OSED-DAP-G-SNET-V3 Final OSED for the use of DAPs in G-SNETs

Document information	
Project Title	Evolution of ground based safety nets
Project Number	04.08.01
Project Manager	DSNA
Deliverable Name	OSED-DAP-G-SNET-V3 Final OSED for the use of DAPs in G-SNETs
Deliverable ID	D80
Edition	00.01.01
Template Version	03.00.00
Task contributors	
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Abstract

This OSED is a V3 update of 4 8 1-D17 (OR-DAP-G-SNET-V2 Preliminary operational requirements for the use of down-linked aircraft parameters in ground based safety nets) after the V3 validation EXE-VP-239 and addresses only the STCA service. The requirements related to other safety nets (APW, APM and MSAW) are still at V2 maturity and can be found in 4.8.1-D17 [29]. Operational requirements for each safety net were derived on existing EUROCONTROL specifications published in May 2009. Analysis of the use of DAPs has not generated any new operational requirements (other than information exchange requirements).
Appendix A is the V3 update of the SPR and also addresses only the STCA service. The requirements related to other safety nets are still at V2 maturity and can be found in 4 8 1-D18 (SPR-DAP-G-SNET-V2 Consolidated Safety and Performance Requirements for the use of down-linked aircraft parameters in ground-based safety nets) **Error!**

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[redacted] EUROCONTROL		01/09/2014 (implicit)
[redacted] INDRA		01/09/2014 (implicit)
[redacted] NATS		01/09/2014 (implicit)

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Rational for rejection
None.

Document History

Edition	Date	Status	Author	Justification
00.01.00	30th July 2014	Final Draft for approval	ENAV	Updated requirements and document after V3 validation activity EXE-VP-239
00.01.01	28/08/2014	Final Draft	ENAV	Review comments, including restructuration (only STCA, SPR in appendix)

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This deliverable consists of SJU foreground.

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Executive summary

The operational concept for avoiding collisions between aircraft and hazards, as supported by Short term conflict alert (STCA) including DAPs, is updated taking into account the results of the V3 validation activity EXE-VP-239. This document also contains in Appendix A the V3 update of the SPR, also addressing only STCA.

The operational concept for avoiding collisions between aircraft and hazards, as supported by other ground-based safety-nets (APW, APM and MSAW) including DAPs, has not been assessed in V3; the V2 concept and requirements can be found in V2 maturity in the preliminary OSED [29] and SPR **Error! Reference source not found.**.

In light of the results of performance evaluations, operating methods are described considering potential new uses of down-linked aircraft parameters (DAPs): Barometric Pressure Setting, MCP/FCU Selected Altitude, Roll Angle and Track Angle Rate.

Some details of the target operational environment Step 1 are given with scenarios focused on ACAS but considering STCA.

Operational requirements are based on existing EUROCONTROL specifications published in May 2009. The main change to requirements due to the introduction of DAPs is the section on information exchange requirements and the addition of a second sentence to an existing note in the first alerting time requirement of STCA. The note now reads: “Note – Insufficient warning time may be provided in cases of sudden, unexpected manoeuvres. However, absence of expected manoeuvres such as level offs or turns should be anticipated”.

These requirements were inputs for ground based safety net design (through derivation of detailed system requirements) and verification in P10.4.3 for the development of the prototype that has been used in EXE04.08.01-VP239. Note: While DAPs are not expected to significantly change operational requirements at this stage, DAPs have an impact on safety and performance requirements.

1 Introduction

1.1 Purpose of the document

This Operational Service and Environment Definition (OSED) defines the operational concept for avoiding collisions between aircraft and hazards supported by Short Term Conflict Alert (STCA), as updated taking into account the results of the V3 validation activity EXE-VP-239. This document contains, also, in Appendix A the V3 update of the V2 SPR **Error! Reference source not found.** after the validation activity EXE-VP-239 and also addresses only STCA. The requirements for the other safety nets are still in V2 maturity and they can be found in the preliminary OSED [29] and SPR **Error! Reference source not found.**.

1.2 Scope

This OSED details the operational concept for the Operational Focus Area (OFA) Enhanced Safety Nets 03.04.01 and in particular Operational Improvement for Step 1 operations CM-0807-A Enhanced Ground-based Safety Nets using Mode S EHS data.

SESAR Step 1 time based operational environment [25] is assumed from 2013 in which ground based safety nets may be enhanced by DAPs [19]. The intended European Operational Concept Validation Methodology (E-OCVM) [6] maturity level is V3 for STCA).

The scope of the document is the update of the operational requirements presented in the V2 OSED [29] after the V3 validation activity EXE-VP-239.

Also, the document contains, in Appendix A, the updated version of the V2 safety and performance requirements **Error! Reference source not found.**.

1.3 Intended readership

This document is for members of:

- 4.8.1 “Ground based safety nets” and 10.4.3 “Safety nets adaption to new modes of operation” intending to evaluate safety and performance aspects of G-SNETs enhanced with DAPs;
- 4.2 “En-route operations - consolidation of operational concept definition and validation including operating mode and air-ground task sharing”.

1.4 Structure of the document

Section 2 summarises the operational concept for Short term conflict alert (STCA).

Section 3 describes details of the operating methods of STCA [9].

Section 4 describes the SESAR Step 1 operational environment.

Section 5 is not completed. The incompleteness comes from the lack of some scenarios in the DoD Step 1. Some scenarios from DOD Step 1 are included but they are focussed on changes to ACAS (reference is made to STCA).

Section 6 defines operational requirements for STCA derived from EUROCONTROL specifications (SPIN) [8]. A section on information exchange requirements describes the main characteristics of DAPs.

1.5 Background

Following the mid-air collision over Überlingen, Germany on 1st July 2002 a number of strategic safety actions were initiated, amongst which were:

- Development of EUROCONTROL specifications and guidance material for ground-based safety nets, in particular STCA and

- Study of the feasibility of Airborne Collision Avoidance System (ACAS) Resolution Advisory (RA) downlink display at the Controller Working Position (CWP).

The EUROCONTROL SPIN (Safety Nets: Planning Implementation & eNhancements) Task Force was created in 2005 to draft standards and guidance material for the ground-based safety nets (STCA, Minimum Safe Altitude Warning (MSAW), and Area Proximity Warning (APW)). These were published in May 2009 [8][9][10][11][12][13][14][15] containing operational requirements for each of the above safety nets.

During 2009 to 2014, SESAR 4.8.1:

- Consolidated above STCA requirements with results of the EUROCONTROL PASS (Performance and safety Aspects of STCA, full Study) project [24]
- Conducted feasibility and performance evaluations of each of the above safety nets using existing down-linked aircraft parameters in the context of SESAR Step 1 [16][17][18].
- Conducted performance evaluations of the use of two DAPs in the STCA, using a prototype [28].

This document contains an updated set of OSEDs for STCA in a SESAR Step 1 operating environment, as results of the validation activity EXE04.08.01-VP239 executed using the STCA+DAPs prototype.

1.6 Glossary of terms

None.

1.7 Acronyms and Terminology

This section defines acronyms specific to this document.

Term	Definition
ANSP	Air navigation service provider
AP/FD	Autopilot/Flight director
APM	Approach path monitor
APW	Area proximity warning
ASAS	Airborne separation assistance systems
ASPA	Airborne spacing
ATM	Air Traffic Management
BT/MT	Business Trajectory (civil) / Mission Trajectory (military)
CORA	COnflict Resolution Assistant
CTA	Controlled Time of Arrival
CTO	Controlled Time Over
DAPS	Down-linked Aircraft Parameters
DOD	Detailed Operational Description

FOC	Flight Operations Centre
MCP/FCU	Mode control panel / Flight control unit
MSAW	Minimum safe altitude warning
OSED	Operational Service and Environment Definition
PANS-ATM	Procedures for air navigation services - Air traffic management
PTC	Precision Trajectory Clearance
QNH	Q code - Barometric pressure adjusted to sea level
RBMT	Reference Business Mission Trajectory
RTA	Required Time of Arrival
SBMT	Shared Business Mission Trajectory
SESAR	Single European Sky ATM Research Programme
SPIN	Safety net Performance Improvement Network
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SPR	Safety and Performance Requirements
STCA	Short term conflict alert
TMA	Terminal control area
TTO/TTA	Target Time Over/Target Time of Arrival
WOC	Wing Operations Centre

2 Summary of Operational Concept from DOD

2.1 Mapping tables

The following mapping is taken from DOD Step 1 [21]

Relevant OI Steps ref. (coming from the definition phase)	Any new / changed OI step (textual form)	Operational Focus Area name	Story Board Step	Master or Contributing (M or C)	Contribution to the OIs short description
CM-0807-A	Enhanced Ground-based Safety Nets using Mode S EHS data	03.04.01 – Enhanced ground based safety nets	Step 1	C	OSEDs for Short term conflict alert, Minimum safe altitude warning, Area proximity warning, and Approach path monitor

2.2 Operational Concept Description

2.2.1 Scope – Step 1

Step 1 is assumed with the addition that ground based safety nets may use existing down-linked aircraft parameters in anticipation of trajectory information. Step 1 DODs [21][22] are split into en-route and TMA.

