Final Technical Specifications for PJ.14-W2-84f TRL6 Surveillance Performance Monitoring - End-to-end

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Authors of the document

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SURVEILLANCE PERFORMANCE MONITORING FOR END-TO-END

Abstract

This document gives the technical requirements which will lead to the implementation of Surveillance Performance Monitoring for End-to-end (at controller working position level) of Surveillance Chain targeting TRL6. The solution PJ.14-W2-84f targets ANSPs in TMA & En-route operational environments. PJ.14-W2-84f targeted first TRL4 in the first part of Wave 2 and currently aims TRL6 maturity by the end of Wave 2. Current technical requirements addressed the harmonisation issues that was the reason for partial validation during TRL4 validation in addition to the development of Quasi Real-Time functionality and changes with the official ESASSP Ed 1.2 standard.

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1 Executive summary

The aim of this document is to produce the technical requirements for the implementation of Surveillance Performance Monitoring (SPM) Tools for the performance analysis at "End-to-end" (controller working position) level of the Surveillance Chain. This document is produced as part of the work for the SESAR 2020 Solution PJ.14-W2-84f aiming TRL6 in the current phase. This TRL6 Final TS/IRS consolidates the TRL6 Initial TS/IRS that was used as basis. TRL6 validation activities have demonstrated that SPM tools calculate the performance metrics specified in ESASSP Ed 1.2. Current technical requirements addressed the SPM Tools harmonisation, development of Quasi Real-Time functionality and the official ESASSP Ed 1.2 standard.

The main objective of the Technological Solution PJ.14-W2-84f is to enable a harmonised performance monitoring for the End-to-end Surveillance Chain following Performance Based Surveillance (PBS). Such monitoring aims to identify degradation trends early, using both off-line and quasi-real time processes. The two SPM Tool prototypes, namely EUROCONTROL SASS-C/VERIF and THALES AGATE, have been further developed. The SPM Tools technical specification is dependent on the standards for Surveillance Data Processing and Distribution Systems (SDPDS), covering ATC surveillance trackers and fusion systems. At the time of the development of this Final TS/IRS, the level of maturity of the relevant standards defining the methods are heterogeneous:

- ESASSP Ed 1.1 published in 2015,
- ESASSP Ed 1.2, a minor update to Ed 1.1, released end April 2021,
- ED-261 (GEN-SUR SPR) released in April 2022 but not used in the end-to-end context yet.

The TRL6 TS/IRS requirements are based on the ESASSP Ed. 1.2. To support in-depth cross verification, additional reporting functionality requirements give the details of the reference and SUT (System Under Test) tracks that are used for the calculation of each performance metric. Furthermore, during the development of the TRL6 prototypes, traffic scenarios of increasing complexity have been used for continuous cross verification of the performance metrics results from each prototype. Additionally, TMA and En-route traffic scenario from a medium/high density operational environment based on multiple sensors (three Mode S radars, ADS-B or WAM) and an operational tracker system have been used for the validation exercises.

Additionally, TRL6 development have added Quasi Real-Time functionality in order to carry out automated periodic performance assessment of the surveillance chain. In normal or manual mode of operation, ATSEP carries out the performance assessment or investigation by configuring input data/settings and checks the performance metrics. The automated performance assessment can be carried out at user specified times with recorded surveillance data from the previous period. Performance metrics can be calculated, stored and displayed from each such performance assessment. TRL6 validation has also verified correct functioning of the Quasi Real-Time mode of operation.

2 Introduction

This project is part of the SESAR 2020 Multi Annual Program for the period 2019-2022. It is part of the Industrial Research & Validation phase, developed under the SJU Private Public Partnership. Solution PJ.14-W2-84f is continuation of the work initiated by PJ.14-04-01 Task 3 which reached Maturity TRL2 at the end of Wave 1. The solution has also completed TRL4 maturity in the first part of Wave 2. In the current phase, the solution targets TRL6 maturity by the end of Wave 2.

There are no changes with respect to the architecture representation that was defined and entered into EATMA during TRL4 phase. Surveillance Performance Monitoring and associated tools are passive consumers of the surveillance data and do not provide input back to the ATM operations. The basic functionality is checking that the surveillance system operates within the defined performance criteria and providing performance assessment reports to the Air Traffic Safety Electronics Personnel (ATSEP). It is up to ATSEP to take the necessary actions to rectify the identified performance degradation.

Communications, Navigation and Surveillance (CNS) systems provide the invisible and often unappreciated infrastructure which is essential for Air Traffic Management. CNS enables efficient navigation and safe separation in all phases of flight. In Surveillance, solutions will be developed to enhance, harmonize and integrate cooperative and emerging non-cooperative sensors, advanced multi-sensors data fusion capabilities, security related functionality together with the methods and tools for Surveillance Performance Monitoring. This is in line with a Performance Based Surveillance (PBS) approach.

The objective of the solution PJ.14-W2-84f is to enable a harmonised performance monitoring of surveillance systems. Such monitoring will seek to identify degradation trends early, using both off-line and continuous quasi real-time processes. These will be applied at the output of the entire surveillance chain. It is to be noted that performance assessment methods for the surveillance chain are still developing and that the available classical methods and tools are considered to be inadequate. In particular with the availability of the ESASSP Ed 1.2 [15] standard. In this regard, recognising that there is a trend of the standards towards harmonisation, the choice has been made to harmonise the various metric assessment methods in line with this trend in line with this updated standard. This approach is also expected to provide useful feedback to future standards.

In TRL6 phase, PJ.14-W2-84f aimed to further develop the two SPM Tool prototypes, namely EUROCONTROL SASS-C/VERIF and THALES AGATE, which were the target of TRL4 development and validation activities. The TRL4 TS/IRS requirements were based on an early draft ESASSP Ed. 1.2. Compared to the draft version used as input to TRL4 development and validation, the official version has a minor change for Probability of Update metric considering the data age for position. At first, this change seems solely to affect the Probability of Update, but it will alter the correct/false target report classification and correspondingly will affect other performance metrics (e.g., accuracy metrics use correct target reports only). This change will be taken into account in target report classification.

A shortcoming of the TRL4 validation was that the harmonisation and cross check of the two SPM Tool prototypes was achieved only partially. To support in-depth cross verification, additional reporting functionality requirements are introduced to give the details of the reference and SUT (System Under Test) tracks that are used for the calculation of each performance metric. Furthermore, during the development of the TRL6 prototypes, traffic scenarios of increasing complexity have been used for continuous cross verification of the performance metrics results from each prototype. Additionally, TMA and En-route traffic scenario from a medium/high density operational environment based on

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multiple sensors (three Mode S radars, ADS-B or WAM) and an operational tracker system have been used for the validation exercises.

Furthermore, TRL6 development adds Quasi Real-Time functionality in order to carry out automated periodic performance assessment of the surveillance chain. In normal or manual mode of operation, ATSEP carries out the performance assessment or investigation by configuring input data/settings and checks the performance metrics. The automated performance assessment can be carried out at user specified times with recorded surveillance data from the previous period. Performance metrics can be calculated, stored and displayed from each such performance assessment. TRL6 validation has verified correct functioning of the Quasi Real-Time mode of operation.

In summary, the following activities have been performed in TRL6 phase:

- Specify the TS/IRS requirements to be in line with the official ESASSP Ed 1.2 [15],

- Enable in-depth cross verification by providing additional reporting functionality,

- Develop Quasi Real-Time functionality in order to carry out automated periodic performance assessment,

- Implement and verify the SPM Tool prototypes with respect to TS/IRS.

2.1 Purpose of the document

The Final Technical Specification document provides the requirements specification targeting TRL6, covering functional, non-functional and interface requirements related to SESAR Solution PJ.14-W2-84f for the SPM Tools for End-to-end Surveillance Chain. The TRL6 Final TS/IRS adds on to the TRL4 Final TS/IRS to specify the changes to performance metrics from official ESASSP Ed 1.2, QRT functionality and detailed reporting for crosscheck of prototypes.

2.2 Scope

The Solution PJ.14-W2-84f Surveillance Performance Monitoring Tool for End-to-end of Surveillance Chain covers the TMA & En-route operational environments.This Final TS/IRS draws the requirements from ESASSP Ed 1.2 [15], adding detailed cross-check and QRT related requirements.

2.3 Intended readership

This document can be of interest for the following readership:

- ANSPs operating in TMA & En-route operational environments,

- Solution PJ.14-W2-84a for surveillance data verification,

- Solution PJ.14-W2-84e to share requirements/information/rationale.

2.4 Background

Solution PJ.14-W2-84f is a continuation of the work initiated by PJ.14-04-01 Task 3 which reached TRL2 maturity at the end of Wave 1. The solution has passed through TRL4 maturity in the first part of the Wave 2.

2.5 Structure of the document

The structure of the document is composed of the following sections:

- **Section 1:** Executive Summary

- **Section 2:** Current section introducing the solution and the document

- **Section 3:** Provides architecture aspects of the solution

- **Section 4:** Details Functional and non-Functional requirements

- **Section 5:** Provides some recommendation for implementation

- **Section 6:** Provides the assumptions considered in the Technical Specification

- **Section 7:** Lists the relevant references used within this document

2.6 Glossary of terms

Term	Definition	Source of the definition
CAV	Conformity Assessment Volume *(See definition of OSV)*	*ESASSP Ed 1.2 [15]*
DOI	Domain of Interest *(See definition of OSV)*	*Eurocontrol SRS Products*
OCV	The *Operational Coverage Volume* is the contracted geographic volume of interest within which the system provides surveillance with required performance. The *Operation Coverage Volume* may be subdivided into several *Operational Service Volumes*, each with their own surveillance performance requirements.	*ED-129C [16], Appendix K*
OSV	An *Operational Service Volume* is a sub volume in the *Operational Coverage Volume* wherein the system provides a specific surveillance service with a single set of performance requirements.	*ED-129C [16], Appendix K*

Table 1: Glossary

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2.7 Acronyms and Terminology

Term	Definition
ADS-B	Automatic Dependent Surveillance - Broadcast
APP	APProach
ASTERIX	All-purpose STructured Eurocontrol suRveillance Information eXchange
ATC	Air Traffic Control
ATM	Air Traffic Management
ATSEP	Air Traffic Safety Electronics Personnel
CAV	Coverage Assessment Volume
CC	Capability Configurations
CNS	Communication Navigation Surveillance
CWP	Controller Working Position
DOI	Domain of Interest
EATMA	European ATM Architecture
ER	En-Route
FL	Flight Level
GEN-SUR SPR	GENeric SURveillance Safety and Performance Requirements
HPA	Horizontal Position Accuracy
IP	Internet Protocol
IRS	Interface Requirements Specification
LAN	Local Area Network
MLAT	MultiLATeration
MTBF	Mean Time Between Failures
NAF	NATO Architecture Framework
NM	Nautical Mile
NSV	NAF System View

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OCV	Operational Coverage Volume
OSV	Operational Service Volume
PBS	Performance Based Surveillance
PJ	ProJect
PLG	Probability of Long Gaps
PMP	Project Management Plan
PTR	Probability of Target Report
PU	Probability of Update
QRT	Quasi Real-Time
RMS	Root Mean Square
SDD	Service Description Document
SDPDS	Surveillance Data Processing and Distribution System (including tracker, data fusion systems)
SE-DMF	System Engineering – Data Management Framework
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SPM	Surveillance Performance Monitoring
SPR	Safety and Performance Requirements
SUR	ATC Surveillance
SUT	System Under Test
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol / Internet Protocol
TMA	Terminal Manoeuvring Area
TRL	Technology Readiness Level
TS	Technical Specification
TS/IRS	Technical Specification / Interface Requirements Specification

TVALP	Technical VALidation Plan
TVALR	Technical VALidation Report
V&V	Validation and Verification
WAM	Wide Area Multilateration

Table 2: Acronyms and terminology

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3 SESAR Solution Impacts on Architecture

3.1 Target Solution Architecture

3.1.1 SESAR Solution(s) Overview

The main purpose of this document is to provide the overall requirements specification, covering functional, non-functional and interface requirements for SESAR Solution PJ.14-W2-84f, namely the Surveillance Performance Monitoring for End-to-end of Surveillance Chain in the TMA and En-route operational environments. It addresses the development of SPM Tools for the performance assessment of end-to-end surveillance chain. The SPM Tool has main input interfaces from the SDPDS whose performance will be assessed and monitored as well as the surveillance sensors that are used by the SDPDS for generating the tracks and data fusion. There can be additional inputs from external references like on-board GPS recordings or other data sources that can be used as reference. There are also configuration data that defines the SDPDS and sensor characteristics, geographical and service characteristics of the service volume, type of analysis to be performed and related settings.

Output interfaces are performance analysis reports and graphical displays for inspection. Performance analysis reports give a list of performance metrics and whether the metrics are within allowed limits. Reports may provide a standardised way to output the performance metrics in order to facilitate the comparison of results from the tools that will be developed as part of the current specification. The optional feature of graphical displays may enable inspection of the results from intermediate processing stages and the detailed analysis results of the tool. The graphical displays may facilitate to investigate the reasons for unexpected values for performance metrics and identify problematic input data that adversely affect the performance metrics. Such problematic input data, typically a faulty aircraft, can be filtered out by defining a filter as part of configuration data.

Surveillance Performance Monitoring – End-to-End aims at enabling an improved performance monitoring of surveillance systems in line with the Performance Based Surveillance (PBS) approach. This Solution focuses on the development of Surveillance Performance Monitoring Tools for end-to-end surveillance chain. One of the objectives of the Solution is the harmonisation of the tools. Recognising there is a trend of the standards towards harmonisation, the choice has been made to harmonise the various metric assessment methods. Solution tasks include tools specification aligned with existing and developing Surveillance Standards, quasi real-time assessment, development of tool prototypes and verification of these prototypes. The results of tools verification are a potential input to the standardisation, in particular the ESASSP specification.

