B]*
The frequency with which target reports are output from the Surveillance Element of the A-SMGCS.

2 EMMA2 System Description

This Chapter gives an overview and describes the generic architecture of a complete A-SMGCS, in accordance with the current conceptual definition. It identifies the major functional elements of the ground equipment and defines the interoperability requirements between them.

For traceability, requirements include references to all operational requirements listed in the SPOR and relevant paragraphs in ICAO and EUROCAE documents.

NOTE
In some cases, an operational requirement may produce several related technical requirements; in other cases, where multiple sources are expressing a similar requirement in different ways, a number of operational requirements may be combined into one technical requirement.

2.1 Operational Context

These requirements have been derived from the operational requirements listed in the EMMA2 document D111 SPOR [2]. The SPOR introduces the operational concepts and principles and specifies operational requirements.

2.1.1 A-SMGCS Services

Previous work and publications on A-SMGCS, by ICAO, EUROCAE and EUROCONTROL in particular, discuss the likely evolution of A-SMGCS in terms of levels of implementation. However, beyond Level 2, these levels have never been clearly defined. Taking this as its initial starting point, the EMMA2 project has gone one step further by outlining A-SMGCS services required for the higher implementation levels. The SPOR identifies various operational services that constitute the A-SMGCS taking into account the different users (ATC, flight crew, vehicle drivers). In this way, the EMMA2 A-SMGCS description remains independent of the implementation levels suggested by ICAO or EUROCONTROL. Depending on the local requirements of each aerodrome, services can be automated to various degrees. Any service can be added to the basic A-SMGCS service, namely the provision of improved situational awareness to air traffic controllers (ATCOs).

2.1.1.1 A-SMGCS Surveillance Service

The basic A-SMGCS is intended primarily to enhance safety and efficiency of ground surface operations through the introduction of an advanced surveillance service. The main objective is to enhance ATM operations, in particular visual surveillance (performed in SMGCS) by an automated system capable of providing the same level of service in all-weather operations. The surveillance service forms a pragmatic first step in the implementation of A-SMGCS, allowing the progressive introduction of other A-SMGCS services for Control, Routing/Planning and Guidance.

2.1.1.2 A-SMGCS Control Service

The EMMA2 Control service aims at complementing the Surveillance service with an alerting tool whose objective is to detect potentially dangerous conflicts in order to improve safety of runways and restricted areas. It provides ATCOs with a traffic situation picture associated to an automated control service capable of detecting potential conflicts. This is fully compliant with ICAO A-SMGCS provisions to prevent runway incidents and accidents. Furthermore, the Control service is to include automated support to ATC clearances and co-ordination between controllers. In EMMA2, this service will be supported by the use of electronic flight strips and data link communications.

2.1.1.3 A-SMGCS Routing/Planning Service

The EMMA2 Routing service will provide ATCOs with a means of designating and assigning a taxi route to each movement, either manually or, as the system evolves, semi-automatically or even automatically.
As the generation and assignment of a taxi route becomes more automated, more support of a Planning function and other information has to be considered to guarantee safe and efficient routes. With the automated Routing/Planning function, optimised routes need to be enhanced by the computation of optimal start up times and overall departure sequencing.

2.1.1.4 A-SMGCS Guidance Service

The EMMA2 Guidance service is predominantly for pilots and drivers, helping them to implement clearances and instructions given by the ATCO, and preventing them from missing their assigned routes and from intruding into restricted areas. For A-SMGCS, the conventional SMGCS guidance means can be complemented by advanced ground lighting or on-board guidance means. For the ATCO, the Guidance service should provide HMI that makes it possible to operate and monitor the guidance means.

2.2 Fundamental System Design Concepts

Development of an A-SMGCS is an evolutionary process. The level of automation to which a particular function is to be implemented will depend upon the evolution of the operational requirements, which is likely to be linked to the safety criticality of the function.

In designing a system, it is important to ensure that early investments can be built upon as the system develops. For example, it should be possible to incorporate existing SMGCS surveillance sensors, such as Surface Movement Radar (SMR), into the A-SMGCS, and every effort should be made to ensure that A-SMGCS surveillance equipment provided initially is capable of modular enhancement to meet the anticipated additional reliability requirements at the higher levels of implementation. The need to replace major items of equipment in order to achieve a higher level of A-SMGCS implementation should be avoided.

Technical requirements should as far as possible be independent of such factors as airport size, layout and complexity, traffic types, traffic density, and prevailing weather conditions.

2.3 EMMA2 System Architecture

The objective of EMMA2 is to augment the Level 2 test-bed systems installed at the test sites during the EMMA project with the necessary components to implement and evaluate an A-SMGCS with high-level surveillance, control, routing/planning and guidance services. Therefore, the system architecture was designed to permit modular enhancements to meet this objective.

2.3.1 A-SMGCS Ground System Functional Architecture

The following data flow chart presents the generic functional architecture of an A-SMGCS Ground System.

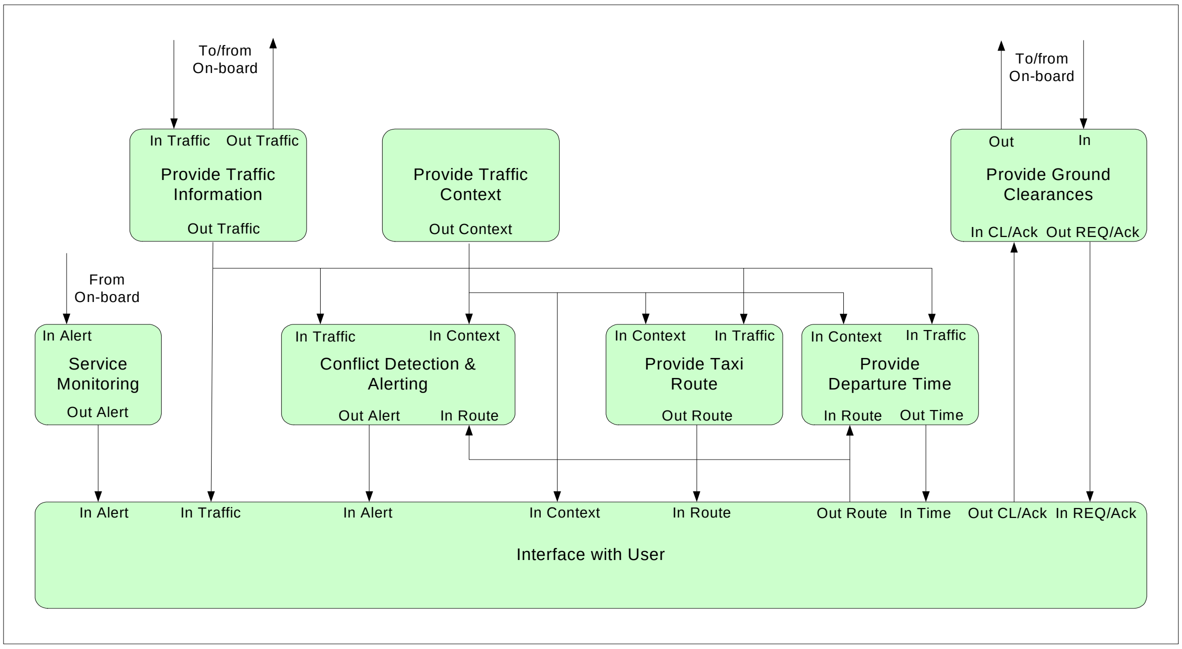

Figure 2-1: Functional Architecture for A-SMGCS Ground System

The various functions are briefly described in the following section. For each connection between two functions, the information exchanged is defined.

2.3.1.1 Provide Traffic Information Function

As shown in the following data flow chart, this function is responsible for the collection and collation of information about mobiles and obstacles relevant to the A-SMGCS application (position, velocity, identity, etc.).

The traffic information can be collected from different systems: cooperative / non-cooperative surveillance sensors, approach surveillance systems, and other systems.

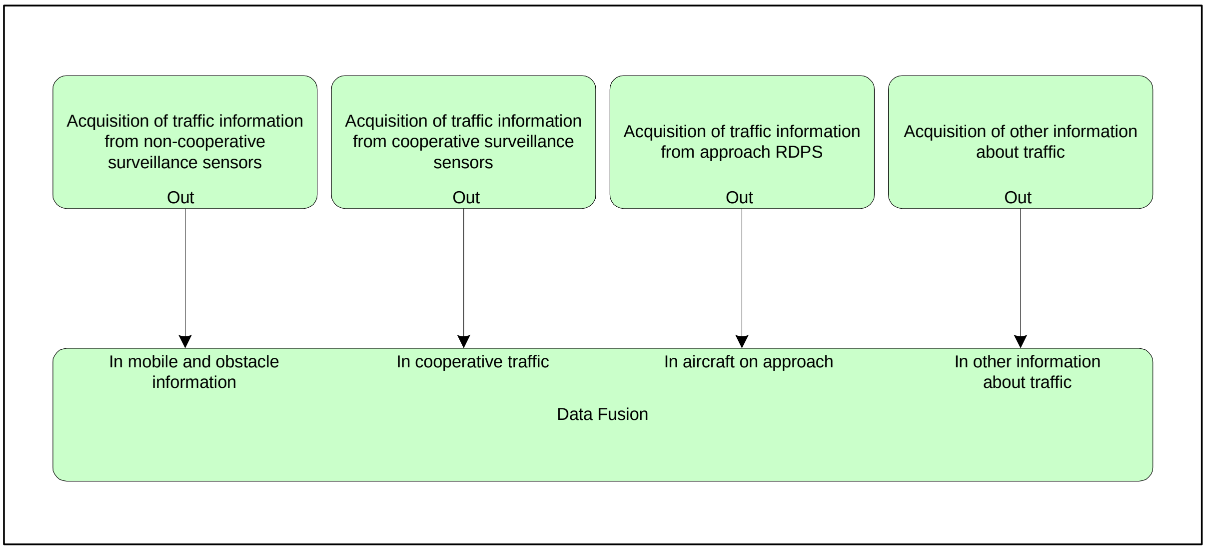

Figure 2-2: Functional Architecture – Provide Traffic Information

The separate functional blocks are explained in the following sections.

2.3.1.1.1 Acquisition of Traffic Information

Traffic information needs to be acquired by a combination of cooperative and non-cooperative surveillance means:

- A cooperative surveillance system is needed to detect and provide the identity of the participating mobiles on the aerodrome surface and in the airspace surrounding the aerodrome. The participating mobiles are those known by the aerodrome authority, and likely to move on the manoeuvring area. Ideally, all the participating mobiles should be cooperative, allowing the cooperative surveillance system to collect information about the mobiles, at least their position and identity. In order to ensure rapid deployment, the cooperative surveillance system must be based on current technologies being implemented on aircraft, such as transponders for Automatic Dependent Surveillance - Broadcast (ADS-B) and Mode S Multilateration (MLAT).
- A non-cooperative surveillance system is needed to detect any mobile or obstacle on the surface, whether participating or not, including intruders. Depending on the size and complexity of the aerodrome, this system may comprise multiple sensors of different types (e.g. SMR, cameras). The non-cooperative surveillance system should provide accurate position information and information about the size, and possibly shape, of objects detected on the movement area of the aerodrome surface.

Existing approach Radar Data Processing Systems (RDPS), which are cooperative surveillance systems, will be able to provide the information (at least position and identity) on airborne aircraft needed by the A-SMGCS. In the future, this surveillance data could be collected from other ground sensors such as passive Mode A/C/S multilateration or ADS-B receivers.

2.3.1.1.2 Acquisition of Other Information about Traffic

The A-SMGCS will require other information about traffic; typically, flight plan, stand allocation, squawk code, etc. Such information should be available from other ground systems at the airport, such as Flight Data Processing System (FDPS) (for flight plan, etc.), Code-Callsign Database (CCDB) (for allocated Mode A code) and Airport Information Databases (AIDB) (for stand allocation, etc.).

2.3.1.1.3 Data Fusion

All the traffic information provided by these different sources needs to be computed in order to obtain a consistent and continuously updated traffic information picture. This is performed by the "Data Fusion" function.

The information provided by the different surveillance sensors and traffic information sources is combined by a data fusion process to provide a comprehensive surveillance package. The output is a continuously updated track for each mobile and obstacle, including all necessary parameters and information associated with each track.

Traffic Information will be distributed to all users and to other Ground and On-board functions that require it. Some users may require the information to be filtered prior to transmission.

2.3.1.2 Provide Traffic Context Function

This function is responsible for the provision of traffic context information such as airport configuration, runways status, separation minima, etc. Some of this information, such as the layout of runways and taxiways, will be relatively static, whereas other, such as runways in use, taxiway closures, weather conditions, may change frequently. The traffic context data may be automatically obtained from other systems (airport databases, meteorological systems, etc.), or updated by human operators.

The “Provide Traffic Context” function is composed of sub-functions as shown in the following diagram and described in the following sections.

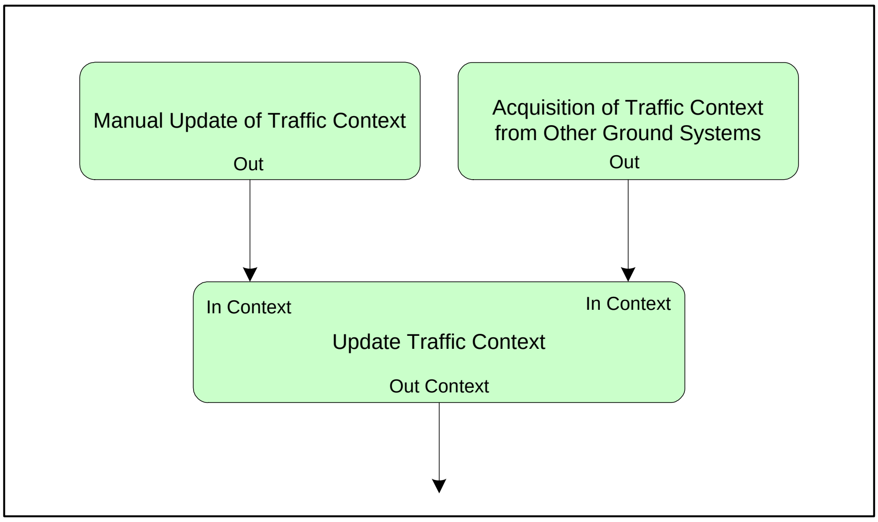

Figure 2-3: Functional Architecture for Provide Traffic Context

2.3.1.2.1 Acquisition of Traffic Context from Other Ground Systems

This function is responsible for the automatic provision of the traffic context information obtained from other systems. It will interface to Airport Information Databases, Meteorological Information Systems, etc.

2.3.1.2.2 Manual Update of Traffic Context

This function is responsible for the provision of traffic context information (airport configuration, runways and taxiway status, etc.) updated by human operators.

2.3.1.2.3 Update Traffic Context

The Traffic Context information provided by the different sources (automatic or manual) is combined to provide a comprehensive traffic context package for distribution to users and to other Ground and On-board functions that require it.

Some users may require the Traffic Context data to be filtered before transmission.

2.3.1.3 Conflict Detection and Alerting Function

This is a function of the A-SMGCS Ground system. It monitors the Traffic Information and utilises Traffic Context information in order to detect and predict conflicts involving aircraft and to alert users of hazardous situations. Users are primarily controllers but in some situations, for example when there is imminent collision danger, it may be required to transmit alert information directly to pilots and/or vehicle drivers.

At higher levels of implementation, this function may also monitor a movement’s conformance with the assigned route and provide an alert in the event of deviation.

2.3.1.4 Provide Taxi Route Function

This function is responsible for the provision and assignment of a suitable taxi route to each aerodrome movement. It will make use of Traffic Information and Traffic Context information to compute a taxi route from a stand to a runway entry point for a departing aircraft or from a runway exit point, once detected, to a stand for an arriving aircraft. In addition, it should be able to provide routes for other movements of aircraft on the aerodrome movement area and for vehicle movements, if required.

From the Traffic Information, the "Provide Taxi Route" function should be able to obtain information about the:

- Type of movement
- Type of aircraft, if the movement is an aircraft
- Start point (e.g. stand for departures, runway exit for arrivals)
- End point (e.g. stand for arrivals, assigned runway entry point for departures)

From the Traffic Context, the "Provide Taxi Route" function should be able to obtain information about the:

- Layout of the runways and taxiways
- Stand locations
- Intermediate waypoints (e.g. de-icing, temporary parking positions)
- Local standard routes
- Local taxi restrictions (closed or restricted-use taxiways, restricted areas)
- Obstacles and temporary hazards

The "Provide Taxi Route" function distributes its output to the users.

2.3.1.5 Provide Departure Time Function

This function is responsible for the computation of an optimal departure sequence aimed at minimising delays from start-up to take-off and the provision of optimum start-up pushback and take-off times for each departing aircraft. It is independent of the on-board side.

The "Provide Departure Time" function will make use of the "Provide Traffic Information" function to obtain information about:

- ETA and ATA for Arrivals
- CTOT or ETD or confirmed/estimated Off-Block Time for Departures
- Type of aircraft
- Destination
- Prioritised flights

It will make use of the "Provide Traffic Context" function to obtain information about:

- Separation minima
- Standard Instrument Departure (SID) Routes
- Runway(s) in operational use (including mixed-mode or single-mode)
- Intersection take-offs (runway entry points)
- Additional constraints set by the ATCO (including runway closures for inspection)

The output of the "Provide Departure Time" function is information about optimal (targeted) start-up, pushback and take-off times to the users.

2.3.1.6 Provide Ground Clearances Function

This function is responsible for the preparation and provision of clearances and taxi route information to aircraft.
It will be interoperable with the on-board side to receive clearance requests, to transmit clearances and to transmit and receive acknowledgements.

2.3.1.7 Service Monitoring Function

This function monitors the quality of service of the A-SMGCS (equipment status, performances, operational failures, etc.) and generates an alert when the A-SMGCS must not be used for the intended operation. As well as monitoring the status of the ground equipment, the "Service Monitoring" function will receive information about the status of on-board systems used for A-SMGCS.

2.3.1.8 Interface with User Function

This function is the interface with the ground-side users, predominantly controllers but also technical staff responsible for monitoring and maintaining the serviceability of the system.

The "Interface with User" function should provide the ground-side users with the following information:

- Traffic information
- Traffic context information
- Conflict alerts
- Taxi route proposals
- Departure time proposals
- Aircrew requests and acknowledgements
- Serviceability alerts

Via the "Interface with User" function, users will have a means to interact with the system to filter the information according to their needs and to input or modify some items of information.

2.3.2 Overall Ground System Architecture

At the architectural level, the requirement analysis defines the physical components of the A-SMGCS, which executes the different functions defined previously. The functions are mapped onto the physical architecture. In this document, the A-SMGCS functional architecture is mapped onto the EMMA2 system architecture. At this level, the specification goes deeper in the details of the system design and the functional requirements are developed into detailed technical requirements. It should be noted that the EMMA2 design is to a certain extent "bottom-up", since the system will necessarily be developed from existing commercial off-the-shelf (COTS) industrial components and built upon the existing airport infrastructure to enhance the current SMGCS.

In order to meet operational requirements for modularity and expandability, the generic A-SMGCS model comprises a number of primary system elements linked together via local area network (LAN), employing standard data communications interfaces and protocols. The A-SMGCS utilises external resources, including surveillance sensors, ATM information systems and Airport information systems, to which it is connected via LAN gateways.

The system should make maximum use of well-proven COTS hardware and software components.
Client-Server architecture and inter-process communication should be adopted throughout the system.

The figure below shows the main system elements and interfaces.

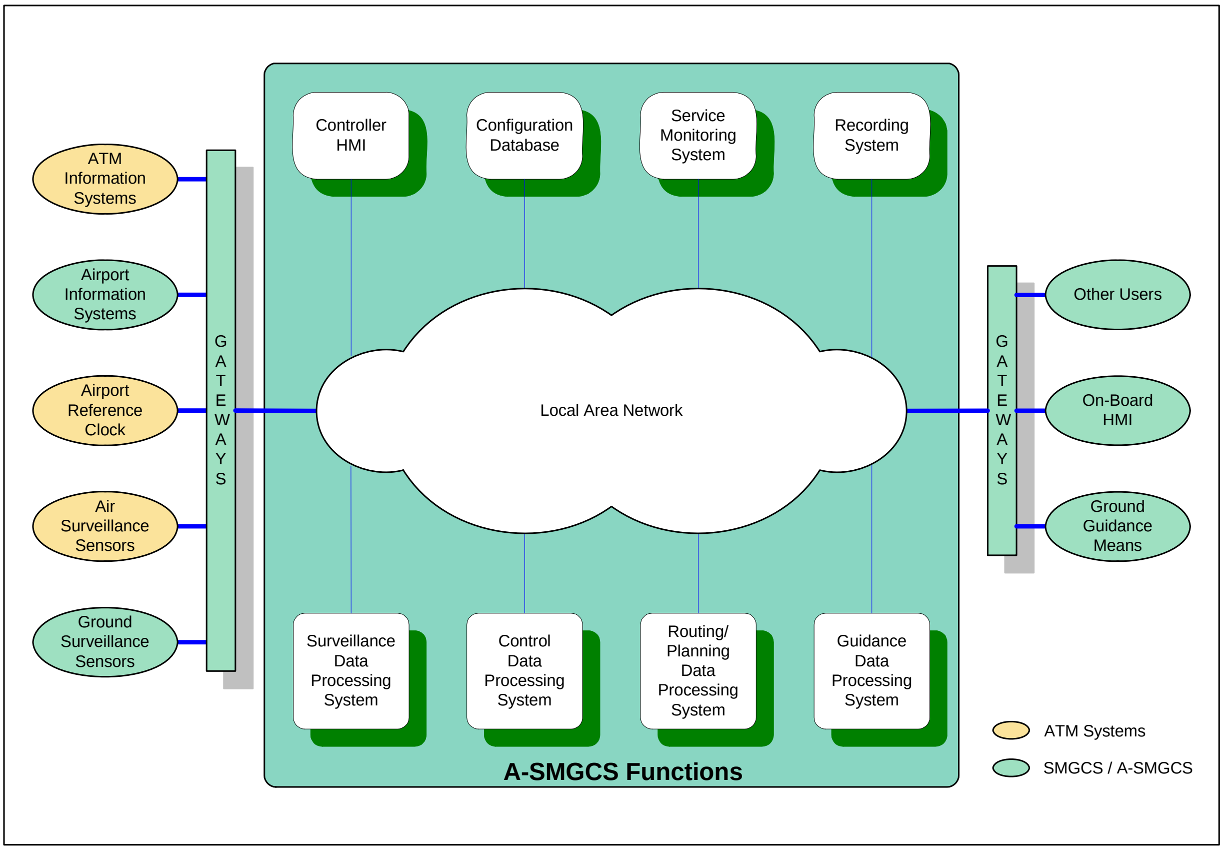

Figure 2-4: EMMA2 Ground System Architecture

The central part of the figure shows the four primary functional elements of an A-SMGCS, as specified by ICAO:

a) Surveillance: to provide accurate position information on all movements within the movement area and to provide identification and labelling of authorized movements;
b) Control: to provide continuous interpretation of the traffic situation, including verification of planned events, and detection and alerting of potential conflicts and other hazardous scenarios;
c) Routing (including Planning): to provide designation of routes and allocation of times to aircraft and vehicles; and
d) Guidance: to provide clear indications to pilots and vehicle drivers to allow them to follow their assigned routes and to maintain situational awareness.

Each of these functions will be realised by an associated Data Processing System, which, in some cases, may comprise multiple modules and processes.
Requirements for Surveillance, Control, Routing/Planning and Guidance are listed in Chapters 4, 5, 6 and 7 respectively.

Each function will be accessible to controllers via suitable HMI. The Controller HMI requirements are provided in Chapter 8.

To support the primary functions, the A-SMGCS will require at least three other elements as shown in the figure:

a) A configuration database: to provide topological information and operational status information about the aerodrome, as well as configurable system parameters;

b) A service monitoring system: to monitor and report the serviceability status of the A-SMGCS components and data sources; and
c) A recording and playback system: to record data communications, voice communications, and displayed information, including operator inputs, for accident and incident investigation.

Requirements for these supporting functions are provided in Chapter 9.

The A-SMGCS will have the capability to provide information to other systems and users. This could include:

a) Provision of surveillance and planning information to Apron Management
b) Coordination with Approach Control
c) Provision of surveillance, guidance and control information to aircraft via air-ground data links
d) Provision of surveillance, guidance and control information to vehicles via data links
e) Control and monitoring of aerodrome ground lighting
f) Provision of event data (actual times of arrival and departure, routes taken, taxi times, etc.) to Airport authorities for statistical and other purposes

Requirements for air-ground interoperability are provided in Chapter 10.

2.3.3 Interface Standards

Although few accepted international standards for A-SMGCS currently exist, it is desirable, wherever possible, to standardise interfaces in order to ensure interoperability of equipment from different manufacturers.

2.3.3.1 Physical Interfaces

Various standards are in use for the physical interfaces to external systems. The type of physical interface used for the connection to the A-SMGCS will normally depend on what is available on the airport's existing equipment.

The preferred physical interface is the Ethernet/Fast-Ethernet 10/100 Mbit/s (10BaseT/100BaseTX) local area network (LAN) connection.

The A-SMGCS should provide any necessary format conversion.

2.3.3.2 Protocols and Data Formats

The following OSI protocols are preferred for A-SMGCS interfaces:

- At the Physical Layer, IEEE 802.3/802.3u (Ethernet 10BaseT/100BaseTX)
- At the Network Layer, Internet Protocol (IP)
- At the Transport Layer, User Datagram Protocol (UDP) for surveillance target reports and other time-critical data, and Transport Control Protocol (TCP) for more secure, but less time-critical, data transmission.

Various data formats exist for the different external interfaces. These are listed below. The A-SMGCS should provide any necessary conversion to its internal format.

- Surveillance Systems

  For surveillance systems, the EUROCONTROL ASTERIX standard data format was developed for the exchange of radar data; it has now been extended to include other types of sensor and sensor data fusion.

- Airport/ATM Information Systems
  These interfaces may include flight data processing systems (FDPS), code-callsign databases (CCDB), airport and airline information databases (AIDB), gate management systems (GMS), meteorological information systems (MET), and others.
  For flight plan data, the EUROCONTROL standard data format ADEXP has been widely adopted.
- Airport Reference Clock
  The A-SMGCS must be synchronized to the airport reference clock system. Currently there are a number of different time code formats in use, some of them pulse-coded (such as IRIG-B and DCF-77), others with a binary data format and a synchronization pulse signal. Most binary-coded types use simple serial protocols and proprietary data formats.
  Modern systems employ GPS clocks and transmit the data via LAN using the network time protocol (NTP). NTP provides an achievable accuracy in the order of milliseconds. NTP is used to synchronize the time of workstations on a LAN with the host time-server. The time-server sends periodic broadcasts to the workstations, which then determine the time based on pre-configured latency. Synchronization is provided to align the internal clocks of workstations, servers, etc., affected by time drift, to a common network time.
- Ground Guidance Means
  There are currently no official international standards for the interfaces to airport ground lighting (AGL) systems. Only manufacturers' proprietary protocols and data formats exist.
- On-board Systems
  The A-SMGCS should be capable to exchange data with aircraft via standard data links. Data transmission via VHF radio is one of several technologies currently under consideration for the air-ground data link. For the EMMA2 project, VDL Mode 2 has been retained for the air-ground data link communication services and Mode S 1090ES for the ADS-B and TIS-B services.

3 General Ground System Technical Requirements

In this section are listed the technical requirements related to the Design, Evolution, Operational Range, Environmental Constraints and Interfaces applicable to the overall A-SMGCS ground system and its components. These general requirements are valid at all levels of implementation of an A-SMGCS. Most requirements have been derived from the referenced EUROCAE ED87B [7] and ICAO Doc 9830 [14] documents.

The requirements are divided into three subsections: Functional, Performance and Interface Requirements, with associated identifiers Func_GEN-nn, Perf_GEN-nn and Intf_GEN-nn, where nn is a two-digit number.

For traceability, requirements include references to all operational requirements listed in the SPOR document [2] and, where applicable, to other sources. The ICAO A-SMGCS Manual (Doc 9830) [14] is the prime source of the parent requirements.

Many of these requirements in this chapter are of a general nature applicable to most ATC systems, not specifically to A-SMGCS. In most cases, compliance with these requirements can be inferred from the system design. It will not be necessary to test compliance in the EMMA2 project. EMMA2 will concentrate on the more specific functional and performance requirements listed in the later chapters of this document.