En-route

The DOD for Step 1 en-route states the following about ground based safety nets:

> Across all ECAC area, according to local operational needs, the following safety nets are deployed in En Route:
>
> - Short Term Conflict Alert (STCA)
> - Area Proximity Warning (APW),
> - Minimum Safe Altitude Warning (MSAW)
>
> In the step 1 timeframe, in the En Route environment, ground based safety nets implementation through ECAC progressed, and enhanced ground based safety nets using Aircraft Derived data in order to improve trajectory prediction accuracy were studied.

TMA

The DOD for Step 1 TMA states the following about ground based safety nets:

> Air Safety Nets [PAC 03 Moving from Airspace to Trajectory Management]
>
> Ground based Safety Nets provide an alert to air traffic controllers when separation minima may be infringed or when a potentially threatening situation to the safe conduct of the flight is developing. The following safety nets are deployed where radar services are provided: Short Term Conflict Alert (STCA) in all ECAC airspace, Area Proximity Warning (APW) in all ECAC airspace to GAT from civil or military ATS Units, Minimum Safe Altitude Warning (MSAW) where the potential for infringements exists, and Approach Path Monitor (APM) where the potential for deviations from the glide path exists.
>
> Ground and air based safety nets will still constitute an important component of the ATM system in the SESAR 2020 concept. It is designed to alert controllers and pilots of collision risks which would have remained undetected by other (longer term) processes. It encompasses STCA systems (risk of collision with other traffic) and MSAW and GPWS types of systems (to prevent terrain collision)."

To summarise, no fundamental change took place in the operational concept of ground based safety nets within collision avoidance for Step 1 and an harmonisation of current state of the art systems was obtained, due to the use of existing down-linked aircraft parameters.

The following sections introduce the operational concept of collision avoidance supported by ground based safety nets.

2.2.2 Collision avoidance

Collision avoidance is the third layer of conflict management and must activate when the separation mode has been compromised. It is concerned with avoiding collisions between aircraft and hazards (see 2.2.3). Collision avoidance systems are not included in determining the calculated level of safety required for separation provision. Collision avoidance systems, however, is considered as part of ATM safety management. The collision avoidance functions and the applicable separation mode, although independent, must be compatible.

Note: The operation of separation provision and collision avoidance may overlap in time.

2.2.3 Hazards

In the context of separation, ICAO defines hazards as "…objects or elements that an aircraft can be separated from. These are: other aircraft, terrain, weather, wake turbulence, incompatible airspace activity and, when the aircraft is on the ground, surface vehicles and other obstructions on the apron and manoeuvring area. For any hazard (i.e. any condition, event or circumstance that could induce an accident), a risk can be identified as the combination of the overall probability or frequency of occurrence of a harmful effect induced by the hazard, and the severity of that effect…"

2.3 Processes and Services (P&S)

The collision avoidance operational service is supported by ground-based and airborne safety nets. Ground based safety nets are intended to support a first layer of collision avoidance with airborne safety nets as the last resort

Note: The operation of ground based safety nets and airborne safety nets may overlap in time.

Only STCA safety net is covered in this document:

2.3.1 Short Term Conflict Alert (STCA)

STCA is a ground-based safety net intended to assist the controller in preventing collision between aircraft by generating, in a timely manner, an alert of a potential or actual infringement of separation minima.
The purpose of STCA is to detect and alert '**operationally relevant conflict**' involving at least one '**eligible aircraft**' with '**sufficient warning time**' for the controller to intervene and the aircraft to execute an appropriate manoeuvre.
This may be either to detect and alert on-time any of the following:

- predicted or actual infringement of separation minima for controlled flights (either IFR or VFR) to which ATC is expected to provide separation;
- hazardous encounters involving at least one controlled flight (either IFR or VFR) in situations where collision avoidance relies on visual separation by aircraft.

The sole purpose of STCA is to enhance safety and its presence is ignored when calculating sector capacity.

STCA is designed, configured and used to make a significant positive contribution to the effectiveness of separation provision and collision avoidance.

2.3.2 Mapping to Service portfolio and Systems (optional for V1 and V2)

N/A.

3 Detailed Operating Method

As described in 2.2.1 for the purposes of this OSED, the Step 1 environment is assumed. Regarding STCA safety net, the 'previous operating method' is assumed to be today's operating method, and the 'new operating method' is with enhanced short term conflict alert using existing DAPs to improve for example prediction accuracy (see 3.1).

3.1 Use of down-linked aircraft parameters (DAPs) in ground based safety nets

The expected benefit of incorporating DAPs into ground-based safety nets will reduce risk of ATM induced accidents or incidents by increasing the effectiveness of the safety net. This safety benefit is expected to be achieved through an enhanced monitoring of the environment of operations with timely alerts of an increased risk of flight safety (both in en-route and TMA).

Another expected benefit from using DAPs is to increase the controller confidence in ground-based safety nets. Confidence in an alert system directly affects human-system interaction and has to be ensured. ATC's decision making is strongly dependent on reliability of alerts. For example, there is a high probability to ignore or even switch-off the system if the number of nuisance or false alerts is too high. Reducing the likelihood of alerts that are not operationally relevant therefore increases controller performance in response to genuine alerts.

The specific mechanisms for improving safety nets through the use of DAPs (for the options identified in the F&O study) are as follows:

- Use of a DAP to identify an aircraft's intention to change direction (laterally or vertically) earlier than would be detected by a tracker;
- Use of a DAP to provide trajectory data for an aircraft (rather than use the tracker derived data);
- Use of a DAP to identify that an aircraft is not manoeuvring – particularly to confirm that an aircraft is in flight level;
- Use of a DAP to determine the eligibility of aircraft for ground-based safety net protection;
- Specific use of a DAP to improve the accuracy of aircraft height – namely: correct the MCP/FCU and FMS Selected Altitude information for sub scale pressure setting when the aircraft is below the transition altitude within ground-based safety net detection functions.

The V2 validation developed and explored the options for the use of DAPs, described and evaluated the expected benefits (of using specific DAPs within specific scenarios) and therefore concluded which of the broad benefits are applicable. The validation activities verified that the outcomes were successful because it confirms that they could be obtainable.

A V3 validation activity, EXE-VP-239, validated the effectiveness of the improvements and the benefits (identified during the V2 activities) related to the introduction of DAPs in STCA.

The validations followed the principles of European-Operational Concept Validation Methodology (E-OCVM). The validation activities [16][17][18] derive via the application of the E-OCVM to the evaluation of the use of existing down-linked aircraft parameters within ground-based safety nets.

The underlying validation strategy was as follows:

- Determination the potential benefits of using (a specific) DAP within ground-based safety nets;
- Determination the circumstances (i.e. scenarios) in which the anticipated benefit might be achieved;
- Determination the frequency with which these circumstances (i.e. scenarios) occur;
- Insurance that any proposed change does not have a negative impact on overall performance – via a safety assurance assessment;
- Determination that any proposed improvement is technically feasible;

- Estimation of the resources (and hence costs) required to implement (and if necessary maintain) any proposed development – to ensure that any proposed change is an economically viable solution.
- Conduction of a real time simulation with the use of STCA prototype in order to validate the operational concept.

The following potential uses for DAPs in ground based safety nets have been identified:

3.1.1 Aircraft ID use 1[1]

The Aircraft Identity (also known as Flight ID) is down-linked by a high proportion of air traffic and could be used to determine the eligibility of aircraft for ground-based safety net protection.

3.1.2 MCP/FCU selected altitude use 1

Earlier warning time within ground-based safety nets could be achieved by providing a track with an assumed vertical rate within the vertical prediction filters when the MCP/FCU Selected Altitude indicates an imminent departure from level flight.