SESAR Solution ID and Title	Functional Blocks/Role impacted by the SESAR Solution (from EATMA)	Enabler ID (from EATMA)	Enabler Title (from EATMA)	Enabler coverage
PJ.14-W2-84f: Surveillance Performance Monitoring – end-to-end	En-route/TMA Surveillance Chain	CTE-S07e	SUR Chain SPM Tool – ER & TMA	Fully

Table 3: SESAR Solution PJ.14-W2-84f Scope and related Functional Blocks/roles & Enablers

OI Step	OI description	Open CR
POI-0062-SUR	Surveillance performance monitoring for end-to-end surveillance chain	

Table 4: SESAR Solution PJ.14-W2-84f Operational Improvement Steps

3.1.1.1 Deviations with respect to the SESAR Solution(s) definition

None has been identified.

Enabler	Opt/Req	Deviation
CTE-S07e - SUR Chain SPM Tool – ER & TMA	Required	

Table 5: SESAR Solution PJ.14-W2-84f no deviations with respect to definition

3.1.1.2 Relevant Use Cases

System Process	Description
Surveillance Performance Monitoring of Surveillance Chain at En-route/TMA	This use case describes the Surveillance Performance Monitoring Tool operation at En-route/TMA for surveillance chain (SDPDS)

Table 6: Surveillance Performance Monitoring for end-to-end use cases

3.1.1.3 Applicable standards and regulations

The applicable standards, specifications and regulations are given in Section 7.2. They are referenced in this section for convenience.

- EUROCONTROL ESASSP v1.1 [14]
- EUROCONTROL ESASSP v1.2 [15]

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3.1.2 Capability Configurations required for the SESAR Solution

SESAR Solution ID and Title	Capability Configurations (CCs) (from EATMA)	Sub-Operating Environment(s) where the CCs operate	Capabilities (from EATMA)	Nodes (from EATMA)	Stakeholders (from EATMA)
PJ.14-W2-84f Surveillance Performance Monitoring – end-to-end	APP ACC (PJ14-W2-84f)	Terminal Airspace;	Adverse Condition Operations Provision; Air Traffic Complexity Management; Air Traffic Flow Management; Airspace Configuration Management; Arrival Sequencing; Arrival Traffic Merging; Clearance/Instruction Management; Coordination and Transfer; Human Computer Interface (HCI) Design; Minimum Pair Separation Provision; RNP based Operations Execution; Separation Service Provision (airspace); Trajectory Conformance Monitoring; Trajectory Revision in Execution; Wake Turbulence Separation Provision; Weather-Dependent Separation Provision;	Air Traffic Flow and Capacity Management; Airspace Management; En-Route/Approach ATS;	Civil ATS Approach Service Provider; Military ATS Approach Service Provider;
	Communication Infrastructure	Airport; En-Route; Network;	Air/ground connectivity provision based on terrestrial infrastructure; Network connectivity provision for		Civil CNS Service Provider; Military CNS

	Terminal Airspace;	aeronautical communications on the airport surface;		Service Provider;
ER ACC (PJ14-W2-84f)	En-Route;	Air Traffic Complexity Management; Air Traffic Flow Management; Airspace Configuration Management; Arrival Sequencing; ATCO Team Operations Management; Clearance/Instruction Management; Coordination and Transfer; Human Computer Interface (HCI) Design; Mid-Air Collision Avoidance; Separation Service Provision (airspace); Trajectory Conformance Monitoring; Trajectory Revision in Execution;	Air Traffic Flow and Capacity Management; Airspace Management; En-Route/Approach ATS;	Civil ATS En-Route Service Provider; Military ATS En-Route Service Provider;
Surveillance Infrastructure En-Route	En-Route;	Detection/Tracking of Mobiles (airspace) from Composite Surveillance and/or Alternative Sources; Ground-based Surveillance Infrastructure Rationalisation		Civil CNS Service Provider; Military CNS Service Provider;
Surveillance Infrastructure TMA	Terminal Airspace;	Detection/Tracking of Mobiles (airspace) from Composite Surveillance and/or Alternative Sources; Ground-based		Civil CNS Service Provider; Military CNS Service Provider;

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			Surveillance Infrastructure Rationalisation		
	Surveillance Performance Monitoring	Airport; En-Route; Terminal Airspace;	Surveillance Performance Monitoring;		Civil CNS Service Provider; Military CNS Service Provider;

Table 7: List of Capability Configurations needed by Solution PJ.14-W2-84f

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3.2 Changes imposed by the SESAR Solution on the baseline Architecture

Solution PJ.14-W2-84f uses the architecture elements available in the EATMA Common Library which defines the baseline architecture. The solution interfaces existing capabilities defined in EATMA. The only changes to the baseline architecture are related to getting "Fused track distribution" data element from APP ACC and ER ACC CCs. The EATMA baseline architecture defined "Fused track distribution" data element as an internal data flow and did not provide a corresponding system port. APP ACC and ER ACC CCs are duplicated to solution space and modified to add the SUR_TRACK_GND system port is added.

Enabler ID (from EATMA)	Enabler Title (from EATMA)	Changes
CTE-S07e	SUR Chain SPM Tool – ER & TMA	Baseline "AP ACC" CC has been been duplicated in solution space as "AP ACC (PJ14-W2-84f)" and SUR_TRACK_GND system port is added, so that "Fused track distribution" data element is available. Baseline "ER ACC" CC has been been duplicated in solution space as "ER ACC (PJ14-W2-84f)" and SUR_TRACK_GND system port is added, so that "Fused track distribution" data element is available.

Table 8: List of changes due to PJ.14-W2-84f

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4 Technical Specifications

4.1 Functional architecture overview

This SESAR solution aims to develop Surveillance Performance Monitoring (SPM) tools as enabler of a harmonised performance monitoring of surveillance systems. SPM tools seek to identify degradation trends early, using both off-line and in continuous quasi real-time processes. SPM aims to demonstrate correct functioning of the ATM surveillance function at the individual sensor level or at ATC end-to-end level. SPM and the mount point for SPM Tools within the ATM Surveillance is shown in Figure 1.
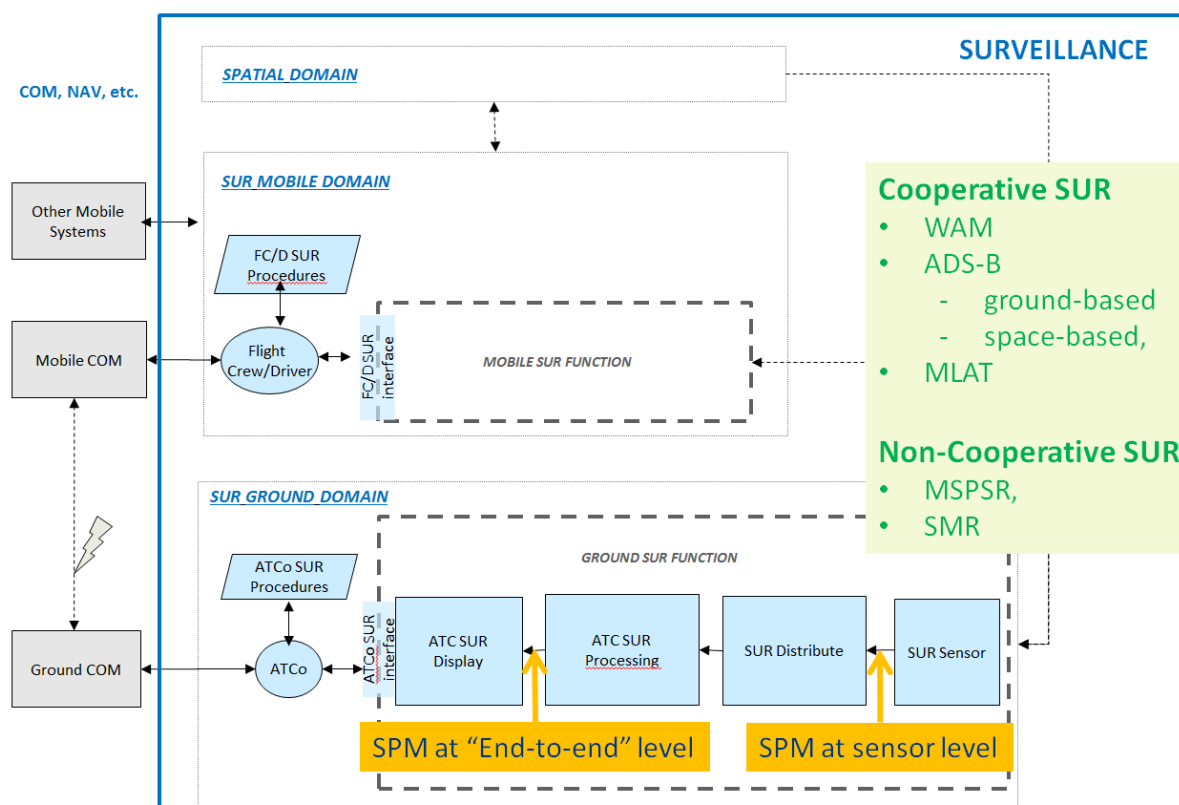
Figure 1: Surveillance Performance Monitoring Tool within Surveillance.

A functional architecture overview for a generic SPM tool is shown in Figure 2. The SPM tool has main input interfaces from surveillance sensors and surveillance chain whose performance will be assessed and monitored. There is additional input from external references like on-board GPS recordings or other data sources that can be used as reference. There are also configuration data that defines the sensor characteristics, geographical and service characteristics of the service volume, type of analysis to be performed and related settings.

Output interfaces are performance analysis reports and optional graphical displays for inspection. Performance analysis reports give a list of performance metrics and whether the metrics are within allowed limits. Reports provide a standardised way to output the performance metrics in order to facilitate the comparison of results from the SPM tools that will be developed as part of the current specification. Optional graphical displays may enable inspection of the results from intermediate

processing stages and the detailed analysis results of the SPM tool. Graphical displays may provide the mechanism to investigate the reasons for unexpected values for performance metrics and identify problematic input data that adversely affect the performance metrics. Such problematic input data, typically a faulty aircraft, can be filtered out by defining a filter as part of configuration data.
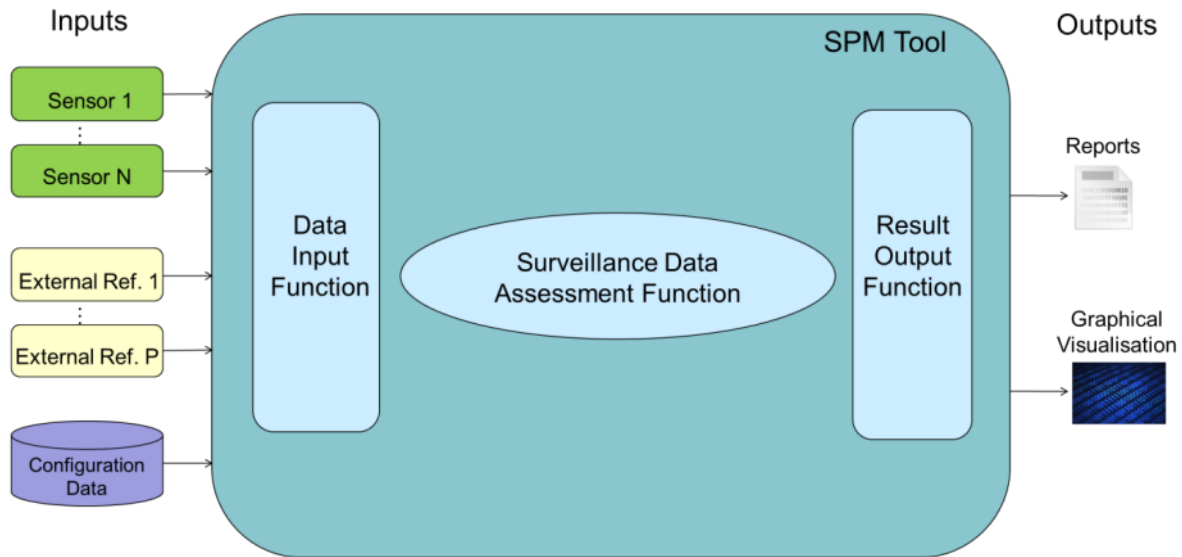
Figure 2: Functional architecture overview of a generic Surveillance Performance Monitoring Tool.

Main functions of the SPM tool can be summarised as:

- Data Input Function (e.g. recording data from different media or decoding data),
- Surveillance Data Assessment Function (e.g. all processing activities related to the performance assessment)

  - o Reference generation and association
  - o Computation of performance metrics

- Result Output Function (e.g. optional graphical interfaces for input/output data to/from the tool)

  - o Geographical displays
  - o Other graphical representations
  - o Report generation

System continuity, availability, reliability, MTBF aspects of the sensors and the SDPDS are out of scope for the SPM tool and are not part of this specification as SPM is not safety critical (see Section 4.4).

The Surveillance Performance Monitoring Tools receive data from the surveillance sensors or the SDPDS system via the TCP/IP network and pre-recorded data files.

In case of the data are acquired from the surveillance sensors or the SDPDS system via the TCP/IP, the Data Input Function of Surveillance Performance Monitoring tool will use several TCP/IP ports for different recording purposes. It is important that these ports are free for use on the system.

