



Phase 2 - System Specification

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Abstract

The document collects and describes the technical requirements (functional and non functional) which shall guide, during Phase 2, the development and implementation of a prototype for a Surface Safety Nets Server. Such System Requirements are derived from the Operational Requirements collected by the specification of previous R&D projects and studies, and from SESAR project 06.07.01.

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69 Executive Summary

70 The document is mainly focused on the Technical Requirements (functional and non functional) which
71 shall guide, during Phase 2, the development and implementation of a prototype for a Surface Safety
72 Nets Server. Such requirements are taken from:

- 73 • The current state of the art for Surface Control function, resulting from previous projects and
74 developments.
- 75 • New functionalities studied by SESAR Project 06.07.01 like “Conflicting ATC Clearances”
76 and “Conformance Monitoring”.

77 All the ATM components interacting with a Surface Safety Nets Server are identified, as well as the
78 external conditions and inputs affecting its behaviour and its operations.

79 System and Performance Requirements are derived from SESAR Operational requirements, but also
80 collected by the analysis of specifications of consolidated R&D projects such as EMMA2, and from
81 ICAO standards, EUROCONTROL and EUROCAE A-SMGCS documents.

82 Requirements are also provided for the external interfaces and to satisfy the installation-related
83 constraints.

84 A section of the document is dedicated to non-functional requirements, focused on System Safety,
85 System Security, HW/SW features.

86 The document is completed with a table for the requirements traceability.

1 Introduction

The Technical Specification document contains descriptions and requirements that define functional and non functional specifications of Surface Safety Nets Server.

1.1 Purpose of the Document

The purpose of this document is to provide information regarding the Specification and the System Requirements of a Surface Safety Nets Server which satisfies the needs and expectations of the Tower Controllers and other actors that need surface safety net alerts.

The information provided by this document shall enable system engineers to develop a Surface Safety Nets prototype. They shall be specified according to the following inputs: operational (coming from previous external studies and P06.07.01) and technical aspects (coming from the related technical projects). HMI requirements are in charge of related project 12.05.02.

Through this document all the actors will be able to map the User Requirements, to analyse the rationale behind each requirement and, in general, to verify and ensure the overall coherence of the project.

1.2 Intended Readership

This document is intended for various stakeholders in the SESAR Programme.

It represents an input for the 12.01.07 project for consolidation of requirements.

It is also an input for Operational projects P06.07.01 and P06.03.02 to be used as a reference document during the validation tasks as well as for WP 3 for the validation infrastructure needs and requirements definition.

Furthermore it will be an input for different projects within WP12 and in particular within Sub WP 12.03 for surface management systems and for project 12.05.02, responsible to develop the HMI for this prototype.

The figure below is a schematic diagram showing the interaction between the 12.03.02 project (i.e. this document) and other SESAR projects:

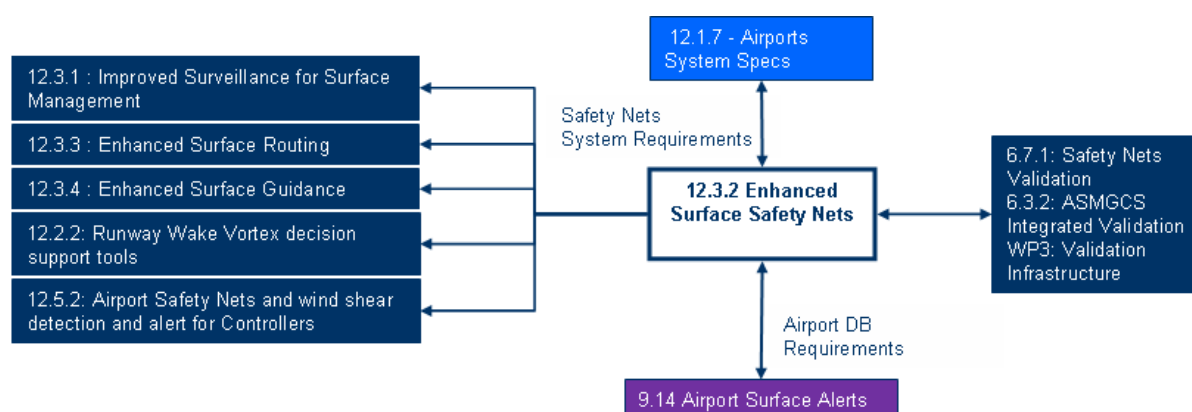


Figure 1: Interactions between P12.03.02 and other SESAR projects

1.3 Inputs from other Projects

In the context of the phase 2 of the SESAR project P12.03.02, the following documents will be used as input for these System Specifications:

- P12.03.02-D01 Phase1 - System Specification Baseline
- P12.03.02-D17 Phase1 - Consolidated Verification Report
- P06.07.01-D16 Updated OSED for “Conflicting ATC Clearances”
- P06.07.01-D17 Updated SPR for “Conflicting ATC Clearances”
- P06.07.01-D22 Preliminary OSED Conformance Monitoring

The specifications for the HMI part of the SSN server are written in parallel by P12.05.02 with close collaboration of P12.03.02.

All the specifications coming from these documents have been analyzed. The purpose of this analysis is to get a set of operational requirements in order to produce the technical specifications that belong to the scope of this project. The result of this analysis is the set of operational requirements shown in section 3.

Other potential inputs were analysed (like P06.07.01-D23 Preliminary SPR for “Conformance Monitoring”, Specifications from projects 12.03.01, 12.03.03, 12.03.04, 12.02.02), but no requirements were considered in project 12.03.02 scope.

1.4 Structure of the Document

Section 1 is the introduction. It describes the purpose and scope of the document and the methodology used to derive the requirements, including the purpose of the system under analysis.

Section 2 gives a general description of the SSN Server.

Section 3 describes the capabilities, conditions and constraints of the SSN Server. In particular it contains the functional and non functional requirements.

Section 4 describes the assumptions taken for this document.

Section 5 describes the referenced documents.

1.5 Requirements Definitions – General Guidance

The Requirements are produced to describe both functional and non-functional requirements at system level. The purpose of technical specification is to transform the operational requirements and safety recommendations identified through analysis of external input into a coherent description of ASN component and its capabilities.

Requirements are structured by Requirement type, and then:

- Functional requirements
- Non-Functional requirements
 - Adaptability Requirements

- 148 ○ Performance Requirements
- 149 ○ Safety Requirements
- 150 ○ Interface Requirements

151 These requirements will address the “what” and not the “how”, therefore they don’t aim at specifying
152 the physical design of the component, but the functional description and the necessary logical
153 interfaces with other functional blocks.

154 The Functional requirements can be further decomposed in other sub-sections, according to
155 component capabilities (see section 2.3).

156 1.5.1 Requirements Properties

157 Each requirement should possess the following properties:

Property	Comment
Necessary	The requirement cannot be deleted without changing the scope;
Complete	The requirement expresses in itself a whole idea or statement without need for further explanations;
Clear and Concise	The requirement is unambiguous and not prone to different interpretations;
Consistent	The requirement is not in conflict with other requirements;
Verifiable	A test method (e.g. testing) has to be defined;
Traceable	A clear link with an initial need or with another requirement can be identified;
Feasible	The concept is technically and legally possible and can be accomplished within affordable cost and schedule;

158 Table 1: Requirements properties

159 The technical requirements are written following the document “Requirements and VV Guidelines”
160 (see [2])

161 In particular, all requirements must contain at least a subject and a statement where the subject is the
162 object under discussion (e.g. system), and the statement is a condition, action, intended result or
163 target objective.