3.1.3 MCP/FCU selected altitude use 2

The MCP/FCU Selected Altitude information does give advance indication that an aircraft is about to depart from a level and could be used to improve the ground-based safety net vertical prediction filter of an aircraft track by including a 'level off' (vertical rate = 0) timeframe (instead of using a constant vertical rate throughout the vertical prediction look-ahead time).

3.1.4 Roll angle and Track angle rate use 2

The Roll Angle and Track Angle Rate both offer benefits in earlier identification of turns and eliminating false identification of turns (by the tracker) – although some filtering of noisy/incorrect updates might be required for maximum effectiveness and could indicate a turn before the manoeuvre is detected by the lateral component of the elementary surveillance tracker.

3.1.5 Track angle rate use 3

The down-linked Track Angle Rate information is down-linked less frequently than Roll Angle, but could be used directly within the lateral trajectory prediction filters of ground-based safety nets (instead of assumed or inferred values from the elementary surveillance tracker).

3.1.6 FMS selected altitude use 2

The FMS Selected Altitude is not down-linked sufficiently often to be used and is unreliable but eventually it could be used to improve the ground-based safety net vertical prediction filter of an aircraft track by including the 'level off' (vertical rate = 0) timeframe (instead of using a constant vertical rate throughout the vertical prediction look-ahead time) when the FMS Selected Altitude is the 'Target Altitude' instead of the MCP/FCU Selected Altitude.

3.1.7 Barometric pressure setting use 2

BPS is available for a large majority of the trajectories and could be used to correct the MCP/FCU and FMS Selected Altitude information for sub scale pressure setting when the aircraft is below the transition altitude within ground-based safety net detection functions.

[1] The 'use indentifiers' are those given in the F&O exercise [16]

3.1.8 True Air Speed (TAS) use 1

The True Airspeed (TAS) could provide improved lateral prediction for functions associated with STEP 1 time based operations that are particularly affected by wind [*e.g. on the base leg of an approach*].

Note: TAS is not part of the mandated DAP set, it is part of the 'alternative DAP set' provided when True Track Angle is not present.

3.2 Short term conflict alert (STCA)

3.2.1 Previous operating method (STCA)

3.2.1.1 General

Figure 1 illustrates STCA and controller actions prompted by STCA (in grey boxes) interacting with other external components in a given operating environment (en-route or TMA). This figure is only depicting the STCA system in its nominal mode of operation. External components encompass pilot related actions after receiving an avoiding instruction. Note that technical aspects related to STCA, i.e. the components providing information to STCA to generate alerts such as the Surveillance Data Processing, Environment Data Processing and Flight Data Processing, have not been illustrated.

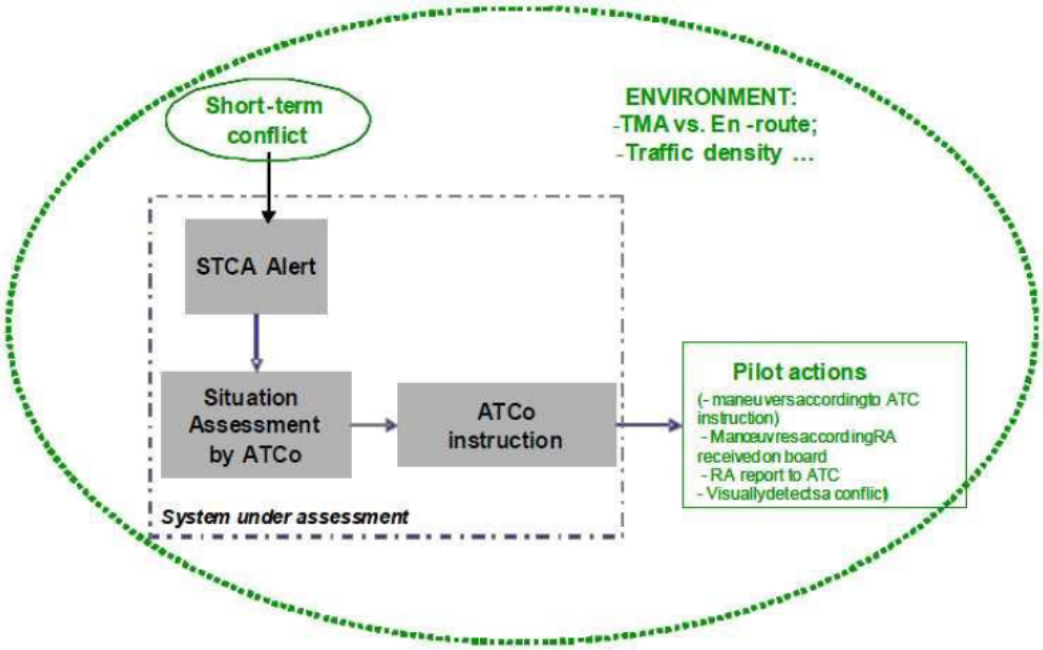

Figure 1 Boundaries of the STCA based safety net service (source PASS)

Figure 2 illustrates the nominal sequence of events to resolve a particular situation involving an STCA alert. It is a human centred system, with the Ground loop reflecting the states of the controller and the Air loop reflecting the corresponding states of the flight crew. For each state transition to occur certain preconditions have to be met and actions performed, complicated by many fixed or variable delays and anomalous cases.

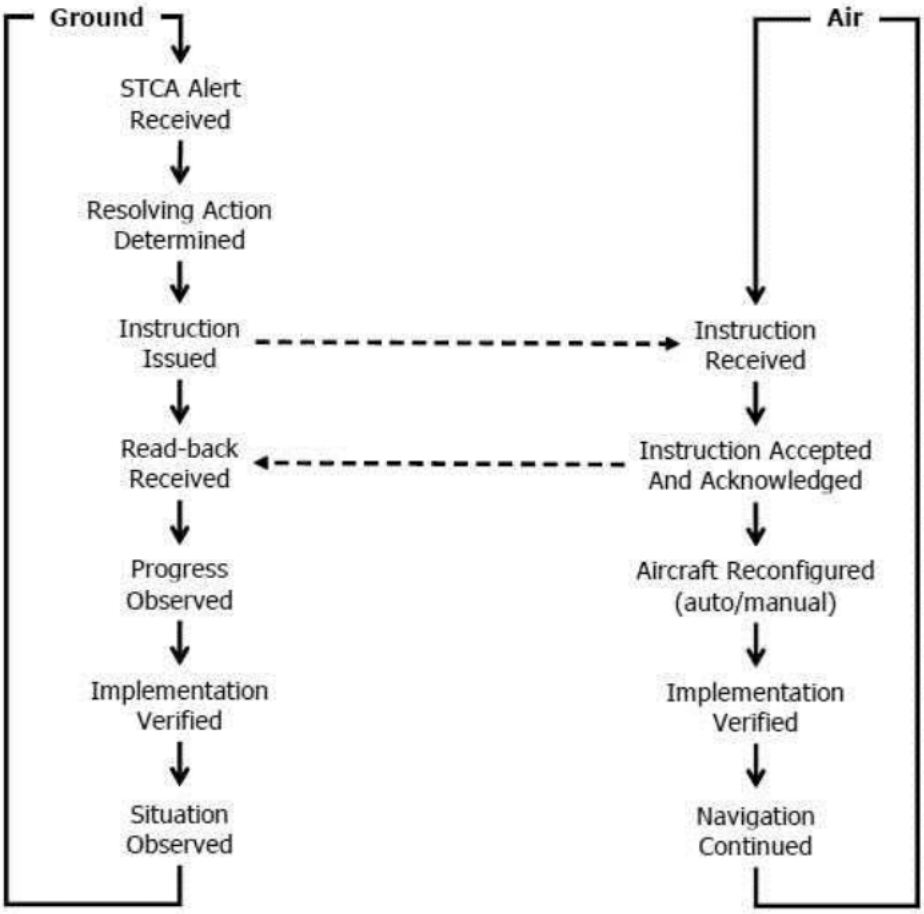

Figure 2 ATC control loop triggered by STCA (Source EUROCONTROL)

Although the sole goal of STCA is to prevent mid-air collisions (collision between aircraft both in airborne phase of flight), this goal may be achieved through different strategies which may overlap to varying degrees with the separation provision function and the airborne collision avoidance function. This is illustrated on the representation of conflict management in Figure 3.