3.1 Functional Requirements

The following table lists general functional requirements for the A-SMGCS.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Service Provision				
Func_GEN-01 Surveillance	For all levels of implementation, the A-SMGCS should provide equipment to support the Surveillance service.	A-SMGCS should support the following primary functions: a) Surveillance b) Routing c) Guidance d) Control	GEN_Serv-01 [ICAO §2.2.1]	
		The system should integrate movements to	GEN_Serv-04	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_GEN-02 Control	At Level 2 and above, the A-SMGCS should provide equipment to support the Control service	provide complete situational information to all users, and to provide conflict prediction and resolution for aircraft and vehicle movements.	[ICAO §2.2.4]	
Func_GEN-03 Routing and Guidance	For higher levels of implementation, the A-SMGCS should also provide equipment to support the Routing and Guidance functions.			
Func_GEN-04 Planning	For higher levels of implementation, the A-SMGCS should also provide equipment to support the planning of surface movements.	In order to achieve the maximum benefits at each level of A-SMGCS implementation, a supporting planning function should be included.	GEN_Serv-02 [ICAO §2.2.2]	
Func_GEN-05	Spare			
Modularity, Scalability and Adaptability				
Func_GEN-06 Modularity 1	The A-SMGCS equipment should comprise hardware and software modules.	The A-SMGCS consists of many elements which, when integrated, are designed to meet the specific operational requirements of an aerodrome. In order to cover a wide range of requirements any element design must comply with the modularity concept.	ED-87B §1.8.2	Each aerodrome will only implement the A-SMGCS modules fitting its needs and its technological choices.
Func_GEN-07 Modularity 2	The system should be based as far as practicable on commercial off-the-shelf (COTS) hardware and software components.	The system should be modular so that the appropriate level of service can be provided to different aerodromes as well as to different areas of an aerodrome.	GEN_Serv-05 [ICAO §2.2.5]	
Func_GEN-08 Scalability 1	The modules should be such that the system can be dimensioned according to the needs of different aerodromes.	The design principle of an A-SMGCS should permit modular enhancements.	GEN_Serv-08 [ICAO §2.4.1]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_GEN-09 Scalability 2	The modules should be such that further components can be added in order to expand the system in terms of functionality and number of users.	The design principle of an A-SMGCS should permit modular enhancements such as implementation of further A-SMGCS levels.	ED-87B §1.8.2	
Func_GEN-10	Spare			
Func_GEN-11 Evolution	It should be possible to utilise the existing SMGCS infrastructure and to add additional modules of ground equipment when required for the operation.	The A-SMGCS design concept should be built upon the integration of the fundamental and principal system elements and facilitate the upgrading of those elements whilst maintaining, where possible, the same HMI and references.	GEN_Serv-10 [ED-87B §2.5.2]	
		A-SMGCS should evolve from the installed SMGCS by progressive enhancements to existing ground equipment to match the desired level of operations.	ICAO §3.3.1.2	
		Components can be added to existing SMGCS when traffic requirements justify an expansion.	ICAO §3.3.1.2	
Func_GEN-12 Open Architecture	An open architecture using COTS equipment and standard interfaces is recommended in order to permit system enhancements at minimal cost.	The design principle of an A-SMGCS should permit system enhancements at minimal cost.	ED-87B §1.8.3	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_GEN-13 Layout Change	In order to accommodate changes to the aerodrome layout after installation, it should be possible to reconfigure the A-SMGCS equipment and to integrate additional modules such as additional surveillance sensors.	An A-SMGCS should be capable of accommodating any change in the layout of the aerodrome (runways, taxiways and aprons).	GEN_Serv-20 [ICAO §2.6.10]	Depending on the nature and extent of the changes, it may be necessary to augment the system with additional components such as additional surveillance sensors.
Func_GEN-14 Adaptability	Adaptation of the equipment to different local site configurations, procedures and working methods should be done through an appropriate database (sensor positions, airport topography/topology, etc.).	In order to efficiently assist the ATCO, the automated A-SMGCS services should be configurable to adapt to local ATC procedures and working methods.	GEN_Serv-23 [EMMA2]	A-SMGCS should also be capable of accommodating changes in procedures and operational rules at the aerodrome.
Traffic Types				
Func_GEN-15 Traffic Types	The design of the equipment should be such that its functional performance is independent of the different types of aircraft and vehicle that are likely to use the aerodrome during the life expectancy of the equipment.	An A-SMGCS should support operations involving all aircraft types.	GEN_Serv-11 [ICAO §2.6.2]	
		An A-SMGCS should be capable of adaptation to cater for future aircraft types.	GEN_Serv-12 [ICAO §2.6.2]	'Future aircraft types' means those aircraft types that are expected to exist in the near future.
Func_GEN-16 Vehicle Equipage	A-SMGCS equipment should be capable of exchanging relevant information (to be further specified) with appropriately equipped vehicles operating within the movement area.	An A-SMGCS should be capable of being used by appropriately equipped vehicles operating within the movement area.	GEN_Serv-13 [ICAO §2.6.3]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Operating Conditions				
Func_GEN-17 MET and Topographical Conditions	The performance of A-SMGCS equipment should not be significantly degraded due to meteorological conditions, topographical conditions or poor visibility conditions in which operations would otherwise be possible.	The system should have adequate immunity to adverse effects such as meteorological conditions or any state of the aerodrome resulting from adverse weather in which operations would otherwise be possible.	GEN_Serv-14c [ICAO §2.6.5.c]	Full immunity to all meteorological and topo-graphical conditions may be difficult/costly to achieve. Heavy precipitation adversely affects SMR. The topographical environ-ment at airports is generally adverse due to buildings, other structures, and traffic, both moving and stationary, causing shadowing and multipath reflections of radar signals.
		A-SMGCS should be capable of operating at a specified movement rate in visibility conditions down to AVOL. When visibility conditions are reduced to below AVOL, an A-SMGCS should provide for a reduction of surface movements of aircraft and vehicles to a level acceptable for the new situation.	GEN_Serv-03 [ICAO §2.2.3]	
Func_GEN-18 Outdoor Environment	The outdoor equipment should operate in the following environmental conditions: Temperature: -25°C to +55°C Rainfall: Up to 16mm/hr Hail: Up to 12mm diameter at 17m/s Wind Speed: Up to 80kt operational; Up to 120kt survival (3s gust)		EUROCAE ED-116, ED-117	This requirement covers the majority of operating conditions experienced at (European) airports. If the equipment is to be installed in a region where greater extremes of environment are experienced, specifically adapted outdoor equipment may be required.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_GEN-19 Weather Resistance	The outdoor equipment, including any enclosure, should utilise materials, coatings and finishes which are resistant to weathering and to industrial pollutants such as sulphur dioxides and/or nitric oxides.		EUROCAE ED-116, ED-117	
Func_GEN-20 Indoor Environment	The indoor equipment should operate in the following environmental conditions: Temperature: +10°C to +30°C Rel. Humidity: 10% to 80% non-condensing		EUROCAE ED-116, ED-117	
Func_GEN-21 Health and Safety	The equipment should comply with all relevant health and safety legislation; European Standard; or Code of Practice, including but not limited to the following: • Grounding and power distribution • Inflammable atmospheres • Human exposure to radiation • Electro-mechanical detonators • Hazardous substances		EUROCAE ED-116, ED-117	
Func_GEN-22	Spare			
Power Requirements				
Func_GEN-23 Standard Power	Electrical equipment should operate from standard mains voltage and frequency at the airport.		EUROCAE ED-116, ED-117	
Installation Requirements				
Func_GEN-24 Obstacle Limitations	Any A-SMGCS equipment installed in the movement area should comply with obstacle limitations requirements.		ICAO Annex 14, Volume I.	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_GEN-25 Reflections and Shadowing	Siting of equipment should take into account the adverse effects of signal reflections and shadowing caused by aircraft in flight, vehicles or aircraft on the ground, buildings, snow banks or other raised obstacles (fixed or temporary) in or near the aerodrome environment, so that performance requirements are met.	The system should not be affected by signal reflections and shadowing caused by aircraft in flight, vehicles or aircraft on the ground, buildings, snow banks or other raised obstacles (fixed or temporary) in or near the aerodrome environment	GEN_Serv-14b [ICAO §2.6.5.b]	Snow clearing procedures need to take account of A-SMGCS surveillance sensor siting so that snow banks do not adversely affect performance.
Func_GEN-26 Noise and Vibration	Audible noise and vibration from the equipment should be confined to within acceptable levels commensurate with the environment. This is particularly important in the tower visual control room(s).			Acceptable noise levels to be defined by the local authority.
Func_GEN-27	Spare			
Electromagnetic Compatibility				
Func_GEN-28 EMI/EMC	Equipment should have appropriate EMI/EMC characteristics for operation in an airport environment. The EU directive 98/336/EEC is applicable.	The system should not be affected by radio interference, including that produced by standard navigation, telecommunications and radar facilities (including airborne equipment)	GEN_Serv-14a [ICAO §2.6.5.a]	
Func_GEN-29 Lightning Protection	Equipment and associated data links should include appropriate lightning conductors and transient protection to ensure continued operation during lightning storms without equipment failure.			IEC 62305-4 provides information on lightning protection.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Reliability				
Func_GEN-30 Continuity	The equipment should be capable of sustained operation 24 hours a day throughout the year.	An A-SMGCS should provide a continuous service.	GEN_Serv-27 [ICAO §2.7.4.2 ED-87B §3.1.1.2]	
Func_GEN-31 Maintenance	Equipment should be installed and configured in such a way that all possible essential maintenance can be carried out without interrupting operation.	Any unscheduled break in continuity should be sufficiently short or rare as not to affect the safety of aircraft using the system.	GEN_Serv-28 [ICAO §2.7.4.2 ED-87B §3.1.1.2]	
Func_GEN-32 Integrity	Appropriate data integrity checks should be employed to ensure that erroneous data is not provided to users.	A-SMGCS should preclude failures that result in erroneous data provided to the users.	GEN_Serv-24 [ICAO §2.7.3.1 ED-87B §3.1.1.1]	
Func_GEN-33 Availability	Appropriate levels of redundancy should be provided for equipment that is to be continuously available.	An A-SMGCS should be designed with the appropriate level of redundancy and fault tolerance in accordance with the safety requirements.	GEN_Serv-30 [ICAO §2.7.5.1]	
		The availability of an A-SMGCS should be sufficient to support the safe, orderly and expeditious flow of traffic on the movement area of an aerodrome down to its AVOL.	GEN_Serv-26 [ICAO §2.7.4.1 ED-87B §3.1.1.2]	
Service Monitoring				
Func_GEN-34 Equipment Status	The A-SMGCS should include built-in test equipment (BITE) to monitor the operational status of all A-SMGCS equipment.	The operational status of surveillance equipment should be monitored by the system, and alerts should be provided as appropriate.	GEN_Serv-09 [ICAO §2.5.1.2]	The term ‘surveillance equipment’ should be replaced by ‘all A-SMGCS equipment’.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_GEN-35 Self-Checking	The BITE should detect operationally significant failures, and should generate alerts when the system must not be used for the intended operations.	Monitoring of the performance of an A-SMGCS should be provided such that operationally significant failures are detected and remedial action is initiated to restore the service or provide a reduced level of service.	GEN_Serv-29 [ICAO §2.7.4.3]	Remedial action should be addressed procedurally.
		A self-checking system with failure alerts should be included in the system design.	GEN_Serv-30 [ICAO 2.7.5.1]	
Func_GEN-36 Data Validation	The BITE should perform a continuous validation of data provided to the user and generate a timely alert to the user when the system must not be used for the intended operation.	The A-SMGCS should perform a continuous validation of data provided to the user and timely alert the user when the system must not be used for the intended operation.	GEN_Serv-25 [ICAO §2.7.3.2]	
Func_GEN-37	Spare			
System Failure				
Func_GEN-38 Basic Functions	Appropriate redundancy should be provided to ensure that a failure of one item of equipment does not result in a loss of basic functions.	A failure of equipment should not cause the loss of basic functions.	GEN_Serv-31b [ICAO §2.7.5.2.b]	The operational requirement should be revised to define precisely what is meant by “basic functions”.
Func_GEN-39 Failure Effect	Equipment should be both fail-safe and fail-soft.	A failure of equipment should not cause a reduction in safety (fail soft).	GEN_Serv-31a [ICAO §2.7.5.2.a ED-87B §3.1.1.2]	
		Equipment which shows control data should be both fail-safe and fail-soft.	GEN_Serv-15 [ICAO §2.6.9.1]	‘Fail-safe’ means sufficient redundancy is provided to

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
		In case of a failure of an element of an A-SMGCS, the failure effect should be such that the element status is always in the "safe" condition.	GEN_Serv-16 [ICAO §2.6.9.2]	carry data to the display equipment to permit some components of the equipment to fail without any resultant loss of data displayed. 'Fail-soft' means that, even if equipment fails to the extent that loss of some data occurs, sufficient data remain on the display to enable operations to continue.
Func_GEN-40 Operationally Significant Failures	Operationally significant failures such as loss of a data source or unreliable or degraded performance should be reported at the Technical Workstation and to Clients.	Operationally significant failures in the system should be clearly indicated to the control authority and any affected user.	GEN_Serv-33 [ICAO §2.7.5.3]	
		The system should allow for a reversion to adequate back-up procedures if failures in excess of the operationally significant period occur.	GEN_Serv-32 [ICAO §2.7.5.3]	This requirement is procedural rather than technical.
Func_GEN-41 Failure Alerts	All critical items of equipment should be provided with timely audio and visual indications of failure.	All critical elements of the system should be provided with timely audio and visual indications of failure.	GEN_Serv-17 [ICAO §2.6.9.3]	
System Restart				
Func_GEN-42 Self-restartable	All items of the equipment should be self-restartable.	The system should be self-restartable. The recovery times should be of a few seconds.	GEN_Serv-18 [ICAO §2.6.9.4]	ICAO gives no rationale for this requirement, which is unlikely to be met by current equipment. A 'few minutes' would be more realistic.
Func_GEN-43 Recovery Time	The recovery time after a restart of any item of equipment should not exceed 60 seconds.			

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_GEN-44 Restoration of Information	The restart of an item of equipment should include the restoration of pertinent information on actual traffic and equipment performance.	The restart of the system should include the restoration of pertinent information on actual traffic and system performance.	GEN_Serv-19 [ICAO §2.6.9.4]	

Table 3-1: General Functional Requirements for A-SMGCS

3.2 Performance Requirements

The following table lists general performance requirements for the A-SMGCS.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Target Velocity				
Perf_GEN-01 Velocity Range	The performance of the A-SMGCS equipment should as far as possible be independent of target velocity, within the following ranges: • 0 to 250 kt for aircraft on final approach, missed approach and runways • 0 to 80 kt for aircraft on runway exits • 0 to 80 kt for vehicles on the movement area • 0 to 50 kt for aircraft on straight taxiways • 0 to 20 kt for aircraft on taxiway curves • 0 to 10 kt for aircraft on stands and stand taxi lanes • Any direction of movement.	The system should be capable of supporting operations of aircraft and vehicles within the following parameters: a) Minimum and maximum speeds for aircraft on final approach, missed approach and runways; b) Minimum and maximum speeds for aircraft on taxiways; c) Minimum and maximum speeds for vehicles; and d) Any heading.	GEN_Perf-01 [ICAO §2.6.4]	
Capacity				
Perf_GEN-02 Processing Capacity	The equipment should have sufficient capacity to process data for at least 500 targets per second simultaneously.	The A-SMGCS should be able to handle all aircraft and vehicles that are on the movement area at any time.	GEN_Perf-02 [ICAO §4.1.1.5]	The A-SMGCS should also have sufficient capacity to handle obstacles on the movement area and traffic within the other areas of interest, e.g. aircraft on approach, helicopters, etc.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Perf_GEN-03 Spare Capacity	When first installed, the processing equipment should have a margin of spare capacity of at least 50%.	System Capacity should be sufficient to meet the stated operational requirements for the aerodrome with a specified margin of spare capacity to permit safe operation and future growth.	ED-87B §3.1.2	
Coordinate System				
Perf_GEN-04 Aerodrome Reference Point	All geographical information should be referenced to a common reference point on the aerodrome. This point should be referenced in WGS-84.	An A-SMGCS should be referenced to the World Geodetic System (WGS-84).	ICAO §2.6.6.1	
Perf_GEN-05 Target Reference Point	The reference point for target position data should be the mid-point of the target's longitudinal axis.	A common reference point on aircraft and on vehicles should be used in A-SMGCS.	ICAO §2.6.6.2	

Table 3-2: General Performance Requirements for A-SMGCS

3.3 Interface Requirements

The following table lists general performance requirements for the A-SMGCS.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Interface Principles				
Intf_GEN-01 Standards	Wherever possible and practicable, the A-SMGCS should utilize standard data communications interface protocols and data formats.	Standards like Standards and Recommended Practices (SARPS) should be written and used to permit interoperability between the A-SMGCS elements developed by different manufacturers.	ED-87B §1.8.4	
Intf_GEN-02 Client-Server Architecture	The system software applications should use extensive client-server architecture and inter-process communication.	The data interchange between systems should be performed in a standardized format in order to ensure an adequate exchange of information.	ICAO §2.6.16.2	
Intf_GEN-03 TCP/IP	The inter-process communication level should support process distribution via LAN, using TCP/IP.			
Time Synchronisation Interface				
Intf_GEN-04 Reference Clock	The A-SMGCS should be synchronised with an airport reference clock so that all date and time indications used within the system agree with the reference time. The synchronisation standard used should be the Network Time Protocol (NTP)			Missing parent OR

Table 3-3: General Interface Requirements for A-SMGCS

4 Surveillance

4.1 Surveillance Architecture

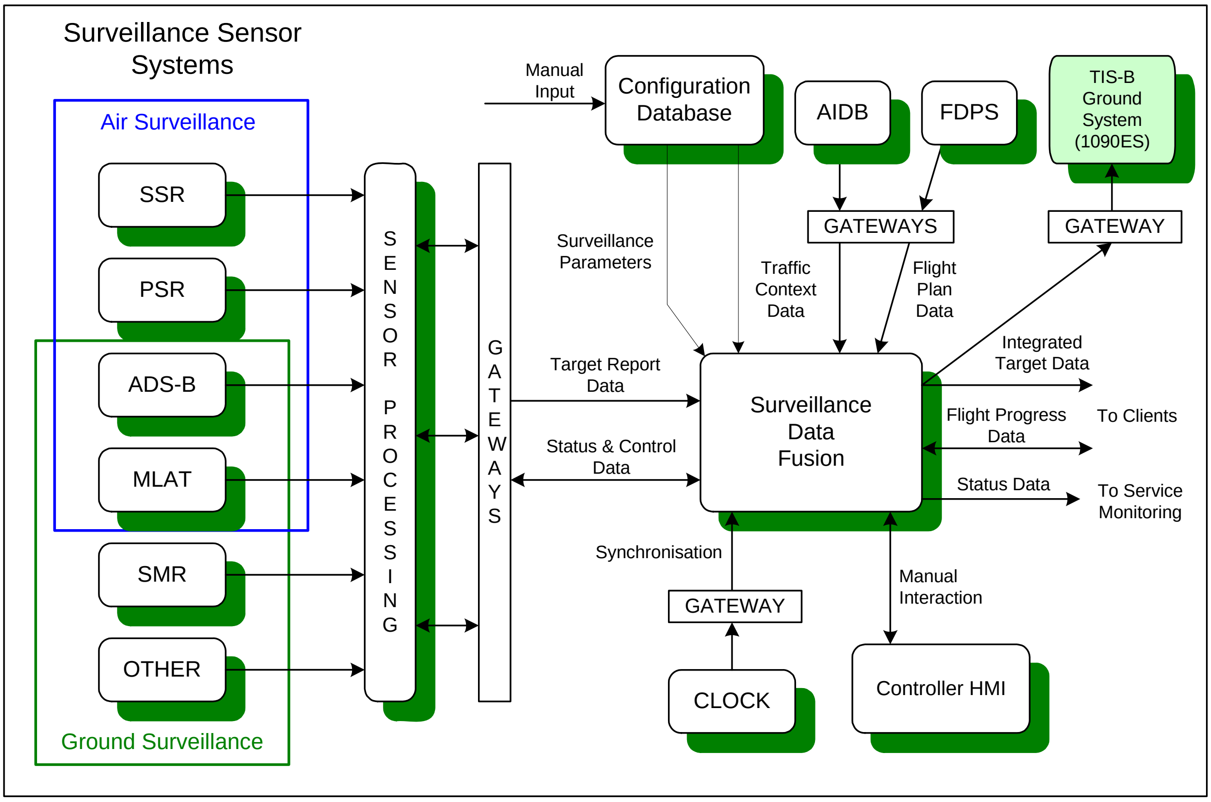

Figure 4-1: EMMA2 Surveillance Architecture

4.2 Surveillance Sensor Systems

Multiple surveillance sensor systems will normally be required to provide acquisition of traffic information for all traffic on and near the aerodrome. In order to detect all types of aircraft, vehicles and obstacles, the sensor systems should be a mix of cooperative and non-cooperative types.
Each sensor system will include pre-processing and plot extraction.
Outputs from the sensor systems should be target reports in the ASTERIX data format. Each target report should be time stamped.

4.2.1 SSR/PSR

Position and identity of airborne aircraft will be provided for the EMMA2 A-SMGCS by existing approach surveillance radars. To ensure both cooperative and non-cooperative surveillance, the approach surveillance system will normally comprise both primary and secondary surveillance radars (PSR and SSR) feeding a multi-sensor Radar Data Processing System (RDPS). In some systems, the RDPS may itself also receive data from other cooperative sensor systems such as ADS-B and wide-area MLAT.

The EMMA2 test-bed will receive an input from the RDPS.

4.2.2 MLAT

At least one cooperative surveillance sensor will be needed to provide the position and identity of the participating mobiles on the surface. The participating mobiles are those known by the aerodrome authority, and likely to move on the manoeuvring area. In the longer term, all the participating mobiles are required to be cooperative, allowing the cooperative surveillance sensor to collect information about the mobiles, at least their position and identity.

MLAT will be the main cooperative sensor system for the EMMA2 ground surveillance because it can utilise the Mode A/C/S transponders that are already standard equipment on aircraft. MLAT ground stations are also capable of receiving and decoding 1090ES ADS-B transmissions.

4.2.3 ADS-B

In the A-SMGCS ground domain, the use of ADS-B is to be considered as a supplement to MLAT. In the longer term, it could perhaps replace MLAT once all aircraft are suitably equipped and the reliability and integrity requirements for the A-SMGCS application are met.

The basic A-SMGCS requirements for the on-board ADS-B are that it should continuously transmit accurate and timely information on:

- Own aircraft / vehicle identity
- Own aircraft / vehicle position
- Accuracy of position measurement

The fact that ADS-B will also permit other information such as speed, heading, turn rate, climb rate, roll angle, waypoints and intent to be down linked is of little or no consequence to the A-SMGCS.

4.2.4 SMR

At least one non-cooperative surveillance sensor will be needed to detect mobiles and obstacles, including intruders, on the aerodrome surface.

In EMMA2, SMR has been chosen for the task of non-cooperative surveillance of the aerodrome surface, being a well-proven technology that is already available on many airports as part of the SMGCS. Multiple SMRs or other non-cooperative sensor systems may be required to meet coverage requirements and/or to provide false target mitigation.

4.3 Traffic Context Information

The Surveillance function of the A-SMGCS requires some traffic context information (e.g. maps of sensor coverage). Traffic context information (airport layout, configuration, runways status, etc.) required by the A-SMGCS will be provided from the Configuration Database and one or more other systems, such as Airport Information Database (AIDB), Meteorological system (MET), etc.

There will normally be two types of Traffic Context data from different sources:

a) Static (or semi-static) Data, which rarely change, such as aerodrome layout, and which would normally require update by a human operator; and
b) Dynamic Data, which can change often, such as runway status and meteorological conditions, and which may normally be obtained automatically from other systems.

4.3.1 Other Traffic Information

Other traffic information (e.g. aircraft type, stand, etc.) which may be required by the A-SMGCS will be provided by one or more other systems, such as a Flight Data Processing System (FDPS) and/or Gate Management System (GMS).

4.4 Surveillance Data Fusion

Data from surveillance sensor systems and other information sources should be fed to the Surveillance Data Fusion (SDF) system via suitable LAN gateways. The surveillance information provided by the different sources should be combined by a data fusion process to provide a comprehensive surveillance package.
The process of data fusion should be employed to link together all relevant information pertinent to a particular aerodrome movement.

Surveillance systems should provide the SDF with target reports for each mobile or obstacle detected by the sensor. Target track processing in the SDF should determine the position of each target based on its previous positions and on each new Target Report received from the surveillance sensor systems.

Flight data processing in the SDF should assemble all available information related to current or planned movements and maintain a local database, which will be used to associate each tracked target to its flight plan. If available, information to uniquely identify the target with its callsign should be linked to the target track.

Complete traffic information in the form of integrated target data should be distributed to clients for presentation or further processing.

To enable higher-level services, the SDF should monitor the progress of each aircraft movement and send a flight progress report to declared clients whenever the status of a movement changes (e.g. start-up clearance, pushback clearance, target detected moving from one topological segment of the aerodrome to another, etc.).

If departure management processing is implemented, the SDF should be capable of receiving timing and sequencing data for each departure movement.

The SDF should monitor the status of each of the attached sensor systems and information sources and sends status reports, including its own status, to the central A-SMGCS Service Monitoring System.

4.5 TIS-B System

EMMA2 should provide surveillance data to appropriately equipped aircraft and vehicles via the Traffic Information Service - Broadcast (TIS-B) System.

The SDF should transmit integrated target data about objects of interest (aircraft, vehicles and significant obstacles) to the TIS-B System. The TIS-B System should filter the data, prepare the TIS-B messages in the appropriate format and broadcast them on the 1090ES data link.

The TIS-B service is described in section 10.2 of this document.

4.6 Surveillance Function Requirements

In this section are listed the technical requirements related to the Surveillance function of the A-SMGCS. These requirements are valid at all levels of implementation of an A-SMGCS. The majority of the parent requirements have been derived from the referenced EUROCAE ED87B [7] and ICAO Doc 9830 [14] documents.

The requirements are divided into three subsections: Functional, Performance and Interface Requirements, with associated identifiers Func_SURV-nn, Perf_SURV-nn and Intf_SURV-nn, where nn is a two-digit number.

For traceability, requirements include references to all parent operational requirements listed in the SPOR document [2] and, where applicable, to other sources. The ICAO A-SMGCS Manual (Doc 9830) [14] is the prime source of the parent requirements.

4.6.1 Functional Requirements

The following table lists functional requirements for the Surveillance function.

<table>
<tr><th>EMMA2 Req. No.</th><th>Requirement</th><th>Parent Requirements</th><th>Source Reference</th><th>Comment</th></tr>
<tr><td colspan="5">Basic function</td></tr>
<tr><td rowspan="2">Func_SURV-01 Ground Traffic Information</td><td rowspan="2">The surveillance equipment should detect and continuously provide accurate positional reporting on aircraft, vehicles and obstacles:
a) whether moving or static,
b) within the aerodrome movement area,
c) within the runway strips, and
d) within any designated protected area as required by airport authorities</td><td>The Surveillance function of an A-SMGCS should provide accurate position information on all movements within the movement area.</td><td>SURV_Serv-01
[ICAO §2.5.1.1.a]</td><td>‘Movement area’ should be replaced by ‘A-SMGCS coverage area’, which includes the approach area.</td></tr>
<tr><td>The Surveillance function of an A-SMGCS should cope with moving and static aircraft and vehicles, within the coverage area of the surveillance function.</td><td>SURV_Serv-03
[ICAO §2.5.1.1.c]</td><td></td></tr>
</table>

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
		The surveillance function should be capable of detecting aircraft, vehicles and obstacles.	ICAO §4.2.1	
Func_SURV-02 Approach Traffic Information	The surveillance equipment should detect and continuously provide accurate positional reporting on aircraft on approach, a) out to a distance such that inbound aircraft can be integrated into the A-SMGCS operation, and b) up to an altitude so as to cover missed approaches and low level helicopter operations.	Within the required area of the aerodrome, surveillance should be provided up to an altitude so as to cover missed approaches and low level helicopter operations.	SURV_Serv-06 [ICAO §2.5.1.4]	
		Surveillance should be provided for aircraft on approach to each runway at such a distance that inbound aircraft can be integrated into an A-SMGCS operation so that aerodrome movements, including aircraft departures or aircraft crossing active runways, can be managed.	SURV_Serv-07 [ICAO §2.5.1.5]	The part of this requirement referring to aerodrome movements is covered by the previous requirement.
Func_SURV-03 Traffic Information	Having detected a target in any of the areas defined above, the surveillance equipment should provide users with information on: a) Target position b) Target identity (for identifiable cooperative targets) c) Target classification (for non-cooperative or unidentifiable targets) d) Track history (at least the last three reported positions)	The surveillance service should continuously provide the following traffic information on the movement area, excluding passive and empty stands: • Position of all vehicles • Identity of all cooperative vehicles • Position of all aircraft • Identity of all cooperative aircraft • History of the aircraft/vehicle positions (e. g. the 3 last positions displayed)	SURV_Serv-11 [EMMA2]	The surveillance service should continuously provide the position and identity of all cooperative aircraft, including helicopters, within the entire coverage area.
		The surveillance function of an A-SMGCS should provide identification and labelling of authorised movements.	SURV_Serv-02 [ICAO §2.5.1.1.b]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
		The surveillance service should provide to the user the ability to manually put the right call sign in the label associated to a vehicle equipped with co-operative equipment used for different vehicles.	SURV_Serv-13 [EMMA2]	This is a Controller HMI requirement. Refer to section 8.3.1.
		The surveillance function of an A-SMGCS should be capable of updating data needed for the guidance and control requirements both in time and position along the route.	SURV_Serv-04 [ICAO §2.5.1.1.d]	'Data to be updated' are not sufficiently identified by this requirement.
		The surveillance service should continuously provide the airport traffic situation, comprising: a) Traffic information b) Traffic context.	SURV_Serv-10 [EMMA2]	a) Traffic information is covered by Func_SURV-01, 02 and 03. b) Traffic context is covered in section 9.1.1.
Func_SURV-04 Obstacles	The surveillance equipment should detect obstacles, whether moving or stationary, located anywhere on the movement area of the aerodrome and having an equivalent radar cross section of 1 square metre or more.	The A-SMGCS should detect obstacles, whether moving or stationary, located anywhere on the movement area of the aerodrome and having an equivalent radar cross section of 1 square metre or more.	SURV_Serv-09 [EMMA2]	An A-SMGCS is not designed to detect every kind of obstacle. The ATCO, as the main user of an A-SMGCS, is also not responsible for detecting obstacles. The airport authority is responsible for ensuring that the manoeuvring area is 'free of obstacles'
Func_SURV-05 Target Size	Objects detected on the movement area should be classified according to size.		ED-87B §3.2.2.2	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_SURV-06 Target Velocity	The surveillance equipment should provide users with information on: a) Target speed b) Direction of movement		ED-87B §3.2.2.6	
Func_SURV-07	Spare			
Surveillance Equipment				
Func_SURV-08 Multiple Sensors	The surveillance equipment should comprise multiple sensor systems and data fusion.	It is expected that more than one type of sensor and a data fusion unit may be needed to meet the requirements.	ICAO §3.4.1.3	
Func_SURV-09 System Expansion	The surveillance system should be capable of expansion to accept and integrate data from other surveillance sensor sources in the future.			
Func_SURV-10 Non-cooperative Detection	The surveillance equipment should include at least one non-cooperative surveillance sensor system to detect and determine the position of mobiles and obstacles on the movement area of the airport. Currently, SMR is preferred as a non-cooperative sensor.	The non-cooperative surveillance sensors should determine the position of any mobile in its area of interest.	ED-87B §2.1.1	
Func_SURV-11 SMR MOPS	SMR systems should comply with the minimum operational requirements given in ED-116 [8].			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_SURV-12 Cooperative Detection	The surveillance equipment should include at least one cooperative surveillance sensor system to detect and determine the position of cooperative mobiles on the movement area of the airport. Currently, MLAT is preferred as a cooperative sensor.	The cooperative surveillance sensors should determine the position of any cooperative mobile in its area of interest	ED-87B §2.1.1	
Func_SURV-13 MLAT MOPS	MLAT systems should comply with the minimum operational requirements given in ED-117 [9].			
Func_SURV-14 Mobile Identity	The cooperative surveillance sensor system(s) should also determine the identity of cooperative mobiles on the movement area of the airport.	The cooperative surveillance sensors should determine the identity of any cooperative mobile in its area of interest.	ED-87B §2.1.1	
Func_SURV-15 Aircraft Position	The SDF should connect to the airport's approach RDPS to obtain the positions of airborne aircraft in the required areas.			
Func_SURV-16 Aircraft Identity	The approach RDPS should also provide the identity of airborne aircraft.			
Func_SURV-17	Spare			
Target Reports				
Func_SURV-18 Position Reports	Each surveillance sensor system should transmit continuous target position reports to the SDF.		ED-87B §3.2.2.9	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_SURV-19 Target Information	As a minimum, each target report from a surveillance sensor system should include the following information: • Data Source Identifier • Target Report Descriptor • Target Position • Time of Measurement If available, the following additional information should be provided: • Target Identifier (e.g. Callsign or SSR Mode A code) • Target Size Classifier • Measured Height • Estimated Accuracy of Position		ED-87B §2.5.1.1	
Func_SURV-20 Reference System	Target position reports should use a common reference system, WGS-84 datum. Target positions may be in LAT/LON or Cartesian coordinates referred to a common reference point on the aerodrome surface.		ED-87B §2.5.1.1	
Func_SURV-21 Reference Point	Target position reports should use a common reference point on aircraft and vehicles. This point has been defined as the geometrical mid-point on the longitudinal axis of the target.		ED-87B §3.2.2.4	
Func_SURV-22 Target Tracking	The SDF should perform correlation of target report data from the sensors and should track target movements in order to determine the best estimate of the target position at each update.		ED-87B §3.2.2.3	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_SURV-23 Seamless Transition	The SDF should provide a seamless transition between the airborne track for an aircraft and its ground track.	A seamless transition should be provided between the surveillance for an A-SMGCS and the surveillance of traffic in the vicinity of an aerodrome.	SURV_Serv-08 [ICAO §2.5.1.6]	
Other Information about Traffic				
Func_SURV-24 Other Information	The SDF should obtain other information about the traffic through appropriate interfaces to other systems.	This function should optionally provide any other information about traffic from other ground systems and as required by the users.	ED-87B §2.5.1.1	
Func_SURV-25 Aircraft Information	For each aircraft the information required will include: • ATC Callsign • Mode A code • Mode S code • Departure Airport • Destination Airport • Estimated Time of Arrival/Departure • Stand identifier • Aircraft type • Wake Vortex Category • Slot time (if applicable) • SID/STAR • Stand status (occupied/free) • Assigned runway • Estimated and Actual Off Block Times	Other information about traffic is a local issue to be decided by the ATC Service provider, but should include at least the following information: a) Vehicle type b) Aircraft type c) Aircraft gate d) Departure runway	SURV_Serv-12 [EMMA2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_SURV-26 Vehicle Information	For each vehicle the information required may include: • ATC Callsign • Transponder code (Mode S or other type) • Vehicle type • Vehicle fleet identifier			
Func_SURV-27 Extended Report	For each tracked target, the SDF should extend the target report data to include the other relevant information available.			
Func_SURV-28	Spare			
ADS-B Ground Station				
Func_SURV-29 ADS-B Interoperability	The ADS-B Ground Station should meet the interoperability requirements in section 10.4.			
Func_SURV-30 ADS-B Receiver Siting	The ADS-B Ground Station cases and antennas should be mounted on a suitable building, mast, or tower. The chosen site should permit clear line of sight to all parts of the specified coverage area. If necessary, multiple stations should be installed, to ensure full coverage for the complete airport movement area.			
Func_SURV-31 ADS-B Integrity Monitoring	The ADS-B Ground Station should include performance and integrity monitoring based on one or more field-mounted test transponders, enabling the verification of the end-to-end performance of the ADS-B system.			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_SURV-32	Spare			
TIS-B Ground System				
Func_SURV-33 TIS-B Interoperability	The TIS-B Ground System should operate in the 1090 MHz frequency band and meet the interoperability requirements in section 10.5.			
Func_SURV-34 TIS-B Siting 1	The TIS-B Ground System antenna should be mounted on a suitable building, mast, or tower. The chosen site should permit clear line of sight to all parts of the specified RF Coverage Volume.			
Func_SURV-35 TIS-B Siting 2	The TIS-B Ground System antenna should be sited and the transmitted RF levels adjusted such that interference with SSR receivers in the vicinity is kept within acceptable limits.			
Func_SURV-36 TIS-B Data Source	The TIS-B Ground System should be capable of receiving and decoding target report data from the SDF.			
Func_SURV-37	Spare			
Func_SURV-38 TIS-B Geometrical Filtering	The TIS-B Ground System should be capable of geometrical filtering of target report data to exclude targets outside of the pre-defined Traffic Information Volume (TIV).			
Func_SURV-39 TIS-B Traffic Information Volume	The TIV should be configurable for any polygonal shape in the horizontal plane and for any height up to 5000 feet in the vertical plane.			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_SURV-40 TIS-B RF Coverage Volume	The RF Coverage Volume should at least include the TIV.			
Func_SURV-41 TIS-B Surveillance Mode	The TIS-B Ground System should operate in full surveillance mode whereby all targets within the TIV are broadcast, including those that are sending 1090ES ADS-B reports.			

