PJ PROSA

SESAR Solution PJ.10-02a SPR-INTEROP/OSED for V3 - Part I

DeliverableID	D04.2.010
Dissemination Level:	PU
ProjectAcronym	PROSA
Grant:	734143
Call:	H2020-SESAR-2015-2
Topic:	Separation Management En-Route & TMA
Consortium coordinator:	DFS
Edition date:	7 November 2019
Edition:	00.01.03
Template Edition	02.00.02

Founding Members

SESAR JOINT UNDERTAKING

PJ.10-02a

IMPROVED PERFORMANCE IN THE PROVISION OF SEPARATION

This SESAR Solution PJ.10-02a SPR-INTEROP/OSED document is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 734143 under European Union's Horizon 2020 research and innovation programme.

Abstract

This document is the SPR-INTEROP/OSED for Solution PJ.10-02a in V3 phase.

The SESAR Solution PJ.10-02a is about the provision of Separation in En-Route and TMA airspace. It focuses on Conflict Detection and Resolution aid for the Air traffic Controllers, e.g. MTCD, TCT, and also on flight conformance monitoring, e.g. CMON.

Regarding the existing CD/R services, the improvement is namely due to the use of a better Trajectory Prediction thanks to additional input data. Among those new supporting data, the Aircraft Derived Data are of prime importance. These data are addressed by Solution PJ.10-02a at V2 level.

In order to clarify the solution content maturity, the solution PJ.10-02a has been split into two sub-solutions. PJ.10-02a2, which is in charge of ADS-C EPP data use into ATC studied concepts; and PJ.10-02a1, which is in charge of the other aspects initially covered by PJ.10-02a. Therefore, solution PJ.10-02a1 is targeting a V3 maturity at the end of Wave 1, whereas PJ.10-02a2 intends to reach V2 maturity.

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The SPR/INTEROP-OSED Template includes the following parts:

- ***SPR/INTEROP-OSED Template – Part I (this volume)***
- SPR/INTEROP-OSED Template – Part II Safety Assessment Report (SAR)
- SPR/INTEROP – OSED Template – Part III Security Assessment Report (SeAR)
- SPR/INTEROP – OSED Template – Part IV Human Performance Assessment Report (HPAR)
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1 Executive Summary

The SESAR Solution PJ.10-02a has been split into two sub-Solutions: PJ.10-02a1 and PJ.10-02a2.

- PJ.10-02a1 is "*Integrated tactical and medium Conflict Detection & Resolution (CD&R) services and Conformance Monitoring tools for En-Route and TMA*". It aims at improving the separation (tactical layer) in the En-Route and TMA operational environments through improved ground trajectory prediction. This is achieved using existing information on lateral and vertical clearances that are known by the ground system and airborne information such as Mode-S data.

- PJ.10-02a2 is "*Improved performance in the provision of separation with use of ADS-C/EPP* data". It aims at improving the separation (tactical layer) in the En-Route operational environment through improved ground trajectory prediction. This is achieved using existing information on lateral and vertical clearances that are known to the ground system along with the ADS-C/EPP airborne information.

These two sub-Solutions mainly differ in the way for improving ground trajectory prediction, however the enhanced services remain unchanged and comprise of:

- Conflict detection and resolution set based on improved ground trajectory prediction and enhanced resolution features,

- Conformance monitoring service based on improved ground trajectory prediction, enriched with additional alerts, such as vertical rate monitoring.

Outstanding R&D needs to improve trajectory prediction and to further reduce the number of nuisance alerts and enhance the accuracy of conflict detections, are:

- The use of closed-loop trajectories amendment, through the horizontal modification of the trajectory ("Route via"), that's to say a flight plan update directly performed by controllers on their CWPs,

- The use of downlinked aircraft data (e.g. ADS-C, Mode-S enhanced data…),

- Integration of available information from the ground e.g. specific areas (military areas, adverse weather...).

The use of these advanced support services should also be investigated in Free Routing airspace configuration and in other organisations in addition to the traditional 1 Executive – 1 Planner, such as for example the introduction of the Extended ATC Planner or the Multi-Sector Planner.

This SESAR Solution is in the continuity of SESAR1 projects, which partly reached V3 maturity:

- the capabilities that are covered by PJ.10-02a1 were V2 at the end of SESAR1 and they are expected to reach V3 maturity in Wave 1;

- the capabilities that were V3 at the end of SESAR1 are the basis for improvements, which are covered by PJ.10-02a2 and are expected to reach V2 in Wave 1.

2 Introduction

2.1 Purpose of the document

This document provides the requirements specification, covering functional, non-functional and interface requirements related to SESAR Solutions PJ.10-02a1 & PJ.10-02a2.

The SESAR Solution Development Life Cycle aims to structure and perform the work at project level and progressively increase SESAR Solution maturity, with the final objective of delivering a SESAR Solution data-pack for industrialisation and deployment. This SESAR Solution PJ.10-02a SPR-INTEROP/OSED for V3 – Part I represents one of the key parts of the SESAR Solutions unique data-pack.

2.2 Scope

This is the SPR-INTEROP/OSED for both Solutions PJ.10-02a1 and PJ.10-02a2, after the V2 and V3 validation exercises (list and description available in chapter 2.4) have been performed and their validation results analysed and consolidated.

It may be noticed that both V2 and V3 maturity content are described in this V3 OSED, as endorsed by SJU through the recent split of the Solution PJ.10-02a into two sub-Solutions PJ.10-02a1 & PJ.10-02a2. Table 6 is a recap of the V2/V3 maturity content covered by solutions PJ.10-02a1 and PJ.10-02a2.

The SPR-INTEROP/OSED common “pack” document is composed of different parts:

- Part I (core part) provides the Safety and Performance Requirements (SPR) and Interoperability Requirements (INTEROP), related to SESAR Solution PJ.10-02a1 and Solution PJ.10-02a2, which have been validated during validation activities at a V3 level.
  They are presented in the context of the Operational Service and Environment Definition (OSED), which describes the environment, assumptions, etc. that are applicable to the SPR and INTEROP requirements.
  These requirements cover safety, performance, operational aspects as well as the interoperability aspects related to a specific technology to support the SESAR Solutions PJ.10-02a1 and PJ.10-02a2.
  The core part of the document is completed by appendices including:
    - The Benefit and cost Mechanisms, showing how the SESAR Solution elements contribute (positively or negatively) to the delivery of performance benefits and the costs.
- Parts II to V provide the series of assessments that justify the SPR and INTEROP requirements:
    - Part II: The Safety Assessment Report describes the results of the safety assessment work for the SESAR Solution. Due to regulatory obligations, a Safety Assessment is required for any proposed change to the system;
    - Part III: The Security Assessment Report describes the results of the Security assessment work for the SESAR Solutions PJ.10-02a1 and PJ.10-02a2. This assessment is made necessary because the previously combined PJ.10-02a solution

has been prioritized due to major impact in case of a cyber-attack. However, for security reasons, Part III is unavailable and only the Minimum Set of Security Requirements has been included in the document;

- Part IV: The Human Performance Assessment Report describes the results of the Human Performance assessment work for the SESAR Solution PJ.10-02a1 and Solution PJ.10-02a2;
- Part V: The Performance Assessment Report (PAR) that consolidates the performance results obtained in different validation activities.

Part I is the current document. The other parts are separated documents.

The V3 validation exercises refer PJ.10-02a1 OIs, and possibly PJ.10-02a2 OIs. In particular, despite ADS-C EPP is mentioned in the current document, the use of this data is only part of V3 exercises that refer PJ.10-02a2 OIs: OI steps CM-0209-b and CM-0210-b.

2.3 Intended readership

The intended audience for the document is:

- Other SESAR Solutions as depicted in [2]:
  - PJ.01-03: Dynamic and Enhanced Routes and Airspace
  - PJ.08-01: Management of Dynamic Airspace configurations
  - PJ.08-02: Dynamic Airspace Configuration supporting moving areas
  - PJ.10-01a: High Productivity Controller Team Organisation
  - PJ.10-01b: Flight Centred ATC
  - PJ.10-01c: Collaborative Control
  - Solution 53: Advanced Separation Management
  - PJ.10-05: IFR RPAS Integration
  - PJ.10-06: Generic' (non-geographical) Controller Validations
  - PJ.14-02-01: FCI* Terrestrial Data Link
  - PJ.14-02-04: FCI* Network Technologies incl. voice solutions and military interfacing
  - PJ.15-08: Trajectory Prediction Service
  - PJ.16-04: Workstation, Controller productivity
  - PJ.18-02: Integration of trajectory management processes in planning and execution
  - PJ.19: Content Integration
- Transverse and federating projects;
  - PJ.06-01: Optimized traffic management to enable Free Routing in high and very high complexity environments.

- PJ.06-02: Management of Performance Based Free Routing in lower Airspace
- PJ.18.06: Performance Based Trajectory Prediction

- Stakeholders;
  - Airspace Users (e.g. airlines, military authorities, etc.)

2.4 Background

The document benefits from work performed in the scope of SESAR, such as Solution #27 and SESAR1 projects P04.07.02 and P05.07.02. Section 5.2 provides with the related references.

SESAR1 Project P04.07.02

As the main background for the En-Route part, SESAR1 project P04.07.02 studied the following services related to separation provision in En-Route:

- The TCT service (including conflict detection and resolution aid) based on tactical trajectory, which has been V3-validated in En-Route environment and which now needs to be extended in scope and functionalities;
- The MTCD service (including conflict detection and resolution aid) based on planning trajectory, which has been V2-validated as regards advanced support for ATC planning (CM-0211), but still needs to complete V2 validation as regards the use of aircraft derived data (CM-0209).
- The TRACT service, which aimed at automatically simplify the situation by solving some conflicts using the CTO uplink capability. This service has not been validated at ATCO level, however it has inspired new services for more strategic processes such as INAP ones.
- The conformance monitoring (CMON) based on tactical trajectory, which have been V3-validated in SESAR1.

SESAR1 Project P05.07.02

Regarding the TMA part, SESAR1 project P05.07.02 studied three services related to separation provision in TMA:

- The TCT service has been partially V2 validated in SESAR1
- The MTCD service has been partially V2 validated in SESAR1
- The CMON service has been V2 validated in SESAR1

SESAR1 Project P05.07.02 also described some additional services to help TMA ATCOs, respectively Separation Management of Departure service and Separation Management of Arrival Service, which were not SUT in this SESAR1 project.

FASTI

For En-Route MTCD service, which has not been V3 validated in SESAR1, the same reference as in SESAR1 has to be considered, that is to say the FASTI baseline [49].

On top of the SESAR1 breeding ground, some V2 activities have been led into previous PJ.10-02a SESAR solution, by different partners, addressing separately different parts of the global PJ.10-02a concept as described in the first version of this SPR-INTEROP-OSED, referring to V2 activities performed during the first part of the global roadmap.

First phase of activities: the solution PJ.10-02a V2

As depicted in the V2 VALR [59], five simulations have been led between end of Q4 2017 and Q2 2018 with a focus on improvements on controller tools (i.e.: the continuity of work from P04.07.02 and P05.07.02). Two of the exercises addressed the accuracy of the trajectory: through addition of parameters into the tools and through a study on impact of accuracy and ATCOs' workload. This work contributed to the work on the use of enriched trajectory for CD/R tools.

The results indicate concepts operational feasibility for both TMA and En-Route environment and also provide detailed explanation on how assessed improved separation management tools can be integrated into the targeted operational system with regard to existing working methods, procedure, human-machine interface, airspace organisation/sectors and traffic load. It was recognised that certain tool parameters and HMI adaptations are needed in order to adapt its performance to the targeted operational environment.

ATCOs stated that the solution under test provided them with more benefits than the reference system. It offered them better situational awareness as it allowed quicker understanding of the conflict, and furthermore supported them in the decision making regarding the resolution strategy to apply to solve the conflict. They also agreed that resolution advisory provided a good overview of resolution options at a glance and increased available time to think about possible solutions. In addition, they evaluated the improved separation management tool more accurate as it is based on actual and clearance data which enabled identification of conflict situations earlier.

In addition, the results obtained through fast-time simulation regarding the improvement of the trajectory prediction accuracy show evident positive impact on the controller workload. Improved accuracy provides greater opportunity for the planning controller to resolve more probable conflicts early, thereby reducing executive controller workload still further. Nevertheless, the benefit of improved TP accuracy requires the trust of the controller to allow the narrowing of buffers and is therefore only likely to be achieved after sufficient experience is gained with the automation.

Second phase of activities: the PJ.10-02a1 V3 phase and the PJ.10-02a2 V2 phase

As a continuity of the previous V2 phase, the Solution PJ.10-02a1 aims at reaching V3 maturity on CD/R services enhancements, whereas Solution PJ.10-02a2 aims at reaching V2 maturity on use of enriched trajectory with ADS-C Data for separation tools.

Among the seven exercises that both Solutions partners have led during this second phase of the PJ.10-02a1/PJ.10-02a2 Solutions, six of them aim at reaching V3 maturity on CD/R services enhancements, and two of them aim at reaching V2 maturity on use of enriched trajectory for separation tools (one exercise, the EXE-10-02a-V3-VALP-007, performed both V2 and V3 activities).

Hereafter is a brief description of each of those seven exercises:

EXE-10.02a-V3-VALP-001 (En-Route) performed by DSNA – part of Solution PJ.10-02a1

The exercise is a real-time simulation (RTS) and focuses on the assessment of an enhanced MTCD with detection of conflict between Aircraft (CM-0211) in French En-Route airspace with high traffic complexity. The aim is to validate the enhanced MTCD up to V3 level. It is thus the continuation of EXE-10.02a-V2-VALP-001.

For conducting the RTS, a Coflight IBP from DSNA has been used. It is coupled with the CD/R aid research prototype in the solution scenario. The simulated airspace covers four French airspace sectors and three positions acting as adjacent sectors. Thus, this research prototype used for this V3 validation exercise consists of the following services:

- What-if probing
- MTCD: Mid-Term Conflict Detection.

EXE-10.02a-V3-VALP-002b (TMA) performed by COOPANS & THALES – part of Solution PJ.10-02a1

The exercise addressed CM-0206 and focussed on understanding the extent to which new Tactical Controller Tools (TCT) impacts controllers' performance in conflict detection and resolution tasks within a TMA and extended TMA airspace environment with high traffic density, including a high percentage of vertical movements. The sub-operating environment covered by this exercise is 'Very High Complexity' TMA.

The validation scenarios comprise very high complexity TMA airspace, Stockholm TMA, with two main airports (Arlanda and Bromma) served by extended arrival management processes and a PBN-based SID and STAR structure, enabling a closed-route structure.

The high-level objective is to assess the TCT's impact on operational acceptability and various ATM performance benefits including the impact on TMA capacity, cost efficiency, fuel efficiency, human performance and safety.

EXE-10.02a-V3-VALP-003 (En-Route) performed by ENAV & LEONARDO – part of Solution PJ.10-02a1

This exercise contributes to the CM-0209A and CM-0210 and the high level objectives are:

- To demonstrate that - in a Free Routes environment - the use of trajectory data (i.e. on-board Mode-S/ADS-B data) in CD/R and in conformance monitoring aid provide benefits in ATCO workload and situational awareness, ANSP cost per flight/ATCO Productivity, Predictability and Fuel efficiency.
- To demonstrate that the integration of on-board data produces a more accurate Trajectory Prediction supporting the operations of separation management and improving the ATCO productivity and predictability.
- To demonstrate that the improved trajectory supports the Executive controller Tool and MTCD to enhance conflict detection which is continuously performed taking into account the complexity of the sector.
- The conflict detection tools (TCT and MTCD) featured by what-if function support the Controller in the resolution of the conflicts and in the planning of conflict-free trajectory with direct benefits in ATCO Workload.

EXE-10.02a-V3-VALP-004 (En-Route) performed by SKYGUIDE – part of Solution PJ.10-02a1

This exercise contributes to the operational validation of OIs CM-0211 "Advanced Support for Conflict Detection and Resolution for ATC planning in En-Route" and CM-0210 "Ground Based Flight Conformance Monitoring in En-Route using enhanced ground predicted trajectory ".

For this purpose, Swiss airspace structure in a Free Routing environment has been developed, managing air traffic in part of the core area of Europe, known has one of the highest traffic densities in the world.

The key validation objectives has been to assess advanced Controller Support Tools and Monitoring Aid adapted to a Free Routing environment on Predictability, Capacity, Safety and Human Performance.

Benefits are expected in Predictability, Capacity and on Human Performance, while Safety must be at least no negatively impacted. This Real Time Simulation provides an analysis of PJ.10-02a1 solution enablers benefits (linked to CM-0210 and CM-0211) to be further used in the frame of PJ.10-02a1 Costs Benefits Analysis.

EXE-10.02a-V3-VALP-005 (En-Route) performed by EUROCONTROL, ANS-CR & THALES – part of Solution PJ.10-02a1

The exercise addresses an enhanced working method, enabled by more reliable CD&R tools (achieved by more accurate trajectory prediction), that is expected to reduce executive controller workload. The exercise builds on the V2 FTS EXE-10.02a-V2-VALP-003, which evaluated the potential reduction in executive controller workload that might be achieved if the sector planner resolves certain, high probability conflicts.

The target environment of the RTS comprised Prague ACC En-Route sectors (medium complexity airspace).

The use of CPDLC is available to both executive and planner controllers, but specifically the planner controller is expected to make use of it to resolve potential conflicts through closed clearances in preference to tactical vectoring.

EXE-10.02a-V3-VALP-006 (En-Route) performed by PANSA & INDRA – part of Solution PJ.10-02a2

The validation exercise EXE-10.02a-V3-VALP-006 is a real-time simulation (RTS) starting at V2. Exercise addresses OI step: CM-0209-b.

The exercise focuses on assessment of new planner tool, detecting conflicts relevant to the planner controller responsibilities. New tool is improved with new TP algorithms, using ADS-C EPP data.

The idea for exercise is to validate the tool that has been built around trajectory prediction mechanism. The prototype of the tool is implemented to the iTEC validation platform and during the series of test sessions involving ACC controllers from PANSA the tool has been validated operationally.

EXE-10.02a-V3-VALP-007 (TMA) performed by AIRBUS D&S and BULATSA – part of both Solutions PJ.10-02a2 and PJ.10-02a1

The exercise addresses the CD/R aid for the EC and the PC as well as the conformance monitoring functionalities within TMA and in transition to En-Route sectors, based on realistic operational constraints with participation of licenced air traffic controllers.

The exercise comprises of further V3 development of Tactical Encounter Solver Assistant (TESLA) functionalities, such as:

- Conflict detection and resolution (including “what-if” and “what-else” set of functionalities, the new geo-fencing function has been added in which the CD/R tool takes into account activated airspace volumes and terrain specifics)
- Conformance monitoring

The functions listed above use a combination of system trajectories and aircraft derived data (EPP information via ADS-C) for enrichment of the trajectory prediction and conflict management.

The exercises focuses on the automation-aided conflict detection and resolution tasks in the pre-tactical and tactical-time horizon. This time horizon is a temporal parameter allowing for using tactical and pre-tactical planning and resolution strategies to both EC and PC.

In addition to V2 validation activities, the exercise also addresses geo-fencing capability of the tool used in providing conflict resolutions.

Both nominal and emergency/abnormal situations have been simulated. OAT traffic has been included.

2.5 Structure of the document

The present volume is the Part I of the SESAR Solution PJ.10-02a SPR-INTEROP/OSED document. Even though this SESAR solution has been split into two sub-solutions (PJ.10-02a1 and PJ.10-02a2), it has been agreed with SJU that a single datapack will be delivered for both solutions. Therefore, each time it is necessary, it is mentioned in this SPR-INTEROP-OSED whether we refer to PJ.10-02a1 or PJ.10-02a2. But the content has been handled as if both of them were inseparable. The document is structured as follows:

Section 1 is the Executive Summary.

Section 2 is an introductive section that has two other side goals:

- To briefly introduce the background R&D Projects whose results have been considered in this document;
- To introduce all terms that are used in the document and in the requirements.

Section 3 describes in a plain and easy to understand language the environment, assumptions, etc. that are applicable to the SPR and INTEROP requirements. It also provides with the impact of both SESAR Solutions PJ.10-02a1 and PJ.10-02a2 on Operating Methods.

Section 4 lists the SPR and INTEROP requirements, which are covering safety, performance, operational aspects as well as the interoperability aspects related to a specific technology to support both SESAR Solutions PJ.10-02a1/PJ.10-02a2.

Section 5 is the recipient for all applicable documents and reference documents.

Appendix A contains the Benefit and cost Mechanisms, showing how the SESAR Solution elements contribute (positively or negatively) to the delivery of performance benefits and the costs.

2.6 Glossary of terms

Term	Definition	Source of the definition
AIR-REPORT	A report from an aircraft in flight prepared in conformity with requirements for position, and operational and/or meteorological reporting.	ICAO Annex
Cluster	A set of one or more Encounters that should be treated as a whole when determining their resolution	Solution #27
Conflict	Any situation involving aircraft and hazards in which the applicable separation minima may be compromised. Note: this term relates to potential infringements of separation minima. More specifically, it is used in the context of ATCO activities where actions are performed in order to anticipate and resolve conflicts for separation management purposes. This is in contrast to the situations detected and processed by CD/R tools where the terminology used is 'encounters', which relates to the applicable Separation of Interest used by the tool-set, rather than Separation Minima.	Solution #27
Conflict Detection Aid	Conflict detection performed by the CD/R aid in accordance to a pre-defined time horizon suitable for the operation environment with the objective to alert the ATCO of a potential conflict between an aircraft and a hazard.	
Conflict Resolution Aid	Conflict resolution options calculated by the CD/R aid and presented to the controller who ensures that the Separation Minima will not be compromised between an aircraft and a hazard.	
Conformance Monitoring	A system function that detects and may alert the ATCO in case the aircraft behaves not in accordance with the CD/R aid hypothesis.	
Encounter	A situation where an aircraft is predicted to be below the applicable Separation of Interest with respect to another aircraft, or a designated volume of airspace, classified respectively as "aircraft-to-aircraft", "aircraft-to-airspace", and "aircraft to terrain" encounters. Note: Encounters relate to the various detection tools and may work to different look-ahead time horizons with different separation criteria, using different trajectories. Different tool configurations can therefore be expected to yield different encounters. The Separation of Interest thresholds are considered with respect to any applicable uncertainty volumes around the predicted aircraft position(s).	Solution #27

False alert	A situation which is presented on CWP HMI as a conflicting situation, whereas it isn't.	
Hazard	The objects or elements that an aircraft can be separated from. Note: hazards could be: other aircraft, airspace with adverse weather, terrain, ARES (TSA, CBA, D zone…etc.)	Solution #27
Missed alert	Operational definition: A relevant alert, which is displayed on the CWP HMI, but which is not seen, or not properly integrated as an alert, by ATCOs, whatever the reason. System definition: An alert which is not detected by the system whereas it should have been detected according to specifications.	
Nuisance alert	A situation which is displayed on CWP HMI as an encounter, but which is not highlighting a real conflicting situation according to ATCOs' expert judgment.	
Open loop clearance/instruction	An ATC clearance or instruction where a full trajectory extrapolation beyond the point or segment(s) affected is not possible using the normal prediction process, i.e. without special measures to assert a closure condition (e.g. time limit on headings and most probable point of return to original routing). Note: Most tactical instructions/clearances take this form; they include heading (including track offset), level, and speed restrictions and exceptionally could also cover rates of climb or descent.	Solution #27
Separation	Spacing between an aircraft and a hazard.	Solution #27
Separation Criteria	A generic term that covers the Separation Minima and the thresholds used for problem identification.	Solution #27
Separation of Interest	The separation threshold below which the proximity of a pair of aircraft or a hazard is considered to be of interest to a controller, for the airspace and conditions concerned. Note: At this point, there may be no actual risk that Separation Minima are infringed. The values chosen for the various controller activities and tools are larger than the Separation Criteria in order to provide an adequate margin of safety. The controller and the aid used need to have awareness of the applicable Separation Minima for the airspace concerned. Note: This is a generic term, independent of the planning or tactical layers of separation activity. Particular instances of the Separation of Interest may be applied for each level of separation activity. The actual separation values used will take into account aspects such as the type of clearance issued, the requested navigation precision and the airspace rules. They will also relate to the type of trajectory used	Solution #27

	at the specific layer of concern. They may vary according to circumstances such as the geometry of the conflicts/encounters and prevailing conditions such as adverse weather	
Separation Minima	The minimum displacements between an aircraft and a hazard, which maintain the risk of collision at an acceptable level of safety. Note: ICAO Doc 9689 describes the methodology to be used for the determination of Separation Minima	Solution #27 ICAO Doc 9689
What-else Probing	A process where several Speculative Trajectories and associated data arising from What-If Probing are assessed for the impact on the occurrence of predicted Encounters. The Speculative Trajectories utilise flight data other than that currently committed or tentatively selected (during What-If Probing operations) by the controller	Solution #27
What-if Probing	A process where a private copy of a Trajectory that is in operational use and associated data is taken and used as a Tentative Trajectory to check the impact of changes to the flight data on the occurrence of predicted Encounters, without affecting the corresponding data for the actual flight. Note: On completion the what-if data and the Tentative Trajectory may be discarded or used to implement an update to the actual flight data and to construct the necessary clearance	Solution #27

Table 1: Glossary of terms

2.7 List of Acronyms

Acronym	Definition
ACARS	Aircraft Communications Addressing and Reporting System
ADD	Aircraft Derived Data
ADS-C	Automatic Dependant Surveillance - Contract
AFTN	Aeronautical Fixed Telecommunication Network
AOI	Area Of Interest
ARES	Airspace Reservation (CBA, TSA, D zone, R zone, P zone)
ARN	ATC Route Network
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATSAW	Airborne Traffic Situation Awareness

B2B	Business to Business
BIM	Benefit and Impact Mechanism
CDM	Collaborative Decision Making
CDO	Continuous Descent Operation
CD/R	Conflict Detection / Resolution
CMON	Conformance MONitoring
CNS	Communication Navigation and Surveillance
CONOPS	Concept of Operations
CPA	Closest Point of Approach
CR	Change Request
CTO	Controlled Time Over
EAP	Extended ATC Planner
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
EC	Executive Controller[1]
EPP	Extended Projected Profile
ERNIP	European Route Network Improvement Plan
FASTI	First ATC Support Tools Implementation
FIS	Flight Information Service
FOC	Flight Operations Centre
FRA	Free-Routing Airspace
GA	General Aviation
GAT	General Air Traffic
HPAR	Human Performance Assessment Report
IER	Information Exchange Requirement
IFR	Instrument Flight Rules
INAP	Integrated Network management and extended ATC Planning
INTEROP	Interoperability Requirements
iRBT	Initial Reference Business Trajectory

[1] Both wordings “Tactical Controller” and “Executive Controller” are used interchangeably within the document

iTEC	Interoperability Through European Collaboration
LoA	Letter of Agreement
LTM	Local Traffic Manager
MSP	Multi Sector Planner
MTCD	Medium Term Conflict Detection
NM	Network Manager
OAT	Operational Air Traffic
OI	Operational Improvement
OSED	Operational Service and Environment Definition
PAR	Performance Assessment Report
PC	Planner Controller[2]
PMP	Project Management Plan
QoS	Quality of Service
RBT	Reference Business Trajectory
RMT	Reference Mission Trajectory
RPAS	Remotely Piloted Aircraft System
RTE VIA	"Route VIA" Service
SAC	Safety Criteria
SAR	Safety Assessment Report
SBT	Shared Business Trajectory
SeAR	Security Assessment Report
SEP	Separation Tool
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SMT	Shared Mission Trajectory
SNF	Subtle Navigational Factors
SPR	Safety and Performance Requirements
SUT	System Under Test

[2] Both wordings "Planner Controller" and "Planning Controller" are used interchangeably within the document

SWIM	System Wide Information Model
TAWS	Terrain Awareness and Warning System
TCT	Tactical Controller Tool
ToC	Top of Climb
ToD	Top of Descent
TC	Tactical Controller[3]
TS	Technical Specification
VLJ	Very Light Jet

Table 2: List of acronyms

[3] Both wordings "Tactical Controller" and "Executive Controller" are used interchangeably within the document

3 Operational Service and Environment Definition

This section details the operational concept aspects described in the CONOPS maintained by PJ19 [4].

3.1 SESAR Solution PJ.10-02a: a summary

The SESAR Solution PJ.10-02a has been split into two sub-Solutions: PJ.10-02a1 and PJ.10-02a2.

- PJ.10-02a1 is "*Integrated tactical and medium Conflict Detection & Resolution (CD&R) services and Conformance Monitoring tools for En-Route and TMA*". It aims at improving the separation (tactical layer) in the En-Route and TMA operational environments through improved ground trajectory prediction. This is achieved using existing information on lateral and vertical clearances that are known by the ground system and airborne information such as Mode-S data.

- PJ.10-02a2 is "*Improved performance in the provision of separation with use of ADS-C/EPP* data". It aims at improving the separation (tactical layer) in the En-Route operational environment through improved ground trajectory prediction. This is achieved using existing information on lateral and vertical clearances that are known by the ground system and ADS-C/EPP airborne information.

This SESAR Solution is in the continuity of SESAR1 projects. Initial maturity at the end of SESAR1 is V2-started. V2 and V3 maturity phases are expected to be completed in Wave 1.

Outstanding R&D needs to improve trajectory prediction are:

- The use of downlinked aircraft data when available:
    - *Aircraft position reporting data*: Mode S enhanced data set, ADS-B data as defined in ED-102-A/DO260B,
    - *Aircraft predictive data*: ADS-C reports as defined in ED-229A, including EPP data
- Available information from various ground sources e.g. specific areas (military areas, adverse weather, etc.)

The availability of new reliable data and the improvement of the ground trajectory prediction positively influence the separation services. The PJ.10-02a1/PJ.10-02a2 concept defines three categories of separation services improvement:

1. Without any modification of the separation tools, the improved ground trajectory prediction (TP) allows ***reducing the number of nuisance alerts and missed alerts***, thus enhancing the accuracy of conflict detection; the PJ.10-02a1/PJ.10-02a2 concept defines which new data brings the highest benefit for which CD/R aid service, e.g. the TCT will highly benefit from downlinked meteorological data while the CMON services will benefit from the access to the more accurate information about the aircraft trajectories;

2. The improved ground TP allows ***diversifying the operational environments*** where the separation services can be used, thanks to new data available from the ground or downlinked data; the PJ.10-02a1/PJ.10-02a2 concept defines which new data are the most beneficial to make CD/R aid services applicable to any kind of operations, and it also defines which functions to modify or add to make CD/R aid services as generic as possible;
3. Last, the new reliable data and the improved ground TP allows ***increasing the capabilities of the separation services***, because the improved reliability/accuracy of the predicted conflicts brings the opportunity to propose new or enhanced functions e.g. tools and procedures for the Planning Controller (PC) to solve potential conflicts in advance, in close cooperation with the Executive controller (EC).

Because there are several separation services, with different maturity levels, these concept items apply distinctly to each separation service.

The two SESAR Solutions PJ.10-02a1/PJ.10-02a2 propose to improve the functions of the separation services as follows:

- The **"CD aid to the PC"** enhancement consists in focusing on the most probable conflicts, during the sector planning timeframe (usual magnitude between 20 and 30 minutes), while conflicts that have lower probabilities of persisting are more discreetly displayed. This offers the opportunity for a new task sharing between the EC and the PC. The PC can now decide to solve high-probability encounters in advance by negotiating entry/exit coordination conditions or by taking in charge some conflict resolutions by up-linking CPDLC clearances to conflicting aircraft if operational procedures support it;
- The **"CD aid to the TC"** in En-Route has been V3-validated in SESAR1 through Solution#27. It thus looks the most relevant to stabilize its functions, and to increase both its scope and its accuracy. It takes advantage of the use of improved ground trajectory prediction, and its application scope may now include environments where almost all flights are climbing/descending i.e. in TMA
- The **Conflict Resolution** aid (What-If and What-Else) based on tactical trajectory in En-Route have been V3-validated in SESAR1 through Solution#27. To increase scope and functionalities, they now take advantage of the use of improved prediction data, particularly in lower airspace where new probe services based e.g. on climb/descent rates, may be proposed. In a mix traffic where ADS-C EPP equipped and non-equipped aircraft share the same ATC volume, the Conflict Resolution aid may implement an optimised conflict resolution system considering flight efficiency and providing best service for flights contributing the most to predictability and conformance monitoring.
- **Conformance monitoring** service based on tactical trajectory in En-Route has been V3-validated in SESAR1 through Solution#27. Based on improved ground trajectory prediction, it can raise additional alerts thanks to the data of aircraft intentions (e.g. ToD, ToC, etc.) that can be downlinked by the aircraft. The CMON shall consider relevance and quality of available data depending on the situation (e.g. open loop clearance).

Solution dependencies

As depicted previously, the improvement proposed by both PJ.10-02a1 and PJ.10-02a2 mainly rely on the improvement of the Ground Trajectory Prediction thanks to the availability of new and reliable data. How to improve the Ground trajectory Prediction is the subject of PJ.18-06.

The use of advanced separation services needs to be investigated in Free Routing airspace configuration (PJ.06-01 and PJ.06-02).

In addition, any SESAR solutions where roles and team organisation are under investigation, could be of interest for solution PJ.10-02a, especially if some specific needs regarding controllers' supporting tools are highlighted. Indeed, some contributions could have been expected from High Productivity Controller Team Organization (PJ.10-01a), Flight Centric roles (PJ.10-01b) or Collaborative Control (PJ.10-01c)

But currently, no particular needs have been relayed by those solutions to solution PJ.10-02a1 or PJ.10-02a2, prior to the delivery of the current document. Therefore, no specific work or requirements have been derived from those solutions, identified as "entry dependencies". If some elements coming from their own V3 deliverables are deemed impacting controller's provision of separation activity, then those elements will have to be taken into consideration by further validations from Solution 53 of PJ18.

Consequently, both Solutions PJ.10-02a1/PJ.10-02a2 take as input the outcomes of the following Solutions:

- **Solution PJ.06-01:** Optimized traffic management to enable Free Routing in high complexity environments. (relevant output: advanced separation services)
- **Solution PJ.18-06:** Performance-Based Trajectory Prediction (relevant output: advanced TP to feed separation services)

OI Steps and Operational Enablers under the scope of the Solution

The solution PJ.10-02a1 addresses the following OI Steps at V3 level: CM-0211[4], CM-0206, CM-0208-A, CM-0209 and CM-0210.

The solution PJ.10-02a2 addresses the following OI Steps at V2 level: CM-0209-b and CM-0210-b.