164 The generic way to write a requirement is: <Object> shall OR should OR may <verb> <Statement>
165 (standard ISO/IEC 15288)

- 166 • Requirements are marked by the use of the verb "shall". This indicates that the requirement is
167 mandatory and it will be developed in all the prototypes of Phase 1 of each developer.
- 168 • Recommendations are marked by the use of the verb "should".
- 169 • Permissions are marked by the use of the verb "may".

170 The last two indicate that the requirement is optional and it will not be developed in all the prototypes
171 of Phase 1.

1.5.2 Writing Requirements

In order to follow a common way of proceeding, the following attributes have been assigned to the requirements ([1] and [3]). In any case the reference document to correctly write the requirements is [2].

In this document "Validation Method" item of each requirement will be blank, because the validation is not purpose of technical projects, but is scope of operational ones. In particular, it depends on the specific validation exercise of each prototype.

The traceability the technical requirements and operational requirements will also be established with OSED requirements (there will not be any INTEROP describing the functionalities in the scope of P12.03.02, and only one SPR is available at the moment, on "Conflicting ATC Clearances").

1.6 Functional Block Purpose

The purpose of Surface Safety Nets is to support controllers in detecting conflict situations. The impacted functional blocks are "Aerodrome Safety Nets" and "Conformance Monitoring" (see §2.6).

The Surface Safety Nets (SSN) server goal for Phase 2 of the project is to detect conflict situations that are not currently addressed by A-SMGCS Level 2 systems and, in particular, to be able to detect and provide warning of potential conflicts earlier than Level 2 systems can do. The alerts generated by the SSN are then broadcasted to interested clients, the main one being the controller HMI.

1.7 Functional Block Overview

The SSN server will contribute to address:

- Runway Incursion: Runway is by far the most critical area for airport surface safety nets. Enhanced algorithms will improve runway incursion detection involving each unauthorised entry by an aircraft or a vehicle. These situations will be detected only with Aerodrome Surveillance data.
- Area Intrusion: Enhanced algorithms will improve the detection of unauthorised entry by an aircraft or a vehicle into predefined areas. These situations will be detected only with Aerodrome Surveillance data.
- Conformance Monitoring: New algorithms and services to detect non conformance to ATC instructions or aerodrome procedures. Conformance monitoring systems need to be assessed in accordance to complex airport layout and new procedures. These situations will be detected combining Aerodrome Surveillance data with data about clearances given and routes assigned.
- Conflicting ATC Clearances: New algorithms will detect conflicting ATC clearances input by the controller (i.e. when ATC provides clearances to a mobile that would result in a conflict with other mobiles). The scope is to provide an early prediction of situations that if not corrected would end up in hazardous situations. These situations will be detected combining Aerodrome Surveillance data with data about clearances given.

These alerts will be sent to controllers HMI developed in the project 12.05.02. In addition, the alert reports can be taken into account by other clients, like Operational Supervision component, etc.

211 1.8 Glossary of Terms

Term	Definition
Obstacle	All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.
Runway Protection Volume	A defined volume including the runway and stopway, if provided, intended: - to reduce the risk of damage to aircraft running off a runway; and - to protect aircraft flying over it during take-off or landing operations The RPV is composed of two boundaries: - Ground boundary to detect mobiles on the surface - Air boundary to detect airborne aircraft
Taxi Plan	Information associated to a mobile regarding Clearances and Cleared taxi route if available.

212

213 1.9 Acronyms and Terminology

Term	Definition
A-FDPS	Aerodrome Flight Data Processing System
A-SMGCS	Advanced Surface Movement Guidance and Control System
ATC	Air Traffic Control
ATC system	In the context of this document the term ATC system refers to a combination of the A-SMGCS (Surveillance and Control) and the Electronic Flight Strips
ATM	Air Traffic Management
DOD	Detailed Operational Description
HMI	Human-Machine Interaction
ICAO	International Civil Aviation Organization
LVP	Low Visibility Procedure
OSD	Operational Service and Environment Definition
RIMS	Runway Incursion Monitoring System
RPV	Runway Protection Volume.

Term	Definition
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
SPR	Safety and Performance Requirements
SSN	Surface Safety Nets
TS	Technical Specification
TAD	Technical Architecture Description

2 General Functional Block Description

2.1 Context

Control, which includes enhanced Surface Safety Nets, is one of the four primary functional elements of an A-SMGCS, as specified in ICAO Doc 9830 A-SMGCS Manual:

- a) **Surveillance**: to provide accurate position information on all movements within the movement area and to provide identification and labelling of authorized movements;
- b) **Routing** (including Planning): to permit designation of a route for each aircraft or vehicle within the movement area;
- c) **Guidance**: to provide clear indications to pilots and vehicle drivers to allow them to follow their assigned routes; and
- d) **Control**: to provide continuous interpretation of the traffic situation, including verification of planned events and detection and alerting of potential conflicts and other hazardous situations.

The diagram below (EUROCAE ED-87B) illustrates the interaction between these functional elements.

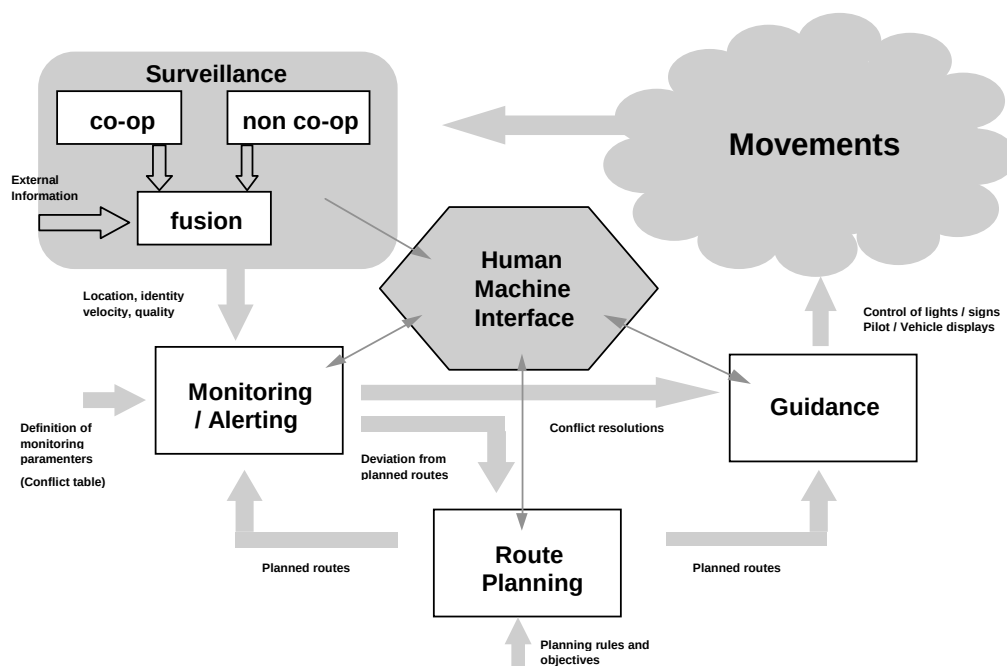


Figure 2: Interaction among different A-SMGCS functional elements

The current definition of an A-SMGCS control function (ICAO Doc 9830 §2.5.4.1) has to be improved through the implementation and the continuous updating of tools for predicting, detecting, and resolving conflicts giving the appropriate alerts.