Table 4-1: Functional Requirements for Surveillance

4.6.2 Performance Requirements

The performance requirements for surveillance are well defined. They mainly concern the accuracy, timeliness and reliability of the target report information provided by the Surveillance function.

The following table lists performance requirements for the Surveillance function.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Coverage				
Perf_SURV-01 Coverage	The A-SMGCS equipment should provide surveillance coverage throughout the movement area up to a height of at least 200	As a minimum, the A-SMGCS should provide coverage throughout the movement area.	ICAO §3.4.1.5 [§3.4.2.2 §3.4.3.6]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
		The A-SMGCS should cover at least the aerodrome movement area and aircraft on approach to each runway at such a distance that inbound aircraft can be integrated into the A-SMGCS operations.	ICAO §4.1.1.4	
Accuracy and Resolution				
Perf_SURV-02 Reported Position Accuracy	The reported position accuracy of the surveillance data transmitted from the SDF to clients should be 7.5m or better on the manoeuvring area and 12m or better on the aprons, both at a confidence level of 95%.	The actual position of an aircraft, vehicle or obstacle on the surface should be determined within a radius of 7.5 m. *Note: [ED-87B] The reported position accuracy should not exceed 7.5m on the manoeuvring area and 12m on the aprons (both at a confidence level of 95%).*	SURV_Perf-03 [ICAO §4.2.3]	
Perf_SURV-03 Reported Position Resolution	The resolution of the position data in a target report should be better than 1 m.	The mobile position resolution should be at least 1 m.	ED-87B §3.2.3	
Perf_SURV-04 Reported Speed Accuracy	The accuracy of the target speed data transmitted from the SDF to clients should be better than 5m/s at a confidence level of 95%.	The velocity should be determined to the following accuracy: • Speed: <5m/s • Direction of movement: <10° *(ED-87B: at a confidence level of 95%)*	ED-87B §3.2.3 [ICAO §4.1.1.8 §4.1.1.10]	
Perf_SURV-05 Reported Direction Accuracy	The accuracy of the direction of movement data transmitted from the SDF to clients should be better than 10° at a confidence level of 95%.			
Perf_SURV-06 Reported Speed Resolution	The resolution of the speed data in a target report should be better than 1 m/s.	The target report velocity resolution should be: • Speed: 1m/s	ED-87B §3.2.3	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Perf_SURV-07 Reported Direction Resolution	The resolution of the direction of movement data in a target report should be better than 1.5°.			
Perf_SURV-08 Aircraft Level Accuracy	For an airborne aircraft, the accuracy of the target measured height, if transmitted from the SDF to clients, should be 10 m or better at a confidence level of 95%.	Where airborne traffic participates in the A-SMGCS, the level of an aircraft when airborne should be determined within ±10m.	SURV_Perf-04 [ICAO §4.2.3]	i.e. approximately ± $^{1}/_{3}$ FL
Velocity Range				
Perf_SURV-09 Velocity Range	The surveillance equipment should be capable of detecting and tracking targets within the following velocity ranges: • 0 to 250 kt for aircraft on final approach, missed approach and runways • 0 to 80 kt for aircraft on runway exits • 0 to 80 kt for vehicles on the movement area • 0 to 50 kt for aircraft on straight taxiways • 0 to 20 kt for aircraft on taxiway curves • 0 to 10 kt for aircraft on stands and stand taxi lanes • Any direction of movement.	The A-SMGCS should be able to accommodate the following speeds determined to within ± 2 km/h (1 kt): a) 0 to 93 km/h (50 kt) for aircraft on straight taxiways; b) 0 to 36 km/h (20 kt) for aircraft on taxiway curves; c) 0 to 150 km/h (80 kt) for aircraft on runway exits; d) 0 to 460 km/h (250 knots) for aircraft on final approach, missed approach and runways; e) 0 to 150 km/h (80 kt) for vehicles on the movement area; and f) 0 to 20 km/h (10 kt) for aircraft and vehicles on stands and stand taxi lanes.	GEN_Perf-03 [ICAO §4.1.1.8]	ICAO provides no rationale for the 1kt accuracy requirement, which seems unnecessarily stringent and is not consistent with the surveillance position accuracy and update rate requirements. It may be useful for the pilot/driver to know own aircraft/vehicle speed with such accuracy, but for the controller it is not important. [ED-87B] requires Reported Velocity Accuracy < 5m/s (10 kt), which is more realistic.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
		The A-SMGCS should accommodate all aircraft and vehicle speeds that will be used within the coverage area with sufficient accuracy.	SURV_Perf-02 [ICAO §4.1.1.7]	
Update Rate				
Perf_SURV-10 Update Rate	An updated target report should be transmitted from the SDF to the clients at least once per second for each target.	The position and identification data of aircraft and vehicles should be updated at least once per second.	SURV_Perf-05 [ICAO §4.2.4]	With current technology, it is not possible to achieve an update rate of once per second for identification of stationary aircraft. This is because the on-board Mode S transponder automatically selects 'low squitter rate' (4.8s - 5.2s) when the aircraft is stationary on the ground. The use of multiple sensors will ensure an update rate of at least once per second for position data, but there is currently only one source for identification data (i.e. the aircraft's transponder).
Perf_SURV-11	Spare			
Data Integrity				
Perf_SURV-12 Probability of Detection	The probability that each actual aircraft, vehicle or object is detected and reported at each update at the output of the SDF should be 99.9% at minimum.	The probability that each actual aircraft, vehicle or object is detected and reported at each update at the output of the Data Fusion should be 99.9% at minimum.	ED-87B §3.2.3 [SURV_Perf-01a ICAO §3.4.1.4.a]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Perf_SURV-13 Probability of False Detection	The probability that anything other than an actual aircraft, vehicle or object is detected and reported at the output of the SDF should not exceed 10E-3 per reported target.	The probability that anything other than an actual aircraft, vehicle or object is detected and reported at the output of the data fusion should not exceed 10E-3 per reported target.	ED-87B §3.2.3 [SURV_Perf-01b ICAO §3.4.1.4.b]	
Perf_SURV-14 Probability of Identification	The probability that the correct identity of a cooperative aircraft, vehicle or object is reported at the output of the SDF should be 99.9% at minimum.	The probability that the correct identity of an aircraft, vehicle or object is reported at the output of the surveillance element should be 99.9% at minimum.	ED-87B §3.2.3 [SURV_Perf-01c ICAO §3.4.1.4.c]	This requirement applies only to cooperative targets.
Perf_SURV-15 Probability of False Identification	The probability that the identity reported at the output of the SDF is not the correct identity of the actual aircraft, vehicle or object, should not exceed 10E-3 per reported target.	The probability that the identity reported at the output of the surveillance element is not the correct identity of the actual aircraft, vehicle or object, should not exceed 10E-3 per reported target.	ED-87B §3.2.3 [SURV_Perf-01d ICAO §3.4.1.4.d]	
Perf_SURV-16	Spare			
ADS-B Ground Station				
Perf_SURV-17 ADS-B Latency	The delay between the Mode S signal reception and outputting the target report from the ADS-B Ground Station should not exceed 0.25 seconds.			Based on MLAT requirement.
Perf_SURV-18 ADS-B Capacity	The ADS-B Ground Station should be able to support 500 targets at a time creating one target report per target at least once per second.			Based on MLAT requirement.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Perf_SURV-19 Probability of Correct Position	For a target that correctly transmits its position, the ADS-B Ground Station should extract and provide the correct target position with a probability of better than 99.9%.	The MLAT system should detect and calculate a position for each active Mode S transponder on runways and taxiways within any two-second period with a probability of detection better than 99.9%.	ED-117 §3.3.4	MLAT parent requirement proposed for ADS-B by EMMA2.
Perf_SURV-20 Probability of Correct Identity	For a target that correctly transmits its identity, the ADS-B Ground Station should extract and provide the correct target identity with a probability of better than 99.9%.	The MLAT system should provide the correct target identity with a probability of better than 99.9%.	ED-117 §3.3.5	MLAT parent requirement proposed for ADS-B by EMMA2.
Perf_SURV-21 Probability of False Report	The probability of the ADS-B Ground Station outputting False Targets should be less than 10^{-4}.	The probability of the MLAT system outputting False Targets should be less than 10^{-4}.	ED-117 §3.3.10	MLAT parent requirement proposed for ADS-B by EMMA2.
Perf_SURV-22 Probability of False Identity	The probability that the ADS-B Ground Station incorrectly identifies a target that correctly transmits its identity should be less than 10^{-6} over any 5-second period per target.	The probability that the MLAT system incorrectly identifies a target that correctly announces its identity should be less than 10^{-6} over any 5-second period per target.	ED-117 §3.3.11	MLAT parent requirement proposed for ADS-B by EMMA2.
TIS-B Ground System				
Perf_SURV-23 TIS-B Latency	The delay between the target report reception from the SDF and outputting the target report from the TIS-B Ground System should not exceed 0.25 seconds.	The TIS-B Ground System should meet or exceed the latency requirements of the associated applications.	DO-286 §2.5-01	
Perf_SURV-24 TIS-B Capacity	The TIS-B Ground System should be able to support 500 targets at a time at an update rate of once per second.	The TIS-B Ground System should be capable of meeting the capacity requirements in DO-242A §3.3.4.	DO-286 §2.6-01	

Table 4-2: Performance Requirements for Surveillance

4.6.3 Interface Requirements

Surveillance data exchange should use the ASTERIX data format. ASTERIX is a data format originally developed as an efficient means of packaging radar data for transmission over narrow-band communication links such as analogue telephone lines. In Europe and elsewhere, the ASTERIX category 001 is widely used for en-route and approach surveillance radars. Categories 034 and 048 are successors to Category 001. Existing air surveillance systems at airports will provide target reports to the A-SMGCS in one of these ASTERIX Categories, or in one of a number of different national or proprietary formats. Some of the proprietary formats are ASTERIX-like, but not fully compatible with any of the existing ASTERIX categories.

Surveillance sensor systems, such as SMR and MLAT, which are specifically intended for airport surface movement applications, should use the ASTERIX Category 010 standard.

ASTERIX Category 011 or the newer Category 062 should be used as the data format for exporting data-fused A-SMGCS surveillance data to other users.

The following table lists interface requirements for the Surveillance function.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Data Sources				
Intf_SURV-01	The equipment should interface to a flight data processing system of the ATM at the airport. In some cases, it may also be necessary to interface to a separate code-callsign database.	See below.		
Intf_SURV-02	To receive data on airborne aircraft in the vicinity, the A-SMGCS surveillance equipment should be interfaced to the approach surveillance system at the airport.			
Intf_SURV-03	The equipment should interface to a processing system of the airport to obtain stand information regarding aircraft about to land or depart.			

<table>
<tr><th>EMMA
Req. No.</th><th>Requirement</th><th>Parent Requirements</th><th>Source
Reference</th><th>Comment</th></tr>
<tr><td>Intf_SURV-04</td><td>If necessary to achieve the required performance, the equipment should interface to a MET system to obtain meteorological data.</td><td rowspan="3">In order to fully benefit from an A-SMGCS by all parties concerned, the system should be capable of interfacing with the following:
a) air traffic management (ATM), including:
• arrival and departure management;
• arrival and departure coordination;
• optimized start-up sequence and times;
• optimized push-back sequence and times; and
• integrated initial FDPS, CFMU, etc.;
b) aerodrome management systems;
c) existing and future ATS systems;
d) meteorological systems;
e) visual aids;
f) existing and future avionics;
g) aerodrome handling systems;
h) aircraft operators;
i) emergency authorities;
j) police/security authorities; and
k) other customers or users.</td><td rowspan="3">GEN_Serv-21
[ICAO §2.6.16.1]</td><td rowspan="3"></td></tr>
<tr><td>Intf_SURV-05</td><td>To obtain information about the status of stop bar lights, the equipment should interface to the aerodrome ground lighting system.</td></tr>
<tr><td>Intf_SURV-06</td><td>The equipment should be capable of interfacing to any other system specified by the local authority.</td></tr>
<tr><td>Intf_SURV-07</td><td>Cooperating mobiles should be adequately equipped to communicate their position, identity, and other relevant data to the A-SMGCS.</td><td>Any authorised vehicle intended to be used on the aerodrome, in the vicinity of the manoeuvring area, should be equipped to inform an A-SMGCS of its position.</td><td>ICAO §2.6.3.2</td><td></td></tr>
<tr><td>Intf_SURV-08</td><td>Spare</td><td></td><td></td><td></td></tr>
</table>

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Data Communication Protocols				
Intf_SURV-09 General Requirements	The Surveillance function should comply with the general interface requirements given in section 3.3.			
Data Formats				
Intf_SURV-10 Position Report Data Format	Target position reports output from surveillance sensor systems should be in the ASTERIX data format.		ED-87B §2.5.1.1	
Intf_SURV-11 SMR Data Format	The SDF should be able to receive input target report data from SMR and other non-cooperative ground sensor systems in the ASTERIX CAT010 data format.	The data interchange with non-cooperative surveillance sensors should be performed in a standardized format in order to ensure an adequate exchange of information. *(ED-87B: ASTERIX will be the standard to be used for surveillance data.)*	ED-87B §2.5.1.1 [ICAO §2.6.16.2]	
Intf_SURV-12 MLAT Data Format	The SDF should be able to receive input target report data from MLAT and other cooperative ground sensor systems in the ASTERIX CAT010 data format.	The data interchange with cooperative surveillance sensors should be performed in a standardized format in order to ensure an adequate exchange of information. *(ED-87B: ASTERIX will be the standard to be used for surveillance data.)*	ED-87B §2.5.1.1 [ICAO §2.6.16.2]	
Intf_SURV-13 RDPS Data Format	The SDF should be able to receive input target report data from approach radar systems in the ASTERIX CAT001, CAT 034, and CAT048 data formats, in accordance with local requirements.	The data interchange with approach RDPS should be performed in a standardized format in order to ensure an adequate exchange of information. *(ED-87B: ASTERIX will be the standard to be used for surveillance data.)*	ED-87B §2.5.1.1 [ICAO §2.6.16.2]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Intf_SURV-14 SDF Output Data Format	The output data of the SDF should be in the ASTERIX CAT011 or CAT062 data format.	The data interchange with ground systems should be performed in a standardized format in order to ensure an adequate exchange of information. ASTERIX will be the standard to be used for surveillance data.	ED-87B §2.5.1.1 [ICAO §2.6.16.2]	
Intf_SURV-15 Clients	It should be possible to route the output data of the surveillance data fusion to pre-defined clients.			
Intf_SURV-16 Data Decoding	Client processes using the surveillance data should be able to receive and decode data in the ASTERIX CAT011 or CAT062 data format.			
Intf_SURV-17	Spare			
ADS-B Ground Station				
Intf_SURV-18 ADS-B Data Format	The ADS-B Ground Station should output target report data to the SDF via LAN using the ASTERIX CAT010 or CAT021 data formats.			

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Intf_SURV-19 ADS-B Service Message	The ADS-B Ground Station should output a periodic service message to the SDF at a rate of once per second. As a minimum, the system should report 3 types of status: operational, degraded and NOGO. At a minimum, the message should contain the following ASTERIX CAT010 or CAT023 data fields: • Message Type • Data Source Identifier • Time of Day • System Status			
Intf_SURV-20 ADS-B Time Synchronisation	The ADS-B Ground Station should be capable of interfacing with the A-SMGCS time reference using the Network Time Protocol (NTP) for the purpose of time synchronisation.			
TIS-B Ground Station				
Intf_SURV-21 TIS-B Data Format	The TIS-B Ground Station should interface to the SDF and receive target report data via LAN in the ASTERIX CAT011 or CAT062 data format.			
Intf_SURV-22	Spare			
Intf_SURV-23 TIS-B Time Synchronisation	The TIS-B Ground Station should be capable of interfacing with the A-SMGCS time reference using the Network Time Protocol (NTP) for the purpose of time synchronisation.			

Table 4-3: Interface Requirements for Surveillance

5 Control

5.1 Architecture

The Control function should consider traffic information and traffic context information as input data, and generate C/I alert when a predefined Conflict/Infringement situation is detected according to a predefined scenario.

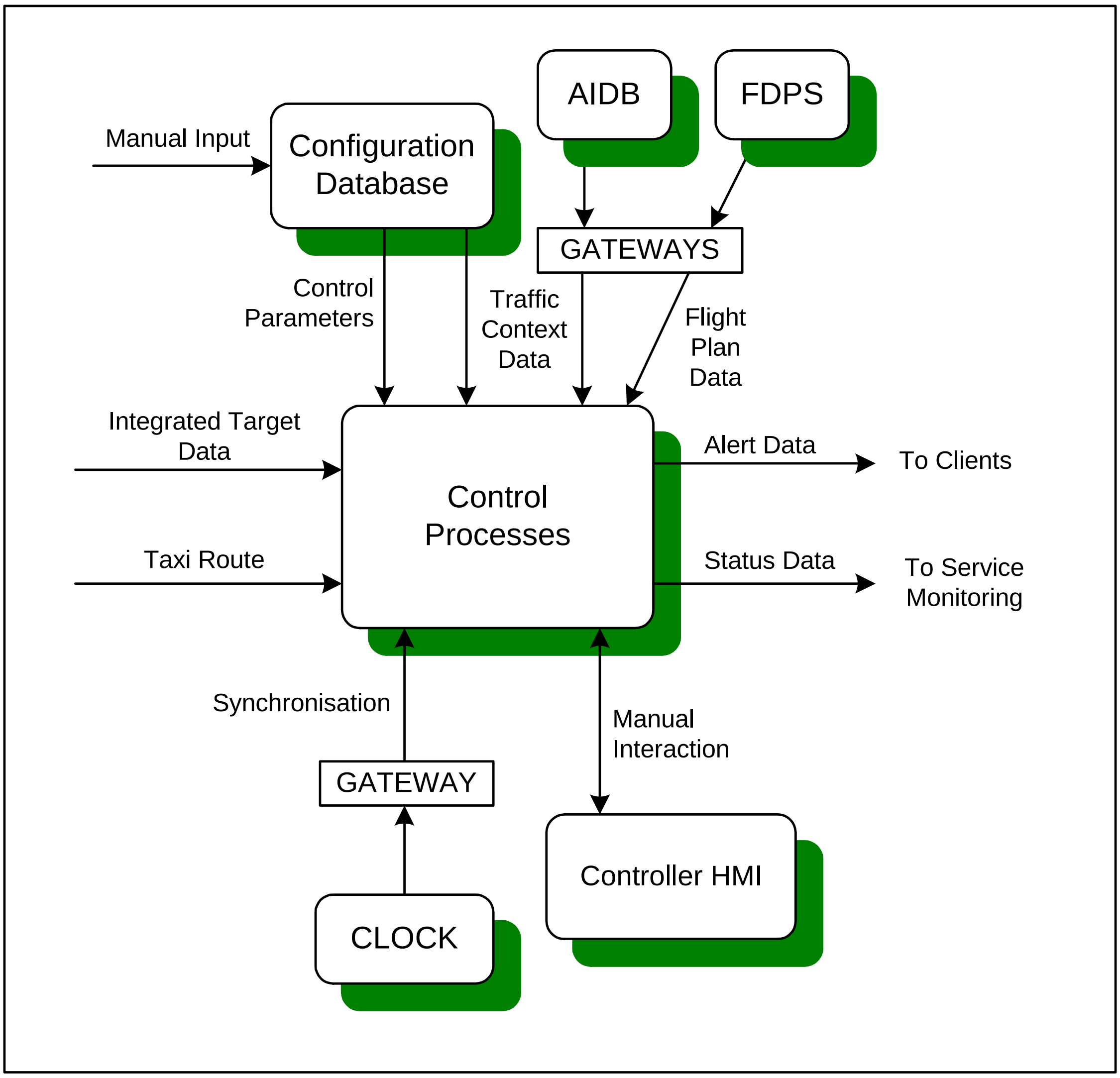

Figure 5-1: Control Function Architecture

The inputs to the Control function should be traffic situation information in the form of integrated target data output from the SDF, and a set of alerting parameters, traffic context data and rules from the supporting Configuration Database [Chapter 9]. The traffic context data should include topological maps of areas to be monitored.

At higher levels of implementation, clearances and assigned routes will need to be input from the Routing/Planning function where applicable for route conformance monitoring.

Outputs from the Control function should be routed to various client systems including the Controller HMI and the Routing/Planning and Guidance functions.

The Control function should provide alerts and adequate information about each alert situation to controller(s) involved.

Control processes should be synchronised to the airport reference clock. Alert messages and status messages should be time stamped.

5.2 Control Function Requirements

In this section are listed the technical requirements related to the Control function of the A-SMGCS. These requirements are valid for all implementations of A-SMGCS requiring a conflict alert service. The majority of the parent requirements have been derived from the referenced EUROCAE ED87B [7] and ICAO Doc 9830 [14] documents.

The requirements are divided into three subsections: Functional, Performance and Interface Requirements, with associated identifiers Func_CONT-nn, Perf_CONT-nn and Intf_CONT-nn, where nn is a two-digit number.

For traceability, requirements include references to all parent operational requirements listed in the SPOR document [2] and, where applicable, to other sources. The ICAO A-SMGCS Manual (Doc 9830) [14] is the prime source of the parent requirements.

5.2.1 Functional Requirements

The following table lists functional requirements for the Control function.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Basic Functions				
Func_CONT-01	The Control function should continuously process the target reports from the SDF to compare the traffic situation in real time with a set of predefined alert situations.	The control function of an A-SMGCS should detect conflicts and provide resolutions.	ALERT_Serv-01 [ICAO §2.5.4.1.c]	EMMA2 ATCOs do not want the A-SMGCS to provide resolution directly to aircraft and vehicles.
Func_CONT-02	The Control function should output an alert report to clients whenever a predefined alert situation occurs.			

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Alert Situations				
Func_CONT-03 Conflict on Runway	The Control function should detect any predefined conflict situation on the runway and generate a timely conflict alert report.	The Control function of an A-SMGCS should provide alerts for incursions onto runways and activate protection devices.	ALERT_Serv-02 [ICAO §2.5.4.1.e]	
		Short-term alerts should be provided by the A-SMGCS within enough time to enable the appropriate remedial action when the predicted spacing will be below preset/predefined minima.	ALERT_Serv-07a [ICAO §2.5.4.3.a]	There are currently no surface movement separation minima defined by ICAO.
Func_CONT-04 Runway Incursion	The Control function should detect whenever a target crosses any predefined runway strip ground boundary and generate an incursion alert report.	The function should provide runway incursion alert, whereby an alert is triggered when a movement likely to enter an active runway (runway strip) is detected.	ALERT_Serv-07d [ICAO §2.5.4.3.d]	”Unauthorised movement entering” would be more appropriate than “movement likely to enter”.
		The A-SMGCS should detect any incursion into areas used for aircraft movement and the runway strips, and within any designated protected area as required by airport authorities.	ICAO §2.5.1.7	
Func_CONT-05 Configurability	The conflict situations should be configurable from the Configuration Database [9.1.1].			
Func_CONT-06 Runway Protection Area	The runway strip boundaries should be configurable from the Configuration Database [9.1.1].	The runway protection area should be composed of two boundaries: a ground boundary to detect the aircraft/vehicles on the surface, an air boundary to detect airborne aircraft.	ALERT_Serv-12 [ECTL D6]	
Func_CONT-07 Ground Boundary	The length of the ground boundary should at least include the runway strip. The width of the ground boundary should be defined differently according to good/poor visibility conditions.	The length of the ground boundary should at least include the runway strip. The width should be defined differently according to the meteorological conditions.	ALERT_Serv-13 [ECTL D6]	

<table>
<tr><th>EMMA
Req. No.</th><th>Requirement</th><th>Parent Requirements</th><th>Source Reference</th><th>Comment</th></tr>
<tr><td>Func_CONT-08
Air Boundary</td><td>The air boundary should be defined as a flight time to threshold and take into account the two stages of alert, INFORMATION and ALARM, as well as the visibility conditions:</td><td>The air boundary should be defined as a flight time to threshold and would take into account the two stages of alert, INFORMATION and ALARM, as well as the meteorological conditions:
• Non-LVP:
INFORMATION around T1 = 30s
ALARM around T2 = 15s
• LVP:
INFORMATION around T1 = 45s
ALARM around T2 = 30s.</td><td>ALERT_Serv-14
[ECTL D6]</td><td></td></tr>
<tr><td>Func_CONT-09
Traffic Context</td><td>The Control function should make use of relevant traffic context information received from the Configuration Database [9.1.1] and/or from the Controller HMI [8.3.1].</td><td>For the conflict/infringement detection, additional updated and correct traffic context information should be provided to the system such as:
• Airport configuration: runways in use, runways status, restricted areas
• Applied procedures and working methods: LVP, multiple line-ups.</td><td>ALERT_Serv-15
[ECTL D6]</td><td></td></tr>
<tr><td rowspan="2">Func_CONT-10
Protected Area Incursion</td><td rowspan="2">The Control function should detect whenever a target enters any predefined protected area and generate a protected area alert report.</td><td>The control function of an A-SMGCS should provide alerts for incursions into critical and sensitive areas established for radio navigation aids.</td><td>ALERT_Serv-04
[ICAO §2.5.4.1.g]</td><td></td></tr>
<tr><td>The control function of an A-SMGCS should provide alerts for incursions into emergency areas.</td><td>ALERT_Serv-05
[ICAO §2.5.4.1.h]</td><td></td></tr>
</table>

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
		The control function of an A-SMGCS should provide alerts for incursions onto taxiways and activate protection devices	ALERT_Serv-03 [ICAO §2.5.4.1.f]	
Func_CONT-11 Protected Area Configuration	The protected areas should be configurable from the Configuration Database [9.1.1].			
Func_CONT-12 Restricted Area Incursion	The Control function should detect whenever an aircraft target enters any predefined restricted area and generate a restricted area alert report. Targets other than aircraft targets should not trigger the alert.	The function should provide area penetration alert, whereby an alert is triggered when a movement likely to enter a critical or restricted area is detected.	ALERT_Serv-07b [ICAO §2.5.4.3.b]	”Unauthorised movement” would be more appropriate.
Func_CONT-13 Restricted Area Configuration	The restricted areas should be configurable from the Configuration Database [9.1.1].			
Func_CONT-14 Route Deviation	Once a route has been assigned to a mobile, and the mobile has started on that route, the Control function should detect when the target begins to deviate from that route by more than a predefined distance and generate a deviation alert report.	The function should provide deviation alert, whereby an alert is triggered when the computed deviation will be more than preset/predefined maximum deviation.	ALERT_Serv-07c [ICAO §2.5.4.3.c]	
		The function should provide taxiway (or an inactive runway being used as a taxiway) or an apron incursion alert, whereby an alert is triggered when a movement likely to enter a taxiway or apron in use, which does not belong to the assigned route, is detected.	ALERT_Serv-07e [ICAO §2.5.4.3.e]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_CONT-13 Deviation Configuration	The deviation limit should be configurable from the Configuration Database [9.1.1].			
Func_CONT-14	Spare			
Stages of Alert				
Func_CONT-15 Alert Stages	Conflict alerts should be configurable in two stages (1 and 2) according to the severity of the situation. Stage 2 (ALARM) is more severe than Stage 1 (INFORMATION).	The conflict prediction, detection and alerting service should provide 2 stages of alert: Stage 1 alert is used to inform the controller that a situation which is potentially dangerous may occur that he/she needs to be made aware of. According to the situation, the controller receiving a Stage 1 alert may take a specific action to resolve the alert if needed. This is called the INFORMATION step. Stage 2 alert is used to inform the controller that a critical situation is developing which needs immediate action. This is called the ALARM step.	ALERT_Serv-16 [ECTL D6]	
Func_CONT-16 Alert Stage Configuration	Incursion alerts, restricted area alerts and deviation alerts should be configurable from the Configuration Database [9.1.1] as either Stage 1 or Stage 2 according to local requirements at the airport.			Controllers have different preferences; some of them want to be alerted only when the situation is critical (only Stage 2 alerts), others wish more anticipation (2 stages of alert).