The Infrastructure connectivity model is reported in the following diagram:

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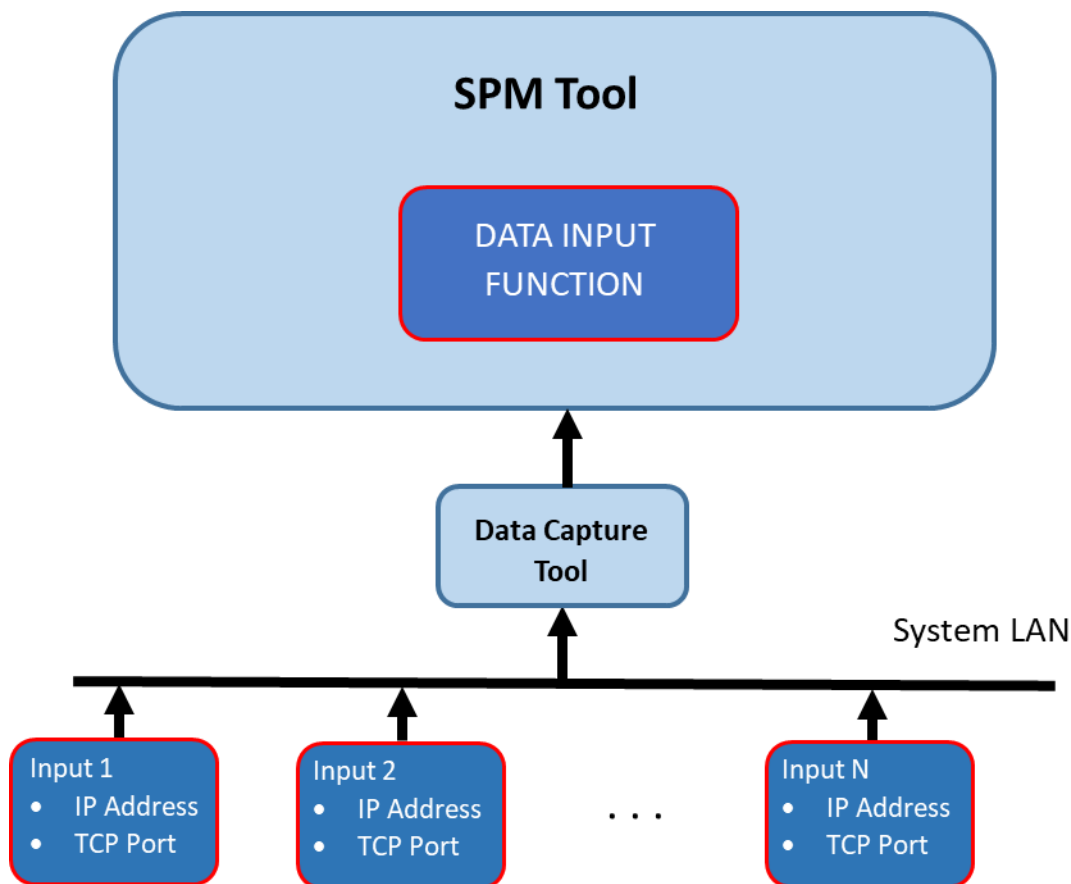
Figure 3: Infrastructure Connectivity Model of Surveillance Performance Monitoring Tool.

SPM Tool uses standard service protocols in order to connect to the system LAN to acquire surveillance data that will be provided in standard ASTERIX format.

Surveillance data received from different sensors, locally or remotely connected, will be provided in a unique system LAN where all the data flows shall be available.

Surveillance data will be provided in standard ASTERIX format. In particular:

- ASTERIX Cat 20 version 1.9, for MLAT/WAM target reports;
- ASTERIX Cat 21 version 2.1 and 2.4, for ADS-B target reports,
- ASTERIX Cat 1 version 1.2 and Cat 48 version 1.27, for radar target reports,
- ASTERIX Cat 62 version 1.18, for SDPDS target report (track updates).

Concerning the quasi real-time aspects, the monitoring of the temporal behaviour of a sensor in operation is of interest to different groups of stakeholders. Quasi real-time functionality has been developed in the current TRL6 phase.

For a manufacturer of a system, monitoring helps in identifying the impact of a system change on the system performance. A continuous performance assessment involving long term recordings of opportunity traffic provides a reasonable check before the system is put in operation. A regular performance update on a daily basis or at most an update every few hours is therefore sufficient.

On the other hand, for a system operator the continuous monitoring of the system performance and the detection of performance degradation trends could be used to provide warnings or alerts in case the system does not meet the expected performance any longer. For this use case the operator needs a real time performance indication, in order to be able taking immediate actions to ensure a safe airspace.

The process of evolution from an offline assessment tool to a monitoring system providing alerts is depicted in the following figure.

- Offline assessment
  -
- Automation
  -
- Storage of Performance Results
  -
- Trend Visualization
  -
- Trend analysis
  -
- Alerting
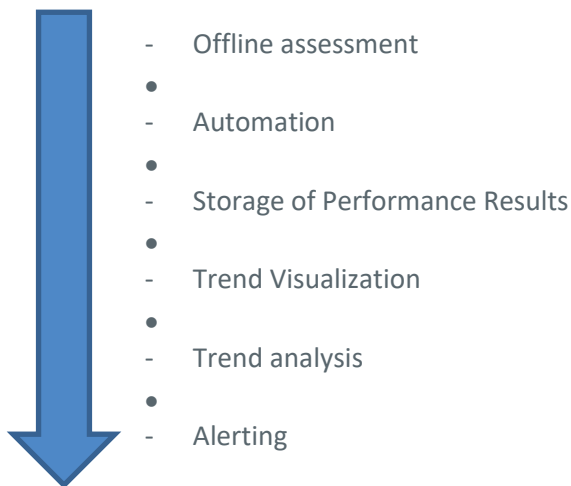
Figure 4: Evolution steps from offline assessment tool to monitoring system with alerts

The *automation* process consists of a mechanism that is able to run recurrent assessments while taking each time a different time portion of a continuous data set for assessment.

The *storage of performance results* comprises the stacking of the recurrent assessment results in a distinct manner, so that they are available and unambiguously traceable for further usage.

The *trend visualization* comprises of the collection of the results of the recurrent assessments and the generation of a graphical output that depicts the performance over time. The graphical output is updated each time a new performance result is obtained, in order to incorporate the latest result.

The *trend analysis* describes the process of investigating the performance trend with respect to performance thresholds and aims to guarantee that anomalies are detected. Therefore a logic is required that depicts the applicable performance threshold in the graphical trend visualization and that makes aware of performance values exceeding the threshold by highlighting them. The analysis might cover several performance thresholds that allow distinction i.e. between a warning and real out of tolerance.

The *alerting* step consists of a mechanism to indicate performance degradations falling below performance threshold expectation. Hereby different alerts (i.e. warning or real alert) could be issued depending on which performance threshold has been exceeded.

The offline assessment is linked to an interactive execution where after the processing phase the results and reports are produced. Performance results are obtained for the selected data set and are compared to the thresholds configured. The age of the data under analysis is thereby irrelevant. The

user has the possibility to manually refine the setup and re-run the execution and/or to investigate specific cases via the interface.

A real time assessment, on the other hand, presents an on-line performance assessment, where live sensor data is fed into the evaluation platform and analysed in real time. Suspicious trend or threshold overshoot detection are required to be announced as alerts within seconds or a few minutes maximum delay.

4.1.1 Resource Connectivity view

This Capability Configuration describes Surveillance Performance Monitoring Tools operations at En-route and TMA environments for Surveillance Chain (end-to-end).

This view includes the following use case:

 - Surveillance Performance Monitoring Tools operations at En-route/TMA for Surveillance Chain (end-to-end).
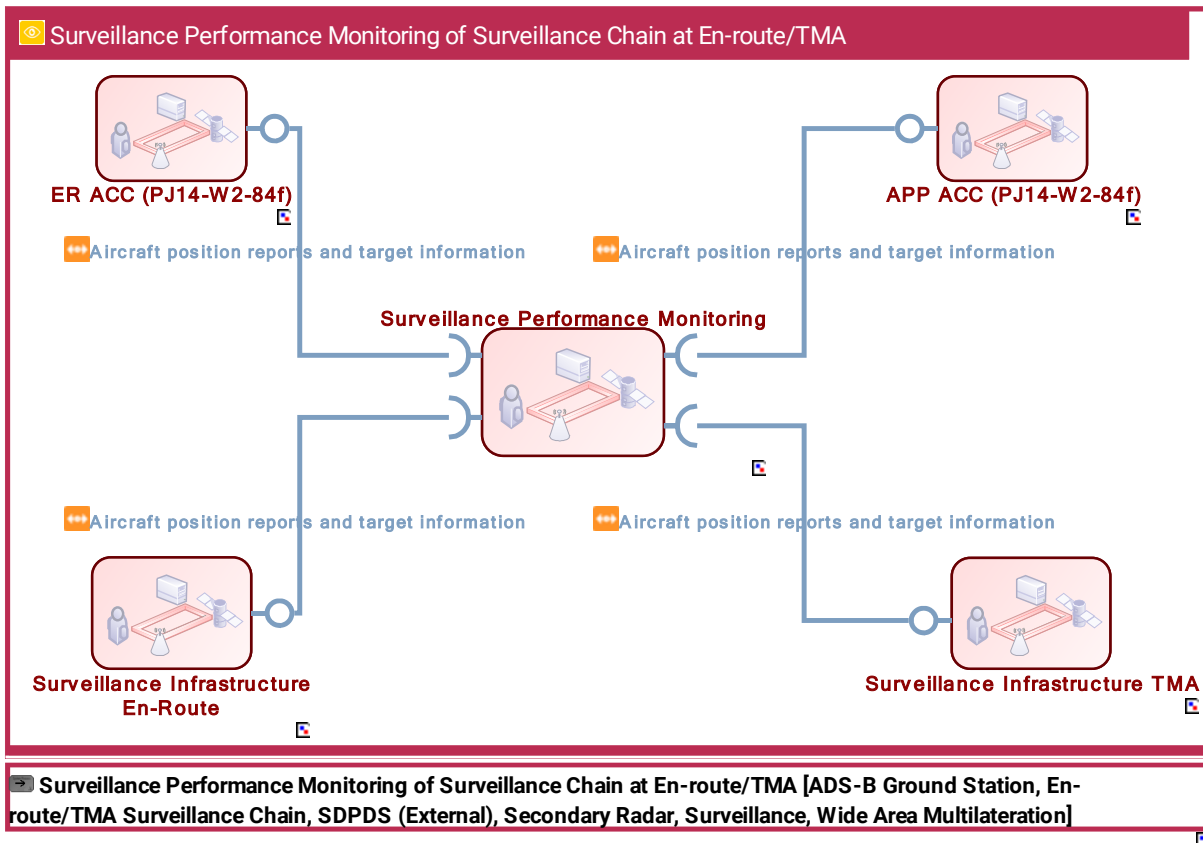
Figure 5: Resource connectivity view for Surveillance Performance Monitoring (end-to-end) at En-route/TMA

4.1.1.1 Resource Infrastructure view
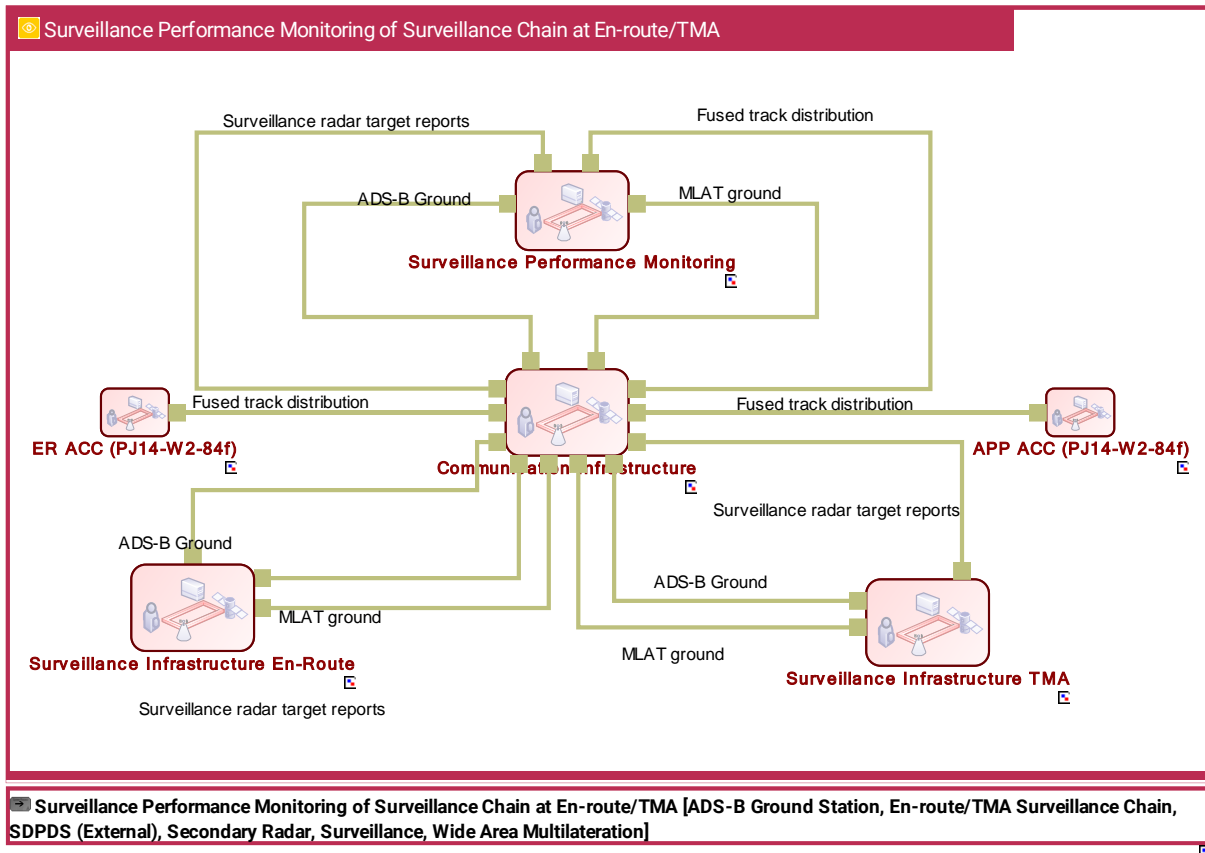
Figure 6: Resource Infrastructure view for Surveillance Performance Monitoring (end-to-end) at En-route/TMA

4.1.1.2 Resource Orchestration view

Resource Orchestration view shows the Surveillance Performance Monitoring Tools for Surveillance Chain processing.

4.1.1.3 Surveillance Performance Monitoring of Surveillance Chain at En-route/TMA

This use case describes the Surveillance Performance Monitoring Tool operation at En-route/TMA for Surveillance Chain.