As far as SESAR is concerned, one of the programme targets is to enable a 3-fold increase in capacity; this issue will become even more critical in the future if no new safety support tool is implemented. This project also aims at contributing to another SESAR objective, which is increasing the safety by a factor 10.

239 According to a EUROCONTROL study, the most frequent runway incursions are:

- 240 • Aircraft enters or crosses a runway without a clearance
- 241 • Airside vehicle driver enters or crosses a runway without a clearance

242 Other airport incidents include:

- 243 • Non-conformance of aircrafts movements to ATC instruction or procedures
- 244 • Conflicting ATC clearances

245 Therefore, additional safety support tools are needed to reduce the incidents probability and increase
246 safety during airport operations (in particular on the runway) which can increase airport capacity.

247 The objective of Project 12.03.02 is the improvement of all aspects of Surface Safety Nets addressing
248 runway incursion, area intrusion, non conformance to ATC procedures and instructions and conflict
249 alerts distribution.

250 The performance of the SSN is largely dependent upon the input data received from the Aerodrome
251 Surveillance element, but also flight data, including clearances given and taxi routes assigned.

252 2.2 Functional Block Modes and States

253 The Surface Safety Nets (SSN) function is a modular component of an A-SMGCS. Its role is to
254 continuously monitor the aerodrome traffic situation and clearances given by ATC, and to detect and
255 report when any of the monitoring rules programmed into the system are not adhered to.

256 The two main inputs required by the SSN to trigger alerts, in its normal mode of operation, are:

- 257 • Traffic situation information is received by the SSN as target report messages in an agreed
258 data format (normally ASTERIX Category 011 or Category 062) from the A-SMGCS
259 Aerodrome Surveillance system. The target report data shall meet (or preferably exceed) the
260 minimum requirements regarding latency, accuracy of position and accuracy of velocity, as
261 specified in [10], and be continuously available throughout the required coverage volume at
262 the aerodrome. The target report data shall include information about target identification and
263 target type (aircraft type or vehicle fleet type),
- 264 • Data describing clearances given, and cleared taxi routes assigned, by ATC. This data will
265 come from the Aerodrome Flight Data Processing System (A-FDPS).

266 Other type of data (Airports layout, Runway status...) are also needed by the SSN, see §2.6.

267 2.2.1 Configurability

268 The SSN has a built-in set of monitoring rules that may be configured and adapted to the specific
269 needs of any aerodrome. The overall rule set is described by the set of capability requirements in
270 section 3.1 of this document.

271 There are separate rule sets for the four different types of conflict situation that the SSN can address:

- 272 1. Runway Incursion
- 273 2. Area Intrusion
- 274 3. Non-Conformance to ATC Instructions or ATC Procedures

4. Conflicting ATC Clearances

Within each of these rule sets, it should be possible to enable or disable any specific rule and to configure parameters and geographical areas, if any, associated with each rule.

Parameters associated with each rule are specified in the requirements in section 3.1.

The adaptability requirements are specified in section 3.2.

2.2.2 Degraded Modes of Operation

The SSN function has two degraded modes of operation:

1. Surveillance-only mode

In this mode, the SSN is missing the input of ATC clearance data, but it is able to continue to monitor the traffic situation, and to give alerts in the event of conflicts, based purely on Aerodrome Surveillance data, i.e. the system degrades to A-SMGCS Level 2.

2. Clearance-only mode

In this mode, the SSN is missing the input of Aerodrome Surveillance data, but it is still able to provide a limited service by monitoring ATC clearances and generating alerts in the event of conflicting clearances. It is not able to provide alerts for Runway Incursion, Restricted Area Intrusion or Non-Conformance.

The degraded mode requirements are specified in section 3.1.

2.3 Major Functional Block Capabilities

The purpose of SSN server is to detect and foresee the conflicts on the airport (both ground and final approach) related to mobiles. Data related to each detected conflict will be distributed to Controller HMI, and to any other client system that needs the data.

The main functions, in which the functional requirements can be grouped, are:

- General
- Runway Incursion
- Area Intrusion
- Conformance Monitoring (Non-conformance to ATC instructions or ATC procedures)
- Conflicting ATC Clearances

2.4 User Characteristics

P12.03.02 is going to develop several safety support tools for controllers:

Tower Controllers provide an Air Traffic Service at controlled aerodromes. They are responsible for the safe and efficient flow of aircraft and vehicles on the runways (Tower Runway Controllers) and on the manoeuvring areas (Tower Ground Controllers).

2.5 Operational Scenarios

2.5.1 Runway Incursion

2.5.1.1 Preamble

Runway incursion is the most critical situation for airport SSN: it shall be dealt with accordingly, through enhanced algorithms for detection of unauthorized entry by aircraft or vehicles into runway protection areas.

The following scenario is based on the Use case 1 from the P06.07.11 draft OSED for RWSL (see Ref [14]), even if the SSN and RWSL are two separate and independent systems.

2.5.1.2 Scenario for a departure flight

Pre Conditions

The ATC system is equipped with A-SMGCS Aerodrome Surveillance and the controller HMI is connected to a Surface Safety Nets server which raises Runway Incursion alerts

Actors

Runway Controller / Pilot / Vehicle drivers

Trigger

An aircraft is taking-off and a vehicle is crossing the stop bar.

Main Flow

1. Aircraft A is waiting at a holding point HP1 for RWY1.
2. Runway controller allows the aircraft to line up on RWY1.
3. Aircraft A is entering RWY1 and is lining on RWY1.
4. Runway controller allows the aircraft to take-off on RWY1.
5. A vehicle enters the runway from the other side of the runway
6. The ATC system sends an alert to the controller HMI and a sound is played to alert the controller of a dangerous situation
7. The controller acknowledges the alert, evaluates the situation and takes the right decision (either by cancelling the take-off or asking the driver to clear the runway)
8. End of the scenario.

2.5.2 Area Intrusion

2.5.2.1 Preamble

The area intrusion is the entry of a mobile either to a Restricted Area or to Limited Access Area.

2.5.2.2 Scenario for a Restricted Area

Pre Conditions

- The ATC system is equipped with A-SMGCS Aerodrome Surveillance and the Controller HMI is connected to a Surface Safety Nets server which raises area intrusion alerts

- Area D is a restricted area

Actors

Ground Controller / Vehicle driver

Trigger

A vehicle is entering a restricted area.

Main Flow

1. Inspection Vehicle going to runway enters Area D
2. The ATC system sends an alert to the controller HMI to alert the controller of entry of a restricted area
3. The controller acknowledges the alert, evaluates the situation and asks the driver to stop immediately.
4. End of the scenario

2.5.3 Conflicting ATC Clearances

2.5.3.1 Preamble

The aim for the detection of Conflicting Clearances by this component is to provide an early detection of situations that if not corrected would end up in hazardous situations. Rather than replacing the existing A-SMGCS Level 2 RIMS, the Conflicting Clearances Detection Function shall complement it and provide an extra layer of safety to prevent accidents from occurring.