Because the ground-based control loop is longer (and uses less frequent surveillance data) than the airborne control loop, the ATC collision prevention supported by STCA relies on the protection of "separation thresholds" (which may significantly differ from the applicable separation minima in order to limit the number of nuisance alerts during managed situations). These thresholds implicitly define a hazardous situation which the STCA shall help to prevent and which may differ from one local STCA implementation to another.

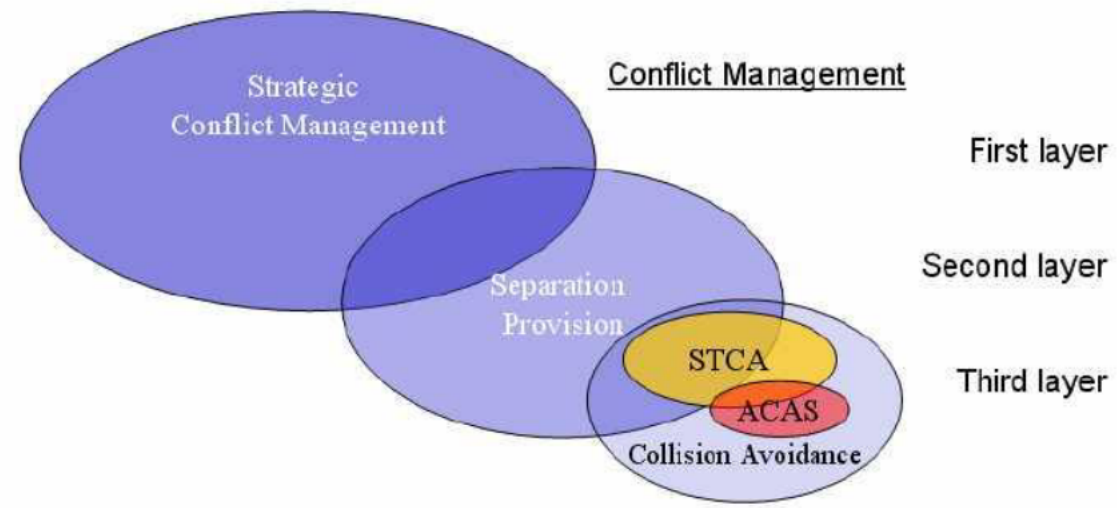

Figure 3 Position of STCA (and ACAS) within Conflict Management (Source PASS)

STCA is dependent on predicting loss of separation, and therefore particularly sensitive to:

- warning time (typically in range 80s to 120s)
- surveillance data
- traffic patterns
- separation standards

STCA should be capable of working in all controlled airspace with appropriate surveillance. Surveillance data quality should be sufficient to predict hazardous situations up to two minutes ahead.

STCA is only effective if the number of nuisance alerts remains below an acceptable threshold according to local requirements and if it provides sufficient warning time to resolve hazardous situations, governed by the inherent characteristics of the human centred system.

3.2.1.2 Airspace specific

Based on monitoring and modelling of European STCA environment (PASS) several approaches to the use of the STCA model have been identified and categorized. These categories first depend on the airspace in which STCA operates. TMA airspace is characterized by lower applicable separation minima (3 NM and 1,000 ft) than in en-route airspace (5NM and 1,000 ft or 2,000 ft minima), which imposes different separation thresholds and warning time on STCA systems. Similarly, each ANSP's strategy may determine whether these STCA parameters are tuned towards more time-critical or less time-critical values and smaller or larger separation values.

3.2.1.3 En route

For en-route airspace, five families have been identified that correspond to increasingly tighter parameters for both the separation thresholds and the warning time used by the STCA in its trajectory prediction, and hence in its determination of alerts. These families and the different approaches to the use of STCA in en-route airspace are illustrated in Figure 4 below.

LOS stands for Loss Of Separation.

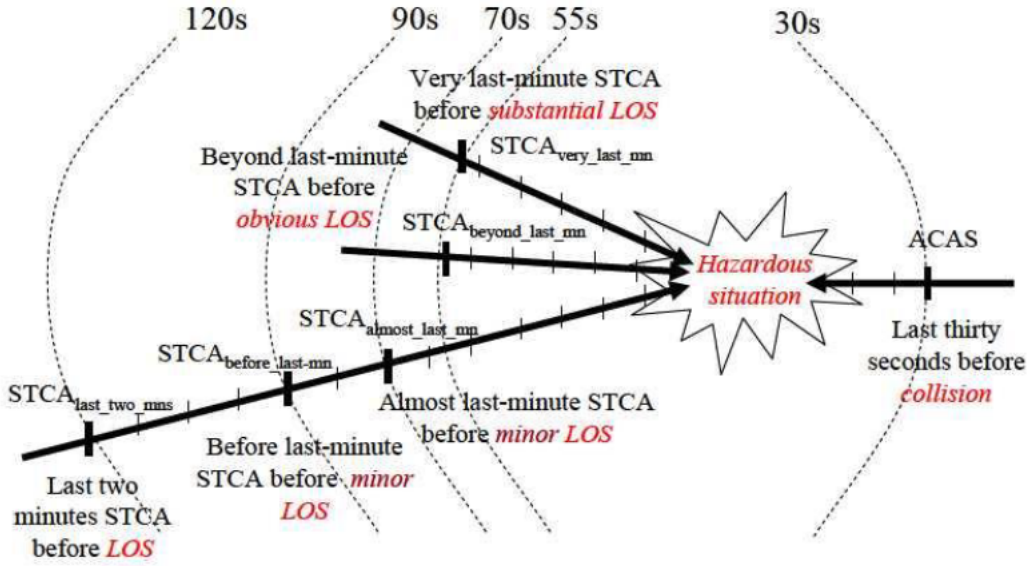

Figure 4 Families of STCA systems in en-route airspace (Source PASS)

3.2.1.4 TMA

For TMA, the identified families of STCA appear to use only two sets of parameters for separation thresholds, but each with two different warning times. These families and the different approaches to the use of STCA in TMA are illustrated in Figure 5.

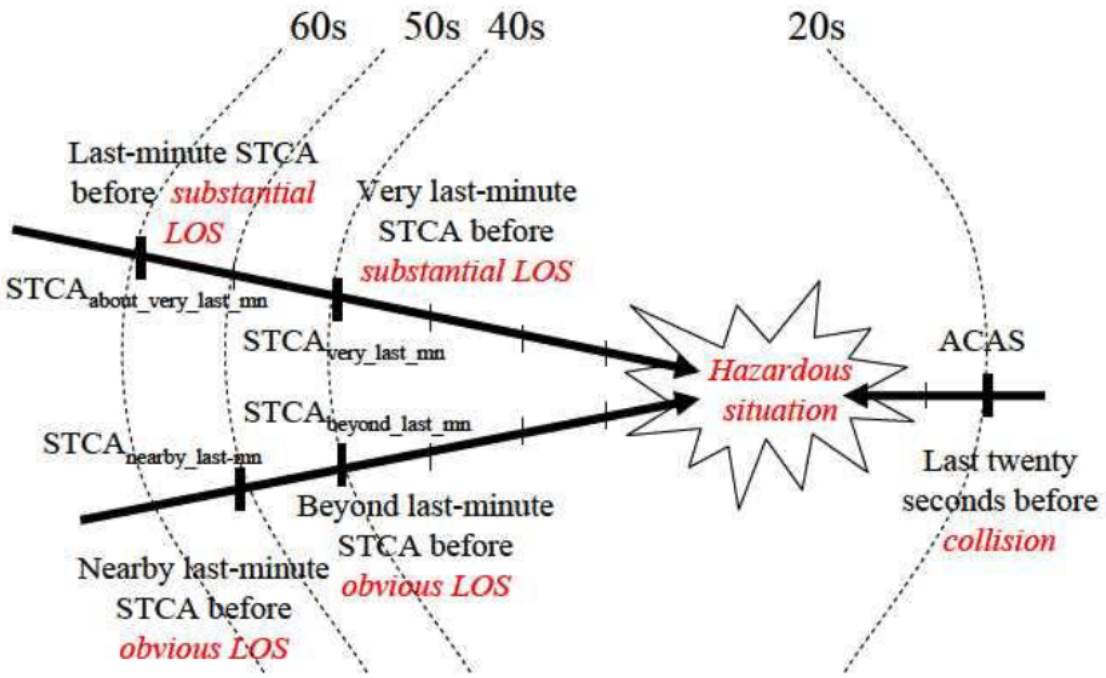

Figure 5 Families of STCA systems in TMA airspace (Source PASS)

3.2.2 New SESAR operating method (STCA)

No change to controller or pilot operating method is envisaged.