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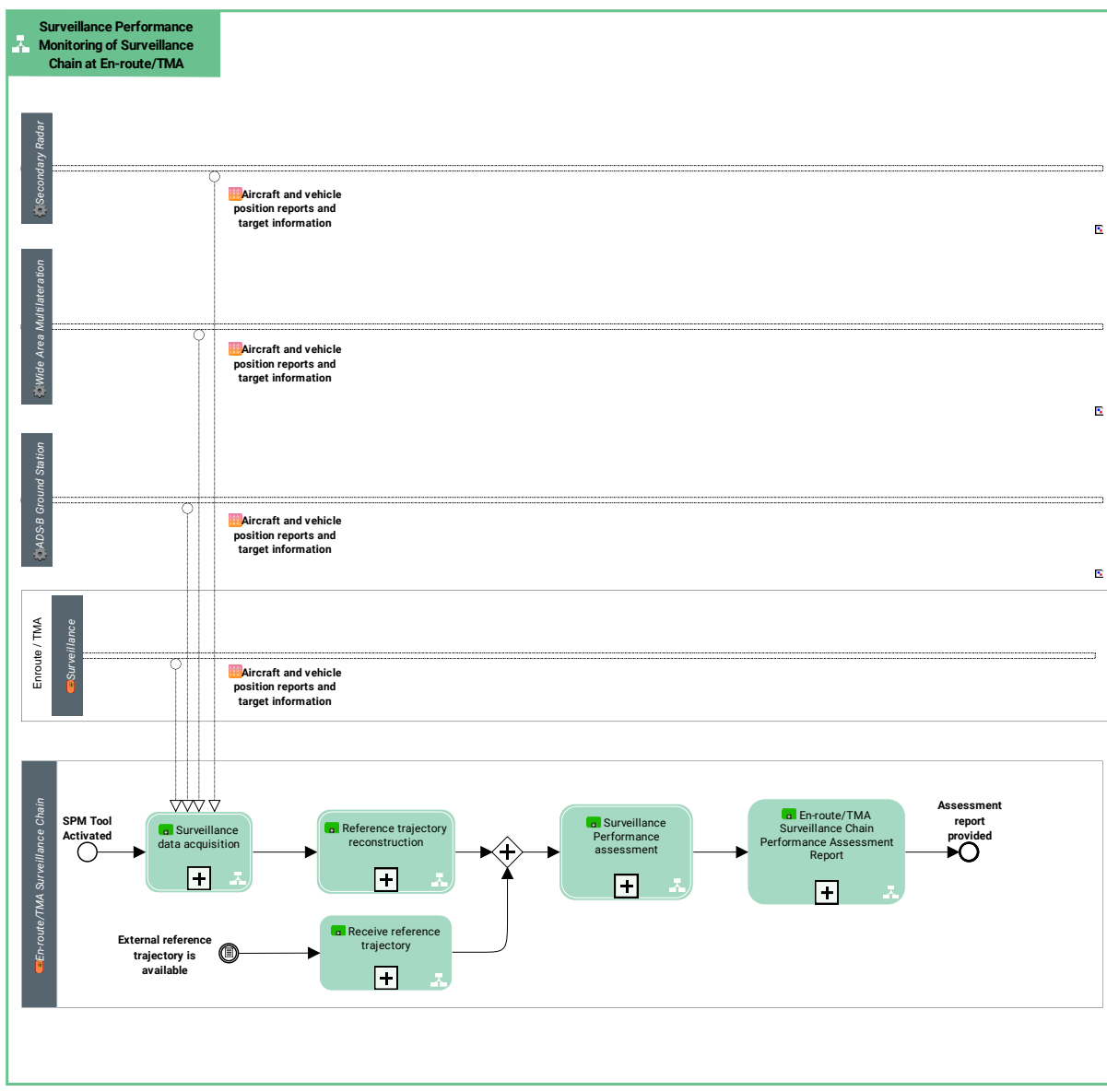
Figure 7: Interaction diagram for Surveillance Performance Monitoring Tools at En-route/TMA

Role	Functional Block	Function
	En-route/TMA Surveillance Chain	En-route/TMA Surveillance Chain Performance Assessment Report; Receive reference trajectory; Reference trajectory reconstruction; Surveillance data acquisition; Surveillance Performance assessment;

Table 9: Surveillance Performance Monitoring Functional Block Overview

Function	Description
En-route/TMA Surveillance Chain Performance Assessment Report	Assesment Report Function provides all reports for output of assesment results from the tool o Geographical displays o Other graphical representations o Report generation
Receive reference trajectory	The reference trajectory can be imported from external systems such as trackers, flight test, on-board GPS recordings. The choice of the reference data is part of the configuration parameters.
Reference trajectory reconstruction	The reference trajectory can be reconstructed from ASTERIX data coming from different sources than the one to be analysed (with the limitation that not all types of analyses can be performed), reconstructed or simulated trajectory. The choice of the reference data is part of the configuration parameters.
Surveillance data acquisition	This function receives data from the optional input from surveillance sensors via the TCP/IP network and pre-recorded data files. This function uses standard service protocols in order to connect to the system LAN to acquire surveillance data that will be provided in standard ASTERIX format. Surveillance data received from different sensors, locally or remotely connected, will be provided in a unique system LAN where all the data flows shall be available. Surveillance data will be provided in standard ASTERIX format. In particular: · ASTERIX Cat 10 for SMR target reports; · ASTERIX Cat 10 for MLAT target reports; · ASTERIX Cat 20 for MLAT target reports; · ASTERIX Cat 21 for ADS-B target reports; · ASTERIX Cat 48 for Radar target reports.
Surveillance Performance assessment	Surveillance Data Assessment Function consists of all processing activities related to the performance assessment o Reference trajectory association to data to be assessed o Computation of performance metrics

Table 10: Surveillance Performance Monitoring Function Details

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4.1.2 Resource Composition

4.1.2.1 En-Route / Approach ATC (PJ14-W2-84f)

This Technical System gathers the ground based automated means, used in En-Route and Approach ATC Centres, to support the air traffic controllers in the provision of the following main Air Traffic Services:

- Update and distribution of flight plan data, potentially correlated with track data built from surveillance sources (mode 3/A code or 24 bit ICAO address - Aircraft Identification (Mode S or ADS-B), when available)
- Distribution of warnings and alerts upon detection of danger areas / separation criteria infringement, or on non-conformance between aircraft behaviour and corresponding flight plan data,
- Medium-term and tactical conflicts detection, conflicts resolution assistance and local traffic complexity assessment
- Sequencing of arrival aircraft on aerodromes or groups of aerodromes,
- Ground-ground and air-ground exchanges of flight and environment data

4.1.2.1.1 Composition
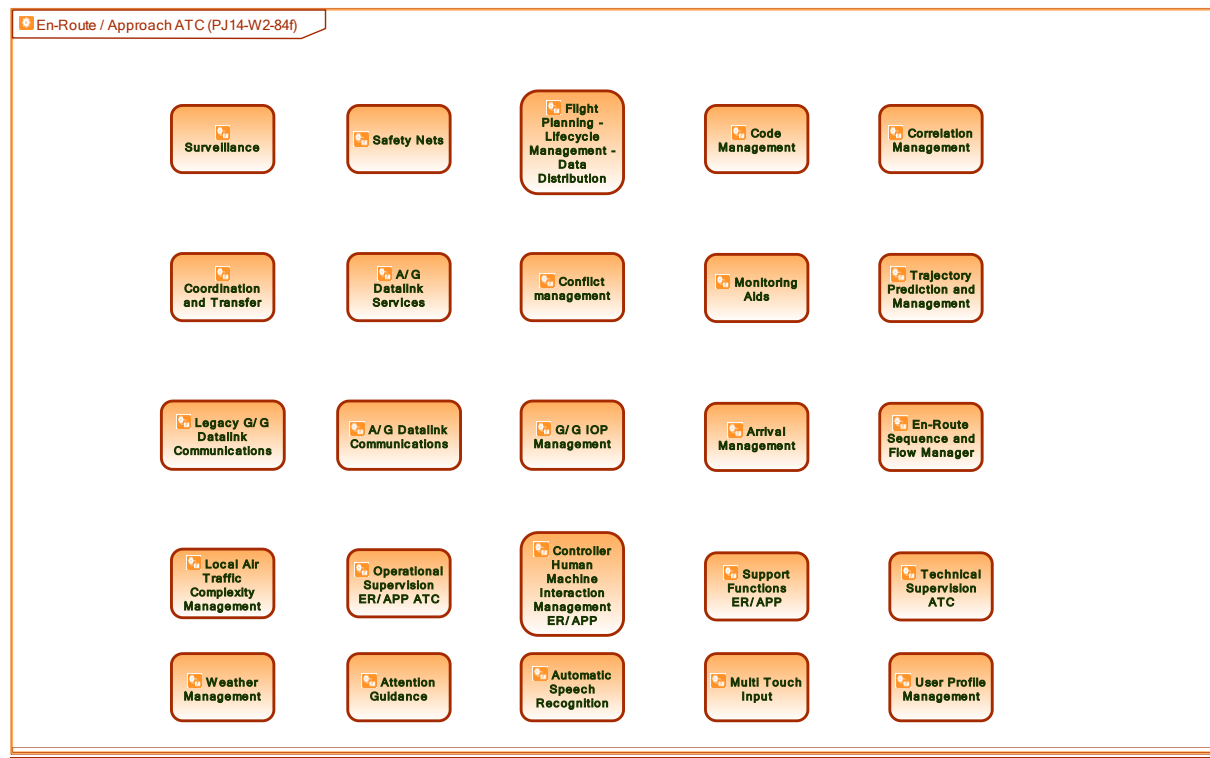
Figure 8: Resource Composition for Surveillance Performance Monitoring Tools at En-route/TMA

4.1.3 Service view

No external services are provided by SPM Tools for Surveillance Chain at En-route/TMA.

4.1.3.1 Service Provisioning

Interaction	Consumer CC	Consumer System	Provider CC	Provider System
Aircraft position reports and target information	Surveillance Performance Monitoring	Surveillance Performance Monitoring Tools;	APP ACC (PJ14-W2-84f)	En-Route / Approach ATC;
Aircraft position reports and target information	Surveillance Performance Monitoring	Surveillance Performance Monitoring Tools;	ER ACC (PJ14-W2-84f)	En-Route / Approach ATC;
Aircraft position reports and target information	Surveillance Performance Monitoring	Surveillance Performance Monitoring Tools;	Surveillance Infrastructure En-Route	Secondary Radar; ADS-B Ground Station; Wide Area Multilateration; Primary Radar;
Aircraft position reports and target information.Surveillance Infrastructure TMA_CC and Surveillance Performance Monitoring_CC (Duplicata)	Surveillance Performance Monitoring	Surveillance Performance Monitoring Tools;	Surveillance Infrastructure TMA	ADS-B Ground Station; Airport Multilateration; Multistatic Primary Radar; Primary Radar; Secondary Radar; Wide Area Multilateration;

Table 11: Surveillance Performance Monitoring Service Provision Details

4.2 Functional and non-Functional Requirements

The requirement identifier is composed as follows:

<Object type>-<Solution code>-<Document code>-<Reference code>.<Reference number>

e.g., REQ-14.84f-TS-SPME.0123

- o REQ is the <Object type> (i.e. requirement),
- o 14.84f is the <Solution code> ,
- o TS is the <Document code> (i.e. technical specification),
- o SPME is the <Reference code> (short for SPM end-to-end)
- o 0123 is the <Reference number>, sequence of 4 digits,

Each requirement has a unique identifier.

Requirements specified as "**shall**" present mandatory requirements, whereas those specified as "**should**" are optional requirements.

A mandatory requirement can be considered generally applicable to both operational environments (En-Route and TMA), *unless it is indicated otherwise by an explanation in the rationale.*

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4.3 Functional Requirements

The requirements developed in this section address the functional requirements of the Surveillance Performance Monitoring Tools for end-to-end surveillance chain. These requirements are organised around the key functional blocks of the SPM Tools.

4.3.1 General and Data Input Requirements

This section addresses the requirements related to the use of input data from SDPDS, sensor and external reference, and configuration parameters as presented in Figure 2. Note that the term Target Report is used to identify reports from either an SDPDS or sensors indistinctively.

The same requirement identifiers from TRL4 Final TS/IRS have been used for existing requirements. Any changes with respect to TRL4 Final TS/IRS are indicated in the Rationale. Note that the Status has been set back to <in progress> since existing requirements will be validated in the validation exercise for non-regression as well as the modified and new requirements.

[REQ]

Identifier	REQ-14.84f-TS-SPME.0001
Title	Input Data Format – ASTERIX Cat 62
Requirement	The SPM Tool **shall** decode track updates in ASTERIX Cat 62 System Track Data (Part 9) version 1.18, August 2018.
Status	<validated>
Rationale	ASTERIX Cat 62 is the recommended category for SDPDS track update exchange.