CM-0209 and CM-0210 have been split. The differences are:

- CM-0209 and CM-0210 focus on ground-based enhanced trajectory prediction possibly enriched with some aircraft data like Mode S, and target a V3 maturity at the end of Wave 1. They are addressed by PJ.10-02a1.
- CM-0209-b and CM-0210-b focus on ADS-C aircraft data integration in predicted trajectories, and target a V2 maturity at the end of Wave 1. They are addressed by PJ.10-02a2.

[4] OI CM-0211 comes from CM-0205 (SESAR 1 OI) which has been split at the end of SESAR1 to reflect maturity and scope discrepancy. CM-0205 has reached V3 and SESAR2020 does not address it. CM-0211 has reached V2 and PJ.10-02a does address it in Wave 1 to reach V3.

SESAR Solution ID	SESAR Solution Title	OI Steps ID ref. (coming from EATMA V13.0)	OI Steps Title (coming from EATMA V13.0)	OI Step Coverage
PJ.10-02a1	Improved Performance in the Provision of Separation	CM-0211	Advanced Support for Conflict Detection and Resolution for ATC planning in En-Route	**Fully**
PJ.10-02a1	Improved Performance in the Provision of Separation	CM-0206	Conflict Detection and Resolution in the TMA using trajectory data	**Fully**
PJ.10-02a1	Improved Performance in the Provision of Separation	CM-0208-A	Automated Ground Based Flight Conformance Monitoring in the TMA	**Fully**
PJ.10-02a1	Improved Performance in the Provision of Separation	CM-0209	Conflict Detection and Resolution in En-Route using enhanced ground predicted trajectory in Predefined and User Preferred Routes environments	**Fully**
PJ.10-02a1	Improved Performance in the Provision of Separation	CM-0210	Ground Based Flight Conformance Monitoring in En-Route using enhanced ground predicted trajectory	**Fully**

Table 3: SESAR Solution PJ.10-02a1 Scope and related OI steps

SESAR Solution ID	SESAR Solution Title	OI Steps ID ref. (coming from EATMA V13.0)	OI Steps Title (coming from EATMA V13.0)	OI Step Coverage
PJ.10-02a2	Improved Performance in the Provision of Separation	CM-0209-b	Conflict Detection and Resolution in En-Route using aircraft data in Predefined and User Preferred Routes environments	**Partial** The use of EPP data cannot be fully covered (V3 level) in PJ.10-02a
PJ.10-02a2	Improved Performance in	CM-0210-b	Ground Based Flight Conformance Monitoring in En-Route using aircraft Data	**Partial** The use of EPP data cannot be

	the Provision of Separation			fully covered (V3 level) in PJ.10-02a

Table 4: SESAR Solution PJ.10-02a2 Scope and related OI steps

High Level CONOPS Requirement ID	High Level CONOPS Requirement	Reference to relevant CONOPS Sections e.g. Operational Scenario applicable to the SESAR Solution
P10-TLOR-01	Enhanced Separation Management in En-Route and TMA shall manage separation in a safe, orderly and expeditious way through sensible combinations of : • Improved performance of enhanced ATC assistance tools; • New functionalities for detection, resolution and coordination tasks; • Shared information provision between all concerned stakeholders; • New separation tools for ATC assistance and Automated support; • More efficient sector team organizations and responsibilities; • Flight-centred ATC in En-Route environment; • Delegation of separation responsibility to the airborne domain in specific operational situations/environment. while: • respecting the associated Safety and performance objectives of capacity, productivity, cost efficiency; • Achieving more efficient flight profiles; • Minimising ATFCM constraints. **Perimeter - Operational scope** • Outbound from single or multiple airports ; from single or multiple sectors (TMA, ACC) ; from individual runway(s) • Delivery to single or multiple sectors (TMA, ACC) ; to single or multiple airports ; to individual runway(s) • Mixed Mode Traffic • Scheduled Air Transport	Section §5.11.1 “Top Requirements PJ10”

	• Free-Route Airspace • General Aviation and rotorcraft • RPAS **Environmental contexts** • Low to High Density/Complexity Airspace • TMA • Extended TMA • En-Route	
S10-02A-HLOR-01	Improved conflict detection and resolution tools with more accurate trajectory prediction and aircraft derived data shall enhance the performance in the provision of separation by : • supporting ATC decision making during execution of the flight; • providing ATCOs with increased opportunity to optimise the execution of trajectories (thanks to longer look-ahead time, integration of both flow management and Trajectory Management options, including across ATSUs/ borders).	Section §5.11.2 "High level Requirements PJ10"

Table 5: Link to CONOPS

SESAR Solutions PJ.10-02a1 & PJ.10-02a2 focus on the following enablers that have not yet completed V3:

Enabler Id	Enabler Title	Requiring OI	Solution
APP ATC 155	ATC System Support to Medium-Term Conflict Detection and Resolution in the TMA	CM-0206	PJ.10-02a1
APP ATC 168	ATC System Support for Advanced Conformance Monitoring in the TMA	CM-0208-A	PJ.10-02a1
ER APP ATC 100	4D Trajectory Management in Step 1 - Synchronization of Air and Ground Trajectories	CM-0209 CM-0209-b CM-0210 CM-0210-b	PJ.10-02a1 and PJ.10-02a2
ER APP ATC 104	Adapt Controller Conflict Detection and Resolution Tools to Use Enhanced Trajectory Prediction	CM-0206 CM-0209	PJ.10-02a1
ER APP ATC 104b	Adapt Controller Conflict Detection and Resolution Tools to Use Enhanced Trajectory Prediction	CM-0209-b CM-0210-b	PJ.10-02a2

ER APP ATC 104c	Adapt Controller Conformance Monitoring Tools to Use Enhanced Ground-Based Trajectory Prediction	CM-0210 CM-0208-A	PJ.10-02a1
ER APP ATC 104d	Adapt Controller Conformance Monitoring Tools to Use Enhanced Trajectory Prediction	CM-0210-b CM-0208-A	PJ.10-02a1
ER APP ATC 149a	Air-Ground Datalink Exchange to Support i4D - Extended Projected Profile (EPP)	CM-0209-b CM-0210-b	PJ.10-02a2
PRO-046b	ATC Procedures for Using Advanced System Assistance to Medium Term Conflict Detection and Resolution	CM-0211	PJ.10-02a1

SESAR Solution PJ.10-02a1 makes use of supplementary enablers that EATMA V13.0 does not link to it yet:

Enabler Id	Enabler Title	Requiring OI
ER ATC 157b	Enhanced ATC System Support to the Planning Activity for Conflict Detection & Resolution in En-Route	CM-0211

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

SESAR Solution PJ.10-02a, as defined in the PMP contextual note [5], deviates from the applicable version of EATMA [2]:

- It does not cover RNP aspects
- The list of enablers that actually support Solution PJ.10-02a1 (refer previous section) differs from the one in EATMA. Namely the following enablers are not used by the solution:

Enabler Id	Enabler Title	Requiring OI
ER APP ATC 160	ATC to ATC Flight Data Exchange Using The Flight Object	CM-0209 CM-0210

- It has been split into two sub-Solutions (PJ.10-02a1 & PJ.10-02a2) to address the issue that the use of EPP data will reach V2 maturity only at end of Wave 1. In general, the level of maturity (per service/data to be used) that will be completed at end of Wave 1 is as follows:

	Maturity at end of Wave1

Data & services to be used by PJ.10-02a1 and PJ.10-02a2 exercises in Wave1			Trajectory	CMON
Aircraft Derived Data	Aircraft position reporting data	Mode-S “Ground speed”	V3	
		Mode-S “Rate of Climb/Descend”	V3	
		Mode-S “Track Angle rate”	Not addressed	
		Mode-S “True Track Angle”	Not addressed	
		Mode-S “Roll Angle”	Not addressed	
		Mode-S “Air speed (IAS)”	V3	V3
		Mode-S “Magnetic Heading”	V3	V3
		Mode-S “Selected Altitude”		V3
		Mode-S “Vertical rate”		V3
		Mode-S “Call-sign”		V3
		ADS-B data	Not addressed	
	Aircraft predictive data	ADS-C reports (including EPP data)	V2 (addressed by PJ.10-02a2)	
Enhanced Ground services	Other data from ground sources		Not addressed	

Table 6: Data & services to be used by PJ.10-02a1 and PJ.10-02a2 exercises

Those deviations are to be taken into account via following in-progress Change Requests:

- CR 03662 : Update ER APP ATC 104
- CR 03664 : Update ER APP ATC 104b
- CR 03667 : Update ER APP ATC 104c
- CR 03668 : Update ER APP ATC 104d
- CR 03684 : Update CM-0206
- CR 03686 : Update CM-0209
- CR 03687 : Update CM-0210
- CR 03688 : Update CM-0211
- CR 03689 : Update CM-0209-b
- CR 03690 : Update CM-0210-b
- CR 03696 : Update solution PJ.10.02a1

3.2 Detailed Operational Environment

This section is a vehicle for the detailed description of the environment, assumptions, etc. that are applicable to the Operational, SPR and INTEROP requirements.

3.2.1 Operational Characteristics

This section describes the operational characteristics that support both SESAR Solutions PJ.10-02a1 and PJ.10-02a2.

It provides all relevant information related to the operational environment, with principles, limitations and assumptions.

3.2.1.1 Airspace Characteristics

During the timeframe of SESAR2020 the future European airspace organisation will initially be based on current ICAO ATS airspace classifications, regulations and applicable rules, including Visual Flight Rules (VFR) and Instrument Flight Rules (IFR).

Classifications and rules will be adopted consistently by all states, thus ensuring uniformity of their application and a simplification of airspace organization throughout the whole ECAC region.

This will provide a progress towards an airspace continuum where the only distinction is between two airspace classes (i.e. Managed and Unmanaged Airspace).

Airspace use will be optimised through dynamic demand and capacity management, queue management, flexible military airspace structures, free, direct and fixed routing and a reduced number of airspace categories. The objective is to have an airspace organisation that:

- Is as transparent and simple as possible with regard to user perception;
- Permits unambiguous rules for ATS service provision;
- Allows simple documentation of the requirements for aspects such as flight planning, airspace reservations, communication actions and minimum equipage.

A general description of the airspace characteristics is provided by the European Route Network Improvement Plan (ERNIP), Part 1 (refer [50]).

3.2.1.1.1 Airspace Structure

The airspace considered by the current document is a managed airspace, where a separation service is provided by ATM services providers.

In such airspace, the role of the separator may in some cases be delegated to the pilot. However, this capability is out of the document's scope.

The vertical scope considered by both SESAR Solutions PJ.10-02a1 and PJ.10-02a2 extends from FL0 to FL660 wherever traffic is controlled except airspace dedicated to final approach and aerodrome vicinity.

The airspace is RVSM, extending from FL290 to FL410.

Currently the airspace is divided into separate areas of responsibility (Sectors). The sectors may be grouped together when traffic and operational complexity are low enough and they will be de-grouped when traffic increases. This is operated by the Operational Supervisor based on specific operational criteria.

A further phase of the SESAR Solution PJ.10-02a2 will need to take into account more dynamic airspace structure, based on moving areas and flight centric concepts, as studied by SESAR Solutions PJ.08-02 and PJ.10-01b.

3.2.1.2 Airspace Configuration

3.2.1.2.1 Route Configuration/Network

In Predefined Routes airspace, advanced RNP will be in place according to AOM-0404 “Optimised Route Network using Advanced RNP” (release 5).

Generally, the route network is supposed to meet the “High Level Network Operational Framework 2019” EUROCONTROL document [46].

More and more ATS routes of the ARN will become conditional, as a function of airspace configurations.

The route network will evolve to fewer pre-defined routes with the exploitation of advanced navigation capabilities.

The introduction of Functional Airspace Blocks (FABs) has the potential to reduce many of the geographical constraints existing between internal FIR boundaries within the participating states. The collaborations established within each FAB, including the measures coming from Flexible Use of Airspace initiatives and the move towards more dynamic airspace reservation should be effective in establishing better airspace design across frontiers, with improved Letters of Agreement (LoA).

This is expected to open up increased opportunities for more optimised routings. One of the operational improvements will be increased possibilities for direct and free routing with reduced State and FIR boundary related constraints. The local ATSU level toolset for separation management will work with these free routings, during the execution phase, dealing with flights which traverse directly across large regions of FAB airspace. When changes are needed they will take advantage from the increased cross border flexibility and reduced boundary constraints within the FABs.

3.2.1.2.2 Free-Routing Airspace

The Free-Routing airspace (FRA) is addressed by SESAR Solutions PJ.06-01.and PJ06-02

The Free-Routing Airspace is a managed airspace, where aircraft separation is provided via an ATSU control service, and which allows airspace users to plan their preferred business trajectories without the need to adhere to the predefined published routes.

It may extend laterally to the outer limits of a FIR or a FAB. At the PCP timeframe (end of 2021), the European airspace environment is expected to consist of a mix of common cross-border FRAs where AUs have the ability to plan for Directs across the FIR borders and adjacent local FRAs at State/ATSU level with supplementary cross-borders En-Route Directs available for flight planning. So that possibly a FRA area can be designed over one or several FIRs even though not extending to a whole FAB.

It addresses all flight levels above a defined level floor. PCP imposes a maximum floor, stating that at and above FL310, all the airspace shall be Free-Routing airspace, but it also offers the possibility for local lower floors if compatible with traffic flows and ATC/ATM operations. In any case, the leading idea should be to define this floor as low as possible to provide maximum freedom to airspace users, yet sufficiently high to reduce the number of vertically evolving flights and be able to maintain safety and capacity in the airspace.

The Free Routing Airspace is published in national AIS together with its entry and exit points, and intermediate points inside FRA. Arrival and Departure connecting points need also to be published for flights vertically evolving to/from FRA. These allow airspace users to plan:

- Either an ATS route that fits with the route network, if the ARN is maintained in FRA, which is not mandatory;
- Or any sequence of DCT segments (e.g. portions of ATS routes, DCT between published points, or geographical points if allowed in the airspace) between the published points of the Free Routing Airspace. Entry/Exit points are defined along Free-Routing Airspace boundaries, and some arrival/departure points are defined additionally into the Free-Routing Airspace, allowing aircraft to enter or to leave the Free-Routing Airspace vertically.

The segregated airspace within the Free-Route airspace and their activity are published to allow airspace users to plan their circumnavigation where and when needed.

3.2.1.3 Traffic Characteristics

Traffic characteristics will vary by airspace type:

- Upper airspace e.g. above FL285: mainly levelled flights and some descending/climbing aircraft;
- Lower airspace e.g. under FL285: A mix of levelled and descending/climbing aircraft depending on the sector. A higher proportion of aircraft that take off from - or arrive to - airports within the area of interest.

In 2025, the forecast is for 12.7 million IFR flight movements (+0.9 million, -2.1 million) in Europe, which is an average annual growth rate of 2% and 15% more IFR movements than in 2018 ([47]).

3.2.1.3.1 Mode of Separation

This section puts both Solutions PJ.10-02a1 and PJ.10-02a2separation modes in the context of the SESAR separation modes as defined by the SESAR CONOPS [4]. It positions these separation modes to the operational environment related to airspace complexity. PJ.10-02a1 and PJ.10-02a2 modes have to be tailored to the local environment and performance needs. All modes can be used but individual configuration parameters (e.g. conflict look ahead horizon) should be set according to sector, airspace, and traffic characteristics.

3.2.1.3.2 Separation Minima

Separation minima are expected to continue to be based on guidance, regulations, and factors used in today's environment (ICAO Doc 4444 Procedures for Air Traffic Management [40], especially Chapter 5):

- Vertical separation: FL< FL410 → 1000ft separation (RVSM);
- Horizontal separation: different separation minima apply in different airspace, depending on the kind of airspace (very often it is 5NM in En-Route airspace and 3NM in TMA airspace) and on the airspace itself (e.g. in Warsaw FIR, the separation minima are currently 7NM in En-Route and 5NM or 3NM in TMA)

The separation standard may not be constant throughout the En-Route sectors. Different separation standards might be required e.g.:

- A non-RVSM flight that is authorized to fly within an RVSM airspace remains subject to separation standard that is applicable above the RVSM limit (i.e. in a non-RVSM airspace);
- At the edges of multi-sensor cover or in the case of a reduction in surveillance sensor service where the separation minimum may be increased up to 10 NM;

- The sectors that interface the lower En-Route sectors may be operating a lower separation standard (procedures ensure that the separation is established prior to transfer of control in this case).

Therefore the choice of separation standard is made on a case-by-case basis depending on both the pair of elements to assess and the airspace where the separation is assessed, and it may not be homogeneous throughout the whole controlled sector. Conflicting aircraft may be in airspace volumes with different separation minima.

3.2.1.3.3 Traffic Specificities in Free Routing Airspace

GAT flights entering and exiting Free Routing Airspace will normally do so via the fixed route network. Flights traversing boundaries between ACCs will continue to be subject to rules, procedures and Letters of Agreement.

Where required, local procedures may allow GAT flights to flight plan climb/descent entry and/or exit at random points. OAT flights entering and exiting Free Routing Airspace are not confined to fixed entry and exit points. They may be subject to rules, procedures and agreements for the purpose.

Free Routing Airspace is expected to have a significant impact on the location, dispersion and predictability of potential conflicts.

Indeed, conflict detection and separation in the Free Routing Airspace is characterised with a distribution of the conflicts over the entire volume of the Free Routing Airspace thus achieving a better spread of the conflicts as opposed to concentration of the conflicts over certain fixed route crossing points (also known as 'hotspots'). Even though temporarily some flows could appear because each aircraft is going to face the same flying conditions (e.g. front wind, turbulences, military zones, etc.), and therefore most aircraft are going to plan a similar 2D route, those flows are not going to match ATCOs' routine mental schemes. Because of that characteristic the Free Routing Airspace operations need to be supported by improved trajectory predictability and enhanced conflict detection and management tools.

This is both PJ.10-02a1 and PJ.10-02a2role to consider the SESAR solutions PJ.06-01 and PJ.06-02 in order to meet their requirements relative to separation management.

3.2.2 Roles and Responsibilities

SESAR 2020 operational environment, advanced tools and operating methods impact the task allocation between controllers (Extended ATC Planner, MSP, PC and TC), thus team structure and communication are also affected.

New sector team arrangements will be used, with new procedures and responsibilities, supported by increasingly sophisticated tools. As well as the traditional Planner-Tactical (1P-1T) two-person ATC sector team, sectors will operate with a combined role of Single Person Operations (SPO) or with the distinct role of Multi-Sector Planner (MSP) where the Planning Controller is responsible for the airspace that is under the executive control of two or more independent Executive controllers (1P-nT).

The applicable roles and responsibilities description are available in EATMA.

The current section is describing who is involved in the provision of separation (as available in EATMA) and what the responsibilities of the various actors are.

It identifies the changes that the two Solutions PJ.10-02a1 and PJ.10-02a2 propose with respect to the applicable EATMA reference.

It provides with the human factor aspects essential for the safe and coherent operation of the Operational Service, particularly in reference to partial implementations, mixed equipage, etc.

3.2.2.1 ATC Sector Executive Controller

The ATC Executive Controller (or Tactical Controller – TC) has responsibility for traffic management within the sector/AoR and for the tactical tasks.

The EC is responsible for the safe and efficient flow of all flights operating within its area of responsibility. Its principal tasks are, in compliance with the ICAO Rules of the Air, with other relevant ICAO (e.g. Doc. 4444) and with European/National provisions, to separate known flights operating within its area of responsibility. Parts of her/his tasks are to issue instructions to pilots for conflict resolution and segregated airspace circumnavigation.

Additionally, the EC monitors the trajectory (4D and 3D) of aircraft, according to the clearance they have received.

The responsibilities of the ATC Sector Executive role are focused on the traffic situation, as displayed at the Controller Working Position (CWP), and are very much related to task sharing arrangements within the sector team.

In case the sector operates with no dedicated Planning Controller (i.e. multiple SPOs CWP with a single MSP) or the Flight Centric operations are in place, the ATC Sector Executive Controller may be in charge of some Coordination tasks with specific needs linked to separation. Such new responsibilities are defined by the PJ.10-01a, PJ.10-01b and PJ.10-01c solutions and are needed before to propose separation aid suited to these new responsibilities.

Neither Solution PJ.10-02a1, nor Solution PJ.10-02a2, change the current responsibilities of the ATC Sector Executive role. It permits to enhance the aid for separation task, leaving more room for the other control tasks.

3.2.2.1.1 Responsibilities

Among ATC Sector Executive Controller main responsibilities expressed in EATMA, those that are relative to separation and Monitoring are:

- Identify conflict risks between aircraft
- Provide separation between controlled flights
- Monitor flights regarding adherence to flight plan/RBT
- Monitor the air situation picture
- Communicate with pilots by means of R/T or data link
- Monitor information on airspace status, e.g. activation/ deactivation of segregated/reserved airspace
- Monitor the weather situation
- Re-route flights to avoid adverse weather areas

- Monitor aircraft equipment status according to information provided by the system
- Coordinate with the Planning Controller about planned conflict[5] solution strategies based on system derived solution proposals
- Coordinate the implementation of possibly system derived conflict solutions with the Planning Controller
- Apply appropriate separation to all controlled flights departing his/her area of jurisdiction
- Transfer control of aircraft to the appropriate Executive controller when clear of traffic within his/her area of jurisdiction

Depending on the sector team organization, or where Collaborative Control or Flight Centric ATC operate, the following responsibilities currently assumed by the Planning Controller may partly move to the Executive controller.

- Co-ordinate entry and exit conditions.
- Resolve boundary problems by re-coordination

3.2.2.1.2 Changes

As explained before, neither PJ.10-02a1 Solution not PJ.10-02a2 Solution change the responsibilities of the Executive controller.

3.2.2.2 ATC Sector Planning Controller

The ATC Sector Planning Controller is mainly responsible for planning and coordination of the traffic entering, exiting or existing within the ATC Sector.

Furthermore, it provides tactical flight control assistance to the ATC Sector Executive role.

There is no change in the current responsibilities of the ATC Sector Planning role. It permits to enhance the aid for separation task, leaving more room for the other control tasks.

3.2.2.2.1 Responsibilities

Among ATC Sector Planning Controller main responsibilities expressed in EATMA, those that are relative to separation and Monitoring are:

- Co-ordinate entry and exit conditions.
- Resolve sector boundary-related issues by performing additional coordination
- Provide early conflict detection and resolution (depending on the Conflict Detection and Resolution tools horizon) if this early resolution brings operational benefit (either on the ground side or the airborne side)

[5] A “planned conflict” is a conflict in the planning time horizon

- Check flight-plans/iRBT/iRMTs for possible conflicts and complexity issues within its area of responsibility.
- Plan conflict-free flight path through its area of responsibility.
- Coordinate with the ATC Sector Executive role about planned conflict solution strategies, possibly formulated using what-else and what-if probes provided by the system
- Implement solution strategies by communicating trajectory changes to the aircraft through the concerned ATC Sector Executive role via Data Link.

3.2.2.2.2 Changes

As explained before, neither PJ.10-02a1 Solution nor PJ.10-02a2 Solution change the listed responsibilities of the Planning Controller, but it may impact their relative apportionment.

For example, due to a better prediction of the encounters, the Planning Controller will be more often in position to implement planned conflict solution strategies.

3.2.2.3 Other Roles

Other roles exist, which tasks may be impacted by SESAR 2020 operational environment, advanced tools and operating methods.

Some contributions could have been expected from SESAR2020 Solutions addressing High Productivity Controller Team Operations (PJ.10-01a), Flight Centric roles (PJ.10-01b) or Collaborative Control (PJ.10-01c)

But currently, no particular needs have been relayed by those solutions to solution PJ.10-02a, prior to the delivery of the current document.

3.2.2.3.1 Multi Sector Planner

The Multi-Sector Planning role is responsible for a multi-sector area (MSA) comprising of two or more of the present control sectors. Depending on the ATSU environment and operational working methods the Multi-sector Planning:

- is operationally positioned between Complexity Management and the ATC Sector Planning;
- may perform tasks related to workload distribution and sectorisation management, and also the task related to the ATC Sector Planning.

3.2.2.3.2 Extended ATC Planner (EAP)

The Extended ATC Planner role is one possible implementation of the Multi Sector Planner role. The EAP is operationally positioned between Complexity Management and the ATC Sector Planning. The EAP performs long-term to medium-term conflict detection in order to propose solutions that help to decrease the traffic complexity. These solutions are proposed to sectors team for implementation.

3.2.2.3.3 Single Person Operation (SPO)

The sector team changes from traditional 1 Tactical and 1 Planning Controller to 1 Controller (Single person operations). The role of the controller changes as the tactical and planning tasks are integrated into one role.

3.2.3 Technical Characteristics

This section describes the fundamental technical characteristics that are part of the context.

3.2.3.1 Aircraft Capabilities

The aircraft capabilities will remain heterogeneous in the target environment.

As a minimum they will comply with existing capabilities and standards as described in the Minimum Aviation System Performance Specification (MASPS) [43].

It is assumed that the highest level of aircraft capabilities available in the scope of the current document can be summarized as follows:

- **Data link**:
  - CPDLC and ADS-C for ATC via ACARS (oceanic flights) and via ATN (continental flight) ED 110B/120 for continental ATN B1, and ED 228A [51] / 229A [52] for continental Europe ATN B2);
  - FIS: ATIS with ATC via ACARS;
  - MET data (winds/temperatures, TEMSI, etc.) with AOC via ACARS.
- **Navigation** (figures currently being assessed by WG85):
  - 2D RNP1 in En-Route and 2D RNP0.3 in approach (2D RNP means lateral containment i.e. not only a required accuracy but also a required integrity and continuity, e.g. the aircraft will remain within +/-1nm 95% of the time and within +/-2nm 99,99% (10^{-7}) of the time for RNP1);
  - Concerning the vertical dimension, the following is required in [43] section 7 "RVSM performance" JAR 25.1325(e): "*Each system must be designed and installed so that the error in indicated pressure altitude, at sea-level, with a standard atmosphere, excluding instrument calibration error, does not result in an error of more than ± 30 ft per 100 knots speed for the appropriate configuration in the speed range between 1.3 VS0 with wing-flaps extended and 1.8 VS1 with wing-flaps retracted. However, the error need not be less than ± 30 ft*";
- **Surveillance**:
  - ADS-B in/out via Mode-S 1090 transponder and ATSAW applications;
  - TAWS;
  - ACAS for the safety net.

The focus here is mainly on Commercial aircraft (legacy, low fare, regional) and on Business aircraft[6].

[6] Mainline and BGA equipage level can be very different

There is generally less capability for GA-VLJ-Helicopter and Military aircraft however they have at least minimum equipage for airspace class they use.

3.2.3.2 Air-Ground Communication

A great deal of work related to Air-Ground Communications is achieved within the WG78 and WG85 for EUROCAE and SC214 for RTCA which are conjointly in charge of the standards for advanced ATS supported by data communication.

The operational needs expressed by SESAR, NEXTGEN and ICAO OPLINK panel have been considered, in particular the following new air-ground data exchanges required to support initial 4D operations:

- **CPDLC** message as voice alternative if not time critical;
- **ADS-C** Extended Projected Profile (EPP) to support the automatic downlink of trajectory data (1 to 128 published and/or computed waypoints with associated constraints and/or estimates in the 4 dimensions, etc.). EPP data are needed to get the predicted aircraft's behaviour from aircraft's point of view, which enable the enhancement of separation services. ADS-C data are downlinked according to the contract that is negotiated between Ground and Air parties. Three types of contract exist for ADS-C EPP report: "on event, on demand & periodic". The “on event” form of contract is used to allow the on-board predicted trajectory to be downlinked when it has changed by a specified threshold from the previously downlinked version;
- **Mode-S** Enhanced Surveillance (EHS) permits to receive downlinked airborne parameters (DAPs) into the ground surveillance system. EHS is mandated in Europe for most airline aircraft. Local wind speed and direction for instance, may be very valuable data that EHS can provide.

3.2.3.2.1 Voice services

While the ATM Target Concept is oriented toward data exchanges between aircraft and ATM ground systems, voice will remain an essential means of communication. It will be used for separation notably for time critical clearances and especially in high density environments.

Voice services are expected to continue to be based on the premise of one channel per controller/sector. SESAR Solution PJ.10-01b is expected to detail how this premise is impacted by the Flight-Centric concept.

In a long term, when Air-Ground datalink is in place and largely used, voice will remain the primary means of communications only in certain circumstances. The role of voice communications will essentially be a safety back-up means of communication; however voice will remain an essential means for pilots to get information and to obtain confirmation of the ATC instructions, namely when complex instructions or transmissions of long and complex non-routine messages are needed.

In the near term, air traffic control operations and aeronautical operations control (AOC) will continue to use the allocated VHF spectrum (118-137 MHz) for voice communications.

The voice service for 2020 will be complemented by SATCOM for oceanic and remote areas.

Future digital voice applications are studied by SESAR Project PJ14.

3.2.3.2.2 Data services

Data exchange will progressively be introduced for routine communications.

In the near term, the point-to-point air/ground data service link in Europe is based on ATN/VDL Mode 2 technology.

This initial step will need to be enhanced and/or complemented to support the full deployment of the ATM Target Concept. It is important to highlight that higher performance (e.g. predictability, security, latency, availability, integrity and throughput) data-links will be required to support advanced services, such as the 4D contract, trajectory exchanges, as well as the increasing air-traffic volumes and density.

To meet the long-term data communication needs, a dual link system is likely to be necessary to cope with the higher availability requirements.

New terrestrial mobile communication technology systems and satellite technologies can provide the advantage to offer complementarities in terms of infrastructure and radio spectrum diversity, and coverage.

3.2.3.3 Ground-Ground communications

The Ground-ground communications are used wherever the local system hosting the separation services needs to communicate with an external ground-based actor (system or human).

3.2.3.3.1 Voice services

While the ATM Target Concept is oriented toward data exchanges with ATM ground systems, voice will remain an essential means of communication between ATCOs whenever coordination is needed that cannot completely rely on automation, or whenever time critical decisions require a rapid coordination.

For inter-sector coordination between sectors from two ATM centres not equipped with the same ATM system (where system coordination is not available yet), the phone remains the major means for communication.

3.2.3.3.2 Data services

The system hosting the separation services is interfaced with many other ground ATM systems. Technically speaking, there are several means to exchange data between ground-based systems; it mainly depends on the nature of this data and on the capabilities of each ATM system. The following ones concern the exchange of flight data:

AFTN: the Aeronautical Fixed Telecommunications Network is a world-wide telecommunication network using low-speed telex type links and specific International Civil Aviation Organisation (ICAO) protocols. AFTN is namely used for the ATSU's to communicate with the CFMU (IFPS and ETFMS).

OLDI: On-Line Data Interchange is used for the exchange of messages relating to inter-ATSU's co-ordination. OLDI is currently the main means of communication between ATSU's for notification, co-ordination and transfer purposes.

B2B: The NM B2B Web Services is an interface provided by the EUROCONTROL Network Manager (NM) for system-to-system access to its services and data, allowing NM customers to retrieve and use the NM information in their own systems, according to their business needs.

The NM B2B Web Services are at the core of the NM Interoperability Strategy and follow SESAR and ICAO SWIM principles, being instrumental to achieve real-time information exchange at global level and to implement Collaborative Global ATFM.

IOP: IOP implements ground-ground flight data exchange between ATC units through the use of Flight Object services as defined by the Flight Object in EUROCAE ED133. The main goal of IOP is to improve

consistency of Flight Data available to stakeholder systems, thereby improving operational efficiency and safety. When IOP is completely in force, it is expected that the following stakeholders will benefit from IOP:

- Aircraft Operators: improved capacity will bring reduced delays and shorter routes,
- Airports: better information about incoming flights permits better use of airside and landside resources,
- Air Defence: more consistent and up-to-date information on aircraft intentions,
- ATC and ATFM: better information on current and future flights permits better planning of resources,
- Supplier Industry: standards based on modern technology permits cost reductions and lower risk.

It has to be noted here that IOP data services are not part of the targeted operational environment.

3.2.4 Applicable standards and regulations

Regulations

There is no specific topic in the field of the regulatory framework to be considered within the SESAR Solution PJ.10-02a, beyond the applicable regulations currently existing.

Standards

For the improvements that take benefits from ADS-C reports, it is critical that ADS-C standards and/or the use of ADS-C reports by the Ground systems are mandated in order to rapidly increase the equipage rate. There is no other specific topic in the field of the standardization framework to be considered within the SESAR Solution PJ.10-02a, beyond the applicable standards currently existing

3.3 Detailed Operating Method

3.3.1 Previous Operating Method

The previous operating methods here described correspond to the baseline considered by the solution PJ.10-02a. It does not correspond to the current operational situation. In particular, some items of the baseline have not necessarily been deployed everywhere in operation yet, but they are here described as "baseline" because they have been V3-validated in En-Route in SESAR1 (e.g. What-else probes in En-Route).

In order to ensure separation between aircraft, the Sector Team basically uses two means:

- Modify the entry conditions in order to initiate a secure transit of the sector (mainly Planning Controller role);
- Modify the transit of the sector (Executive controller role with PC as an assistant at least for coordinating the exit conditions in accordance with the transit modifications).

Although the current Operating Method is hereafter described as two distinct sections, it has to be noticed that the Controller Team currently works as an entity i.e. there exists a necessary cooperation between both Controllers. At least common situation awareness is required in order to avoid misunderstandings.

3.3.1.1 Planning Separation Assurance Operating Method

Separation assurance at Planning Controller level is a continuous process triggered on a cyclic basis in order to detect and solve encounters between pairs of aircraft and between aircraft and areas within its area of responsibility, at every step of the coordination process (e.g. receipt of an offer, selection of a suitable sector exit level etc.). Depending on the local organization, the PC or the MSP can provide planning separation.

Conflict resolution in planning terms may involve the identification of alternative co-ordination conditions (level, route, profile etc.) at either the entry and/or exit boundaries of the AoR, or whenever deemed necessary for collaborative control.

Planning separation may be based on minimum time differences between flights at a common point, e.g. 5 minutes, or a minimum expected distance at closest approach, e.g. 15 nautical miles, depending on the geometry of the encounter, its geographical position with respect to the sector boundaries and the nature of any agreed separation techniques with neighbouring sectors and/or centres.

Currently a PC makes use of fairly basic co-ordination and flight data inputs (in particular, flight progress strips displaying the predicted position, time and level data) and has some system support based on radar data (e.g. ground-speed extrapolated vector lines).

Some systems do offer an additional level of system support to the identification of potentially conflicting traffic by highlighting the flights which have a common co-ordination level.

Additionally, a FASTI-compatible MTCD may be available to identify whether an offer can be accepted or whether some flight modifications may need to be imposed (which might be a change of entry level or a direct routing agreement etc.).

However, it is left to the PC to judge the likelihood and severity of a given problem and to apply manually the test as to whether planning separation is going to be achieved.