The introduction of an enhanced safety net will assume to:

- not change the roles and responsibilities of any ATM actor.
- not increase the complexity of the controller's task for a given level of traffic.
- not change the allocation of tasks between different ATM actors
- not negatively impact the task relevant information to an ATM actor
- not change the allocation of tasks between human and machine
- require a small amount of training for air traffic controller regarding update to enhanced ATC functionality
- not require changes in team structure
- change the nature of human system interaction. Confidence in alert system directly affects human-system interaction and has to be ensured. ATC's decision making is strongly dependent on reliability of alerts. For example, there is high probability to ignore or even switch-off the system if number of nuisance or false alerts is too high.

3.2.3 Differences between new and previous operating methods (STCA)

Potential change to system using DAPs:

The validation exercise [17] clarified that the most promising use of the down-linked vertical intention (from Mode S BDS 4,0) is with a multi-hypothesis STCA mainly predicting aircraft trajectories with the MCP/FCU Selected Altitude, but also using a linear prediction based on their current vertical speed as a backup. The various options for use of track and turn reports (from Mode S BDS 5,0) inside the Turning Prediction Filter showed similar, and limited, potential for improving STCA alerting performance.

The validation exercise [28] confirmed that the most valuable DAP is the MCP/FCU Selected Altitude maintaining as backup linear prediction based on aircraft's current vertical speed.

As foreseen by the previous exercise, the STCA improvements with the implementation of track and turn reports inside the turning prediction filter performed more limited benefits.

4 Detailed Operational Environment

4.1 Operational Characteristics

As introduced in 2.2.1, the scope of this work is an operational context Step 1.

The Step 1 goal is to implement net-centric trajectory management, in order to get a synchronized and predictable European ATM system, where partners are aware of the business and operational situations and collaborate to optimize the network.

In an en-route operational environment this goal will be achieved through the deployment of initial trajectory based operations as described in the DOD ([21]).

4.2 Roles and Responsibilities

Sector Team Operations Adapted to New Roles for Tactical and Planning Controllers

New operating procedures associated to an optimized task sharing will be put in place. The Tactical Controller workload will be alleviated or smoothed and made manageable by the Planning or Multi-Sector Planning controller (i.e. tactical interventions decrease and smoothing, via new automated support tools implementation).

New integrated En Route CWP requirements will be defined in order to enable optimal use of the new tools and efficient sector team operations (addressed within WP5).

4.3 Constraints

N/A

5 Use Cases

The following scenarios are taken from [21].

5.1 OS-4-04-Safety Nets in En Route

5.1.1 Scenario Scope

The safety net scenario takes place in the third layer of conflict management: collision avoidance.

Collision avoidance is supported by a safety net, on board by Airborne Collision Avoidance System (ACAS) and on the ground side by Short Term Conflict Alert (STCA) which is available on the Controller Working Position (CWP) (other ground safety nets also exist e.g. APW, but as no improvements are studied in SESAR Step 1, they are not described in this scenario).

The objective of ACAS is to provide advice to pilots for the purpose of avoiding potential collisions. This is achieved through resolution advisories (RAs), which recommend actions (including manoeuvres), and through traffic advisories (TAs), which are intended to prompt visual acquisition and to act as a precursor to RAs.

Within the Step 1 timeframe, the overall safety performance of ACAS will be enhanced with extensions among the fleet for automated response to ACAS RA .In addition, new altitude capture laws implemented within the Flight Guidance System will also lead to a reduced number of undesired RA occurring in 1000ft level off geometries.

STCA is a ground-based safety net intended to assist the controller in preventing collision between aircraft by generating, in a timely manner, an alert of a potential or actual infringement of separation minima. (EUROCONTROL Guidance Material for Short Term Conflict Alert 19/05/2009) [9]

Improved STCA using ADD is part of the SESAR Step 1 studies and is addressed in the following scenario.

5.1.2 Additional Information and Assumptions

5.1.2.1 Information

Figure 6 below depicts a 1000 feet level off encounter, where FLY 01 is maintaining its altitude, while FLY 02 is climbing toward the adjacent FL.

Today, depending on FLY 02 rate of climb, a TA and then a RA could be generated on board this aircraft. A TA as well as an RA could also occur on board FLY 01.[2]

[2] In that kind of encounter geometry, the RA triggering on board the levelled aircraft is delayed in order to reduce the number of undesired RA. Depending on the climbing aircraft vertical profile, RA could not be triggered on board FLY01.

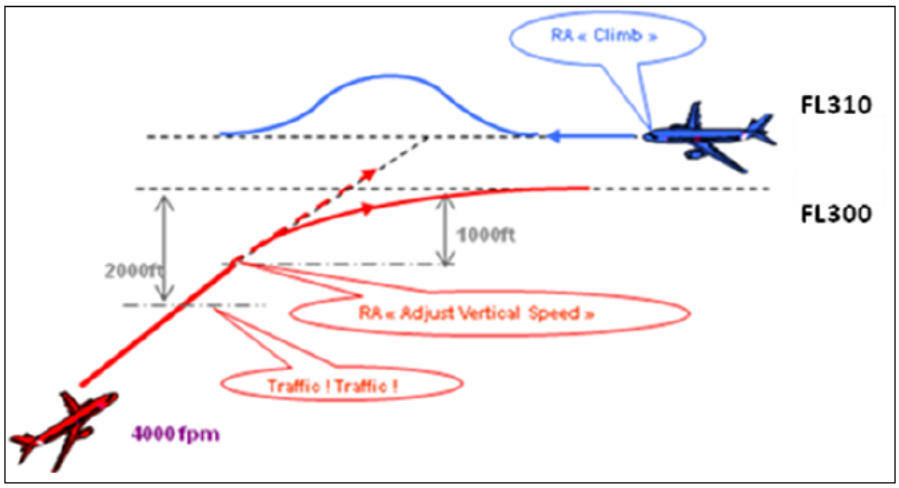

Figure 6: RA triggering in a 1000 feet level off encounter

5.1.2.2 Assumptions

It is assumed in the following scenarios that the aircraft described are equipped with ACAS II and that STCA is available on the CWP.

5.1.3 List of Actors

The actors included in the scenario are:

- The Flight Crew
- Executive controller

5.1.4 Scenario Text

5.1.4.1 Operations prior to En Route Safety Nets

Among the SWP4.2 operational scenarios, this operational scenario comes after the scenario OS-4-01-Complexity Management in En Route and 0S-4-02-Separation Management in En route. Indeed, Collision avoidance is the third layer of conflict management and must activate when the separation mode has been compromised.

5.1.4.2 Scenario text

The scenarios take place in the Execution phase, in the En Route segment of the flight.

Two sub scenarios are considered for the airborne safety nets to illustrate the two ACAS enhancement provided within step1.

- Sub scenario1:
  In this sub scenario, we consider a 1000 feet level-off encounter, one aircraft performing altitude capture respecting executive controller clearance where current ACAS system deliver an RA and we will show how the new altitude capture law will suppress this undesired RA. Moreover, STCA improved by ADD is addressed in this scenario.
- Sub scenario2:
  In this sub scenario, we consider any kind of ACAS avoidance manoeuvres, and consider an automated response to the ACAS request.

5.1.4.2.1 Sub scenario 1

This scenario takes place on one En route sector in controlled airspace. Only 2 aircraft in the sector are described in this scenario. It is assumed that aircrafts fly according to their assigned convergent trajectories.

- FLY 01 is maintaining its cleared altitude: FL310

- FLY 02 is cleared to climb to FL300 [3], (FL300 is provided as SFL in the ADD).

As the STCA is using the ADD, here the SFL, no alert is triggered on the CWP as the FLY 02 is climbing to a FL 1000 feet below FLY 01. The use of ADD here avoids a nuisance alert to trigger.

Evolutions proposed in the frame of SESAR step1 also concern modification of the aircraft autopilot altitude capture control law in order to avoid the existing ACAS to generate a RA in such a case.

The new altitude capture law is set when a Traffic Alert is issued on board FLY 02 and the aircraft is close the assigned altitude target. When such case occurs, the on board Auto Flight system reduces the aircraft vertical speed in a way to avoid any subsequent RA to occur and to avoid any subsequent Traffic Alert to be generated. The onboard system providing this improvement is called TCAP (TCAS Alert Prevention).

Error! Reference source not found. illustrates the situation with this evolution compared to the current situation illustrated in Figure 6.