The following data items are expected to be present in the input data:
Positional data:
 • Horizontal (2D) position,
 • Time of applicability of horizontal position,
 • Vertical position based upon pressure altitude received from the aircraft,
 • Time of applicability of vertical position (for conformity assessment).
Operational identification data:
 • Aircraft identity (ICAO Aircraft Identification and/or Mode 3/A code) reported by the aircraft.
Supplementary indicators:
 • Emergency indicator (General emergency, radio failure and unlawful interference),
 • Special Position Identification (or Indicator) SPI.
Surveillance data status:
 • Cooperative/non-cooperative/combined,
 • Coasted/not coasted (position).
The following data items may also be available:
 • Track velocity vector,
 • Rate of climb/descent. |

	The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Interface>
Category	<Interface>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0002
Title	Reference trajectory data
Requirement	The SPM Tool **shall** use reference data either provided externally or reconstructed using the same sensors that are used by the SDPDS under assessment.
Status	<validated>
Rationale	The reference trajectory can be ASTERIX data from another tracker, GPS data (with the limitation that not all types of analyses can be performed), reconstructed or simulated trajectory. The choice of the reference data is part of the configuration parameters. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Interoperability>
Category	<Interoperability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0004
Title	Data Format – External Reference trajectory data in ASTERIX Cat 62
Requirement	The SPM Tool **shall** decode external reference data in ASTERIX Cat 62 v1.18 format.
Status	<validated>
Rationale	External reference data in ASTERIX Cat 62 enables comparison of one SDPDS performance using another SDPDS or a different configuration/version of the same SDPDS. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Interoperability>,<Interface>
Category	<Interface>,<Interoperability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0005
Title	Data Format – sensor data for reconstruction
Requirement	The SPM Tool **should** decode sensor data in ASTERIX Cat 1, 20, 21 and 48 and generate reconstructed reference to be used as reference for SDPDS performance assessment.
Status	<validated>
Rationale	All the sensor data that is processed by SDPDS should be provided for reconstruction. The reconstruction is outside the scope of this specification. The sensor data in the following format is to be processed: • ASTERIX Cat 20 version 1.9, for MLAT/WAM target reports; • ASTERIX Cat 21 version 2.1 and 2.4, for ADS-B target reports,

	• ASTERIX Cat 1 version 1.2 and Cat 48 version 1.27, for radar target reports. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Interface>
Category	<Interface>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0006
Title	Mandatory Configuration Parameters

Requirement	The SPM Tool **shall** manage the following minimum set of configuration parameters:
	
	• Update Interval for Probability of Update and Probability of Long Gaps,
	
	• SDPDS characteristics,
	
	    o Measured position output type (Cartesian, Geodetic, Stereographic Projection)
	    o System Center Position (latitude, longitude, altitude),
	• Horizontal separation minima applicable for the OSV (3/5 NM),
	• Vertical separation minima applicable for the OSV (10/20 FL),
	• Input data acquisition settings (disk file, LAN capture),
	• Display delay to incorporate delay of displaying data at ATCO,
	• Geographical and service characteristics of the OSV (see Note 1) (operational environment as given in ESASSP Ed 1.2 Table 2,
	• General filtering aiming to support exemption,
	• Reference to be used (another tracker, reconstruction, simulated, GPS recording).

Status	<validated>

Rationale	Requirements and methods are fully defined with the selection of operational environment and applicable standard, the individual metrics can be selected (full set or a subset).
	Note 1: The OSV is defined as vertically extruded geodetic polygon where the vertex to vertex segment is a great circle arc and where the vertical extension is defined as flight level. As the focus of this solution is on the harmonisation of the core part of the assessment functionality such features as OSV has been kept to a minimum.
	The following change(s) are made with respect to TRL4 Final TS/IRS [18]:
	• Requirement category is changed from <Functional> to <Adaptability>
Category	<Adaptability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0007
Title	Recommended Configuration Parameters
Requirement	The SPM Tool **should** manage the following configuration parameters:
	• Graphical output for background information (geographic maps, aeronautical information).
Status	<validated>
Rationale	Gap size is used as input parameter to Probability of Long Gaps analysis and it can be user configurable to allow calculation with respect to the evolution of standards and operational environments.
	While gap sizes of N=3 UIs represent a mandatory probability of long gaps performance evaluation, optionally also gaps larger than N>=4 UI, with configurable N, can be evaluated.
	This was considered to be clarified when the ESASSP Ed 2.0 standard is published, but the work on this standard has not started and is not expected to be available in Wave 2.

	The following clarifications are made with respect to initial TS/IRS [18]: • User configurable gap size is removed, • SASS-C/VERIF has graphical output with map display, • AGATE does not have a dedicated graphical interface, but the results can be displayed on a generic map display. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Adaptability>
Category	<Adaptability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.3.2 Surveillance Data Assessment Function Requirements

4.3.2.1 General

[REQ]

Identifier	REQ-14.84f-TS-SPME.0008
Title	Performance Metrics to be assessed
Requirement	The SPM Tool **shall** assess the following performance metrics: • Probability of Update and Long Gaps, • Data Item Accuracy, • Data Age and Change Delay, • False Target Reports and Tracks. The details for these metrics will be defined in the subsequent requirements.
Status	<validated>
Rationale	These metrics are the key performance indicators addressed by ESASSP Ed 1.2.
Category	<Functional>

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[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0009
Title	Operational Service Volume
Requirement	The SPM Tool **shall** consider geometrical volumes that limit the evaluation to operational service volumes (OSV).
Status	<validated>
Rationale	Operational service volume identifies the geographic airspace volume for which the tracker provides the ATC surveillance data. For description of OSV see Note 1 in Configuration Parameters Requirement (REQ-14.84f-TS-SPME.0007).
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0010
Title	Operational Environment
Requirement	The SPM Tool **shall** allow the allocation of an Operational Environment to the OSV. Current ESASSP Ed 1.2 draft defines the following sector types: - 5 NM horizontal separation (En-Route),

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	- 3 NM horizontal separation (TMA).
Status	<validated>
Rationale	Each Operational Environment is attached with a parameter set (minimum PU threshold, minimum PLG threshold, update interval, minimum number of samples, etc.) which is to be used for the assessment. These parameters will be detailed in the corresponding sections for each assessment.
	The following change(s) are made with respect to TRL4 Final TS/IRS [18]:
	• Requirement category <Adaptability> is added
Category	<Adaptability>,<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0011
Title	OSV Based Evaluation
Requirement	The SPM Tool **shall** calculate the full set of performance metrics for the complete OSV.
Status	<validated>
Rationale	The calculation of the performance metrics for the complete OSV is the principal method for demonstrating compliance with respect to ESASSP Ed 1.2.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring Tools

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[REQ]

Identifier	REQ-14.84f-TS-SPME.0012
Title	Trajectory Based Evaluation
Requirement	The SPM Tool **shall** calculate the following performance metrics for each reference trajectory: • Probability of update, • Horizontal Position Accuracy, • Delay of change.
Status	\<validated\>
Rationale	The calculation of these performance metrics per trajectory is needed for demonstrating compliance with respect to ESASSP Ed 1.2.
Category	\<Functional\>

[REQ Trace]

Relationship	Linked Element Type	Identifier
\<SATISFIES\>	\<SESAR Solution\>	PJ.14-W2-84f
\<SATISFIES\>	\<Enabler\>	CTE-S07e
\<ALLOCATED_TO\>	\<Functional block\>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0013
Title	OSV-Based Evaluation – Data Selection
Requirement	The SPM Tool **shall** use the reference trajectories and target reports when these are either 3D located in the defined OSV (when reference or target report has a height) or 2D located in the defined OSV (when reference or target report has no height).
Status	\<validated\>
Rationale	The Probability of Update and Probability of Long Gaps assessment metrics are based on reference trajectory in OSV and verifying whether target reports are present at given Measurement Interval. The rest of the performance assessment metrics compare the contents of the target reports in OSV with respect to the reference trajectory.

Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0014
Title	OSV Reference Trajectory Segment Identification
Requirement	The SPM Tool **shall** identify the segments of trajectory in the OSV and their respective time of entry/birth or exit/death.
Status	<validated>
Rationale	Identifying these segments is an essential prerequisite for the performance assessment / metrics computation as it will contribute to the identification of false/true target reports and tracks.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0015
Title	Calculation Projection Definitions
Requirement	The SPM Tool **shall** perform the horizontal position error calculations in Cartesian Coordinate System using Stereographic Projection.
Status	<validated>

Rationale	ESASSP Ed 1.2 indicates that the horizontal position error calculations be done in the same coordinate system as used for ATCO display. ATC CWP for En-route and TMA environments use Cartesian Coordinate System with Stereographic Projection.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

ESASSP introduces two types of timing:

- Time of Applicability (ToA) is the time the provided data item is best applicable. It shall be the TOD (record Time Of Detection/Day), corrected by estimated bias for sensors. It might also be corrected by the known data age when relevant (e.g. forwarded data),

- Time of Display (ToDisp) is the time the data is presented onto the CWP. It shall be the TOR (Time of Recording) plus the Display Delay between the reception of the record by the CWP and its actual display. This Display Delay is a user defined parameter.
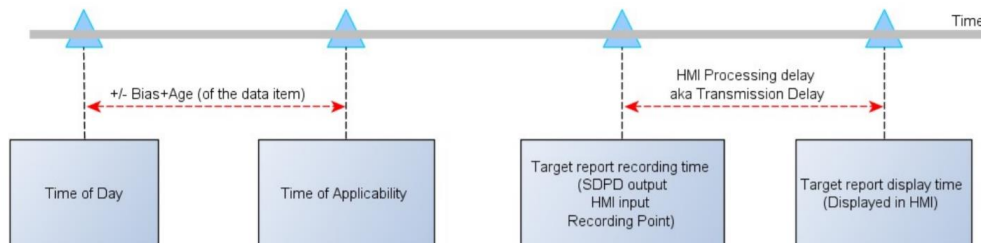
Figure 9: Relation of various timings in the surveillance chain

[REQ]

Identifier	REQ-14.84f-TS-SPME.0016
Title	Horizontal Position Error to Reference
Requirement	The SPM Tool **shall** calculate the horizontal position error from track data to reference data as the distance between target report position and associated reference position interpolated at the time of display (time of recording plus the display delay from configuration options).
Status	<validated>

Rationale	The position errors are required for the horizontal position accuracy calculations and for the false target identification. Furthermore, the calculation of position errors is necessary for PU and PLG, in order to exclude false targets from evaluation.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.3.2.2 Target Report Classification

Target report classification is done on the basis of whether a target report is associated to a reference trajectory and if associated, its horizontal position error and the horizontal position data age. The target report to reference trajectory association is performed on the basis of a reference trajectory presence and the correlation between various data items (e.g., identity, position/altitude at the same time). Target report to reference trajectory association, as well as the reference trajectory reconstruction is not within the scope of this specification.

A valid data item means that the data item (e.g. horizontal position or pressure altitude) is provided to the user and can be used by the ATCO to perform the application. It could be that specially tagged data items (e.g. a coasted horizontal position) may not be allowed to be used to maintain separation, in which case the data item is considered as not "valid", although it has been delivered by the surveillance system. The precise criteria, for deciding whether a data item is valid or not, are assumed to be defined locally in accordance with the local procedures.

Target reports are classified as either True or False for the ESASSP performance assessment. Depending on the presence of an associated reference, horizontal position error and the number simultaneous target reports associated to a reference trajectory point.

- target reports without an associated reference in OSV are considered as False (also known as ghost),
- target reports with an associated reference in OSV with a position error greater than a given threshold will be considered as False (also known as outlier),
- target reports with an associated reference in OSV with a horizontal position data age greater than a given threshold will be considered as False,
- target reports with an associated reference in OSV with a position error less than a given threshold and with a horizontal position data age less than a given threshold will be considered as True,
- supernumerary (additional) target reports associated to a reference in OSV (also known as split target report) will be considered as False.

Additionally, target reports with a forwarded pressure altitude data item with age greater than or equal to 16 seconds will be considered as False for PLG, altitude PU, altitude average data age and percentage of incorrect forwarded pressure altitude.

A false target report contains at least the following data items:

- Horizontal position,

- Time of applicability,

- Aircraft identity (Code 3/A or Aircraft Identification).

Additionally, depending on whether "less than" or "more than or equal to" 3 consecutive target reports with correlated position error, the target reports are sub-classified as "spurious" or "correlated" False target reports (also known as False Track).

[REQ]

Identifier	REQ-14.84f-TS-SPME.0017
Title	True Target Reports - Identification
Requirement	The SPM tool **shall** identify true target reports as all target reports associated to reference trajectories when the latter is in OSV excluding the false target reports (see next requirement).
Status	<validated>
Rationale	Identifying the true target reports is an essential prerequisite for the performance assessment / metrics computation.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0018
Title	False Target Reports - Identification
Requirement	The SPM tool **shall** identify the following as false target reports: - target reports without an associated reference in OSV,

	• target reports with an associated reference in OSV with a position error:
	    o > 2100 m for 5 NM separation,
	    o > 1690 m for 3 NM separation.
	• target reports with an associated reference in OSV with a horizontal position data age:
	    o > 10 s for 5 NM separation,
	    o > 7 s for 3 NM separation.
	• supernumerary (additional) target reports associated to a reference in OSV which already has an associated target report,
	• containing at least the following data items:
	    o Horizontal position,
	    o Time of applicability,
	    o Aircraft identity (Code 3/A or Aircraft Identification).
	
	Additionally:
	
	• target reports with a forwarded pressure altitude data item with age greater than or equal to 16 seconds are considered False for PLG, altitude PU, altitude average data age and percentage of incorrect forwarded pressure altitude.

