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Copyright Statement

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This Initial V2 OSED is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 732996 under European Union's Horizon 2020 research and innovation programme.

Abstract

This Initial OSED describes the services, intended functions and associated procedures of ACAS Xo and the assumptions about the environment in which the application is specific to operate from the European perspective. This document will be used as a basis for V2 validation phase. Once validation exercises PJ.11-A3-EXE01 and PJ11-A3-EXE02 have been performed and their validation results analysed and consolidated, this document will be updated and delivered as V2 SPR-INTEROP/OSED.

Final V2 OSED will provide a list of Operational Requirements (OR) characterizing the ACAS Xo. Initial OSED for ACAS Xo (Solution PJ11-A3) also aims to describe main use cases for ACAS Xo capability from European perspective.

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

- ***SPR/INTEROP-OSED Template – Part I (this volume)***

Following reports are not part of initial OSED delivery:

- 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

ACAS Xo is integrated with ACAS Xa systems, but activation of the ACAS Xo functionality is optional. It provides additional collision avoidance logic modes designed to support closely-spaced flight operations, and allows specifically designated traffic to be monitored by an alternative ACAS logic more compatible with the flight operation than the standard ACAS Xa logic. So far, there are two Xo modes defined by RTCA in MOPS draft:

1. Closely Spaced Parallel Operations down to 3,000ft runway separation mode (**CSPO-3000**) which provides designated traffic with modified CAS (Collision Avoidance System) logic monitoring more appropriate for parallel operations; applicable in both visual and instrument conditions. ACAS Xa protection is maintained on all other cooperative traffic.

2. Designated No Alerts mode (**DNA**) which suppress all alerts and guidance (except during multi-threat encounters) on the specifically designated traffic; requiring flight crew to visually acquire the desired traffic before designating it and then maintaining visual separation from the DNA-designated aircraft. This mode is intended for use in closely-spaced operations on visual conditions, where ACAS Xa alerts would otherwise be a nuisance, ignored, and/or disruptive. DNA mode may be used instead of placing ACAS Xa into TA-only mode, preventing alerts on the designated traffic but still allowing full ACAS Xa protection from all other cooperative traffic.

Additional ACAS Xo modes are expected in the future, however only CSPO-3000 and DNA will be defined in ACAS Xa/Xo MOPS with planned delivery in 2018. This document relies on US scenarios as long as there are no European use cases identified for ACAS Xo modes (DNA or CSPO3000) at the moment.

This Initial OSED describes the services, intended functions and associated procedures of ACAS Xo and the assumptions about the environment in which the application is specific to operate from the European perspective. This document will be used as a basis for V2 validation phase. Once validation exercises PJ.11-A3-EXE01 and PJ11-A3-EXE02 have been performed and their validation results analysed and consolidated, this document will be updated and delivered as V2 SPR-INTEROP/OSED.

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2 Introduction

2.1 Purpose of the document

This Initial OSED describes the services, intended functions and associated procedures of ACAS Xo and the assumptions about the environment in which the application is specific to operate from the European perspective. This document will be used as a basis for V2 validation phase. Once validation exercises PJ.11-A3-EXE01 and PJ11-A3-EXE02 have been performed and their validation results analysed and consolidated, this document will be updated and delivered as V2 SPR-INTEROP/OSED.

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2.2 Scope

This is the initial version of OSED for V2 phase of ACAS Xo (Solution PJ11-A3), aiming to describe the ACAS Xo as it is understood from European perspective. This document will cover the description of ACAS Xo, operational characteristics, (unchanged) roles and responsibilities, technical characteristics, list of applicable standards and regulations and description of current operations that are to be impacted/changed with the introduction of ACAS Xo.

2.3 Intended readership

The intended audience for this initial document are PJ.11-A3 solution members, PJ.11 project members in general, and transversal projects PJ.19 and PJ.20.

2.4 Background

“ACAS” is a generic acronym used by ICAO for the specific line of avionics that is certified to provide decision support to pilots during encounters with other aircraft when there is an imminent risk of collision. ACAS implementation, TCAS II, is mandated for all aircraft with a maximum take-off mass (MTOM) of over 5 700 kg or authorized to carry more than 19 passengers.

Since 2008, the FAA’s TCAS Program Office (PO) initiated a research and development program under RTCA SC-147 of a new approach to collision avoidance – ACAS X. The work is done in cooperation with SJU, under aegis of FAA-SJU Coordination Plan 4.1. ACAS X has several variants which share an underlying common design, but have hardware, surveillance, and collision avoidance logic tailored for different user groups as summarized at the figure below.

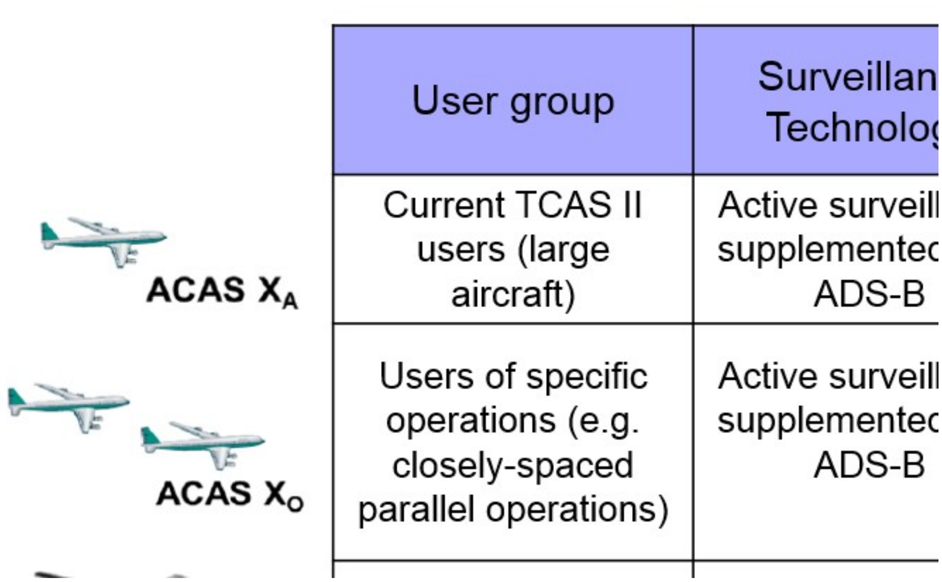


Figure 1: ACAS X variants

In SESAR 1, two projects were addressing the development of ACAS Xa – SESAR 04.08.01 with focus on logic and SESAR 9.47 focusing on the surveillance aspects. The work undertaken in SESAR 1 now continues in SESAR2020 as solution PJ.11-A1.

Solution PJ.11-A3, address a specific function of the ACAS X system, variant ACAS Xo which allows the use of alternative CAS logic for specifically designated traffic while maintaining normal ACAS Xa alerting against all other aircraft. ACAS Xo is a supplement to ACAS Xa to allow special operations such as parallel approaches that would otherwise be likely to trigger ACAS Xa alerts. Both ACAS Xa and Xo are being developed in parallel and will share the same standard which is due at the end of 2018. In Europe, EUROCAE WG-75 group was tasked to develop ACAS X MOPS as a joint RTCA/EUROCAE activity.

2.5 Structure of the document

This document is organized in the following way:

- The first and current section serve as introduction to the topic, scope of the document and background.
- Section 3 provides formal description and solution allocation at the program level, it's relation to EATMA and description of operational environment where ACAS X will operate.
- Section 4 will be further specified in the final V2 SPR-INTEROP/OSED document in 2018.

2.6 Glossary of terms

Term	Definition	Source of the definition
ACAS Xo Mode	An alternative ACAS X logic. Two ACAS Xo modes are included in MOPS document: DNA and CSPO-3000.	Pre-FRAC MOPS
Cooperative traffic	Aircraft, proximate to another aircraft, using avionics equipment that provides identification, position, or other data, e.g., for ATM surveillance, which can be detected by suitably equipped aircraft and used to provide situation awareness and for detecting and assessing potential conflicts. Examples of such devices are transponders (Mode A/C and Mode S), position reporting systems such as ADS-B transceivers or general aviation devices (e.g., FLARM).	Modified EUROCAE ED-238
CSPO-300 mode	An ACAS Xo mode for Closely Spaced Parallel Operations down to 3,000ft runway separation.	Pre-FRAC MOPS
Designated traffic	A particular ACAS X traffic that has been designated by the flight crew for a particular ACAS Xo mode.	CONUSE
DNA mode	An ACAS Xo Designated No Alerts mode which suppress all alerts and guidance (except during multi-threat encounters) on the specifically designated traffic.	Pre-FRAC MOPS
No Transgression Zone (NTZ)	A corridor of airspace established equidistant between 2 extended runway centre lines.	EUROCONTROL
Normal Operating Zone (NOZ)	Airspace in which aircraft are expected to operate while manoeuvring to pick up and fly the ILS localizer course or the MLS final approach track.	EUROCONTROL
To undesignate	A process by which either the flight crew or automation removes the designation of traffic for an ACAS Xo alternative logic mode. When traffic is undesignated, it is returned to normal ACAS X operation	CONUSE
Valid traffic	Traffic that meets the criteria, such as data quality requirements, defined for an ACAS Xo mode. Different criteria may be defined for each	CONUSE

	individual mode.	