Flights which are, in the PC's judgement, expected to exceed the minimum planning separation requirements are accepted. Those that do not are amended either so that the entry co-ordination is acceptable or, in discussion with the Executive controller who will make a judgement in context with the other flights s/he is, or will be, controlling, accepted and highlighted to the EC to ensure that any mitigating action is not overlooked when the flight calls on frequency.

Once the flight is coordinated at entry of the sector, the PC must identify a suitable exit level for that flight. For overflying aircraft, these two levels will be the same (traffic permitting) but in many cases, there will need to be a change of level as the aircraft transits the airspace, and so some judgement is required in order to determine a suitable target level.

Although the PC may choose not to deal with the exit co-ordination immediately after a flight has been accepted (for example, because several other flights are awaiting entry co-ordination agreement and the PC decides that the backlog should be dealt with as a high priority) there are good reasons for the exit conditions to be set reasonably soon after acceptance.

- Firstly, onward co-ordination cannot occur until an exit level is set (or, in some systems, a default level may be automatically offered on which may then lead to more workload in order to revise the co-ordination);

- Secondly, unless the Executive controller knows that there is a procedural level which can be assumed for the flight (e.g. a standing agreement between sectors), or it is clearly a flight that is not expected to change its level in the sector, it becomes difficult for the EC to develop his plan for managing the sector in the near-term if flights have not had their exit criteria set.

Again, the PC today must use his own judgement (supported by information from the radar and flight data display) to combine the desires and likely performance of the flight with the expected behaviour of the other flights in and around the sector to determine the nature of the future tactical task (particularly the likely complexity of the traffic and, hence, the potential workload being built up as a result of the PC's decisions) when determining what a suitable target exit level should be for the flight.

Having identified a potential level, and ensured that it is safe around the exit boundary (i.e. there are no conflicting co-ordinations that would render it untenable for the Executive controller to issue a clearance to) the PC assigns the level to the system or contacts the receiving sector's PC to coordinate a flight level with him.

Trajectory efficiency

Trajectory revisions during the execution phase to expedite traffic (in the frame of Air Traffic Control service) will still be part of ATC planning role tasks, but will be much scarcer. Indeed, the RBT defined in planning phase represents the best compromise between known ATM constraints, aircraft performance and flight/company business needs. Therefore, this RBT must be facilitated as far as possible. However, in some specific situations, like the cancellation of an ATM constraint (e.g. early deactivation of an ARES) expedite traffic on ATCO's initiative will still be possible.

Before any trajectory revision, ATCOs need to check that it does not degrade traffic separation below the separation minima. What-if probe capability is available to support such a task.

3.3.1.2 Tactical Separation Assurance Operating Method

Tactical Separation Assurance is a continuous process that describes how the operator (mostly the Executive controller, and sometimes the Planning Controller) detects and solves potential trajectory profile problems between aircraft and between aircraft and restricted airspace that are within its Area of Responsibility (AoR) or even within others' AoR when collaborative control operating procedures apply (PJ.10-01c). The goal is to address any remaining encounters highlighted by the Planning Controller, or any tactical conflict resulting from an aircraft altitude change or a horizontal update of the trajectory, and achieve the overall trajectory profile targets set by him/her.

Conflict resolution in tactical terms may involve the identification of different resolution strategies, e.g. by modifying the trajectory laterally, vertically or in terms of speed adjustments.

Detection of Conflicts

The Executive controller (EC) detects a potential conflict in his sector during the continuous traffic scanning process or when checking special aircraft pairs or special routes where potential conflicts can occur (the controller is aware of this because of his experience and his knowledge about this sector).

It has to be stressed out that a differentiation can be made for the different types of En-Route environment and associated scans. For example, the fixed route environment allows the EC to perform a structured scan at the sector hotspots, at sector boundaries, crossing points etc. while in the free route environment the scan is performed normally along the flight trajectories.

Another possibility is that the PC has already marked aircraft pairs which might have a conflict.

In most current ATC systems, the EC is supported by Range and Bearing functionalities and by a "Minimum Separation" function that allows extrapolating the closest point of approach under the assumptions that the involved aircraft maintain current ground speed and heading.

As both Solutions PJ.10-02a1 and PJ.10-02a2 are built upon SESAR1 solution #27, it is assumed that the EC is supported by a TCT service operated in combination with a CMON service.

Due to complex traffic situations, unpredicted wind or aircraft speed changes, late implementation of controller clearances by the pilot, unknown or unexpected vertical profiles, technical failures and other reasons, the TCT detects a potential conflict in the sector around 6 minutes in advance, i.e. before loss of separation. This detection of possible separation infringements is continuously performed. The look-ahead time and tactical separation of interest values should be variable due to sector size and complexity. The conflict detection will also be performed if an aircraft deviates from its original clearance. In this case, different parameters may be used for trajectory prediction. The CMON function provides the required inputs related to these deviations.

The potential conflict is shown at least in the sector where one of the involved aircraft is under control. Alternatively other display and filter algorithms may be possible, e.g. to show the conflict in the upstream sectors which currently control these flights.

If there are more than two aircraft involved, the alarm will always be shown per aircraft pair.

Once the conflict has become known to ATCOs, then the conflict analysis process can start. It is a mental process including the determination of the trajectories of the conflicting aircraft, and the estimation of the minimum distance extrapolated according their relative geometries.

Planning of Solutions

The EC is responsible for the implementation of conflicts solutions in his own sector (both PC and EC may co-build these solutions). So s/he starts now planning the solution of this problem. At this point the EC can use his own "mental solution library" as well as looking for novel solutions.

Usually there is more than a single option to solve a conflict and the ATCOs assess which are the options available for that conflict. Quite often some of the most commonly used options will be made impossible by other traffic and due to unavailability of certain airspace portions. Often coordination need to be carried out with controllers from downstream sectors to determine if a particular option is available or not. Then the options that remain available need to be prioritized in accordance with current operational conditions.

Depending on local facilities, the EC may be assisted by CWP tools to analyse the situation, e.g. to forecast the minimum separation distance if both aircraft maintain their current heading and speed.

If multiple solutions are available, then a selection has to take place. The EC will choose the "best" solution for this conflict in the current individual situation. The controller will determine the "best"

solution according to safety considerations, anticipated traffic load, workload, time needed to implement the solution, or other factors which may be specific to the situation.

Normally depending on the circumstances, the “best” solution is the most economical option to the operator (e.g. climb is preferred to descent), but at times when the workload is high or the situation is time critical, the ATCO will prefer an option which is quicker and easier to implement, irrespective of economic factors.

In a complex and busy SESAR environment, the EC may decide to use the What-If or What-Else probing functionality. For the planning of solutions, s/he selects one of the concerned aircraft, either the subject or the context flight.

The selection is generally based on the following priorities:

1. Safety considerations (e.g. aircraft performance envelope, implications of aircraft non-adherence with clearances, misunderstanding or late compliance with clearance);
2. Trajectory management and network considerations: descending aircraft before, cruising aircraft before, climbing aircraft;
3. Complexity or queue management considerations (e.g. workload implications, target time of arrival, I4D-aircraft on CTA / CTO);
4. Efficiency of flight profiles.

With support of the What-else probing (WeP) the EC immediately sees all available flight level i.e. all level that do not cause a conflict within the specified look ahead horizon of the probing tool. This look ahead horizon should be greater than the Conflict Detection look ahead horizon in order to avoid any “new” encounter at the horizon limit when the clearance is actually implemented. Level that require a specific vertical rate for a conflict free trajectory are clearly distinguished from all level that are impossible (i.e. will lead to another conflict).

The EC can also access the WeP-‘Direct’ menu and immediately sees the next En-Route and selected off-route waypoints (trajectory change points) and whether a ‘Direct’ to one of these points will lead to a potential conflict. For example, if an aircraft is subject to CTA and already late (this information may be provided by an advanced AMAN as 'time to gain’) a ‘Direct’ may be the preferred solution strategy in order to gain some time.

The EC can also access the WeP-‘Heading’ menu and immediately sees the conflict free headings with a resolution of e.g. 5° degrees. At the same time, he can also see all headings that cause a potential conflict, together with the call-sign of the encounter aircraft.

The EC can also suppress the display of the conflict (e.g. if the conflict will be solved by another solution strategy or the EC concludes that it may be a false alarm). The conflict detection function shows the conflict with these two aircraft again if the previous conflict has been solved and yet another conflict with the same aircraft pair appears.

Implementation of Solutions

The EC selects the preferred solution either from the available WeP suggestions or from his own judgement.

In general, a closed loop clearance is always preferred to an open loop clearance because an open loop clearance impairs flight predictability and requests the controller to issue the end clearance afterwards

Normally, only one aircraft will receive a clearance in a typical conflict situation with two aircraft. If there are multiple clearances required to provide separation, the EC must carefully examine the most time critical clearance which needs to be given first.

Should exit conditions be affected, the EC advices her/his PC to make a revision with the next sector.

The EC implements the solution by issuing a clearance via R/T or CPDLC to the aircraft and inputs the clearance into the ATC ground system. The pilot acknowledges the reception via R/T or CPDLC and modifies the trajectory accordingly. Except for “open” clearances (clearances with no specified resume on trajectory), the pilot is also expected to revise the trajectory in the FMS. It is worth mentioning that it is not required for the aircraft to be equipped with “autoload capable” FMS, which impedes the ATCOs to issue complex instructions such as resuming navigation on a latitude, longitude point.

Both the EC and the PC monitor that the aircraft will behave as expected. Shortly after the trajectory revision issued by the ATCO (one radar update after implementation of the solution) and on trajectory update the TCT recalculates the overall traffic situation and the conflict alert disappears.

Alternatively, the EC delegates the implementation of a conflict solution to another sector (e.g. if one of the involved aircraft is not yet handed over or if the conflict is close to the sector boundary after entering the own sector). The delegation will be done by the PC on behalf of the TC. In this case, if the operational situation permits, also data link can be used.

The EC is responsible for securing the separation minima for the flights under her/his jurisdiction. The jurisdiction for assuring the separation minima generally remains on an area basis (sector), unless otherwise agreed (e.g. procedure “release upon contact”).

Furthermore the EC shall not handover converging traffic from his sector to the next sector, or in other words a potential conflict has to be resolved by the most upstream sector that is passed by both aircraft.

The PC is responsible for co-ordination with adjacent sectors through modification of the entry and exit conditions, leading to a revision.

Furthermore s/he has to assist the EC in his tasks on request. For assisting the EC on an individual basis it is necessary for him to maintain situational awareness for the traffic that is currently handled by the TC.

Trajectory efficiency

Tactical actions to expedite traffic (in the frame of Air Traffic Control service) will still be part of ATC tactical role tasks, but will be much scarcer. Indeed, the RBT defined in planning phase represents the best compromise between known ATM constraints, aircraft performance and flight/airline business needs. Therefore this RBT must be facilitated as far as possible. However, in some specific situations, like the cancellation of an ATM constraint (e.g. early deactivation of an ARES) or changing weather conditions, expedite traffic on ATCO initiative or flight crew request will still be possible.

Before any trajectory revision, the ATCO needs to check that it does not degrade traffic separation below the separation minima. What-if probe capability is available to support such a task.

3.3.2 New SESAR Operating Method

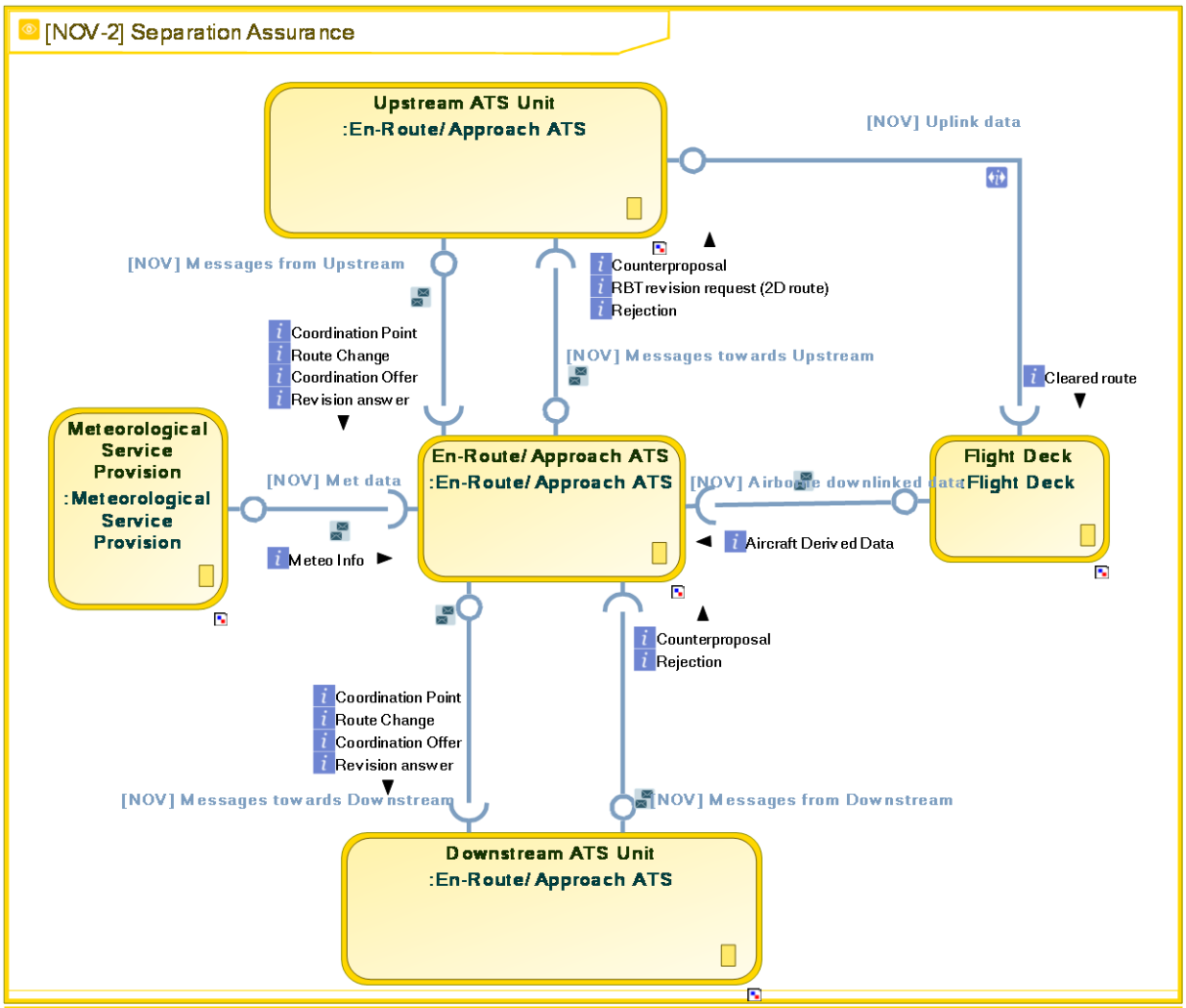
Scope of scenario

Separation provision is an iterative process, applied to the conflict horizon. It consists of:

- the detection of conflict, which is based on the current position of the aircraft involved and their trajectories as predicted by the Ground systems, in relation to known hazards;
- the formulation of a solution, including selection of the separation modes, to maintain separation of aircraft from all known hazards within the appropriate conflict horizon;
- the implementation of the solution by communicating the solution and initiating any required trajectory modification; and
- the monitoring of the execution of the solution to ensure that the hazards are avoided with the appropriate separation minima.

The scenario takes place in the Execution phase: from publication to termination on completion of the flight.

Operational Scenario Description



[NOV-5] Provide Planning Separation Assurance [Downstream ATS Unit, En-Route/Approach ATS, Flight Deck, Meteorological Service Provision, Upstream ATS Unit]
[NOV-5] Provide Tactical Separation Assurance [En-Route/Approach ATS, Flight Deck, Meteorological Service Provision]

Planning Controller actions for Separation Management

Before every flight entry in the sector, controllers are provided with flight information by the FDP system.

Once flight information is provided, and before the pilot is expected to contact the sector, the Planning Controller checks the consistency of available flight plan information for this flight and performs an initial assessment of potential conflicts at planned entry and exit conditions. In order to assist the Executive controller, the Planning Controller may also perform an initial assessment of the potential conflicts during the traversal of the sector and arrange entry/exit conditions to minimize them.

For detection tasks, s/he is supported by potential conflicts displayed on the CD/R aid interface, displaying RBT/RMTs and/or the flight plan routes of conflicting aircraft in its area of Responsibility. Enhanced CD/R aid is fed with trajectories that take into consideration downlinked data and advanced environment data (e.g. specific areas) to improve the prediction algorithm, increasing the reliability of detected encounters (cf UC-SM-05-01)

Considering the input from CD/R aid, and when the ATC sector configuration includes a Planning Controller, the PC may choose between two possibilities according to her/his experience and knowledge:

- Either the input from CD/R aid is not satisfying for any reason and s/he can remove it with no other actions afterward
- Or the input from CD/R aid is relevant and then an action, or at least a close monitoring, is going to be required

In order to determine the best solution for the situation, the PC is going to use all standard ATC tools available to analyse the situation (SEP, probes...). Once this analysis is performed, the PC, according to the situation, and if this is of interest regarding the EC workload, might solve some pending conflicts by implementing a RBT/RMT revision.

The PC often implements such a resolution before the flight is under the sector responsibility, by means of a coordination with the upstream PC. Even if not likely to be that frequent, it may happen that planning CD/R service is out of service or corrupted. In such a case, ATCOs have to be informed as soon as possible and have to perform manually the whole detection task, via standard ATCOs toolset available (SEP, extrapolation, highlights, CPA…etc.) and their own expertise (cf UC-SM-05-02).

Depending on the local working methods, the PC may also perform a resolution when the flight is already under frequency with her/his TC-mate. To do it, the PC may directly uplink CPDLC clearances if supported by specific operational procedures (in this case, in order to advise the TC, it could be necessary to have a visual stimuli so that he could be informed instantaneously of the PC initiative) or, in a more classical way, s/he provides the EC with the clearances to uplink by voice or by datalink (cf UC-SM-01).

PC is supported by CD/R aid resolution advisory functions (including what-if and what-else capabilities), allowing for instance to assess the impacts of the closed-loop clearance to be issued (cf UC-SM-06-01), or to select a more suitable XFL.

When needed and if time permits a CDM process takes place, which may involve Extended ATC Planner and/or LTM, Airspace Users (FOC) and Airport Operations Centres. CDM process aims at finding the optimum way to amend the trajectory whilst maintaining the overall performance of the ATM system.

The Planning Controller, as far as practicable, would refrain from amending the trajectory of flights with an existing CTO or CTA. Nevertheless, if need be, this has to be done in a coordinated way with Extended ATC Planner to find the optimum solution.

When possible, flight efficiency has to be considered and preserved when building the conflict resolution solution, in order to avoid actions that could adversely affect the benefits brought by optimized trajectory based operations (e.g. CDOs).

Once decision is made and coordination is agreed, the Executive controller is automatically advised.

If need be, in addition to the shared conflict detection information display, the Planning Controller may highlight specific remaining conflicts to the Executive controller for sector team communication purpose.

Once the flight has established radio contact with her/his TC-mate, the PC continues to monitor aircraft behaviour and EC clearances.

There is a tacit agreement of flight exiting condition once it has been relayed to downstream sector if no coordination is initiated by the PC of this downstream sector (cf UC-SM-08-01). In case of modification in exiting conditions after the electronic transfer of information, the PC can still change the exiting contract. If time remaining before frequency transfer is too short to allow downstream sector to re-analyse the impact of the new “contract”, then a phone coordination is required.

There is also another situation implying manual revision via phone calls, which is in case of automated coordination service failure. In such a case ATCOs have to be advised as soon as possible, and they will have to coordinate each revision or further TP modification manually (cf UC-SM-08-02).

Finally, while the flight is not in radio contact anymore with his EC because it has been transferred, the PC is still in charge of monitoring the aircraft behaviour and the compatibility of this flight and the other inbound flights arriving into the sector.

Executive controller actions for Separation Management

The Executive controller, using continuously updated and clearly displayed information coming from the conflict detection and resolution tools and/or the Planning Controller, analyses potential remaining conflicts and takes conflict resolution decisions.

TC solves conflicts by issuing adequate clearances at adequate time, using voice or datalink if time permits.

TC is supported by CD/R aid resolution advisory functions (including what-if and what-else capabilities), which are called “TC-aid” services/functions/tools, allowing:

- To assess the new envisaged tactical trajectories, and select the optimized one, that’s to say ensuring safety and minimum deviation (cf UC-SM-05-01 & UC-SM-06-01).
- To issue the corresponding clearance. Closed-loop trajectory clearances are preferably used to reduce uncertainty. Nevertheless, for obvious safety reasons, open-loop clearances may still

be used (e.g. time critical actions) but should remain as rare as possible and be superseded as soon as possible by closed-loop clearances. (cf UC-SM-02)

Even if not likely to be that frequent, it may happen that tactical CD/R service is out of service or corrupted. In such a case, ATCOs have to be informed as soon as possible and have to perform manually the whole resolution task, via standard ATCOs toolset available (SEP, extrapolation, highlights, CPA…etc.) and their own expertise.

In SESAR 2020 environment, considering IOP and SWIM availability, common and shared view of the flight should be automated, therefore coordination actions are supposed to be limited. However, in case of unusual action or last minute decision, EC may still ask PC (or EAP in a traffic centric ATC configuration) to initiate a coordination action (intra or inter-centre electronic coordination) with downstream sector(s).

When needed and if time permits a CDM process takes place, which may involve Extended ATC Planner and/or LTM, Airspace Users (FOC) and Airport Operations Centres. CDM process aims at finding the optimum way to amend the trajectory whilst maintaining the overall performance of the ATM system.

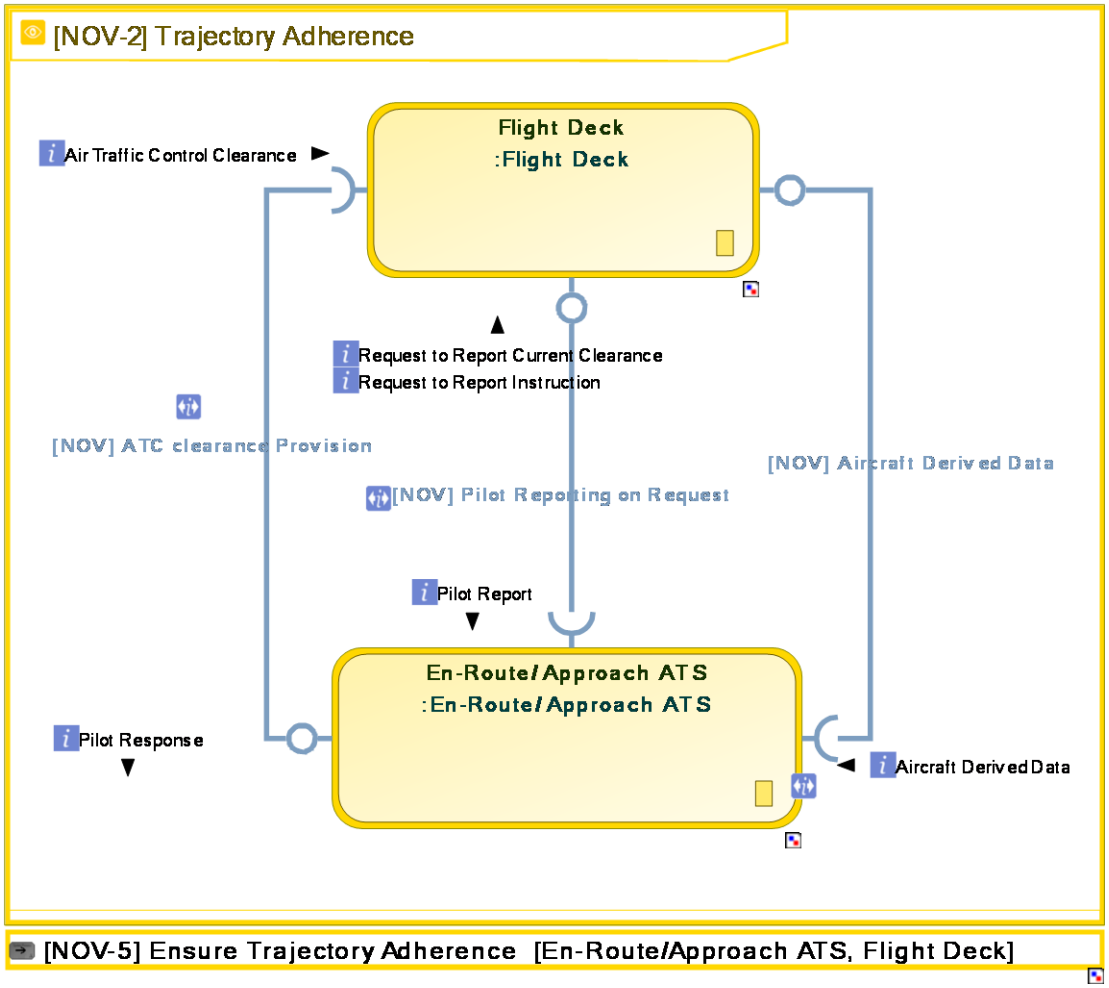
As far as practicable, the Executive controller would refrain from amending the trajectory of flights, all the more when they are under a CTO or a CTA. These constraints have to be part of the parameters considered by the Controller when building his/ her resolution solution using supporting tools/ functionalities. Still, for obvious safety reasons, tactical separation provision will always have priority on any other more strategic consideration.

Nevertheless, in order to perform expected exiting conditions of the flight, the EC might change the vertical profile of the flight by providing either a climbing or a descending clearance. In this case, the EC analyse is supported by probe services in order to verify each clearance before delivering it to the concerned flight.

As described before, flights performing a CDO are also to be considered when elaborating the conflict resolution, as well as the entry/ exit features of the Free Routing Airspace.

The conflict resolution is implemented by issuing a new clearance by data link or Voice communications in time critical situations or as a backup solution.

Clearance execution by the flight crew and flight progress monitoring by the sector team



When the clearance is agreed, the flight crew performs the required manoeuver and accordingly modifies the on-board systems (FMS). The updated on-board trajectory prediction is automatically downlinked (ADS-C EPP) [7] from ADS-C EPP equipped aircraft, to provide the ATM system with the latest trajectory parameters.

Both Tactical and Planning Controllers, assisted by a trajectory conformance tool, monitor the progress of the flights with respect to the given clearances in order to ensure that the strategy implemented to avoid the conflict is fully respected (cf UC-SM-03 & UC-SM-07-01).

If the flights involved in the separation process unexpectedly modify their trajectories, both Planning and Executive controllers are provided by CMON tools with alerts. They reassess the situation (assisted by automation), and if need be, elaborate and execute a new conflict resolution scenario (cf UC-SM-07-02).

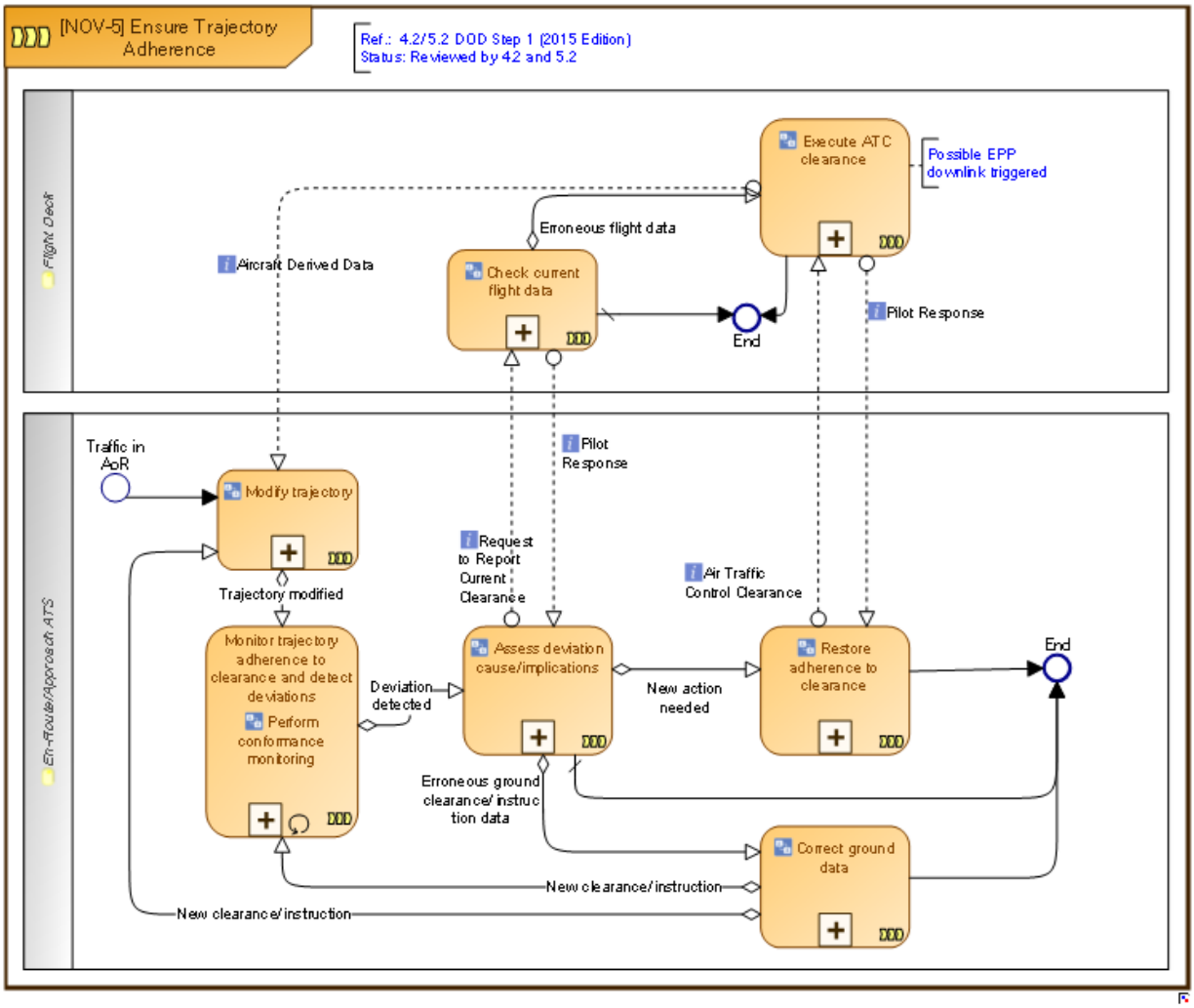
[7] Considering that the ADS-C contract adapted to the clearance revision is established with the aircraft

The trajectory conformance tool may also raise an alert if the solution that the "TC aid" assessed as conflict-free has not been implemented in due time so that it now raises a new conflict ("time validity" assistance, cf UC-SM-07-03). In such a case, an alternative/corrective ATC solution has to take place.

It is to be pointed out that both Planning and Executive controllers, assisted by CMON, permanently check flights' adherence to their trajectories. Should they notice a deviation, they take the appropriate actions to bring the involved flight on its trajectory. If this deviation leads or could lead to a separation minima infringement, quick intervention is necessary to restore or preserve these separation minima.

3.3.2.1 Ensure Trajectory Adherence

This process is run on an iterative basis and consists in monitoring the traffic situation and detecting when aircraft deviate from the predicted trajectory. This may lead to safety critical situations that must be detected as early as possible so that the controller can react quickly and resolve them. Both the planning and the executive controllers can be involved in the process.



Activity	Description

Assess deviation cause/implications	When ATCOs detect a deviation and safety is not immediately compromised, they analyse it, together with the flight crew (via voice communication or DL if available), in order to detect the cause for this deviation (human, system, or external) and mitigate its impact.
Check current flight data	The flight crew checks flight data and on-board systems availability. In case of erroneous manual inputs or technical failures, corrective actions are immediately undertaken, in coordination with ATC.
Correct ground data	In case of clearance input mistake on the ground: the controller corrects his/her inputs, in coordination with flight crew. In case of ground system failure, the ATCOs apply corrective measures (backup solutions, technical intervention, etc...).
Execute ATC clearance	The airborne trajectory is updated and activated in the FMS, which may lead to EPP downlink depending on the established ADS contract terms.
Monitor trajectory adherence to clearance and detect deviations	Both Planning/MSP and Executive Controllers monitor the required flight adherence to cleared trajectory. Potential deviations (route, rate, flight level, level bust) from the ground predicted trajectory are highlighted for potential controller intervention. In case of aircraft flying on closely spaced A-RNP routes or parallel off-track, this monitoring task has to be carefully performed as the time available before the loss of separation when a flight is deviating from its track is likely to be shorter than today.
Restore adherence to clearance	If a detected deviation is considered as significant, the controller takes the appropriate actions to bring the involved aircraft back to its planned trajectory, including the provision of a new ATC clearance. Quick intervention will be necessary for deviations that may lead to a loss of separation minima.
Modify trajectory	

Issuer	Info Exchange	Addressee	Info Element	Info Entity
Flight Deck	Execute ATC clearance o--> Modify trajectory	En-Route/Approach ATS	Aircraft Derived Data	AircraftDerivedData
En-Route/Approach ATS	Restore adherence to clearance o--> Execute ATC clearance	Flight Deck	Air Traffic Control Clearance	ATCClearance
Flight Deck	Execute ATC clearance o--> Restore adherence to clearance	En-Route/Approach ATS	Pilot Response	AIRM_Change_Request
En-Route/Approach ATS	Assess deviation cause/implications o--> Check current flight data	Flight Deck	Request to Report Current Clearance	ATCRequest

Issuer	Info Exchange	Addressee	Info Element	Info Entity
Flight Deck	Check current flight data o--> Assess deviation cause/implications	En-Route/Approach ATS	Pilot Response	AIRM_Change_Request

The hereafter textual Use Cases are related to Trajectory Adherence. They are issued from the SESAR CONOPS [4].

UC-SM-03 Sector team and flight crew ensure trajectory adherence

For aircraft which downlink reliable trajectory data, ground systems may detect a discrepancy between the flight trajectory known by the ground, and the one computed on board of the aircraft. In this case, the sector team faces a conformance monitoring alert, either an on-going situation, or a future situation estimated on the basis of flight intentions. In this situation, ATCOs double check their HMI input in order to secure ground data, and, if needed, ask for a clarification to the crew. Depending on the situation, either ATCOs will update ground trajectory in order to match with flight intentions or behaviour, or pilots could be asked to comply with ground trajectory in order to restore a shared and unique view of the situation.

UC-SM-07-03: Conformance monitoring with time validity assistance

Depending on the implementation, CMON may include a “time validity” assistance to the ATCO. This is to provide information to the ATCO until which time the envisaged solution could be applied AND to alert if this applied solution is no longer valid and a new/corrective solution needs to be implemented.