It will be based on the knowledge of the clearances given to aircraft or vehicles by controllers, as well as in some cases on A-SMGCS Aerodrome Surveillance data from mobiles' position on the airport surface or on short final.

Different types of conflicting clearances are identified and explained in the P06.07.01 Conflicting ATC Clearance OSED (see Ref [7]). The P06.07.01 OSED provides also some scenarios, the following paragraph provides an example of scenario, and others can be found in the OSED:

2.5.3.2 Scenario “Cleared to Land versus Line-Up”

Pre Conditions

The ATC system is equipped with Electronic Flight Strips (and A-SMGCS Aerodrome Surveillance for alternative flow), and the Controller HMI is connected to a Surface Safety Nets server which raises Conflicting ATC Clearances alerts.

Post Conditions

A “Conflicting ATC Clearance” alarm (Cleared to Land versus Line-Up) is presented on the Runway Controller's HMI.

Actors

Runway Controller / Pilots

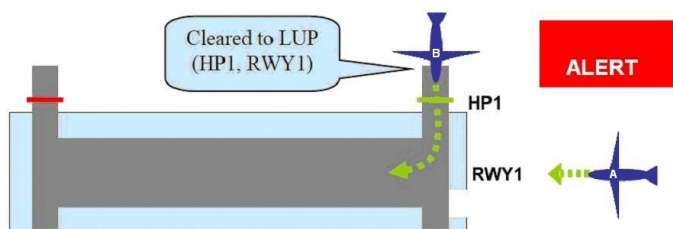
Trigger

The input of the ‘line up’ ATC Clearance by the ATCO

Main Flow

1. Aircraft A is on final for RWY1 and receives from the Tower Runway Controller his landing clearance on this runway via R/T.

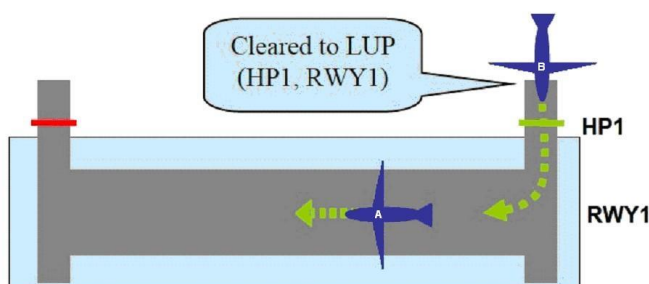
2. The Tower Runway Controller makes an input 'Cleared to Land on runway 1' on the Human Machine Interface (HMI) for Aircraft A,
3. Aircraft B is ready for departure, waiting at a Holding Point HP1 for RWY1.
4. The Tower Runway Controller clears aircraft B to line up on RWY1 and makes an input 'Line-Up RWY1' on the HMI for Aircraft B.
5. The ATC system verifies the relative position of both aircraft based on A-SMGCS Aerodrome Surveillance data.



6. The ATC system detects that the aircraft A has not passed the HP1 for the runway where aircraft B is waiting and then triggers an alarm, informing the Tower Runway Controller, that a conflict situation has been detected by the ATC system.
7. The alarm triggered by the ATC system, is displayed on the Tower Runway Controller's HMI, and clearly identifies the pair of aircraft involved and the reason for the alarm.
8. Simultaneously with [7], an audio alarm sounds on the CWP to warn the Tower Runway Controller
9. The Tower Runway Controller cancels the 'line up' clearance by R/T to aircraft B and cancels the 'line up' input on the HMI.
10. The ATC system cancels the Conflicting ATC clearance alarm and removes the Conflicting ATC clearance from the Tower Runway Controller's HMI.
11. The Use Case ends.

Alternative Flows

[6] -The ATC system detects that the landing aircraft A has already passed the HP1 for the runway where aircraft B is waiting and then no alarm is triggered.



No alarm is triggered
The Use Case ends.

[9] - The Tower Runway Controller considers the situation still safe and ignores the triggered alarm.

The Tower Runway Controller informs the ATC system, via an input, that he/she ignores the triggered alarm.
The flow continues at step 10.

2.5.4 Non-conformance to ATC Instructions

2.5.4.1 Preamble

A non-conformance to ATC instructions alert is generated by the ATC system when a mobile's behaviour is not conforming to ATC clearances given by the controller. The inputs of the Controller in the ATC system via the Controller Human Machine Interface are compared with the Surveillance data from the A-SMGCS Aerodrome Surveillance function.

The following is an example of Non conformance to ATC instructions scenario.

2.5.4.2 Scenario “route deviation”

Pre Conditions

The ATC system is equipped with A-SMGCS Aerodrome Surveillance and the Controller HMI is connected to a Surface Safety Nets server which raises route deviation alerts (it is able to compare the current position with the cleared one).

Actors

Ground Controller / Pilot

Trigger

An aircraft is deviating from its cleared route.

Main Flow

1. The Pilot asks for Taxi clearance (Aircraft A is waiting at apron after finishing pushback.)
2. The Ground controller allows the aircraft to TAXI to holding point HP1 of RWY1 via A-B-C-E. (another alternative route to HP1 is A-B-C-D)
3. Aircraft A arrives to the junction and has the choice between D and E
4. The Pilot chooses taxiway D (and Aircraft A continues taxiing on taxiway D)
5. The SSN server sends an alert to the HMI to alert the controller of route deviation: it is a non conformance to ATC instruction.
6. The controller acknowledges the alert, evaluates the situation and asks the pilot to hold immediately or to change the route.
7. End of the scenario.

2.5.5 Non-conformance to ATC Procedures

2.5.5.1 Preamble

The A-SMGCS Aerodrome Surveillance function and elements of the Flight Plan Data (such as aircraft flight type) are checked against published ATC procedures. Alerts shall be generated for infringements to any explicit ATC procedures.

The following is an example of Non conformance to ATC procedures scenario.

2.5.5.2 Scenario “High speed”

Pre Conditions

The ATC system is equipped with A-SMGCS Aerodrome Surveillance and the Controller HMI is connected to a Surface Safety Nets server which raises high speed alerts (it is able to compare the current aircraft speed with the airport standard rules).

Actors

Ground Controller / Pilot

Trigger

An aircraft is taxiing with a speed higher than the maximum speed limit for the airport taxiways.

Main Flow

1. The Pilot asks for Taxi clearance (Aircraft A is waiting at apron after finishing pushback.)
2. The Ground controller allows the aircraft to taxi to holding point HP1 of RWY1 via A-B-C-E.
3. Aircraft A is in a long taxiway (B) and reaches the airport taxiway maximum speed limit
4. The pilot continues to accelerate
5. A “High Speed” alarm is raised in the HMI “High Speed” for Aircraft A
6. The controller asks the pilot of Aircraft A to reduce the speed.

End of scenario.

2.6 Functional

2.6.1 Functional Decomposition

The current version of TAD document [15], produced by P12.01.07, decomposes the Aerodrome ATC Domain System in several Functional Blocks, according to Figure 3.