Table 1: Glossary of terms

2.7 List of Acronyms

Acronym	Definition
1090ES	1090 MHz Extended Squitter
ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependent Surveillance - Broadcast
ATC	Air Traffic Control
ATM	Air Traffic Management
CA/CAS	Collision Avoidance (System)
CDTI	Cockpit Display of Traffic Information
CNS	Communication Navigation and Surveillance
CONOPS	Concept of Operations
CR	Change Request
CSPO	Closely Spaced Parallel Operation
DNA	Designated No Alert
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
FAA	Federal Aviation Administration
FRAC	Final Review And Comments
HPAR	Human Performance Assessment Report
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
INTEROP	Interoperability Requirements
MOPS	Minimum Operational Performance Standards
MSL	Mean Sea Level
MTOM	Maximum Take-Off Mass
NMAC	Near Mid-Air Collision
NOZ	Normal Operating Zone
NTZ	Non Transgression Zone
KPA	Key Performance Area

OI	Operational Improvement
OPAR	Operational Performance Assessment Report
OSED	Operational Service and Environment Definition
PAR	Performance Assessment Report
PIRM	Programme Information Reference Model
RA	Resolution Advisory
QoS	Quality of Service
SAC	Safety Criteria
SAR	Safety Assessment Report
SecAR	Security Assessment Report
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SPR	Safety and Performance Requirements
STM	Surveillance and Tracking Module
SWIM	System Wide Information Model
TA	Traffic Advisory
TCAS	Traffic Collision Avoidance System
TOPA	TCAS Operational Performance Assessment
TPCS	Third Party Call Sign
TRM	Threat Resolution Module
TS	Technical Specification

Table 2: List of acronyms

3 Operational Service and Environment Definition

The following sub-sections provide further details on the operational concept aspects of ACAS Xo solution and describe applicable operational environment.

3.1 SESAR Solution PJ.11-A3: a summary

ACAS Xo is a mode of operation of ACAS X designed for particular operations for which ACAS Xa is unsuitable and might generate an unacceptable number of nuisance alerts (e.g. procedures with reduced separation, such as closely spaced parallel approaches).

ACAS Xo is integrated with ACAS Xa systems, but activation of the ACAS Xo functionality is optional. It provides additional collision avoidance logic modes designed to support closely-spaced flight operations, and allows specifically designated traffic to be monitored by an alternative ACAS logic more compatible with the flight operation than the standard ACAS Xa logic. So far, there are two Xo modes defined by RTCA in MOPS draft:

1. Closely Spaced Parallel Operations down to 3,000ft runway separation mode (**CSPO-3000**) which provides designated traffic with modified CAS logic monitoring more appropriate for parallel operations; applicable in both visual and instrument conditions. ACAS Xa protection is maintained on all other cooperative traffic.

2. Designated No Alerts mode (**DNA**) which suppress all alerts and guidance (except during multi-threat encounters) on the specifically designated traffic; requiring flight crew to visually acquire the desired traffic before designating it and then maintaining visual separation from the DNA-designated aircraft. This mode is intended for use in closely-spaced operations on visual conditions, where ACAS Xa alerts would otherwise be a nuisance, ignored, and/or disruptive. DNA mode may be used instead of placing ACAS Xa into TA-only mode, preventing alerts on the designated traffic but still allowing full ACAS Xa protection from all other cooperative traffic. DNA mode is also applicable for parallel runways where separation is below 2500ft.

Additional ACAS Xo modes are expected in the future, however only CSPO-3000 and DNA will be defined in ACAS Xa/Xo MOPS with planned delivery in 2018. This document relies on US scenarios since there are no European use cases identified for ACAS Xo modes (DNA or CSPO3000) at the moment.

However, the purpose of upcoming validation activities aims at evaluating the following items:

- ACAS Xo alerting time,
- ACAS Xo designation operational acceptability,
- ACAS Xo automatic undesignation operational acceptability,
- ACAS Xo HMI and ACAS Xo algorithm acceptability at human factor perspective,

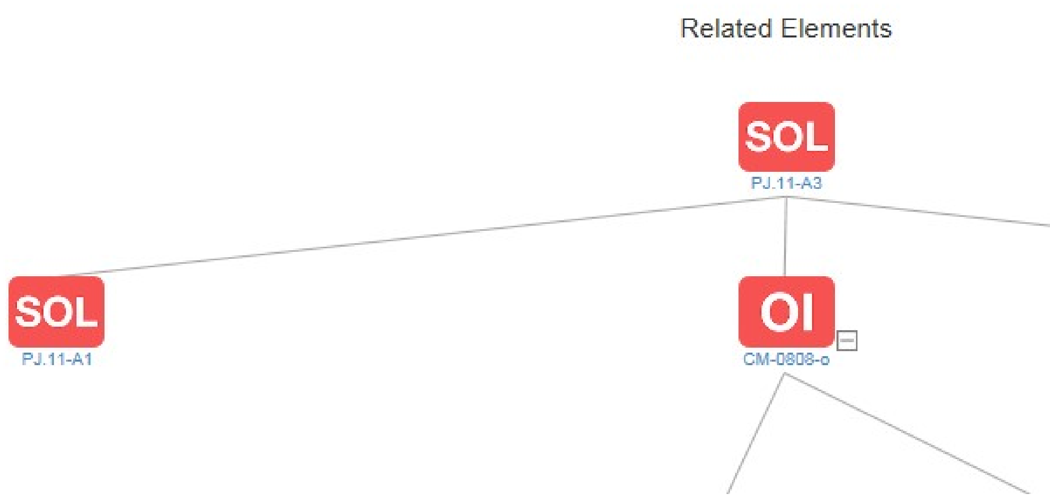
- the adapted Navigation Display symbology,
- compatibility with other current traffic functions like separation applications,
- ACAS Xo Safety assessment;

These items will be rigorously similar in case of potential future European ACAS Xo operation. So, the study performed from US scenarios is nearly as valuable as a study based on European scenarios from European Airspace perspective.

Furthermore, it is very likely that potential European parallel approaches operations that would require ACAS Xo will be similar to current US parallel approach operations that require ACAS Xo. Additionally, since European operators frequently serve destinations in the US, those fleet will inherently benefit from ACAS Xo once in US airspace and therefore assessing the US scenarios and estimating ACAS Xo achievable benefits for European stakeholder within PJ.11-A3 is relevant.

SESAR Solution ID	SESAR Solution Title	OI Steps ID ref. (coming from EATMA)	OI Steps Title (coming from EATMA)	OI Step Coverage
PJ.11-A3	ACAS for Commercial Air Transport specific operations - ACAS Xo	CM-0808-o	Collision Avoidance for commercial air transport Adapted to New Separation Modes	**Fully**

Table 3: SESAR Solution PJ.11-A3 Scope and related OI steps



The OI Step CM-0808o is linked to two enablers and set of sub-enablers that needs to be revised. A/C-54a refers to Enhanced Airborne Collision Avoidance system, and A/C-54b refers to ACAS adaptation to new separation modes, e.g. ASAS separation, aircraft flying to close parallel runways, aircraft converging with high closer rate.

Per DS16, CM-0808p does not have allocated Key Feature (suggested SESAR Key Feature to be allocated: Advanced Air Traffic Services) or Capability (suggested SESAR Capability to be allocated: Conflict Management – Collision Avoidance).

This solution is related to PJ.11-A1 (ACAS Xa) solution.

High Level CONOPS Requirement ID	High Level CONOPS Requirement	Reference to relevant CONOPS Sections e.g. Operational Scenario applicable to the SESAR Solution
S11-A3-HL-01	ACAS for Commercial Air Transport specific operations (ACAS Xo) shall be improved in terms of safety and operational compatibility by: • Using information from the more accurate surveillance available; • Optimising the rules for triggering an RA by applying state-of-the-art mathematical processes and modelling. While avoiding unnecessary triggering of RA in new separation modes (i.e. ACAS), in particular if lower separation minima are considered.	CONOPS section 5.12.1

Table 4: Link to CONOPS

EATMA PJ.11-A3 solution definition: ACAS for Commercial Air Transport specific operations - ACAS Xo improves ACAS (Airborne Collision Avoidance System) building on optimised resolution advisories and additional surveillance data, while avoiding unnecessary triggering of resolution advisories (RAs) in new separation modes (e.g. ASAS), in particular if lower separation minima are considered.

Definition of relevant operational enabler under the scope of this solution: CM-0808-o: Airborne Collision Avoidance for commercial Air transport in specific operations taking advantage of surveillance data from passive sources (ADS-B), additional aircraft data, providing optimized resolution advisories and improving compatibility with non-equipped aircraft. The ACAS function resulting from CM-0808-a is adapted to new separation modes, so that the execution of the new operations is not disturbed by unnecessary resolution advisories, in particular if lower separation minima is considered.