As an example:

- Aircraft A has a conflicting trajectory with Aircraft B, presenting a potential separation infringement.
- The ATCO is warned about the potential conflict by the Conflict Detection functionality of the “TC aid”.
- The ATCO reviews the available resolution options (what-if/what-else) and selects the best possible solution for this particular case and conflict geometry – to solve the conflict by using DCT function by instructing Aircraft A to proceed direct to [certain waypoint]
- The ATCO receives information that if DCT is applied within the next [time interval] it will solve the conflict => assistance to the ATCO of the time validity
- The ATCO instructs Aircraft A to proceed direct to […] and makes the appropriate input => tactical conformance monitoring now starts to monitor the compliance to that instruction
- The crew of Aircraft A acknowledges but do does not comply /or starts compliance with certain delay
- The conformance monitoring function raises two types of alerts => tactical conformance monitoring alerts
    - The instruction is not being followed – the non-conformance element of the trajectory is being presented to the ATCO => non-conformance alert of the tactical trajectory CMON

- The applied solution (DCT instruction in our case) does not longer solve the conflict and new corrective instruction is needed (e.g. heading or FL change) => solution no longer valid alert of tactical trajectory CMON

3.3.2.2 Provide Planning Separation Assurance

Separation assurance at planning level is a continuous process triggered on a cyclic basis in order to detect and solve potential interactions between (pairs of) aircraft and between aircraft and restricted airspace that are within his/her area of interest, at every step of the coordination process (e.g. receipt of an offer, selection of a suitable sector exit level etc.). According to the ATSU/ ATC team configuration, planning separation can be provided by the MSP and/or the PC.

Conflict resolution in planning terms may involve the identification of alternative co-ordination conditions (level, route, profile etc.) at either the entry and/or exit boundaries of the AoR.

The use of Medium Term Conflict Detection tools and What-if or What-else probing tools permit to support detection of problems at Entry/Exit and along planned flight trajectory within AoR/AoI.

In order to ensure the continuity of the detection at planning level, it is extremely important to have the minimum number of aircraft in tactical deviation in comparison with their planning trajectories. Otherwise the planning detection is less efficient because input data are not reliable anymore. That's why the closed-loop clearances have to be preferred while implementing resolution strategies. In order to ease associated ATCOs workload, it should be nice to have a graphical access to a route amendment service. This service is called here the "Route Via" service (RTE VIA).

While performing a RTE VIA, a controller amends the flight planning trajectory, changing its horizontal shape, while keeping the aircraft in a closed-loop clearance. If necessary, the controller could initiate a coordination with neighbouring sectors to ensure the acceptance of the new trajectory.

During the validations, no exercise was able to validate the necessity for a conflict detection assistance while performing a "RTE VIA" amendment. Anyway, it is strongly thought that it should be the case in order to support appropriately ATCOs in their rerouting task, which is part of deconfliction. Therefore, before committing a route clearance the ATCO should make sure it is conflict-free. Varying levels of automation can be envisaged:

- At a most basic level, the ATCO may benefit from the system displaying the flight legs of the aircraft involved in the conflict and indicating the conflicting legs and point of closest approach;
- A more automated tool might give a continuous feedback of the predicted minimum separation as the controller moves the inserted point[s];
- The system might automatically propose inserted point[s] on one or both tracks that solve the conflict with a given probability.

A routing proposed by the system should avoid turns greater than those normally used when vectoring (e.g. 10-15 degrees).

Aircraft may have different RNP values along their trajectories, and/or may have a different RNP value when cleared towards a non-published waypoint. Turns at waypoints may also be performed

differently – in a ""fly-by" or "fly-over" manner. All this needs to be taken into account by the probe tool.[8]

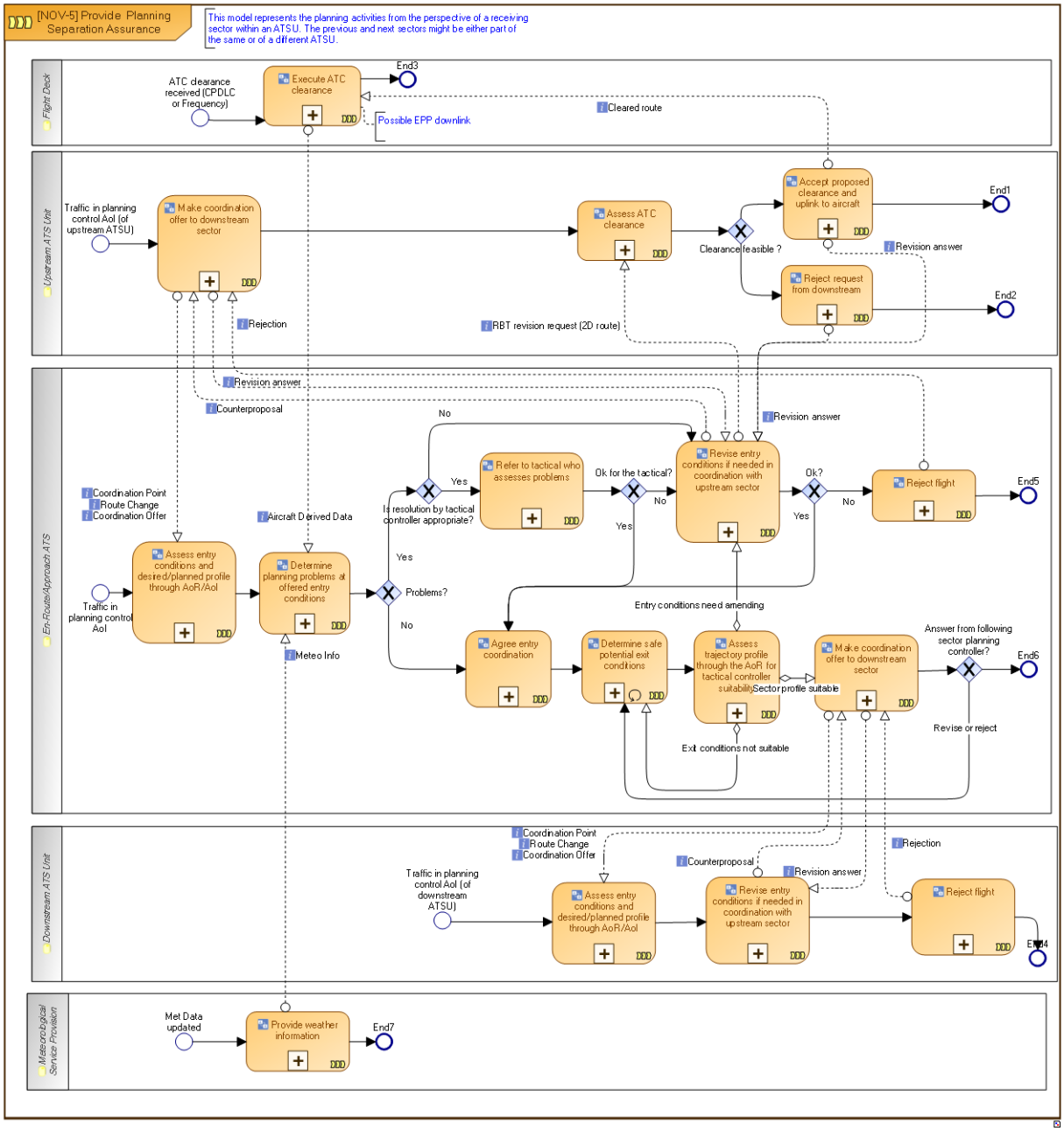
The implementation of advanced ATC support tools allows a better anticipation of traffic situation (medium term) and provide ATCOs with more time to analyse problems and select the best solutions, taking into account ATM aspects (e.g. safety, flights subject to constraints) but also flight efficiency aspects (minimum RBT deviation principle).

Through the use of newly available data, the solution PJ.18-06 is able to improve the Planning Trajectory. No numerical targets regarding expected improvement for planning separation are expressed by solution PJ.10-02a.

This novelty permits to improve the ATC tools as follows:

- A drop in false positive detection rate, thanks to the better accuracy of the TP, matching more with real aircraft trajectory.
- An anticipated display and categorization of detected encounters, thanks to a significant reduction of longitudinal uncertainty.

[8] *When system support is used to propose automatically a VIA point for conflict resolution, the above difference in RNP values and types of turns shall be taken into account to adjust separation buffers*



Activity	Description
Agree entry coordination	Inform previous sector and tactical controller that the coordination is accepted (can be fully supported by automation).
Assess trajectory profile through the AoR for tactical controller suitability	The planning controller looks along the flight path in his/her AoR to assess whether the anticipated exit conditions or any in-AoR constraints present an unacceptably high level of difficulty for the tactical controller to achieve (e.g. due to conflicting flights within the sector). Note: The planning controller AoR may comprise several tactical AoRs.

Determine planning problems at offered entry conditions	Looking along the flight path within his/her AoR, the planning controller assesses the entry conditions of the flight and, taking into account any separation/complexity issues, determines: - The possibility to remove any unnecessary pre-tactical and/or procedural constraint which was so far applicable for the flight - The potential need to apply additional constraints Note: The planning controller AoR may comprise several tactical AoRs.
Determine safe potential exit conditions	The planning controller looks at the characteristics of the flight and its expected trajectory profile through his/her AoR, gaining an overview of potential issues and optimisation opportunities within his/her AoI and potentially anticipating new exit conditions if necessary. Note: The planning controller AoR may comprise several tactical AoRs.
Execute ATC clearance	The airborne trajectory is updated and activated in the FMS, and possibly downlink via ADD. If the aircraft is EPP capable, these ADD could be EPP data depending on the established ADS contract terms. In case a RTE VIA clearance is received, and because there is no "autoload" function in ATN B1, the pilot has to manually insert the "VIA" point. To minimize the chance of input error, the point may be specified as bearing/distance from a known point. An example of a complete RTE VIA instruction is as follows: "callsign CLEARED TO TESGA VIA ABAMI/035/10 REST OF ROUTE UNCHANGED".
Revise entry conditions if needed in coordination with upstream sector	Entry coordination is amended as required in agreement with offering sector. In case of a conflict and if a resolution using closed clearances (““RTE VIA””) is available for the Planner, and time and workload permitting, (s)he may input the revised routing for the aircraft involved and propose it to the upstream sector. To ensure that the Executive will not attempt to make a conflicting input on the same pair of aircraft, the Planner shall either coordinate with them, or make the input early enough, before the aircraft are in the Executive’’s AoI.
Accept proposed clearance and uplink to aircraft	If accepted, the route clearance is automatically converted into a CPDLC message (UM79 - "CLEARED TO... VIA...") and uplinked to the aircraft. An acceptance is also sent to the downstream sector.
Assess ATC clearance	The flight crew assess the impact of the clearance from a safety/flight execution perspective and inform ATC about their decision of either accept or reject the it. The reason for rejection is also communicate to facilitate amendment from ATC. ATC clearance and associated pilot response can be communicated by either voice or datalink messages depending on the particular situation.
Assess entry conditions and desired/planned profile through AoR/AoI	The planning controller looks at the characteristics of the flight and its expected trajectory profile through his/her AoR, gaining an overview of potential issues and/or optimisation opportunities (e.g. ARES early deactivation) within his/her AoR.

	Note: The planning controller AoR may comprise several tactical AoRs.
Make coordination offer to downstream sector	Having identified appropriate exit conditions, coordination offer is made to next planning AoR for their consideration.
Provide weather information	This activity involves handling requests and proving weather information concerning the flight or mission activity, in standardised format like WXXM. Broadcast services where weather information is distributed in regular intervals is also handled by this activity.
Refer to tactical who assesses problems	The planning controller highlights issue to the tactical controller. The tactical controller makes a decision whether he/she accepts the responsibility for monitoring and/or resolving the problem or whether a revised sector entry coordination is required.
Reject flight	If the flight cannot be reasonably accepted into the sector the coordination is to be rejected.
Reject request from downstream	A route clearance request might be rejected if the ATCO is too busy to consider it, or has a conflict with that aircraft.
Revise entry conditions if needed in coordination with upstream sector	Entry coordination is amended as required in agreement with offering sector.

Issuer	Info Flow	Addressee	Info Element	Info Entity
En-Route/Approach ATS	Make coordination offer to downstream sector o--> Assess entry conditions (by downstream ATSU)	Downstream ATS Unit	Coordination Offer	
En-Route/Approach ATS	Make coordination offer to downstream sector o--> Assess entry conditions (by downstream ATSU)	Downstream ATS Unit	Route Change	RouteChange
En-Route/Approach ATS	Make coordination offer to downstream sector o--> Assess entry conditions (by downstream ATSU)	Downstream ATS Unit	Coordination Point	TransferOfControlPoint
En-Route/Approach ATS	Reject flight o--> Make coordination offer to downstream sector (by upstream ATSU)	Upstream ATS Unit	Rejection	

Upstream ATS Unit	Make coordination offer to downstream sector (by upstream ATSU) o--> Revise entry conditions if needed in coordination with upstream sector	En-Route/Approach ATS	Revision answer	
Downstream ATS Unit	Revise entry conditions (by downstream ATSU) o--> Make coordination offer to downstream sector	En-Route/Approach ATS	Counterproposal	
En-Route/Approach ATS	Revise entry conditions if needed in coordination with upstream sector o--> Make coordination offer to downstream sector (by upstream ATSU)	Upstream ATS Unit	Counterproposal	
En-Route/Approach ATS	Make coordination offer to downstream sector o--> Revise entry conditions (by downstream ATSU)	Downstream ATS Unit	Revision answer	
Upstream ATS Unit	Accept proposed clearance and uplink to aircraft o--> Execute ATC clearance	Flight Deck	Cleared route	TaxiRoute
Upstream ATS Unit	Reject request from downstream o--> Revise entry conditions if needed in coordination with upstream sector	En-Route/Approach ATS	Revision answer	

En-Route/Approach ATS	Revise entry conditions if needed in coordination with upstream sector o--> Assess ATC clearance	Upstream ATS Unit	RBT revision request (2D route)	
Upstream ATS Unit	Accept proposed clearance and uplink to aircraft o--> Revise entry conditions if needed in coordination with upstream sector	En-Route/Approach ATS	Revision answer	
Flight Deck	Execute ATC clearance o--> Determine planning problems at offered entry conditions	En-Route/Approach ATS	Aircraft Derived Data	AircraftDerivedData
Downstream ATS Unit	Reject flight (by downstream ATSU) o--> Make coordination offer to downstream sector	En-Route/Approach ATS	Rejection	
Upstream ATS Unit	Make coordination offer to downstream sector (by upstream ATSU) o--> Assess entry conditions and desired/planned profile through AoR/AoI	En-Route/Approach ATS	Coordination Offer	
Upstream ATS Unit	Make coordination offer to downstream sector (by upstream ATSU) o--> Assess entry conditions and desired/planned profile through AoR/AoI	En-Route/Approach ATS	Route Change	RouteChange

Upstream ATS Unit	Make coordination offer to downstream sector (by upstream ATSU) o--> Assess entry conditions and desired/planned profile through AoR/AoI	En-Route/Approach ATS	Coordination Point	TransferOfControlPoint
Meteorological Service Provision	Provide weather information o--> Determine planning problems at offered entry conditions	En-Route/Approach ATS	Meteo Info	

3.3.2.3 Provide Tactical Separation Assurance

This process describes how the controller (mostly the Executive, and sometimes the Planning) detects and solves potential trajectory profile problems between (pairs of) aircraft and between aircraft and restricted airspace that are within his/her AoR or even within others' AoR when new collaborative control operating procedures apply. The goal is to address any remaining potential interactions that have been highlighted by the Planning Controller and achieve the overall trajectory profile targets set by him/her.

Conflict resolution in tactical terms may involve the identification of different solutions, e.g. by modifying the trajectory laterally, vertically or in terms of speed adjustments. In the envisaged operational environment priority should be given to solutions that impose a minimum deviation from the iRBT.

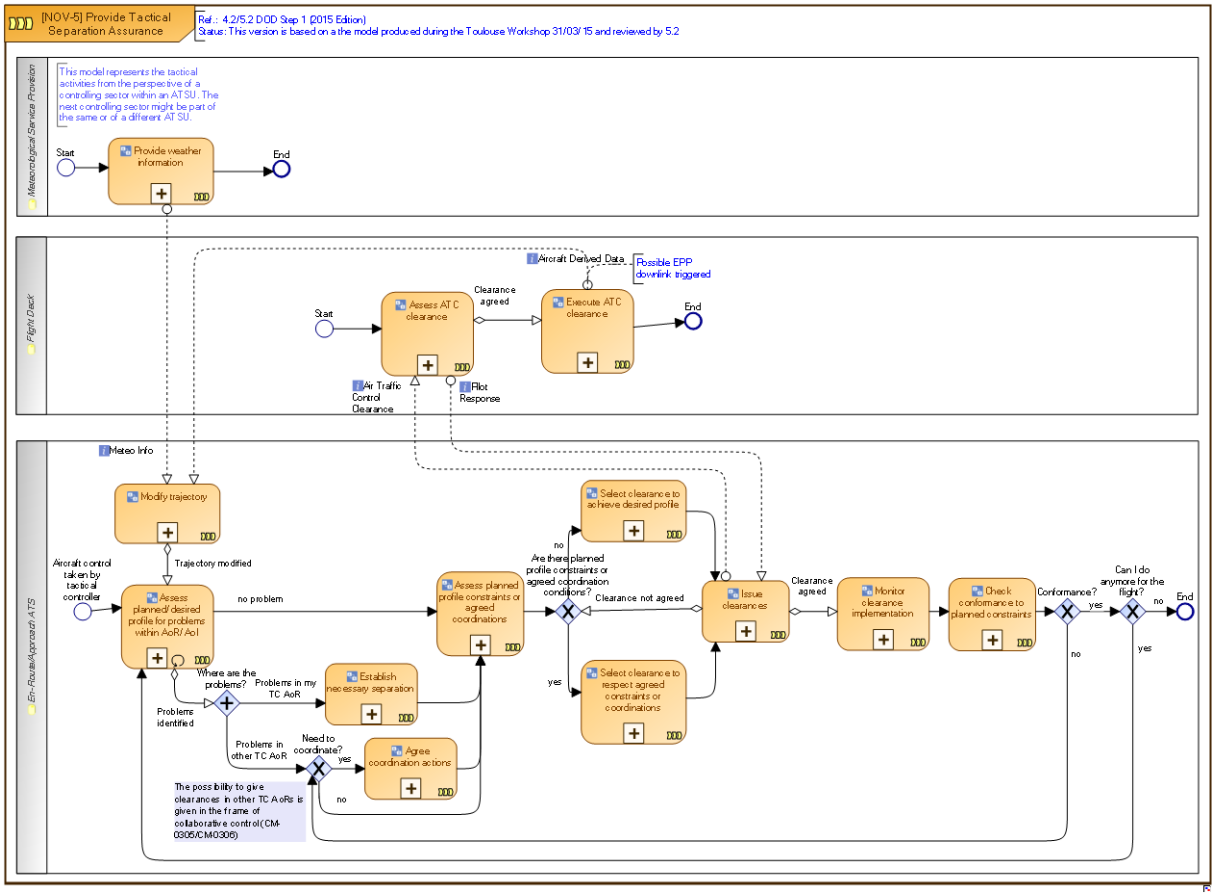
The use of Tactical Conflict Detection tools, conformance monitoring and electronic coordination tools support tactical separation assurance: detection of problems at along planned flight trajectory within AoR/AoI.

In order to assess tactical conflict resolution options ATCOs should be provided with What-if probing tools or what-else propositions.

The use of newly available data enables to improve the Tactical Trajectory: benefits are expected to be the same order of magnitude as the improvement brought by the solution PJ.18-06 on the Planning Trajectory, even if the data and the algorithm to use them differ. No numerical targets regarding expected improvement for tactical separation are expressed by solution PJ.10-02a.

Thanks to Tactical Trajectory improvements, the advanced ATC support tools allow a better anticipation of traffic situation and provide ATCOs with more accurate conflict data (e.g. conflict geometry display, minimum separation distances, extrapolation of aircraft positions at separation minima infringement), more time to analyse problems and select the best solutions, taking into account Safety, ATM constraints and flight efficiency aspects. These advanced tools support the selection of solutions ensuring a minimum deviation from agreed RBT. Task sharing and coordination

within ATC sector team as well as coordination with adjacent sectors are facilitated by advanced HMI functions (e.g. common TC/PC conflict list and display of conflict resolution allocation TC/PC, trajectory revision proposal display shared with adjacent sectors).



Activity	Description
Agree coordination actions	Except with the new collaborative control procedures where the traditional requirement to coordinate traffic at all sector boundaries is removed, the Executive Controller will coordinate the appropriate actions when he/she: - Identifies a planned/profile trajectory profile problem that concerns other tactical AoR. - Realises that conformance to planned constraints is not achievable anymore after the issue of the clearance. This coordination is improved thanks to new interoperability capabilities enabling increased support tools efficiency and the Executive Controller could delegate this task to the Planning Controller. Note: In MSP configuration, more flexible/optimised solutions can be set up due to extended situation awareness (both tactical sectors are known traffic to the planner).

Assess ATC clearance	The flight crew assess the impact of the clearance from a safety/flight execution perspective and inform ATC about their decision of either accept or reject it. The reason for rejection is also communicate to facilitate amendment from ATC. ATC clearance and associated pilot response can be communicated by either voice or datalink messages depending on the particular situation.
Assess planned profile constraints or agreed coordinations	Assess whether there are any planned constraints or agreed coordination actions to consider in order to select the clearance accordingly.
Assess planned/desired profile for problems within AoR/AoI	Determine whether there are any problems between the aircraft's trajectory profile and other flights' trajectory profiles through his/her AoR or even through others' AoR (if collaborative control procedures apply) to achieve overall profile targets set by the Planning Controller. This monitoring activity is run in a cyclic basis to identify and classify potential interactions between flights under tactical control, including interactions already highlighted by the planning controller as pending conflicts. Conflicts between aircraft and between aircraft and restricted airspace are detected by comparing the set of predicted trajectories modelling the behaviour of the aircraft in order to identify potential losses of minimum separation.
Check conformance to planned constraints	Both executive and planning controllers, assisted by a conformance monitoring tool, monitor the progress of the aircraft and check that conformance to planned constraints is achieved. If they are no longer achievable, they will need to be revised.
Establish necessary separation	Determine what actions need to be taken to maintain necessary separation.
Execute ATC clearance	The airborne trajectory is updated and activated in the FMS, which may lead to EPP downlink depending on the established ADS contract terms.
Issue clearances	The agreed conditions are implemented by issuing one or more clearances.
Monitor clearance implementation	Both executive and planning controllers, assisted by a conformance monitoring tool, monitor the progress of the aircraft with respect to the given clearance to ensure that the problem is solved.
Select clearance to achieve desired profile	If there are not planned constraints or agreed coordination actions to respect, the Executive Controller will select the clearance to achieve the desired trajectory profile.
Select clearance to respect agreed constraints or coordinations	If there are planned constraints or agreed coordination actions, the Executive Controller will select the clearance to respect them.
Modify trajectory	
Provide weather information	This activity involves handling requests and proving weather information concerning the flight or mission activity, in standardised format like WXXM. Broadcast services where weather information is distributed in regular intervals is also handled by this activity.

Issuer	Info Flow	Addressee	Info Element	Info Entity
Flight Deck	Execute ATC clearance o--> Modify trajectory	En-Route/Approach ATS	Aircraft Derived Data	AircraftDerivedData
Flight Deck	Assess ATC clearance o--> Issue clearances	En-Route/Approach ATS	Pilot Response	AIRM_Change_Request
En-Route/Approach ATS	Issue clearances o--> Assess ATC clearance	Flight Deck	Air Traffic Control Clearance	ATCClearance
Meteorological Service Provision	Provide weather information o--> Modify trajectory	En-Route/Approach ATS	Meteo Info	

3.3.2.4 Use Cases from SESAR CONOPS

The following Use Cases are issued from the SESAR CONOPS [4].

UC-SM-01 (exception): data link failure, clearances have to be issued by voice

If the ATC system is not able anymore to support datalink exchanges between ground and aircraft, then each clearance or dialogue between pilots and controllers will have to be performed via R/T communication.

In this situation, the ATC capacity will be impacted because of frequency occupation rate that is going to rise, directly impacting sector team workload. On board, switching from advanced datalink capability (more particularly DL messages loading capability) to voice-only communication will increase the crew workload, more particularly if complex clearances are to be issued.

Regarding ATC procedures or manoeuvres, there is no impact as long as any DL communication can be replaced by a voice communication.

UC-SM-05-01 (nominal case): optimum performance of CD/R aid

All aircraft are fully 4D-equipped and environment conditions are complete and up-to-date. CD/R aid is fully operational at Planning and Tactical levels, and well-performs CD/R processes with no technical issue.

In such an idealistic situation, ATCOs can rely on CD/R aid to perform detection task and lighten her/his double check. Indeed, thanks to aircraft data updating the ground trajectories, ATC systems have a realistic view of the future behaviour of the aircraft. ATCOs are in charge of taking into account highlighted encounters as well as resolution proposals if any, in order to elaborate the most appropriate strategy to provide separation between aircraft.

UC- SM-05-02 (non-nominal case): altered performance of CD/R aid

In such a situation, CD/R aid is not reliable enough to secure the whole detection task. It may happen because of a technical issue in ground systems, or because not all aircraft are able to downlink their behaviour or intentions, or because some environment data are missing, out-of-date or degraded.

Consequently, ATCOs have to perform their own analysis of the situation in order to be able to identify the problematic situation they will have to deal with. To support this activity, they can rely on standard ATC supporting services (SEP, TCT, electronic communications, highlights…etc.) and their own experience. Depending on the baseline situation, ATCOs may also be supported by legacy CD/R aid if any.

At least, the degraded CD/R aid can support ATCOs by partly detecting the potential conflicts, and by providing the ATCOs with a means to store/manage the potential conflicts they detect on their own.

UC-SM-06 EAP, PC and/or EC build a resolution solution

In the whole analysing process taking place prior to a resolution elaboration, the expected behaviour and capabilities of each flight have to be considered by ATCOs (or EAP). PJ.10-02a1 and PJ.10-02a2 permit to get a better overview of the situation thanks to additional aircraft data that increase reliability and accuracy of the predicted behaviour, as well as aircraft intentions. Therefore, ATCOs (or EAP) decisions are more adequate with the actual situation.

UC-SM-06-01 (nominal case): optimum performance of CD/R aid

In such a situation, CD/R aid are going to provide ATCOs with one or several possible resolution strategies by offering what-if/what-else capabilities.

According to their own assessment of the situation, ATCOs choose the most suitable one in order first to fully ensure safety, then to minimize the impact on aircraft RBT/SBT. It is up to ATCOs to make up their mind on which resolution to implement.

UC-SM-06-02 (exception): altered performance or failure of CD/R aid

In such a situation, resolution strategies proposed by the systems are erroneous, or at least incomplete.

Consequently, ATCOs can’t rely on CD/R aid and have to build their own resolution strategy thanks to their experience and any other standard ATC supporting services. They still have the benefit of improved trajectories, and so of reliable data concerning future aircraft evolutions, which is rather a good point to select the most suitable resolution strategy.

UC-SM-07 PC and EC monitor conflict resolution effectiveness

Once conflict resolution has been implemented, it is up to PC and EC to monitor that the flight complies with the clearances that have been ordered. The monitoring service brought by PJ.10-02a1 or PJ.10-02a2 is a very valuable support service because it monitors that pilot’s intentions actually match with the sequence of clearances corresponding to the implemented conflict resolution.

UC-SM-07-01 (Nominal case): monitoring of conflict resolution (CTO or EAP/PC/TC-initiated resolution) and no need for tactical action

The situation corresponds to a conflict resolution that has been implemented at the planning horizon, thanks to a better mid-term accuracy of the conflict detection. This conflict resolution may have been initiated by either the sector team or the EAP, while its implementation is always under the sector team' responsibility.

Most of the time, such a resolution is implemented by a sequence of closed-loop clearances that need not performing additional tactical actions, but monitoring. Thanks to aircraft derived data, PJ.10-02a2 effectively supports ATCOs or the EAP in this monitoring task.

UC-SM-08 Sector team coordinates with upstream/downstream sectors using intra or inter-centre automated coordination.

There are many cases where intra-centre or inter-centre coordination is required:

- RBT/RMT, and/or flight plan route, may have been revised by any upstream sector, leading to potential conflicts at entry/exit initial conditions, thus entry/exit conditions have to be negotiated
- In free-route airspace, the resolution of potential conflicts at border between several sectors often need a coordination to choose the most adequate resolution strategy
- In flight centric operations (PJ.10-01b), coordination between ATCOs is highly required, other than pure upstream/downstream coordination

Coordination is supported by CD/R aid either to probe an incoming request, or as a supporting tool to effectively choose the most adequate resolution strategy, provided that CD/R aid outcomes are shared between all involved ATCOs. This latter option requires a high level of interoperability when involved sectors belong to distinct centres.

UC-SM-10 (nominal) Limited Aircraft equipment / equipment rate

The optimal case would be that all aircraft are fully 4D-equipped, however the nominal case is that some aircraft have limited equipment, leading CD/R aid to consider a mix traffic made of 4D-equipped and non-equipped aircraft. The non-nominal case is the very low level of equipage, as of today.

CD/R aid consider each aircraft individually, with an indicator related to the quality of downlinked aircraft data, if any. This indicator is dynamic, in order to take into account any degradation of the quality of aircraft data.

Consequently, for what concerns airborne data, the PJ.10-02a2 CD/R aid has to be considered not as a step, but as a climbing slide starting from the baseline CD/R aid when involved flights are not 4D-equipped, to a fully reliable and accurate CD/R aid when involved flights are optimally equipped. The mix traffic makes the CD/R aid be able to manage all kinds of intermediate situations.

It is important to inform the ATCOs about the quality of the detection, for each potential conflict. Those that involve aircraft fully 4D-equipped are more reliable and accurate than those that involve non-equipped aircraft. It also supports the ATCO in considering the "Best equipped best served" principle when solving the conflicts.

UC-SM-05 EAP and/or sector team detect potential conflicts

The EAP and/or sector team may detect a potential conflict that hasn't been raised by the dedicated CD/R aid. It may be a nominal situation if the potential conflict is out of CD/R aid scope (out of the time

horizon, or out of the detection thresholds, or out of the location criteria) or if the ATCOs' intentions are not known by the system.

On the other hand, it may be a miss of the CD/R aid. In such a case, the supervisor has to be advised in order to check whether the associated CD/R aid is operating properly or if a technical failure occurred.

In both cases, this new conflicting situation has to be taken into account by the sector team (respectively the EAP). The CD/R aid makes it possible to manually enter the new conflict, in order to be considered with the same analysing and solving process at human level than other encounters automatically provided by CD/R aid.

UC-SM-08-01 (nominal): optimum performance of automation supported coordination

In an optimal way, coordination is highly supported by probing tools to assess any incoming request. The What-if service automatically processes the incoming request for new co-ordination conditions, and provides the ATCO with a reliable and accurate assessment.

A probing tool (what-if or what-else) is also used to assess a change in exit conditions before to propose it to the downstream sector. Such an assessment needs to increase the geographical scope of CD/R aid to take into account aircraft outside the sector AOR. However, it has to be noted that even an increase of scope cannot result in a definitive assessment and coordination still remains necessary.

In free-route airspace, when all involved centres are equally equipped and interoperability between them is fully operational, potential conflicts at border between several centres can be exchanged between them in order to efficiently support the setting of individual responsibility in the resolution, and to choose the best resolution strategy to implement.

UC-SM-08-02 (exception): failure of automated support for co-ordination

When CD/R aid services to support co-ordination are failing, either because of a partial implementation or because of a technical issue, ATCOs cannot rely on them anymore and co-ordination is processed without advanced support, by phone mainly as of today.

This affects the PCs workload, and this also degrades the common situation awareness. Consequently, the ATCOs must adopt high separation thresholds with upstream/downstream sectors.

UC-SM-02 Executive controller issues an open-loop clearance for time-critical action or operational reasons

The TC, in order to provide separation between several interfering aircraft for instance, or in order to grant a bad weather cell avoidance action, can break the RBT/SBT contract by issuing an open loop clearance, that is to say a heading alteration. If this heading clearance implies another actor permission (neighbouring sectors, military controllers…etc.), then the PC will support the EC by coordinating with related interlocutors. Any CD/R aid service that is based on planning trajectories is degraded during all the open loop clearance process, because based on non-updated planning trajectory data: short-term conflict detection, if based on planning trajectories, is not valid anymore, and mid-term conflict detection is degraded as the mid-term impact of the open loop clearance is not known. Once there is no need any longer for this open loop clearance, the aircraft will be cleared back to his initial RBT/SBT, and planning-trajectory based CD/R aid can operate appropriately again.

UC-SM-07-02 (non-nominal case): need for tactical action by TC, preferably a closed-loop clearance, resulting in a RBT/RMT revision. Clearance is issued by voice or data link.

It may happen that the resolution that is implemented at planning level does not completely solve the conflicting situation e.g. unexpected wind, or pilot implementing late a clearance, etc... Such a case is detected either by own EC assessment, or by a TCT alert. The EC implements then an extra resolution probably by voice due to the urgency. In order not to degrade the CD/R aid in particular, and any trajectory-based service in general, the EC is highly incited to prefer closed-loop clearances when possible and adequate. Support probing tools are designed to encourage such an EC choice.

3.3.2.5 Use Cases from EXE-10.02a-V3-VALP-003

The following textual Use Cases are issued from EXE-10.02a-V3-VALP-003 (En-Route) performed by ENAV & LEONARDO and they have been partially tested[9].

UC-(nominal): CD/R tools and CMON service support to ATCOs for conflict situation with no service degradation.

All aircraft are fully 4D-equipped. CD/R and conformance monitoring aids are fully operational at Planning and Tactical levels, and well-performs Medium and Tactical conflict detection processes with no technical issue.

ATCOs can rely on Medium and Tactical conflicts detection to resolution assuring separations. Thanks to aircraft data updating the ground trajectories, ATC system permits to provide ATCOs with a better overview of the situation thanks to additional aircraft Mode-S data that could improve the FDP trajectory calculation and increase reliability and accuracy of the future aircraft behaviour.

MTCD and TCT tools are going to provide ATCOs with possible resolution strategies by offering what-if capabilities. ATCOs will take into account encounters identified by the tools in order to elaborate the most appropriate way to provide separation between aircraft. The ATCO is provided with the capability to probe the effect of different orders on different aircrafts, to evaluate the possible effects of combined clearances.

Once conflict resolution has been implemented, it is up to PC and EC to monitor that the flight complies with the clearances that have been ordered. The CMON service with aircraft derived data via Mode-S supports ATCOs to monitor that aircraft intentions actually match with the ATC clearances

[9] Deviation from the activities initially planned has been reported in the VALR relevant section, due to following technical issues arisen during platform integration tests.