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_CONT-17	T.b.d.	Distinctive medium-term alerts should be provided well in advance to enable the appropriate remedial action to be taken with respect to: a) Conflict prediction; b) Conflict detection; and c) Conflict resolution	ALERT_Serv-08 [ICAO §2.5.4.4]	This OR is imprecise. Needs clarification.
Alert Reports				
Func_CONT-18 Alert Report	As a minimum, each alert report transmitted from the Control function to clients should include the following information: • Data Source Identifier • Alert Report Identifier • Type of alert (runway, taxiway, apron, etc.) • Alert severity level • Time of Alert • Identity of target(s) in alert situation	The output of an alert report which may be used by the HMI should at least include: • Data Source Identifier • Alert Report Identifier • Type of alert • Alert severity level • Time of alert • Identity of target(s) in alert situation	ED-87B §2.5.1.2	
		Priorities should be established so as to ensure system logic performs efficiently. Conflict alerting priorities should be as follows: a) Runway conflicts b) Taxiway conflicts c) Apron/stand/gate conflicts.	ALERT_Serv-17 [ICAO 3.4.5.10]	ALERT_Serv-17 modified to ICAO wording
Func_CONT-19 Alert Continuity	An alert report should be transmitted for each target position update for as long as the alert situation persists.	The information should be displayed continuously while the conflict is present	ALERT_Serv-09 [ICAO §3.4.5.14]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
		Conflict information should be unambiguously displayed on a surveillance display or by other appropriate means	ALERT_Serv-10 [ICAO §3.4.5.14]	Refer to Controller HMI section 8.3.1.
Conflict Resolution				
Func_CONT-20 Conflict Resolution	T.b.d.	Once a conflict has been detected, an A-SMGCS should either automatically resolve the conflict or, on request from the controller, provide the most suitable solution.	RESOL_Serv-01 [ICAO §2.5.4.5]	EMMA2 ATCOs are not in favour of automatic conflict resolution.
		The ATCO should remain the supreme authority to resolve a conflict situation	RESOL_Serv-02 [SPOR §2.1.2.1.2]	
		A prerequisite for a reasonable and efficiently working automatic support is that the conflict resolution function is provided with at least all traffic information the ATCO is aware of.	RESOL_Serv-03 [SPOR §2.1.2.1.2]	

Table 5-1: Functional Requirements for Control

5.2.2 Performance Requirements

The following table lists performance requirements for the Control function.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Data Integrity				
Perf_CONT-01 Probability of Detection of Alert Situation	The probability of detection of an alert situation should be greater than 99.9%	The probability of detection of an alert situation should be greater than 99.9%	ED-87B §3.3.3 [ICAO §4.5.1]	
Perf_CONT-02 Probability of False Alert	The probability of false alert should be less than 10E-3.	The probability of false Alert should be less than 10E-3.	ED-87B §3.3.3 [ICAO §4.5.1]	Note: The false alerts rate should be evaluated in all weather conditions.
		The number of false alerts should be sufficiently low to meet local safety objectives and to ensure that users do not, consciously or sub-consciously, downgrade the importance of alerts.	ED-87B §3.3.2.3	
Timeliness				
Perf_CONT-03 Alert Response Time	Having received the target report from the surveillance element, the time taken for the Control function to detect and report any alert situation should be not more than 0.5 s.	Delays due to the control service should be kept small compared to other delays in the system, particularly with regard to human action, aircraft braking times, etc. In the absence of a specific operational requirement, the proposed minimum performance figure for the ART should be 0.5s	ED-87B §3.3.2.4 [ICAO §4.5.2]	

Table 5-2: Performance Requirements for Control

5.3 Interface Requirements

The following table lists interface requirements for the Control function.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Data Communication Protocols				
Intf_CONT-01 General Requirements	The Control function should comply with the general interface requirements given in section 3.3.			
Data Format				
Intf_CONT-02 Target Report Data Format	The Control function should be able to receive input target report data from the SDF in the ASTERIX CAT011 or CAT062 data format.			
Intf_CONT-03 Alert Report Data Format	Alert reports output from the Control function systems should be in the ASTERIX CAT011 or CAT004 data format.			

Table 5-3: Interface Requirements for Control

6 Routing/Planning

The EMMA2 Routing/Planning function should provide tools to assist the controller in assigning a taxi route for each aerodrome movement and providing sequencing and timing for each departure aircraft.

With these tools, EMMA2 will try to show that the predictability and reliability of departures will improve.

Transmission of a route to an aircraft or vehicle, by whatever means, is considered in EMMA2 to be a part of the Guidance function, which is described in Chapter 7.

6.1 Architecture

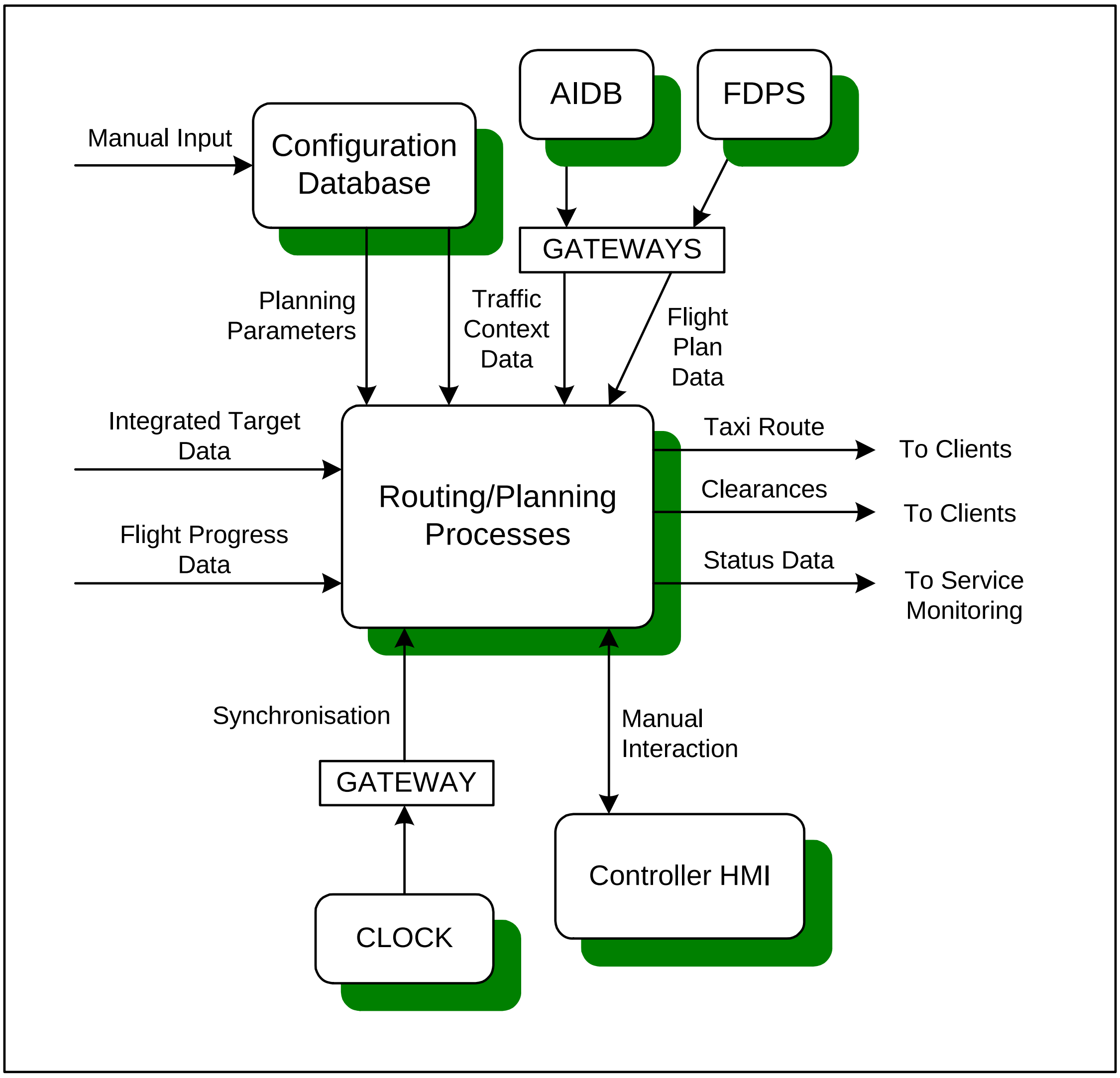

Figure 6-1: Routing/Planning Function Architecture

The inputs to the Routing/Planning function will be traffic situation information in the form of integrated target data and flight progress data output from the SDF, and a set of planning parameters, traffic context data and rules from the supporting Configuration Database [Chapter 9]. The traffic context data should incorporate a model of the aerodrome movement area.

Flight plans could be obtained either as part of the integrated target data or directly from the airport's Flight Plan Data Processing System (FDPS).

From these sources, the Routing/Planning function should be able to obtain information about the:

- Start point (e.g. the stand for a departure; the runway exit taken by an arriving aircraft)
- End point (e.g. the allocated stand for an arrival; the assigned runway entry point for a departure)
- Intermediate waypoints (e.g. de-icing, temporary parking positions, holding positions)
- Local standard routes
- Local taxi restrictions (closed or restricted-use taxiways, restricted areas)
- Meteorological restrictions (i.e. low visibility condition, de-icing requirements)
- Type of aircraft
- Wake vortex category
- Obstacles and temporary hazards
- ETA, ATA (for Arrivals)
- CTOT, ETD or EOBT (for Departures)
- Standard Departure Route (SID)
- Separation minima
- Runway(s) in operational use (including mixed-mode or single-mode)
- Prioritised flights

The most advanced systems should provide continuously updated routing and timing information, whereby the Routing/Planning function computes the path to be taken and the time needed to perform the movement.

Outputs from the Routing/Planning function should be the proposed taxi route and timing for each movement. The outputs should be transmitted to client systems, which will include the Controller HMI and the Control and Guidance functions. The controller should be given the means to modify a taxi route or choose a different route before the route is assigned to a movement.

A further enhancement would be to provide the Controller with a departure management (DMAN) tool that provides optimal off-block times and optimal take-off times for all flights and an optimal take-off sequence taking into account arrivals, wake vortex categories, CFMU slot, and SID. The purpose of the departure management tool is to:

- Assist the controllers to achieve maximum runway capacity
- Maximise slot compliance
- Minimise taxi-out delays.

A departure management tool will need accurate estimations of taxi times for its calculations. Taxi times could be internal parameters of the tool, established in off-line configuration, or they could be obtained from an additional planning process.

All Routing/Planning processes should be synchronised to the airport reference clock.

6.2 Routing/Planning Function Requirements

In this section are listed the technical requirements related to the Routing/Planning function of the A-SMGCS. These requirements are valid at higher levels of implementation of an A-SMGCS.

The requirements are divided into three subsections: Functional, Performance and Interface Requirements, with associated identifiers Func_ROUT-nn, Perf_ROUT-nn and Intf_ROUT-nn, where nn is a two-digit number.

For traceability, requirements include references to all parent operational requirements listed in the SPOR document [2] and, where applicable, to other sources. The ICAO A-SMGCS Manual (Doc 9830) [14] is the prime source of the parent requirements.

6.2.1 Functional Requirements

The following table lists functional requirements for the Routing/Planning function.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Routing Function				
Func_ROUT-01 Routing Capability	The Routing/Planning function of an A-SMGCS should be able to designate a taxi route for each aircraft or vehicle within the movement area based on: • Starting point (start-point) • Destination point (end-point) • Aerodrome configuration	Either manually or automatically, the routing function of an A-SMGCS should be able to designate a route for each aircraft or vehicle within the movement area.	ROUT_Serv-01 [ICAO §2.5.2.1a]	
Func_ROUT-02 Destination Change	Either manually or automatically, the Routing/Planning function should allow for a change of destination at any time.	Either manually or automatically, the routing function of an A-SMGCS should allow for a change of destination at any time.	ROUT_Serv-02 [ICAO §2.5.2.1b]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_ROUT-03 Route Change	Either manually or automatically, the Routing/Planning function should allow for a change of a route to the same end-point at any time.	Either manually or automatically, the routing function of an A-SMGCS should allow for a change of a route.	ROUT_Serv-03 [ICAO §2.5.2.1c]	
Func_ROUT-04 Routing Capability	The Routing/Planning function should be capable of meeting the needs of dense traffic at complex aerodromes.	The routing function of an A-SMGCS should be capable of meeting the needs of dense traffic at complex aerodromes.	ROUT_Serv-04 [ICAO §2.5.2.1d]	
Func_ROUT-05 Runway Exit	The Routing/Planning function should not constrain the pilot's choice of a runway exit following the landing.	The routing function of an A-SMGCS should not constrain the pilot's choice of a runway exit following the landing.	ROUT_Serv-05 [ICAO §2.5.2.1e]	
Func_ROUT-06 Runway Exit	For a given aircraft type, a given runway and a given taxi route end-point or waypoint, the Routing/Planning function should provide the optimal runway exit that the aircraft should use to exit the runway after landing.			
Func_ROUT-07 Provision of Routing Information	For vehicles, the Routing/Planning function should be capable of providing a route to areas outside of the movement area, if necessary.	The routing function should be capable of providing routing information for aircraft and vehicles on the movement area and, when necessary, other areas used by vehicles.	ROUT_Serv-15 [ICAO §3.4.2.2]	
Func_ROUT-08 Modes of Operation	The Routing/Planning function should have three modes of operation: Manual, Semi-Automatic and Automatic.	A routing function should enhance efficiency, particularly at complex aerodromes. In these situations, and when traffic density is heavy, some form of routing function automation may be needed.	ICAO §3.4.2.1	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
		The route will be chosen from those proposed by the tactical plan if available, or from predetermined routes, or, if none of these selections suits the actual needs of the ground movement situation, the route will then be calculated by the system.	ICAO §3.5.8.3	
Func_ROUT-09 Manual Routing	In Manual mode, the Routing/Planning function should provide the user with a means to select or construct a taxi route between a given start-point and a given end-point and assign it to a movement.	In a manual routing mode, the routing function should be able to compute a valid taxi route between a given start-point and a given end-point taking into account local standard routes.	ROUT_Serv-06 [SPOR §2.1.3.1.1]	
Func_ROUT-10 Semi-Automatic Routing	In Semi-Automatic mode, the Routing/Planning function should propose an optimal taxi route. The user should then be able to assign the proposed taxi route or modify it prior to assignment.	In a semi-automatic mode, the routing function should also provide the control authority with advisory information on designated routes.	ROUT_Serv-07 [ICAO §2.5.2.2]	
Func_ROUT-11 Automatic Routing	In Automatic mode, the Routing/Planning function should be capable of computing and assigning routes automatically.	In an automatic mode, the routing function should also: a) Assign routes; and b) Provide adequate information to enable manual intervention in the event of a failure or at the discretion of the control authority	ROUT_Serv-08 [ICAO §2.5.2.3]	
Func_ROUT-12 Manual Intervention	In Automatic mode, the Routing/Planning function should permit manual intervention (reverting to Semi-Automatic mode). The user should be able to visualise the taxi route, modify it and assign the new route manually.			
		ATC must be able to monitor automatically allocated routing instructions and be able to intervene with re-routing instructions.	ICAO §3.5.13.9	
Func_ROUT-13	Spare			

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_ROUT-14 Taxi Distance	In Semi-Automatic and Automatic modes, the Routing/Planning function should seek to minimise taxi distances in accordance with current constraints that are known to the function.	When assigning routes, an A-SMGCS should minimise taxi distances in accordance with the most efficient operational configuration.	ROUT_Serv-09 [ICAO §2.5.2.4a]	Minimising the taxi distance should also minimise the taxi time, provided there are no obstructions on the route.
Func_ROUT-15 Conflict-free Routes	In Semi-Automatic and Automatic modes, the Routing/Planning function should seek to minimise crossing conflicts by taking account of taxi routes already assigned.	When assigning routes, an A-SMGCS should be interactive with the control function to minimise crossing conflicts.	ROUT_Serv-10 [ICAO §2.5.2.4b]	
Func_ROUT-16 Operational Changes	In Semi-Automatic and Automatic modes, the Routing/Planning function should be able to receive traffic context information and respond to operational changes, such as: • Runway in use • Taxiways closed • Temporary hazards or obstacles • Meteorological conditions	When assigning routes, an A-SMGCS should be responsive to operational changes (e.g. runway changes, routes closed for maintenance, and temporary hazards or obstacles).	ROUT_Serv-11 [ICAO §2.5.2.4c]	
Func_ROUT-17 Standard Terminology	The Routing/Planning function should use standardised terminology or symbology.	When assigning routes, an A-SMGCS should use standardised terminology or symbology.	ROUT_Serv-12 [ICAO §2.5.2.4d]	
Func_ROUT-18 Performance	The Routing/Planning function should be capable of providing taxi routes as and when required, in accordance with the performance requirements in section 6.2.2.	An A-SMGCS should be capable of providing routes as and when required by authorised users.	ROUT_Serv-13 [ICAO §2.5.2.4e]	
Func_ROUT-19 Route Validation	In Semi-Automatic and Automatic modes, the Routing/Planning function should provide a means of validating taxi routes.	An A-SMGCS should provide a means of validating routes.	ROUT_Serv-14 [ICAO §2.5.2.4f]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_ROUT-20 Route Optimisation	In Semi-Automatic and Automatic modes, the Routing/Planning function should compute an optimised taxi route for each movement, taking into account the overall time needed for the mobile to complete the route under the current meteorological conditions.	The routing function should provide an optimised route for each participating aircraft and vehicle. It should consider the overall time for an aircraft or vehicle to complete the route in all visibility conditions.	ROUT_Serv-16 [ICAO §3.4.2.3]	
Func_ROUT-21 Traffic Flow Optimisation	When computing a taxi route, the Routing/Planning function should take into account the following constraints: a) CTOT (or ETD) for departures and EIBT for arrivals, minimising average delays but, where possible, permitting an aircraft to meet its assigned take-off time or reach its allocated gate on time b) Wing-tip to wing-tip spacing between aircraft on parallel taxiways c) Longitudinal spacing when visibility becomes a factor, including jet blast and propeller / rotor wash d) Obstructed, unavailable or temporarily closed parts of the movement area (open/closed taxiway segments e) Taxi speeds (to reduce braking and acceleration, and fuel burn) f) Unidirectional taxiways g) Taxiways closed to certain aircraft	The routing function should optimise the traffic flow of aircraft and vehicle surface movements, including aircraft under tow, with respect to: a) Reducing delay – when planning a route, an effort should be made to permit an aircraft to meet its assigned take-off time or reach its allocated gate on time. b) Potential conflict; the wing-tip to wing-tip spacing between certain types of aircraft on parallel taxiways should be taken into account. c) Longitudinal spacing when visibility becomes a factor, including jet blast and propeller / rotor wash d) Obstructed, unavailable or temporarily closed parts of the movement area; and e) Taxi speeds (to reduce braking and acceleration, and fuel burn).	ROUT_Serv-17 [ICAO §3.4.2.4]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
		The ground movement planning will calculate different possible routes for each aircraft and vehicle taking into account the predicted capacities, gate/slot allocation, the minimum taxi times and delays.	ICAO §3.5.8.3	
Func_ROUT-22	Spare			
Func_ROUT-23 Intermediate Waypoints	When computing a taxi route, the Routing/Planning function should permit intermediate waypoints (e.g. routing through de-icing stations).	The routing function should be able to handle predefined or user defined intermediate waypoints (e.g. routing through de-icing stations).	ROUT_Serv-18 [ICAO §3.4.2.5]	
Func_ROUT-24 Alternative Route	The Routing/Planning function should permit the user to select an alternative taxi route.	An alternative route should always be available on request	ROUT_Serv-19 [ICAO §3.4.2.6]	
		When required the system must allow a manual input by ATC to select alternative routes to support a particular operational need.	ICAO §3.5.13.8	
Func_ROUT-25 Route Modification / Cancellation	In the event of a conflict being detected by the system, or by user intervention, it should be possible to cancel or change an already assigned taxi route.	By human-initiated means, or as a result of a conflict, it should be possible to cancel or change an existing and used route. In the event that a route is cancelled, a new route to continue should be provided.	ROUT_Serv-20 [ICAO §3.4.2.7]	
Func_ROUT-26 Re-routing	In Semi-Automatic and Automatic modes, in the event that a taxi route already assigned to an aircraft or vehicle is cancelled, the Routing/Planning function should provide a new taxi route to continue.			

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_ROUT-27 Aircraft Database	The Routing/Planning function should have access to a database of aircraft types, containing aircraft parameters relevant for the calculation of optimum taxi routes and departure sequencing.			
Func_ROUT-28 Vehicle Database	The Routing/Planning function should have access to a database containing details of vehicles authorised to drive on the airport movement area.			
Func_ROUT-29	Spare			
Departure Sequencing				
Func_ROUT-30 Role of Departure Management	The Routing/Planning function should include a Departure Management (DMAN) component to perform departure and start-up sequencing.	Surface traffic planning automation functions will be integrated with approach/departure operations. For departures, engine start and push-back times can be coordinated and managed to gain optimum departure sequencing, taking into account the planned route.	ICAO $1.3.12	Currently, there are only a few ICAO requirements relevant to a departure management tool.
Func_ROUT-31 Main Functions	The Departure Management component should have the following main functions: • Calculation of departure sequence(s) and departure times • Calculation of optimum Target Take-Off Time (TTOT) • Dynamic Constraint Handling for sequence constraints imposed by users.	The control function of an A-SMGCS should provide for sequencing of (aircraft after landing or) departing aircraft to ensure minimum delay and maximum utilisation of the available capacity of the aerodrome	ICAO §2.5.4.2 a)	ICAO describes sequencing as part of the Control function ($2.5.4.2). In this ATR, it is part of the Routing/Planning function. TTOT is the take-off time calculated by the Departure Management function.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_ROUT-32 Operational Status	The Departure Management component should maintain the association of an operational status with each arrival and departure.			
Func_ROUT-33 Sequence of Operational States	The Departure Management component should consider possible sequences of operational states.			
Func_ROUT-34 Duration of Operational States	The Departure Management component should consider the time durations of operational states.			
Func_ROUT-35 Aircraft Database	The Departure Management component should have access to a database of aircraft types, containing aircraft parameters relevant for the calculation of optimum departure sequencing, including: • Wake vortex weight class • Speed class • Engine type (propeller or jet).			
Func_ROUT-36 Queue Length	The Departure Management component should seek to minimise the queue length at the runway thresholds consistent with an optimal departure sequence taking into account wake vortex categories and other constraints.	The control function of an A-SMGCS should provide for spacing between aerodrome movements according to the prescribed minima, taking into account: • Wake vortex; • Jet blast and propeller/rotor wash; • Aircraft dimensions; and • Different locations and layouts (runway, taxiway, apron or aircraft stand).	ICAO §2.5.4.2 c)	There are currently no surface movement separation minima defined by ICAO.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_ROUT-37 Separation	The Departure Management component should ensure that required separation exists among all departures and between all departures and arrivals at all times.		ICAO $2.5.4.2	
Func_ROUT-38 Separation Times	The Departure Management component should consider minimum separation times between successive landing and takeoff operations.			
Func_ROUT-39	Spare			
Func_ROUT-40 Default SeparationParameters	The Departure Management component should use default constraint values to ensure that all valid separation rules are maintained in case of missing aircraft properties data.			
Func_ROUT-41 Wake Vortex Parameters	The Departure Management component should consider required wake vortex separation parameters between a leading and a following aircraft dependent on • Aircraft weight classes and in case of crossing runways • Whether both operations are performed on the same or on different runways.			
Func_ROUT-42 SID Separation Constraints	The Departure Management component should ensure that the optimum take-off schedule meets all SID separation constraints among a set of departure flights.			

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_ROUT-43 Runway Operations	The Departure Management component should able to handle both single mode and mixed mode runway operations for a set of interdependent runways.			
Func_ROUT-44 Same or Different Runways	The Departure Management component should distinguish between operations on the same or on different runways when considering minimum separation times between two successive operations.			
Func_ROUT-45 Exclusive Runway Occupancy	The Departure Management component should ensure that every planned take-off schedule ensures the exclusive use of the runway for take-offs and landings.			
Func_ROUT-46 Runway Configuration	The Departure Management component should consider the current runway configuration of the airport.			
Func_ROUT-47 Runway Maintenance Operations	The Departure Management component should take into account particular time intervals for specific runway operations like runway inspection, snow clearance, friction test etc., where take-off and landing operations are not allowed.	Closure of sections of movement area for maintenance or snow clearance may exceed the allocated expected time.	ICAO §3.5.8.2	
Func_ROUT-48 Routing Capability	The Departure Management component should consider the taxi times resulting from the taxi route for each aircraft based on: • Starting point • Destination point • Aerodrome configuration			

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_ROUT-49 Destination Change	The Departure Management component should consider the change of a destination at any time.			
Func_ROUT-50	Spare			
Func_ROUT-51 Route Change	The Departure Management component should consider the changed taxi times resulting from a changed taxi route to the same destination at any time.			
Func_ROUT-52 Dense Traffic	The Departure Management component should be capable of meeting the needs of dense traffic at complex aerodromes.			
Func_ROUT-53 Standard Terminology	The Departure Management component should use standardised terminology or symbology.			
Func_ROUT-54 Optimum Times	The Departure Management component should calculate and assign an optimum target time of departure (TTOT) and an optimum target off-block time (TOBT) to each departure flight.			
Func_ROUT-55 Start of Optimisation	The Departure Management component should start optimising the departure and start-up sequence when the aircraft requests departure clearance.			
Func_ROUT-56 ETOT	The Departure Management component should consider for every departure an estimated minimum time for being ready for takeoff (ETOT).			

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_ROUT-57 CTOT/TTOT	The Departure Management component should ensure that a slotted aircraft receives a TTOT not earlier than the slot starting time.			
Func_ROUT-58 RTUC	The Departure Management component should consider all clearances and generate the Recommended Time Until next Clearance (RTUC).			
Func_ROUT-59 User Input	The Departure Management component should take account of declared ready-time estimates input by the user.			
Func_ROUT-60 Constraints	The Departure Management component should be able to plan in compliance with all constraints that are accepted in a manual system.	The design of any control system should take account of the requirements for safety and efficiency. It should also take account of the taxiing performance and limitations of all relevant aircraft and vehicles.	ICAO §3.4.4.1	
Func_ROUT-61 Constraint Models	The Departure Management component should use adequate constraint models if there are airport specific permanent constraints, either operational or physical.	The control function should be able to handle operational changes (e.g. runway changes, routes closed for maintenance, temporary hazards or obstacles, etc.).	ICAO §3.4.4.2 b	
Func_ROUT-62 Sequence Constraints	The Departure Management component should consider sequence number constraints, i.e. an aircraft must have a certain position within the departure sequence.			
Func_ROUT-63 User Entry of Sequence Constraints	The Departure Management component should allow the user to enter constraints to the departure sequence.			