PJ.11-A3 (ACAS Xo) solution is not yet defined in EATMA. Solution model needs to be developed and integrated into EATMA.

3.1.1 Deviations with respect to the SESAR Solution definition

There are no deviations with respect to the list of OI steps & enablers.

3.2 Detailed Operational Environment

Use of ACAS Xo alters only the CAS logic used aboard the ACAS Xo–equipped aircraft. It has no effect on collision avoidance systems aboard the designated aircraft.

3.2.1 Operational Characteristics

The two initial ACAS Xo applications are aircraft-specific No-Alert functionality, also referred to as designated No-Alert (DNA), and Closely Spaced Parallel Operations down to 3,000' feet runway separation (CSPO-3000). Additional applications are expected to be developed to address other specific airspace operations where ACAS XA is not sufficient to provide an acceptable nuisance alert rate.

Existing ACAS II systems allow pilots to select a global TA-only function which prevents the ownship ACAS II from generating any RAs. The ACAS Xo designated No-Alert functionality allows pilots to prevent RAs and TAs only on specifically designated aircraft while maintaining normal CAS protection on other aircraft not involved in the closely-spaced operation. As with the global TA-only function, the flight crew is expected to ensure the situation meets allowed conditions for use of function.

ACAS Xo application can be used in airspace of any traffic density. CSPO-3000 operational environment is currently limited and cannot be used at high altitudes, above 14 000ft. Both modes of ACAS Xo are applicable during approaches since most of the nuisance RAs occur in this phase of flight, while DNA is not limited only to approaches and can be potentially used during closely spaced departures, or other closely spaced flight operations. Current definition of DNA however limits it application for visual conditions only. CSPO-3000 operation is possible in both visual and instrument conditions.

3.2.2 Roles and Responsibilities

This section addresses the respective roles of ATC, crew and expected on-board ACAS Xo function. As a reminder: **The roles and responsibilities of pilots and controllers in normal ACAS operation are not expected to change with the introduction of ACAS Xo.**

3.2.2.1 Roles and Responsibilities in Normal ACAS operation

The roles and responsibilities of pilots and controllers in normal ACAS operation are described respectively in PANS-OPS [42] and PANS-ATM [43].

Additionally, FAA advisory [39] on the use of TCAS II concludes pilot, operators and ATC responsibilities with regard to TCAS:

Pilot responsibilities:

"The intent of a TCAS is to serve as a backup to visual collision avoidance, application of right-of-way rules, and air traffic separation service. For TCAS to work as designed, immediate and correct crew

response to TCAS advisories is essential. Delayed crew response or reluctance of a flight crew to adjust the aircraft's flight path as advised by TCAS due to ATC clearance provisions, fear of later FAA scrutiny, or other factors could significantly decrease or negate the protection afforded by TCAS." Flight crew should respond to a TCAS in accordance with guidance as described in sec 12.b. in [39].

Operator responsibilities:

"Operators have the following general responsibilities regarding the TCAS:

- *Ensure follow-up and evaluation of unusual TCAS events; and*
- *Periodically assess TCAS training, checking, and maintenance programs to ensure their correctness, pertinence, timeliness, and effectiveness."*

ATC responsibilities:

"1. Controllers will not knowingly issue instructions that are contrary to RA guidance when they are aware that a TCAS manoeuvre is in progress. When an aircraft deviates from its clearance in response to an RA, ATC is still responsible for providing assistance to the deviating aircraft as requested until:

- *The pilot informs ATC that the RA conflict is clear; and the aircraft has returned to the previously assigned altitude; or*
- *Alternate ATC instructions have been issued and the pilot has acknowledged them.*

2. Workload permitting, controllers may continue to provide pertinent traffic information in accordance with the current edition of FAA Order JO 7110.65, Air Traffic Control.

3. Maintain awareness of TCAS programs and program changes.

4. Train ATC specialists on TCAS and expected flight crew responses to TCAS advisories and provide familiarization flights for specialists on TCAS-equipped aircraft to the extent possible.

5. When requested by the flight crew, and if appropriate, provide separation from TCAS-observed traffic and assistance in returning to the assigned clearance. Issue additional clearance instructions when the situation so requires.

6. Advise pertinent FAA offices, such as a SFDO, via TCAS questionnaires about airspace or airports where excessive numbers of RA occur. This facilitates initiation of corrective actions related to TCAS enhancements, TCAS procedures, and airspace adjustments. "

3.2.2.2 Roles and Responsibilities in ACAS Xo Context

The above-mentioned responsibilities are not expected to change with the introduction of ACAS Xa/Xo so this section intends at describing these roles that take place in the frame of ACAS Xo use during concerned closely spaced flight operations (parallel approaches for CSPO-3000 and possible other closely spaced for DNA).

In general, the **approach controller**:

- Is in charge of an aircraft flow. These aircraft come originally from different origins and have been put in order by another controller upstream to build a single flow.

- Is responsible for managing separations and bring aircraft to the final approach. Aircraft are following each other with respect to appropriate separations depending on respective categories and weather conditions.
- Then, the controller delivers the approach clearance
    - So, e.g. the crew activate the APProach mode to intercept the Glide
- Delivers the landing clearance when sure the runway is clear for landing.

During ACAS Xo application, the flight crew is responsible for:

- Correct designation of the right aircraft based on guiding information.
- Activation of the correct mode of ACAS Xo.
- Following the RA in case of alert issued by ACAS system, and then informing the ATC.
- Decision about the corrective action in case TA is issued during Xo operation.
- Coordination with ATC about any problems on board or decisions taken.
- Manual un-designation in case of erroneous designation.
- Visual acquisition of the relevant aircraft for DNA mode.
- Maintaining of the visual separation from the DNA designated aircraft.

Additionally, ATC is responsible for:

- Monitoring aircraft approaching to runway in his/her responsibility and in case of detection that aircraft on approach to parallel runway deviates from its path, contact the crew.

To summarize:

- Roles and responsibilities remain unchanged for both crews and controllers,
- A specific additional task is allocated to the crew:
    - To designate the relevant aircraft on their own without support from ATC
    - Select the mode (CSPO 3000 or DNA)
- Otherwise, no specific task is requested from the crew with this new function because ACAS Xo is not intended to be used for guidance but only as a safety net. However, maintaining visual separation remains even more necessary due to the absence of TCAS alert.

Specific attention shall be given on situations when pilots and controllers may refer to other (third party) aircraft on a common voice frequency since using the Third Party Call Signs (TPCS) to talk about (rather than talking to) other aircraft on the same frequency introduces potential for confusion for controllers and pilots. MITRE technical report [44] on evaluation of pilot and ATC use of TPCS in voice communications, identified two possible approaches with respect to TPCS format that are recommended for further analysis. TPCS placement should be carefully considered to maintain a natural flow and minimize the deviations from current phraseology for the individual clearance, instruction, or advisory in which it is expected to be used.

3.2.3 Technical Characteristics

Aircraft

Operating aircraft should be equipped with the following equipment:

- ACAS Xa anti-collision system with active and passive surveillance to ensure collision avoidance with surrounding traffic, to recover ADS-B IN messages coming from paired aircraft (associated aircraft with which the parallel operation is performed) and to support ACAS Xo
- ACAS Xo (O for Operations) which is a supplement to ACAS XA to allow special operations on specifically designated traffic, such as parallel approaches, that would otherwise be likely to trigger ACAS XA nuisance alerts.
- ASA System that includes a surveillance and application processing function (ASSAP), and a control and display function (CDTI). ASA system will allow the pilot to designate/undesignate the paired aircraft as well as to select the operational ACAS Xo mode: DNA (designated No Alert) or CSPO3000 (Closely Spaced Parallel Operation for runway down to 3000ft). ASA system will also offer the identification of the paired aircraft on the Display. It is integrated with ACAS X and relies on ADS-B messages.
- Mode S transponder (DO-260A/B compliant)

Paired Aircraft

Paired Aircraft should be equipped with:

- A Mode S transponder.
- A 1090 ADS-B out equipment meeting the US/European mandates in order to be tracked with an appropriate precision and to have the Flight ID displayed at the Operating Aircraft Navigation Display

Airport

For DNA (designated No Alert) ACAS Xo mode:

- Airport should have runways below 3000ft. indeed DNA application is intended to support visual separation operations such as VMC dependent approaches to runways below 3,000ft runway spacing or visual separation during climb/descent in the terminal area.
- Airport should have radar to maintain the dependent approach separation ranges.