- Mode-S data integrated by FDP for the trajectory calculation also in reference scenario (even though not distributed to the CD/R tools because these aids are not used in the reference)
- Mode-S data integrated by FDP for the trajectory calculation but not displayed on the relevant HMI list for providing CMON alerts to controllers in case of deviations between ATC clearances and received Mode-S data (Selected Altitude, Vertical rate, Received Call sign, Speed, Magnetic Heading). No contribution to CM-0210 related to conformance monitoring.

corresponding to the implemented intervention and the conformance monitoring function raises alerts if the instruction is not being followed.

UC- (non-nominal): failure of CD/R aids

During the normal condition, will be simulated a failure of MTCD and TCT: no conflicts detection will be available also the what-if capability wouldn't receive information about possible conflicts resolution. Consequently, ATCOs can't rely on CD/R aids to build their own resolution strategy.

No information regarding conflicts based on the planned trajectories will be given to the ATCO. Also, the what-if resolution cannot receive information about possible conflicts and the controller needs to implement a resolution without support of probing tools.

The ATCOs doesn't receive any feedback from the system when they propose changes for new co-ordination conditions/exit conditions.

Moreover, it may happen that the resolution that is implemented does not completely solve the conflicting situation due to pilot implementing late a clearance or pilot perform a wrong selection to comply with the ATC instruction.

UC- (non-nominal): No-go area activation

During the normal conditions with CD/R and conformance monitoring aids fully operational at Planning and Tactical levels with no service degradation, unexpected closure of a portion of airspace due to severe bad weather conditions to be avoided.

Unexpected closure means an activation not planned: the duty supervisor in this case warns all the controllers (EXEs and PLNs) of the involved sectors, 5 minutes before the effective activation.

The PLN Controllers is responsible of all the coordination needed (using telephone or specific tools available) with upstream and downstream sectors to negotiate the entry/exit conditions of all traffic potentially crossing the no-go area.

3.3.3 Differences between new and previous Operating Methods

There are few specific points which differ between new and previous operating methods. Obviously, the main one is coming from the addition of aircraft data in ground trajectory predictions, so that each TP is more reliable, with less uncertainty. The two major expected benefits coming from these aircraft data are the reduction of nuisance alerts from conflict detection services, and also an earlier display of reliable information allowing ATCOs to take the appropriate decisions with more anticipation.

In addition of those expected benefits, some enhanced features of existing CD/R are also going to contribute to ease ATCOs work and to support them in their provision of separation task. This is the aim of the different resolution advisory services, and also of appropriate probes enabling to take faster and consolidated real-time resolution decisions. Some other elements are eventually going to play a part in improving the operating method, like the possibility for PCs to perform CPDLC clearances in parallel of TCs clearances delivery.

The following table lists the Operating Methods linked to the OIs related to both PJ.10-02a1 and PJ.10-02a2 Solutions:

Related OIs	Activities (in EATMA) that are impacted by the SESAR Solution	Current Operating Method	New Operating Method
CM-0206, CM-0209, CM-0209-b	Assess planned profile constraints or agreed coordination	CMON	Improved CMON thanks to TP improvements: earlier detection of discrepancies
CM-0206, CM-0209, CM-0209-b	Assess planned/desired profile for problems	FASTI compliant MTCD service	Enhanced MTCD service targeting precisely entry condition encounters and exiting condition encounters.
CM-0206, CM-0209, CM-0209-b	Assess trajectory profile through the AoR for executive controller suitability	Baseline tools (SEP, probe)	Baseline tools (SEP, probe) with more reliability thanks to improved TPs
CM-0206, CM-0209, CM-0209-b	Check conformance to planned constraints	Conformance monitoring services	Conformance monitoring services with earlier warning thanks to aircraft data used in ground TPs
CM-0208-A, CM-0210, CM-0210-b	Determine planning problems at offered entry conditions	FASTI compliant MTCD service	Enhanced MTCD service targeting precisely entry condition encounters and exiting condition encounters.
CM-0206, CM-0209, CM-0209-b	Determine safe potential exit coordination	FASTI compliant MTCD service	Dedicated detection including local model within MTCD detection, plus probes or filtering tools to support exit coordination
CM-0206, CM-0209, CM-0209-b	Establish necessary separation	All the different CD/R services.	All the different CD/R services, with earlier and more reliable detections. Earlier because if uncertainty drops, it is possible to extent the tools' time horizons. More reliable, because better categorized from the beginning, thanks to less uncertainty.
CM-0206, CM-0209, CM-0209-b	Issue clearances to achieve conditions	TC via voice communication or CPDLC PC via phone coordination	TC via voice communication or CPDLC PC via phone or electronic coordination, or via CPDLC

CM-0206, CM-0209, CM-0209-b	Refer to tactical who assesses problems	Local highlights	Local highlights, no differences
CM-0206, CM-0209, CM-0209-b	Select clearance to achieve desired profile	What-Else probing	Enhanced clearance selection via What-Else probe menu
CM-0206, CM-0209, CM-0209-b	Select clearance to respect agreed constraints or coordination	HMI solution, out of scope	HMI solution, out of scope
CM-0208-A, CM-0210, CM-0210-b	Monitor clearance implementation	CMON service	CMON service with faster detections (thanks to aircraft data) and less nuisance warnings
CM-0208-A, CM-0210, CM-0210-b	Monitor trajectory adherence to clearance and detect deviations	CMON service	CMON service with faster detections (thanks to aircraft data) and less nuisance warnings
CM-0208-A, CM-0210, CM-0210-b	Perform Conformance Monitoring	ATCOs monitoring + CMON	ATCOs monitoring + improved CMON

Table 7: Difference between new and previous Operating Method

The more reliable and accurate the CD/R aid are, the less will be the need for ATCOs to crosscheck and verify its accuracy CD/R aid. Nevertheless, it is a safety issue to monitor that the CD/R aid is processing in an optimal way, and to warn the ATCOs in case it fails, in order to prevent ATCOs blind confidence in a faulty CD/R aid.

4 Safety, Performance and Interoperability Requirements (SPR-INTEROP)

4.1 Generalities

4.1.1 Contents

This section contains the requirements relevant for the Solutions PJ.10-02a1 & PJ.10-02a2 at OSED/SPR/INTEROP level. These requirements have been defined using the SESAR Requirements and V&V guidelines [27].

The REQ definition and Trace tables contain the Rationale field providing an initial explanation about the requirement formulation.

The Requirement layout is illustrated below:

[REQ]

Identifier	REQ-XXb.YY-SPRINTEROP-UU01.0123
Title	
Requirement	
Status	<validated><in progress><deleted>
Rationale	This requirement has been validated in EXE…… This requirements has been deleted because validation Exercise XXXX confirmed that the expected role could not perform the expected activity without a significant reduction of the situational awareness
Category	<Operational>,<Safety>, <Security>,<Human Performance>, <IER>, <Interoperability>

[REQ Trace]

Linked Element Type	Identifier
<SESAR Solution>	SESAR Solution Identifier
<Service>	Service Identifier
<Information Exchange>	Information Exchange Identifier
<Function>	Function Identifier
<Activity>	Activity Identifier
<Functional Block><role>	Functional Block/Role Identifier
<Sub-Operating Environment>	Sub-Operating Environment Identifier

Table 8: Requirement capture layout

4.1.2 Remarks

- The current section has been split into two main sub-sections :
  - The first section contains the requirements that have been V2-validated only because they are related to the OIs that are not fully addressed at V3 level : CM-0209-b and CM-0210-b
  - The second section contains the requirements that have been V3-validated.
- The current document does not include the requirements that are relevant with the functional scope of the PJ.10-02a1 Solution and which have been V3-validated by SESAR1 projects (P4.7.2 or P5.7.2). Such requirements mainly concern the TC-Aid and the Monitoring aid and can be retrieved in SESAR1 outcomes.

4.1.3 Naming rules

Requirement identifiers follow the schema:

REQ-10.02a-SPRINTEROP-XXXX.zzzz

'XXXX' is set to:

- 'PC00' or 'TC00' for Operational requirements related to Separation Assurance
- 'CMON' for Operational requirements related to Conformance Monitoring
- 'SAFE' for Safety requirements
- 'SECU' for Security requirements
- 'PERF' for Performance requirements

- ‘HPRF’ for Human Performance requirements
- ‘IER0’ for Information Exchange requirements
- ‘IOP0’ for Interoperability requirements
- ‘EPP0’ for requirements related to the use of ADS-C EPP data

‘zzzz’ is a numerical identifier.

4.2 PJ.10-02a2 V2 requirements

The following V2 requirements mainly concern the use of ADS-C EPP data through CM-0209-b and CM-0210-b OI’s.

4.2.1 Operational Requirements (at OSED level)

The two PJ.10-02a2 exercises addressing EPP concerns (EXE 006 and EXE 007) have permitted to highlight some high level operational requirements in relation with the use of those ADS-C EPP data to improve the ground trajectories.

[REQ]

Identifier	REQ-10.02a2-SPRINTEROP-EPP0.0001
Title	Identification of ADS-C EPP data update into ground TPs
Requirement	The ATCO should easily understand when the ADS-C EPP data is used for the TP improvement and when it’s not
Status	<in progress>
Rationale	As long as ADS-C EPP data will impact the precision of the ground TP, it is necessary for ATCOs to know when a trajectory is updated with those ADS-C EPP data, and more precisely to clearly know when a trajectory is not updated with those data. So that they can possibly consider more margin in their resolution strategies in such a case.
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a

<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI Determine planning problems at offered entry conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a2-SPRINTEROP-EPP0.0002
Title	ADS-C EPP data validity information
Requirement	There should be clear indication if there's a degradation of the EPP information or if there isn't any information at all
Status	<in progress>
Rationale	Because it is likely that ATCOs are going to optimize trajectories and to reduce their personal buffers on top of the minimal separation applicable (5NM or 3NM) in case of a very precise trajectory updated with ADS-C EPP data, they need to be informed immediately in case of a non reliable information transmission, or in case of a sudden lack of ADS-C EPP information update.
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI Determine planning problems at offered entry conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route

		Terminal Airspace

[REQ]

Identifier	REQ-10.02a2-SPRINTEROP-EPP0.0003
Title	PC-Aid display margin even with ADS-C EPP data improved TPs calculations
Requirement	The system should have the possibility to present situations where the CPA (Closest Point of Approach) is close to minimum required separation, but no PC-Aid alert is furthermore displayed due to EPP enhanced TP
Status	<in progress>
Rationale	As long as ATCOs are still in charge of the provision of separation, they have to be informed of a situation where the CPA is above the minimum separation threshold, but still close enough to keep an eye on it. In a further automated environment, where a system would be in charge of the separation, the combination of the CMON and the detection-service should be sufficient to let down this kind of margin considerations. But a human operator needs to have an up-to-date mental image of the situation, and needs to be aware of close convergences even above the legal minimum of separation.
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Assess planned/desired profile for problems within AoR/AoI
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace

		En-Route

4.2.2 Safety and Performance Requirements (at SPR level)

Disclaimer: The following V2 requirements linked to the use of EPP in improvement of the ground Trajectory Prediction, are not requirements that have been directly addressed by any PJ.10-02a2 validation exercise. They are derived from calculations made by safety experts, as explicitly detailed into the SAR [53] in which further explanations on how those Safety Requirements have been issued are provided.

In the case of a steady aircraft flying towards a Waypoint, the ADS-C EPP data contains an expected time of arrival at this Waypoint, together with a value of the CAS.

[REQ]

Identifier	REQ-10.02a2-SPRINTEROP-EPP0.0004
Title	Use of ADS-C EPP data in the improvement of the TP of a steady flight
Requirement	For a steady EPP-equipped aircraft flying towards a waypoint, the Ground Speed should be derived from the EPP distance and the EPP estimate of the next waypoint.
Status	<in progress>
Rationale	In such a flight configuration, there are two ways to predict the aircraft trajectory towards the waypoint: 1) From the EPP distance and the time of arrival to the waypoint, derive a Ground Speed (GS), and extrapolate the aircraft trajectory with this Ground Speed. 2) Convert the EPP CAS into a True Air Speed (TAS), then add an estimate of the wind speed to this TAS in order to estimate a Ground Speed. If both methods are possible, the first one is preferable (expert judgment).
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory Determine planning problems at offered entry conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

If the aircraft flies towards a waypoint, being in vertical evolution, both the predicted speeds in EPP waypoints and the 4D trajectory prediction provided by the EPP shall be used to provide an optimal estimate.

[REQ]

Identifier	REQ-10.02a2-SPRINTEROP-EPP0.0005
Title	Use of ADS-C EPP data in the improvement of the TP of an evolving flight
Requirement	For an evolving EPP-equipped aircraft flying towards a waypoint, the Ground Trajectory should be derived from the predicted speeds in EPP waypoints and the 4D trajectory prediction provided by the EPP.
Status	<in progress>
Rationale	A usual assumption is that the aircraft keeps a constant CAS along the vertical sections defined by the predicted speeds in EPP waypoints. The algorithm detailed into the SAR makes the best use of the EPP report, in the sense that it is compliant with the “Constant CAS” assumption, and that the aircraft flies with the CAS provided by the EPP report, and arrives at the different Waypoints as indicated in the EPP report.
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a

<ALLOCATED_TO>	<Activity>	Modify trajectory Determine planning problems at offered entry conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

The EPP profile has to consider operational vertical constraints from the Ground (such as Letters Of Agreement, or a possible negotiation of the Exit FL with the downstream Sector) in order to be reliable in any cases. In such a case, if a Ground constraint applies, then the ADS-C EPP data should be appropriately incorporated into the ground TP in order to keep those operational constraints.

[REQ]

Identifier	REQ-10.02a2-SPRINTEROP-EPP0.0006
Title	Caution in use of ADS-C EPP data in the improvement of the TP in case of Ground constraints on the trajectory
Requirement	For an EPP-equipped aircraft, the Ground Trajectory shall use an appropriate merge of ADS-C data and ground information if any Ground constraint is applicable.
Status	<in progress>
Rationale	Ground constraints mean operational constraints in vertical (letter of Agreement, negotiation of the Exit FL) that are ignored by airborne systems. As long as aircraft view is not connected to possible Ground constraints that may exist, it is necessary to use ADS-C EPP data with heedfulness if some Ground-Ground coordination are in progress, or if some LOAs constraints are applicable according to the real time ACC sectors split. In order to avoid a loss of information from the Ground.
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier

<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory Determine planning problems at offered entry conditions
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

In the case of a What If for a horizontal clearance (such as a heading), the previous algorithm will have to be modified in order to consider the impact of the wind on the aircraft trajectory.

[REQ]

Identifier	REQ-10.02a2-SPRINTEROP-EPP0.0007
Title	Impact of the wind on ADS-C EPP data to be considered into the What-if service
Requirement	For an EPP-equipped aircraft on which a What-if horizontal clearance applies, the longitudinal part of the tentative trajectory should derive from the Ground trajectory by adapting the wind conditions accordingly to MET data.
Status	<in progress>
Rationale	The trajectory prediction should be modified by subtracting the “Wind Along Track” and adding the “Wind along track (What If).
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory Determine planning problems at offered entry conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller

<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

4.2.3 INTEROP Requirement

4.2.3.1 Information Exchange Requirements (at Service level)

There is no Information Exchange requirement at V2 level.

4.2.3.2 Interoperability Requirements (at System level)

There is one Interoperability Exchange requirement that is considered at V2 level, as it concerns the ADS-C EPP data.

[REQ]

Identifier	REQ-10.02a2-SPRINTEROP-IOP0.0002
Title	ADS-C data
Requirement	The ATC System shall receive trajectory data from the aircraft using data link.
Status	<in progress>
Rationale	Having aircraft downloaded data such as ADS-C EPP reports can be used to compute a more accurate trajectory and therefore improve conflict detection tools.
Category	<Interoperability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Information Flow>	Execute ATC clearance o--> Modify trajectory (CMON) Execute ATC clearance o--> Modify trajectory Execute ATC clearance o--> Determine planning problems at offered entry conditions

4.3 PJ.10-02a1 V3 requirements

All requirements in the current section are “Validated”.

4.3.1 Operational Requirements (at OSED level)

All requirements in the current section are traced with the <Operational> category

4.3.1.1 Planning Separation Assurance

This section includes all operational requirements about the “PC aid”.

It encompasses:

- Operational requirements to comply with the OI CM-0211. These requirements are mainly issued from the non-validated requirements from SESAR1 projects P04.07.02 and P05.07.02.
- New Operational requirements, to comply with the Planning part of CM-0206 and CM-0209

4.3.1.1.1 General requirements

There is no reason to deprive an ATCO of the detection of mid-term encounters at least to share the situational awareness between Planning and Tactical roles. So the “PC aid” has to be available to all ATCOs, whatever her/his role (Tactical or Planner). As this is a Safety issue, the related requirement has moved to the Safety section.

On the other side, it is not operationally required for the ATCOs to use the “PC aid”, so it is up to each ATCO to decide to display it or not (select or deselect). Depending on the implementation, it could be beneficial to deselect the “PC aid” e.g. in order to train ATCOs’ own conflict detection.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0001
Title	“PC aid” selection/de-selection
Requirement	The ATCO shall have the ability to display/remove from display the "PC aid" tool.
Status	<validated>
Rationale	It is up to each ATCO to decide to display the “PC aid” or not (select or deselect). Depending on the implementation, it could be beneficial to deselect the “PC aid” e.g. in order to train ATCOs' own conflict detection. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-005
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess entry conditions and desired/planned profile through AoR/AoI
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

The “PC aid” has to be flexible enough to support ATCOs within whatever environment. It does not preclude some features to be specific to a given environment e.g. detection thresholds shall be specific depending on whether the airspace is En-Route or TMA.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0002
Title	Airspace where the “PC aid” applies
Requirement	The "PC aid" shall be capable of operating within all types of airspace.
Status	<validated>
Rationale	The “PC aid” has to be flexible enough to support the ATCO within whatever environment e.g. sectors whose boundaries are defined by a geographical area and upper and lower levels (which may not be the same throughout the whole sector), within free routing airspace, within TMA. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess entry conditions and desired/planned profile through AoR/AoI

		Determine planning problems at offered entry conditions Assess trajectory profile through the AoR for tactical controller suitability Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0003
Title	"PC Aid" in Free Routing Airspace
Requirement	The "PC aid" shall be capable of operating with no reference to a fixed route network.
Status	<validated>
Rationale	The "PC aid" is essential in Free-Route Airspace, so it must be independent on any fixed airspace item to enable any Free Routing Airspace design This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-001.
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess entry conditions and desired/planned profile through AoR/AoI Assess trajectory profile through the AoR for tactical controller suitability Determine planning problems at offered entry conditions Determine safe potential exit conditions

<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0023
Title	Access to RTE VIA clearance
Requirement	RTE VIA shall be available for aircraft planned to enter their AoR a certain time or distance before the sector boundary.
Status	<validated>
Rationale	To be able to provide early conflict resolution or rerouting, the planner or executive need to act on aircraft about to enter the sector. Time or distance are subject to local implementations and inter-sector or inter-centre agreements. This requirement has been validated in EXE-10.02a-V3-VALP-005
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Issue clearances Revise entry conditions if needed in coordination with upstream sector
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0025

Title	Sector team awareness of an aircraft cleared on a RTE VIA
Requirement	When either the PC or EC has given a RTE VIA instruction to an aircraft, a clear indication shall be provided at both work positions.
Status	<validated>
Rationale	For situational awareness to both ATCOs, the system indicates that the aircraft is flying towards a “VIA” point of the new route preferably through an indication in the label of the aircraft. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Revise entry conditions if needed in coordination with upstream sector Issue clearances
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0026
Title	PC and EC procedure for input of RTE VIA
Requirement	There should be a procedure between EC and PC before input of a RTE VIA into the system.
Status	<validated>

Rationale	PC and EC may attempt to make a RTE VIA input on the same aircraft, or may start resolving a conflict between two aircraft while making opposing inputs. This may delay the resolution of a conflict, or result in no improvement of the situation or even its deterioration. Therefore, there should be a local procedure for the input of a RTE VIA. This may involve prior communication between PC and EC before any input, and/or an indication on the screen by the PC or EC that a certain conflict is under resolution. In the case when the PC is resolving a conflict without prior communication, they should aim to do so before the aircraft are in the AoI of the EC. That would minimize the chance that the EC is attempting to resolve it. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Coordinate within the CWP for sharing situational awareness
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0027
Title	Downstream sector consideration of the impact on the upstream before proposing a RTE VIA clearance.

Requirement	Before proposing a RTE VIA clearance, the downstream sector should consider its impact on the workload of the upstream ATCOs and the distance of the aircraft to their boundary.
Status	<validated>
Rationale	To minimize the possibility that the upstream sector may have conflicts or pending actions with the subject aircraft, the downstream sector should not send requests too early before the boundary. Exact distance and time parameter is to be specified in local procedures. This requirement may be waived if the downstream sector ATCO is able to confirm with sufficient certainty that there are no such conflicts and/or actions. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Make coordination offer to downstream sector
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0028
Title	RTE VIA conversion to CPDLC message
Requirement	The system shall convert a RTE VIA input by the ATCO into a corresponding CPDLC message, ready for uplink to the aircraft.
Status	<validated>

Rationale	Example of message used is UM79 “UM79 CLEARED TO (position) VIA (route clearance)” where (route clearance) is the point selected by the ATCO which is not on the original route and (position) is the re-joining point. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Issue clearances Revise entry conditions if needed in coordination with upstream sector
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

4.3.1.1.2 Detection

Each sector/volume/airspace shall be provided with encounters that are relevant for its operations. They include at least the encounters that involve the aircraft distributed for control to the CWP. The aircraft distributed for control to the CWP are called the “eligible flights for detection”. They include not only the aircraft that are actually in frequency with the sector, but also flights that should be transferred soon to the sector.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0004
Title	Eligible flights for detection
Requirement	For a given CWP, the "PC aid" shall define the set of “eligible flights for detection” depending on local criteria, including at least the flights that are distributed for control to the CWP.
Status	<validated>

Rationale	The flights distributed for control to the CWP not only include the aircraft that are currently in frequency with the sector, but also flights that will be transferred soon to the sector. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

The “PC aid” is a mid-term tool that mainly aims to support the coordination task. At least the entry and exit conditions shall be assessed.

The “PC aid” might also detect the “risk” encounters, however as the “TC aid” is dedicated to the management of encounters that may occur during the traversal of the sector depending on the local clearances, it may be inappropriate to pollute the coordination supporting tool with encounters that do not concern the entry or exit conditions. So the detection of “risk” encounters by the “PC aid” is possible but it is not required.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0005
Title	"PC aid" encounters types
Requirement	For a given CWP, the "PC aid" shall detect the encounters regarding the entry or exit conditions of each eligible flight.
Status	<validated>

Rationale	It does not preclude “risk” encounters to be detected, however this depends on local implementation This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001.
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

The “PC aid” objective is to display encounters involving at least one “eligible” flight. It does not preclude that other encounters may be displayed.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0006
Title	“PC aid” detection of 2-aircraft encounters
Requirement	For a given CWP, the “PC aid” shall detect all 2-aircraft encounters involving at least one eligible flight.
Status	<validated>
Rationale	This is the minimum set of encounters to be detected. Depending on local implementation, encounters involving no eligible flights may also be displayed. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

The “PC aid” detection is based on a mid-term prediction of the flight behaviour. As it is mainly a Planning tool, it has to consider a stable mid-term prediction of flight behaviour, with no need to consider the little and local deviations due to open tactical clearances.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0007
Title	“PC aid” detection basic principle
Requirement	The "PC aid" shall use a mid-term prediction of the flight behaviour to detect the encounters, with no consideration of any open loop clearance.
Status	<validated>
Rationale	It does not preclude the resolution open-loop clearances to be considered for removing short term encounters. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a

<ALLOCATED_TO>	<Activity>	Assess entry conditions and desired/planned profile through AoR/AoI Assess trajectory profile through the AoR for tactical controller suitability
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

To support the ATCO, not only the initial detection of encounters is useful, but also the monitoring of them in order to upgrade them or to delete them when the situation is not conflicting any longer.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0008
Title	“PC aid” continuous monitoring
Requirement	The "PC aid" shall continuously update and monitor any planning encounter.
Status	<validated>
Rationale	It is important that the “PC aid” remains up-to-date with the flight modifications. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller

<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

The “PC aid” has to hide encounters that would occur long after the involved eligible flights have left the sector, because it is out of the responsibility scope of the sector team.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0010
Title	"PC aid" range of detection
Requirement	For a given CWP, the "PC aid" shall discard encounters that would occur long after the involved eligible flights have left the Area of Responsibility.
Status	<validated>
Rationale	“long after” is a sector-based time/distance parameter. This requirement has been validated in EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine safe potential exit conditions Determine planning problems at offered entry conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

4.3.1.1.3 Display

4.3.1.1.3.1 Display of the conflicting traffic

In addition to aircraft interfering encounters, displayed automatically, ATCOs need to be able to display on demand other flights associated, in order to support their mental image.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0011
Title	Display of the context traffic
Requirement	For a given CWP and for a subject flight, the "PC aid" shall indicate the other flights associated to the encounters involving the subject flight.
Status	<validated>
Rationale	It is necessary for the ATCO to get a mental image of the context traffic, on demand. This requirement has been validated in EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

4.3.1.1.3.2 Display of encounters

The detected encounters between two aircraft have to be displayed to the ATCO, together with their essential attributes.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0012

Title	Display of 2-aircraft encounters
Requirement	For a given CWP, the "PC aid" shall display the encounters of the eligible flights on the controllers HMI.
Status	<validated>
Rationale	Basic requirement about the output towards the main users of the “PC aid”. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0013
Title	Encounter information
Requirement	The ATCO shall be provided with all of the relevant information needed for each encounter.
Status	<validated>

Rationale	To prevent separation infringements, the controller has to be informed about flight encounters (and all the relevant details) in order for the appropriate action to be made: the a/c pair, their minimum separation, in which sector the infringement will occur, the CPA (Closest Point of Approach), etc. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0014
Title	Display of the conflict geometry
Requirement	In Free Routing Airspace, the "PC aid" shall display the conflict geometry as one relevant information of each encounter.
Status	<validated>
Rationale	In Free Routing Airspace, the geometry is one key aspect of the encounters. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0015
Title	First encounter
Requirement	If two aircraft are involved with more than one encounter with each other the “PC Aid” shall only display the first encounter.
Status	<validated>
Rationale	Since it is assumed that the secondary encounter may disappear as soon as the first encounter has been solved, the “PC aid” will only display the first encounter to avoid visual clutter and make it easy for the controller to distinguish information. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller

		ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

The “PC aid” is used to detect conflicting situations in advance, leaving time to choose the most relevant resolution. In some cases, a complex situation may be solved with a limited impact on aircraft. It is thus relevant to display a conflicting situation involving more than two aircraft, if trajectories are much imbricated. Such a complex situation may be solved consistently, and not conflict by conflict.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0016
Title	Display of n-aircraft encounters
Requirement	The "PC aid" should display inter-dependant encounters into a single multi-aircraft encounter.
Status	<validated>
Rationale	Inter-dependant encounters are encounters that may be solved as a whole. It is namely the case when every involved flight has an encounter with the others, and all these encounters concern the entry of the flight (or the exit). This requirement has been validated in EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine safe potential exit conditions Determine planning problems at offered entry conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

The “PC aid” mainly supports coordination tasks, however it is important to distinguish between coordination conflicts that have to be solved, and potential conflicts that will occur only when the intended exit conditions are met.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0017
Title	Particularization of potential exit encounters
Requirement	The "PC aid" shall display differently the encounters resulting from the intended flight exit conditions that are not met yet.
Status	<validated>
Rationale	A dedicated window may encompass those encounters. The encounters that concern the exit conditions that are not met yet e.g. CFL differs from XFL, are part of the coordination tasks but they do not represent any problem for the moment. Such an encounter is not a conflict to be solved by the controller, it is a non-existing situation that has to be avoided. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

Because of uncertainties, it happens that some encounters are more critical than others. The “critical” encounters correspond to low uncertainties and to a low predicted separation so they represent “for sure” a conflict that will occur. At the opposite, if the encounter is detected long in advance and the predicted separation is large, the encounter is likely to be removed once the uncertainties diminish.

The “PC aid” should display differently the encounters depending on whether they are critical or not, in order for the ATCO to focus on the critical ones when they are under workload pressure.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0018
Title	Critical encounters
Requirement	The “PC aid” shall clearly identify the critical encounters.
Status	<validated>
Rationale	Critical encounters are those that will certainly occur. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine safe potential exit conditions Determine planning problems at offered entry conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

4.3.1.1.4 Manual management

The manual management of the “PC aid” is a feature that is very dependent on local decisions. As a minimum, the ATCO must have the capability to remove any displayed encounters that are non-conflicting situations according to ATCOs’ judgment. This is moved to the Safety section, because it may negatively impact the ATCO’ situational awareness.

4.3.1.1.5 Probing services

As the “PC aid” focuses on coordination encounters, the probing functions focus on ATC instructions that may impact the entry/exit conditions. The Planning what-if probe permits the ATCOs to assess the consequences of one ATC action in terms of mid-term encounters. The Planning what-else probe permits the ATCO to be provided with a list of non-conflicting ATC actions.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0019
Title	Planning What-if or What-else probing
Requirement	For a given eligible flight (the subject flight), the ATCO shall have the possibility to probe a change in entry or exit conditions with regards to the related encounters.
Status	<validated>
Rationale	The what-if probe permits the ATCO to assess the consequences of one ATC action in terms of mid-term encounters. The what-else probe permits the ATCO to be provided with a list of non-conflicting ATC actions. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-003
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess entry conditions and desired/planned profile through AoR/AoI Make coordination offer to downstream sector Revise entry conditions if needed in coordination with upstream sector
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route

		Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0020
Title	Planning What-If conflict detection
Requirement	The Planning What-If probe shall create a temporary tentative trajectory supporting the detection service.
Status	<validated>
Rationale	The detection service is then used to display the risk of or the lack of tactical conflicts. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess entry conditions and desired/planned profile through AoR/AoI Make coordination offer to downstream sector Revise entry conditions if needed in coordination with upstream sector
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

In order to reflect the complexity of some ATC actions, the What-if probes may concern either a simple ATC action or several ATC actions combined together.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0021
Title	Multiple probes
Requirement	The "PC aid" shall permit the ATCO to probe a unique parameter (CFL, DCT, XFL…) or a combined set of parameters.
Status	<validated>
Rationale	The combination of parameters to probe together depends on local implementation and on probing service (what-if / what-else). This requirement has been validated in EXE-10.02a-V3-VALP-004
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess entry conditions and desired/planned profile through AoR/AoI Make coordination offer to downstream sector Revise entry conditions if needed in coordination with upstream sector
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

At end of a What-if probe, when the ATCO has assessed the consequences of its potential actions, it is important that the “PC aid” reverts back to the real life with the actual parameters.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0022
Title	What-if cessation
Requirement	On cessation of a what-if probe, the "PC aid" shall remove all data related to the what-if probe.

Status	<validated>
Rationale	It should remain no risk of interfering with a simulated data. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-005 & EXE-10.02a-V3-VALP-001
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess entry conditions and desired/planned profile through AoR/AoI Make coordination offer to downstream sector Revise entry conditions if needed in coordination with upstream sector
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

4.3.1.1.6 Coordination

In order to ensure a proper planning detection service, the planning trajectories have to be amended in accordance to neighbouring sector strategies. Therefore a coordination process is necessary for those trajectories, on which the planning detection service is going to be performed.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0029
Title	RTE VIA coordination with upstream sector
Requirement	Once the RTE VIA has been input by the PC or EC, the system shall allow it to be coordinated with the upstream sector.
Status	<validated>

Rationale	For early conflict resolution or rerouting, the clearance is proposed to the upstream sector for uplink to the aircraft. PC and EC of the proposing sector are provided with an indication that coordination is ongoing. The upstream sector can view the proposal graphically and accept or reject it. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Revise entry conditions if needed in coordination with upstream sector
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0030
Title	RTE VIA WILCO by the pilot and display of the new waypoint
Requirement	Once WILCO from the cockpit has been received on the new route the system shall indicate this to both EC and PC.
Status	<validated>
Rationale	For situational awareness to both ATCOs, the system shall indicate that the aircraft is flying towards a “VIA” point of the new route preferably through an indication in the label of the aircraft. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Issue clearances
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0031
Title	Timing of the RTE VIA
Requirement	Any RTE VIA should be given a sufficient time before the conflict.
Status	<validated>
Rationale	Several factors contribute to the delay in issuing a route modification: - Input by the ATCO in the system (may include several probe inputs); - Upstream sector workload and assessment of a proposed clearance; - Flight crew assessment, input of route clearance in the FMS and WILCO; Due to this delay, ATCOs should use it only when sufficient time is available. This requirement has been validated in EXE-10.02a-V3-VALP-005
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Issue clearances Revise entry conditions if needed in coordination with upstream sector
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-PC00.0032
Title	Downstream sector awareness of an incoming aircraft cleared on a RTE VIA
Requirement	The downstream sector should be aware through the system if any incoming aircraft are subject to a RTE VIA when the VIA point is close to the sector boundary or when the change of the trajectory is outside of LoA conditions.
Status	<validated>
Rationale	As with existing waypoints (REV highlight?) it should be obvious to the downstream sector that a RTE VIA is performed, so that they can anticipate any turns at the VIA point close to the boundary (parameter subject to local system tuning). In case the VIA point is further out in the upstream sector, but takes the trajectory outside of entry conditions as per LoA (parameter subject to local system tuning) this should also be obvious. In both cases this may be done through e.g. displaying the VIA point in the normal label, or highlighting it if it is already displayed. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Make coordination offer to downstream sector
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

4.3.1.2 Tactical Separation Assurance

This section encompasses Operational requirements, to comply with the Tactical part of CM-0206 and CM-0209

The “TC aid” related Operational Requirements that have been V3-validated in SESAR1 Solution#27 are not duplicated in this section. Only the extra requirements that are needed to comply with CM-0206 and CM-0209 are included.

4.3.1.2.1 Service availability and general requirements

The availability of the “TC aid” is required in SESAR1 and it has been V3-validated (REQ-04.07.02-OSED-0001.1001).