<table>
<tr><th>EMMA
Req. No.</th><th>Requirement</th><th>Parent Requirements</th><th>Source Reference</th><th>Comment</th></tr>
<tr><td rowspan="3">Func_ROUT-64
Operational Changes</td><td rowspan="3">The Departure Management component should be able to respond to operational changes, such as:
• Runway in use
• Meteorological conditions</td><td>It is critical to the efficient and flexible operation of any aerodrome that planning elements can be tactically adjusted to meet changing circumstances.</td><td>ICAO §3.5.8.1</td><td></td></tr>
<tr><td>Aerodrome operations are vulnerable to many factors which must be taken into account in planning operations. These factors include weather conditions, which may require an adjustment of movement rates or landing and take-off directions.</td><td>ICAO §3.5.8.2</td><td></td></tr>
<tr><td rowspan="2">Additionally, unserviceable equipment and movement surfaces may require the use of non-routine procedures and routing.</td><td rowspan="2">ICAO §3.5.8.2</td><td rowspan="2">Closed taxiways, etc. should be handled by the Routing function.</td></tr>
<tr><td>Func_ROUT-65
Planning Strategies</td><td>The Departure Management component should be able to provide different modes of optimisation, so that the planning strategy can be tactically adapted to different traffic demands and operational conditions.</td></tr>
</table>

Table 6-1: Functional Requirements for Routing/Planning

6.2.2 Performance Requirements

The following table lists performance requirements for the Routing/Planning function.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Perf_ROUT-01 Processing Time	The Routing function should process an initial route within 10 seconds. Reprocessing to account for tactical changes once the aircraft or vehicle is in motion should not exceed 1s.	The time taken to process an initial route should not exceed 10 seconds. Reprocessing to account for tactical changes once the aircraft or vehicle is in motion should not exceed 1s.	ROUT_Perf-02 [ICAO §4.3.2]	
Perf_ROUT-02 Resolution	In the processing of optimised routes, the Routing function should compute the length of taxi distances with a resolution better than 10m, and timing with a resolution better than 1s.	In the processing of optimised routes, the length of taxi distances should be computed to a resolution better than 10m, and timing to a resolution better than 1s.	ROUT_Perf-03 [ICAO §4.3.3]	This ICAO requirement is questionable. Resolution is meaningless without an accuracy requirement. There is also no rationale for the requirement.
Perf_ROUT-03 Dynamic Capacity	The Routing function should be capable of processing and designating at least 4 routes during any one second period	The control function of an A-SMGCS should have a capacity sufficient for the maximum authorized movement rate.	ICAO §2.5.4.1 a	
Perf_ROUT-04 Static Capacity	The Routing and Departure Management components should be capable to continuously exchange and process flight plan data for all flights for which flight plans from the FDPS exist.	The control function of an A-SMGCS should have a capacity sufficient for the aerodrome planning of requested movements for a period up to one hour.	ICAO §2.5.4.1 b	
Perf_ROUT-05 Optimal TTOT	For a departing aircraft, the Departure Management component should compute an optimal Targeted Take-off Time (TTOT). An aircraft reaching the runway entry should need to wait for take-off not longer than the aircraft specific line-up time plus 1 minute.		EMMA2	

Perf_ROUT-06 Slot Compliance	For a slotted flight, the planned TTOT should not be earlier than the slot starting time and not later than the slot ending time.		EMMA2	
Perf_ROUT-07 Optimal TSAT	For a departing aircraft, the Departure Management component should compute an optimal Targeted Start-up Approval Time (TSAT). After start-up, the aircraft should need to wait for the pushback clearance not longer than 2 minutes.		EMMA2	
Perf_ROUT-08 Optimal Timing	The Departure Management component should provide an optimal timing for the planned aircraft operations, and for the respective clearances to be issued. The accuracy of the Recommended Time Until next Clearance (RTUC) should be 1 minute.		EMMA2	

Table 6-2: Performance Requirements for Routing/Planning

6.2.3 Interface Requirements

The following table lists interface requirements for the Routing/Planning function.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Data Communication Protocols				
Intf_ROUT-01 General Requirements	The Routing/Planning function should comply with the general interface requirements given in section 3.3.			
Flight Plan Interface				
Intf_ROUT-02 Flight Plan Interface	The Routing/Planning function should be capable of interfacing to an external FDPS to receive flight plans.			
Intf_ROUT-03 Flight Plan Types	The Routing/Planning function should be capable to receive and process • Arrival flight plans • Departure flight plans • Flight plan updates • Flight plan cancellations			
Intf_ROUT-04 Departure Data	A departure flight plan should have at least the following data fields: • ICAO Aircraft Identifier (Callsign) • Aircraft type • Assigned stand / parking position • Assigned destination (if known) • Assigned runway • SID (or heading information for smaller VFR-flights) • CFMU slot (CTOT) (if allocated)			

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
	• TOBT • Taxi route (if applicable) • Runway entry			
Intf_ROUT-05 Arrival Data	An arrival flight plan should have at least the following data fields: • ICAO Aircraft Identifier (Callsign) • Aircraft type • Assigned parking position • Assigned runway • ETA • Proposed exit • Taxi route (if applicable)			
Flight Progress Event Interface				
Intf_ROUT-06 Flight Progress Reports	The Routing/Planning function should be capable of receiving flight progress event reports, including type of event, for: • Aircraft on final approach • Aircraft landing • Aircraft go-around • Aircraft taking off • Aircraft rejected take-off • Aircraft stopped on runway • Aircraft stopped on taxiway • Aircraft at route start-point, waypoint or end-point, including: o Off-block or on-block o Apron exit or entry point o Taxiway junction			

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
	o Runway crossing o Runway entry or exit point			
Intf_ROUT-07	Spare			
Traffic Context Interface				
Intf_ROUT-08 Traffic Context Data	The Routing/Planning function should be capable of receiving traffic context data, including: • Airport layout: topological representation of tarmac (RWYs, TWYs, etc.) • Reference points: ARP, RWY thresholds, holding positions, stand locations • Fixed obstacles • Restricted Areas • Unidirectional taxiways • Taxiways closed to certain aircraft types			
Intf_ROUT-09 Operational Changes	The Routing/Planning function should be capable of receiving at any time changes to traffic context data, such as: • Runway(s) in use • Taxiways closed • Temporary hazards or obstacles • Meteorological conditions			

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Controller HMI Interface				
Intf_ROUT-10 HMI Interface	The Routing/Planning function should be capable of interfacing to an HMI, where the routing and planning results will be presented.			
Intf_ROUT-11 Departure Time Update	The departure planning function should provide departure time update data, which can be displayed e.g. on an Electronic Flight Strip (EFS) display at the Controller HMI.			
Intf_ROUT-12 Departure Time Update Data	Departure time update data should have at least the following data fields: • ICAO Aircraft Identifier (Callsign) • Target Start-up Approval Time (TSAT) • Target Take-off Time (TTOT) • Recommended Time Until next Clearance (RTUC) • Next clearance • Number in sequence of departures			

Table 6-3: Interface Requirements for Routing/Planning

7 Guidance

The Guidance function should provide services for pilots and drivers, helping them to keep their aircraft or vehicles on the surfaces and assigned routes intended for their use.

In a conventional SMGCS, guidance to pilots and drivers is usually provided by:

- Instructions and information from the controller via voice radio communication
- Aerodrome paper maps used on board
- Guidelines painted on the tarmac
- Signposts placed near taxiways and runways
- Follow-me vehicles
- Manually operated runway and taxiway lighting

On airports not equipped with advanced guidance systems, guidance is managed by the aerodrome controller or apron controller, indicating to the pilot the ground path to follow (taxiways, runway entrance and exits, stand). Pilots are responsible for navigation, and use airport maps and ground signs to follow painted lines along the assigned taxi route.

For the higher levels of A-SMGCS, several technical solutions exist to improve surface movement guidance. These include:

- Ground-based guidance means, comprising segmented taxiway centreline lighting with selectable routing ("follow the greens") and automated stop bars
- On-board moving map displays showing the aerodrome layout and own ship position
- Air-ground data link, employing the transmission of taxi route description by data link and presentation on the on-board moving map display.

7.1 Ground-based Guidance Means

Ground-based guidance by visual aids has the advantage that guidance can be provided to every aircraft or vehicle, independent of the on-board equipage, and that the controller can interact with every aircraft in the same way.

A-SMGCS ground-based guidance means should supplement existing SMGCS by providing additional visual aids, which will consist of:

- Selectively or segment-wise switched centreline lights, and
- Selectively switched stop bars

To fulfil ICAO recommendations, the taxiways should be equipped with green centreline lights, which can be either addressed and switched individually or grouped in segments and switched segment by segment, with red stop bars at the beginning and end of each segment. Stop bars have to be interlocked with the taxiway centreline lights so that when the centreline lights beyond the stop bar are illuminated the stop bar is extinguished and vice versa.

Switching of the visual aids may occur either manually or automatically, depending on the level of implementation. The ATCO or an assistant should be provided with an interface to operate the visual aids and to monitor their status. For an automated system, it is conceivable that the Guidance function could switch on the respective centreline segments from the actual position of a mobile up to the intended holding position, where the red stop bar is switched on. As the mobile progressed along its route, the segments behind it would be extinguished. However, such operation would require very high integrity and reliability of the Surveillance function.

In general, the following requirements apply to aerodrome ground lighting in A-SMGCS:

- Taxiway centreline lights should comply with the requirements and recommendations given in ICAO Annex 14, Volume 1 [16].
- The controller should be provided with clear indications showing the guidance provided to the pilot.
- The ICAO A-SMGCS Manual [14] requires an actuation time inclusive feedback of not more than 2 seconds and a reversion time of 0.5 seconds maximum.
- A monitoring function must raise an alert when the visual guidance function fails, deactivate the visual guidance means, and protect the runways from access by switching on the stop bars.

7.2 Air-Ground Data Link

The targeted EMMA2 Air-Ground Data Link Services are the services used for controller-pilot exchanges of surface movement clearances that are not time-critical. These Air-Ground Data Link Services comprise Departure, Start-up, Pushback and Taxi clearances and instructions.

The Air-Ground Data Link is considered in three parts:

a) Air-Ground Data Link Communications
b) Departure Clearances
c) Start-up, Pushback and Taxi Clearances

7.2.1 Air-Ground Data Link Communications

The Air-Ground Data Link Communications comprise:

- The Data Link Communications transport media, ATN over VDL-2, and
- The selected applications/message sets used to relay the EMMA2 Data Link Services, ATN CPDLC Bit-Oriented Application messages, documented in the ATN SARPS [17] and in EUROCAE ED-110A [10].

7.2.2 Departure Clearances

Departure clearance is covered by the DCL Data Link Service that is already internationally standardised at EUROCAE/RTCA level. The relevant documents are:

- ED-85A [6] Data Link Application System Document (DLASD) for the Departure Clearance Data Link Service;
- ED-110A [10] Interoperability Requirements Standard for ATN Baseline 1 (INTEROP ATN B1);
- ED-120 [11] Safety and Performance Requirements Standard for Air Traffic Data Link Services in Continental Airspace.

DCL is a mature service, and will not be included in the EMMA2 validation scope.

7.2.3 Start-up, Pushback and Taxi Clearances

Start-up, Pushback and Taxi Clearances in EMMA2 will be implemented as sub-services of a single TAXI-CPDLC Service.

A summary of the TAXI-CPDLC Service description derived from the EMMA2 SPOR [2] is provided below:

- The objective of the TAXI-CPDLC service is to provide automated assistance and additional means of communication to controllers and pilots when performing communication exchanges during ground movement operations.

- A flight due to depart from an airport, or an aircraft that just landed, must obtain a series of clearances from the Controlling Air Traffic Service Unit (C-ATSU) in order to proceed from/to its stand to/from the runway.
- In particular, start-up, pushback and routine taxi messages are supported by this service. Some special airport operations such as "de-icing" may also be supported.
- Routine operations like aircraft taxi from stand to the assigned departure runway as well as taxi from the landing runway to the arrival stand require numerous ATC communication exchanges that, under heavy traffic loads, may saturate the ATC frequencies and reduce airport throughput.
- Although some non-routine operations, such as helicopter operations, will continue to use voice communications only, others, like remote de-icing, are likely to be supported by data link exchanges.
- Depending on technology availability, a graphical presentation of the routing instructions to the flight deck may facilitate aircraft ground navigation and increase ground safety. A graphical display should also support operations in lower visibility.
- The TAXI-CPDLC operating method and the exchange diagram presented below illustrate the process that will be adhered to in most cases. Request clearance is used as an example. It is anticipated the other elements of TAXI-CPDLC will follow a similar pattern.

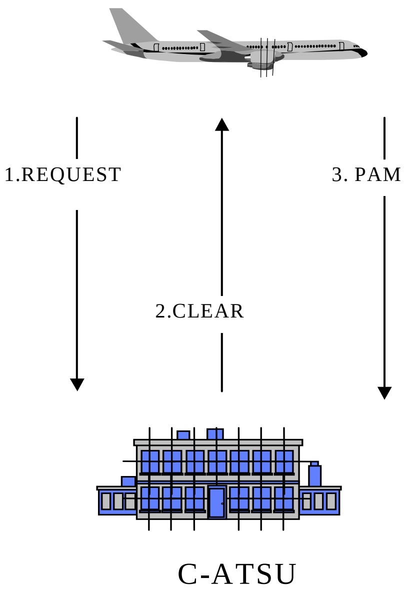

Figure 7-1: TAXI-CPDLC Exchange Diagram

Step	Operating Method
1	Flight crew transmits a Clearance Request to the C-ATSU via data link.
2	The Clearance is composed by the C-ATSU based on flight related data. The controller transmits the composed Clearance to the aircraft via data link.
3	The flight crew verifies the operational contents of the Clearance message, and transmits a Pilot Acknowledgement Message (PAM) via data link.

Table 7-1: TAXI-CPDLC Operating Method

Although local operations could ask for data link procedures tailored to their airport, it is considered that most of the TAXI-CPDLC elements can be incorporated into 4 sub-services as described below.

Start up

The request by the flight crew (if applicable) and the delivery by the controller of the start up approval as well as all related messages, in accordance with local procedures.

Pushback

The request by the flight crew (if applicable) and the delivery by the controller of the pushback as well as all related messages, in accordance with local procedures.

Taxi-OUT

The request by the flight crew, and the delivery by the controller, of the first departure taxi message in accordance with local procedures.

This message includes the taxi route description and the authorisation to taxi up to a clearance limit (i.e. up to a given holding point that is not necessarily the departure holding point). This initial taxi route description should contain the whole taxi route to be followed by the aircraft, but the authorisation is only given up to the clearance limit. Further authorisations, either along the initial expected taxi route or on a new taxi route will be provided either via the Taxi Data Link Sub-service or via voice as appropriate.

Taxi

Routine ground movement related messages occuring between:

- o The time when the aircraft starts moving on its own power or when the flight crew has acknowledged the Taxi-OUT clearance, whichever is later, and the arrival of the aircraft at its departure holding point.
- o The landing of the aircraft and its engine shutdown at the assigned parking position.

The TAXI-CPDLC service should be available to all aircraft having an active flight plan.

Respective sub-service availability will depend on airport operational needs.

The TAXI-CPDLC service requires the previous establishment of the C-ATSU CPDLC link.

Expected constraints associated with TAXI-CPDLC are the following:

- Controllers will have to cope with mixed data link equipped and non-equipped aircraft.
- Data used on the ground by ATC must be up-to-date and consistent with data used on-board.
- Regardless of the level of system automation in use, controllers and flight crew should have the capability to review, validate and acknowledge (where appropriate) any message being delivered or received.
- There is a head-down time issue associated with the taxi clearances.
- The TAXI-CPDLC service may not be available during the transfer of ATC voice/control communications, depending on the local partitioning of data link addresses on the airport.

Termination of the sub-services:

- Start-up, Pushback, Taxi-OUT and Taxi sub-services end when the C-ATSU automatically transfers a logical acknowledgement to the aircraft, indicating the reception of the related pilot acknowledgement of the clearance
- Taxi sub-service ends when the departing aircraft reaches its departure runway holding point, or when the arriving aircraft shuts down its engines at its destination stand.

7.2.4 EMMA2 System Air-Ground Data Link Architecture

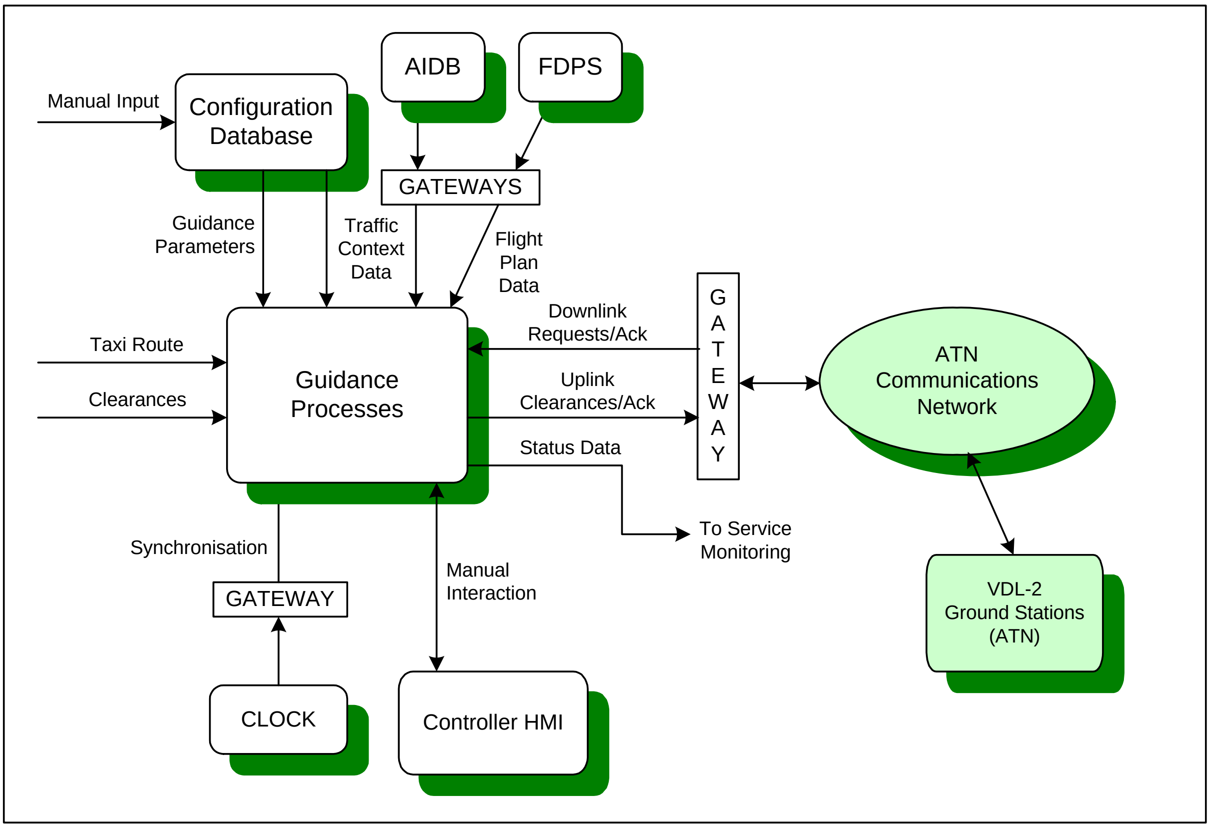

Figure 7-2: Air-Ground Data Link System Architecture

7.2.4.1 Guidance Processes

The Guidance Processes perform the following main functional processing for the Ground Clearances services:

- Data Link Clearance element composition (derived from the Traffic Context and Taxi Route) for proposal to the controller
- Data Link Services management (Data Link Applications message sequences, operational time-outs, etc.)
- Uplink message element composition ATN Communications Network usage
- Downlink message elements decoding for controller display, and global system usage.

The EMMA2 Guidance Processes should interface with the following systems:

- External Airport Information Database (AIDB) system and external Flight Data Processing System (FDPS): To obtain the Traffic Context dynamic data (e.g. Runway in Use) and other information about traffic (e.g. Aircraft Type, Stand, etc.) necessary for the EMMA2 Data Link Services to propose Data Link Clearance elements to the responsible controller
- Routing/Planning Data Processing System: To obtain the clearances given by the responsible controller and the taxi route information necessary to build the Taxi-OUT and Taxi Uplink messages
- Controller HMI: So that the responsible controller can view requests and acknowledgements from the on-board systems and check the proposed Data Link Clearance elements prior to actual clearance activation and Air-Ground Data Link message exchange

- ATN Communications Network: To provide and obtain Air-Ground Data Link message elements
- Airport Reference Clock: To get time synchronisation
- Recording and Playback System: To record Air-Ground Data Link Services data and events for research purposes (or for accident and incident investigation in an operational system)
- Configuration Database: To set up parameters for the Guidance Services and control the Guidance Processes (e.g. Start/Stop of separate processes)
- Service Monitoring System: To monitor and report the serviceability status of the Air-Ground Data Link Services and data sources.

7.2.4.2 ATN Communications Network

The ATN Communications Network performs the following main functional processing for the Air-Ground Data Link Communications function:

- ATN Applications (ATN Application Service Elements) based on the following message formats:
  - Context Management (CM): ATN Logon messages for the DLIC Data Link Service
  - Controller Pilot Data Link Communications (CPDLC): Uplink and Downlink message set for the TAXI-CPDLC Services
- ATN Communications Stack

The ATN Communications Network exchanges data link messages with the Guidance Processes via a gateway and is connected to one or more VDL-2 ground stations to relay Air-Ground Data Link messages to and from aircraft.

7.3 Guidance Function Requirements

In this section are listed the technical requirements related to the Guidance function of the A-SMGCS. These requirements are valid at higher levels of implementation of an A-SMGCS.

The requirements are divided into three subsections: Functional, Performance and Interface Requirements, with associated identifiers Func_GUID-nn, Perf_GUID-nn and Intf_GUID-nn, where nn is a two-digit number.

For traceability, requirements include references to all parent operational requirements listed in the SPOR document [2] and, where applicable, to other sources. The ICAO A-SMGCS Manual (Doc 9830) [14] is the prime source of the parent requirements.

7.3.1 Functional Requirements

The following table lists functional requirements for the Guidance function.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
General Requirements				
Func_GUID-01 Route Indication	The Guidance function should be able to clearly indicate any assigned taxi route to an authorised movement.	The guidance function of an A-SMGCS should provide guidance necessary for any authorized movement and be available for all possible route selections.	GUID_Serv-01 [ICAO §2.5.3.a]	
		The guidance function of an A-SMGCS should provide clear indication to pilots and vehicle drivers to allow them to follow their assigned route.	GUID_Serv-02 [ICAO §2.5.3.b]	
Func_GUID-02 Own Position	The Guidance function should be able to clearly indicate to pilots and vehicle drivers their positions on the assigned routes.	The guidance function of an A-SMGCS should enable all pilots and vehicle drivers to maintain situational awareness of their positions on the assigned routes.	GUID_Serv-03 [ICAO §2.5.3.c]	

<table>
<tr><th>EMMA Req. No.</th><th>Requirement</th><th>Parent Requirements</th><th>Source Reference</th><th>Comment</th></tr>
<tr><td>Func_GUID-03
Route Change</td><td>The Guidance function should be capable of accepting a change of taxi route at any time.</td><td>The guidance function of an A-SMGCS should be capable of accepting a change of route at any time.</td><td>GUID_Serv-04
[ICAO §2.5.3.d]</td><td></td></tr>
<tr><td>Func_GUID-04
Restrictions</td><td>The Guidance function should be capable of indicating routes and areas either restricted or not available for use.</td><td>The guidance function of an A-SMGCS should be capable of indicating routes and areas either restricted or not available for use.</td><td>GUID_Serv-05
[ICAO §2.5.3.e]</td><td>On-board HMI and/or ground signs/barriers/lighting.</td></tr>
<tr><td rowspan="2">Func_GUID-05
Service Monitoring</td><td rowspan="2">The Guidance function should provide on-line monitoring of the operational status of all guidance aids.</td><td>The guidance function of an A-SMGCS should allow monitoring of the operational status of all guidance aids.</td><td>ICAO §2.5.3.f</td><td></td></tr>
<tr><td rowspan="2">The guidance function of an A-SMGCS should provide on-line monitoring with alerts where guidance aids are selectively switched in response to routing and control requirements.</td><td rowspan="2">ICAO §2.5.3.g</td><td rowspan="2"></td></tr>
<tr><td>Func_GUID-06
Fault Alert</td><td>The Guidance function should output an alert report to clients whenever a guidance aid is detected to be faulty.</td></tr>
<tr><td>Func_GUID-07</td><td>Spare</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Ground-based Guidance Means</td></tr>
<tr><td rowspan="2">Func_GUID-08
Guidance Aids</td><td rowspan="2">The Guidance function may incorporate switched centreline lights and/or addressable signs to enable routes to be uniquely designated.</td><td>When visibility conditions permit a safe, orderly and expeditious flow of authorised movements, the guidance function will primarily be based on standardised ground visual aids including lighting, markings and signage.</td><td>ICAO §3.4.3.1</td><td>Advanced ground-based guidance means are not implemented for EMMA2.</td></tr>
<tr><td>Improved aerodrome visual aids providing guidance for surface movements should be an integrated component of the system.</td><td>ICAO §1.2.h</td><td></td></tr>
</table>

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
		Guidance aids indicate where on the taxiway or apron the aircraft or vehicle can be manoeuvred safely. Switched centreline lights and/or addressable signs enable routes to be uniquely designated.	ICAO §3.4.3.4	
Func_GUID-09 Standard Requirements	Taxiway centreline lights should comply with the requirements and recommendations given in ICAO Annex 14, Volume 1.		EMMA2	
Func_GUID-10 Power Failure	In the event of a failure (other than a total power failure) of an automatic visual aids management system, the Guidance function should switch on all the runway guard bars at runway access points, and switch off all taxiway centreline lights and intermediate stop bars. Manual selection and de-selection of the taxi guidance visual aids should be provided.	In the event of a failure (other than a total power failure) of an automatic visual aids management system, the A-SMGCS should switch on all the runway guard bars at runway access points, and switch off all taxiway centreline lights and intermediate stop bars. Manual selection and de-selection of the taxi guidance visual aids should be provided.	ICAO §3.4.3.11	
Func_GUID-11	Spare			
TAXI-CPDLC				
Func_GUID-12 Transport Media	The TAXI-CPDLC ground station should be based on VDL-2 and the ATN for the data link communications transport media.		EMMA2	
Func_GUID-13 Interoperability	The TAXI-CPDLC ground station should comply with the air-ground interoperability requirements in section 10.6.		EMMA2	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_GUID-14 ATN/API	The TAXI-CPDLC ground station should include the ATN communication stack with an Application Programming Interface (API) to provide access.		EMMA2	
Func_GUID-15 API Features	The ground station ATN API should provide the following features: • Read access in order to retrieve a received CPDLC message from the ATN stack • Write access in order to hand over a CPDLC message to the ATN stack • Notification for each aircraft that logs on or of (join / leave notification) • Connection status information		EMMA2	
Func_GUID-16 Initialisation	The VDL-2 / ATN data link should initialise automatically.		EMMA2	
Func_GUID-17 Link Establishment	The TAXI-CPDLC service requires the previous establishment of the C-ATSU CPDLC link.		EMMA2	
Func_GUID-18 Logon	As soon as a connection between the ground station radio and the on-board radio exists, the Controller HMI end application should be notified that a logon is possible.	In any data link dialogue, the end-user should be able to positively identify the other end-user.	TAXI-CPDLC_Serv-01 [ICAO DLI §3.26]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_GUID-19 Service Availability	The TAXI-CPDLC service should be available to all appropriately equipped aircraft within the coverage volume of the A-SMGCS having an active flight plan.	Air traffic control facilities providing a data link based ATS should be capable of receiving, storing, processing, displaying and disseminating specific flight information relating to flights equipped for and operating within environments where a data link service is provided.	TAXI-CPDLC_Serv-05 [ICAO DLI §3.32]	
Func_GUID-20	Spare			
Func_GUID-21 Sub-services	The TAXI-CPDLC ground station should support Start-up, Pushback, Taxi-OUT and Taxi sub-services.		EMMA2	
Func_GUID-22 Downlink Messages	The TAXI-CPDLC ground station should be capable of receiving and decoding downlink messages of the following types: a) Logon/Logoff request messages b) System management messages c) Clearance request messages d) Logical acknowledgement messages (LACK) e) Pilot acknowledgement messages (PAM)		EMMA2	
Func_GUID-23 Downlink Message Decoding	For downlink messages, the ASN.1 coded CPDLC messages should be decoded inside the ATN stack and provided to the Controller HMI end application.		EMMA2	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_GUID-24Message Routing	The TAXI-CPDLC ground station should automatically route downlink messages to the Controller HMI to which they are addressed.	The system should be capable of facilitating automatic transfer of data link authority within data link based ATS airspace using digital data interchange.	TAXI-CPDLC_Serv-07 [ICAO DLI §3.37]	
		The system should ensure that messages are sent to the specified recipient.	TAXI-CPDLC_Serv-11 [ICAO DLIV §2.2]	
Func_GUID-25 ATSU Identifier	When a flight strip is transferred from one CWP to the next, the ground application should automatically send an uplink message identifying the ATSU.	Aircraft should be under the control of only one ATC unit at a time, whether or not data link applications are being used.	TAXI-CPDLC_Serv-17 [ICAO DLI §3.36]	
Func_GUID-26 Uplink Messages	The TAXI-CPDLC ground station should be capable of encoding uplink messages of the following types: a) System management messages b) Clearance messages c) Logical acknowledgement messages (LACK)		EMMA2	
Func_GUID-27 Uplink Message Encoding	For uplink messages, the human-readable text messages from the Controller HMI end application should be encoded inside the ATN stack into ASN.1 coded CPDLC messages.		EMMA2	
Func_GUID-28 Message Order	Uplink messages should be transmitted from the TAXI-CPDLC ground station in the order in which they are sent from the Controller HMI.	The CPDLC application requires: a) That messages should be generated and sent in a time ordered sequence; b) That messages should be delivered in the order that they are sent.	TAXI-CPDLC_Serv-10 [ICAO DLIV §2.1]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_GUID-29	Spare			
Func_GUID-30 Unsupported Services	If the TAXI-CPDLC ground station receives a message requesting an unsupported function or service, it should automatically respond indicating that the requested service is unsupported.	When a ground system receives a message requesting an unsupported function or service, the ground system should respond indicating that the requested service is unsupported.	TAXI-CPDLC_Serv-12 [ICAO DLIV §2.3]	
Func_GUID-31 Uplink LACK	The TAXI-CPDLC Ground station should automatically transmit a logical acknowledgement (LACK) in response to each message received, successfully decoded and presented at the Controller HMI.	Each data link message transmission is followed by a logical (technical) acknowledgement (LACK), i.e. the sender gets an immediate feedback that the message has completely been transmitted and is available on the recipient's display.	TAXI-CPDLC_Serv-19 [SPOR §3.7.3c]	
Func_GUID-32 Downlink LACK	The TAXI-CPDLC Ground station should be capable of receiving LACK messages from the on-board systems in response to any message it transmits.			
Func_GUID-33	Spare			
Func_GUID-34 Sub-service Termination	Taxi sub-service should terminate when the departing aircraft reaches its departure runway holding point, or when the arriving aircraft reaches its destination stand.		EMMA2	
Func_GUID-35 Link Failure	In the event of an unexpected termination of the TAXI-CPDLC application, the Controller HMI should be notified of the failure.	In the event of an unexpected termination of a data link application, both the aircraft and the ground should be notified of the failure.	TAXI-CPDLC_Serv-09 [ICAO DLI §3.39]	

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
TAXI-CPDLC (additional operational requirements)				
		In any data link based ATS, provision should always be made for direct pilot-controller voice communications.	TAXI-CPDLC_Serv-02 [ICAO DLI §3.27]	Not relevant for A-SMGCS technical requirements.
		The pilot or controller should be capable of initiating direct controller-pilot communication by voice in emergency or urgent, non-routine, safety-related situations.	TAXI-CPDLC_Serv-03 [ICAO DLI §3.28]	Not relevant for A-SMGCS technical requirements.
		Simple actions should be used by either the pilot or controller to initiate voice communications.	TAXI-CPDLC_Serv-04 [ICAO DLI §3.29]	Not relevant for A-SMGCS technical requirements.
		In case of complete communications failure, procedures should be in accordance with ICAO provisions.	TAXI-CPDLC_Serv-08 [ICAO DLI §3.38]	Not relevant for A-SMGCS technical requirements.
		Effective human-machine interfaces should exist on the ground and in the air to permit efficient interactivity between the pilot, controller and ground automation.	TAXI-CPDLC_Serv-06 [ICAO DLI §3.34]	Refer to Controller and Pilot HMI requirements.