CSPO-3000 (Closely Spaced Parallel Operation for runway down to 3000ft)

- This application is designed to support IMC operations to runways separated by less than 4,300' but at least 3,000'
- The airport should implement Precision Runway Monitor (PRM) procedures. PRM is an acronym for the high update rate Precision Runway Monitor surveillance system which is required to monitor the No Transgression Zone (NTZ) for specific parallel runway separations used to conduct simultaneous close parallel approaches. PRM is also published in the title as part of the approach name for IAPs used to conduct Simultaneous Close Parallel approaches. “PRM” alerts pilots that specific airborne equipment, training, and procedures are applicable.
- Because Simultaneous Close Parallel PRM approaches are independent, the NTZ and normal operating zone (NOZ) airspace between the final approach courses is can be monitored by two monitor controllers, one for each approach course. The NTZ monitoring system consists of high resolution ATC radar displays, automated tracking software which provides monitor controllers with aircraft identification, position, speed and a ten-second projected position,

as well as visual and aural NTZ penetration alerts. A PRM high update rate surveillance sensor is a component of this system only for specific runway spacing.[1]

3.2.4 Applicable standards and regulations

Following list of standards and regulations are applicable to PJ.11-A3 solution, and were used as reference documents during development of this document:

- ACAS Xa/Xo MOPS which is currently under development with target delivery date in 2018. During the work on this document, pre-FRAC version was used as reference.
- DO-317B: MOPS for Aircraft Surveillance Applications (ASA) System, since ACAS Xo will handle target designation and display in accordance with this standard.
- Concept of Use for the ACAS Xo, V2R0 (February 2015) was used, but is considered to be out-of-date – need for update.
- Advisory circular, AC 20-151B addressing Airworthiness Approval of TCAS II, Versions 7.0 & 7.1 and Associated Mode S Transponders.

3.3 Detailed Operating Method

3.3.1 Previous Operating Method

Currently mandated system, TCAS II, aids pilots in visually acquiring potential threats and, if necessary, provides last-minute collision avoidance guidance directly to the flight crew. It is therefore important that TCAS alert the flight crew early enough the evasive action can be taken, but it is also important that it does not alert unnecessarily as RAs represent high-stress, time-critical interruptions to normal flight operations. These interruptions, in addition to distracting the aircraft's crew, may lead to unnecessary manoeuvring that disrupts the efficient flow of traffic and may over time also pilots to distrust the automation. [38] The latter already become a reality. High % of nuisance RAs in US cases pilots ignoring RAs what introduces high safety risk.

The analysis of FAA's TOPA program which collects TCAS RA downlink data from US NAS shows that over 25% of TCAS RAs in the US NAS are due to visual separation procedures (parallel approach and traffic pattern operations, most of them during VMC). In order to deal with airspace procedures leading to frequent nuisance RAs, the FAA allows for several mitigations:

- **TA-Only mode:** mode inhibiting RAs against all traffic. See section 3.3.1.1 for details about TA-Only mode operations.
- **Noncompliance with ACAS II RA**: the same circular advisory allows pilots to ignore RAs in situations where they can assure separation with the help of definitive acquisition of the

[1] Ref. ICAO-Doc-4444

aircraft causing the RA. Note that ICAO guidance as well as approved air carrier operational procedures requires RA compliance regardless of visual acquisition. TOPA data indicate that noncompliance with TCAS is observed in almost 50% of Climb and Descent RAs. While RA noncompliance may enhance airspace efficiency, TCAS cannot provide the intended safety benefit in the absence of RA compliance. This is especially true in cases where visual acquisition did not occur or did not involve the actual intruder. Furthermore, compliance is very low for RAs during **closely spaced parallel operations** with fewer than 2% of RAs during these operations resulting in a go-around. If these RAs were to occur in IMC, response to these RAs would result in a significant decrease in airspace efficiency [40]. Refer to section 3.3.1.2 for more details about closely spaced parallel operations.

3.3.1.1 TA-Only Mode Operations

According to AC 120-55C CHG1, it is appropriate to operate the TCAS in TA-only mode in circumstance where unnecessary RAs frequently occur and where such RAs are disruptive to the operation of the aircraft. These circumstances include:

- During take-off towards traffic that is in visual contact;
- During IMC or VMC approaches to closely spaced parallel runways;
- At airports or circumstances frequently leading to unwanted or inappropriate RAs.
- In the event of particular in-flight failures, such as engine failure, as specified by the Aircraft Flight Manual (AFM) or operator;
- During take-offs or landings outside of the nominal TCAS reference performance envelope for RAs, as designated by the AFM or operator.

TA-only mode is in reality used rarely (FAA indicates 10%). Pilots are reluctant to use TA-only function since doing so would also inhibit RAs from all other traffic, beyond those in visual contact or participating in the visual separation procedure.

3.3.1.2 Closely Spaced Parallel Runway Operations

The main objective of implementing simultaneous operations on parallel runways is to increase runway capacity and airport flexibility. Once CSPO operations are in place, both capacity and efficiency are significantly impacted during low visibility conditions.

Parallel runways can have several modes of operations:

- **Simultaneous parallel approaches**
  - Mode 1, Independent parallel approaches: simultaneous approaches to parallel instrument runways where radar separation minima are not prescribed between aircraft using adjacent ILS or MLS

    In Mode 1, as no ATS separation is prescribed to protect aircraft on the other approach path, a **N**o **T**ransgression **Z**one (NTZ) is defined.

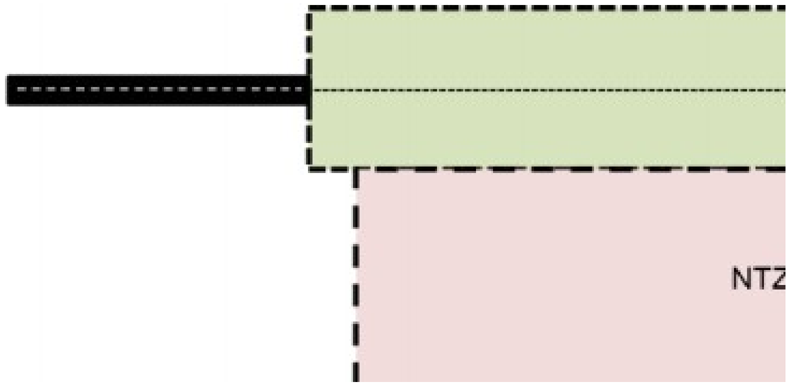


Figure 2: Illustrative figure depicting NTZ and NOZ zones

The NTZ has a minimum width of 2000ft (610m) and extends from the nearest threshold to the point where the 1000ft (300m) vertical separation is reduced between aircraft on the adjacent extended runway centre lines. The **N**ormal **O**perating **Z**one (NOZ) is the airspace in which aircraft are expected to operate while manoeuvring to pick up and fly the ILS localizer course of the MLS final approach track.

- Mode 2, Dependent parallel approaches: simultaneous approaches to parallel instrument runways where radar separation minima between aircraft using adjacent ILS or MLS are prescribed.

- **Simultaneous parallel departures**
  - Mode 3, Independent parallel departures: simultaneous departures for aircraft departing in the same direction from parallel runways.
- **Segregated parallel approaches/departures**
  - Mode 4, segregated parallel operations: simultaneous operations on parallel runways where one runway is used exclusively for approaches and landings, and one runway is used exclusively for departures.

In the case of segregated parallel approaches and departures, there may be semi-mixed modes of operations, what means that one runway is used exclusively for approaches while the other is used for a mixture of approaches and departures, or when one runway is used exclusively for departures while other is used for both departures and approaches.

Mixed parallel operations refer then to simultaneous parallel approaches with departures interspersed on both runways.

Closely Spaced Parallel Runway Operations (CSPO) are defined as operations on parallel runways separated by less than 2,500 feet[2].

Dependency or independency of operations is determined by distance between parallel runways, airport's surveillance capabilities, and supported procedures. The high-level overview of independent and dependent CSPR operations is depicted at the figure below.