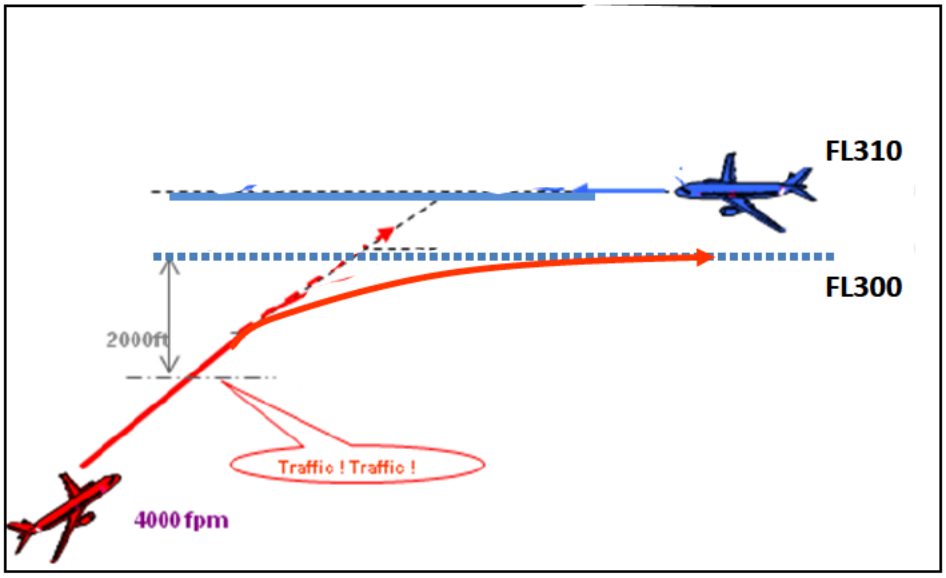

Figure 7: TCAS Alerts in a 1000 feet level off encounter with TCAP improvement

5.1.4.2.2 Sub scenario 2

This scenario takes place on one En route sector in controlled airspace.

Only 2 aircraft in the sector are considered in this scenario.

The scenario is based on the hypothesis that either the executive controller gives a clearance that is going to generate a conflict (assigned altitude for example) or the aircrew does not respect the clearance delivered (for example: erroneous flight crew altitude setting)4.

On the ground side, depending on the local STCA setting, STCA should trigger on the CWP. In specific cases, thanks to the use of ADD, the warning time of necessary (or desirable) alerts are expected to be increased, e.g. when using the SFL to anticipate a level-off at an occupied FL or to anticipate an imminent departure for level flight towards another aircraft, or when using the roll angle/track angle rate to anticipate a conflicting turn manoeuvre of an aircraft towards another aircraft. Reacting to the STCA alert, the executive controller will take action to avoid separation infringement or to restore the separation minima.

We consider in this scenario that despite the avoiding clearance given by the executive controller, RA are triggered on board both aircraft.

[3] This scenario could also consider FLY 01 is cleared to descent to FL310
[4] In that case if the ground system gets Mode S information (Selected Flight Level) and check it for consistency with the Cleared FL a warning will be displayed to the EC prior to any STCA: CLAM Cleared FL Adherence Monitoring

On the flight deck, in such a case, the existing safety net available based on ACAS provides vertical avoidance manoeuvres to both aircraft. Without the AP-FD TCAS, the avoidance manoeuvres are flown manually by the flight crew, resulting in a large variety of response (dynamics, time response, non-response...).

The evolution proposed in the frame of SESAR step1 and supported by a new AP-FD TCAS system involves a modification of the aircraft autopilot so that the avoidances manoeuvres are automatically performed.

6 Requirements

6.1 General

Table 1 gives the structure used in this document to describe each requirement.

[REQ]

Identifier	
Requirement	
Title	
Status	
Rationale	
Category	
Validation Method	
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	DOD Requirement Identifier	<Full>
<SATISFIES>	<ATMS Requirement>	DOD Requirement Identifier / (KPA 1)	<Full>
<SATISFIES>	<ATMS Requirement>	DOD Requirement Identifier / (KPA n)	<Full>
<APPLIES_TO>	<Operational Process> or <Operational Service>	Operational Process or Operational Service Identifier	N/A
<APPLIES_TO>	<Operational Focus Area>	Operational Focus Area Identifier	N/A
<APPLIED_IN_ENVIRONMENT>	<Environment Class>	Environment Class Identifier	N/A
<ALLOCATED_TO>	<Operator>	Operator identifier	N/A
<ALLOCATED_TO>	<Procedure>	Procedure identifier	N/A
<ALLOCATED_TO>	<Information Service>	Information Service identifier	N/A
<ALLOCATED_TO>	<Application Service>	Application Service identifier	N/A
<ALLOCATED_TO>	<System Function>	System Function identifier	N/A
<CHANGED_BECAUSE_OF>	<Change Order>	Change reference	N/A

Table 1: REQuirement Trace layout

Where:

- *Identifier*: Requirement identification
- *Requirements*: Requirement text
- *Title*: Synthetic textual description of the object to be used for future reference.
- *Status*: Data life cycle (In Progress, Deleted)
- *Rationale*: Requirement explanation if needed
- *Category*: Requirement category type (Operational, Service, System, Functional, Non Functional, Security, Safety, Performance, Interoperability)
- *V&V Method*: Requirement verification methods (Review of Design, Analysis, Inspection, Test)

Regarding the identifier, the following 4.8.1.project convention for the last 8 digits is proposed and followed:

Reference number 1 corresponds to the safety net i.e. 0010 is STCA.

Reference number 2 corresponds to the requirement number in default incremental units of ten where the last digit is reserved for numbering related requirements in a group,

e.g. REQ-04.08.01-SPR-0010.0030 is the third SPR requirement of STCA

or REQ-04.08.01-OSED-0010.0014 corresponds to the fourth OSED requirement in the first group (this is to handle mappings to external legacy IDs where letters have been used such as 1d).

To accommodate the SESAR Requirements (and V&V) Data Structures and Writing Guidelines [2], it is proposed that:

- Mandatory, recommended and optional requirements from the EUROCONTROL Specification are translated into “shall” requirements with different levels of importance.
- Initial requirements that use the operative verb “shall” are considered as “Essential” to claim compliance with the baseline operational service supported by STCA in all environments with ATS surveillance services.
- Initial requirements that use the operative verb “should” are considered as ”Important” to improve the operational, functional and performance aspects of STCA in all operational environments.
- Initial requirements that use the operative verb “may” are optional, but can be considered as ”Desirable” in some operational environments.

Note the above importance field was removed to be compatible with Version 2.0 of the OSED template.

<ALLOCATED_TO>	<Operator>	Operator identifier	N/A
<ALLOCATED_TO>	<Procedure>	Procedure identifier	N/A
<ALLOCATED_TO>	<Service>	Service identifier	N/A
<CHANGED_BECAUSE_OF>	<Change Order>	Change reference	N/A

Table 2: REQuirement Trace layout

6.2 Requirements for short term conflict alert (STCA)

6.2.1 Policy, Organisational Clarity and Training Requirements (STCA)

6.2.1.1 Policy

Policy requirements are not needed at this stage (V2) but will be required before implementation. Examples are contained in [8].

6.2.1.2 Responsibility for Management of STCA

This section summarises the organisational requirements on the responsibility for management of STCA at the ANSP level. These baseline operational requirements are derived from the mandatory and recommended requirements (“shall” or “should”) contained in the EUROCONTROL Specification for STCA.

Identifier	REQ-04.08.01-OSED-0010.0021
Requirement	The ANSP shall assign to one or more staff, as appropriate, the responsibility for overall management of STCA.

Identifier	REQ-04.08.01-OSED-0010.0022
Requirement	It should be possible for other staff in the organisation to identify the assigned staff responsible for overall management of STCA.

Identifier	REQ-04.08.01-OSED-0010.0023
Requirement	The assigned staff responsible for overall management of STCA should seek advice from the STCA manufacturer, as appropriate.

6.2.1.3 Training and Competence

This section summarises the organisational requirement ("shall") about training and competence on STCA at the ANSP level. This baseline operational requirement is extracted from the EUROCONTROL Specification for STCA

Identifier	REQ-04.08.01-OSED-0010.0030
Requirement	The ANSP shall ensure that all controllers concerned are given specific STCA training and are assessed as competent for the use of the relevant STCA system. Note.- The primary goal of the training is to develop and maintain an appropriate level of trust in STCA, i.e. to make controllers aware of the likely situations where STCA will be effective and, more importantly, situations in which STCA will not be so effective (e.g. sudden, unexpected manoeuvres).