Status	<validated>
Rationale	Identifying the false target reports is an essential prerequisite for the performance assessment / metrics computation. Note that the horizontal position error should be calculated prior to classification. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Target report classification also uses horizontal position data age.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.3.2.3 Probability of Update and Probability of Long Gap

The probability of update (PU) is calculated for horizontal position (with and without coasted status), pressure altitude and aircraft identity separately. PU is calculated for the applicable update interval (UI) for the specific data item as:

- Consider one flight reconstructed trajectory,

- Subdivide reconstructed trajectory into portions of time frames of length UI,

- Consider the trajectory portions that are entirely located within the OSV and count them (N_T),

- Count the number of these portions in which there is at least one target report with the specific data item (N_R) with correct value,

- Calculate the probability of update for a given flight (PU) as the ratio N_R / N_T (Equation 1), if N_T is greater than or equal to 100,

- Or calculate the probability of update for a given flight (PU) if N_T is smaller than 100 (Equation 2),

- Calculate the global probability of update (PU) as where n is the number of flights (Equation 3).

$$PU = \dfrac{N_R}{N_T}$$	**Equation 1**
$$PU = 1 - \dfrac{N_T - N_R}{100}$$	**Equation 2**
$$PU = \dfrac{\sum_n N_R}{\sum_n N_T}$$	**Equation 3**
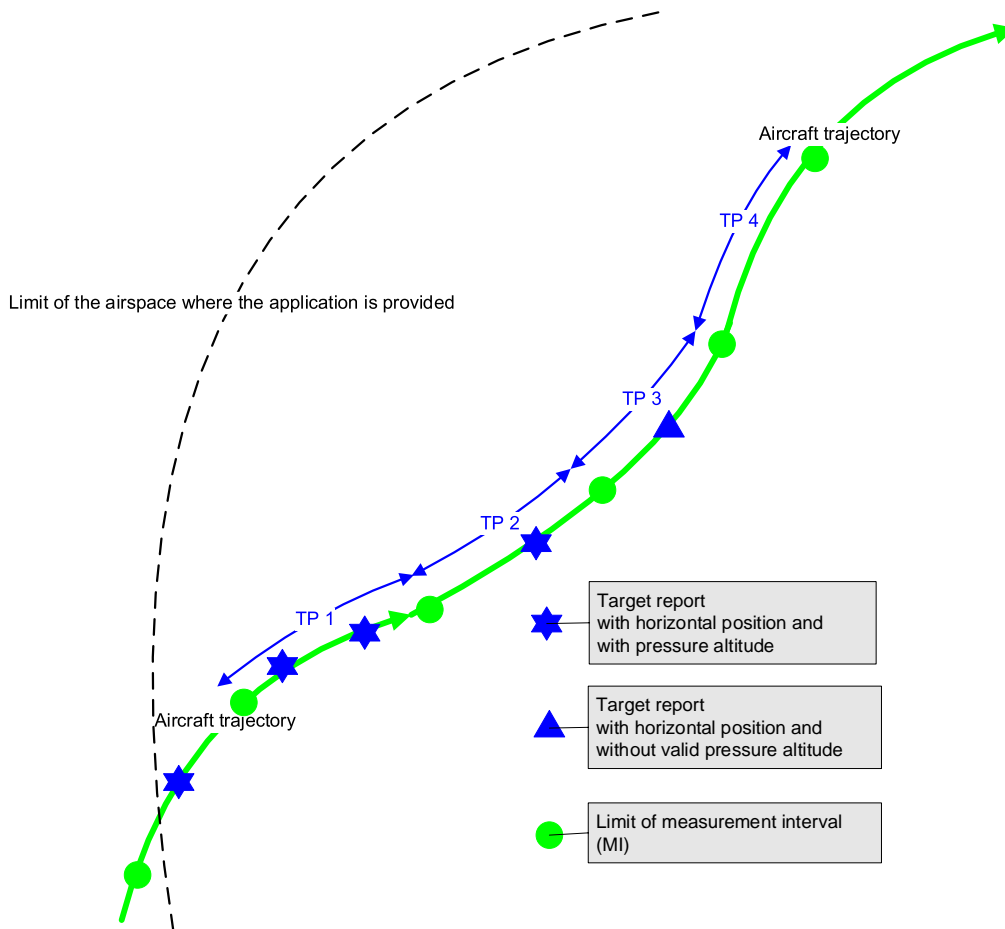
Figure 10: Probability of Update for horizontal position calculation illustrated

In the above figure, TP4 interval is considered as intervals with no update for horizontal position. For pressure altitude, TP3 and TP4 are considered as intervals with no update. It would be similar for identity, if no valid/correct identity instead of pressure altitude.

[REQ]

Identifier	REQ-14.84f-TS-SPME.0019
Title	Probability of Update Computation for OSV
Requirement	The SPM Tool **shall** compute the probability of update (PU) for the OSV for the data items (horizontal position, non-coasted horizontal position, pressure altitude and identity (Code 3/A, Aircraft Identification)) as follows: $$PU = \frac{\sum_n N_R}{\sum_n N_T}$$ where n is the number of trajectories within applicable volume

	N_R is the number update intervals (UI) with a target report with the correct data item (horizontal position, pressure altitude and identity) N_T is the number of trajectory UIs UI is the update interval applicable for the operational environment.
Status	<validated>
Rationale	ESASSP has separate performance requirements to be met for PU of horizontal position, non-coasted horizontal position, pressure altitude and identity (Code 3/A, Aircraft Identification). Therefore, the Probability of Update should be calculated separately for each data item.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0020
Title	Probability of Update Computation per Trajectory
Requirement	The SPM Tool **shall** compute the probability of update (PU) for the OSV for the data items (horizontal position, non-coasted horizontal position, pressure altitude and identity (Code 3/A, Aircraft Identification)) per trajectory as follows: If $N_T >= 100$ $PU = \frac{N_R}{N_T}$ If $N_T < 100$ $PU = 1 - \frac{N_T - N_R}{100}$ where N_R is the number update intervals (UI) with a target report with the correct data item (horizontal position, pressure altitude and identity) N_T is the number of trajectory UIs UI is the update interval applicable for the operational environment.

Status	<validated>
Rationale	ESASSP has separate performance requirements to be met for PU of horizontal position, pressure altitude and identity (Code 3/A, Aircraft Identification). Therefore, the Probability of Update should be calculated separately for each data item.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

The probability of long gaps (PLG) is calculated for horizontal position only. A gap is a portion of aircraft reference trajectory between 2 consecutive target report updates inside the OSV or between a target report update inside the OSV and the beginning/end of the reference trajectory within the OSV. A target report is including full update of the position (i.e. with horizontal position, pressure altitude and identity). The size of the gap is the time difference between start and the end of the gap.
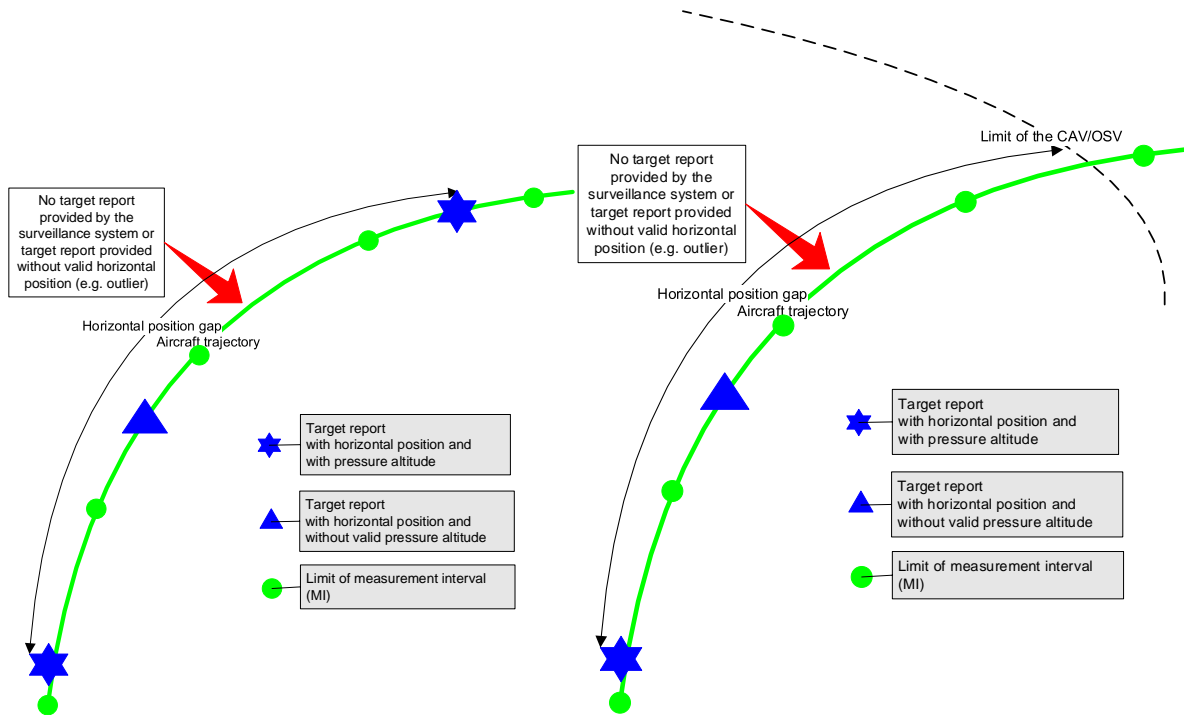
Figure 11: Determination of the gaps for Probability of Long Gap assessment

[REQ]

Identifier	REQ-14.84f-TS-SPME.0021
Title	Probability of Long Gaps Computation
Requirement	The SPM Tool **shall** compute the probability of long gaps (PLG) for the OSV for the horizontal position with correct pressure altitude as follows: $$PLG = \frac{\sum_g N_G}{\sum_n N_T}$$ where n is the number of trajectories within applicable volume N_G is the number update intervals (UI) involved in gaps larger than 3 UIs N_T is the number of trajectory UIs UI is the update interval applicable for the operational environment.
Status	<validated>
Rationale	ESASSP specifies the calculation of PLG of horizontal position with correct pressure altitude only.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.3.2.4 Data Item Accuracy

Data item accuracy calculates metrics for the accuracy of horizontal position, altitude, rate of climb/descent, track velocity and aircraft identity.

Horizontal position accuracy performance assessment includes various performance metrics. The basic performance metric is the root mean square (RMS) value of horizontal position error. A second performance metric is the ratio of target reports involved in series of at least 3 consecutive correlated horizontal position errors larger than 555/926 m for 3/5 NM separation. Third performance metric is the RMS of the unsigned time difference for aircraft in close.

For altitude accuracy, there are two performance metrics: the ratio of incorrect forwarded pressure altitude and the ratio of target reports with absolute altitude error larger than a specified value in different phases of the flight.

For rate of climb/descent and track velocity, basic performance metric of RMS is used.

For aircraft identity, the metric is the percentage of the incorrect aircraft identity.

[REQ]

Identifier	REQ-14.84f-TS-SPME.0022
Title	RMS of Horizontal Position Error
Requirement	The SPM tool **shall** calculate the RMS of horizontal position error for all true target reports as $$RMS = \sqrt{\frac{1}{N}\sum_{i=1}^{N} Pos\ Error_i^2}$$ where N = the number of target reports Pos Error$_i$ = the horizontal position error of the ith true target report.
Status	<validated>
Rationale	ESASSP has requirements related to RMS of Horizontal Position Error being less than specified values for different operational environments.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0023
Title	Correlated Horizontal Position Errors
Requirement	The SPM tool **shall** calculate the percentage of target reports involved in a series of at least 3 consecutive correlated horizontal position errors larger than 555/926 m for 3/5 NM separation respectively.

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Status	<validated>
Rationale	ESASSP considers a correlated position error as a series of at least 3 consecutive horizontal positions showing errors in the same direction and above the specified threshold. For the specific purpose of this metric, any missed or false target report will be considered to present the same horizontal position error as the previous target report with horizontal position from the same flight, provided it is followed by a target report with a horizontal position (i.e. lack of detections at the end of a flight will not be taken into account).
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0024
Title	Target reports in close proximity
Requirement	The SPM tool **shall** calculate the RMS of the unsigned time difference between target reports for aircraft in close proximity (less than 6/10 NM for 3/5 NM separation and less than half UI) for each target report pair.
Status	<validated>
Rationale	ESASSP specifies that target reports pairs that are close in horizontal position (less than 6/10 NM horizontally for respectively 3/5 NM horizontal separation service) and close in time (less than half the applicable measurement interval) are to be selected for this metric. In addition a criteria on close proximity in altitude may also be used.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f

<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0025
Title	Percentage of incorrect forwarded pressure altitude
Requirement	The SPM tool **shall** calculate the percentage of target reports with forwarded pressure altitude error more than 200/300 ft for 10/20 FL vertical separation minima (VSM).
Status	<validated>
Rationale	ESASSP specifies to identify the correctness of the forwarded pressure altitude by comparing to the reference trajectory altitude. The reference altitude is used is at the time of the target report minus the altitude data age.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0026
Title	Percentage of pressure altitude error – level phase
Requirement	The SPM tool **shall** calculate the percentage of target reports with unsigned pressure altitude error greater than 200/300 ft for 10/20 FL vertical separation minima (VSM) for level flight phase.
Status	<validated>
Rationale	ESASSP specifies upper bounds for the percentage of target reports with pressure altitude error for level and climb/descent flight phases separately. This metric is calculated for either forwarded or calculated pressure altitude.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0027
Title	Percentage of pressure altitude error – climb/descent phase
Requirement	The SPM tool **shall** calculate the percentage of target reports with unsigned pressure altitude error greater than 300 ft for climbing/descending flight phase.
Status	<validated>
Rationale	ESASSP specifies upper bounds for the percentage of target reports with pressure altitude error for level and climb/descent flight phases separately. This metric is calculated for either forwarded or calculated pressure altitude.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0028
Title	RMS of rate of climb/descent error
Requirement	The SPM tool **shall** calculate the RMS of the rate of climb/descent error for all true target reports as

	$$RMS = \sqrt{\frac{1}{N} \sum_{i=1}^{N} Vertical\ Rate\ Error_i^2}$$ where N = the number of target reports Vertical Rate Error$_i$= the rate of climb/descent error of the ith true target report.
Status	\<validated\>
Rationale	The calculation of the RMS of rate of climb/descent error is applicable only if the rate of climb/descent data item is provided.
Category	\<Functional\>

[REQ Trace]

Relationship	Linked Element Type	Identifier
\<SATISFIES\>	\<SESAR Solution\>	PJ.14-W2-84f
\<SATISFIES\>	\<Enabler\>	CTE-S07e
\<ALLOCATED_TO\>	\<Functional block\>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0029
Title	RMS of track ground speed error
Requirement	The SPM tool **shall** calculate the RMS of the track ground speed error for all true target reports as $$RMS = \sqrt{\frac{1}{N} \sum_{i=1}^{N} Track\ Ground\ Speed\ Error_i^2}$$ where N = the number of target reports Track Ground Speed Error$_i$= the track ground speed error of the ith true target report.
Status	\<validated\>

Rationale	The calculation of the RMS of track ground speed error is applicable only if the track velocity data item is provided.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0030
Title	RMS of track angle error
Requirement	The SPM tool **shall** calculate the RMS of the track angle error for all true target reports as $$RMS = \sqrt{\frac{1}{N}\sum_{i=1}^{N} Track\ Angle\ Error_i^2}$$ where N = the number of target reports Track Angle Error$_i$ = the track angle error of the ith true target report.
Status	<validated>
Rationale	The calculation of the RMS of track angle error is applicable only if the track velocity data item is provided.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e

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<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0031
Title	Percentage of incorrect aircraft identity
Requirement	The SPM tool **shall** calculate the percentage of target reports with incorrect aircraft identity.
Status	<validated>
Rationale	ESASSP specifies upper bound for the percentage of target reports with incorrect aircraft identity. Aircraft identity is both Code 3/A and Aircraft Identification, if available in reference.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.3.2.5 Data Age and Delay of Change

Data age is principally measured for forwarded pressure altitude, as there are requirements in the surveillance chain concerning the age of the pressure altitude. There are principally two metrics, namely average and maximum forwarded pressure altitude data age.