Table 7-2: Functional Requirements for Guidance

7.3.2 Performance Requirements

The following table lists performance requirements for the Guidance function.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Ground-based Guidance Means				
Perf_GUID-01 Time and Distance Resolution	For ground-based guidance aids, the overall response time of initiation of the guidance to verification that the correct route or information has been provided should not exceed 2 seconds.	The overall response time of initiation of the guidance to verification that the correct route or information has been provided should not exceed 2 seconds.	GUID_Perf-01 [ICAO §4.4.1]	This requirement refers to taxiway guidance lighting, which is not implemented in EMMA2.
Perf_GUID-02 Reversion Time	The reversion time of a ground-based guidance aid to the OFF state should not exceed 0.5 seconds.	Reversion Time 0.5 seconds maximum.	GUID_Perf-02 [ICAO §4.4.2]	This requirement refers to taxiway guidance lighting, which is not implemented in EMMA2.
Coverage				
Perf_GUID-03 Coverage	The Guidance function should provide coverage of all possible taxi routes throughout the airport movement area.	As a minimum, coverage should be provided on the airport movement area.	ICAO §3.4.3.6	

Table 7-3: Performance Requirements for Guidance

7.3.3 Interface Requirements

The following table lists interface requirements for the Guidance function.

EMMA Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Data Communication Protocols				
Intf_GUID-01 General Requirements	The Guidance function should comply with the general interface requirements given in section 3.3.		EMMA2	
API Interface				
Intf_GUID-02 Controller HMI	The Guidance function should be capable of interfacing to Controller HMI to exchange uplink and downlink messages.		EMMA2	

Table 7-4: Interface Requirements for Guidance

8 Controller HMI

The basic A-SMGCS HMI will concentrate on the Controller Working Position (CWP). The requirements for on-board HMI are covered separately in D112b ATR-AIR.

It is envisaged that the CWP will include a data entry device and display(s) providing situation awareness together with the necessary information to support the appropriate level of A-SMGCS.
The Controller HMI design must take into account the working environment of the controller under various operational conditions. In this respect, the HMI will be required to be adaptable to the various circumstances of the user. As an example, good visibility operations with high traffic throughput will require a different A-SMGCS set-up than that required for low visibility operations with reduced throughput. The A-SMGCS functions must be designed to have a satisfactory performance during operations based on both visual and non-visual surveillance.

The HMI design must ensure that the advanced A-SMGCS functions of higher-level systems do not have a detrimental effect on the performance of the basic A-SMGCS functions. The HMI design of a higher level A-SMGCS must be conducted as a whole. As an example, the HMI of the Control, Routing/Planning and Guidance functions must not degrade the quality of the supporting Surveillance HMI.

It is expected that A-SMGCS HMI will evolve through the following stages:

- Basic situational awareness
- Alerts of situations requiring user action
- Prompts to users with suggested actions for their approval and the eventual presentation of decisions already made by the processors.

8.1 Generic Requirements for Controller HMI

Certain fundamental principles should be observed in the design of the Controller HMI functions.
In particular, Controller HMI should fulfil the following requirements:

- Permit rapid situation assessment
- Employ user friendly and familiar data entry means
- Minimize the number of input actions required
- Permit the user to make the decisions on those actions for which he/she is responsible;
- Maintain a balance between human and machine functions
- Ensure a level of user workload which is consistent with efficient and effective activity
- Permit full manual operation in the event of a failure of an automatic function or whenever manual operation is required
- Harmonize where possible with existing ATM HMI
- Immediately forward alerts to users in the event of a failure or when system performance is degraded.

As a minimum, the Controller HMI should provide basic situational awareness, the ability to alert the user to both operational and system events, and a data entry device. Functions should be configurable according to the tasks to be performed by the user and integrated where this facilitates the use of the system.

High-resolution, colour displays, capable of being viewed in all ambient light levels appropriate to the ATC environment, are required.
The information that should be available for display on the Controller HMI includes, but is not limited to the following:

For a basic A-SMGCS:

- Static maps showing the entire airport layout including special overlays appropriate to the task being performed
- Dynamic target symbols with labels showing the reported positions and identities of airport traffic in real-time
- Track history symbols, state vectors, etc., as appropriate
- Alert information (graphical, textual, audible, as appropriate)
- Graphical and textual facilities, such as menus and icons, to present user options for management of the A-SMGCS
- Planning information (e.g. sorted lists of arrivals, departures, vehicles, flight plans)
- Weather data (e.g. visibility, wind conditions, icing)
- System status data
- Time of day

Additionally, for the higher-levels of A-SMGCS:

- State of ground-based guidance devices (e.g. taxiway centreline lighting, stop bars)
- Proposed and assigned taxi routes
- Movement mode information (e.g. push back, taxi, hold)
- Runway/taxiway status information (e.g. closed, active)
- Electronic flight strips
- Data link messages

The input devices at the Controller HMI should allow the user access to at least the following A-SMGCS management capabilities:
For a basic A-SMGCS:

- Display capabilities (e.g. range scale selection, pan/zoom, brightness, map overlays)
- Label operations (e.g. label contents, label deconfliction)
- Means to input dynamic configuration data (e.g. runway changes, day/night and low visibility procedures, restricted areas)
- Means to acknowledge alerts

Additionally, at the higher levels:

- Means to accept, modify or reject a proposed taxi route
- Means to assign a taxi route to a movement
- Means to give clearances and exchange messages via data link.

8.2 Electronic Flight Strip HMI

An Electronic Flight Strip (EFS) system is an enabler for some of the higher-level functions of A-SMGCS, in particular for departure management and controller-pilot data link services. The use of EFS should replace the use of paper strips and support the Tower (TWR) controllers in operating more efficiently.

It is expected that replacing paper strips by electronic flight strips will bring multiple benefits including easier circulation of flight data among controller positions (compared to transferring the paper strip manually) and the ability to easily maintain a permanent record of clearances and flight progress. It should also offer the possibility for two-way update of information and support for providing additional A-SMGCS services (such as support for departure clearances, provision of taxi route via data link, etc.).

Since the control TWR forms an integral part of the ATM system, it should be regarded as a sector in the same way as sectors in Approach (APP) or Area Control Centres (ACC). The Air Traffic Services provided by the TWR may be delegated to several different Controller Working Positions (CWPs) according to the controller roles.

EMMA2 should provide controllers with EFS displays and input devices to permit each controller to interact with all of the flight strip functions relevant to the controller role. The presentation of the electronic flight strips should be harmonised with current paper strips and the way they are stacked in flight strip bays.

In addition, the EFS-HMI should fulfil the following generic requirements:

- The EFS-HMI design should be functionally simple involving the controllers in a minimum number of input actions and providing fast response times.
- It should be possible to execute often-used functions with single-stroke actions.
- The EFS-HMI layout should be self-explanatory and easy-to-use.
- Where appropriate, it should be possible to configure the EFS-HMI according to local requirements.
- Information that is important to the controller's tasks should be visible at all times.
- The text on flight strips should be clear, unambiguous and easy to read in all ambient lighting conditions experienced in a control tower.
- The result of any operation on a flight strip should be predictable.
- It should be possible for the controller to easily correct a mistaken action.

8.3 Controller HMI Requirements

In this section are listed the technical requirements related to the Controller HMI. These requirements are valid at all levels of implementation of an A-SMGCS. The majority of the parent requirements have been derived from the referenced EUROCAE ED-87B [7] and ICAO Doc 9830 [14] documents.

The requirements are divided into three subsections: Functional, Performance and Interface Requirements, with associated identifiers Func_HMI-nn, Perf_HMI-nn and Intf_HMI-nn, where nn is a two-digit or three-digit number.

For traceability, requirements include references to all parent operational requirements listed in the SPOR document [2] and, where applicable, to other sources. The ICAO A-SMGCS Manual (Doc 9830) [14] is the prime source of the parent requirements.

8.3.1 Functional Requirements

The following table lists functional requirements for the Controller HMI.

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Basic Functions				
Func_HMI-01 HMI Devices	The HMI should provide users with displays, indicators and input devices to permit each user to interact efficiently with all of the A-SMGCS functions relevant to his or her role.	The HMI should permit the user to make the decisions on those actions for which he/she is responsible.	ED-87B §2.5.2.1	
		The A-SMGCS ATCO HMI should: a) maintain a balance between human and machine functions; b) permit the human to retain the power to make decisions as to those functions for which the human is responsible; c) provide for a balanced mix of visual, audio and tactile inputs and responses.	HMI_Serv-02 [ICAO §2.6.15.2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Display Characteristics				
Func_HMI-02 Ambient Light	The HMI should employ high resolution, high contrast-ratio displays appropriate for viewing in all ambient light levels found in the user environment.	It should be possible to view displays in all ambient light levels typical of an aerodrome control tower environment.	HMI_Serv-04 [ICAO §2.6.15.4]	
Input Devices				
Func_HMI-03 Entry Means	The HMI should employ user friendly and familiar data entry means such as keyboard, mouse and on-screen icons and menus. Touch screen and pen input devices should be considered, particularly for EFS-HMI.	The HMI should employ user friendly and familiar data entry means.	ED-87B §2.5.2.1	
Func_HMI-04 Input Actions	Input devices for the controllers should be functionally simple involving the controllers in a minimum number of input actions.	Input devices for the controllers should be functionally simple - involving the controllers in a minimum number of input actions.	HMI_Serv-03 [ICAO §2.6.15.3]	
Func_HMI-05	Spare			
Display Controls				
Func_HMI-06 Display Capabilities	The HMI should allow the user to configure the display capabilities (e.g. range scale selection, pan/zoom, brightness, map overlays).	The HMI should allow the user to configure the display capabilities (e.g. range scale selection, pan/zoom, brightness, map overlays).	HMI_Serv-10 [ED-87B §2.5.2.1]	
Func_HMI-07 Adaptability	The HMI should be adaptable to the various operational conditions (visibility conditions, de-icing and snow-clearing operations, number of working positions, controller roles, etc.) of the user.	The HMI design should take into account the working environment of the user under various operational conditions. In this respect, the HMI should be adaptable to the various circumstances of the user.	HMI_Serv-09 [ED-87B §2.5.2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-08 Local Configuration	Where appropriate, it should be possible to configure the HMI according to local requirements.	Where appropriate, it should be possible to configure the HMI according to local requirements.	HMI_Serv-11 [EMMA2]	
Func_HMI-09 Manual Label Attribution	The surveillance service should provide to the user the ability to manually put the right callsign in the label associated to a vehicle equipped with cooperative equipment used for different vehicles.	The surveillance service should provide to the user the ability to manually put the right call sign in the label associated to a vehicle equipped with co-operative equipment used for different vehicles.	SURV_Serv-13 [EMMA2]	
Func_HMI-10	Spare			
Design Principles				
Func_HMI-11 Harmonisation	The HMI design should adhere to established principles for ATC equipment.	The HMI should be harmonised where possible with existing ATM HMI.	HMI_Serv-08 [ED-87B §2.5.2.1]	ATM HMI may be specific to each local implementation.
		The operation of A-SMGCS ATCO HMI should not interfere with other ATC responsibilities.	HMI_Serv-01 [ICAO §2.6.15.1]	
Func_HMI-12 Situation Assessment	The HMI should display the complete airport traffic situation in a clear and uncluttered manner to permit rapid situation assessment.	The HMI should permit rapid situation assessment.	ED-87B §2.5.2.1	
		The HMI should display the complete airport traffic situation, allowing a rapid situation assessment.	HMI_Serv-12 [EMMA2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-13 Evolutionary Design	The HMI should be designed to be modular and scalable such that its functionality can evolve as the A-SMGCS evolves.	The A-SMGCS design concept must be built upon the integration of the fundamental and principal system elements and facilitate the upgrading of those elements whilst maintaining, where possible, the same HMI and references. This is important when considering harmonisation, familiarisation and training requirements. It will allow the evolution of the system design through to a full A-SMGCS with the minimum negative impact on the users' ability to interface with the system.	ED-87B §2.5.2	
Func_HMI-14 Minimal Interaction	The HMI design should try to minimise the need for user interaction.	The HMI should minimise the number of input actions required.	ED-87B §2.5.2.1	
		For control staff, the system should have interfaces that allow them to manage the routing, guidance and control functions in a safe and efficient manner.	HMI_Serv-07 [ICAO §2.6.15.7]	
		The HMI should maintain a balance between human and machine functions.	ED-87B §2.5.2.1	
		The HMI should ensure a level of user workload which is consistent with efficient and effective activity.	ED-87B §2.5.2.1	
		A-SMGCS should enable users to interface and function efficiently.	GEN_Serv-22 [ICAO §2.6.16.3]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-15 Data Sets	Different sets of traffic data should be provided in order to assist the controllers in different types of tasks (e.g. updating of data, planning of actions, traffic monitoring and conflict detection). These sets of data should be presented in a combination of graphical and textual formats.	Different sets of traffic data should be provided in order to assist the controllers in different types of tasks (e.g. updating of data, planning of actions, traffic monitoring and conflict detection). These sets of data should be presented in a combination of graphical and textual formats.	HMI_Serv-16 [EMMA2]	
Func_HMI-16 Textual Data	The HMI should provide textual data in various formats including: a) Labels b) Lists of data c) Electronic flight strips	Textual data should be provided in several formats: a) Isolated sets of data related to each aircraft or vehicle, i.e. labels. Access to current flight parameters should be provided through interaction with any aircraft or vehicle label. b) Lists of data allowing comparisons to help the controller to detect conflicts and to prioritise the planning of actions. c) Electronic flight strips allowing the controllers to visualise the planned movements and to enter clearances.	HMI_Serv-18 [EMMA2]	
Traffic Situation Display				
Func_HMI-17 Display Airport Traffic Situation	The HMI should provide, at each controller working position, a traffic situation display capable to present labelled target tracks superimposed on an airport and approach map.	Traffic position and trajectory should be provided in graphical format with labels to help the controller to easily locate each aircraft or vehicle and visualise its progress.	HMI_Serv-17 [EMMA2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-18 Unauthorised Movements	The HMI should continuously indicate the position of unauthorised aircraft, vehicles and obstacles, whilst they are in the movement area, the runway strips and within any designated protected area as required by airport authorities.	The HMI should continuously indicate the position of unauthorised aircraft, vehicles and obstacles, whilst they are in the movement area, the runway strips and within any designated protected area as required by airport authorities.	HMI_Serv-19 [ICAO §2.5.1.7]	
Func_HMI-19 Updates	The traffic representation should be updated following: a) Target reports received from the Surveillance function b) Controller-initiated update of data c) Updates of traffic context data d) Flight plan updates from the Routing/Planning function.	The traffic representation should be updated following: a) Updates of the surveillance system b) Controller or system initiated update of data.	HMI_Serv-20 [EMMA2]	
Func_HMI-20 Minimal Screen Congestion	Permanently displayed traffic data should be only the minimum information needed by the controller.	To avoid screen congestion and minimise overlap of displayed information, the permanently displayed traffic data should be only the minimum information needed by the controller.	HMI_Serv-21 [EMMA2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-21 Target Selection	The selection of an aircraft or vehicle target should: a) Highlight all the available representations of that target wherever such information appears, allowing for an easy location of the traffic information. b) Show the surveillance label in the appropriate selected format.	The notion of selection relates to the intention to interact with the traffic label and/or with the associated symbol and trajectory, and/or its representation through traffic data. The interface should support the notion of the currently selected traffic whose data the controller is currently examining or modifying. The selection of an aircraft or vehicle should: a) Highlight all the available representations of that traffic wherever such information appears, allowing for an easy location of the traffic information. b) Show the surveillance label in the appropriate selected format.	HMI_Serv-13 [EMMA2]	
Func_HMI-22 Accessible Information	The HMI should present a clear 'picture' of the actual traffic situation in the controller's responsibility area, with all the necessary traffic data to assist in the control and guidance tasks, i.e. to easily <u>locate and identify</u> aircraft and vehicles and to have a direct access to essential information.	Controllers should be presented with a clear 'picture' of the actual traffic situation in their areas of responsibility, and with all the necessary traffic data to assist them in their control and guidance tasks, i.e. to easily <u>locate and identify</u> aircraft and vehicles and to have a direct access to essential information.	HMI_Serv-15 [EMMA2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-23 Responsibility	The HMI should provide a clear indication that a movement is: a) Entering the controller's responsibility area; b) Inside the controller's responsibility area; c) Leaving the controller's responsibility area.	The controller should be provided with a clear indication that a movement is: a) Entering her/his area of responsibility; b) Being under her/his responsibility; c) Leaving her/his area of responsibility.	HMI_Serv-14 [EMMA2]	
Func_HMI-24	Spare			
Alert Display				
Func_HMI-25Display Alerts	On receipt of an alert report, the HMI should display alerts at the appropriate controller working positions.	Conflict information should be unambiguously displayed on a traffic situation display or by other appropriate means.	HMI_Serv-23 [EMMA2]	
Func_HMI-26 Identification	The alert information should include the identification of the involved traffic, if known.	The controller should be provided with clear and visible indication of a conflict alert as soon as the alert exists. The provided information should include, at the minimum the identification of the involved aircraft and/or vehicle, wherever present.	HMI_Serv-22 [EMMA2]	
Func_HMI-27 Route Deviation	A visual alert indication should be provided when a movement is detected to have deviated from its cleared route.	The controller should be provided with clear and visible indication when a movement is deviating from its cleared route. The provided information should include, at the minimum, the identification of the involved aircraft, wherever present.	HMI_Serv-29 [EMMA2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-28 Clearance Deviation	A visual alert indication should be provided when a movement is deviating from its clearance, or is operating without clearance.	The controller should be provided with clear and visible indication when a movement is deviating from its clearance, or is operating without clearance.	HMI_Serv-30 [EMMA2]	
Func_HMI-29 Aural Alerts	As well as the visual alert indication, highly critical events requiring immediate action should be indicated by an aural alert.	An alert should always be associated with a visual signal. The use of aural signal should be restricted to highly critical events requiring immediate action.	HMI_Serv-24 [EMMA2]	
Func_HMI-30 Alert Stages	Alerts should be indicated with two levels of severity: a) Stage 1 alert (INFORMATION) b) Stage 2 alert (ALARM)	An alert associated with a <u>detected</u> conflict should be provided with an adequate time and brought to the attention of the controller (**ALARM** coding). An alert associated with a <u>predicted</u> conflict (**INFORMATION** coding) should also be provided.	HMI_Serv-26 [EMMA2]	
Func_HMI-31 Alert Priorities	In the event of multiple simultaneous alerts, it may be appropriate to prioritise them, e.g. by listing or colour coding. In any case, a Stage 2 alert will always have higher priority than a Stage 1 alert.	Priorities should be established so as to ensure system logic performs efficiently. Conflict alerting priorities should be as follows: a) Runway conflicts b) Taxiway conflicts c) Apron/stand/gate conflicts.	HMI_Serv-27 [ICAO §3.4.5.10]	HMI_Serv-27 modified to ICAO wording.
Func_HMI-32 Alert Continuity	The visual alert should be displayed continuously as long as the alert situation persists.	The HMI should continuously display a Conflict/Infringement Alert while the conflict is detected.	HMI_Serv-25 [ICAO §3.4.5.14]	
Func_HMI-33 Alert Acknowledgement	The aural alert should be terminated when acknowledged by the controller.			
Func_HMI-34	Spare			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
EFS HMI				
Func_HMI-35 EFS Display	The HMI should provide, at each controller working position, an EFS display capable of presenting flight strips sorted into bays according to the phase of flight.	The HMI should be capable of displaying electronic flight strips (EFS) to replace the use of paper strips and support the controller by reducing workload.	HMI_Serv-31 [EMMA2]	
		The presentation of electronic flight strips should be harmonised with current paper strips and the way they are stacked in flight strip bays.	HMI_Serv-33 [EMMA2]	
Func_HMI-36 EFS Display Format	Flight strips should be highly configurable with regard to layout, size, shape, information fields, fonts, colours and interaction capability, and displayable in a variety of pre-defined formats.	Depending on operational needs, traffic data items should be highly configurable with regard to layout, size, shape, fonts, colours and interaction capability.	HMI_Serv-40 [EMMA2]	
Func_HMI-37 EFS Configurability	The layout of the flight strips should be independently configurable for each bay area.			
Func_HMI-38 EFS Data Format	The flight strip should contain data fields with all flight plan data relevant for the controller role at each position.	The flight strips should contain data fields with all flight plan data relevant for the controller role at each position.	HMI_Serv-32 [EMMA2]	
		All traffic data items pertinent to a controller should be presented in clear and pre-defined formats that help to prioritise planning and control actions.	HMI_Serv-39 [EMMA2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-39 EFS Extended Data Format	Flight strips should normally contain the minimum information required for the controller role. Additional data should be easily accessible.	Traffic Data Items should be represented in minimum format or extended format based on controllers' choice. It should be possible to configure independently the extended format of traffic data items from the minimum format, by displaying and removing additional data.	HMI_Serv-41 [EMMA2]	
Func_HMI-40 EFS Additional Data	It should be possible for the controller to expand a flight strip in order to view the complete flight plan.	The controller should be able to expand the format of a displayed traffic data item to access additional data. By default, traffic data items should be presented under normal (minimum) format.	HMI_Serv-42 [EMMA2]	
Func_HMI-41 EFS Special Fields	As well as flight plan data fields, the flight strip may contain special-purpose fields, such as: • Clearance fields for issuing clearances • Handover field for transferring the flight strip to another controller role • Regress field for returning the flight strip to its previous location • Taxi route information field • Request field to indicate pilot requests received via data link. • Data link dialogue fields			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-42 EFS Responsibility	The EFS-HMI at each working position should display the flight strips for flights under control of that position, as well as flights that will become controlled in the near future.	The HMI at each working position should display the flight strips for flights under control of that position, as well as flights that will become controlled in the near future.	HMI_Serv-34 [EMMA2]	
Func_HMI-43 EFS Grouping	Flight strips should be logically grouped in the bays according to user requirements (e.g. pending, inbound, outbound, etc.).	Flight strips should be logically grouped in bays according to the phase of flight and user requirements (e.g. inbound, outbound, pending, etc.).	HMI_Serv-35 [EMMA2]	
Func_HMI-44 EFS Sorting Criteria	The flight strip bays should contain lists of flight strips that are selected, sorted and presented according to configurable criteria.	The flight strip bays should contain lists of flight strips that are selected, sorted and presented according to configurable criteria.	HMI_Serv-36 [EMMA2]	
Func_HMI-45	Spare			
Func_HMI-46 Manual Interaction	It should be possible to manually sort and move flight strips.	Controllers should have the capabilities to sort, move, and create new traffic data items in the traffic data lists.	HMI_Serv-37 [EMMA2]	
Func_HMI-47 EFS Editing 1	If the controller role has the authority to modify certain items of flight plan data, the EFS-HMI should provide means for the controller with that authority to input missing data and to correct wrong data for a flight.	If required locally, the controller should be provided with an easy and simple means to manually create a new flight plan or modify an existing flight plan.	HMI_Serv-45 [EMMA2]	
Func_HMI-48 EFS Editing 2	It should be possible to edit editable fields of a flight strip by direct manual input, selection from pop-up lists or via dialogue windows, depending on the type of field.			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-49 EFS Editing 3	Once the controller has changed a field in a flight strip, further updates of that field by the external system should be inhibited.			
Func_HMI-50 EFS Editing 4	If required locally, the EFS-HMI should provide means for a predefined controller role to create flight strips for VFR flights and for other mobiles whose plans are not filed, for instance local traffic, towing operations and ground vehicle movements.			
Func_HMI-51 EFS Editing 5	If required locally, the EFS-HMI should provide means for the controller to input expected delays of departure operations.			
Func_HMI-52 EFS Bay Area Title Field	Flight strip bay areas should be separated by a title field.			
Func_HMI-53 EFS Bay Area Configurability	The number of bay areas and the title of each bay should be configurable for each working position according to the controller role.			
Func_HMI-54 EFS Bay Criteria	Each flight strip should be placed in the appropriate bay area based on the user-selected sorting criteria and the phase of flight.			
Func_HMI-55	Spare			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-56 EFS Initialisation	Depending on the controller role, flight strips should appear in the entry (pending) area when generated by the flight data processing system (FDPS) or when transferred from another control position.	Depending on the controller role, flight strips should appear in the entry (pending) area a pre-defined time before expected arrival or departure or when transferred from another control position.	HMI_Serv-38 [EMMA2]	
Func_HMI-57 EFS ARR Timing	Inbound flight strips should first appear at the concerned positions a configurable time before the expected landing time (ELDT).	Arrival traffic data should be displayed on concerned positions at a time parameter before the expected landing time (ELDT). The time parameter should be defined at local level.	HMI_Serv-43 [EMMA2]	
Func_HMI-58 EFS DEP Timing	Outbound flight strips should first appear at the concerned positions a configurable time before the expected off-block time (EOBT).	Departure traffic data should be displayed on concerned positions at a time parameter before the expected off-block time (EOBT). The time parameter should be defined at local level.	HMI_Serv-44 [EMMA2]	
Func_HMI-59 Flight Delay	There should be a means to recognise when a flight has been cancelled or delayed.			
Func_HMI-60 Change of CTOT	There should be a means to recognise when a CTOT has been changed or cancelled.			
Func_HMI-61 EFS Clearance Input	The EFS HMI should provide a means to input clearances into the system, in accordance with the authority allocated to the controller role at each working position.	Controllers should be presented with a means to input clearances into the system (via the electronic flight strip and/or labels).	HMI_Serv-55 [EMMA2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-62 EFS Clearance Types	Clearances should represent the normal set of clearances a controller gives to an aircraft, such as: 'cleared to land', 'continue approach', 'go-around', 'vacate', 'cross', taxi', 'start-up', 'push-back', 'hold', 'line-up', 'conditional line-up', 'take-off', 'abort take-off', etc.	Clearances should represent the normal set of clearances a controller gives to an aircraft, such as: 'cleared to land', 'continue approach', 'go-around', 'vacate', 'cross', taxi', 'start-up', 'push-back', 'hold', 'line-up', 'conditional line-up', 'take-off', 'abort take-off', etc.	HMI_Serv-56 [EMMA2]	
Func_HMI-63 EFS Clearance Durability	The EFS HMI should ensure that a logically correct sequence of clearances is observed and that the last given clearance is maintained until the flight strip is terminated.	The durability of the clearances input shall be ensured until the next clearance has been input.	HMI_Serv-57 [EMMA2]	
Func_HMI-64 Mistake Correction	The EFS HMI should enable the controller to easily correct a mistaken action, such as a wrongly given clearance.	It should be possible for the controller to easily correct a mistaken action.	HMI_Serv-58 [EMMA2]	
Func_HMI-65	Spare			
Func_HMI-66 EFS Display	If a departure management tool is operating, there should be a means to display relevant departure sequencing and timing information (such as TSAT and TTOT) to the controller.			
Func_HMI-67 EFS Handover 1	The EFS-HMI should provide manual and semi-automatic means for handover of flight strips between controllers.	The system should support the controller by automatic distribution/exchange of flight data and co-ordination between control positions.	HMI_Serv-47 [EMMA2]	
		It should be possible to trigger the 'transfer of control' procedure either manually, e.g. by ATCO's input on a flight strip, or automatically, i.e. based on a significant flight event.	HMI_Serv-50 [EMMA2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-68 EFS Handover 2	The handover mechanism should be simple and secure, e.g. by selecting a special-purpose field in the flight strip.	The HMI should provide a simple and secure means for handover of electronic flight strips between controllers.	HMI_Serv-46 [EMMA2]	
Func_HMI-69 EFS Handover 3	An electronic handover should transfer flight strips from one controller role to another and should normally consist of two actions: transfer and assume.	Controllers should be provided with system assistance for transferring aircraft control from one to another control position.	HMI_Serv-48 [EMMA2]	
Func_HMI-70 EFS Handover 4	If required locally, the EFS-HMI may provide a pop-up menu that contains entries for alternative controller roles. Selecting a menu entry should transfer the flight strip to the corresponding controller role.			
Func_HMI-71 EFS Handover 5	All information on the flight strip should be retained during handover.	The durability of annotations and instructions shall be ensured during handover.	HMI_Serv-49 [EMMA2]	
Func_HMI-72 EFS Handover 6	The controller role that has the flight strip should be allowed to transfer it to another role. After transfer, the flight strip should remain under control of the former until the latter assumes it, which completes the handover.	Similarly, it should be possible to perform the ‘assumption of control’ manually or automatically depending upon local operational practices.	HMI_Serv-51 [EMMA2]	
Func_HMI-73 Mistaken Transfer	It should be possible for a controller to take back a flight strip that has been transferred by mistake, as long as it has not been assumed by the controller to whom it was transferred.			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-74 EFS Handover Restriction	It should not be possible for a controller to take a flight strip from an active bay of another controller.			
Func_HMI-75	Spare			
Func_HMI-76 EFS Coordination Support	The EFS HMI should support coordination between Clearance Delivery, Ground and Tower controller roles.	The introduction of automation of surface movement planning and electronic flight strips should support the ATCOs coordination between Ground and Tower controllers and adjacent Approach controllers.	HMI_Serv-52 [EMMA2]	EMMA2 does not support electronic coordination between Tower and Approach
		The ground sectorisation in a tower should be based on the following types of logical sectors: • Apron / Clearance Delivery, • Ground, • Tower	HMI_Serv-53 [EMMA2]	
Func_HMI-77 EFS Combined Roles	The EFS HMI should permit controller roles to be easily combined at any physical working position.	It should be possible to combine the operational roles in a number (1 to n) of physical controller working positions based on operational constraints, e.g. traffic load, time of day, etc.	HMI_Serv-54 [EMMA2]	
Taxi Routing HMI				
Func_HMI-78 Route Selection	The HMI should provide a means for the user to access the Routing function in order to: a) Select or construct a taxi route between a given start-point and a given end-point for each movement; and b) View the proposed taxi route (whether	The HMI should be able to show and to assign the most probable/standard route to individual aircraft and vehicles to provide safe, expeditious, efficient and conflict-free movement from its current position to its intended position.	HMI_Serv-59 [EMMA2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
	manually or automatically generated) for each movement and modify it if necessary; and c) Accept the taxi route for assignment to the movement.	The controller should be provided with a quick and efficient means to modify a system assigned route to an aircraft.	HMI_Serv-61 [EMMA2]	
		The ATCO can always intervene with the electronic flight strips to set additional constraints unknown to the routing function.	HMI_Serv-62 [EMMA2]	
Func_HMI-79 Route Presentation	Taxi route information should be presented textually on the EFS Display and be easily accessible graphically on the Traffic Situation Display.	The route (path) information should be indicated alphanumerically within the EFS but should also be linked with the traffic situation display (TSD) (on request of the ATCO the route could be presented graphically).	HMI_Serv-60 [EMMA2]	
Func_HMI-80 Graphical Route Presentation 1	The HMI should clearly distinguish (e.g. by colour and/or line width) between taxi routes that are pending and taxi routes for which clearance has been given.			
Func_HMI-81 Graphical Route Presentation 2	Taxi route information (either pending or cleared) should be distinguishable from all other aerodrome map attributes.			
Func_HMI-82	Spare			
TAXI-CPDLC HMI				
Func_HMI-83 Clearance Request	The HMI should provide a means for the controller to receive and display START-UP, PUSHBACK, and TAXI clearance requests.	The controller should be provided with the capability to respond to messages, including emergencies, to issue clearances, instructions and advisories, and to request and provide information, as appropriate.	TAXI-CPDLC_Serv-13 [PANS ATM §14.1.2.1]	Emergency handling by CPDLC is not supported by EMMA2.
Func_HMI-84 Clearance Transmission	The HMI should provide a means for the controller to answer the clearance request by sending a related ground clearance.			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-85 Textual Display	The HMI should provide a textual display of the TAXI-CPDLC downlink messages received from flight crews and uplink messages from the ATSU.	Ground systems should allow for messages to be appropriately displayed, printed when required and stored in a manner that permits timely and convenient retrieval should such action be necessary.	TAXI-CPDLC_Serv-16 [PANS ATM §14.1.2.4]	
Func_HMI-86 Printing, Storage and Retrieval	Means should be provided to print, store and easily retrieve CPDLC messages.	Ground systems should allow for messages to be appropriately displayed, printed when required and stored in a manner that permits timely and convenient retrieval should such action be necessary.	TAXI-CPDLC_Serv-16 [PANS ATM §14.1.2.4]	
Func_HMI-87 Message Formats	Displayed CPDLC message formats should use standard phraseology and construction with unambiguous terms as established in ATC procedures or data link standards.			
Func_HMI-88 No Overwrite	Displayed CPDLC messages should not be automatically overwritten.			
Func_HMI-89 Free Text Messages	If required locally, the HMI should provide the means to compose, transmit, receive and display free text messages.	The controller should be provided with the capability to exchange messages which do not conform to defined formats (i.e. free text messages).	TAXI-CPDLC_Serv-15 [PANS ATM §14.1.2.3]	
Func_HMI-90	Spare			
Func_HMI-91 Data Link Equipage	The HMI should indicate, by a field in the flight strip or in the flight plan, whether or not an aircraft is equipped for TAXI-CPDLC and whether or not it has connected to the CPDLC end-application.	The controller should be informed if an aircraft is data link equipped or not.	HMI_Serv-71 [EMMA2]	
Func_HMI-92 Dialogue Deactivation	The HMI should provide a means for the controller to deactivate the data link dialogue and inform the flight crew to revert to voice.	The controller should have the means to de-activate the data link dialogue for a particular aircraft.	HMI_Serv-73 [EMMA2]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_HMI-93 Data Link Failure	In the event of a failure of the TAXI-CPDLC communication link (e.g. non-receipt of LACK) the HMI should display a visual alert, accompanied, if required locally, by an aural alert.	An alert should be presented to the controller when a data link dialogue has failed.	HMI_Serv-72 [EMMA2]	
Func_HMI-94	Spare			
Stop Bars				
Func_HMI-95 Lighting Status	Information about the status of the lighting system and protection devices such as stop bars (on/off) should be easily accessible at the Controller HMI.	The information about the status of the lighting system and protection devices such as stop bars (on/off) should be easily accessible to the controller.	HMI_Serv-28 [EMMA2]	Ground lighting is not covered by EMMA2.
		The display of stop bars should be integrated into the A-SMGCS HMI.	HMI_Serv-67 [EMMA2]	
Func_HMI-96 Stop Bars Status	The HMI should continuously present the status of stop bars.	The current status of stop bars should always be presented to the controller.	HMI_Serv-68 [EMMA2]	
Func_HMI-97 Stop Bars Manual Switching	It should be possible to manually activate or de-activate stop bars.	It should be possible to manually switch (i.e. activate or de-activate) protection devices such as stop bars.	HMI_Serv-70 [EMMA2]	
Func_HMI-98 Stop Bars Automatic Switching	It should be possible to automatically de-activate the stop bar at a runway entrance when an aircraft is cleared to cross or line up and to reactivate the stop bar when the aircraft has crossed the stop bar.	Switching (i.e. activate or de-activate) status of stop bars should be changed automatically according to ATCO clearances and a/c position.	HMI_Serv-69 [EMMA2]	Control of ground guidance aids is not covered by EMMA2.
Func_HMI-99	Spare			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
MET Display				
Func_HMI-100 MET Data	The HMI should continuously display weather information, including (per runway): surface wind direction (touch down) and strength (graphical and text), QNH (mb), ATIS code, temperature and dew point.	Minimum weather information should always be displayed and available to the controller and should include (per runway): surface wind direction (touch down) and strength (graphical and text), QNH (mb), ATIS code, temperature and dew point.	HMI_Serv-63 [EMMA2]	No requirement to integrate MET data into the EMMA2 Controller HMI.
Func_HMI-101 Additional MET Data	The HMI should provide easy access to additional weather information including surface wind (Touch Down and Stop End), visibility, current weather, cloud ceiling, QNH and QFE (mb and inches), weather forecast information, RVR conditions and a remarks section.	The controller should be provided with an easy means to access to additional weather information that should include surface wind (Touch Down and Stop End), visibility, current weather, cloud ceiling, QNH and QFE (mb and inches), weather forecast information, RVR conditions and a remarks section. The display should either be provided on controller request or automatically triggered on specific events defined at local level.	HMI_Serv-64 [EMMA2]	No requirement to integrate MET data into the EMMA2 Controller HMI.
Navaids				
Func_HMI-102 Navaids Status	The HMI should provide easy means to access the status of airport navaids equipment.	The controller should be provided with an easy means to display on request the status of airport NAVAIDS equipment.	HMI_Serv-65 [EMMA2]	No requirement to integrate Navaids status into the EMMA2 Controller HMI.
Func_HMI-103 Navaids Serviceability	An alert should be given in the event of a failure of navaids equipment.	The controller should be warned automatically in case of modification of airport NAVAIDS equipment serviceability.	HMI_Serv-66 [EMMA2]	No requirement to integrate Navaids alerts into the EMMA2 Controller HMI.