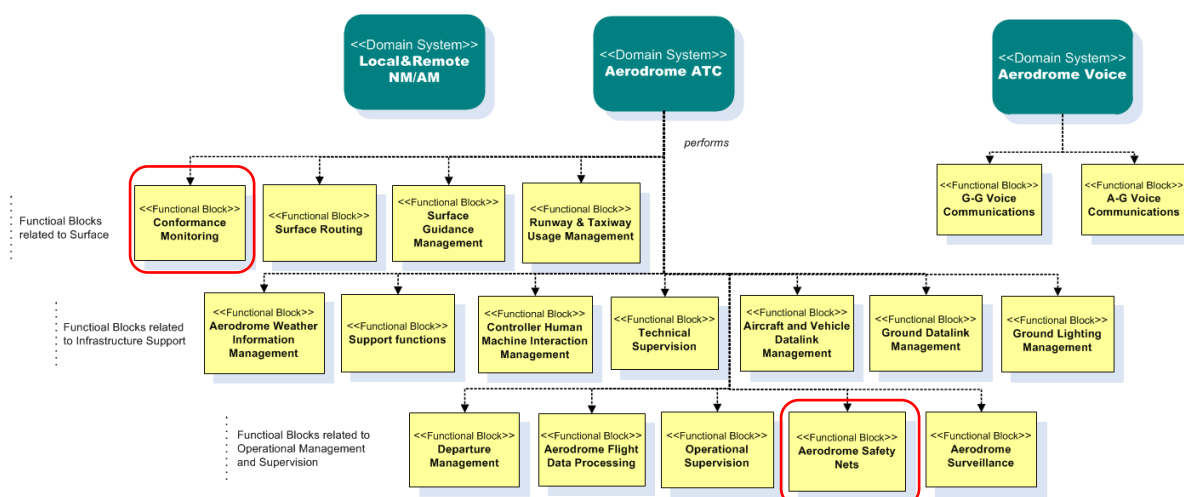


Figure 3 - Aerodrome ATC Domain System - Functional Breakdown

In this picture, the “Conformance Monitoring” and “Aerodrome Safety Nets” functional blocks are circled because they are the two functional blocks addressed in this document.

Unlike P12.01.07, the P12.03.02 does not separate those two functional blocks, and will consider only one functional block: the “Surface Safety Net”. The “Surface Safety Nets” server described in this document will generate all ground alerts sent to the Tower Controller:

- “Runway Incursion” alerts
- “Area Intrusion” alerts
- “Non-Conformance to ATC Instructions or ATC Procedures” alerts
- “Conflicting ATC Clearances” alerts

In case of detection this function triggers alerts in order to warn concerned controllers.

2.6.2 Functional Analysis

The Surface Safety Nets is a part of Aerodrome ATC System and its role is to monitor the traffic situation and the flight plans and to detect any of the monitoring rules programmed into the system are violated.

Figure 4 shows the SSN (the coupling of Taxi Conformance Monitoring and Aerodrome Safety Nets functional blocks) in the context of its relationship with the other functional blocks of Aerodrome ATC.

In this analysis, the starting point has been the TAD of 12.01.07 [15].

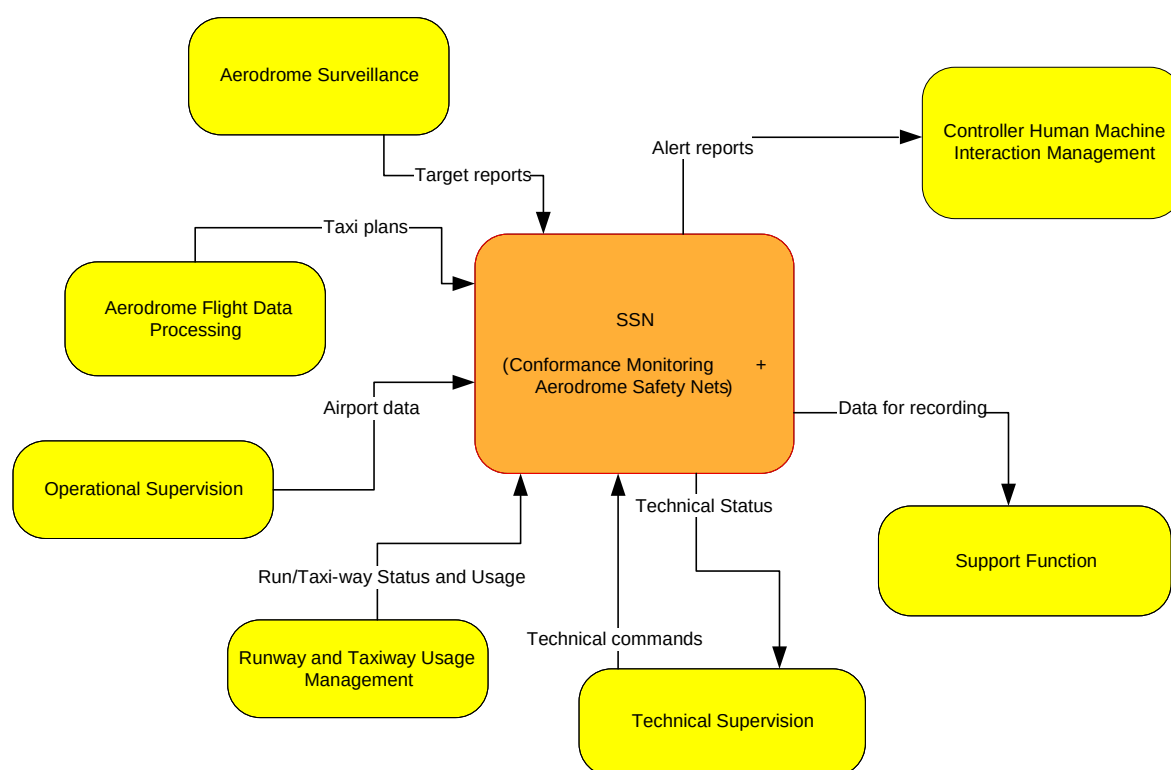


Figure 4 - SSN interfaces

Interface	Content	Provided by SSN	Required by SSN	Functional Block involved
Target Reports	Position and ID of Aerodrome traffic		X	Aerodrome Surveillance

Alert Reports	Alert of detected conflicts	X		Controller Human Machine Interaction Management ¹
Data for recording	Alert of detected conflicts and technical status	X		Support function (in particular Recoding & Playback)
Technical Status	Technical status of SSN	X		Technical supervision
Technical commands	Commands of switch-on/off		X	Technical supervision
Run/Taxi-way Status and Usage	Usage and Status of Runways and Taxiways		X	Runway and Taxiway Usage Management
Airport data	Airport geographical and operational data		X	Operational Supervision
Taxi plans	Taxi plans		X	Aerodrome Flight Data Processing

Table 2: SSN Interfaces

In case of unavailability of one of the inputs, the SSN would not be able to work in nominal mode. A degraded mode is defined in §2.2.2.

2.7 Service View

N.A.

¹ This interface and is only an example, because SSN broadcasts the Alert reports to all interested clients.

3 Functional Block Functional and Non-Functional Requirements

3.1 Capabilities

3.1.1 General Requirements

Identifier	REQ-12.03.02-TS-2001.0010
Requirement	The SSN server shall continuously process the target reports coming from the Aerodrome Surveillance function, related clearances and cleared routes coming from the AFDPS to compare the traffic situation in real time with the set of predefined alert situations (specified in following requirements).