Delay of change is measured for emergency indicator, SPI and aircraft identity, since changes in these data items should be made available to the ATCO within certain time period.

[REQ]

Identifier	REQ-14.84f-TS-SPME.0032
Title	Forwarded Pressure Altitude – average data age
Requirement	The SPM tool **shall** calculate the average data age for the forwarded pressure altitude for all true target reports as $$avg = \frac{1}{N}\sum_{i=1}^{N} Data\ age_i$$

	where N = the number of target reports Data age$_i$= the data age of the ith true target report.
Status	<validated>
Rationale	The calculation of the average data age is applicable only if the data age data item is provided.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0033
Title	Forwarded Pressure Altitude – maximum data age
Requirement	The SPM tool **shall** calculate the maximum data age of the forwarded pressure altitude for all true target reports.
Status	<validated>
Rationale	The calculation of the maximum data age is applicable only if the data age data item is provided.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0034
Title	Percentage of Delay of Change
Requirement	The SPM tool **shall** calculate the percentage of target reports with a delay of change larger than 7.5/12 s in emergency code and SPI, larger than 15/24 s in aircraft identity for 3/5 NM separation respectively.
Status	<validated>
Rationale	ESASSP expects that the delay of change should be less than the given upper limits for all target reports. The delay should be calculated by comparing time of recording plus the display delay with respect to reference.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.3.2.6 Density of False Target Reports and Number of False Tracks

False target reports are analysed separately for uncorrelated false target reports and false tracks (correlated target reports). The principal metrics are the density of the false target reports and number of false tracks. False tracks are identified as 3 or more false target reports with the following properties:

1. Time between successive target reports is less than 1 UI,

2. Horizontal position difference between successive target reports less than 1000 kt,

3. Altitude difference between successive target reports less than 1000 ft,

[REQ]

Identifier	REQ-14.84f-TS-SPME.0035
Title	Density of False Target Reports
Requirement	The SPM tool **shall** calculate the density of false target reports in the OSV for the duration of the analysed data.
Status	<validated>

Rationale	ESASSP specifies for the density of false target reports to be calculated using recorded data of 720/450 UIs for 3/5 NM separation respectively.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0036
Title	Number of False Tracks
Requirement	The SPM tool **shall** calculate the number of false tracks closer to true tracks by 9/7 NM in the OSV for 3/5 NM separation respectively.
Status	<validated>
Rationale	ESASSP expects that the delay of change should be less than the given upper limits for all target reports.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.3.3 Reporting Output Function Requirements

Reporting functionality requirements aim to specify the output of the performance metrics defined in the Section 4.3.2 "Surveillance Data Assessment Function Requirements". The report contains the performance metrics that are output in a well-defined layout with the corresponding pass/fail grades in order to demonstrate standards compliance. The pass/fail grades are generally the thresholds to be applied for the particular Operating Environment in combination with the sample size. The pass/fail

grade of each metric is indicated with a colour coding as well as the mention of the Pass/Fail grade or with the mention of NC/NA (Not Computed/ Not Applicable).

The following simple pass/fail grades will be used for the reporting:

- "Pass" text and dark green colour indicates the metric satisfies the standard,

- "Fail" text and red colour indicates the metric fails the standard,

- "NC" text and light grey colour indicates the metric cannot be computed,

- "NA" text and dark grey colour indicates the metric is not applicable.

Not Computed (NC) condition can be reported in the case the pass/fail cannot be determined due to insufficient sample size or other reasons. Not Applicable (NA) condition is reported if the metric is not applicable for the currently evaluated sensor or operational environment. NA condition is necessary as the SPM tool supports analysis of end-to-end surveillance chain with corresponding standards in various operational environments.

The report outputs the performance metrics and associated information in a tabular format. As the metrics are calculated in three domains, there are three base tables corresponding to these three domains of metrics calculation:

- Overall OSV metrics,

- Per trajectory metrics.

Additional information is also provided for the sensor under evaluation, OSV, Operational Environment, applied filters and reference used for the analysis.

4.3.3.1 General

Depending on the performance evaluation type, the report will have several parts giving different aspects of the analysis performed:

- Background information,

- Performance evaluation type (e.g., PU/PLG, accuracy, etc.)

  o OSV based metric results,

  o Trajectory based metric results.

One or more performance evaluation types can be selected for reporting, as well as the calculation domain. For trajectory and grid based evaluation, each performance metric will be output in a separate table grouping similar information for all trajectories or grid cells; e.g., PU and PLG will be output in separate tables. Considering the large number of trajectories and grid cells, the output will be limited to user configurable metric value threshold; e.g., all trajectories with PU up to 98%.

The first part of the report gives the background information for the analysis performed including the following:

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- Name or identifier of surveillance system at the output of which the end-to-end performance assessment is done,

- Input data date time start-end,

- OSV definition,

- Operational Environment and applicable parameter set,

- Type of reference used for analysis,

- Grid definition,

- Applied filters if any,

- Date-time of evaluation,

- SPM Tool Identifier.

The background information is given in text format similar to the example below:

Surveillance system under evaluation: MUAC ARTAS System

Input Data Date-Time start-end: 2017-09-01 08:00:00 – 2017-09-01 12:00:00

OSV Definition: Maastricht Upper Area Control, (50.0N, 7.0E; 52.0N, 7.0E; 52.0N, 9.0E; 50.0N, 9.0E; 50.0N, 7.0E)

Operational Environment: En-route (5 NM Separation)

Type of Reference used for analysis: Internal reconstruction from Radars X, Y, Z and MUAC ADS-B

Applied filters: None

Date-time of evaluation: 2020-09-18 10:00:00

SPM Tool Identifier: SASS-C VERIF v8.1.0

The OSV based metric results are output in a tabular format with the following columns:

- Metric value,

- Metric threshold,

- Sample size,

- Pass/Fail grade or NA/NC condition,

Probability of Update

PU Metric Value	Metric Threshold	Sample Size	Pass/Fail Grade

98 %	≥ 95 %	100000	Pass

Probability of Long Gap

PLG Metric Value	Metric Threshold	Sample Size	Pass/Fail Grade
0.1 %	≥ 95 %	100000	Pass

The trajectory based metric results are output as sorted by their corresponding metric value in a tabular format with the following columns:

- Trajectory Id (Code 3/A, Aircraft Identification or internal trajectory identifier),

- Trajectory start/end within OSV,

- Metric value,

- Sample size,

- Pass/Fail/NA/NC condition,

The trajectories that are included in this table will be limited by a user configurable metric value threshold; e.g., all trajectories with PU up to 99% are to be output with ascending metric value. The metric threshold, as it is applicable to all trajectories, is given in the metric value column header.

Probability of Update

Trajectory Id	Trajectory start/end	PU Metric Value (≥ 95 %)	Sample Size	Pass/Fail Grade
123456	10:00:00-10:30:00	98 %	400	Pass
654321	10:00:00-10:20:00	99 %	600	Pass
…				

Identifier	REQ-14.84f-TS-SPME.0037
Title	Reporting Template

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Requirement	The SPM Tool **should** output the background information and the OSV, Trajectory and Grid based performance metrics for the user selected performance evaluations in the Report Template given in this section.
Status	<validated>
Rationale	Reporting template is optional for uniform output of metrics.
	The following change(s) are made with respect to TRL4 Final TS/IRS [18]:
	• Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0038
Title	OSV based Metrics Reporting
Requirement	The SPM Tool **should** output the OSV-based performance metrics for one or more of following user selected performance evaluations:
	• Probability of Update and Probability of Long Gaps,
	• Data Item Accuracy,
	• Data Age and Delay of Change,
	• Density of False Target Reports and Number of False Tracks.
Status	<validated>
Rationale	Reporting template is optional for uniform output of metrics.
	The following change(s) are made with respect to TRL4 Final TS/IRS [18]:
	• Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

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Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0039
Title	Reporting Template Metrics for Trajectory
Requirement	The SPM Tool **should** output the trajectory based performance metrics for one or more of following user-selected performance evaluations ordered from the worst to the best metric value for trajectories with metric values between user selected thresholds: • Probability of Update and Probability of Long Gaps, • Data Item Accuracy, • Data Age and Delay of Change.
Status	<validated>
Rationale	Reporting template is optional for uniform output of metrics. Trajectory based reporting will facilitate the cross check verification. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0040
Title	Metric Pass/Fail/NC/NA

Requirement	The metric output table row **should** be output with a certain colour and pass/fail condition column set whether or not the metric satisfies the criteria as following: • Dark Green and condition Pass if condition is satisfied, • Red and condition Fail if condition is not satisfied, • Light grey and condition NC if sample size is not sufficient, • Dark grey and condition NA if condition is not applicable.
Status	<validated>
Rationale	Reporting template is optional for uniform output of metrics. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.3.3.2 Probability of Update and Probability Long Gaps

[REQ]

Identifier	REQ-14.84f-TS-SPME.0041
Title	Reporting of Horizontal Position PU - Overall
Requirement	The SPM tool **shall** report horizontal position PU for the whole OSV with 99% as pass/fail threshold.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

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Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0042
Title	Reporting of Horizontal Position PU – Flights
Requirement	The SPM tool **shall** report horizontal position PU for each flight with 97% as pass/fail threshold.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. Any flight with PU less than 97% needs to be reported for further investigation. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0043
Title	Reporting of Horizontal Position PU excluding coasted
Requirement	The SPM tool **shall** report horizontal position PU for the whole OSV with 99% as pass/fail threshold excluding target reports with horizontal position data age: • > 10 s for 5 NM separation,

	• > 7 s for 3 NM separation.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following changes(s) are made with respect to TRL4 Final TS/IRS [18]: • Exclusion for target reports is detailed using horizontal position data age by operational environment (separation) • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0044
Title	Reporting of Probability of Long Gaps
Requirement	The SPM tool **shall** report horizontal position PLG for the whole OSV with 0.5% as pass/fail threshold.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f

<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0045
Title	Reporting of Pressure Altitude PU - Overall
Requirement	The SPM tool **shall** report pressure altitude PU for the whole OSV with 96% as pass/fail threshold.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold.
	The following change(s) are made with respect to TRL4 Final TS/IRS [18]:
	• Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0046
Title	Reporting of Aircraft Identity PU - Overall
Requirement	The SPM tool **shall** report aircraft identity PU for the whole OSV with 98% as pass/fail threshold.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold.
	The following change(s) are made with respect to TRL4 Final TS/IRS [18]:
	• Requirement category is changed from <Functional> to <Data>

Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.3.3.3 Data Item Accuracy

[REQ]

Identifier	REQ-14.84f-TS-SPME.0047
Title	Reporting of Horizontal Position Error - Overall
Requirement	The SPM tool **shall** report RMS for horizontal position error for the whole OSV with 330/550 m for 3/5 NM separation for all flights as pass/fail threshold.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the thresholds. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0048
Title	Reporting of Horizontal Position Error - Flight

Requirement	The SPM tool **shall** report RMS for horizontal position error for the flights which has more than 330/550 m for 3/5 NM separation as fail for further analysis.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the thresholds. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0049
Title	Reporting of Correlated Horizontal Position Errors
Requirement	The SPM tool **shall** report the correlated horizontal position error calculated in REQ-14.84f-TS-SPME.0023 with 0.03% as pass/fail criteria.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f

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<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0050
Title	Reporting of Target reports in close proximity
Requirement	The SPM tool **shall** report the target reports in close proximity metric calculated in REQ-14.84f-TS-SPME.0024 with 0.3 second as pass/fail criteria.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0051
Title	Reporting of Percentage of incorrect forwarded pressure altitude
Requirement	The SPM tool **shall** report the percentage of incorrect forwarded pressure altitude metric calculated in REQ-14.84f-TS-SPME.0025 with 0.1% as pass/fail criteria.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]:

	• Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0052
Title	Reporting of Percentage of pressure altitude error – level phase
Requirement	The SPM tool **shall** report the percentage of pressure altitude error metric calculated in REQ-14.84f-TS-SPME.0026 with 99.9% as pass/fail criteria.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0053
Title	Reporting of Percentage of pressure altitude error – climb/descent phase

Requirement	The SPM tool **shall** report the percentage of pressure altitude error metric calculated in REQ-14.84f-TS-SPME.0027 with 98.5% as pass/fail criteria.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0054
Title	Reporting of RMS of rate of climb/descent error
Requirement	The SPM tool **shall** report the RMS of rate of climb/descent error metric calculated in REQ-14.84f-TS-SPME.0028 with 250/500 ft/min as pass/fail criteria for level and climbing/descending flights respectively.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the thresholds. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f

<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0055
Title	Reporting of RMS of track ground speed error
Requirement	The SPM tool **shall** report the RMS of track ground speed error metric calculated in REQ-14.84f-TS-SPME.0029 with 4/8 m/s as pass/fail criteria for steady and turning flights respectively.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the thresholds. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0056
Title	Reporting of RMS of track angle error
Requirement	The SPM tool **shall** report the RMS of track angle error metric calculated in REQ-14.84f-TS-SPME.0030 with 10/25 deg as pass/fail criteria for steady and turning flights respectively.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the thresholds.