Table 8-1: Functional Requirements for Controller HMI

8.3.2 Performance Requirements

The following table lists performance requirements for the Controller HMI.

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Accuracy and Resolution				
Perf_HMI-01 Map Accuracy	The accuracy of all map information to be presented on the HMI display(s) should be 1m or better.	The accuracy of all map information presented on the traffic situation displays should be sufficient to ensure that each movement is seen in the correct position with respect to the aerodrome layout and other traffic, and particularly with respect to hold lines and stop bars.	HMI_Perf-01 [EMMA2]	
Perf_HMI-02 Display Resolution	The resolution of the HMI displays should be sufficiently high that quantisation errors are negligible. As a minimum, the display resolution should be 1024 lines of 1280 pixels.	The resolution of the HMI displays should be sufficient to not noticeably degrade the accuracy of the information being presented.	HMI_Perf-02 [ED-87B §3.4.1.1]	
Perf_HMI-03 Position Registration Accuracy	The position registration accuracy of all information presented on the HMI display(s) should be one pixel.	The accuracy with which the HMI registers position information on the display should be sufficient to not appreciably degrade the accuracy of the information it receives from surveillance.	HMI_Perf-03 [ED-87B §3.4.1.2]	
Timeliness				
Perf_HMI-04 Target Display Latency	The Target Display Latency should not exceed 500 ms.	The presentation of surveillance data to controllers should not be delayed to an extent where it is no longer operationally acceptable. A worst-case value of 500ms is appropriate.	HMI_Perf-04 [ED-87B §3.4.1.3]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Perf_HMI-05 Response Time to Operator Input	The Response Time to Operator Input should not exceed 250 ms on average and should never exceed 500 ms.	The response time of the ATCO HMI should be adequate to allow the controller to make inputs without having to wait unduly for the system to process and validate the input. This should be less than 250ms on average and should never exceed 500 ms.	HMI_Perf-05 [ED-87B §3.4.1.5]	This does not include the time taken for external systems (e.g. stop bars) to respond.

Table 8-2: Performance Requirements for Controller HMI

8.3.3 Interface Requirements

The following table lists interface requirements for the Controller HMI.

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Data Communication Protocols				
Intf_HMI_01 Interface Requirements	The Controller HMI should comply with the general interface requirements given in section 3.3.			
Data Formats				
Intf_HMI_02 Data Format	The data interchange with ground systems should be performed in a standardized format in order to ensure an adequate exchange of information.	The data interchange with ground systems should be performed in a standardized format in order to ensure an adequate exchange of information.	ICAO §2.6.16.2	Currently there are no standard data formats for this type of interface. Proprietary formats may be used.

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Intf_HMI-03 Time Stamp	TAXI-CPDLC uplink messages from the Controller HMI should be time-stamped with the date (YYMMDD) and time (HHMMSS) when the message is composed.	Time stamping should be available for all messages. The timestamp should consist of the date (YYMMDD) and time (HHMMSS). The timestamp should be the time the message is dispatched by the originating user.	TAXI-CPDLC_Serv-18 [ICAO DLIV §2.7]	

Table 8-3: Interface Requirements for Controller HMI

9 Supporting Functions

9.1 General Description of Supporting Functions

The Supporting Functions are sub-divided into three functions:

a) Configuration database
b) Service monitoring
c) Recording and playback

These are briefly described in the following sub-paragraphs.

9.1.1 Configuration Database

The Configuration Database contains all traffic context data, except traffic information (mobiles position and identity), which is necessary for the ATCo in its surveillance task.

The Configuration Database at least includes:

- Airport layout: geographical representation of various airport areas (TWY, RWY, etc.)
- Reference points: ARP, Surveillance sensor locations, RWY thresholds, holding positions, stop bars, stand locations
- Fixed obstacles
- Restricted Areas
- Localizer Sensitive Areas

The traffic context data may optionally include (local issue):

- Operational status of runways and taxiways (open / closed)
- Operational status of ATS systems: landing systems aids, ATIS,
- Other data: meteorological conditions,

The Configuration Database also contains variable system parameters needed to adapt the system to local requirements and to changes in aerodrome operations or operational rules at the aerodrome.

It includes a means of modifying topological and topographical information and parameters, and a means of transferring selected contents of the database to the respective system elements.

9.1.2 Service Monitoring

This function monitors the quality of service of A-SMGCS (equipment status, performances, operational failures, etc.) and generates an alert when A-SMGCS must not be used for the intended operation.

9.1.3 Recording and Playback

This function records selected data on communication, control activity and display information to satisfy State legislation for accident and incident investigation.

The data can be archived for the period of time required by the authority and retrieved at any time for immediate playback, either to the operational system to check that it is functioning correctly or to separate playback equipment for accident or incident investigation.

9.2 Supporting Function Requirements

In this section are listed the technical requirements related to the Supporting Functions of the A-SMGCS. These requirements are valid at all levels of implementation of an A-SMGCS. Most requirements have been derived from the SPOR document [2] and the referenced EUROCAE ED-87B [7] and ICAO Doc 9830 [14] documents. Where these are lacking, additional technical requirements have been included.

The requirements are divided into two subsections: Functional and Interface Requirements, with associated identifiers Func_SUPP-nn, and Intf_SUPP-nn, where nn is a two-digit number. Currently there are no specific performance requirements for supporting functions.

For traceability, requirements include references to all parent operational requirements listed in the SPOR document [2] and, where applicable, to other sources. The ICAO A-SMGCS Manual (Doc 9830) [14] is the prime source of the parent requirements.

9.2.1 Functional Requirements

The following table lists functional requirements for the Supporting Functions.

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Traffic Context				
Func_SUPP-01 Traffic Context 1	This function should gather data from other airport systems to provide relevant information about the status of runways and taxiways, the runway(s) in use and meteorological conditions.			
Func_SUPP-02 Traffic Context 2	It should be possible to manually update topological and topographical data that cannot be updated automatically.			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_SUPP-03 Traffic Context 3	This function should provide all topological and topographical information necessary for the A-SMGCS, including: • Airport layout: geographical representation of various airport areas (TWY, RWY, etc.) • Reference points: holding positions, stop bars (and other airfield lighting), RWY thresholds, etc. • Fixed obstacles			
Func_SUPP-04 Traffic Context 4	The technical support equipment should have a user-friendly and efficient means of entering and editing traffic context data.			
Func_SUPP-05 Traffic Context 5	For the Conflict/Infringement detection, the function should provide updated information on: • Airport Configuration: runways in use, runways status, restricted areas, • Applied procedures and working methods: LVP, multiple line-ups			
Func_SUPP-06 Operational Change	This function should be capable of accommodating any operational change of the aerodrome, for instance a physical change in layout (runways, taxiways and aprons), or a change in the aerodrome procedures, rules	This function should be capable of accommodating any operational change of the aerodrome, for instance a physical change in layout (runways, taxiways and aprons), or a change in the aerodrome procedures, rules.	[ICAO §3.4.5.2.b]	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_SUPP-07 Adaptation to local procedures	This function should permit configuration of the Conflict/Infringement detection parameters in order to adapt to local rules.			
Func_SUPP-08 Runway Protection Area	For each runway, the traffic context function should define a configurable topological area, the runway protection area, composed of two boundaries: A ground boundary to detect the mobiles on the surface, and an air boundary to detect airborne aircraft.	The runway protection area should be composed of two boundaries: a ground boundary to detect the aircraft/vehicles on the surface, an air boundary to detect airborne aircraft.	ALERT_Serv-12 [ECTL D6]	
Func_SUPP-09 Ground Boundary	The length of the ground boundary should include the runway strip. The width should be defined according to the meteorological conditions, one width for Non-LVP and a wider width for LVP.	The length of the ground boundary should at least include the runway strip. The width should be defined differently according to the meteorological conditions.	ALERT_Serv-13 [ECTL D6]	
Func_SUPP-10 Air Boundary	The air boundary should be parameterised and configurable to take into account the two stages of alert, as well as the meteorological conditions. The time to threshold parameter should be typically: • Non-LVP: Prediction around T1 = 30s, Alert around T2 = 15s • LVP: Prediction around T1 = 45s, Alert around T2 = 30s	The air boundary should be defined as a flight time to threshold and would take into account the two stages of alert, INFORMATION and ALARM, as well as the meteorological conditions: • Non-LVP: INFORMATION around T1 = 30s ALARM around T2 = 15s • LVP: INFORMATION around T1 = 45s ALARM around T2 = 30s.	ALERT_Serv-14 [ECTL D6]	
Func_SUPP-11	Spare			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Service Monitoring				
Func_SUPP-12 Status Monitoring	The system should provide a technical workstation with suitable HMI for monitoring the status of each major item of equipment.	Monitoring of the performance of an A-SMGCS should be provided so that operationally significant failures are detected and remedial action is initiated to restore the service or provide a reduced level of service.	GEN_Serv-29 [ICAO §2.7.4.3]	
Func_SUPP-13 Failure Alert	A clear indication should be given in the event of any failure of an item of equipment.			
Func_SUPP-14 Controller Alert	Operationally significant failures should be reported to the Controller HMI.			
Func_SUPP-15 System Expansion	The system should be capable of expansion to accept and integrate data from other surveillance sensor sources in the future.			
Func_SUPP-16	Spare			
System Configuration and Control				
Func_SUPP-17 System Configuration	The system should provide a technical workstation with suitable HMI for configuring and controlling each major item of equipment.			
Recording and Playback				
Func_SUPP-18 Recording Equipment	The system should provide recording equipment capable of continuously recording and archiving relevant data in order to re-construct the image at any controller working position later.	Selected data on communications, control activity and display information should be recorded for accident and incident investigation.	ICAO §2.6.8.1	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Func_SUPP-19 Playback Equipment	The system should provide playback means to directly replay recorded data within the operational system, as part of the requirement for immediate checking of suspect equipment and initial incident investigation.	There should be a function to provide direct replay of recorded data within the operational system, as part of the requirement for immediate checking of suspect equipment and initial incident investigation.	ICAO §2.6.8.2	

Table 9-1: Functional Requirements for Supporting Functions

9.2.2 Interface Requirements

The following table lists interface requirements for the Supporting Functions.

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
Data Communication Protocols				
Intf_SUPP-01 General Requirements	The Supporting functions should comply with the general interface requirements given in section 3.3.			
Data Formats				
Intf_SUPP-02 Data Format	The data interchange with ground systems should be performed in a standardized format in order to ensure an adequate exchange of information.	The data interchange with ground systems should be performed in a standardized format in order to ensure an adequate exchange of information.	ICAO §2.6.16.2	Currently there are no standard data formats for this type of interface. Proprietary formats may be used.

Table 9-2: Interface Requirements for Supporting Functions

10 Air-Ground Interoperability Requirements

This section presents separately the interoperability requirements identified to ensure the air-ground interactions for EMMA2 services.

The sub-sections include the interoperability requirements associated with the data link services used (ADS-B, TIS-B, TAXI-CPDLC) and covers:

- Technical standards used for data links (aircraft and ground)
- Usage or non-usage of available data elements and message types and reports
- Quality of service requirements associated with exchanged information
- Abnormal event handling and recovery, and interoperability requirements associated with recovery from those modes.

10.1 ADS-B

10.1.1 Background

Automatic Dependent Surveillance (ADS) is an ATS ATN application, in which aircraft automatically transmit, via a data link, data derived from on-board navigation systems. As a minimum, the data include three-dimensional position, the corresponding time of the position data, and a Figure of Merit (FOM) that characterises the accuracy of the position data. Additional data may be provided as required. The technology can be used on-board vehicles as well as aircraft.

The ADS-B Surveillance application allows the transmission of on-board data to air or ground-based users via a data link using a broadcast mode. The aircraft or vehicle originating the broadcast has no knowledge of which systems are receiving the broadcast. Any air or ground-based user may choose to receive and process this information.

ADS-B has the capability to provide accurate and timely position information about aircraft and vehicles and to provide the unambiguous identity of each aircraft and vehicle, while keeping RF pollution within acceptable levels.

There are two principle ADS-B technologies recognized at ICAO level, these are:

- Mode-S "extended squitter" (1090ES ADS-B)
- VDL Mode-4.

In addition, the Universal Access Transceiver (UAT) technology is being developed by US industry for general aviation.

The EMMA2 ground stations will be capable of receiving and processing 1090ES ADS-B data.

10.1.2 Parameters of 1090ES ADS-B

For A-SMGCS surveillance purposes, only the following 1090ES parameters are of interest:

- Aircraft/vehicle parameters: position (transmitted through registers BDS 0,5 and BDS 0,6) and identity (transmitted through register BDS 0,8)
- ESS and ESP[1] parameters: position integrity, position accuracy, and Mode S health (transmitted through register BDS 0,7)[2].

[1] Embedded System Status and Embedded System Performances
[2] Not all transponders have this capability.

10.1.2.1 Aircraft / Vehicle Identity

For an aircraft equipped with a Mode S transponder, there are three possible identifiers:

- Aircraft Mode A code
- Aircraft Address (24-bit Mode S Address)
- Aircraft Identification (Callsign from BDS register 2,0)

The Mode A code[3] is entered into the transponder by the pilot to identify the flight. Because there are only 4096 codes available, the Mode A code may have to be changed during a flight.
The ICAO 24-bit Aircraft Address is an individual and unique identification number assigned to each aircraft. It cannot be changed from the cockpit.

On modern transponders, the pilot can identify the flight by entering the Callsign, as recorded in the associated Flight Plan, into the transponder or flight management system. This information will eventually be used by ATC systems as the primary means of identifying flights and will replace the current usage of Mode A codes for this purpose. Requirements for the format of the Mode S Aircraft Identification are detailed in ICAO Annex 10 [15].

10.1.2.2 Aircraft / Vehicle Position Information

If ADS-B is to be useful in the A-SMGCS domain, it is essential that the position reports are at least as accurate as those provided by SMR and MLAT systems, i.e. 7.5 metres or better. It is equally important that ADS-B position reports include Figure of Merit data to inform the Ground system that the source of the position measurement (i.e. the on-board navigation system) is operating correctly and that it is indeed providing position data of the required accuracy.

10.1.2.3 Timeliness of Position Information

Equally as important as the accuracy of the position information is the timeliness of the information. Delays in the processing and down linking of position information must be kept short or the information will be unusable. For example, a latency figure of 2 seconds between the measurement of the aircraft position and the presentation of the position information to the controller means that a aircraft / vehicle moving at 30 knots will progress approximately 30 metres after the measurement is made. This means that, if the original measurement error is 5 metres, by the time the information is presented to the controller the aircraft / vehicle can be as much as 35 metres from the position shown for the target. Since the operational requirement (yet to be validated) for A-SMGCS is currently stated as 7.5 metres, there is virtually no margin for delay in collecting, transmitting, receiving, processing and displaying the position data.

10.1.2.4 Update Rate

Due to the small distances involved and the rapid changes of speed and direction that aircraft / vehicles can make on the airport surface, the position information should be updated at a high rate. In practise, an update rate of once per second has been found to be acceptable, but a higher rate could be desirable.
For identity information, a lower update rate is acceptable. A mobile’s identity should be confirmed at least every 10 seconds.

10.1.2.5 Embedded System Status (ESS) & Performances (ESP)

Embedded System Status messages provide:

- The status of the transmitting ADS-B function
- The status of the navigation system used in ADS-B messages.

The performances of an ADS-B system address the following parameters:

[3] The Mode A code is not part of an ADS-B transmission; it has to be obtained by interrogation. In the longer term, once ADS-B becomes fully established, Mode A codes will no longer be used.

1) Accuracy of the transmitted position: NAC (Navigation Accuracy Category)
The NACp is reported so that surveillance applications may determine whether the reported geometric position has an acceptable level of accuracy for the intended use.
NIC and NACp replace the earlier term NUCp used in ICAO Annex 10 Vol. III [15].
The NACp is based on the EPU (Estimated Position Uncertainty), which is a 95% accuracy bound on the horizontal position.
EPU is defined as the radius of a circle, centred on the reported position, such that the probability of the actual position being outside the circle is 0.05. When reported by a GPS or GNSS system, EPU is commonly called HFOM (Horizontal Figure Of Merit). Likewise, the Vertical EPU stands for the Vertical Figure of Merit for GNSS-based systems.
For example, NACp=5 for EPU<926 m (0.5NM).

2) Integrity of the transmitted position and velocity:
   a) NIC (Navigation Integrity Category) for position and velocity
The NIC is reported so that surveillance applications may determine whether the reported geometric position has an acceptable level of integrity for the intended use. The NIC parameter is intimately associated with the SIL (Surveillance Integrity Level) parameter described below.
The NIC parameter specifies an integrity containment radius Rc. The SIL parameter specifies the probability of the true position lying outside that containment radius without alerting, including the effects of the airborne equipment condition, which airborne equipment is in use, and which external signals are used.
For example, NIC=2 for Rc<14.816 km (8NM).
NIC is reported by an aircraft because there will not be a uniform level of navigation equipage among all users. Although GNSS is intended to be the primary source of navigation data used to report ADS-B position data (and is the only source with acceptable accuracy for the A-SMGCS application), it is anticipated that during initial uses of ADS-B/TIS-B, or during temporary GNSS outage an alternate source of navigation may be used for transmission.
   b) SIL (Surveillance Integrity Level)
The Surveillance Integrity Level defines the probability of the integrity containment radius used in the NIC parameter being exceeded, without detection, including the effects of the airborne equipment condition, which airborne equipment is in use, and which external signals are used by the navigation source.
For example, SIL=2 for a probability of exceeding the Rc integrity containment Radius without detection of 10-5 per flight hour or per operation.

3) Surface squitter rate selected (High/Low)
This squitter indicates the selected rate used for surface squitter transmitting (high or low).

10.1.2.6 Addressing/Routing Aspects

The interfaces between aircraft and ground systems concern 1090ES ADS-B only, i.e. all exchanges are made via the Mode-S transponder.

- Air-ground interoperability for A-SMGCS is covered in Chapter 10 of this document.
- Interoperability between aircraft and ground MET systems (e.g. D-ATIS data link service) is not in the scope of EMMA2

The protocols within the Mode S system permit to uplink messages intended for all aircraft in the coverage area and to downlink messages to be made available to all interrogators.

10.1.2.7 Security Aspects

Today, no security functions against malicious attack – jamming – spoofing (to generate false reports) have been defined for dependant surveillance networks.

A special focus should be paid in the future on aircraft navigation instruments spoofing (GPS), on communication signal spoofing (1090 MHz for Mode S for instance) and on flooding external messages.

10.1.3 Current Issues with ADS-B for Surface Movements

The first implementations and use of ADS-B on airport and onboard aircraft have revealed several technical and operational issues:

- Discrepancy between the aircraft positions given by the ADS-B system and the position given by other sensors (MLAT, SMR), which are apparently more accurate.
- Incorrect aircraft identification input by the pilot.
- Variable ADS-B report update rate: some targets are updated irregularly and target reports sometimes simply cease for a while and re-appear later on.
- Note that the Mode S ADS-B standard (RTCA DO-260A) states that stationary targets shall enter, after a while, a low rate mode, which means:
    - Positional update (surface position extended squitter ADS-B message) approximately once every 5 seconds
    - Identity update (identity and type extended squitter ADS-B message) approximately once every 10 seconds.
- Latency of target reports: there can be an unacceptably high delay (> 0.5 second) between the calculation of the target position by the on-board system and the receipt of the target position report by the ground system. Furthermore, the latency is not constant but randomly variable from about 0.5 seconds up to two seconds.

In addition, the introduction of the surveillance service to flight crews requires that the surveillance data provided to the aircraft be of adequate quality to ensure:

- Correctness and completeness of the traffic situation picture provided to the flight crew (the traffic situation picture must include all relevant traffic, including targets not equipped with cooperative surveillance means)
- Consistency between the traffic situation picture provided to flight crew and the one provided to the ATCOs

These critical issues should be addressed in EMMA2. The following guidelines have been devised by the EMMA2 consortium:

- The first task is to ensure that the technical standards for ADS-B/TIS-B are sufficient to fulfil A-SMGCS operational requirements, without inducing controller and pilot confusion or additional workload.
- Furthermore, update rates should be investigated in order to ensure that aircraft moving again after a stationary state (30s at a holding point for instance) immediately update their target reports accordingly.

The related requirements in this document on identification, position accuracy, update rate and integrity should be adequate.
In addition, abnormal events, for instance an aircraft transmitting erroneous information, should be detected by the ground system (this is currently realised by the sensor data fusion) and the corrected information should be broadcast to other aircraft.

10.2 Traffic Information System Broadcast (TIS-B)

Traffic Information Service - Broadcast (TIS-B) is a surveillance technique that provides surveillance information from the ground to suitably equipped air or ground-based mobiles (an aircraft in the air or on the ground, or a surface vehicle) on Objects of Interest. Objects of Interest are the physical objects for which any TIS-B user may require information, principally the aircraft and airport vehicles, but also significant obstacles.

The broadcast traffic information is derived from one or more ground surveillance sources. The related ground system originating the broadcast has no knowledge of which systems are receiving the broadcast.

TIS-B should broadcast predefined sets of traffic information, with an identified Quality of Service (such as availability, continuity, integrity, nominal accuracy and latency characteristics of the broadcast traffic items).

TIS-B should support a number of TIS-B Services, a service being defined as a data stream with predefined characteristics made available to the TIS-B Users.

Each TIS-B service can be described through the following attributes:

- Track Selection, i.e. the definition of which targets will be broadcast by the TIS-B service
- Track Data Items Definition, i.e. the definition of which traffic information items (parameters) will be broadcast by the TIS-B service, with which resolution
- Transmission characteristics, i.e. which reporting period for each of the traffic items
- Quality of Service, i.e. the:
    - Nominal accuracy and latency characteristics of the broadcast traffic data items
    - Integrity
    - Availability
    - Continuity

For EMMA2, the TIS-B service will be an A-SMGCS service. The TIS-B ground station should broadcast target reports for traffic and obstacles on the aerodrome movement area and for airborne aircraft approaching and/or departing the aerodrome. The target report update rate should be the same as that of the Surveillance Data Fusion (typically, once per second for surface targets).

10.2.1 Aircraft/Vehicle Identity

The basic identification information conveyed by the TIS-B system should include the following elements if they are available:

- Target address and Address Qualifier (either ICAO 24-bit address or ICAO Mode A Code)
- Callsign (Aircraft Identification)
- Target Category

10.2.2 Aircraft / Vehicle Position Information

Position information is transmitted in a form that can be translated without loss of accuracy, integrity to latitude, longitude, geometric height and barometric pressure altitude.

10.2.3 Time of Applicability

The time of applicability of TIS-B messages indicates the time at which the reported values were valid (computed from the reception time). Time of applicability should be provided in all reports containing State Vector information.

10.2.4 Latency

TIS-B system latency is the component of latency attributed to the TIS-B system, which is composed of ground and aircraft systems.
The TIS-B latency is measured from the time of sensor measurement to the Time of Arrival (TOA) computed in the TIS-B receiving system.

10.2.5 Update Rate

TIS-B messages use one of two levels of precision (Fine and Coarse) in reporting position. Coarse format data are derived from an SSR/PSR with an update rate of approximately once per 5 seconds and is expected to have a positional accuracy less than that of TCAS.

Fine TIS-B messages derived from A-SMGCS have an update rate of approximately once per second and are expected to have a positional accuracy that is greater than that of TCAS.

10.2.6 Embedded System Status (ESS) & Performance (ESP)

The parameters NIC/SIL related to integrity and NACp/NACv related to position and velocity accuracy are provided through a dedicated TIS-B message.

10.2.7 Addressing/Routing/Security Aspects

The same considerations apply as for the ADS-B rationale (refer to section 10.1.2.8).

10.3 ADS-B/TIS-B Interoperability Overview

Mode S extended squitter systems supporting ADS-B and TIS-B protocols should conform to the functional model depicted in the Figure 10-1: ADS-B/TIS-B Functional Model.