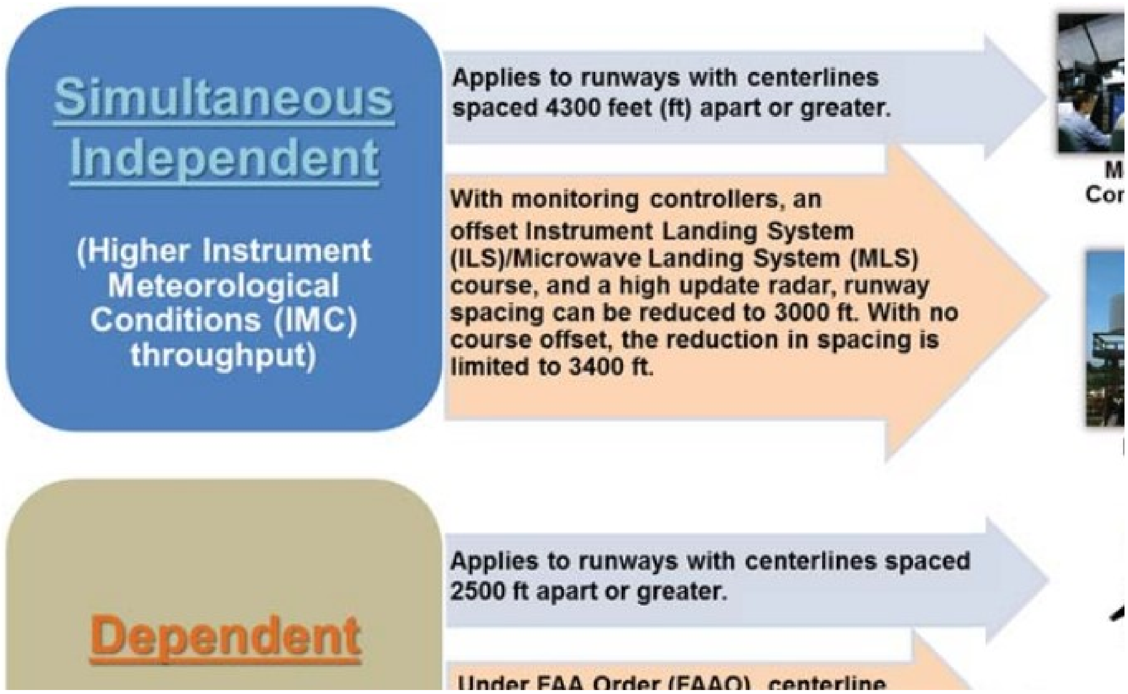


Figure 3: CSPO today (Source: mitrecaasd.org)

3.3.1.2.1 Independent parallel approaches

Since ACAS Xo CSPO-3000 mode is addressing independent operations, this subsection will focus on that. There are several requirements that apply for independent parallel approaches:

- Instrumental landing systems (ILS) and/or MLS are being conducted on both runways;
- Missed approach track for one approach diverges by at least 30° from the missed approach track of adjacent approach.
- Aircraft are advised of the runway identification (or ILS localizer of MLS frequency) as early as possible;
- Aircraft shall not penetrate the NTZ;

[2] Also referred as Closely Spaced Parallel Runways (CSPR)

- For independent parallel approaches two aerodrome controllers should be required, one for each runway, with separate aerodrome control frequencies;
- Radar vectoring is used to intercept the ILS localizer course or the MLS final approach track;

The safety of parallel runway operations in controlled airspace is affected by several factors such as the use and accuracy of the radar monitoring system, the effectiveness of the controller intervention when an aircraft deviates from the approach course, or the precision with which aircraft fly the approach. Independent operations on CSPR are therefore significantly safety critical. The list of safety-related issues is available in ICAO Manual 9643 Manual on Simultaneous Operations on Parallel or near-parallel Instrument Runways (SOIR).

One of the elements in SOIR list is ACAS. During operational evaluations of ACAS II, some unnecessary missed approaches occurred as a result of “nuisance” RA. To remedy this situation, a number of modifications were made to the collision avoidance logic. However, these modifications did not completely eliminate such occurrences. Accordingly, the use of TA-Only mode during parallel approach operations is recommended (refer to 3.3.1.1) and should be indicated on the published approach charts.

3.3.2 New SESAR Operating Method

Since existing TCAS II alerting is not compatible with many visual separation procedures and frequently leads to nuisance alerts in these cases, ACAS Xo introduces two modes with improved collision alerting for operations with reduced separations.

ACAS Xo will be an optional feature integrated within ACAS Xa system. TCAS II retrofits and aircraft without installed ASA Systems may not support ACAS Xo functionality. ACAS Xo allows designated traffic to be monitored by an alternative ACAS logic. On the traffic, which is not specifically designated to an ACAS Xo mode, usual ACAS X logic will be applied.

3.3.2.1 Designated No Alert (DNA) Mode

Designated No Alert (DNA) mode will suppress all ACAS Xa alerts and guidance on the designated traffic. It is intended to be used during closely spaced operations and may be used instead TA-Only mode, in situations when alert would be considered as nuisance, ignored, and/or disruptive. **However, current pre-FRAC version of the MOPS suggests its applicability in visual conditions only, while according to [39], it is appropriate to use TA-only mode also in instrument conditions during approaches to CSPR.**

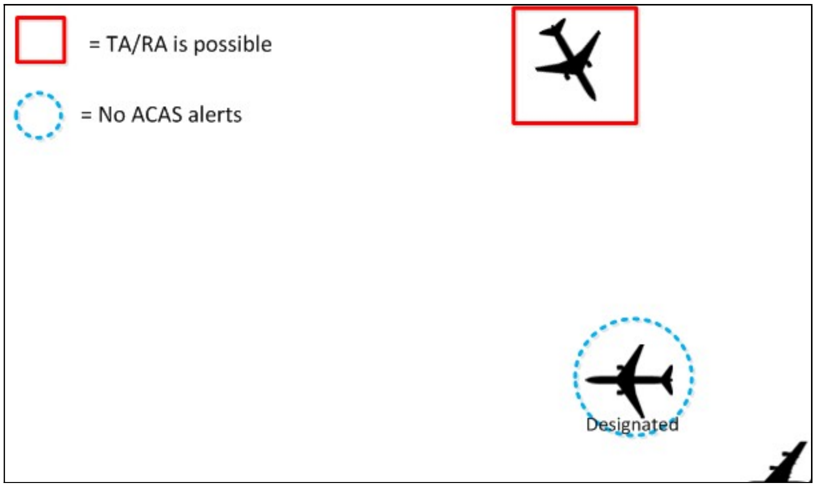


Figure 4: DNA mode illustration (source: FAA, RTCA SC-147)

When DNA aircraft is part of multi-threat RA encounter, DNA mode will be temporarily suspended until the multi-threat RA clears. The operating method of DNA should be much wider than the one of CSPO-3000, as it may be used not only during CSPO, but also during any other close proximity operations, during take offs towards known nearby traffic that is in visual contact and which could cause an unwanted RA, or at certain airports, during particular procedures, or in circumstances identified by the operator as having a significant potential for unwanted or inappropriate RAs.

Concept of Use for DNA mode was not yet defined however, section 3.3.2.3 shows one potential use cases for DNA as envisaged by Airbus.

3.3.2.2 CSPO-3000 Mode

CSPO-3000 mode refers to independent Closely Spaced Parallel Operations down to 3,000 ft runway separations (and less than 4,300 ft).

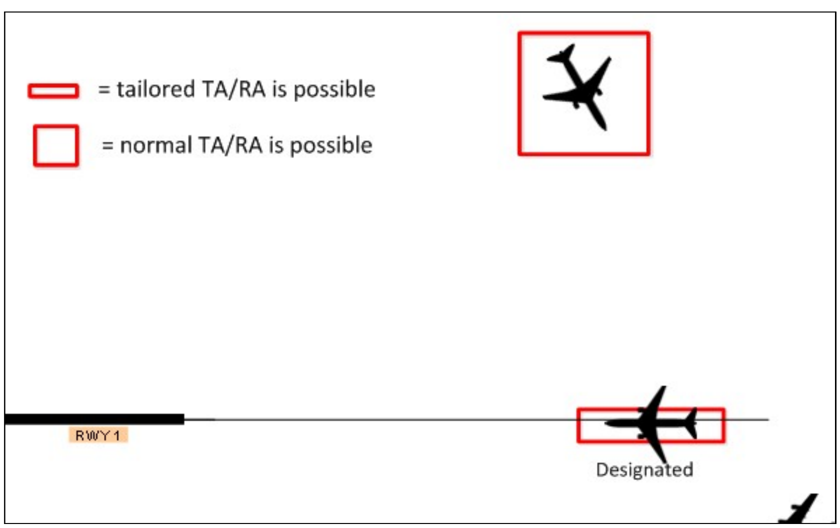


Figure 5: CSPO-3000 mode illustration (source: FAA, RTCA SC-147)

ACAS Xo with this mode will provide traffic with modified CAS logic monitoring that is appropriate for parallel operations, still providing TAs and RAs on the traffic. This mode will not provide wake turbulence protection and can be used in both visual and instrument conditions. It is assumed that CSPO-3000 will be interoperable with PRM procedures.

CSPO-3000 mode has been developed with the following assumptions in mind:

- Risk of blunder during join up to final approach is mitigated by greater than 500 ft altitude separation;
- Maximum nuisance alert rate across expected range of runway separation, stagger and overtake is 3%;
- ACAS Xo uses same vertical-only RA set as ACAS Xa;
- Standard ACAS Xa RA low-altitude inhibits and cut-offs apply;
- Standard ACAS Xa RA response with 5 second pilot response delay is expected.

3.3.2.3 ACAS Xo Open Points

- Concept of use for ACAS Xo is not clearly defined at this stage. ConUse released in 2015, does not define DNA mode;
- Time of ACAS Xo designation remains unclear;
- Potential operational use-cases in European airspace;
- Initial system allows only one aircraft to be eligible for designation and mode application. Future operations may require possibility to designate more aircraft.

3.3.2.4 Use Cases

There are no use cases known in the European environment. However, European Operators frequently serve destinations in the US. Those operators may profit from ACAS Xo.