Identifier	REQ-12.03.02-TS-2001.0020
Requirement	The SSN server, in case of unavailability of clearances and/or of cleared routes from AFDPS (Degraded Mode), shall continuously process the target reports only, to compare the traffic situation with a sub-set of predefined alert situations.

Identifier	REQ-12.03.02-TS-2001.0030
Requirement	The SSN server, in case of unavailability of target reports from Aerodrome Surveillance function (Degraded Mode), shall continuously process the AFDPS information to detect a sub-set of predefined alert situations.

Identifier	REQ-12.03.02-TS-2001.0040
Requirement	The SSN server shall be capable of providing two stages of alert (Stage 1 and Stage 2) according to the severity of the alert situation. Stage 2 (ALARM) is more severe than Stage 1 (INFORMATION). NOTE: The required alert severity is stated for each requirement in the following sections.

Identifier	REQ-12.03.02-TS-2001.0050
Requirement	Whenever it detects a mobile or mobiles in a predefined alert situation, the SSN server shall create and broadcast alert reports with at least the following information: - Alert report identifier - Type of alert - Alert severity level - Time of alert - Identity of target(s) in alert situation - Track number (if available) - Target ID (call-sign, SSR code, or registration) (if available)

Identifier	REQ-12.03.02-TS-2001.0060
Requirement	For each detected alert situation, the SSN server shall transmit an alert report for each target position update as long as the alert situation persists.

3.1.2 Runway Incursion Requirements

Identifier	REQ-12.03.02-TS-2002.0010
Requirement	The SSN server shall trigger an alert (ALARM) if a mobile is detected crossing a red stop bar (wherever the location of the stop bar is).

Identifier	REQ-12.03.02-TS-2002.0020
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Requirement	The SSN server shall trigger an alert (INFORMATION) if an aircraft is detected approaching to land and its expected time to reach the runway threshold is T1 (or less, T1 being configurable) and another mobile or obstacle is in the RPV. The alert ends when the Aerodrome Surveillance has detected that the mobile left the RPV.
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Identifier	REQ-12.03.02-TS-2002.0030
Requirement	The SSN server shall trigger an alert (ALARM) if an aircraft is detected approaching to land and its expected time to reach the runway threshold is T2 (or less, T2 being configurable and $T2 < T1$) and another mobile or obstacle is in the RPV. The alert ends when the Aerodrome Surveillance has detected that the mobile left the RPV.

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Identifier	REQ-12.03.02-TS-2002.0040
Requirement	The SSN server shall trigger an alert (ALARM) if an aircraft is detected taking off and another mobile is in the RPV, ahead of the taking-off aircraft. The alert ends when the Aerodrome Surveillance has detected that the mobile left the RPV, or is behind the taking-off aircraft.

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Identifier	REQ-12.03.02-TS-2002.0050
Requirement	The SSN server shall trigger an alert (INFORMATION) if 2 mobiles approaching, or on, 2 different converging or intersecting runways have converging trajectories, that would bring them closer than D meters to each other within T1 seconds (D and T1 being configurable parameters). The alert ends when the Aerodrome Surveillance has detected that the trajectories are no longer converging.

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Identifier	REQ-12.03.02-TS-2002.0060
Requirement	The SSN server shall trigger an alert (ALARM) if 2 mobiles approaching, or on, 2 different converging or intersecting runways have converging trajectories, that would bring them closer than D meters to each other within T2 seconds (D and T2 being configurable parameters, and $T2 < T1$). The alert ends when the Aerodrome Surveillance has detected that the trajectories are no longer converging.

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Identifier	REQ-12.03.02-TS-2002.0070
Requirement	The SSN server shall trigger an alert (ALARM) if an aircraft is detected landing, and an opposite direction approaching aircraft with expected time to reach the runway threshold is T (or less). The alert ends when the Aerodrome Surveillance has detected that the trajectories are no longer converging.

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Identifier	REQ-12.03.02-TS-2002.0080
Requirement	The SSN server should trigger an alert (INFORMATION) if it detects that an aircraft is stationary in the runway protection volume (OFZ/RPV) for longer than a configurable time. The alert ends when the Aerodrome Surveillance has detected that the aircraft is moving.

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Identifier	REQ-12.03.02-TS-2002.0090
Requirement	The SSN server shall trigger an alert (INFORMATION) when an aircraft is detected approaching to a closed runway and its expected time to reach the runway threshold is T (or less) from the runway threshold. The alert ends if the Aerodrome Surveillance detects that aircraft is no longer approaching this runway, or if the runway status changes to "Open".

Identifier	REQ-12.03.02-TS-2002.0100
Requirement	The SSN server shall trigger an alert (ALARM) if an aircraft is detected taking off on a closed runway. The alert ends if the Aerodrome Surveillance

	detects that aircraft is no longer taking off, or if the runway status changes to "Open".
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3.1.3 Area Intrusion

Identifier	REQ-12.03.02-TS-2003.0010
Requirement	The SSN server shall trigger an alert if it detects penetration by any tracked target (any mobile) into an area defined as a Restricted Area. The alert ends when the Aerodrome Surveillance has detected that the mobile is no longer within the Restricted Area.

Identifier	REQ-12.03.02-TS-2003.0020
Requirement	The SSN server shall permit to configure (via a configuration database) each Restricted Area with at least the following information: • Geographical locations (defining the area size and shape) and the name of the Restricted Area • Visibility criterion: LVP/non-LVP • Restricted Area Alert severity: Stage 1 (INFORMATION) or Stage 2 (ALARM)

Identifier	REQ-12.03.02-TS-2003.0030
Requirement	The SSN server shall trigger an alert if it detects penetration by any tracked target (any mobile) that is not authorised to enter into an area defined as a Limited Access Area. Mobile types shall be checked against the allowed access criteria for the Limited Access Area. The alert ends when the Aerodrome Surveillance has detected that the mobile is no longer within the Limited Access Area.

Identifier	REQ-12.03.02-TS-2003.0040
Requirement	The SSN server shall permit to configure (via a configuration database) each Limited Access Area with at least the following information: • The geographical locations (defining the area size and shape) and the name of the Limited Access Area • Visibility criterion: LVP/non-LVP • Authorised mobile type(s) • Authorised entry point(s) • The Limited Access Area Alert severity: Stage 1 (INFORMATION) or Stage 2 (ALARM).

3.1.4 Conformance Monitoring Requirements

Identifier	REQ-12.03.02-TS-2004.0010
Requirement	The SSN server shall generate an alert (ALARM) if an aircraft is approaching to land on a runway and is less than D meters from the runway threshold without having received a Landing clearance (D being a configurable parameter).

Identifier	REQ-12.03.02-TS-2004.0020
Requirement	The SSN server shall trigger an alert (INFORMATION) if an aircraft is moving from its stand without having received a Push-back clearance. NOTE: This only applies for aircraft on stands that require push-back, otherwise REQ-12.03.02-TS-2004.0030 applies.

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Identifier	REQ-12.03.02-TS-2004.0030
Requirement	The SSN server shall trigger an alert (INFORMATION) if a mobile with a taxi plan is moving without having received a Taxi clearance.