In this figure:

- The term "ADS-B Out" indicates a capability of an aircraft or surface vehicle to support the transmission of ADS-B messages (i.e. equipped with a transmitting system as described in the figure).
- The term "ADS-B In" indicates a capability of an aircraft, surface vehicle or ground system to support the receiving of ADS-B messages (i.e. equipped with a receiving system as described in the figure).
- The term "TIS-B Out" indicates a capability of a ground system to support the transmission of TIS-B messages (i.e. equipped with a transmitting system as described in the figure).
- The term "TIS-B In" indicates a capability of an aircraft or surface vehicle to support the receiving of TIS-B messages (i.e. equipped with a receiving system as described in the figure).

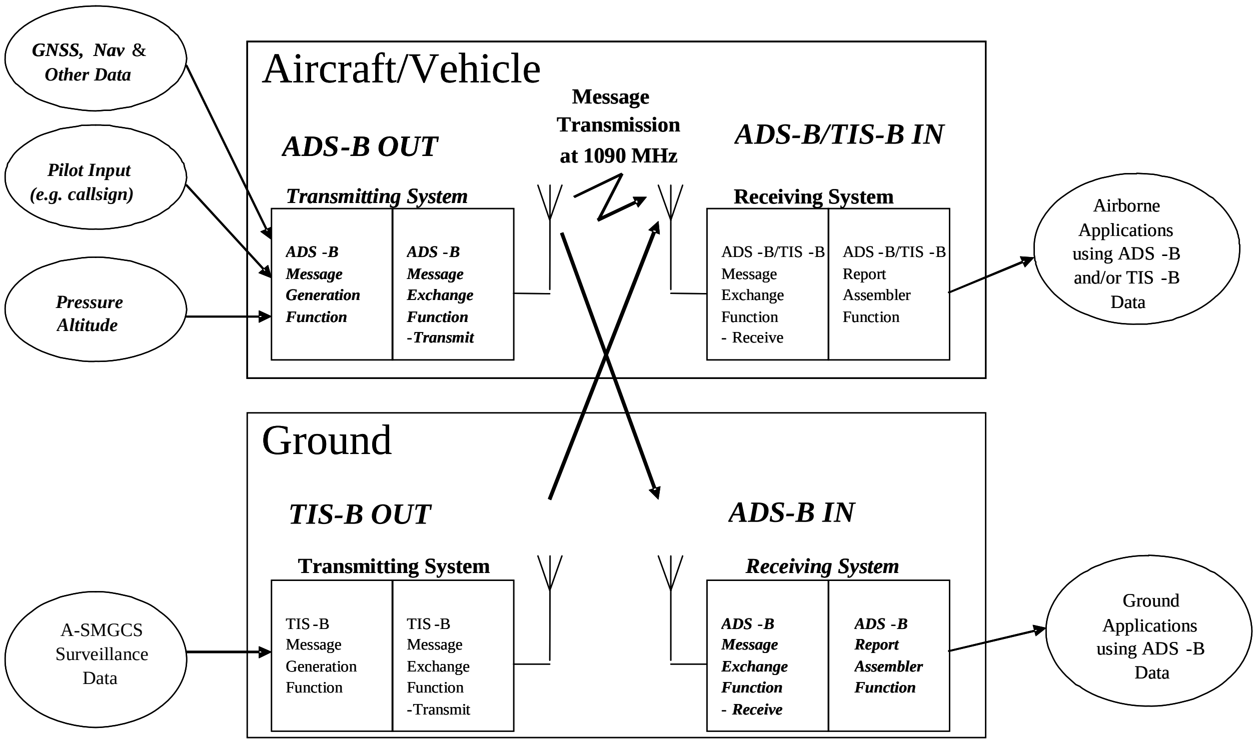

Figure 10-1: ADS-B/TIS-B Functional Model

The different ADS-B/TIS-B functions called “Message Generation Function”, “Message Exchange Function”, and “Report Assembly Function” are described in details in the RTCA/DO-260A MOPS ADS-B document [23].

10.3.1 ADS-B/TIS-B Standard Documents

The 1090 MHz ADS-B/TIS-B System uses the Mode S Extended Squitter defined in the ICAO Annex 10, Volumes III and IV, [15] to broadcast the aircraft/vehicle position, identity and other relevant information over the RF medium. Volume III also provides the Mode S transponder register definitions as well as the 56-bit data formats required for the ADS-B and TIS-B Messages.

RTCA/DO260A[4] MOPS ADS-B Appendix A [23] specifies the formats of the Mode S transponder registers contained in ICAO Annex 10, Volume III.

SARPs Mode S have to be updated for extended squitter transmitting and receiving systems to include support to ADS-B and TIS-B services as already described in the DO-260A MOPS 1090 ES document.

The DO-260A MOPS includes many changes including substantial new material related to the required capabilities of the Mode S extended squitter receiving systems and some updates to the material related to the categories of extended squitter transmitting systems. Integrity and accuracy of the data being transmitted has been modified by the introduction of the NIC (Navigation Integrity Category), NAC (Navigation Accuracy Category) and SIL (Surveillance Integrity Level) parameters.

[4] Most of the currently available equipment complies with the DO-260 standard. Implementers should take differences between DO-260 and DO-260A into consideration.

10.4 ADS-B Interoperability Requirements

The following table lists the interoperability requirements applicable for an ADS-B service in the airport environment. Source references are maintained for ease of traceability.

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
ADS-B Out Aircraft/Vehicle				
INT_MODE_S-01	Aircraft or vehicle should be equipped with Class B extended squitter systems (providing a transmission only capability without reception capability)		RTCA/DO260A	Mode S extended squitter transmitting/receiving equipment is classified according to the unit's range capability and the transmitting/receiving capabilities.
INT_MODE_S-02	Ground systems should be equipped with Class C extended squitter systems (providing a reception only capability without transmission capability)			
INT_MODE_S-03	The aircraft/vehicle should transmit the following Mode S extended squitters for transmitting position and identity parameters: • BDS 0,5: airborne position • BDS 0,6: surface position • BDS 0,8: identification & category		RTCA/DO260A	
INT_MODE_S-04	The aircraft/vehicle should transmit the following Mode S extended squitters for transmitting system status and performance: • BDS 0,7: extended squitter status		RTCA/DO260A	Provide capability and status of the ES rate of the transponder. Not all Mode S transponders have this capability.

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
INT_MODE_S-05	The aircraft/vehicle should be compliant with the minimum update rates defined in the RTCA/DO260A MOPS document, which are summarized below: Airborne Position: 0.4-0.6s Surface position High rate: 0.4-0.6s Surface position Low rate: 4.8-5.2 s Identification: 4.8-5.2 s Identification Low rate: 9.8-10.2 s Target State and Status: 1.2-1.3 s Operational State: 0.7-0.9 s Operational State: 2.4-2.6 s		RTCA/DO260A	Low rate is active when navigation source position has not changed by more than 10m in a 30s sampling interval. Target State and Status transmitted only when aircraft is airborne. Operational State is transmitted at high rate if Target and Status is not being broadcast and there has been a change within the past 24 seconds on the following parameters: • TCAS/ACAS operation • ACAS/TCAS RA • NACp • SIL
INT_MODE_S-06	Spare			
INT_MODE_S-07	The airborne design and installation should ensure that HPL and HFOM values (from GNSS) are provided to the ADS-B transmit function for the calculation of NUC/NIC/NAC parameters.		RTCA/DO260A	
ADS-B In Ground Station				
INT_ GND-01 Input	The ADS-B Ground Station should be capable of receiving and decoding 1090ES messages from transponders.			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
INT_ GND-02 Processing	The ADS-B Ground Station should process Mode S ADS-B messages and output the positional information, the target identity, the appropriate validity time, and any quality, mode, or other A-SMGCS relevant information included in the ADS-B message. The system should be able to decode the ADS-B information as defined in the most recent version of the ICAO Manual on Mode S Specific Services, or its successor.			
ADS-B In Aircraft/Vehicle				
INT_ AIRB-01 Input	Aircraft or vehicle should be equipped with **Class A extended squitter systems** (providing both transmission and receiving capabilities)		RTCA/DO242A	This class allows ADS-B and TIS-B reception.
INT_ AIRB-02 Receiving	The ADS-B receiving system should be able to decode the ADS-B information (squitters) as defined in the most recent version of the RTCA/DO260A document (version 1) or eventually its former version DO260 (version 0).		RTCA/DO260A	
INT_ AIRB-03 Time Stamp	The ADS-B receiving system should be capable of time-stamping the decoded ADS-B message. For an ADS-B message containing position information, the time stamp should represent the time of applicability of the position. For all other messages, the time stamp should represent the time of report composition or the time of receipt of the ADS-B message.			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
INT_ AIRB-04 Latency	The delay between the Mode S signal reception and outputting the decoded ADS-B message from the ADS-B receiving system should not exceed 2.0 milliseconds.		RTCA/DO260A	
INT_ AIRB-05 Association	The ADS receiving system should use the content of the 24-bit address field: • To correlate all ADS-B messages transmitted from each aircraft/vehicle • To differentiate it from other aircraft/vehicles in the operational domain			
ADS-B Operations				
INT_ ADSB_OP-01 Unique address	All aircraft/vehicle addresses should be unique within the dedicated airport domain. ADS-B systems that broadcast vehicle identification information should be designed and installed such that the identification information must be manually confirmed by the vehicle operator prior to operation.			
INT_ ADSB_OP-02 Consistent address	Aircraft with Mode-S transponders using an ICAO 24-bit address should use the same 24-bit address for ADS-B.			
INT_ ADSB_OP-03 Failure monitoring	In case of any failure of ADS-B transmitting or receiving systems, the flight crew/driver or ATC controller should be notified through adequate means.			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
INT_ ADSB_OP-04 Performance monitoring	When the performance levels of ADS-B transmitted information regarding latency or integrity are not reached for a specific target, the flight crew/driver or ATC controller should be notified through adequate means.			
INT_ ADSB_OP-05 High-density environment	The ADS-B receiving system should operate in high-density airspace.			
INT_ ADSB_OP-06 Range	The minimum ADS-B-Out to ADS-B-In Operational Range (95% squitters receiving) is 5 Nm for airport operations.		RTCA/DO242A	

Table 10-1: ADS-B Interoperability Requirements

10.5 TIS-B Interoperability Requirements

The following table lists the interoperability requirements applicable for a TIS-B service in the airport environment. Source references are maintained for ease of traceability.

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
TIS-B Out Ground				
INT_TISB-01 Transmitter	Ground systems should be equipped with Class B 1090 extended squitter systems (providing a transmission-only capability without reception capability)			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
INT_TISB-02 Coverage	The TIS-B system should be capable of providing reports for aircraft, vehicles and designated obstacles in the aerodrome movement area.		RTCA/DO-286 2.1-02	
INT_TISB-03 Time Reference	Universal Coordinated Time (UTC) should be used as the standard reference for time to ensure synchronization among all TIS-B system components.		RTCA/DO-286 2.1-03	
INT_TISB-04 Target Quality	The TIS-B system should provide sufficient information to the airborne surveillance processing subsystem to enable it to determine the quality of each TIS-B target.		RTCA/DO-286 2.1-07	
INT_TISB-05 Service Availability	The TIS-B system should provide sufficient information to the airborne surveillance processing subsystem to enable it to determine the availability of all implemented TIS-B services.		RTCA/DO-286 2.1-08	
INT_TISB-06 Targets	In support of its Fundamental Service, the TIS-B system should provide traffic information for all targets within its Coverage Volume.		RTCA/DO-286 2.1-09	
INT_TISB-07 Security	The TIS-B system should support security measures that ensure data transmitted between external sources and its subsystems are secure, unalterable and protected from being spoofed.		RTCA/DO-286 2.1-12	Not tested in EMMA2
INT_TISB-08 Client Application	The system should provide TIS-B reports to the aircraft client application.		RTCA/DO-286 2.3-01	
INT_TISB-09 Mode S Address	The TIS-B system should convey the ICAO Mode S Address in TIS-B reports about targets for which this address is available.		RTCA/DO-286 2.3-06	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
INT_TISB-10	Spare			
INT_TISB-11 TIS/ADS Differentiation	The TIS-B system should provide the means for the receiving system application to differentiate TIS-B reports from ADS-B reports.		RTCA/DO-286 2.3-07	
INT_TISB-12 Target Address	The Target Address and Address Qualifier should be included in all TIS-B reports.		RTCA/DO-286 2.3-09	
INT_TISB-13 Call Sign	The TIS-B system should be able to convey the ICAO Aircraft Identification (call sign) for a target.		RTCA/DO-286 2.3-10	
INT_TISB-14 Target Category	TIS-B should be able to convey the target category.		RTCA/DO-286 2.3-11	
INT_TISB-15 Position Information	Position information should be transmitted in a form that can be translated, without loss of accuracy and integrity, to latitude, longitude, geometric height, and barometric pressure altitude.		RTCA/DO-286 2.3-12	
INT_TISB-16 Reference Datum	All geometric position elements should be referenced to the WGS-84 datum.		RTCA/DO-286 2.3-13	
INT_TISB-17 Barometric Pressure	Barometric pressure altitude should be reported referenced to standard temperature and pressure.		RTCA/DO-286 2.3-14	
INT_TISB-18 Altitude Information	The TIS-B system should convey altitude information in accordance with DO-242A §2.1.2.6.		RTCA/DO-286 2.3-15	
INT_TISB-19 Geometric Height	TIS-B reports for which a geometric height is available should be provided when the accuracy and integrity requirements meet those specified in DO-242A §2.3.9 and §2.3.8 respectively.		RTCA/DO-286 2.3-17	
INT_TISB-20	Spare			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
INT_TISB-21 NIC	The TIS-B system should use the Navigation Integrity Categories defined in DO-242A Table 2-2 to describe the integrity containment radius, RC, associated with the horizontal position information in TIS-B messages.		RTCA/DO-286 2.3-23, 3.1-17	
INT_TISB-22 NACp	The TIS-B system should use the Navigation Accuracy Categories defined in DO-242A Table 2-3 to describe the accuracy of positional information (NACp) in TIS-B messages.		RTCA/DO-286 2.3-24, 3.1-15	
INT_TISB-23 NACv	The TIS-B system should use the Navigation Accuracy Categories defined in DO-242A Table 2-4 to describe the accuracy of velocity information (NACv) in TIS-B messages.		RTCA/DO-286 2.3-25	
INT_TISB-24 Priority Status	The TIS-B system should be capable of supporting the broadcast of emergency and/or priority status if this information is available to the TIS-B system.		RTCA/DO-286 2.3-27	
INT_TISB-25 Air/Ground State	The TIS-B system should determine the air/ground state of a target in accordance with the tests one through four that are specified in DO-242A §3.4.3.1.1.		RTCA/DO-286 2.3-28	
INT_TISB-26 Update Period	The TIS-B report should meet the update period and the percentile update period requirements for each ASA application the TIS-B system is supporting.		RTCA/DO-286 2.4-02	
INT_TISB-27 Latency	The TIS-B system latency should meet or not exceed the latency requirements of the associated ASA applications.		RTCA/DO-286 2.5-01	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
INT_TISB-28 Standard Deviation	The standard deviation and mean report time error for position should be in accordance with DO-242A §3.3.3.2.2.		RTCA/DO-286 2.5-02	
INT_TISB-29 Capacity	The TIS-B system should be capable of meeting the capacity requirements in DO-242A §3.3.4.		RTCA/DO-286 2.6-01	
INT_TISB-30	Spare			
INT_TISB-31 RF Medium	The TIS-B system should use the ADS-B RF medium and meet the requirements in DO-242A §3.3.5.		RTCA/DO-286 2.7-01	
INT_TISB-32 Availability	The probability that the TIS-B system is unavailable during an operation, presuming that the system was available at the start of that operation, should be no more than 10^{-3} per flight hour.		RTCA/DO-286 2.8-01	Not tested in EMMA2
INT_TISB-33 Integrity	Using the ADS-B MASPS as guidance, the end-to-end integrity of the TIS-B system should be 10^{-6} or better on a per report basis.		RTCA/DO-286 2.8-02	Not tested in EMMA2
INT_TISB-34 Track Report	A TIS-B Track Report should refer to a single target.		RTCA/DO-286 3.1-08	
INT_TISB-35 Identifier	Target Address field should report either an ICAO 24-bit address assigned to the particular target about which the report is concerned or another kind of address that is unique (e.g., combination of tracker identification and track number) within the operational domain, as determined by the Address Qualifier.		DO-286 §3.1-10	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
INT_TISB-36 Address Qualifier	The Address Qualifier field should indicate whether the Target Address is the ICAO address or another kind of address that is unique within the operational domain.		DO-286 §3.1-11	
INT_TISB-37 Call Sign Field	Call Sign field should be reported as specified in DO-242A §3.4.4.4.		DO-286 §3.1-12	
INT_TISB-38 Target Category	Target Category field should be reported as specified in DO-242A §3.4.4.5.		DO-286 §3.1-13	
INT_TISB-39 Time of Applicability	Time of Applicability should be reported as specified in DO-242A §3.4.3.3.		DO-286 §3.1-14	
INT_TISB-40 SIL	SIL should be encoded as specified in DO-242A Table 2-5.		RTCA/DO-286 3.1-18	
INT_TISB-41 Priority Encoding	Emergency/priority status, if available to the TIS-B system, should be encoded as specified in DO-242A §3.4.4.8.		RTCA/DO-286 3.1-19	
INT_TISB-42 IDENT Switch	The IDENT Switch Active flag is a 1-bit Operational Mode code. This flag should be set to the normal condition in accordance with DO-242A (§3.4.4.10.2).		RTCA/DO-286 3.1-20	
INT_TISB-43 Air/Ground Field	If the Air/ground State cannot be determined, the default value for the Air/Ground State field should be “Uncertain whether airborne or on the surface”		RTCA/DO-286 3.1-25	
INT_TISB-44 Airborne Target	If the Air/ground State cannot be determined, the TIS-B reports should include all required data elements for an airborne target.		RTCA/DO-286 3.1-26	
INT_TISB-45	Spare			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
INT_TISB-46 Version Number	The TIS-B Version Number should be defined as specified in Table 3-2.		RTCA/DO-286 3.1-27	
INT_TISB-47 State Vector	The State Vector should contain the data elements in Table 3-3.		RTCA/DO-286 3.1-28	
INT_TISB-48 Horizontal Position	Horizontal Position should be reported as specified in DO-242A §3.4.3.4.		RTCA/DO-286 3.1-29	
INT_TISB-49 Horizontal Position Valid	Horizontal Position Valid field should be encoded as specified DO-242A §3.4.3.5.		RTCA/DO-286 3.1-30	
INT_TISB-50 Geometric Altitude	Geometric Altitude should be reported as specified in DO-242A §3.4.3.6.		RTCA/DO-286 3.1-31	
INT_TISB-51 Geometric Altitude Valid	Geometric Altitude Valid field should be encoded as specified DO-242A §3.4.3.7		RTCA/DO-286 3.1-32	
INT_TISB-52 Horizontal Velocity	Geometric Horizontal Velocity (i.e., North and East Velocity While Airborne fields) should be reported as specified in DO-242A §3.4.3.8.		RTCA/DO-286 3.1-33	
INT_TISB-53 Horizontal Velocity Valid	Airborne Horizontal Velocity Valid field should be encoded as specified DO-242A §3.4.3.9.		RTCA/DO-286 3.1-34	
INT_TISB-54 Ground Speed	Ground Speed While on the Surface field should be reported as specified in DO-242A §3.4.3.10.		RTCA/DO-286 3.1-35	
INT_TISB-55 Ground Speed Valid	Surface Ground Speed Valid field should be encoded as specified DO-242A §3.4.3.11.		RTCA/DO-286 3.1-36	
INT_TISB-56 Heading	Heading While on the Surface field should be reported as specified in DO-242A §3.4.3.12.		RTCA/DO-286 3.1-37	

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
INT_TISB-57 Heading Valid	Heading Valid field should be encoded as specified DO-242A §3.4.3.13.		RTCA/DO-286 3.1-38	
INT_TISB-58 Report Mode 0	Report Mode field is a 1-bit field, which should be ZERO if only measurement data are used to derive the State Vector.		RTCA/DO-286 3.1-43	
INT_TISB-59 Report Mode 1	The Report Mode field should be ONE if track data (e.g., estimated) are used to derive the State Vector.		RTCA/DO-286 3.1-44	
TIS-B In Aircraft/Vehicle				
INT_TISB_AIRB-01 Receiving	The TIS-B receiving system should be able to decode the TIS-B information as defined in the most recent version of the RTCA/DO260A document.		RTCA/DO260A	
INT_TISB_AIRB-02 Association	The TIS-B receiving system should use the content of the 24-bit address or Mode A/Track Number field: • To correlate all ADS-B messages transmitted from each aircraft/vehicle • To differentiate it from other aircraft/ vehicles in the operational domain			
TIS-B Operations				
INT_TISB_OP-01 Unique Mode A Code	All aircraft/vehicle Mode A codes (if provided) should be unique within the dedicated airport domain.			
INT_TISB_OP-02 Ground Stations	The TIS-B receiving system should manage messages received from up to two TIS-B stations simultaneously.			

Table 10-2: TIS-B Interoperability Requirements

10.6 TAXI-CPDLC Interoperability Requirements

The description of the TAXI-CPDLC service is given in section 7.2.

The following table lists the interoperability requirements applicable for a TAXI-CPDLC service in the airport environment. Source references are maintained for ease of traceability.

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
General				
INT_CPDLC-01 Aircraft Requirements	The aircraft should prepare, send, receive and decode all CPDLC messages for TAXI-CPDLC services in accordance with: • The technical requirements for such services • The ATN Baseline 1 standard (ED-110A)			
INT_CPDLC-02 Ground station Requirements	The ground system should prepare, send, receive and decode all CPDLC messages TAXI-CPDLC services in accordance with: • The technical requirements for such services • The ATN Baseline 1 standard (ED-110A) for ATN aircraft			
INT_CPDLC-03 Naming and Addressing Exchange	Before operating the TAXI-CPDLC service, the aircraft and ground systems should have first exchanged the CPDLC application naming and addressing information.			

EMMA2 Req. No.	Requirement	Parent Requirements	Source Reference	Comment
CPDLC Operations				
INT_CPDLC_OP-01 Operational Rules	The aircraft and ground systems should follow the operational rules (availability, sequence of exchanges, normal mode and abnormal mode) for CPDLC services as defined in EUROCAE ED-110A.			
INT_CPDLC_OP-02 Timing	The aircraft and the ground systems should notify within a specified timeframe respectively the flight crew and the (concerned) ATCO upon the receipt of any CPDLC service message.			
INT_CPDLC_OP-03 Timeout Termination	The aircraft and the ground systems should notify within a specified timeframe respectively the flight crew and the (concerned) ATCO about the unexpected termination of on-going CPDLC service (e.g. timeout termination).			
INT_CPDLC_OP-04 Missing LACK/PAM	The aircraft and the ground systems should notify within a specified timeframe and thus remind the flight crew and the (concerned) ATCO, when upon the transmission of a message the respective the LACK and/or PAM has not been issued.			

Table 10-3: CPDLC Interoperability Requirements

11 Annex A

11.1 References

[1] EMMA2: Annex I - "Description of Work", Sixth Framework Programme, FP6 - 513522, version 0.35, 24.11.2005
[2] EMMA2: D111 A-SMGCS Services, Procedures and Operational Requirements (SPOR)
[3] EMMA D1.4.1u Air-Ground Functional Architecture (AGFA), August 2006
[4] EMMA D1.4.2au Technical Requirements Document (TRD) Part A Ground, May 2006
[5] EMMA D1.4.2bu Technical Requirements Document (TRD) Part B Airborne, August 2006
[6] EUROCAE ED-85A Data Link Application System Document (DLASD) for the "Departure Clearance" Data Link Service, December 2003
[7] EUROCAE ED-87B: Minimum Aviation System Performance Specification for A-SMGCS, Final Draft, December 2007
[8] EUROCAE ED-116: Minimum Operational Performance Specifications for Surface Movement Radar Sensor Systems for Use in A-SMGCS, January 2004
[9] EUROCAE ED-117: Minimum Operational Performance Specifications for Mode S Multilateration Systems for Use in A-SMGCS, November 2003
[10] EUROCAE ED-110A (RTCA DO-280A) Interoperability Requirements Standard For ATN Baseline 1 (INTEROP ATN B1) Revision A, August 2004
[11] EUROCAE ED-120 (RTCA DO-290) Safety And Performance Requirements Standard For Air Traffic Data Link Services In Continental Airspace (CONTINENTAL SPR Standard), May 2004
[12] ICAO Doc 4444: Procedures for Air navigation Services - ATM, Edition 14, 2003
[13] ICAO Doc 9476: Manual of Surface Movement Control and Guidance Systems (SMGCS) First Edition 1986
[14] ICAO Doc 9830: Manual on Advanced Surface Movement Guidance and Control Systems (A-SMGCS), AN 452 - 2004
[15] ICAO Annex 10, Volume III Part 1 - Digital Data Communication Systems, Edition 1, 2003, and Volume IV - Surveillance Radar and Collision Avoidance Systems, Edition 3, 2002
[16] ICAO Annex 14, Volume 1 - Aerodrome Design and Operations, Edition 3, 1999
[17] ICAO Doc 9705: Manual of Technical Provisions for the Aeronautical Telecommunication Network (ATN), Edition 2, 1999
[18] ICAO Doc 9694: Manual of Air Traffic Services Data Link Applications, First Edition, 1999
[19] EUROCONTROL Standard Document for Radar Data Exchange - Part 1, SUR.ET1.ST05.2000-STD-01-01, Edition 1.0, November 1997
[20] EUROCONTROL Standard Document for Surveillance Data Exchange - Part 7: Category 010, SUR.ET1.ST05.2000-STD-07-01, Edition 0.31, December 2001
[21] EUROCONTROL Standard Document for Surveillance Data Exchange - Part 8: Category 011, SUR.ET1.ST05.2000-STD-08-01, draft version 0.17, December 2001
[22] EUROCONTROL Standard Document for ATS Data Exchange Presentation (ADEXP) DPS.ET1.ST09-STD-01-01
[23] RTCA DO-260A MOPS for 1090ES ADS-B and TIS-B
[24] RTCA DO-212 MOPS for Airborne ADS Equipment
[25] RTCA DO-242A MASPS for ADS-B
[26] RTCA DO-286B MASPS for TIS-B

11.2 List of Figures

11.3 List of Tables

11.4 List of Acronyms and Abbreviations

Acronym	Long Name
ACARS	Aircraft Communication Addressing and Reporting System
ACC	Area Control Centre
ADEXP	Air Traffic Control Data Exchange Protocol
ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance - Broadcast
AGL	Aerodrome Ground Lighting
AIDA	Airport Integrated Data link
AIDB	Airport Information Data Base
API	Application Programming Interface
APP	Approach
ARP	Aerodrome Reference Point
ART	Alert Response Time
A-SMGCS	Advanced Surface Movement Guidance and Control System
ASTERIX	All-Purpose Structured EUROCONTROL Surveillance Information Exchange
ATA	Actual Time of Arrival
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATR	A-SMGCS Technical Requirements
ATS	Ait Traffic Service
ATSU	ATS Unit
AVOL	Aerodrome Visibility Operational Level
BDS	Comm-B Data Selector
BETA	Benefit Evaluation by Testing an A-SMGCS (a project the Fifth Framework)
CASCADE	Cooperative ATS through Surveillance and Communication Applications Deployed in ECAC
C-ATSU	Controlling - ATSU
CFMU	Central Flight Management Unit
CPDLC	Controller-Pilot Data Link Communication
CRC	Cyclic Redundancy Check
CTOT	Calculated Take-Off Time
CWP	Controller Working Position
DCL	Departure Clearance
DCR	Departure Clearance Request
DG-TREN	Directorate General Transport and Energy
DLASD	Data Link Application Service Document
DLIC	Data Link Initiation Capability

Acronym	Long Name
DMAN	Departure Management
D-TAXI	Data Link - TAXI
ECAC	European Civil Aviation Conference
EMC	Electromagnetic Compatibility
EIBT	Estimated In-Block Time
EOBT	Estimated Off-Block Time
EPU	Estimated Position Uncertainty
ES	Extended Squitter
ESS	Embedded System Status
ESP	Embedded System Performances
ETA	Estimated Time of Arrival
ETC	Expected Taxi Clearance
ETD	Estimated Time of Departure
ETOT	Estimated Take-Off Time
EUROCAE	European Organisation for Civil Aviation Equipment
EUROCONTROL	European Organisation for the Safety of Air Navigation
FANS	Future Air Navigation System
FDPS	Flight Data Processing System
FOM	Figure Of Merit
GMS	Gate Management System
GNSS	Global Navigation Satellite System
HFOM	Horizontal Figure Of Merit
HMI	Human-Machine Interaction
MASPS	Minimum Aviation System Performance Specification
MLAT	Multi-Lateration
NAC	Navigation Accuracy Category
NIC	Navigation Integrity Category
NUC	Navigation Uncertainty Category
ICAO	International Civil Aviation Organisation
IDL	Information Display Latency
IP	Integrated Project
LAN	Local Area Network
LVO	Low Visibility Operations
OR	Operational Requirements
ORD	Operational Requirements Document
OSED	Operational Service and Environmental Description
PAM	Pilot Acknowledgement Message
PAS	Park Air Systems AS
PD	Probability of Detection
PDAS	Probability of Detection of Alert Situation
PFA	Probability of False Alert

Acronym	Long Name
PFD	Probability of False Detection
PFID	Probability of False Identification
PID	Probability of Identification
PRA	Position Registration Accuracy
Rc	Containment Radius
RDPS	Radar Data Processing System
RPA	Reported Position Accuracy
R/T	Radio/Telecommunication
RTCA	Radio Technical Commission for Aeronautics
RTOI	Response Time to Operator Input
RVA	Reported Velocity Accuracy
RWY	Runway
SDF	Surveillance Data Fusion
SID	Standard Instrument Departure
SIL	Surveillance Integrity Level
SMAN	Surface Manager
SMR	Surface Movement Radar
SP	Sub-Project
SPOR	Services, Procedures and Operational Requirements document
SSR	Secondary Surveillance Radar
TDL	Target Display Latency
TIS-B	Traffic Information Service - Broadcast
TRD	Technical Requirements Document
TRUR	Target Report Update Rate
TWY	Taxiway
UAT	Universal Access Transceiver
VDL	VHF Data Link
VDL-2	VDL - Mode 2
VFR	Visual Flight Rules
VHF	Very High Frequency
WP	Work-Package