There are parallel runways also at European airports, but the way they are used operationally have not resulted in frequent TCAS nuisance alerts, unlike at several locations in the US. If the future traffic demand in Europe will lead to change in operations on parallel runways on European airports, ACAS Xo might become an efficient tool to eliminate potential nuisance RAs.

Following subsections however illustrate two potential use cases including roles and responsibilities description for the two modes, as envisaged by Airbus.

3.3.2.5 1st case: CSPO 3000

Distance between runways is comprised between 3000 and 4300 ft.

Approaches are independent. This means that 2 aircraft may fly parallel final approaches without consideration of visually monitoring each other.

These approaches can be managed by 2 different controllers managing different aircraft flows.

3.3.2.5.1 Designation step

The crew should determine the aircraft to be designated as candidate for using ACAS Xo appropriate protection during the coming approach.

➔The crew is responsible for the correct designation of the right aircraft based on guided/preliminary information. For instance in the situations when:

- The approach is already known as subject to nuisance alerts with current ACAS II/ACAS Xa,
- There is no doubt about the concerned aircraft to be designated.
  - This is an assumption that the crew can designate the right aircraft without ambiguity.
  - This assumption has to be verified

The figure below presents a simplified action flow regarding the designation action by A/C 1 crew.

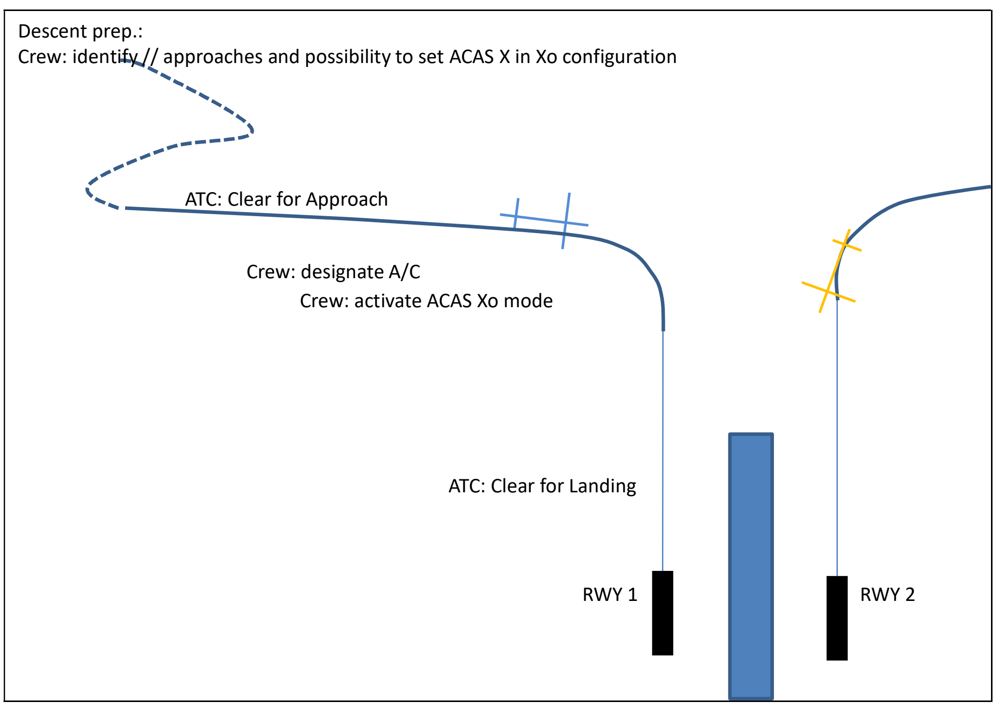


Figure 6: Designation and mode activation

3.3.2.5.2 Alert case

If ATC detects a risk of conflict, he/she may request specific corrective action (lateral or vertical). In case of alert in the cockpit, according to the current rules, the crew in A/C 1 follows the vertical RA given by TCAS, then informs ATC.

<u>Alert when joining the final approach axis.</u>

In this situation – see Figure 7, ownship (A/C 1) overshoots the runway 1 extended axis during the interception. While doing this, it is closing to another aircraft which is also intercepting the approach axis to runway 2.

In this situation, it is expected that ACAS Xo is more tolerant than ACAS Xa and triggers a bit later.

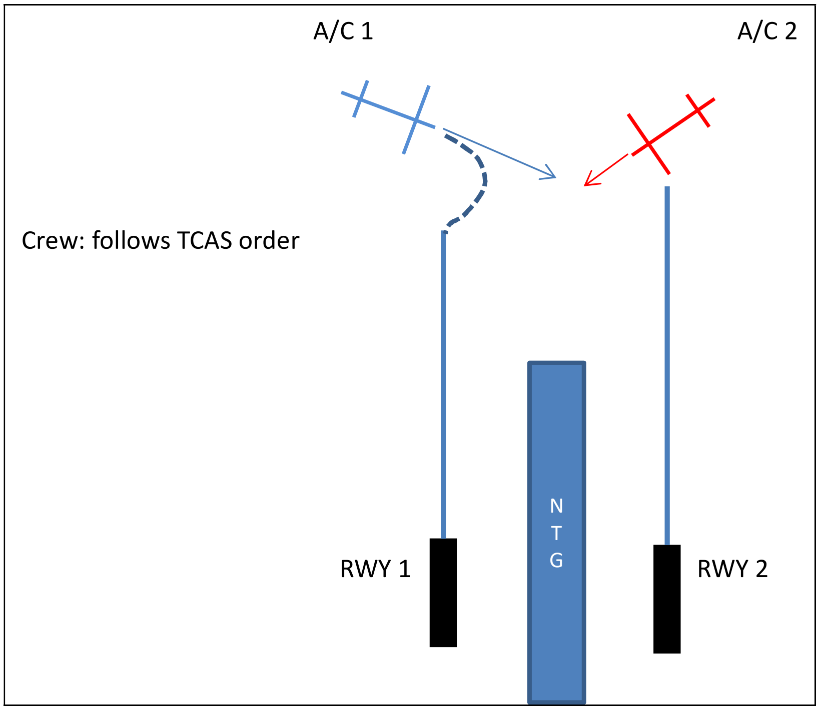


Figure 7 : Alert when joining the final approach path

<u>Alert caused by the designated aircraft during the approach.</u>

In this 2nd scenario – see Figure 8:

- A/C 1 (ownship) is in approach to RWY 1.
- A/C 2 (designated aircraft) is in approach to RWY 2.
- A/C 2 deviates from the approach path and infringes the NTZ (No Transgression Zone).
- ACAS Xo triggers the alerts.

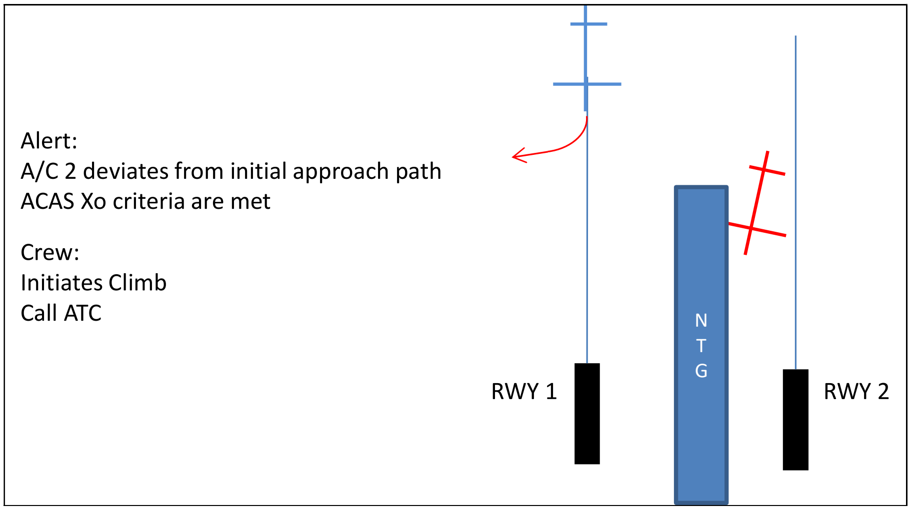


Figure 8 : Alert during CSPO-3000 approach

Note: ATC controllers on respective runways monitor their own aircraft (Ownship for ATC 1 and other aircraft for ATC 2 on runway 2).

It is also expected that in parallel, ATC2 detects that A/C 2 is deviating from its approach path and contact it.

<u>Alert caused by the ownship aircraft during the approach.</u>

In this scenario – see Figure 9:

- A/C 1 (ownship) is in approach to RWY 1.
- A/C 2 (designated aircraft) is in approach to RWY 2 but behind ownship.
- A/C 1 deviates from the approach path and infringes the NTZ generating a conflict with A/C2.
- ACAS Xo in A/C 1 triggers the alerts with a TA

A/C1 crew has to decide of the best corrective action:

- Possibility to join the initial approach path and continue descent to the runway,
- Climb or go-around,
- Call ATC to inform of a problem on-board or decision to go-around.