The airspace where the “TC aid” is available has been partly V3-validated in SESAR1 (En-Route environment). The following requirement completes with the TMA requirement.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0014
Title	"TC Aid" service
Requirement	The system shall provide the “TC Aid” service at every CWP.
Status	<validated>
Rationale	Depends on a local decision from ops people. Recommendations on the relevant conditions & environment for implementing the service shall be provided. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.1001 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA

Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI Establish necessary separation Assess planned profile constraints or agreed coordinations
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0015
Title	Switch off/on the "TC Aid"
Requirement	At each CWP, an eligible operator shall be capable of enabling or disabling the “TC Aid”.
Status	<validated>
Rationale	This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.2001 in En-Route, validated in EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI

<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0001
Title	Airspace where the “TC aid” applies
Requirement	The “TC aid” shall be available for any controlled airspace of both TMA and En-Route operational environment.
Status	<validated>
Rationale	This requirement has been validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI Establish necessary separation Assess planned profile constraints or agreed coordinations Modify trajectory
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0002

Title	"TC aid" in Free Routing Airspace
Requirement	The "TC aid" shall be capable of operating with no reference to a fixed route network.
Status	<validated>
Rationale	The "TC aid" is essential in Free-Route Airspace, so it must be independent on any fixed airspace item to enable any Free Routing Airspace design. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 in En-Route, validated by EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory Assess planned profile constraints or agreed coordinations Assess planned/desired profile for problems within AoR/AoI Establish necessary separation
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

The “TC Aid” is a service giving Tactical Separation Information data to ATCO, which are updated at a defined frequency or on manual input.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0003
Title	Update frequency of tactical data

Requirement	The “TC Aid” service shall be updated at a predefined frequency and upon user input.
Status	<validated>
Rationale	The operational use of tactical data requires a dynamic system updates, therefore two types of updates are required which need to be initiated upon: • predefined update interval and • each manual “TC aid” system input made by the ATCO. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 in En-Route, validated by EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory Establish necessary separation Assess planned/desired profile for problems within AoR/AoI Assess planned profile constraints or agreed coordinations
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

4.3.1.2.2 Prediction of Tactical Trajectories

The principles of the prediction of tactical trajectories have been V3-validated in SESAR1.

In particular, the use of open and closed tactical clearances has already been required and V3-validated in SESAR1 (REQ-04.07.02-OSED-0001.2043 for lateral clearances and REQ-04.07.02-OSED-0001.3124 for vertical clearances).

The “TC aid” shall detect short-term encounters (called tactical encounters) by comparing two tactical trajectories. This has already been required and validated in SESAR1 (REQ-04.07.02-OSED-0001.2007).

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0016
Title	Lateral clearance processing
Requirement	The “TC Aid” shall accept lateral clearance input from the controller and consider the reaction time of controller and pilot for calculation of the tactical trajectory.
Status	<validated>
Rationale	A fixed time buffer plus an additional variable time buffer dependant on the turn progress of the aircraft shall be used. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3091 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0017
Title	Tactical Reference Flight Path
Requirement	For a given aircraft, the “TC Aid” shall calculate a tactical reference flight path based on the route and the active lateral clearance(s).

Status	<validated>
Rationale	This reference is required for flight path monitoring in order to determine lateral deviations. The tactical reference flight path reflects the current clearance status of the flight. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.2043 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0018
Title	Vertical Clearance Processing
Requirement	The TC Aid shall accept vertical clearance input from the controller and consider the reaction time of controller and pilot for calculation of the tactical trajectory.
Status	<validated>
Rationale	CFL, vertical rate. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3124 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0019
Title	CFL setting
Requirement	Each aircraft shall have a Cleared Flight Level (CFL) based on the system flight plan data, defaulted to the Entry Flight Level (NFL) of the first controlled sector if no CFL is available, or be dealt with as if it is CFL deviated if neither CFL nor NFL are available.
Status	<validated>
Rationale	Makes sure that each flight has a CFL. Pre-requisite for trajectory calculation and CMON. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3089 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route

		Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0020
Title	Predict the Ground speed
Requirement	The “TC Aid” shall base the speed of an aircraft on the ground speed, taking into account the expected speed change at a different altitude.
Status	<validated>
Rationale	For the expected speed increase/decrease with increasing/decreasing altitude a constant acceleration is assumed. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3007 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0021
Title	Predict the vertical trajectory

Requirement	The “TC Aid” shall base the speed and altitude change of the aircraft on the actual rate (or cleared rate if available) from AFL to CFL if the aircraft climbs or descends towards the CFL.
Status	<validated>
Rationale	This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3112 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0027
Title	Conditions to predict the lateral part of the trajectory
Requirement	If no lateral deviation has been detected by CMON, the “TC Aid” shall calculate the lateral part of the Tactical Trajectory from the actual position: a) NO LATERAL CLEARANCE: along the cleared route; b) OPEN HEADING: to extrapolated lat/long position based on the cleared heading c) ON-ROUTE DIRECT: to the cleared fix, and then along the cleared route d) OFF ROUTE DIRECT: to the cleared fix
Status	<validated>

Rationale	Lateral part of the Tactical Trajectory (no deviation detected). In case of an OFF ROUTE DIRECT the trajectory ends at the fix. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3093 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0028
Title	Predict the vertical part of the trajectory
Requirement	The "TC Aid" shall calculate the vertical part of the tactical trajectory either based on the actual rate plus a rate buffer if the aircraft shows any vertical movement, or else based on a minimum and maximum rate if the aircraft is still at level and the controller has given a vertical clearance beforehand.
Status	<validated>

Rationale	The actual rate is derived from downlinked Mode-S DAP if available. Rate buffer reflects vertical uncertainty; several cases need to be distinguished (e.g. in case of vertical deviation). The change of the ground speed during climb or descent shall be respected. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3011 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

4.3.1.2.3 Detection

Each ATCO shall be informed about tactical encounters that are relevant in the assigned area of responsibility (AoR) and in the area of interest with a pre-defined buffer [parameter] around the AoR. They include at least the encounters that involve the flights distributed for control to her/his assigned sector. All flights that are actually in the current data authority (CDA), crossing nearby sector boundaries or expected to be transferred soon to the sector are called the “eligible flights”.

The “TC aid” is active for all eligible flights.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0004
Title	Eligible flights
Requirement	For a given CWP, the "TC aid" shall define “eligible flights” as flights that are within the AoR or within the AoI.
Status	<validated>

Rationale	The “TC aid” must detect any encounter involving flights in AoR or in AoI, in order for the ATCO to solve conflicts if it under sector’s responsibility, or at least to be aware of any conflicting situation near the sector. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0005
Title	Eligible flights for the “TC aid”
Requirement	For the assigned area of responsibility (AoR) and in the area of interest (AoI), the "TC aid" shall be active for all “eligible flights”.
Status	<validated>
Rationale	All eligible flights within the AoR and predefined AoI for conflicts beyond certain distance from the sector boundaries of AoR need to be assessed by the “TC Aid” for the purpose of operational safety. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI Establish necessary separation
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

The lateral and vertical separation minima that the “TC aid” shall use are already required and validated in SESAR1 (REQ-04.07.02-OSED-0001.2007) and it has been validated in PJ.10-02a1 (see hereafter). However the TMA environment requires to consider also time-based separation minima.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0029
Title	"TC Aid" detection of tactical encounters
Requirement	The “TC Aid” shall detect potential conflicts within a defined conflict area within a certain time horizon between any two aircraft by determining the minimal lateral and vertical distances reached along the predicted tactical trajectories of the two aircraft
Status	<validated>
Rationale	At least one aircraft needs to be within the conflict detection area. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.2007 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Establish necessary separation
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0006
Title	Distance and time-based operations dimensions of “TC aid” detection
Requirement	For TMA environment, the “TC aid” shall provide to the EC traffic conflict detection within the lateral, vertical or temporal dimensions or a combination thereof.
Status	<validated>
Rationale	The “TC aid” needs to consider two types of separation depending on the operational environment: (1) minimum distance **and** (2) time based. Time-based separation (TBS) is theoretically applicable for defined conflict geometries both in En-Route and TMA, but is only used in TMA. For this TMA environment, it is additionally applicable to aircraft trajectories within a predefined parameter from touchdown. This parameter is determined based on local specifics, local procedures for TBS operations, runway configurations and use. This requirement has been validated in EXE-10.02a-V3-VALP-004 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier

<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace

The “TC aid” shall use specific separation minima for the specific airspace where it applies. This has already been required and V3-validated in SESAR1 (REQ-04.07.02-OSED-0001.3035).

The “TC aid” shall use a separation infringement risk buffer considering the applicable separation minima. This has already been required and V3-validated in SESAR1 (REQ-04.07.02-OSED-0001.3011) however it also applies to the time-based separation minima.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0007
Title	Risk buffer
Requirement	The “TC aid” shall consider a predefined separation infringement risk buffer, to detect encounters.
Status	<validated>
Rationale	The separation infringement risk buffer is defined either in absolute terms or in relative terms as a percentage of the separation minima applicable for the specific airspace. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI

<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

A tactical encounter shall be detected within a predefined look-ahead time horizon. This has already been required and V3-validated in SESAR1 (REQ-04.07.02-OSED-0001.2007).

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0030
Title	Lateral conflict detection
Requirement	The “TC Aid” shall identify aircraft pairs that have the potential, based on the existing clearance, to infringe the lateral separation of interest within a configurable look ahead time.
Status	<validated>
Rationale	Check lateral separation minima. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3027 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0031
Title	Vertical conflict detection
Requirement	The “TC Aid” shall identify aircraft pairs that have the potential, based on the existing clearance, to infringe the vertical separation of interest within a configurable look ahead time based on the interval between minimum FL and maximum FL.
Status	<validated>
Rationale	Check vertical minima. The minimum and maximum FL shall be calculated by taking into account the vertical minimum and maximum rate buffer of the trajectories. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3028 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

4.3.1.2.4 Resolution

4.3.1.2.4.1 Probing services

The What-If and What-else services let the ATCO create tentative Tactical Trajectories that support the Detection service.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0032
Title	TC Resolution Advisory
Requirement	The “TC Aid” shall perform a What Else Probing periodically whenever new data is available by simulating different possible (fictive) clearances for a particular aircraft and determine if such a clearance would result in a conflict with any of the other aircraft for which the currently active clearances are assumed.
Status	<validated>
Rationale	What-Else look ahead time should always be longer than EC conflict detection look ahead time because the probing must not trigger an alarm after implementation. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3038 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Establish necessary separation Assess planned/desired profile for problems within AoR/AoI
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

The What-else and the What-If services may be activated on any tactical order.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0008

Title	Tactical What-Else activation
Requirement	In TMA, the Tactical What-Else service may be activated individually for any kind of tactical clearance before the instruction is being provided by the ATCO.
Status	<validated>
Rationale	In TMA, the TC-Aid is similar as in En-Route: the what-else service is activated on ATCO's demand, in order to rapidly find a conflict-free clearance. This is rather a supporting service than a necessary one. The list of kinds of clearances that can be probed depends on local implementation. This requirement has been validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI Establish necessary separation Select clearance to achieve desired profile Select clearance to respect agreed constraints or coordinations
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0009
Title	Tactical What-If activation

Requirement	The Tactical What-If service may be activated individually for any tactical clearance before the instruction is being provided by the ATCO.
Status	<validated>
Rationale	The what-if service is activated on ATCO demand, in order to assess an ATC instruction. This is rather a supporting service than a necessary one. The list of clearances that can be probed depends on local implementation. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 in En-Route, validated in EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Select clearance to achieve desired profile Select clearance to respect agreed constraints or coordinations Assess planned/desired profile for problems within AoR/AoI Establish necessary separation
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

The What-If probe shall create a temporary tentative Tactical trajectory supporting the Detection service that may detect and display the risk of and lack of tactical conflicts.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0010
Title	What-If conflict detection

Requirement	The Tactical What-If probe shall create a temporary Tactical trajectory supporting the detection service.
Status	<validated>
Rationale	The detection service is then used to display the risk of or the lack of tactical conflicts. This requirement has been validated in EXE-10.02a-V3-VALP-003 in En-Route, validated in EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0011
Title	What-If conflict detection visualisation
Requirement	The visual outcomes from the Tactical What-If service shall be unambiguously separated from the other “TC aid” results.
Status	<validated>
Rationale	Both the detected what-if encounters and the tentative trajectory need to be clearly separated from the nominal outcomes from the “TC aid” in order to be unambiguously identified by the ATCO. This requirement has been validated in EXE-10.02a-V3-VALP-007
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI Assess planned profile constraints or agreed coordinations
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

During a What-if probe, the “TC aid” may assist the ATCO by looking for other possible actions. The list of other possible actions defines the What-else service. The What-else service has been defined and V3-validated in En-Route in SESAR1 (REQ-04.07.02-OSED-0001.3038 and REQ-04.07.02-OSED-0001.4009), it is completed by the following requirement in TMA:

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0012
Title	What-else probes in TMA
Requirement	In TMA, the "TC Aid" shall provide on demand a set of conflict-free clearances by probing among the following possible (fictive) clearances for a particular aircraft: a) Level clearances including rates (all suitable level clearances multiplied by number of vertical rates); b) Direct clearances – for fixes on route and off route; c) Open heading/track clearances (relative and absolute open heading clearances in steps); d) Speed and vertical speeds.
Status	<validated>
Rationale	In TMA, the what-if of the “TC aid” is similar as it is in En-Route. This requirement has been validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory Assess planned/desired profile for problems within AoR/AoI Assess planned profile constraints or agreed coordinations Establish necessary separation
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace

4.3.1.2.4.2 Monitoring the resolution

Once the conflict resolution has been implemented, it is important to monitor that the aircraft rapidly conforms with the ATC instruction so that the conflict is actually solved. If the on-board implementation is too late, it may happen that the ATC instruction is not sufficient to solve the conflict, and it is up to the ATCO to instruct a complementary urgent action.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0013
Title	Monitoring the time validity of a Tactical What-if
Requirement	When a tactical instruction has been probed by the ATCO using the Tactical What-if service, the “TC aid” shall monitor that it is implemented before producing any new conflict: • determine the time validity (time horizon on which the instruction is still applicable and does not produce any conflict); • raise an alert that the probed instruction is no longer valid if the instruction is not implemented a predefined parameter below the time validity.
Status	<validated>
Rationale	A Time validity alert means “the given instruction is no longer valid to solve the conflict”. This requirement has been validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Monitor clearance implementation
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

4.3.1.3 Conformance Monitoring

This section encompasses Operational requirements, to comply with CM-0208-A and CM-0210

These Operational Requirements are based upon V3-validated requirements from SESAR1 Solution#27 requirements.

The Conformance Monitoring service has been defined and V3-validated in En-Route in SESAR1 Solution #27. It is completed by the following requirements in TMA:

4.3.1.3.1 Lateral Monitoring

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-CMON.0003
Title	Conditions for a lateral Deviation
Requirement	The system shall determine if an aircraft deviates from its lateral clearances: a) Lateral route deviation; b) No valid flight plan data available, beyond route, before route (noTT).
Status	<validated>
Rationale	A deviation assumes that the aircraft does not follow the current controller clearance. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.2004 in En-Route, validated in EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Perform conformance monitoring
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-CMON.004
Title	Detection of a route Deviation
Requirement	The system shall detect a route deviation if all the following conditions are met: a) the actual track position differs from the cleared flight path and the closest waypoint position by more than a parameter, b) the actual track position is outside a radius around a waypoint, or a route deviation existed in the previous cycle
Status	<validated>
Rationale	The latest sub condition avoids a cancellation of an existing route deviation if an aircraft enters a way point radius. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3020 in En-Route, validated in EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Perform conformance monitoring
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller

		ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

4.3.1.3.2 Vertical Monitoring

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-CMON.0005
Title	Conditions for a vertical Deviation
Requirement	The system shall determine if an aircraft deviates from its vertical clearances based on the following detected conditions: a) Cleared flight level (CFL) deviation; b) Vertical rate deviation; c) Level Bust.
Status	<validated>
Rationale	A deviation assumes that the aircraft does not follow the current controller clearance. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3126 in En-Route, validated in EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess deviation cause/implications Perform conformance monitoring
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-CMON.0006
Title	Detection of a CFL deviation
Requirement	The system shall detect a Cleared Flight Level (CFL) deviation if the aircraft leaves a CFL Deviation Window by more than a threshold parameter.
Status	<validated>
Rationale	When a new AFL is available, the CFL Deviation Window shall be calculated as the range between the previous AFL and the CFL. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3022 in En-Route, validated in EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Perform conformance monitoring
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-CMON.0007
Title	Cancel a vertical rate clearance
Requirement	The system shall cancel a cleared vertical rate if the difference between AFL and CFL is less than a threshold.
Status	<validated>

Rationale	Defines validity of vertical rate clearance. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3090 in En-Route, validated in EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory Perform conformance monitoring
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

4.3.1.3.3 Filter algorithms

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0033
Title	Conditions for displaying a deviation warning
Requirement	The “TC Aid” shall display the deviation warnings for aircraft depending on sector frequency status and actual position.
Status	<validated>
Rationale	This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3019 in En-Route, validated in EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a

<ALLOCATED_TO>	<Activity>	Restore adherence to clearance
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0034
Title	Responsible for solving the encounter
Requirement	The “TC Aid” shall only display a TC Conflict Search alert at the controller working positions concerned by such alert.
Status	<validated>
Rationale	Concerned CWP is defined by location of the aircraft and infringement: begin/end of infringement in Area of Responsibility and at least one aircraft located vertically in the sector. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.3037 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI Establish necessary separation
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-TC00.0035
Title	Characteristics of an encounter
Requirement	For each tactical encounter, the ”TC Aid” shall provide the following information: a) identification of the conflicting aircraft pair b) area for which the conflict has been identified (e.g. default, 3NM, FL410+) c) times relative to the current time, positions and altitude of the beginning of separation infringement on the extrapolated trajectories of the two aircraft d) times relative to the current time, positions and altitude of the Closest Points of Approach (CPA) on the extrapolated trajectories of the two aircraft, as well as the lateral distance between the two points and middle point between those two points e) times relative to the current time, positions, altitude of the end of separation infringement on the extrapolated trajectories of the two aircraft.
Status	<validated>
Rationale	This information should be available at the concerned CWP. This requirement has been validated by SESAR1 P04.07.02 as REQ-04.07.02-OSED-0001.2008 in En-Route, validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-007 in TMA
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Establish necessary separation
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

4.3.2 Safety and Performance Requirements (at SPR level)

4.3.2.1 Safety Requirements

All requirements in the current section are traced with the <Safety> category.

4.3.2.1.1 Success case

The Success Case requirements need to be placed for the services to deliver their safety benefits, considering the services when working as intended.

4.3.2.1.1.1 Planning Separation Assurance

This section includes:

- Safety requirements to comply with the OI CM-0211. These requirements are mainly issued from the non-validated requirements from SESAR1 projects P04.07.02 and P05.07.02.
- New Safety requirements, to comply with the OI's CM-0206, CM-0209 and CM-0209-b

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SAFE.0001
Title	"PC aid" availability
Requirement	The "PC Aid" shall be available at all controller workstations.
Status	<validated>
Rationale	Both tactical and planner controllers will be aware of the same traffic picture in order to maintain a common situational awareness and to enhance planner-tactical collaboration. This requirement has been validated in EXE-10.02a-V3-VALP-001 & EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess entry conditions and desired/planned profile through AoR/AoI
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller

		ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SAFE.0002
Title	Coherent output by the “PC aid”
Requirement	The “PC Aid” shall output coherent information to the sector team.
Status	<validated>
Rationale	Both tactical and planner controllers will be aware of the same traffic picture in order to maintain a common situational awareness and to enhance planner-tactical collaboration. This requirement has been validated in EXE-10.02a-V3-VALP-001 & EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Coordinate within the CWP for sharing situational awareness
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

Apart from eligible flights with a lack/loss/corrupted predicted trajectory, which are out of the “PC aid” scope, some special flights merit a dedicated attention from the ATCOs.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SAFE.0005
Title	Discard encounter
Requirement	The “PC Aid” shall discard any encounter between a pair of aircraft if vertical or horizontal separation is not infringed anymore.
Status	<validated>
Rationale	The “PC aid” will not mislead the controller by displaying already solved encounters in order to avoid unnecessary actions which will distract the controller from the actual traffic picture. Depending on the implementation, the “PC aid” may either mark the discarded encounters (up to the ATCO to manually suppress them), or immediately remove them from display. This requirement has been validated in EXE-10.02a-V3-VALP-001 & EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SAFE.0006
Title	ATCO supresses “PC aid” alerts

Requirement	ATCOs shall be able to manually discard any encounter.
Status	<validated>
Rationale	The “PC aid” must not negatively impact controller’s situational awareness by creating clutter on the situational displays. Therefore the ATCO should have means to discard the unwanted/nuisance alerts. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-001
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SAFE.0007
Title	“PC aid” alerts
Requirement	If the critical encounters are displayed differently, the "PC aid" shall warn the controller if any “non critical” encounter turned into a “critical” one.
Status	<validated>
Rationale	The ATCO has to be warned if any encounter moves from non-critical to critical, because it may require an urgent management by the ATCO. This requirement has been validated in EXE-10.02a-V3-VALP-001

Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

4.3.2.1.1.2 Tactical Separation Assurance

This section encompasses Safety requirements linked to Success Case, to comply with the Tactical part of CM-0206 and CM-0209.

These Safety requirements are based upon V3-validated requirements from SESAR1 Solution#27 requirements.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SAFE.0008
Title	"TC aid" for Tactical or Planner ATCO
Requirement	The “TC Aid” shall be available at all controller workstations.
Status	<validated>
Rationale	Both tactical and planner controllers will be aware of the same traffic picture in order to maintain a common situational awareness and to enhance planner-tactical collaboration. This requirement has been validated in EXE-10.02a-V3-VALP-005
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Assess planned/desired profile for problems within AoR/AoI
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

4.3.2.1.1.3 Conformance Monitoring

In order to avoid duplication, the Safety Requirements related to Success cases of the Conformance Monitoring service are situated in the "SPR/INTEROP – OSED – Part II Safety Assessment Report" (SAR) document [53].

4.3.2.1.2 Failure case

The Failure Case requirements consider how the services continue to operate safely under failure conditions. These failures are identified in terms of hazards, and the SESAR Safety Reference Material (SRM, see §3.3 in [28]) recommends to identify hazards at the level of the operational services:

	To avoid System-generated hazards to be inconsistently defined across the SESAR work programme, they have to be identified at the level of the Operational services, *i.e.* a level that is independent of the actual design of the System and is related to the failure of an operational service.

Basically, for the ATC tools of PJ10-02a1, there are two failure modes:

a) The tool does not operate whereas it ought to (a conflict is not detected, a trajectory deviation is not detected, a conflicting aircraft is not taken into account by the What If/What Else) ;

b) The tool "over operates": it launches an unnecessary alarm (for instance).

In the following subsections we apply these two failure modes in order to identify hazards for the operational services of PJ10.02a1.

4.3.2.1.2.1 Planning Separation Assurance

As any complex service that supports the ATCO, it is essential that the "PC aid" refers the user about its own operating state. Indeed, due to the task complexity, it is neither easy nor desirable that the ATCO manually monitors the correct functioning of the "PC aid" service.

If we consider the first failure mode a), we identify the two following hazards:

1. The Planner Controller fails to detect a pre tactical conflict (failure a) of the "Conflict Detection aid for the PC");
2. The Planner Controller improperly solves a pre tactical conflict (failure of the "Conflict Resolution aid for the PC");

Similarly, if we consider the second failure mode b), we identify the two following hazards:

1. The “Conflict Detection aid for the PC” signals to the Planner Controller a false pre tactical conflict;
2. The “Conflict Resolution aid for the PC” is polluted by a false conflict and suggests a less optimal trajectory for an incoming aircraft.

However, no related requirement has been V3-validated yet.

4.3.2.1.2.2 Tactical Separation Assurance

This section encompasses Safety requirements linked to Failure Case, to comply with the Tactical part of CM-0206 and CM-0209.

If we consider the first failure mode a), we identify the two following hazards:

1. The Tactical Controller fails to detect a tactical conflict (failure of the “Conflict Detection aid for the TC”);
2. The Tactical Controller improperly solves a tactical conflict (failure of the “Conflict Resolution aid for the TC” operational service).

Similarly, if we consider the second failure mode b), we identify the two following hazards:

1. The “Conflict Detection for the TC” signals to the Tactical Controller a false tactical conflict;
2. The “Conflict Resolution aid for the TC” is polluted by a false conflict and suggests a less optimal trajectory for an aircraft in the sector.

These Safety requirements are based upon V3-validated requirements from SESAR1 Solution#27 requirements.

The “TC Aid” should report an operational status to report any unavailability of the service.

However, no related requirement has been V3-validated yet.

4.3.2.1.2.3 Conformance Monitoring

If we consider the first failure mode a), we identify the following hazard:

1. A trajectory deviation is not detected by the two air traffic controllers.

Similarly, if we consider the second failure mode b), we identify the two following hazards:

1. The “Trajectory deviation aid” improperly signals a deviation;
2. A trajectory deviation is not detected by the two air traffic controllers.

In order to avoid duplication, the Safety Requirements related to Failure cases of the Conformance Monitoring service are situated in the “SPR/INTEROP – OSED – Part II Safety Assessment Report” (SAR) document [53].

4.3.2.2 Performance Requirements (QoS)

The requirements on performance metrics focus primarily on the **CD/R aid to PC** service, as defined in section 3.3.2.1, but are also relevant to the **CD/R aid to TC**.

The main input for these requirements is the development of Appendix A (BIM) of the current document. The BIM describes two system changes resulting from improved TP accuracy, which can be summarized as follows:

a) Borderline encounters are more accurately identified either as potential conflicts or non-conflicts, which allows more efficient management and monitoring of potential conflicts, and perhaps a reduction in the number of “unnecessary” resolutions;

b) An increase in the potential to detect true conflicts (i.e. where controller action would have been required), which will allow resolution actions to be performed earlier.

These features are addressed by two distinct qualities that are described below as the system tuning envelope and the system dynamic range. These qualities are considered relevant from an operational concept point-of-view as their impact on working method and procedures can be identified. However, from a system point-of-view, this quality of service ultimately is provided by a TP that meets given performance requirements, which has the advantage of being more readily measurable/testable. For this reason, underlying TP performance requirements are also provided.

It is important to note that these requirements make frequent reference to assumptions that the flights are proceed in conformance with the known “flight intent” and no further ATC instructions are given that change the flight intent within the given prediction horizon. To attempt to fulfil these assumptions, the prediction time is normally adapted in function of the expected frequency of tactical instructions (typically higher frequency and therefore shorter prediction time in lower sectors and TMA). However, the requirements nevertheless describe a potential level of performance which, in reality, will never be fully met and “reliability of the trajectory” is therefore considered one of the factors that the controller must judge when analysing a potential conflict.

4.3.2.2.1 System Tuning Envelope

If limits are defined denoting “safe” and “unsafe” separation, a notification of potential conflict can be termed “desired” if, in the absence of controller intervention, the resulting separation would be less than the safe limit; if a “desired” potential conflict is not notified, it is termed “missed”. The converse is an encounter where, in the absence of controller intervention, the separation would be greater than the safe limit; a notification of potential conflict for this encounter would be termed a “nuisance”.

Note that this definition of nuisance encompasses only aspects of prediction accuracy and are distinct from notifications that could be termed “false” that result from incorrect input parameters or logic – e.g. incorrect exit level entered.

Uncertainty can be represented as a prediction error in the trajectories that can be approximated as a statistical distribution. This then allows the probability of an encounter being safe or unsafe to be calculated and, by implication, the probability that a conflict notification is desired or a nuisance.

To take into account the uncertainty in the trajectory, conflict detection tools can be tuned by means such as a separation buffer or conflict probability threshold; a large buffer will result in few desired notifications being missed, but will generate many nuisance notifications. Thus a tuning envelope can be derived, defining the range of performance with a given TP error, as shown for four TP error values (e.g. for different time horizons) in the figure below.

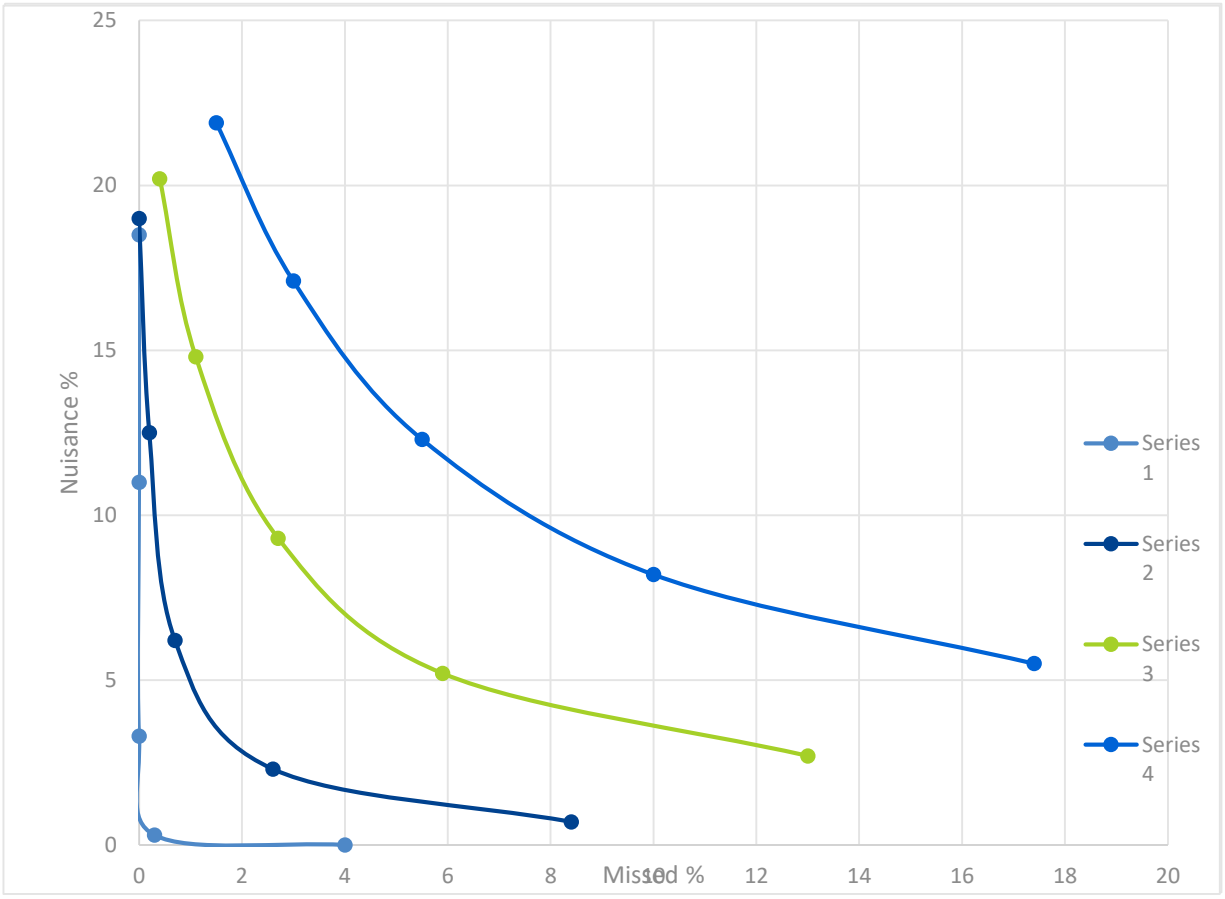


Figure 1 - Conflict Detection Tuning Envelope

The tuning of CD/R parameters is essentially a trade-off between providing adequate warning time for the proper management of conflicts and avoiding cluttering the display with too much unreliable and unstable information. However, experience shows that controller confidence in the CD/R tool is diminished if its detection of potential conflicts does not match their own, leading them to believe them the CD/R tools is not functioning correctly (see P04.07.02-D21 Validation Report).

No related requirement has been V3-validated yet.

4.3.2.2.2 Dynamic Range

An element of “added value” is in the classification of encounters as described in P04.07.02-D28 OSED, “according to the proximity, geometry and uncertainty of the predicted aircraft positions and the clearance or co-ordination conditions”, which is used by the controller in assessing encounters and prioritising the resolution of potential conflicts. An aim of the encounter classification is to distinguish those encounters that have a high probability of developing into conflicts, which should therefore be

actioned with priority, from those with greater uncertainty, for which it might be more efficient to let run.

To support this notion of classification, another way to consider the performance of the CD/R tool is in the relation between the calculated (predicted) nominal separation of an encounter and the probability that the "unsafe" separation limit would be breached if no intervention were made. In this context, the dynamic range can be considered as the difference in conflict probability between the most severe and least severe encounters, as shown in Figure 2figure below. The very shallow line shows a poorly performing CD/R tool with low dynamic range, where the prediction error distribution is such that very little certainty can be derived from encounter. At the other extreme, a highly performant CD/R tool is characterized by a large dynamic range, demonstrated by the steep curve.

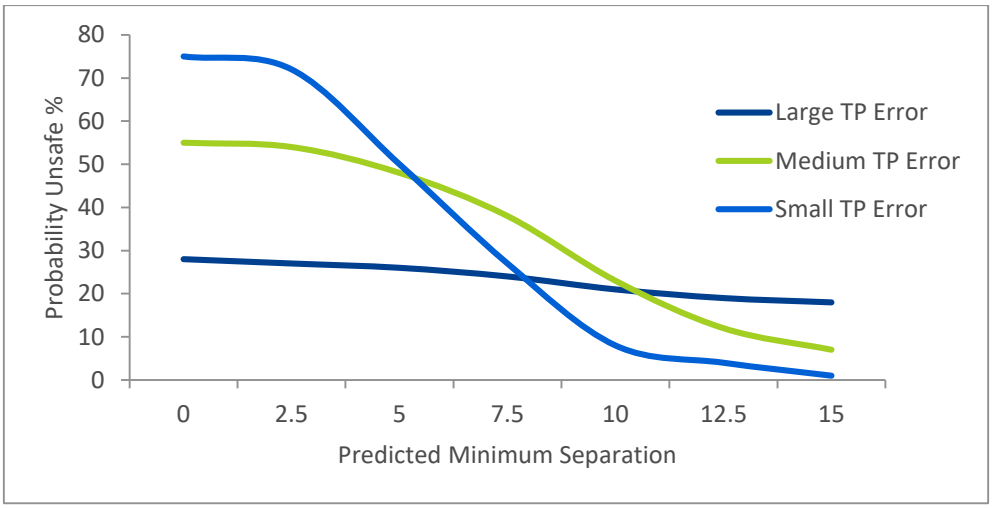


Figure 2 - Probability Unsafe With Given Predicted Minimum Separation

No related requirement has been V3-validated yet.

4.3.2.2.3 Trajectory Prediction Performance

The process for measuring TP accuracy are described in the EUROCONTROL Specification of Trajectory Prediction (cf reference [19]), based on the following principles:

- The performance of the TP is evaluated by means of a statistical analysis on a large sample of data in order to reduce the effect of individual anomalies, quantifying accuracy by means of a number of KPIs.
- The measurement of trajectory accuracy is performed by comparing truth data, in the form of radar tracks, with calculated and updated trajectories.
- Portions of flights are selected where the flight is cleared, and the aircraft operated, in accordance with the flight intent as described by the functional requirements.
- Performance is specified for three basic metrics (longitudinal, lateral and vertical accuracy), applicable to both the planned and tactical trajectories, and specializing these with various conditions under which they are measured.