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Identifier	REQ-12.03.02-TS-2004.0040
Requirement	The SSN server shall trigger an alert (ALARM) if a mobile is detected entering a RPV without having received a line-up / cross / enter clearance.

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Identifier	REQ-12.03.02-TS-2004.0050
Requirement	The SSN server shall generate an alert (ALARM), if an aircraft is taking off without having received a Take-Off clearance.

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Identifier	REQ-12.03.02-TS-2004.0060
Requirement	The SSN server shall generate an alert (ALARM) if an aircraft is detected as approaching to land on a runway that is not the assigned one (the one contained in relevant flight plan), and is less T seconds from the runway threshold (T being a configurable parameter).

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Identifier	REQ-12.03.02-TS-2004.0070
Requirement	The SSN server shall trigger an alert (INFORMATION) if an aircraft is cleared to line up but the aircraft is lining-up on a runway that differs from the assigned one.

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Identifier	REQ-12.03.02-TS-2004.0080
Requirement	The SSN server shall trigger an alert (INFORMATION) if a vehicle is cleared to enter the runway but the position of the vehicle is not consistent with the cleared runway and/or holding point.

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Identifier	REQ-12.03.02-TS-2004.0090
Requirement	The SSN server shall trigger an alert (INFORMATION) if an aircraft is cleared to land but the cleared runway is closed.

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Identifier	REQ-12.03.02-TS-2004.0100
Requirement	The SSN server shall trigger an alert (INFORMATION) if an aircraft is cleared to line-up or take off but the cleared runway is closed.

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Identifier	REQ-12.03.02-TS-2004.0110
Requirement	The SSN server shall trigger an alert (INFORMATION) when a taxiway is closed after it has been assigned to an aircraft as part of its cleared route and the aircraft has not yet entered the taxiway.

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Identifier	REQ-12.03.02-TS-2004.0120
Requirement	The SSN server shall trigger an alert (INFORMATION) for an arriving aircraft, if there has been no "Contact indication", and the arriving aircraft is at less than D1 meters from threshold. Note: D1 should be configurable, depending upon optimisation at the aerodrome.

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Identifier	REQ-12.03.02-TS-2004.0130
Requirement	The SSN server shall trigger an alert (INFORMATION) when an excessive speed of an aircraft in taxi phase is detected (speed > X). Note: X value shall be configurable.

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Identifier	REQ-12.03.02-TS-2004.0140
Requirement	The SSN server shall trigger an alert as soon as a mobile has deviated from its cleared taxi route.

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Identifier	REQ-12.03.02-TS-2004.0150
Requirement	The SSN server shall generate an alert (INFORMATION) if an inbound aircraft deviates, more than a configurable distance, from the approach funnel to the assigned runway for landing (the one contained in relevant flight plan).

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Identifier	REQ-12.03.02-TS-2004.0160
Requirement	The SSN server shall trigger an alert (INFORMATION) when a mobile does not move after X seconds (configurable parameter), having received an instruction to push-back, taxi, line-up, cross, or take-off.

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635 3.1.5 Conflicting ATC Clearances Requirements

Identifier	REQ-12.03.02-TS-2005.0010
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to line up and another aircraft is cleared to line up on the same runway on the opposite threshold.

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Identifier	REQ-12.03.02-TS-2005.0020
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to line up and another aircraft is cleared to line up on the same runway and their holding points are opposing.

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Identifier	REQ-12.03.02-TS-2005.0030
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to line up and another aircraft is cleared to line up on the same runway and their holding points are the same or neighbouring, and multiple line ups are not permitted.

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Identifier	REQ-12.03.02-TS-2005.0040
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to line up and another mobile is cleared to cross the same runway and holding points are opposing.

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Identifier	REQ-12.03.02-TS-2005.0050
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to line up and another mobile is cleared to enter the same runway and holding points are opposing. Note: Alarm should not trigger if the mobile entered first the runway and the aircraft has enough space to line-up behind the mobile.

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Identifier	REQ-12.03.02-TS-2005.0060
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to line up and another aircraft is cleared to take-off and the cleared runway entry point for the aircraft receiving the line-up clearance is in front of the aircraft receiving the take-off clearance on the same runway.

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Identifier	REQ-12.03.02-TS-2005.0070
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to line up and another aircraft is cleared to take-off from the opposite threshold of the same runway.

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Identifier	REQ-12.03.02-TS-2005.0080
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to line up and another aircraft is cleared to land, and the planned runway entry point for the aircraft receiving the Line-Up clearance is in front of the aircraft receiving the landing clearance on the same runway.

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Identifier	REQ-12.03.02-TS-2005.0090
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to line up and another aircraft is cleared to land at the opposite threshold.

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Identifier	REQ-12.03.02-TS-2005.0100
Requirement	The SSN server shall trigger an alert (ALARM) when a mobile is cleared to cross a runway and another mobile is cleared to cross the same runway and their holding points are opposing.

Identifier	REQ-12.03.02-TS-2005.0110
Requirement	The SSN server shall trigger an alert (ALARM) when a mobile is cleared to enter a runway and another mobile is cleared to cross the same runway and their holding points are opposing. Note: Alarm shall not trigger if the first mobile entered the runway and the second one can cross behind the first one.

Identifier	REQ-12.03.02-TS-2005.0120
Requirement	The SSN server shall trigger an alert (ALARM) when a mobile is cleared to enter a runway and another mobile is cleared to enter the same runway and their holding points are opposing.

Identifier	REQ-12.03.02-TS-2005.0130
Requirement	The SSN server shall trigger an alert (ALARM) when a mobile is cleared to cross a runway and another aircraft is cleared to take-off on the same runway, and the planned runway entry point for the mobile receiving the Cross clearance is in front of the aircraft receiving the Take-Off clearance on the same runway.

Identifier	REQ-12.03.02-TS-2005.0140
Requirement	The SSN server shall trigger an alert (ALARM) when a mobile is cleared to enter a runway and another aircraft is cleared to take-off on the same runway, and the planned runway entry point for the mobile receiving the Enter clearance is in front of the aircraft receiving the Take-Off clearance on the same runway.

Identifier	REQ-12.03.02-TS-2005.0150
Requirement	The SSN server shall trigger an alert (ALARM) when a mobile is cleared to cross and another aircraft is cleared to land, and the planned runway entry point for the mobile receiving the Cross clearance is in front of the aircraft receiving the Landing clearance on the same runway, and the aircraft is not expected to vacate the runway before the crossing point.

Identifier	REQ-12.03.02-TS-2005.0160
Requirement	The SSN server shall trigger an alert (ALARM) when a mobile is cleared to enter and another aircraft is cleared to land on the same runway, and the planned runway entry point for the mobile receiving the Enter clearance is in front of the aircraft receiving the Landing clearance on the same runway, and the aircraft is not expected to vacate the runway before the entering point.

Identifier	REQ-12.03.02-TS-2005.0170
Requirement	The SSN server shall trigger an alert (ALARM) when two aircraft are cleared

	to take off on the same runway, and the planned runway entry point for the second aircraft (or its position if it's already on the runway) is in front of the first aircraft.
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Identifier	REQ-12.03.02-TS-2005.0180
Requirement	The SSN server shall trigger an alert (ALARM) when two aircraft are cleared to take-off on converging runways and their trajectories are converging.