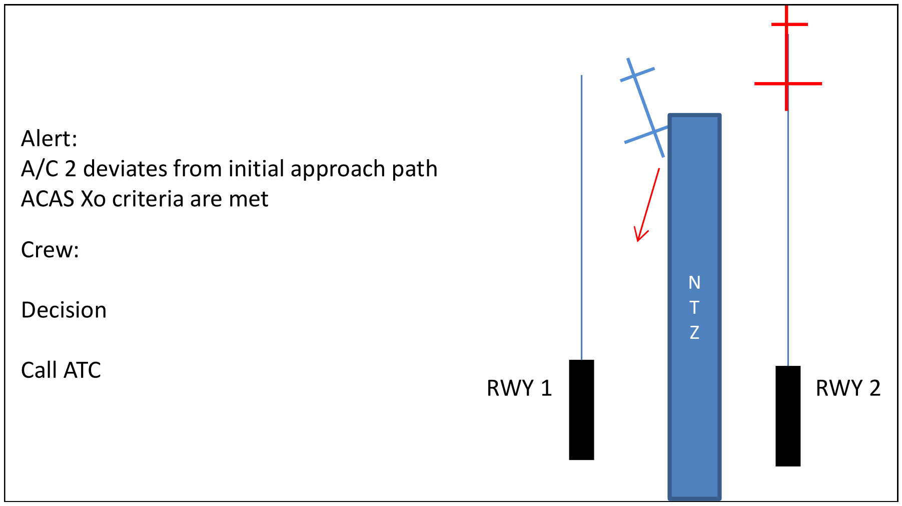


Figure 9 : Conflict during CSPO 3000 with ownship ahead of the designated aircraft

<u>Other alert cases caused by a 3rd aircraft.</u>

The same rule applies in terms of responsibilities.

Both aircraft may be subject to an alert caused by the 3rd aircraft.

3.3.2.5.3 End of ACAS Xo operation

ACAS mode can switch from ACAS Xo to ACAS Xa when it is no longer appropriate e.g.:

- Crew: Manual un-designation in case of erroneous designation
    - In this case, the crew can make a new designation/mode selection if the workload permits
- ACAS Xo Automatic undesignation if:
    - Designated aircraft data are out of required performance (specific performance is to be identified if any)
    - Designated aircraft has landed or ownship has landed
- Crew: Ownship interrupts the approach after an alert.

3.3.2.6 2nd case: DNA

In this version, dependent approaches are considered.

One single controller (or a team of controllers) is in charge of both approaches.

This could be extended to independent approaches in the future.

3.3.2.6.1 DNA mode activation

The crew knows in advance that this approach may need to deactivate ACAS for the aircraft on approach to the other runway.

After the approach clearance has been received, the crew in aircraft 1:

- Acquires visually the relevant aircraft,
- Designates A/C2,
- Activates DNA mode,
- Maintains visual separation from the DNA designated aircraft.

The Figure below summarizes the sequence with aircraft/mode selection where A/C1 is the ownship (no alert in this case).

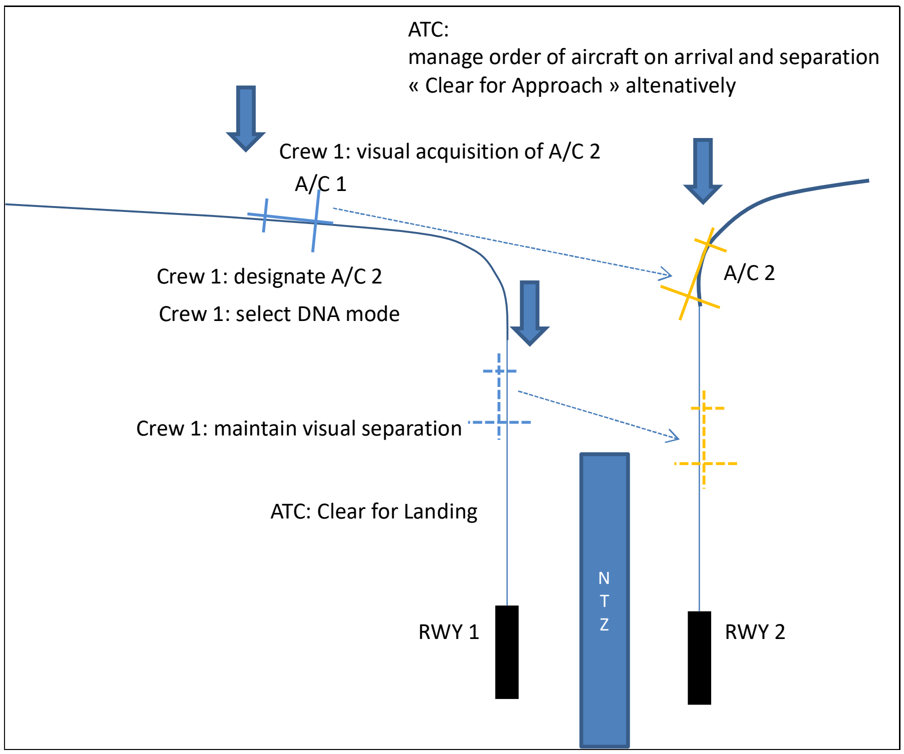


Figure 10 : DNA mode activation

3.3.2.6.2 Conflict situations in DNA mode

Conflict between ownship and designated aircraft for DNA mode

In case the designated aircraft deviates significantly from its approach path to infringe the Non-Transgression Zone, there is no alert in the ownship. So, the situation can be managed:

- By the controller who calls A/C2 to inform him to resume guidance along the approach path,
    - if not possible, ATC can ask A/C 2 to go-around.
- By the crew who monitors the situation visually and can assess if a corrective action is needed e.g. like calling ATC if time permits or perform a go-around.

Conflict with a 3rd aircraft.

The following Figure 8 illustrates the case where:

- A 3rd aircraft (A/C 3) generates a conflict with aircraft on approach (ownship A/C 1 and DNA-designated A/C2). This may cause the DNA mode to be de-activated and TA or RA can be triggered between A/C1 and 2 and 3rd A/C.

➔ In any case, the ownship (A/C 1) crew has to follow the RA order.

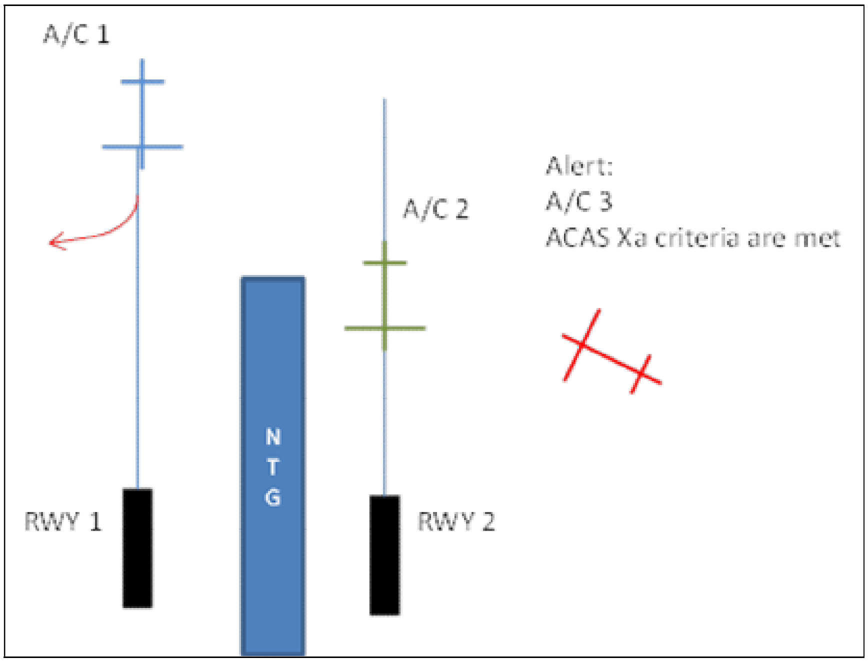


Figure 11 : Alert caused by a 3rd intruder

3.3.3 Differences between new and previous Operating Methods

At this initial stage, the table describes differences with regard to already existing activities on EATMA portal. For the next revisions, it is expected that new activities related to ACAS Xo operations and their description, will be defined.

Activities (in EATMA) that are impacted by the SESAR Solution	Current Operating Method	New Operating Method
Avoid Collision in the Air (Step 1) – Manage mid-air collision alert	Appropriate characteristics of each intruder are assessed to determine whether or not it is a threat. If it is actually a threat a RA is generated.	Appropriate characteristics of each intruder are assessed to determine whether or not it is a threat. If it is actually a threat a RA is generated. **If ACAS X with Xo feature is in use, ACAS will apply alternative logic for designated aircraft**

		which will either: - **Provide TAs and RAs based on logic modified for closely spaced parallel runway operations down to 3,000ft runway separation;** - **or supress both TA and RA against designated traffic;**

Table 5: Difference between new and previous Operating Method – According to EATMA

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

This section will be completed for final SPR-INTEROP/OSED document with planned delivery in 2018.