6.2.2 Requirements on Procedures (STCA)

6.2.2.1 Local instructions

This section summarises the procedural requirement that calls for local instructions for the use of STCA at the ANSP level. This baseline operational requirement is extracted from the EUROCONTROL Specification for STCA and complies with existing ICAO PANS-ATM provisions for STCA (cf. Doc 4444, section 15.7.2 "Short-term conflict alert (STCA) procedures").

Identifier	REQ-04.08.01-OSED-0010.0040
Requirement	Local instructions concerning use of STCA shall specify, inter alia: a) the types of flight (GAT/OAT, IFR/VFR, RVSM/NON-RVSM, etc.) which are eligible for generation of alerts; b) the volumes of airspace within which STCA is implemented; c) the method of displaying the STCA to the controller; d) in general terms, the parameters for generation of alerts as well as alert warning time; e) the volumes of airspace within which STCA can be selectively inhibited and the conditions under which this will be permitted; f) conditions under which specific alerts may be inhibited for individual flights; and g) procedures applicable in respect of volumes of airspace or flights for which STCA or specific alerts have been inhibited

6.2.2.2 Controller Actions

This section summarises the procedural requirement that applies to controller in the event of an STCA alert. This baseline operational requirement is extracted from the EUROCONTROL Specification for STCA.

It complements existing ICAO PANS-ATM provisions for STCA (cf. Doc 4444, section 15.7.2 "Short-term conflict alert (STCA) procedures") as it also addresses the specific circumstances of an alert being generated while the separation minima are already infringed.

Identifier	REQ-04.08.01-OSED-0010.0050
Requirement	In the event an alert is generated in respect of controlled flights, the controller shall without delay assess the situation and if necessary take action to ensure that the applicable separation minimum will not be infringed or will be restored.

	Note.- STCA does not exist in isolation; when a pilot reports a manoeuvre induced by an TCAS resolution advisory (RA), the controller is required not to attempt to modify the aircraft flight path.

6.2.2.3 Performance analyses

This section summarises the procedural requirement that calls for regular STCA performance analyses at the ANSP level. This baseline operational requirement is extracted from the EUROCONTROL Specification for STCA [8].It supplements existing ICAO PANS-ATM provisions for STCA (cf. Doc 4444, section 15.7.2 "Short-term conflict alert (STCA) procedures"), which only call for statistical analyses of justified alerts.

Identifier	REQ-04.08.01-OSED-0010.0061
Requirement	STCA performance shall be analysed regularly to identify possible shortcomings related to STCA.

6.2.2.4 Statistical Analyses

This section summarises the organisational and procedural requirements that relate to STCA statistical analyses. These baseline operational requirements are derived from the recommended requirements ("should") contained in the EUROCONTROL Specification for STCA [8], which comply with existing ICAO PANS-ATM provisions for STCA (cf. Doc 4444, section 15.7.2 "Short-term conflict alert (STCA) procedures") [23].

Identifier	REQ-04.08.01-OSED-0010.0062
Requirement	The appropriate ATS authority should retain electronic records of all STCA alerts generated.

Identifier	REQ-04.08.01-OSED-0010.0063
Requirement	The data and circumstances pertaining to each STCA alert should be analysed to determine whether an alert was justified or not.

Identifier	REQ-04.08.01-OSED-0010.0064
Requirement	Non-justified STCA alerts, e.g. when visual separation was applied, should be ignored.

Identifier	REQ-04.08.01-OSED-0010.0065
Requirement	A statistical analysis should be made of justified STCA alerts in order to identify possible shortcomings in airspace design and ATC procedures as well as to monitor overall safety levels.

6.2.3 Requirements on STCA Capabilities

6.2.3.1 Alerting performance

This section summarises the functional and performance requirements that apply to STCA alerting performance. These baseline operational requirements are derived from the mandatory or optional requirements ("shall" or "may") contained in the EUROCONTROL Specification for STCA [8]

Identifier	REQ-04.08.01-OSED-0010.0070
Requirement	STCA shall detect operationally relevant conflicts involving at least one eligible aircraft.

Identifier	REQ-04.08.01-OSED-0010.0080
Requirement	STCA shall alert operationally relevant conflicts involving at least one eligible aircraft. Note.- Conflicts are operationally relevant when covered by the adopted rule set and optimisation strategy. The rule set and optimisation strategy should be determined taking into account the relevant local factors. STCA should not be expected to alert all operationally relevant conflicts.

Identifier	REQ-04.08.01-OSED-0010.0091
Requirement	STCA alerts shall attract the controller's attention.

Identifier	REQ-04.08.01-OSED-0010.0092
Requirement	STCA alerts shall identify the aircraft involved in the conflict.

Identifier	REQ-04.08.01-OSED-0010.0093
Requirement	STCA alerts shall be at least visual.

Identifier	REQ-04.08.01-OSED-0010.0094
Requirement	An audible element may be included to improve the STCA systems ability to draw the controller's attention to the alert where necessary. Note.- Human factors and local circumstances determine whether or not audible alerts are necessary.

Identifier	REQ-04.08.01-OSED-0010.0095
Requirement	If a continuous audible element is included in STCA, an acknowledgement mechanism may be provided to silence an alert.

Identifier	REQ-04.08.01-OSED-0010.0100
Requirement	The number of nuisance alerts produced by STCA shall be kept to an effective minimum. Note.- Human factors and local circumstances determine what constitutes an effective minimum.

Identifier	REQ-04.08.01-OSED-0010.0110
Requirement	The number of false alerts produced by STCA shall be kept to an effective minimum. Note.- Local circumstances determine what constitutes an effective minimum.

6.2.3.2 Warning time

This section summarises the functional and performance requirements that apply to STCA warning time. These baseline operational requirements are extracted from the EUROCONTROL Specification for STCA [8].

Identifier	REQ-04.08.01-OSED-0010.0120
Requirement	When the geometry of the situation permits, the warning time shall be sufficient for all necessary steps to be taken from the controller recognising the alert to the aircraft successfully executing an appropriate manoeuvre. Note.- Insufficient warning time may be provided in cases of sudden, unexpected manoeuvres. However, absence of expected manoeuvres such

	as level offs or turns should be anticipated.

Identifier	REQ-04.08.01-OSED-0010.0130
Requirement	STCA shall continue to provide alert(s) as long as the alert conditions exist.

6.2.3.3 Alert inhibition

This section summarises the functional requirements that deal with STCA alert inhibition. These baseline operational requirements are derived from the mandatory requirements ("shall") contained in the EUROCONTROL Specification for STCA [8].

Identifier	REQ-04.08.01-OSED-0010.0141
Requirement	STCA shall provide the possibility to inhibit alerts for predefined volumes of airspace to suppress unnecessary alerts.

Identifier	REQ-04.08.01-OSED-0010.0142
Requirement	STCA shall provide the possibility to inhibit alerts for individual flights to suppress unnecessary alerts.

Identifier	REQ-04.08.01-OSED-0010.0150
Requirement	Alert inhibitions shall be made known to all controllers concerned.

6.2.3.4 Status information

This section summarises the functional requirement that calls for the provision of STCA status information on CWP. This baseline operational requirement is extracted from the EUROCONTROL Specification for STCA [8].

Identifier	REQ-04.08.01-OSED-0010.0160
Requirement	Status information shall be presented to supervisor and controller working positions in case STCA is not available.

6.2.3.5 Data recording

This section summarises the functional requirement that calls for the availability of STCA data recordings. This baseline operational requirement is extracted from the EUROCONTROL Specification for STCA [8].

Identifier	REQ-04.08.01-OSED-0010.0170
Requirement	All pertinent STCA data shall be made available for off-line analysis. Note.- Off-line analysis may need access to other data sources as well (surveillance data and voice recordings) for complete analysis.

6.2.3.6 Adaptability

This section summarises the functional requirements that call for STCA adaptability to airspace and traffic characteristics at any time and under different conditions (e.g. in RVSM airspace, in case of system degradation, etc). These baseline operational requirements are derived from the recommended or optional requirements ("should" or "may") contained in the EUROCONTROL Specification for STCA [8].

Identifier	REQ-04.08.01-OSED-0010.0181
Requirement	STCA should be adaptable for the procedures in use in all distinct volumes of airspace at any moment in time.