The specification is considered applicable to the SESAR baseline (IP1); this SPR extends those requirements on the basis of improved accuracy achieved by PJ18.06 through use of additional data such as the downlinked data.

Three components of accuracy are identified corresponding to the longitudinal and vertical dimensions, and these are further specialised under level flight, climb and descent. The TP is expected to make use of certain information such as meteorological conditions, track state vectors, etc., for which a given level of accuracy is assumed.

The derivation of signed mean error indicates any bias present in the trajectory calculation. The standard deviation of the error indicates the spread of the error and can be used to calculate the limits of an aircraft position at a given moment in time with a given probability. The peak error might indicate an incorrect logic or aircraft model, or the deviation of the aircraft from the flight intent.

Assumptions are made on the accuracy of input data to the TP function as specified in the table below:

Meteorological Conditions[10]	**Peak Error**
Wind vector error	7 knots
Temperature error	2^0 C
Track State Vector[11]	
Position error when in uniform motion	120m
Along-track speed error when in uniform motion	1.5 m/sec

Table 1 – Input Metrics

4.3.2.2.3.1 Longitudinal Accuracy

Longitudinal error represents the difference between the estimated progress at a point in time determined from the trajectory and the actual progress determined by the system track. Measurements are taken at fixed intervals over a defined period for aircraft in cruise, climb and descent phases. In all cases, the measurements are taken only when the aircraft is in conformance with the flight intent for the duration of the measurement period.

Longitudinal Prediction Error (NM per minute of prediction)	Magnitude of Mean	Standard deviation
Cruise phase (FL200 – FL299)	0.1 NM/min	0.2 NM/min
Cruise phase (FL300 – FL600)	0.1 NM/min	0.2 NM/min

[10] Peak meteorological errors have been chosen such that they encompass achievable forecast values as documented in the EATMP - Met Data in ATM – Final Report.

[11] Values taken from the Radar Surveillance Standard for En-Route and Major Terminal Areas, Table 7A – Accuracy requirements En-Route assuming dual SSR coverage.

Climb phase (FL200 – FL299)	0.2 NM/min	0.6 NM/min
Climb phase (FL300 – FL600)	0.2 NM/min	0.4 NM/min
Descent phase (FL200 – FL299)	0.2 NM/min	0.6 NM/min
Descent phase (FL300 – FL600)	0.2 NM/min	0.6 NM/min

Table 2 – Longitudinal Prediction Error[12]

No related requirement has been V3-validated yet.

4.3.2.2.3.2 Vertical Accuracy

Vertical error is measured in terms of the difference between the estimated vertical position at a moment in time as determined from the trajectory and the actual vertical position of the aircraft at that moment in time, and is a result of the vertical rate used by the trajectory prediction differing to the actual vertical rate.

As with longitudinal error, measurements are taken at fixed intervals over a defined measurement horizon. Measurement points are taken at FL 250 and FL 300, with measurements starting only once the aircraft has a continuous climb/descent through the measured level. Note that this does not necessarily imply that the aircraft need be cleared immediately through the measured level, providing that subsequent clearances are issued in sufficient time that the vertical rate has not reduced for stopping at an intermediate level.

Vertical Prediction Error (feet per minute of prediction)	Magnitude of Mean	Standard deviation
Climb phase (FL200 – FL299)	100 feet/min	300 feet/min
Climb phase (FL300 – FL600)	100 feet/min	200 feet/min
Descent phase (FL200 – FL299)	100 feet/min	300 feet/min
Descent phase (FL300 – FL600)	100 feet/min	200 feet/min

Table 3 – Vertical Prediction Error

No related requirement has been V3-validated yet.

4.3.2.3 Human Performance Requirements

All requirements in the current section are traced with the <human performance> category. They are issued from the "SPR/INTEROP – OSED – Part IV Human Performance Assessment Report" (HPAR) document [54].

[REQ]

[12] This longitudinal prediction error is assumed to grow linearly in the covered prediction horizon which is 20 minutes in cruise phase and 10 minutes in climb/descent phases.

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0001
Title	Time Horizon
Requirement	The "PC Aid" detection parameters shall at least ensure the detection of aircraft-to-aircraft encounters crossing in time horizon above of the "TC Aid" time horizon.
Status	<validated>
Rationale	Continuum of separation management supporting tools. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-001
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0002
Title	“Risk” interference not in scope of MTCD
Requirement	The "PC Aid" shall detect aircraft-to-aircraft encounters along stable flight legs.
Status	<validated>

Rationale	In order to avoid all the not relevant aircraft-to-aircraft interferences which are qualified as being “Risk” conflicts and under the EC responsibility and supported by the associated ATC tools such as "TC Aid" and/or What-if Clearance. This requirement has been validated in EXE-10.02a-V3-VALP-001
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0003
Title	Criticity & Severity
Requirement	The "PC Aid" shall classify the detected aircraft-to-aircraft encounters according to the associated operational impacts and the probability of occurrences.
Status	<validated>
Rationale	Adequacy of mental-model between ATCO and System. This requirement has been validated in EXE-10.02a-V3-VALP-001
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier

<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0004
Title	Classes of Severity
Requirement	The "PC Aid" severity thresholds shall be customizable in line with ATCO operational needs.
Status	<validated>
Rationale	Filter the encounters to focus on the most critical in busy period => For instance, it could have only one value such as between 0 and 8NM or three levels of severity: [0; 6[; [6;8[and [8;15NM[. This requirement has been validated in EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-001
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0005
Title	Flight Leg Embellishment
Requirement	The "PC Aid" service shall provide ATCO with a concept of Flight Leg Embellishment displaying MTCD information along the flight legs of each aircraft involved in an aircraft-to-aircraft encounter.
Status	<validated>
Rationale	In order to improve ATCO task and activity (e.g. flight integration, conflict analysis and resolution). This requirement has been validated in EXE-10.02a-V3-VALP-001 & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine safe potential exit conditions Determine planning problems at offered entry conditions
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0006
Title	Multiple Flight Leg Embellishment
Requirement	The "PC Aid" service should allow ATCO to display all of the available Flight Leg Embellishments for a given aircraft at the same time.

Status	<validated>
Rationale	In order to provide ATCO with an overall view about the conflicts concerning the flight. This requirement has been validated in EXE-10.02a-V3-VALP-001 & EXE-10.02a-V3-VALP-005
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine safe potential exit conditions Determine planning problems at offered entry conditions
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0007
Title	Result Accuracy
Requirement	The conflict detection algorithm of What-if shall be designed in line with ATCO expectation and mental-model, especially about climbing and descending aircraft.
Status	<validated>

Rationale	A too accurate detection algorithm could be counter-productive as it may lead to downgrade the level of operational acceptability and/or ATCO's trust in automation. This requirement has been validated in EXE-10.02a-V3-VALP-001 & EXE-10.02a-V3-VALP-005
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0008
Title	DB to support Team COM
Requirement	The PC and the EC should be provided with a dynamic recap of the "PC Aid" encounters to support ATCO's cooperation and traffic analysis.
Status	<validated>
Rationale	Such a recap is a good vector of communication between TC/PC and allow an access to other feature such as cross-highlight, warning, extrapolation, SEP tools. This requirement has been validated in EXE-10.02a-V3-VALP-001 & EXE-10.02a-V3-VALP-005
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine planning problems at offered entry conditions Determine safe potential exit conditions
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0009
Title	Training on tool usage
Requirement	Training shall be provided to the controllers to clearly understand what can be expected from the tools in different traffic situations (use cases) and what the limitations of the tools are.
Status	<validated>
Rationale	This is in order to ensure know the strengths and weaknesses of the tool in different situations and to achieve a satisfying level of job satisfaction and performance. For using the "TC Aid", this level of understanding needs to be achieved as well in order to integrate it as an additional tool for the tactical time horizon. This requirement has been validated in EXE-10.02a-V3-VALP-002b
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier

<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0010
Title	Tool adaptation to operational environment
Requirement	Tool parameters shall be adjusted when bringing the tools to a new target operational environment.
Status	<validated>
Rationale	The airspace and route structure complexity of the traffic flows highly effect look ahead time and buffers of the tools. The need to be adjusted in order to ensure optimal impact of the tools and sufficient level of trust and acceptability. This requirement has been validated in EXE-10.02a-V3-VALP-002b
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine safe potential exit conditions Determine planning problems at offered entry conditions Assess trajectory profile through the AoR for tactical controller suitability Assess entry conditions and desired/planned profile through AoR/AoI
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller

		ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0011
Title	integration into alarm chain
Requirement	The look-ahead times and information provision of the "TC Aid" shall be in line with existing supporting tools (e.g. "PC Aid") when bringing the tools to a new target operational environment
Status	<validated>
Rationale	This requirement enables a merged alarm chain of conflict detection and resolution aid. Contradictory or double conflict indications have to be avoided. This also ensures a better understanding of new functionalities within a given and used operational environment among the controllers. This requirement has been validated in EXE-10.02a-V3-VALP-001 & EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-002b
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Coordinate within the CWP for sharing situational awareness
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0012
Title	Refreshing rate of tool information display
Requirement	The Detection and Resolution tools shall be updated directly after every clearance input.
Status	<validated>
Rationale	ATCOs would prefer to have an update directly after every input, not with every radar update. This requirement has been validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Modify trajectory Determine planning problems at offered entry conditions Assess entry conditions and desired/planned profile through AoR/AoI Revise entry conditions if needed in coordination with upstream sector
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0013
Title	Input device for multiple clearances

Requirement	With a resolution advisory tool providing information about combined lateral and vertical conflict free clearances, the system shall offer the capability for the ATCO to input multiple clearances.
Status	<validated>
Rationale	In a stripless environment there is a need of an input device for multiple (lateral and vertical) clearances, as the controllers often give such combined clearances. This requirement has been validated in EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-002b
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Issue clearances
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-HPRF.0014
Title	Tool colour coding for deployment
Requirement	The colour coding shall be brought in line with the colour coding philosophy used in the operational ATM system.
Status	<validated>

Rationale	In order to ensure HMI integration with an appropriate level of acceptability and usability. This requirement has been validated in EXE-10.02a-V3-VALP-001 & EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Human Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Activity>	Determine safe potential exit conditions Determine planning problems at offered entry conditions
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

4.3.2.4 Security Requirements

For security reason, the Security Requirements are situated in the “SPR/INTEROP – OSED – Part III Security Assessment Report” (SeAR) document.

This document is classified and not available freely with other assessment reports. This is not a Solution level decision, but rather a global SESAR2020 guidance which has to be respected for security reasons.

Nevertheless, a minimum set of high-level security requirements have been selected from this document by INDRA and DSNA experts which can be consulted by anyone, and therefore presented into this document. This minimum set of security requirements is composed of the following requirements that have been validated by expert judgment:

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SECU.0001
Title	Human resource security

Requirement	Background verification checks on all staff shall be carried out in accordance with relevant laws, regulation, and ethics.
Status	<validated>
Rationale	The checks shall be proportional to the roles and responsibilities, in particular in respect to the business requirements (e.g. safety-critical function, developments), the classification of information to be accessed, and the perceived risks. This requirement has been validated by experts' judgment (INDRA & DSNA).
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SECU.0002
Title	Information Security aspects of business continuity management
Requirement	A managed process shall be developed and maintained that addresses the ATM service and information security requirements needed for ATM business continuity.
Status	<validated>
Rationale	This requirement has been validated by experts' judgment (INDRA & DSNA).
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SECU.0003
Title	Information security incident management
Requirement	ATM service and Information security events shall be reported through appropriate management channels as quickly as possible.
Status	<validated>
Rationale	This requirement has been validated by experts' judgment (INDRA & DSNA).
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SECU.0004
Title	Logging and Monitoring

Requirement	Faults shall be logged, analysed, and appropriate action taken.
Status	<validated>
Rationale	This requirement has been validated by experts' judgment (INDRA & DSNA).
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SECU.0005
Title	Network security management
Requirement	ATM Networks shall be adequately managed and controlled, in order to be protected from threats, and to maintain security for the ATM systems and applications using the network, including information in transit.
Status	<validated>
Rationale	This requirement has been validated by experts' judgment (INDRA & DSNA).
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller

		ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SECU.0006
Title	Physical and environmental security
Requirement	Security perimeters shall be used to protect ATM sensitive areas and ATM processing facilities.
Status	<validated>
Rationale	This requirement has been validated by experts' judgment (INDRA & DSNA).
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SECU.0007
Title	Protection from malware
Requirement	Detection, prevention, and recovery controls to protect ATM software against malicious code and appropriate user awareness procedures shall be implemented.
Status	<validated>

Rationale	This requirement has been validated by experts' judgment (INDRA & DSNA).
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SECU.0008
Title	Secure access controls
Requirement	The allocation of access privileges shall be restricted to users who have been specifically authorized to use ATM facilities.
Status	<validated>
Rationale	Such privileges should be controlled by a formal management process. This requirement has been validated by experts' judgment (INDRA & DSNA).
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Role>	ATC Sector Executive Controller ATC Sector Planning Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	En-Route

		Terminal Airspace

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-SECU.0009
Title	Security requirements of information systems
Requirement	Security testing shall be performed whenever a system is updated.
Status	<validated>
Rationale	This requirement has been validated by experts' judgment (INDRA & DSNA).
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Role>	ATC Sector Planning Controller ATC Sector Executive Controller
<ALLOCATED_TO>	<Sub-Operating Environment>	Terminal Airspace En-Route

4.3.3 INTEROP Requirement

4.3.3.1 Information Exchange Requirements (at Service level)

An Information Exchange Requirement (IER) is associated with an information exchange between nodes or activities.

The current section describes the contents of the main IER, with suppliers and recipients, as well as the exchange conditions.

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-IER0.0001
Title	Surveillance data
Requirement	For each flight in scope the “TC aid” and the Conformance Monitoring services shall be provided with Surveillance data with a frequency equal or better than the refresh period of the tracks in the CWP.
Status	<validated>
Rationale	The issuers of the Surveillance data are the COM Service providers, which convey Data flows over the Ground-Ground and Air-Ground segments. They include both the sensors (radar stations,..) and the needed infrastructure to convey the data (network, routing, etc..). The surveillance data include both the measured aircraft position and behaviour, and the downlinked mode-S data for equipped aircraft This requirement has been validated in EXE-10.02a-V3-VALP-002b
Category	<IER>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Information Exchange>	[NOV] Aircraft Derived Data
<ALLOCATED_TO>	<Information Flow>	Execute ATC clearance o--> Modify trajectory Execute ATC clearance o--> Modify trajectory (CMON)

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-IER0.0002
Title	Ground trajectory
Requirement	For each flight in scope, the “PC aid” and the “TC aid” services shall be provided with the Ground Predicted Trajectory with a frequency equal or better than a predefined refresh period.

Status	<validated>
Rationale	The issuer of the Ground predicted Trajectory is the Flight Data Processing System (FDPS) in charge of the local ATSU. The Ground predicted data include at least the predicted positions and behaviours and it covers at least the range of the ATSU and its AOI. This requirement has been validated in EXE-10.02a-V3-VALP-001 & EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<IER>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Information Exchange>	[NOV] Messages from Upstream
<ALLOCATED_TO>	<Information Flow>	Make coordination offer to downstream sector (by upstream ATSU) o--> Assess entry conditions and desired/planned profile through AoR/AoI

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-IER0.0003
Title	Flight Script
Requirement	For each flight in scope, the “PC aid”, the “TC aid” and the Conformance Monitoring services shall be provided with the up-to-date Flight Script.
Status	<validated>

Rationale	The issuer of the Flight Script is the Flight Data Processing System (FDPS) in charge of the local ATSU. The Flight Script include at least the Flight plan, the ATC constraints, and the instructions and the clearances that are applicable to the flight. It may include other data if available such as the Flight intent. This requirement has been validated in EXE-10.02a-V3-VALP-001 & EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<IER>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Information Exchange>	[NOV] Messages from Upstream
<ALLOCATED_TO>	<Information Flow>	Make coordination offer to downstream sector (by upstream ATSU) o--> Revise entry conditions if needed in coordination with upstream sector

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-IER0.0004
Title	MET data
Requirement	The ATC system shall be provided with the MET data with a frequency equal or better than a predefined refresh period.
Status	<validated>

Rationale	The issuers of the MET data are the local Meteorological data providers. Generally, the MET data are used to improve the predicted trajectory. The MET data include at least the predicted wind data, which may be taken into account by CD/R services and the Conformance Monitoring service not only via the predicted trajectory (e.g. to compute longitudinal uncertainties or to assess a measured deviation). This requirement has been validated in EXE-10.02a-V3-VALP-002b
Category	<IER>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Information Exchange>	[NOV] Met data
<ALLOCATED_TO>	<Information Flow>	Provide weather information o--> Determine planning problems at offered entry conditions Provide weather information o--> Modify trajectory

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-IER0.0005
Title	Encounters
Requirement	The ATC system shall provide the encounters it has detected.
Status	<validated>
Rationale	The recipients of the encounters data are the CWP or any data analysis system. Roles as the FMP or the MSP or EAP may also be potential recipients. The encounters data include at least the involved flights, the location of the detected conflict, and the kind of conflict. This requirement has been validated in EXE-10.02a-V3-VALP-001 & EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-003 & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005

Category	<IER>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Information Exchange>	[NOV] Messages towards Downstream
<ALLOCATED_TO>	<Information Flow>	Make coordination offer to downstream sector o--> Revise entry conditions (by downstream ATSU) Make coordination offer to downstream sector o--> Assess entry conditions (by downstream ATSU)

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-IER0.0006
Title	Non-conformance alerts
Requirement	The ATC system shall provide the non-conformance alerts it has raised.
Status	<validated>
Rationale	The recipients of the non-conformance alerts are the CWP or any data analysis system. The non-conformance data include at least the involved flight, the clearance it does not conform with, and the kind of non-conformance. This requirement has been validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<IER>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Information Exchange>	[NOV] Messages towards Downstream

<ALLOCATED_TO>	<Information Flow>	Make coordination offer to downstream sector o--> Revise entry conditions (by downstream ATSU) Make coordination offer to downstream sector o--> Assess entry conditions (by downstream ATSU)

4.3.3.2 Interoperability Requirements (at System level)

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-IOP0.0001
Title	Surveillance information
Requirement	The ATC System shall receive surveillance information (including Mode-S data) from any surveillance sources using the ASTERIX standard.
Status	<validated>
Rationale	Live surveillance information and downloaded data from aircraft is necessary to enhance the conflict detection tools. This requirement has been validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-004 & EXE-10.02a-V3-VALP-005
Category	<Interoperability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Information Exchange>	[NOV] Aircraft Derived Data
<ALLOCATED_TO>	<Information Flow>	Execute ATC clearance o--> Modify trajectory Execute ATC clearance o--> Modify trajectory (CMON)

[REQ]

Identifier	REQ-10.02a1-SPRINTEROP-IOP0.0003

Title	Weather data
Requirement	System shall receive forecast weather data (wind and temperature) from Meteorology Providers using GRIB format.
Status	<validated>
Rationale	Having wind and temperature data will improve trajectory accuracy and therefore improve conflict detection. This requirement has been validated in EXE-10.02a-V3-VALP-002b & EXE-10.02a-V3-VALP-005
Category	<Interoperability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ10-02a
<ALLOCATED_TO>	<Information Exchange>	[NOV] Met data
<ALLOCATED_TO>	<Information Flow>	Provide weather information o--> Determine planning problems at offered entry conditions Provide weather information o--> Modify trajectory

5 References and Applicable Documents

5.1 Applicable Documents

Content Integration

[1] B.04.01 D138 EATMA Guidance Material

[2] EATMA Community pages

[3] SESAR ATM Lexicon

Content Development

[4] SESAR Concept of Operations (CONOPS 2019) 00.00.02, May 2019

[5] SESAR 2020 PJ10 PROSA Project Management Plan

System and Service Development

[6] 08.01.01 D52: SWIM Foundation v2

[7] 08.01.01 D49: SWIM Compliance Criteria

[8] 08.01.03 D47: AIRM v4.1.0

[9] 08.03.10 D45: ISRM Foundation v00.08.00

[10] B.WP04.03 D102 SESAR Working Method on Services

[11] B.WP04.03 D128 ADD SESAR1

[12] B.WP04.05 Common Service Foundation Method

Performance Management

[13] B PJ.19 Performance Framework dated Oct 2017

[14] PJ.19 Validation Targets dated Feb 2017 (Note that a 2018 edition exists)

[15] B.05 D86 Guidance on KPIs and Data Collection support to SESAR 2020 transition.

[16] 16.06.06-D68 Part 1 –SESAR Cost Benefit Analysis – Integrated Model

[17] 16.06.06-D51-SESAR_1 Business Case Consolidated_Deliverable-00.01.00 and CBA

[18] Method to assess cost of European ATM improvements and technologies, EUROCONTROL (2014)

[19] Eurocontrol specifications of Trajectory Prediction (Eurocontrol-spec-0143 TrajPred ED 2.0.pdf, Eurocontrol, 2017)

[20]ATM Cost Breakdown Structure_ed02_2014

[21]Standard Inputs for EUROCONTROL Cost Benefit Analyses

[22]16.06.06_D26-08 ATM CBA Quality Checklist

[23]16.06.06_D26_04_Guidelines_for_Producing_Benefit_and_Impact_Mechanisms

Validation

[24]03.00 D16 WP3 Engineering methodology

[25]Transition VALS SESAR 2020 - Consolidated deliverable with contribution from Operational Federating Projects

[26]European Operational Concept Validation Methodology (E-OCVM) - 3.0 [February 2010]

System Engineering

[27]SESAR Requirements and V&V guidelines

Safety

[28]SESAR, Safety Reference Material, Edition 4.0, April 2016

[29]SESAR, Guidance to Apply the Safety Reference Material, Edition 3.0, April 2016

[30]SESAR, Final Guidance Material to Execute Proof of Concept, Ed00.04.00, August 2015

[31]SESAR, Resilience Engineering Guidance, May 2016

Human Performance

[32]16.06.05 D 27 HP Reference Material D27

[33]16.04.02 D04 e-HP Repository - Release note

Environment Assessment

[34]SESAR, Environment Reference Material, alias, “Environmental impact assessment as part of the global SESAR validation”, Project 16.06.03, Deliverable D26, 2014.

[35]ICAO CAEP – “Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes” document, Doc 10031.

Security

[36]16.06.02 D103 SESAR Security Ref Material Level

[37]16.06.02 D137 Minimum Set of Security Controls (MSSCs).

[38]16.06.02 D131 Security Database Application (CTRL_S)

[39]SESAR 16.06.06-D26_03, Methods to Assess Costs and Monetise Benefits for CBAs, Edition 00.02.02

5.2 Reference Documents

[40]ICAO – DOC 4444 ATM/501, Procedures for Air navigation Services, Air Traffic Management, edition 16, 2016

[41]JAA TGL6 Administrative and Guidance Material "Guidance Material on the Approval of Aircraft and Operators for Flight in Airspace above Flight Level 290 where a 300M (1,000 ft) Vertical Separation Minimum is applied"

[42]ED-78A GUIDELINES FOR APPROVAL OF THE PROVISION AND USE OF AIR TRAFFIC SERVICES SUPPORTED BY DATA COMMUNICATIONS.[13]

[43]RTCA DO-236C. Minimum Aviation System performance Standards: Required Navigation Performance for Area Navigation. 2014.

[44]JAA TGL6 Administrative and Guidance Material "Guidance Material on the Approval of Aircraft and Operators for Flight in Airspace above Flight Level 290 where a 300M (1,000 ft) Vertical Separation Minimum is applied"

[45]ICAO Doc 9854, Global Air Traffic Management Operational Concept, 1st edition, 2005, ISBN 92-9194-554-4

[46]High Level Network Operational Framework 2019, Edition 2.0, January 2016

[47]EUROCONTROL Seven-Year Forecast – February 2017, Flight Movements and Service Units 2017-2023, STATFOR Team, Edition 17/01/02-100

[48]EUROCONTROL ATM Cost-Effectiveness (ACE) 2016 Benchmarking Report, May 2018

[49]EUROCONTROL FASTI Operational Concept, Edition 1.1, 20/03/2007

[50]**European Route Network Improvement Plan (ERNIP), Part 1**, European Airspace Design Methodology Guidelines - General principles and technical specifications for airspace design, Edition 1.6, June 2016

[51]EUROCAE ED-228A, Safety and Performance Requirements Standard for Baseline 2 ATS Data Communications (Baseline 2 SPR Standard), March 2016

[13] The EUROCAE ED-78A has been used as an initial guidance material. ED-78A is useful, but is not an applicable document, because it mostly addresses the V4-V5 phases, whilst the SESAR R&D programme is focused on development (V1-V2-V3, and because of its partial compliance with safety regulatory requirements).

[52]EUROCAE ED-229A, Interoperability Requirements Standard for Baseline 2 ATS Data Communications (Baseline 2 Interop Standard), March 2016

[53]SESAR Solution PJ.10-02a: SPR/INTEROP-OSED for V3– Part II Safety Assessment Report (SAR), Edition 00.01.01, 16 September 2019

[54]SESAR Solution PJ.10-02a: SPR/INTEROP-OSED for V3– Part IV Human Performance Assessment Report (HPAR), Edition 00.01.03, 16 September 2019

[55]SESAR Solution PJ.10-02a SPR/INTEROP-OSED for V3 – Part V Performance Assessment Report (PAR), Edition 00.01.02, 16 September 2019

[56]SESAR1 Project P04.07.02, Final MTCD/TCT Safety and Performance Requirements_4, Edition 00.03.05, July 2016

[57]SESAR1 Project P04.07.02, OSED_4, Edition 00.01.01, October 2016

[58]SESAR1 Project P05.07.02, Preliminary V2 OSED for Step 1, 00.01.00, May 2016

[59]SESAR Solution PJ10-02a1 (V3) and Solution PJ10-02a2 (V2) Validation Report (VALR), Edition 00.01.01, 15 October 2019

Appendix A Cost and Benefit Mechanisms

The increase in automation support facilitates tactical coordination, increases ATCO productivity and therefore would allow for increased En-Route and TMA capacity.

Routine tasks, including conformance monitoring, would become fully automated. ATCOs would thus be allowed to concentrate on tasks where human cognitive skills have added value.

Where some of the mentioned ATC tools have already been implemented, harmonisation and generalisation of their operational use might bring additional gains.

A.1 Stakeholders identification and Expectations

This section describes who the stakeholders are and how they are concerned by the scope of the Solution PJ.10-02a.

Stakeholder	Involvement	Why it matters to stakeholder
Airspace Users (Civil and Military AUs, Commercial Airlines, Business Aviation, Flight/Wing Operations Centres, Pilots)	AU will be involved at the end of the validation phase, to review all results, including impacts and benefits	Benefit from more efficiency in separation management, allowing them to fly closer to their business trajectory, with lower deltas and delays
ANSPs (Civil and Military ANSPs, En-Route ACCs, local dDCB actors (LTM/EAP/MSP), ATCOs (Planning and Tactical/Executive)	ANSP have provided inputs, models proposals based on their experience and contributed to cross-reviews	Invest on material and training to enjoy assistance in operations: separation provision.
Network Manager	NM has provided thorough review in En-Route aspect	Benefit from improved local efficiency of the network use through separation provision, with direct effect on traffic flows (smoother management, less delays) and flight trajectory predictability (improved thanks to better accuracy and capability to provide highest adherence

Table 9: Stakeholder's expectations

A.2 Benefits mechanisms

Hereafter is a high-level description of the Benefit and Impact Mechanism of both Solution PJ.10-02a1 and PJ.10-02a2 for each impacted Stakeholder. This description has been developed at the OSED level (using the reference Guidelines for Producing Benefit and Impact Mechanisms [23]) and aligned with the SESAR 2020 Performance Framework [13]. These benefit mechanisms might also be refined in the context of the different Validation Exercises related to the Solution.

Distinction between Solutions 10.02a1 and 10.02a2 – AU level

After review sessions with the BIM experts' team, it has been agreed that, at BIM level for AU point of view, the distinction between the two solutions is not relevant. Indeed the benefits for the AU are similar independent on how the trajectory is improved (i.e.: from ground or board sources). The main benefits lie in the fact that the services and tools for separation provision are enhanced, providing a more efficient support from ATC to AU.

Distinction between Solutions 10.02a1 and 10.02a2 – ANSP level

After review sessions with the BIM experts team, it has been agreed that, at BIM level for ANSP point of view, the distinction between the two solutions is less relevant than the distinction of the environment : TMA and En-Route and services : CD/R tools (e.g. : MTCD and TCT) and conformance monitoring service (e.g.: MONA). Therefore the group has split the Benefit Impact Mechanism Analysis into:

- One for CD/R tools in all environments (CM-0206 & CM-0209 for PJ10.02a1 and CM-0209b for PJ.10.02a2). We have first work BIMs separately, one for each environment, but after work sessions it appears that in both environments the expected benefits and changes are very similar. We have made the choice to group them as one BIM
- One for Conformance monitoring service in TMA (CM-0208A for PJ10.02a1)
- Two for Conformance monitoring service in En-Route CM0210 for PJ10.02a1 and CM-0210b for PJ10.02a2). We have worked initially as one BIM but found after review sessions that the use of aircraft derived data (PJ10.02a2) brings significant additional benefit, worth mentioning it. Therefore we have made two BIMs.
- One for the advanced service of the MTCD (CM-0211 for PJ10.02a1). This OI came from SESAR 1 work and we choose to keep it separate from the CD/R tools BIM in order to highlight the benefits of the specific added features and improvements, in line with the only exercise addressing it.

Note: the OIs related to solution PJ10.02a2 are indicated in green on the concerned BIMs for better readiness

A.2.1 Structure and syntax

A Benefit and Impact Mechanism (BIM):

- Is a cause-effect description of the impacts of the proposed solution;
- Describes and identifies all relevant impacts, whether positive or negative, that the proposed solution is expected/ shown to provide.

A Benefit and Impact Mechanism consists of a diagram showing an overview of the links between the boxes in the different columns, this is supplemented by textual descriptions of the feature and the numbered mechanisms.

The BIM diagram is laid out in columns:

Column Title	Box Shape	Column Description
OI Step(s)		Identifies the OI Step that will bring changes to the world of ATM and briefly describes it
Changes		Short description of a change brought about by the OI Step
Performance Indicators / Metrics		Aspects which can be measured (or calculated from other metrics) to identify if the expected positive and negative impacts are actually realised. These need to be things that can be measured in the validation exercises.
Impacts (Positive or Negative)		Describes the expected positive or negative impacts
KPA / TA Impacted		The KPA which is related to the Impact, as defined in the SESAR2020 Performance Framework.

Table 10: Benefit and Impact Mechanism Syntax – Columns

The boxes in these columns are linked by numbered arrows, which represent the mechanisms.

(n)	The numbers provide links to the mechanism descriptions in the text.

Table 11: Benefit and Impact Mechanism Syntax – Mechanisms

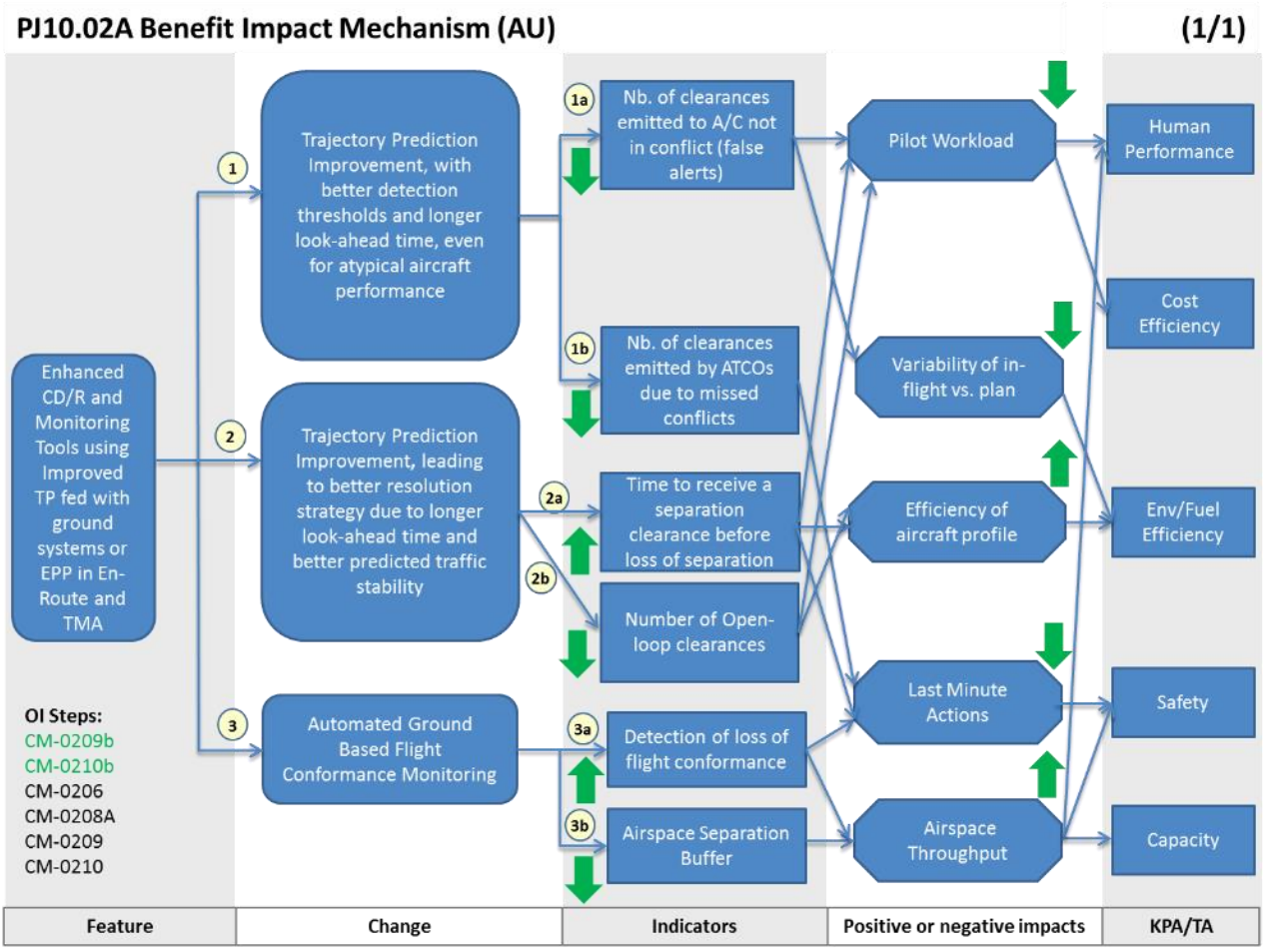
The arrows associated with the Indicators and the Positive or Negative Impacts are:

OI Step(s)	 Identifies the OI Step that will bring changes to the world of ATM and briefly describes it
	A beneficial decrease e.g. a reduction in CO2 emissions (indicator) or a reduction in controller workload (positive impact)
	A detrimental increase e.g. an increase in CO2 emissions (indicator) or an increase in controller workload (negative impact)
	A beneficial increase

	e.g. an increase in no. of movements (indicator) or an increase in safety (positive impact)
	A detrimental decrease e.g. a reduction in no. of movements (indicator) or a reduction in safety (negative impact)
	A change in the indicator, a positive or negative impact is expected but with current knowledge the direction is still not clear. Can be coloured to show the main expectation. It is preferable to use a direction arrow, however this is provided as a 'last resort', for example where input from a TA expert is required or if there are two possible hypotheses on the change which need to be explored in the validation activities.