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Identifier	REQ-12.03.02-TS-2005.0190
Requirement	The SSN server shall trigger an alert (ALARM) when two aircraft are cleared to take-off on intersecting runways and their trajectories are converging.

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Identifier	REQ-12.03.02-TS-2005.0200
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to take-off on a runway and another aircraft is cleared to take-off on the same runway but on opposite threshold.

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Identifier	REQ-12.03.02-TS-2005.0210
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to land and another aircraft is cleared to take-off on the same runway in the same direction, and the aircraft taking off has not reached a certain position or speed (parameter).

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Identifier	REQ-12.03.02-TS-2005.0220
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to take-off on a runway and another aircraft is cleared to land on the opposite threshold.

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Identifier	REQ-12.03.02-TS-2005.0230
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to take-off on a runway and another aircraft is cleared to land with intersecting runways and converging trajectories, and the aircraft, which received the clearance first, has not reached a certain position or speed (parameter).

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Identifier	REQ-12.03.02-TS-2005.0240
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to take-off on a runway and another aircraft is cleared to land with converging runways and converging trajectories, and the aircraft, which received the clearance first, has not reached a certain position or speed (parameter).

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Identifier	REQ-12.03.02-TS-2005.0250
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to

	land on a runway and then another aircraft is cleared to take-off on a different but closely spaced parallel runway, and the landing aircraft has passed a certain position or is below a certain speed (parameter).
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Identifier	REQ-12.03.02-TS-2005.0260
Requirement	The SSN server shall trigger an alert (ALARM) when two aircraft are cleared to land on the same runway.

Identifier	REQ-12.03.02-TS-2005.0270
Requirement	The SSN server shall trigger an alert (ALARM) when an aircraft is cleared to land, and another aircraft is cleared to land on intersecting or converging runway and aircraft trajectories are converging.

Identifier	REQ-12.03.02-TS-2005.0280
Requirement	The SSN server shall trigger an alert (ALARM) when two aircraft are cleared to land on the same runway at opposite threshold.

3.2 Adaptability

Adaptability requirements are stated with the functional requirements in section 3.1.

3.3 Performance Characteristics

The requirements in this section are the only performance requirements available at the moment from P06.07.01. Since they can only be verified by extensive long-term testing of a real implementation in a live aerodrome environment, those requirements will not be tested in this phase.

Identifier	REQ-12.03.02-TS-2007.0010
Requirement	The SSN should detect Runway Incursion conflicts with a probability of false alert less than 10E-3 per movement.

Identifier	REQ-12.03.02-TS-2007.0020
Requirement	The SSN should detect Conflicting ATC Clearances with a probability of false alert less than 10E-4 per movement.

Identifier	REQ-12.03.02-TS-2007.0030
Requirement	The SSN should detect Conflicting ATC Clearances with a detection rate of 99.9%.

Identifier	REQ-12.03.02-TS-2007.0040
Requirement	The SSN shall provide alerts no more than 1 second after the reception of the conflicting clearances.

3.4 Safety & Security

The requirement in this section is the only safety requirement available at the moment from P06.07.01.

Identifier	REQ-12.03.02-TS-2008.0010
Requirement	The SSN server shall continuously transmit a regular, up-to-date status report to the Technical Supervision function. In the event of a failure of the SSN server, the Technical Supervision function should detect the absence of SSN status reports and take the appropriate action.

3.5 Maintainability

N.A.

3.6 Reliability

N.A.

3.7 Functional Block Internal Data Requirements

N.A.

3.8 Design and Construction Constraints

N.A.

3.9 Functional Block Interface Requirements

Identifier	REQ-12.03.02-TS-2009.0010
Requirement	The SSN server shall continuously receive up-to-date target reports from Aerodrome Surveillance functional block. The target reports should meet the minimum requirements stated in EUROCAE ED-87B sections 2.5.1.1 and 3.2.4.

Identifier	REQ-12.03.02-TS-2009.0020
Requirement	The SSN server shall receive Airport operational data (Airport Configuration, LVP operations...) from the appropriate source (according to local implementation).
	Operational data

Identifier	REQ-12.03.02-TS-2009.0030
Requirement	The SSN server shall continuously transmit a regular, up-to-date status report to Technical Supervision functional block.

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Identifier	REQ-12.03.02-TS-2009.0035
Requirement	The SSN server shall be able to receive technical commands (Start, Stop...) from Technical Supervision functional block.

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Identifier	REQ-12.03.02-TS-2009.0040
Requirement	The SSN server shall receive the necessary flight plans data and all the information relative to the given clearances from the Aerodrome Flight Data Processing functional block.

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Identifier	REQ-12.03.02-TS-2009.0050
Requirement	The SSN server shall receive the necessary vehicle taxi plan information from Aerodrome Flight Data Processing functional block.

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Identifier	REQ-12.03.02-TS-2009.0060
Requirement	The SSN server shall continuously broadcast regular alert reports to all clients (until the alert situation no longer exists).

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Identifier	REQ-12.03.02-TS-2009.0070
Requirement	The SSN server shall receive the status and usage of Runways and Taxiways from Runway the appropriate source (according to local implementation).
	Status and Usage of Runways and Taxiways

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Identifier	REQ-12.03.02-TS-2009.0080
Requirement	The SSN server shall continuously transmit the Data for Recording (Alert reports and status reports) to the Support Functions functional block.

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4 Assumptions

The operational project 06.07.01 is composed of several Work Areas. Two of them correspond to functionalities in the scope of 12.03.02:

- Conformance Monitoring
- Conflicting ATC Clearances

The other functionalities in 12.03.02's scope (Runway Incursions, Area Intrusions) are standard A-SMGCS Level 2 functions and are therefore not directly addressed by 06.07.01, or other SESAR projects, but they are assumed to be present in the baseline. Therefore, the following documents were used as input to specify the SSN server:

- EUROCONTROL – Functional Requirements for A-SMGCS Implementation Level 2, Ed. 2.1, 30/06/2010
- EMMA2 A-SMGCS Services, Procedures, and Operational Requirements (SPOR) “A Preliminary Concept and Framework for Validation Activities in EMMA2”. 2-D111_SPOR_V1.0.doc (02/12/2008).
- EMMA2 A-SMGCS Technical Requirements – Ground. 2-D112a_ATR_GND_V1.0.pdf

All the specifications coming from these documents have been analyzed. The purpose of this analysis is to get a set of operational requirements in order to produce the technical specifications that belong to the scope of this project.

5 References

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- [2] Requirements and V&V Guidelines 03.00.00
<https://extranet.sesarju.eu/Programme%20Library/Requirements%20and%20VV%20Guidelines.doc>
- [3] Templates and Toolbox User Manual 03.00.00
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- [4] EUROCONTROL ATM Lexicon
<https://extranet.eurocontrol.int/http://atmlexicon.eurocontrol.int/en/index.php/SESAR>
- [5] 12.03.02-D02 Phase 1 – System Specification Baseline, Edition 00.02.00, 30/09/2011
- [6] 12.03.02-D17 Phase1 - Consolidated Verification Report, Edition 00.01.00, 01/08/2012
- [7] 06.07.01-D16 Updated OSED for “Conflicting ATC Clearances”, Edition 00.01.01, 08/03/2012
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