Identifier	REQ-04.08.01-OSED-0010.0182

Requirement	STCA may take into account the specific volume of airspace in which each aircraft is flying, in order to apply appropriate parameters or trajectory estimation.

Identifier	REQ-04.08.01-OSED-0010.0183
Requirement	Different parameters may be applied in the case of system degradation (e.g. unavailability of one or more radar stations).

Identifier	REQ-04.08.01-OSED-0010.0184
Requirement	In RVSM airspace, STCA should be able to selectively assess the applicable vertical separation minimum of either 300 m (1 000 ft) or 600 m (2 000 ft), as determined by the current RVSM approved or non-approved (incl. unknown and exempt) status of the flight concerned.

6.2.3.7 Interoperability with TCAS

The following requirements are derived from PASS [24]

Identifier	REQ-04.08.01-OSED-0010.0191
Requirement	When a time-critical avoiding instruction is deemed necessary in reaction to an STCA alert, the controller should use avoiding action phraseology to prompt pilot quick response. Note: a prompt pilot response normally has the positive side-effect of preventing the occurrence of TCAS resolution advisories.

Identifier	REQ-04.08.01-OSED-0010.0192
Requirement	When an avoiding instruction is deemed necessary in reaction to an alert, the controller should use horizontal instructions each time it is permitted by the current situation to ensure maximum compatibility with potential TCAS resolution advisories. Note: elements of the current situation to consider include encounter geometry, quality of radar detection and lack of ambiguity in the radar identification. Note: horizontal avoiding instructions with significant heading alteration are likely to prompt quick pilot response and shorten the period of aircraft convergence, thus increasing the likelihood of preventing the occurrence of TCAS resolution advisories.

Identifier	REQ-04.08.01-OSED-0010.0193
Requirement	STCA alerts may also attract the attention of controllers from adjacent sectors to allow them to warn the controller in which sector the alert is occurring.

Identifier	REQ-04.08.01-OSED-0010.0194
Requirement	STCA may take into account information on actual or possible future aircraft trajectory to reduce the number of nuisance alerts during aircraft manoeuvres complying with standard ATC procedures.

Identifier	REQ-04.08.01-OSED-0010.0195
Requirement	When the geometry of the situation permits having sufficient warning time, the number of short duration alerts should be kept to an effective minimum.

Identifier	REQ-04.08.01-OSED-0010.0196
Requirement	The number of split alerts should be kept to an effective minimum.

6.3 Information exchange requirements

This section describes the subset of operational requirements associated with down-linked aircraft parameters.

Identifier	Name	Issuer	Intended Addressees	Information Element	Status	Rationale
IER-04.08.01-D17-3.2.1	Aircraft ID	Aircraft	Area control unit, Approach control	Aircraft Derived Data : aircraft identification in 8 characters	<Validated>	In addition of flight Plan Information, to confirm the eligibility of aircraft for ground-based safety net protection
IER-04.08.01-D17-3.2.2 & 3.2.3	Final State Selected Altitude	Aircraft	Area control unit, Approach control	Aircraft Derived Data : vertical intent value set by pilot on the altitude control panel	<Validated>	To improve the ground-based safety net vertical prediction 1)by providing a track with an assumed vertical rate within the vertical prediction filters when the MCP/FCU Selected Altitude indicates an imminent departure from level flight 2) by giving advance indication that an aircraft is about to depart from a level.
IER-04.08.01-D17-3.2.4	Roll Angle	Aircraft	Area control unit, Approach control	Aircraft Derived Data: Roll angle for turn indicator	<Validated>	To improve the ground-based safety net trajectory prediction by earlier identification of turns and elimination of false identification of turns
IER-04.08.01-D17-3.2.5	Track Angle Rate	Aircraft	Area control unit, Approach control	Aircraft Derived Data: Track Angle Rate for turn rate information	<Validated>	To improve the ground-based safety net trajectory prediction by earlier identification of turns and elimination of false identification of turns
IER-04.08.01-D17-3.2.6	Intermediate Selected Altitude	Aircraft	Area control unit, Approach control	Aircraft Derived Data: Short term vertical intent derived from FMS or altitude control panel or current altitude depending on mode of flight	<Deleted>	To improve the ground-based safety net vertical prediction when the FMS Selected Altitude is the 'Target Altitude' instead of the MCP/FCU Selected Altitude.
IER-04.08.01-D17-3.2.7	Barometric Pressure Setting	Aircraft	Area control unit, Approach control	Aircraft Derived Data : Barometric Pressure Setting (BPS) of the aircraft	<Deleted>	To correct the MCP/FCU and FMS Selected Altitude information for sub scale pressure setting when the aircraft is below the transition altitude within ground-based safety net detection functions

Table 3: IER layout

7 References

7.1 Applicable Documents

This OSED complies with the requirements set out in the following documents:

[1] SESAR SEMP v2.0

[2] B4.2 Initial Service Taxonomy document

[3] Template Toolbox 02.00.00

[4] Requirements and V&V Guidelines 02.00.00

[5] Toolbox User Manual 02.00.00

[6] European Operational Concept Validation Methodology (E-OCVM), Version 3, March 2010

7.2 Reference Documents

The following documents were used to provide input/guidance/further information/other:

[7] SESAR 4.8.1 "Evolution of ground-based safety nets", Project initiation report, Edition 1.01, 9th April 2010

[8] Specification for Short Term Conflict Alert, EUROCONTROL, 19th May 2009

[9] Guidance material for Short Term Conflict Alert, EUROCONTROL, 19th May 2009

[10] Specification for Minimum safe altitude warning, EUROCONTROL, 19th May 2009

[11] Guidance material for Minimum safe altitude warning, EUROCONTROL, 19th May 2009

[12] Specification for Area proximity warning, EUROCONTROL, 19th May 2009

[13] Guidance material for Area proximity warning, EUROCONTROL, 19th May 2009

[14] Specification for Approach path monitor, EUROCONTROL, 19th May 2009

[15] Guidance material for Approach path monitor, EUROCONTROL, 19th May 2009

[16] Feasibility and options for use of existing down-linked parameters in ground based safety nets, SESAR 4.8.1, Edition 1.01, 19th January 2011

[17] Evaluation of safety and performance benefits from the use of existing down-linked parameters in STCA, SESAR 4.8.1, Edition 1.01, 2nd December 2011

[18] Evaluation of safety benefits from the use of Existing Downlinked Parameters in Ground-based Safety Nets (other than STCA), SESAR 4.8.1, Edition 1.0, 13th January 2012

[19] Initial development plan for G-SNETs evolution for future 3/4D trajectory operations with ground-based separation, SESAR 4.8.1, Edition 1.01, 23rd September 2011

[20] Consolidated baseline framework for safety and performance evaluation of STCA, SESAR 4.8.1, Edition 1.0, 2nd March 2011

[21]04 02-D101-WP4 detailed operational description Step 1-00 06 03, 5th May 2014

[22] WP5 TMA Step 1 Detailed Operational Description, SESAR 5.2, Edition 1.5, 12th December 2013

[23] Procedures for air navigation services, Air traffic management, ICAO, Fifteenth edition, 2007

[24]PASS (Performance and safety Aspects of STCA, full Study) Final report – Synthesis and guidelines, EUROCONTROL, 12th November 2010

[25] SESAR, Concept story board, Edition 1.0, 2nd June 2009

[26]Procedures for air navigation services – air traffic management (PANS-ATM), International Civil Aviation Organization (ICAO), Doc 4444, Fifteenth edition 2007.

[27] Stakeholder consultation: November 2010, SESAR 4.8.1, Edition 1.0, 15th April 2011

[28] 4.8.1-D20-VALR-DAP-G-SNET-V3-v.1.0, 21st July 2014

[29] 4 8 1-D17-OR-DAP-G-SNET-V2-"Preliminary operational requirements for the use of down-linked aircraft parameters in ground based safety nets", Ed 01,01.00, 5th April 2013.

[30]4.8.1-D18-SPR-DAP-G-SNET-V2-"Preliminary Safety and Performance Requirements for the use of down-linked aircraft parameters in ground-based safety nets (Step 1)", Ed. 00.01.00, 5th April 2013.

Appendix A Updated Safety and Performance Requirements (SPR)

This section reported the updated SPR taking into account the V3 validation activity EXE-VP-239.

4.8.1-AnnexofD80-S
PR-DAP-G-SNET-V3-E

-END OF DOCUMENT-