	The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0057
Title	Reporting of Percentage of incorrect aircraft identity
Requirement	The SPM tool **shall** report the percentage of incorrect aircraft identity metric calculated in REQ-14.84f-TS-SPME.0031 with 0.1% as pass/fail criteria.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.3.3.4 Data Age and Delay of Change

[REQ]

Identifier	REQ-14.84f-TS-SPME.0058
Title	Reporting of Forwarded Pressure Altitude – average data age
Requirement	The SPM tool **shall** report the average data age of forwarded pressure altitude metric calculated in REQ-14.84f-TS-SPME.0032 with 4 s as pass/fail criteria.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0059
Title	Reporting of Forwarded Pressure Altitude – maximum data age
Requirement	The SPM tool **shall** report the maximum data age of forwarded pressure altitude metric calculated in REQ-14.84f-TS-SPME.0033 with 16 s as pass/fail criteria.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

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Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0060
Title	Reporting of Percentage of Delay of Change
Requirement	The SPM tool **shall** report the percentage of delay of change metric calculated in REQ-14.84f-TS-SPME.0034 with 100% as pass/fail criteria.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.3.3.5 Density of False Target Reports and Number of False Tracks

[REQ]

Identifier	REQ-14.84f-TS-SPME.0061
Title	Reporting of Density of False Target Reports – 5 NM Separation
Requirement	The SPM tool **shall** report the density of false target reports metric calculated in REQ-14.84f-TS-SPME.0035 with 10 false target reports in an area of 900 NM^2 over 450 UI as pass/fail criteria.
Status	<validated>

Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0062
Title	Reporting of Density of False Target Reports – 3 NM Separation
Requirement	The SPM tool **shall** report the density of false target reports metric calculated in REQ-14.84f-TS-SPME.0035 with 2 false target reports in an area of 100 NM^2 over 720 UI as pass/fail criteria.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0063
Title	Reporting of Number of False Tracks – 5 NM Separation
Requirement	The SPM tool **shall** report the number of false tracks metric calculated in REQ-REQ-14.84f-TS-SPME.0036 with 2 non-coincident false tracks closer than 7 NM to a true track as pass/fail criteria.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0064
Title	Reporting of Number of False Tracks – 3 NM Separation
Requirement	The SPM tool **shall** report the number of false tracks metric calculated in REQ-REQ-14.84f-TS-SPME.0036 with 1 non-coincident false track closer than 9 NM to a true track as pass/fail criteria.
Status	<validated>
Rationale	Although, reporting template is optional, this metric is required by ESASSP. This performance metric is reported together with the threshold. The following change(s) are made with respect to TRL4 Final TS/IRS [18]: • Requirement category is changed from <Functional> to <Data>
Category	<Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.3.4 Mode of Operation Requirements

The SPM Tool is expected to operate in two distinct modes: Manual (Offline) and Quasi Real-Time. Manual mode is aimed for one offline or occasional performance assessment of surveillance sensors with a human operator. In this mode, input data to be processed, configuration options and type of analysis to be performed can be specified by the operator. Quasi Real-Time mode corresponds to an automated mode of operation where only the input data is different for each performance assessment run. The exact mechanism of getting new input data is not specified as requirements, since different surveillance infrastructure may choose to implement or may have different choices; e.g., capturing data directly from surveillance chain, requesting data from a recorder, getting data files from a network location, etc. Nonetheless, there needs to be a set of configuration options defining mode of operation, configuration data for automated run and how to locate the input data. The requirements related to mode of operation are given below:

[REQ]

Identifier	REQ-14.84f-TS-SPME.0065
Title	Manual mode of operation
Requirement	The SPM Tool **shall** implement a manual mode of operation, where all settings for a full performance assessment can be defined and the results are visualised interactively by an operator.
Status	<validated>
Rationale	This requirement specifies the normal mode of operation, with the operator providing the parameters for retrieving input data, configuration options, type of assessment to be performed and visualising the assessment results/reports. This is a new requirement introduced with respect to TRL4 Final TS/IRS [18].
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e

<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0066
Title	QRT mode of operation
Requirement	The SPM Tool **shall** implement a QRT mode of execution as a fully automated and recurrent run of performance assessment analysis with new input data for a specified configuration.
Status	<validated>
Rationale	This is the basis of the QRT mode: to be able to run in a programmed way for a fixed configuration and new input data at a frequency between 20 min and 24h. The input data does not need to be contiguous, uniform duration or increasing, in order to allow data gaps, different duration for different time of day or processing historic data.
	This is a new requirement introduced with respect to TRL4 Final TS/IRS [18].
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0067
Title	QRT time programming
Requirement	The SPM Tool **shall** implement the QRT mode based on an assessment configuration as defined in Section 4.3.1 and a user defined execution schedule.
Status	<validated>
Rationale	The execution schedule would define successive input data retrieval as well as at what times the automated analysis is run.

	This is a new requirement introduced with respect to TRL4 Final TS/IRS [18].
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0068
Title	Trend Metric Data base
Requirement	The SPM Tool **shall** implement a Trend Metric Data base mechanism to store the performance assessment measurements calculated as given in Section 4.3.2.
Status	<validated>
Rationale	The exact mechanism for storing trend data is not specified, but input data properties, configuration identification and calculated metrics are expected to be stored to identify an individual run. This is a new requirement introduced with respect to TRL4 Final TS/IRS [18].
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0069

Title	Trend Metric Data identifier
Requirement	The SPM Tool **shall** store the following Trend Metric Data for each run: • time period of assessed input data, • configuration settings identification (including sensors in input data), • the performance assessment measurements.
Status	<validated>
Rationale	These will be used for identifying each run and the calculated performance metrics, which will facilitate Trend Metric Data Analysis and Visualisation. This is a new requirement introduced with respect to TRL4 Final TS/IRS [18].
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0070
Title	Trend Visualization
Requirement	The SPM Tool **shall** gather the stored Trend Metric Data performance assessment measurements and visualize a trend of the performance over time for the selected OSV at user-defined granularity.
Status	<validated>
Rationale	The trend visualization is part of the quasi-real time monitoring. The trend visualization aims at displaying the temporal performance behaviour of a selected performance metric type over time. This is a new requirement introduced with respect to TRL4 Final TS/IRS [18].
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0071
Title	Trend Visualization Display Period
Requirement	The SPM Tool **shall** display the trend of the performance for an user-selected display time period.
Status	<validated>
Rationale	The trend visualization is part of the quasi-real time monitoring. The trend visualization display period aims at displaying the performance trend within a time period as selected by the user. This is a new requirement introduced with respect to TRL4 Final TS/IRS [18].
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0072
Title	Trend Visualization Update
Requirement	The SPM Tool **shall** for each new time period of assessed input data update the visualization of the trend to include also the new performance measurement.
Status	<validated>

Rationale	The trend visualization update is part of the quasi-real time monitoring.
	This is a new requirement introduced with respect to TRL4 Final TS/IRS [18].
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0073
Title	Trend Data Performance Degradation Indication
Requirement	The SPM Tool **should** indicate performance values in the trend data exceeding defined performance thresholds.
Status	<validated>
Rationale	The Trend Data Performance Degradation Indication is part of the quasi-real time monitoring.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0074
Title	Trend Metric Data Analysis

Requirement	The SPM Tool **should** allow different representation types on a user defined data interval of the stored metric data such as - Histograms showing distribution of performance results (y=events, x= performance value) - Max, min and mean value
Status	\<validated\>
Rationale	The Trend Metric Data Analysis supports the analysis of performance metric data evolution.
Category	\<Functional\>

[REQ Trace]

Relationship	Linked Element Type	Identifier
\<SATISFIES\>	\<SESAR Solution\>	PJ.14-W2-84f
\<SATISFIES\>	\<Enabler\>	CTE-S07e
\<ALLOCATED_TO\>	\<Functional block\>	Surveillance Performance Monitoring at En-route/TMA

4.4 Safety and Security Requirements

Safety and Security are not applicable (in this phase and subsequent phases) as Surveillance Performance Monitoring (SPM) Tools do not provide input to other systems. SPM Tool is a tool operated by ATSEP for assessment of the surveillance performance, typically delivering only reports with a defined set of performance metrics to surveillance technical personnel. No data is transmitted to the air or other ground systems, and no operational use is done. In addition, SPM tools (for both sensor and "end-to-end" levels) do not affect or manipulate the surveillance chain.

PJ.19-04 has initially identified Indirect Safety Impact through increased resilience for both PJ.14-W2-84e and PJ.14-W2-84f solutions. This is implied by SPM Tools aiming to identify degradation trends early, hence improving safety of the overall ATM operations. The only identified stakeholder for the SPM Tools is ATSEP. The benefit impact of SPM Tools will be reduced workload for ATSEP and earlier detection of degradation to undertake corrective action.

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SPM Tools are not intended to be deployed to interact with other operational systems or other SESAR operational solutions. With such limited impact on ATM operations, it was determined that technical safety assessment report and specification will not be required.[1]

4.5 Maintainability Requirements

Not applicable as SPM is not a safety critical function as indicated in Section 4.3.4.

4.6 Reliability Requirements

The validation activities performed in TRL4 phase have achieved only partial harmonisation. The complete harmonisation has not been achieved due to the difference in the set of data used for performance metrics calculation by each tool. For TRL6 specification, new requirements are added to provide detailed information on the set of data (track updates, tracks and reference trajectories) used for the calculation of each performance metric. Additionally, for TRL6 validation simple test cases (few tracks) for each performance metric needs to be developed for "unit" testing.

To support in-depth cross verification, additional reporting functionality will be developed for both tools to give the details of the reference and SUT (System Under Test) tracks that are used for the calculation of each performance metric. Furthermore, during the development of the TRL6 prototypes, traffic scenarios of increasing complexity will be used for continuous cross verification of the performance metrics results from each prototype. Additionally, TMA and En-route traffic scenario from a medium/high density operational environment based on multiple sensors (three Mode S radars, ADS-B or WAM) and an operational tracker system shall be used for the validation exercises.

[REQ]

Identifier	REQ-14.84f-TS-SPME.0075
Title	Identification of data used for OSV performance metrics calculation
Requirement	The SPM Tool **shall** provide the following information on the data used for the calculation of each OSV performance metric: • Reference trajectory segments with start-end times, • Track segments with start-end times, • Track segments to reference trajectory segment associations, • Target reports to track segment association, • Target report classification for all target reports.
Status	<validated>

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[1] After discussions with PJ.19-04 Safety Experts, both Solution PJ.14-W2-84e and PJ.14-W2-84f have been identified as having "No Safety Impact", instead of "Indirect Safety Impact", and that the Validation Targets table will be updated accordingly.

Rationale	This is a new requirements introduced for TRL6 development to provide detailed information to facilitate cross verification of the SPM Tool prototypes.
Category	<Reliability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

[REQ]

Identifier	REQ-14.84f-TS-SPME.0076
Title	Identification of data used for trajectory performance metrics calculation
Requirement	The SPM Tool **shall** provide the following information on the data used for the calculation of each trajectory performance metric: • Reference trajectory segments with start-end times, • Track segments associated to the reference trajectory with start-end times, • Target report classification for target reports associated to reference trajectory.
Status	<validated>
Rationale	This is a new requirements introduced for TRL6 development to provide detailed information to facilitate cross verification of the SPM Tool prototypes.
Category	<Reliability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<SATISFIES>	<SESAR Solution>	PJ.14-W2-84f
<SATISFIES>	<Enabler>	CTE-S07e
<ALLOCATED_TO>	<Functional block>	Surveillance Performance Monitoring at En-route/TMA

4.7 Performance Requirements

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The human performance is not applicable. SPM Tools are not used in an operational context and not associated with an ATM solution. SPM Tool is a separate tool for assessment of the surveillance performance, whose typical output is a report containing a set of performance metrics for surveillance systems. No operational use is done. Therefore, it does not include human performance assessment.

Concerning the technical performance, it is addressed through the functional requirements of this document.

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5 Recommendation for Implementation

The SPM Tools, for both sensor and "end-to-end" level, do not interact or manipulate the surveillance chain. The SPM Tool prototypes developed by this solution are software that can be implemented in any operating environment and there aren´t specific requirements about software performance. Each manufacturer has the freedom to choose the details of the software implementations following the functional and non-functional requirements given in this document as long as the hardware guidelines from the manufacturer are followed.

SPM Tools for surveillance chain implementation is intended to be done at ATC surveillance infrastructure level.

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6 Assumptions

None.

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7 References and Applicable Documents

7.1 Applicable Documents

Content Integration

[1] EATMA guidance material and report, Dec 2019.

[2] EATMA Community pages.

Concept Development

[3] Concept of Operations, Dec 2019.

System and Service Development

[4] Report of the progress on standardisation of Services, Information and Terminology, Oct 2019.

Performance Management

[5] Performance Framework, Dec 2019.

Validation

[6] Validation Strategy, Dec 2019.

[7] Validation Targets W2, Jun 2020.

System Engineering

[8] System Engineering - Methodology for the V&VP, V&VI and Demonstration Platform development, Jun 2019.

Safety

[9] SESAR Safety Reference Material, Dec 2018.

[10] Guidance to Apply SESAR Safety Reference Material, Dec 2018.

Human Performance

[11] Human Performance - Guidance Reference Material, Aug 2020.

Environment Assessment

[12] ENV - Guidance Reference Material, Dec 2019.

Security

[13] SecRAM, Sep 2017

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7.2 Reference Documents

[14] EUROCONTROL Specification for ATM Surveillance System Performance (ESASSP), Edition 1.1 Draft, Sep 2015

[15] EUROCONTROL Specification for ATM Surveillance System Performance (ESASSP), Edition 1.2, Apr 2021

[16] EUROCAE ED-129C, Technical Specification for a 10190 MHz Extended Squitter ADS-B Ground System, Draft, March 2020

[17] EUROCAE ED-261-1, Safety and Performance Requirements Standard for a Generic Surveillance System (GEN-SUR SPR), Apr 2022

[18] Final Technical Specifications (TS/IRS) for Surveillance Performance Monitoring (SPM) Tools for End-to-end Surveillance Chain at TRL4, D12.6.120, Edition: 00.01.00, Jun 2021

[19] Initial Technical Specifications (TS/IRS) for Surveillance Performance Monitoring (SPM) Tools for End-to-end Surveillance Chain at TRL6, D12.7.100, Edition: 00.01.00, Oct 2021

[20] Technological Validation Plan for Surveillance Performance Monitoring (SPM) Tools for End-to-end Surveillance Chain at TRL6, D12.7.200, Edition: 00.01.00, Dec 2021

[21] Technological Validation Report for Surveillance Performance Monitoring (SPM) - End-to-end at TRL6, D12.7.400, Edition: 00.01.00, Jul 2022

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Appendix A   Service Description Document (SDD)

No services are provided by SPM Tools.

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-END OF DOCUMENT-

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