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] B4.2 D106 Transition Concept of Operations SESAR 2020

System and Service Development

[5] 08.01.01 D52: SWIM Foundation v2

[6] 08.01.01 D49: SWIM Compliance Criteria

[7] 08.01.03 D47: AIRM v4.1.0

[8] 08.03.10 D45: ISRM Foundation v00.08.00

[9] B.04.03 D102 SESAR Working Method on Services

[10] B.04.03 D128 ADD SESAR1

[11] B.04.05 Common Service Foundation Method

Performance Management

[12] B.04.01 D108 SESAR 2020 Transition Performance Framework

[13] B.04.01 D42 SESAR2020 Transition Validation

[14] B.05 D86 Guidance on KPIs and Data Collection support to SESAR 2020 transition.

[15] 16.06.06-D68 Part 1 –SESAR Cost Benefit Analysis – Integrated Model

[16] 16.06.06-D51-SESAR_1 Business Case Consolidated_Deliverable-00.01.00 and CBA

[17] Method to assess cost of European ATM improvements and technologies, EUROCONTROL (2014)

[18] ATM Cost Breakdown Structure_ed02_2014

[19] Standard Inputs for EUROCONTROL Cost Benefit Analyses

[20] 16.06.06_D26-08 ATM CBA Quality Checklist

[21] 16.06.06_D26_04_Guidelines_for_Producing_Benefit_and_Impact_Mechanisms

Validation

[22] 03.00 D16 WP3 Engineering methodology

[23] Transition VALS SESAR 2020 - Consolidated deliverable with contribution from Operational Federating Projects

[24] European Operational Concept Validation Methodology (E-OCVM) - 3.0 [February 2010]

System Engineering

[25] SESAR Requirements and V&V guidelines

Safety

[26] SESAR, Safety Reference Material, Edition 4.0, April 2016

[27] SESAR, Guidance to Apply the Safety Reference Material, Edition 3.0, April 2016

[28] SESAR, Final Guidance Material to Execute Proof of Concept, Ed00.04.00, August 2015

[29] SESAR, Resilience Engineering Guidance, May 2016

Human Performance

[30] 16.06.05 D 27 HP Reference Material D27

[31] 16.04.02 D04 e-HP Repository - Release note

Environment Assessment

[32] SESAR, Environment Reference Material, alias, “Environmental impact assessment as part of the global SESAR validation”, Project 16.06.03, Deliverable D26, 2014.

[33] ICAO CAEP – “Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes” document, Doc 10031.

Security

[34] 16.06.02 D103 SESAR Security Ref Material Level

[35] 16.06.02 D137 Minimum Set of Security Controls (MSSCs).

[36] 16.06.02 D131 Security Database Application (CTRL_S)

5.2 Reference Documents

[37] ED-78A GUIDELINES FOR APPROVAL OF THE PROVISION AND USE OF AIR TRAFFIC SERVICES SUPPORTED BY DATA COMMUNICATIONS.[3]

[38] J.K.Kuchar, A.C.Drumm, The Traffic Alert and Collision Avoidance System, Lincoln Laboratory Journal, Volume 16, Number 2, 2007

[39] Advisory Circular no. 120-55C CHG1, Air Carrier Operational Approval and Use of TCAS II, U.S. Department of Transportation, Federal Aviation Administration, 03/08/2013

[40] Concept of Use for the Airborne Collision Avoidance System Xo, Version 2, Revision 0, February 12, 2015, FAA

[41] Order JO 7110.308B, Effective Date: July 25, 2017, U.S. Department of Transportation, Federal Aviation Administration, Air Traffic Organization Policy

[42] ICAO PANS-OPS DOC8168, “AIRCRAFT OPERATIONS Volume I”, Flight Procedures, Fifth Edition November 2006 plus Amendment 3.

[43] ICAO PANS-ATM DOC4444, “Procedures for Air Navigation Services”, Fifteenth Edition, 2007, ATM/501

[44] MITRE, Evaluation of Pilot and Air Traffic Controller Use of Third Party Call Sign in Voice Communications with Pilot Utilization of Cockpit Display of Traffic Information, July 2013

3

Appendix A Cost and Benefit Mechanisms

A.1 Stakeholders identification and Expectations

Stakeholder	Involvement	Why it matters to stakeholder
ANSP (Air Traffic Controllers)	Indirect	Synchronisation between on-board ACAS Xo selection and on ground ATC awareness. Reduction of Go-arounds at low altitude. Reduction of RA investigations due to unnecessary alerts. ACAS Xo may be subject of Third Party Call Signs (TPCS).
Scheduled Airlines (Mainline and Regional) / AU (Airlines, Pilots)	Direct	Significant reduction of TCAS nuisance alerts for specific operations (CSPO-3000 and DNA) Cost Reduction (Reduction of Go-arounds) Safety gain Modification of the HMI and addition to specific control for ACAS Xo mode selection Additional movements at congested airports
Military – Airborne	Indirect	Same impact as for civil Investments similar to other airspace users
Airports	Indirect	Additional movements in congested airports through enabling of parallel operations
Other impacted stakeholders (ground handling, weather forecast service provider, NSA….) (Training centre)	Indirect	Training on new feature of anti-collision system. Modification of the HMI and addition to specific control for ACAS Xo mode selection.

Table 6: Stakeholder's expectations

A.2 Benefits mechanisms

PJ.11-A3 does not have Validation Targets defined. Initial draft of BIM presented in this section was developed according to SESAR Guidelines and might be subject to modifications in further revisions of OSED.

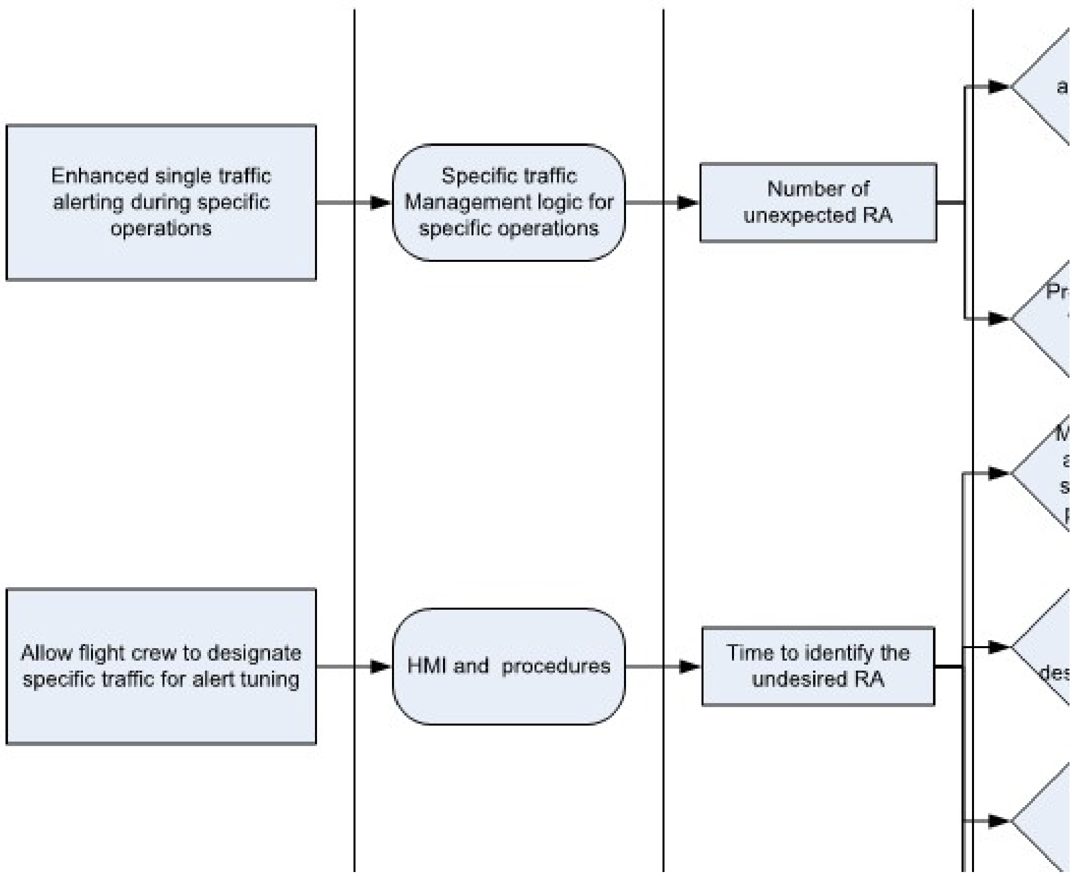


Figure 12: BIM Diagram

*This BIM will be updated in final OSED based on feedback from EUROCONTROL CBA experts.

A.3 Costs mechanisms

These subsections are to be completed for final V2 OSED.