Table 12: Benefit and Impact Mechanism Syntax – Coloured Arrows

A.2.2 Airspace User benefits mechanism



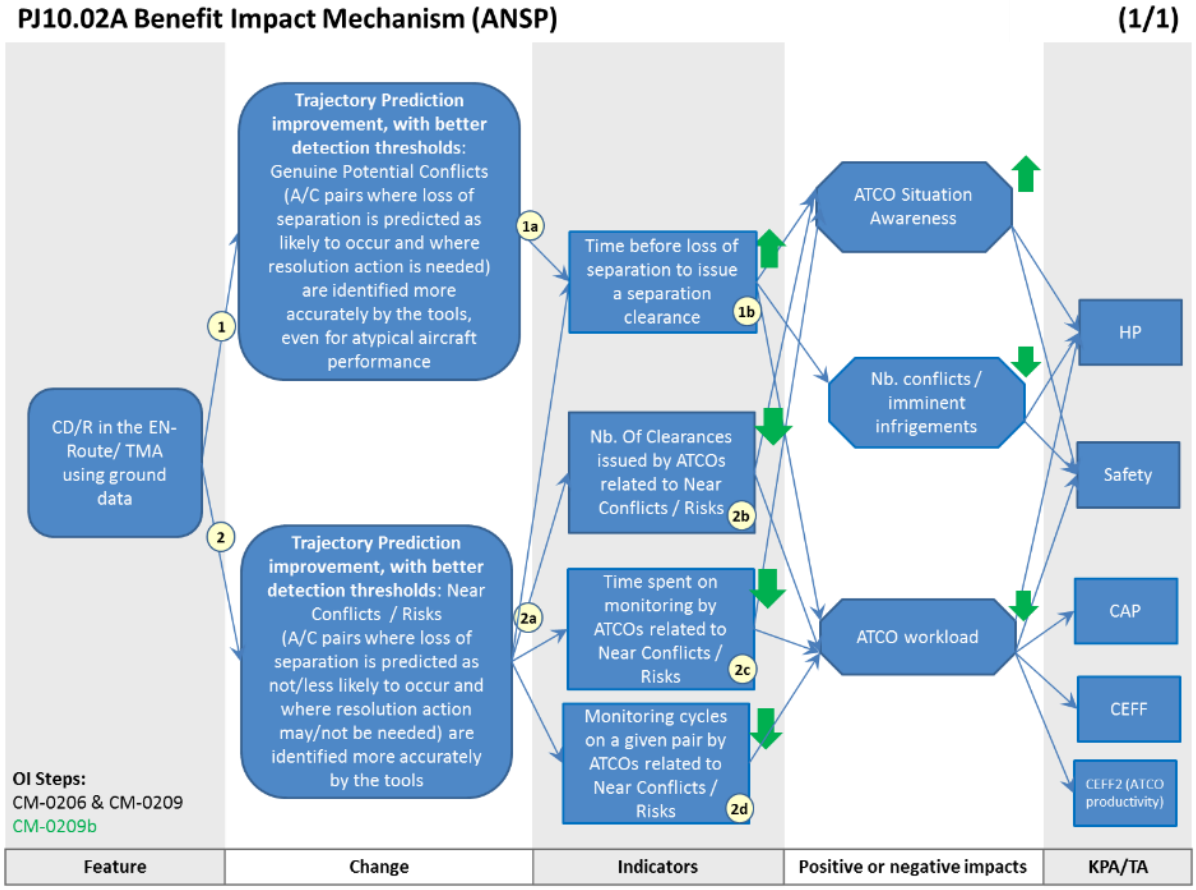
1	The use of enhanced CD/R and monitoring tools with ground trajectory prediction that is fed with predicted aircraft trajectory data (through ADS-C reports) in En-Route and TMA will result in an improved quality of service for airspace users. The integration of these reports will allow for improvements in the technical accuracy of the CD/R and monitoring tools with better thresholds, thus reducing the operational uncertainty and extending the look-ahead time of these tools.
(1a)	The number of unnecessary route alterations is minimized due to a reduction in the number of false alerts, resulting in less pilot and controller actions/workload which links to Human Performance. The decrease in controller workload has the potential to increase the number of flights in the sector/improve rostering, thus allowing for a decrease in the costs for airspace users due to higher economies of scale achieved by ANSPs. Moreover, this improvement allows for a preservation of the aircraft profile efficiency and less variability between planned versus actual flight, impacting thus also the environmental/fuel efficiency area.

(1b)	The number of clearances emitted by ATCOs due to missed conflicts is decreased due to the higher accuracy of the trajectory prediction, resulting in less last minute actions with impact on safety.
2	The improvement in trajectory prediction tools allows for better resolution strategies and better predicted traffic stability leading to longer look-ahead time. This gives controllers more flexibility in optimizing the resolution clearances.
(2a) (2b)	The accuracy of the provided conflict resolution clearances is improved. The total number of corrective conflict resolution instructions (due to provision of more efficient conflict resolution clearances) and open-loop clearances is decreased and provided earlier in time. This improves the flight profile predictability and reduces the pilot workload, impacting thus HP. This improves also the resolution strategy and flight profile predictability and efficiency allowing AU to compute more accurate and stable optimal trajectories with better expected adherence, impacting thus positively environmental and fuel efficiency.
(3)	An automated flight conformance monitoring ground tool will have an improved detection rate of loss of flight conformance resulting in less last minute actions that impact the safety area. Furthermore, the improved detection rate of flight conformance may allow for 4D-equipped aircrafts a decrease in airspace separation buffer with the potential to increase the number of flights in the airspace (airspace throughput), which is linked to capacity. However, this may also impact negatively on safety and human performances.

A.2.3 ANSP benefits mechanism

There are five ANSP Benefit and Impact Mechanisms, each corresponding to one or several Operational Improvements.

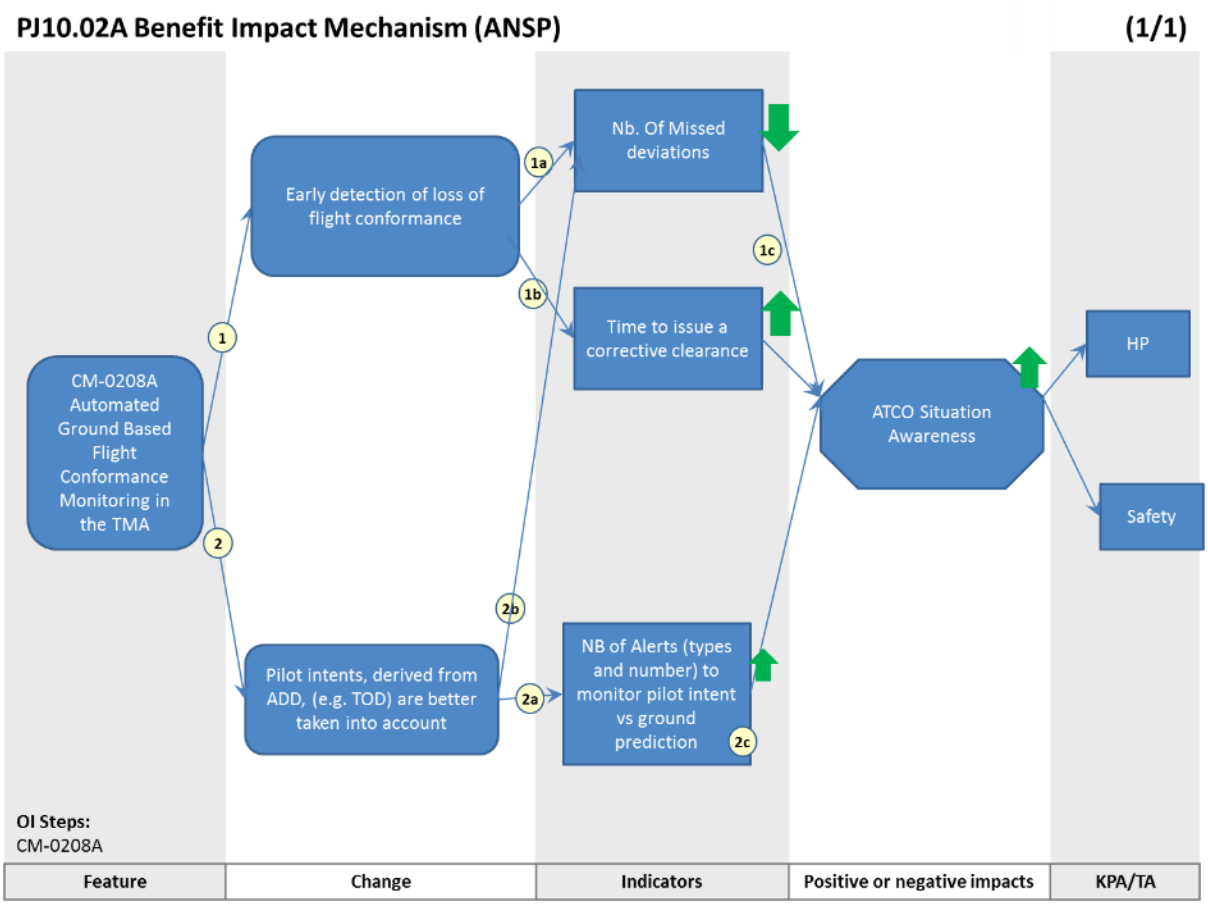
OI steps: CM-0206, CM-0209 & CM-209-b



(1)	Actual Potential Conflicts (aircraft pairs and/or situations where loss of separation is predicted as likely to occur – and where control action for resolution is required) will be better detected thanks to the accuracy of the tools through the trajectory enhancements, even for A/C with atypical performance
(1a)	As the potential conflicts are more accurately detected, the time available to issue a clearance before the effective loss of separation will increase
(1b)	Situational awareness for ATCOs (PLN and EXE) will increase & Nb. Of conflicts / imminent infringements will decrease through the additional time/mental capacity available to the ATCO brought about by the lack of unnecessary control and monitoring actions as conflicts are more accurately detected. All of this will positively impact both Human Performance & Safety. In addition, it will result in a decreasing of the ATCO workload. This will impact positively Human Performance, Safety, as well as Capacity, Cost Efficiency and ATCO productivity, allowing to handle a higher potential of flights.

(2)	Near Conflicts / Risks (aircraft pairs and/or situations where loss of separation is predicted as less likely to occur – and where control action for resolution may or may not be needed) will be better detected thanks to the accuracy of the tools through the trajectory enhancements
(2a)	Since Near Conflicts / Risks are identified more accurately, ATCO resolution decisions/strategies (e.g. PLN action, EXE action or wait) will be applied more appropriately and with greater confidence, resulting in more time available to issue a clearance. The number of required EXE control clearances related to these situations will decrease accordingly and the time spent on monitoring by ATCOs (PLN and EXE) related to these situations will also decrease as well as the number of monitoring cycles (check and re-check) on a given pair of aircrafts.
(2b)	As the number of tactical clearances related to Near Conflicts / Risks will decrease, ATCO workload overall will decrease, and the ATCO situation awareness will increase, both positively impacting Human Performance & Safety, as well as Capacity, Cost Efficiency and ATCO productivity through the positive impact on ATCO workload.
(2c)	As the global time spent on monitoring - related to Near Conflicts / Risks will decrease, ATCO situation awareness will increase, positively impacting Human Performance & Safety. In addition as the time spent on monitoring is decreasing, the ATCO overall workload will decrease, impacting positively Human Performance & Safety, as well as Capacity, Cost Efficiency and ATCO productivity.
(2d)	As the iterations spent on monitoring a given pair of aircrafts - related to Near Conflicts / Risks will decrease, the ATCO workload will decrease, impacting positively Human Performance & Safety, as well as Capacity, Cost Efficiency and ATCO productivity

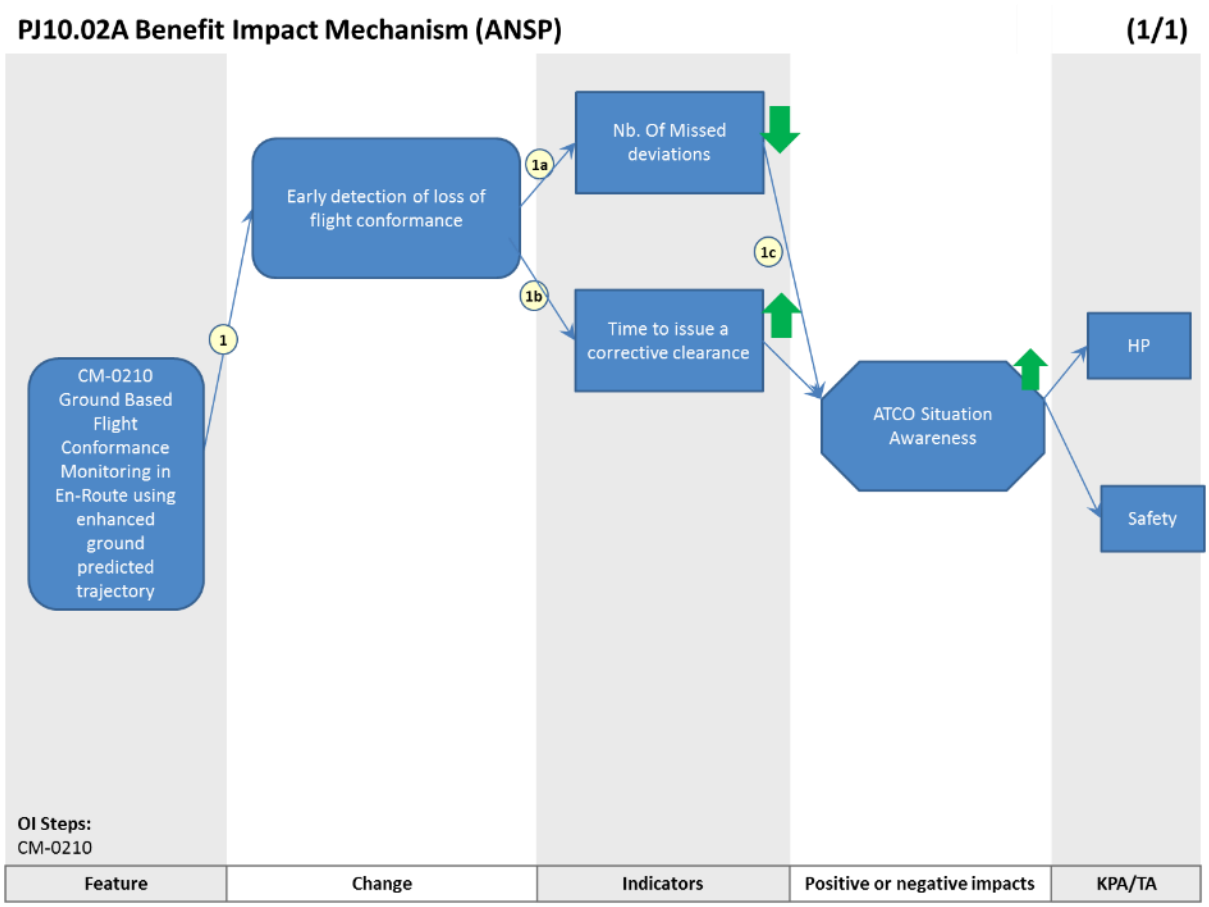
OI steps: CM-0208A



(1)	Detection of loss of conformance will be earlier detected, thanks to the trajectory accuracy, in a more reliable way
(1a)	In case of an incorrect clearance input (CFL, heading, direct, etc.) in the HMI or pilot non conformance, an alarm is immediately displayed, even before the start of the maneuver as the ATCO timely updates the HMI, the number of missed deviations will thus decrease
(1b)	As the detection is performed earlier, the time to provide corrective clearance will increase
(1c)	As there will be more time to detect and handle non conformance, the ATCO situation awareness will improve, impacting both HP & Safety

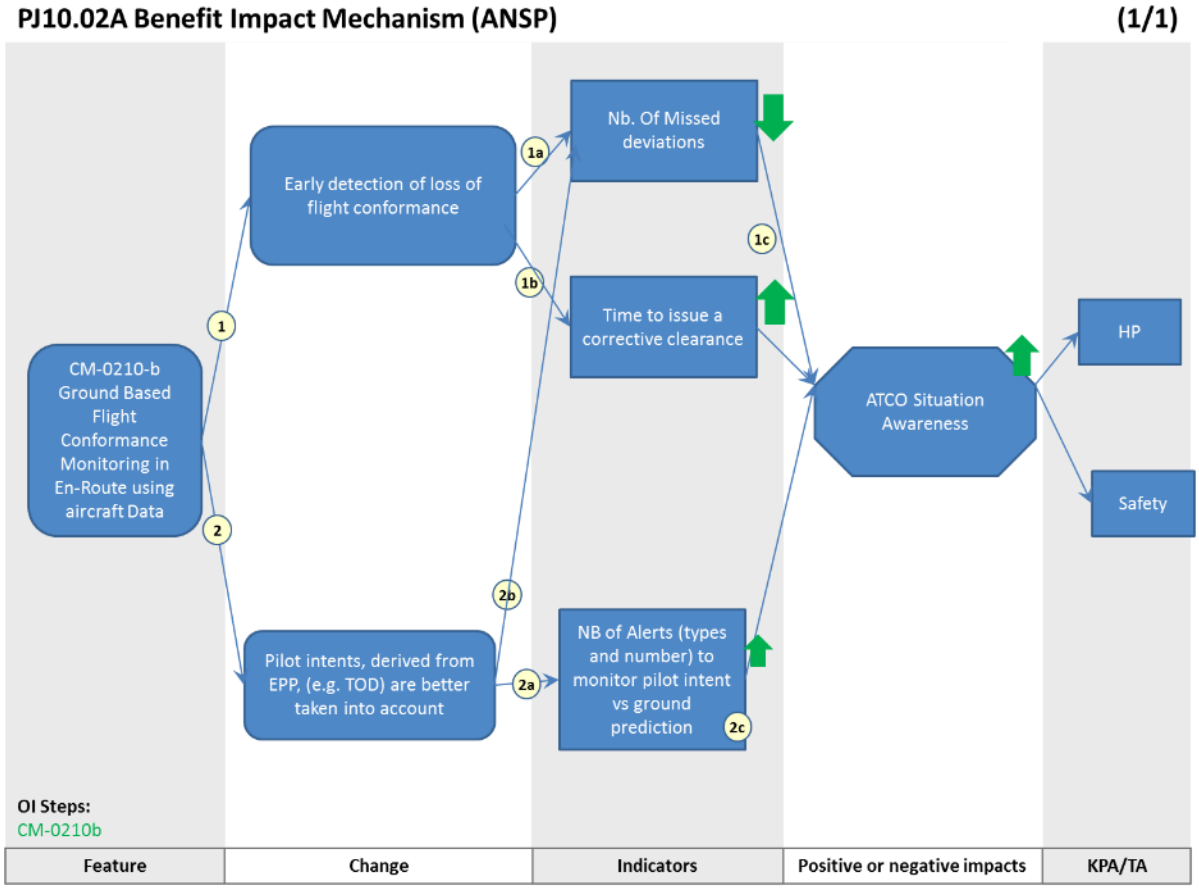
(2)	Thanks to the trajectory downlink from A/C, pilot intents will be known and taken into account, resulting in newer alerts of the conformance between pilot intent and ground flight profile prediction
(2a)	As the pilot intents are taken into account, new alerts will be available to monitor pilot intent vs ground flight profile prediction, increasing both the number and the types of alerts
(2b)	As the pilot intents are taken into account, there will be less non conformance un-detected as a new kind of alarm and monitoring is now available for ATCO
(2c)	This increase of the types of alerts and non conformance situations detected will improve the ATCO situation awareness, impacting both Human Performance & Safety

OI steps: CM-0210



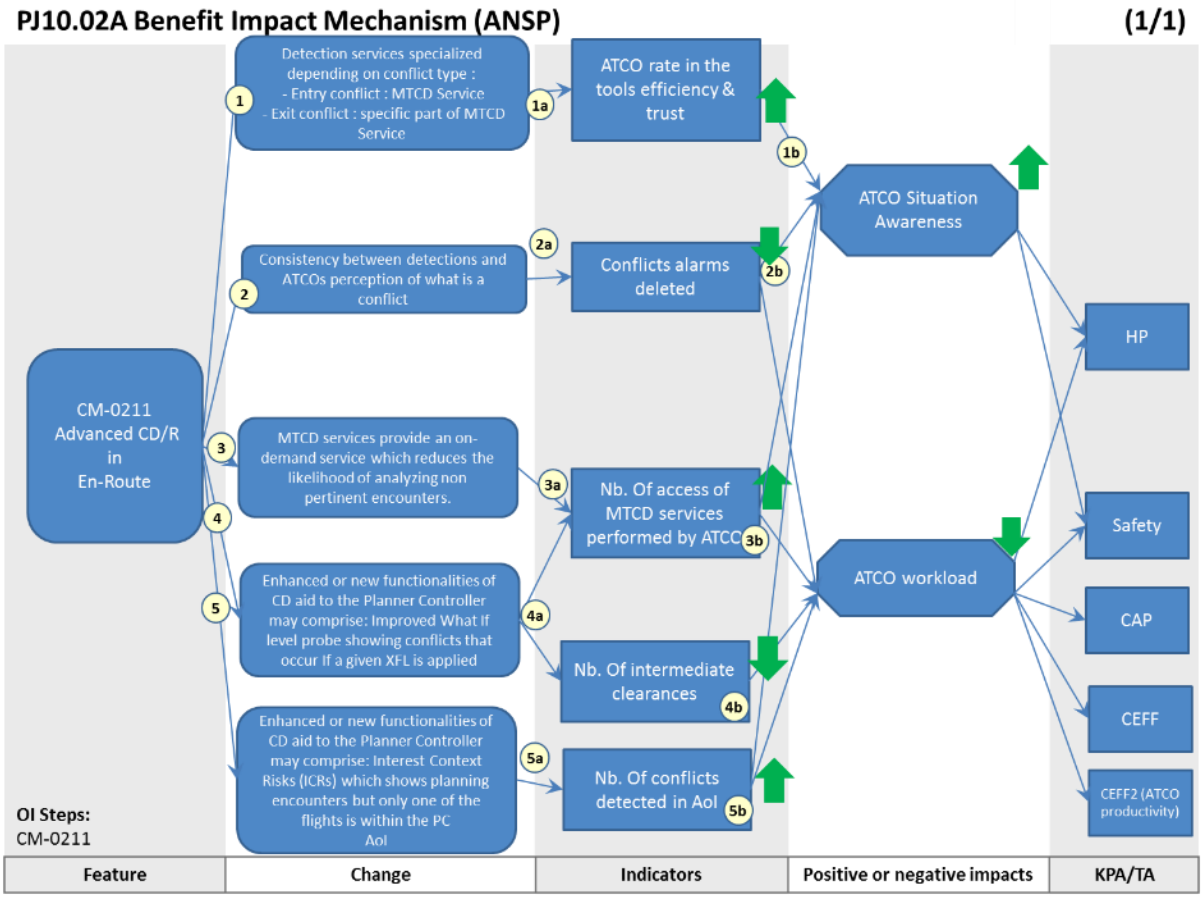
(1)	Detection of loss of conformance will be earlier detected, thanks to the trajectory accuracy (e.g. : through Mode S), in a more reliable way
(1a)	In case of an incorrect clearance input (CFL, heading, direct, etc.) in the HMI or pilot non conformance, an alarm is immediately displayed, even before the start of the maneuver as the ATCO timely updates the HMI, the number of missed deviations will thus decrease
(1b)	As the detection is performed earlier, the time to provide corrective clearance will increase
(1c)	As there will be more time to detect and handle non conformance, the ATCO situation awareness will improve, impacting both HP & Safety

OI steps: CM-0210-b



(1)	Detection of loss of conformance will be earlier detected, thanks to the trajectory accuracy (e.g. : through EPP), in a more reliable way
(1a)	In case of an incorrect clearance input (CFL, heading, direct, etc.) in the HMI or pilot non conformance, an alarm is immediately displayed, even before the start of the maneuver as the ATCO timely updates the HMI, the number of missed deviations will thus decrease
(1b)	As the detection is performed earlier, the time to provide corrective clearance will increase
(1c)	As there will be more time to detect and handle non conformance, the ATCO situation awareness will improve, impacting both HP & Safety
(2)	Thanks to the trajectory downlink from A/C, pilot intents will be known and taken into account, resulting in newer alerts of the conformance between pilot intent and ground flight profile prediction
(2a)	As the pilot intents are taken into account, new alerts will be available to monitor pilot intent vs ground flight profile prediction, increasing both the number and the types of alerts
(2b)	As the pilot intents are taken into account, there will be less non conformance un-detected as a new kind of alarm and monitoring is now available for ATCO
(2c)	This increase of the types of alerts and non conformance situations detected will improve the ATCO situation awareness, impacting both Human Performance & Safety

OI steps: CM-0211



(1)	Detection services specialized depending on conflict type : - Entry conflict : MTCD Service - Exit conflict : specific part of MTCD Service - In sector conflict : What-if Service
(2)	Consistency between detections and ATCOs perception of what is a conflict
(3)	MTCD services provide an on-demand service, which reduces the likelihood of analyzing non pertinent encounters.”
(4)	Advanced or new functionalities of CD aid to the Planner Controller may comprise: Improved What If level probe showing conflicts that occur If a given XFL is applied
(5)	Advanced or new functionalities of CD aid to the Planner Controller may comprise: Interest Context Risks (ICRs) which shows planning encounters but only one of the flights is within the PC AoR
(1a)	As the detection service is specialized on ATCO needs in En-Route, notably the difference between entry and exit conflicts, ATCOs feedback after EXE on their

	experience with FASTI MTCD in reference scenario & Solution MTCD in solution scenario will show a better rate of trust and efficiency in the scenario solution
(1b)	As the tool is deemed more efficient and trustful, ATCO rely on it and get a better situation awareness, impacting both Human Performance & Safety
(2a)	As false positive are reduced, the number of conflicts alarms deleted will decrease,
(2b)	A lower rate of datablock to delete and of false datablock will improve both ATCO workload and situation awareness, both impacting Human Performance & Safety
(3a)	As the what if is provided with the tool, the ATCO working method will change with a higher Number of on-demand action generated by ATCOs
(3b)	The increasing on-demand actions (such as filtering, what-if,…) will Help ATCOs in delivering vertical clearances (CFL/rate) and thus the ATCO workload will decrease, impacting both Human Performance & Safety as well as Capacity, Cost Efficiency and ATCO productivity.
(4a)	If ATCO working method consists of applying an initial EFL which solves all "candidate conflicts", this initial EFL is more efficient which is measurable through the increasing number of on-demand actions generated by ATCOs and decreasing of intermediate clearances.
(4b)	The decreasing intermediate clearances to solve a conflict will accordingly reduce the ATCO workload, impacting thus Human Performance, Safety, Capacity, Cost Efficiency and ATCO productivity
(5a)	In case of a conflict in the AOI involving a "neighbouring flight" (flight in the AOI), the ATCO are more likely to detect the conflict , increasing then the number of conflicts detected in AOI
(5b)	The better detection of conflicts in AoI will increase ATCO situation awareness as he will be able to detect upcoming conflicts in its AoR earlier, though it might also increase ATCO workload in case he is not concerned by the conflicts detected, but that should be counter-balanced by the other changes effects, impacting thus Human Performance & Safety as well as Capacity, Cost Efficiency and ATCO productivity.

A.2.4 Network Manager benefits mechanism

No BIM is provided because of the following rationale:

At this stage, no direct link between ATC tools and services covered by PJ10.02a and NM processes has been identified. Moreover, ATC tools and services are considered as external elements from NM systems. Therefore, it is assumed that any eventual benefits would come from lucky side-effects. Some examples might be:

- Earlier resolution of conflicts using “closed” clearances might facilitate aircraft’s adherence to target time constraints;

- Less “unnecessary” resolution of conflicts, thanks to better MTCD classification of non-conflicts, gives greater adherence to RBT / greater predictability.

However, these benefits are deemed extremely questionable and impossible to demonstrate.

Therefore, a BIM from NM point of view for solution PJ.10-02a seems not relevant.

A.3 Costs mechanisms

This section details the costs identified, the assumptions and the proposed approach used for the cost analysis, per identified stakeholder.

The methodology applied to write this section is in line with the proposed approach provided in the Guideline [39].

As a reminder: it is important to keep in mind that we evaluate ONLY the deltas induced by this solution. The Reference scenario is assumed to be deployed. Therefore, some CD/R tools and services are already deployed while others are not. This cost assessment will take this in consideration and provides a cost evaluation depending on the initial status of the tool / service (i.e.: not deployed / deployed).

A.3.1 ANSPs costs

Following the guidance, the costs can be refined into three categories.

1. **Pre-Implementation Costs**: all costs that need to be used up to define the needs, to develop solutions (R&D), to decide which solution best serves the needs.
   An important note in that respect is that the SESAR R&D costs (up to V3) should not be included as costs in any SESAR CBA. The CBA should be focussed on deployment, i.e. what the stakeholders will pay to put the solution in place.

2. **Implementation Costs**: all costs related to the acquisition and implementation of the solutions.

3. **Operating costs**: all costs related to the change in daily operations that is brought about by the solution.

At this stage, the following costs have been identified, at ANSP level

Cost category	Sub-categories
Pre-Implementation Costs	Concept definition review, with a panel of experts to identify the potential lacks and specificities needed for a given system Concept definition completion, where applicable *(this item will not be evaluated as considered optional)*
Implementation costs	**One-Off costs**: installation costs, including coding, testing until Deployment, Validation & Certification costs, Initial Training costs, Project Management costs, Administrative costs

	Capital Costs (evaluated for one ACC): equipment, hardware, licence, physical integration costs **Transition Costs** Optional: Airspace design & Procedures *(this item will not be evaluated as considered optional)*
Operating costs	**Personal & Training,** **Maintenance & Repair** **Facility Costs** **Administration Costs**

ANSPs cost approach

The costs have been deduced from past and similar experiences on ATM tools and systems' evolutions and provided in this document per tool or service to update.

Indeed, it is likely that an ANSP might not implement the whole solution but only parts of it to complete its own system and it also matched the case study (exercise 003).

In addition, in the OSED as in the TS, the requirements are provided per tool / service, so it should be easy to identify each requirements' scope (e.g.: only MTCD, TCT and MTCD, all, and so on).

One major issue when evaluating costs is the difficulty to remain sufficiently general to englobe most of the situations (e.g.: each ANSP has its own way of managing costs) and sufficiently detailed to provide accurate data and give a rough but good idea of the implementing costs.

To avoid as much as possible this bias, 3 ANSPs have been involved to perform the cost evaluation, including the two ANSPs involved in the exercise 003.

ANSPs cost assumptions

Assumptions on metrics used

In order to evaluate costs ranges, one metric could be defined as the number of requirements, so as to evaluate the size of the evolution and ease the comparison with a similar one performed on existing tools.

However, from DSNA expertise, the granularity of the requirements used to evaluate the cost of an evolution might differ significantly from one project to another. It could then be higher or lower than the one known to date and used in this analysis (i.e.: from OSED and TS). It has then been assumed that a requirement in this document "costs" is between 5 to 7 man-days for implementation (installation costs only).

Assumptions on scope

Costs have been evaluated in link with the exercise 003 to allow NVP computation, considering so that each ANSPs involved needed an upgrade of the tools. Therefore the costs have been evaluated for an ANSP and multiplied by two to reflect the costs of the exercise 003 and allow the benefit comparison on their area (Maastricht and Prague). It has been assumed that the same costs applied for each ANSP for easier computation. However values have been evaluated between a minimum and a maximum and only the maximum value has been used for NVP

Number of investment instances (units)

This solution (or parts of it) is applicable to any TMA or ACC environment in Europe, whatever its category is. **Although it is assumed more useful in H and M environments**.

Cost per unit

In the frame of this solution, the costs per ECAC unit are deemed identical. A service will be implemented in its full scope or will not be. Therefore, whatever the ECAC category, the costs should not vary significantly.

On the contrary, one key factor as a significant influence on costs: the initial status of the tool / service, in extenso, if the tool or service is already deployed and operational or not.

In the first case, the impact induced by this solution would be similar as a major evolution, while in the second case, the impact is much more significant to consider.

Reminder: to give an idea of the granularity used here, a requirement is considered between 5 and 7 man-days (for installation costs only)

Pre-Implementation Costs	**Tool or Service already deployed = major upgrade expected**	**Tool or Service not deployed = brand new equipment**
Concept Definition Review		
Implementing Costs		
One-off costs	**Project Management costs** Installation costs 5-7 man-days per requirement Initial Training costs Administrative costs Validation & certification costs	
Capital costs	**Integration Costs** **Equipment costs:** considered 0 as tools / services are already deployed in the reference scenario of this solution	

Transition costs		
Operational Costs		

Table 13: Cost per Category- ANSP

A.3.2 Network Manager costs

The main investments have to be expected at local ANSP level, to upgrade existing systems and tools and deploy brand new one.

There should be low or negligible cost effort at NM level.

Therefore the NM costs are not considered.

To reach the conclusion written above, expert judgement has been used from NM members.

To evaluate the effort, new ATM systems (such as 4-Flight, SYSAT) set in place by DSNA have been used as examples. Those systems have not induced specific costs at NM level. Given their nature and importance, it is likely that evolutions induced by this solution should remain local and not impact NM systems and costs.

A.3.3 Airspace User costs

The main investments have to be expected at local ANSP level, to upgrade existing systems and tools and deploy brand new ones.

At AU level, aircraft should be equipped with EPP / ADS-C enabler systems. However, while writing this V3 OSED, no aircraft equipment upgrade have been considered as mandatory.

-END OF DOCUMENT-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