VERY LARGE-SCALE DEMONSTRATION

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SESAR DEMO STAIRS Report - Part I

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STAIRS

SESAR VLD2 STAIRS

This DEMO report is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 874476 under European Union's Horizon 2020 research and innovation programme.

Abstract

This document is the demonstration report for SESAR VLD2 STAIRS project, the very large-scale demonstration (TRL7) of the SESAR2020 solution PJ03b-05 "Traffic alerts for pilots for airport operations" and is building on results of the SESAR PJ28 project. The Very Large Demonstration (VLD) report includes strategy with three main work packages WP2 (Interoperability), WP3 EXE-VLD02-001 (EXE-H) business aircraft and WP4 EXE-VLD02-002 (EXE-T) for mainline aircraft. Mainline and business aircraft demonstrations were supposed to be executed on international airports and in-service data replay aligned with interoperability aspects and data analysis. This VLD2 STAIRS project involved all relevant stakeholders for successful demonstration and execution including aircraft manufacturer, avionics suppliers of the SESAR PJ03B-05 solution and regional ANSPs. The main objectives of the VLD2 demonstration focus on safety KPA with system performance, ADS-B qualitative assessment and Interoperability assessment.

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1 Executive summary

This document is the demonstration report for the Very Large-scale Demonstration project SESAR VLD2 STAIRS (SESAR-IR-VLD-WAVE2-15-2019).

The demonstration focuses on the SESAR2020 solution PJ03b-05 “Traffic alerts for pilots for airport operations” SURF-A and -ITA as an onboard safety solution for pilots developed within the SESAR Airport Safety Net technology. It aims at triggering cockpit alerts to inform the flight crew of a risk of collision with traffic equipped with ADS-B OUT transmitter. Following an alert, the flight crew is prepared to possibly undertake any action required to resolve the risk of collision during runway operations.

The main goals of the program were to demonstrate 4 high level objectives OB1 through OB4 including controlled entry into service with required system performance supported by in-service data fed fast time simulations, addressing qualitative assessments of ADS-B and interoperability with the existing ATC infrastructure.

Under exercise EXE-H (work package 3) of STAIRS, deployment readiness of the SURF-ITA solution was expected to be demonstrated with an identification of anticipated technical, certification, operational and business risks. The project was expected to demonstrate that the system reaches its expected performance objectives.

Due to various industrial and contractual delays, the SURF-ITA final demonstration (EXE-H) campaign could not happen within the STAIRS timeline, but project members still plan to pursue with demonstration out of the SESAR program scope in 2023. Although materialized risk established in the beginning of the project, there is no change of the deployment strategy for this technology on future European and global business aircraft with expected EIS around 2026.

The activities performed under exercise EXE-T concerning SURF-A solution (Work Package 4are a significant input to consider the function as ready to be deployed and certified, however due to several delay factors, some of the initially planned activities will be continued beyond the SESAR STAIRS project thus their results aren’t included within the final DEMO Report.

Partners plan to bring relevant STAIRS outcomes in standardization working groups.

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2 Introduction

2.1 Purpose of the document

This document provides a demonstration report for the SESAR VLD2 STAIRS project including objectives, scope, management, demonstration exercises, communication and dissemination of the demonstrated SESAR PJ03B-05 technology.

2.2 Scope

This section provides a description of the scope of the document with demonstration exercises and results. The VLD2 STAIRS covers demo of two implementation options following from SESAR solution PJ03B-05 in Wave 1:

- Mainline aircraft: Surface Traffic Alert on the runway (SURF-A)
- Business aircraft: Surface Traffic Indication and Alert on the runway (SURF-ITA)

The SURF-A provides audio alerts and textual amber/red alerts on the Primary Flight Display (PFD). In addition, SURF-ITA provides an airport moving map (AMM) with Cockpit Display Traffic Information (CDTI) and colored indications of traffic runway occupancy.

Based on the type of alert, flight crews were expected to conduct dedicated actions like go-around or abort take-off as relevant to the situation.

The proposed demonstration approach was aligned with DEMO plan with agreed changes in reference to Impact Document (see chapter 3.4 Deviations) and exercised the system performance with in-service data evaluation, experimental stress-test flights, and assessed the maturity of both concepts.

The project comprises two parallel sequential demonstration threads of two exercises (EXE-H and EXE-T) and 4 project objectives (OB1-4) under 4 work packages (see Figure 1):

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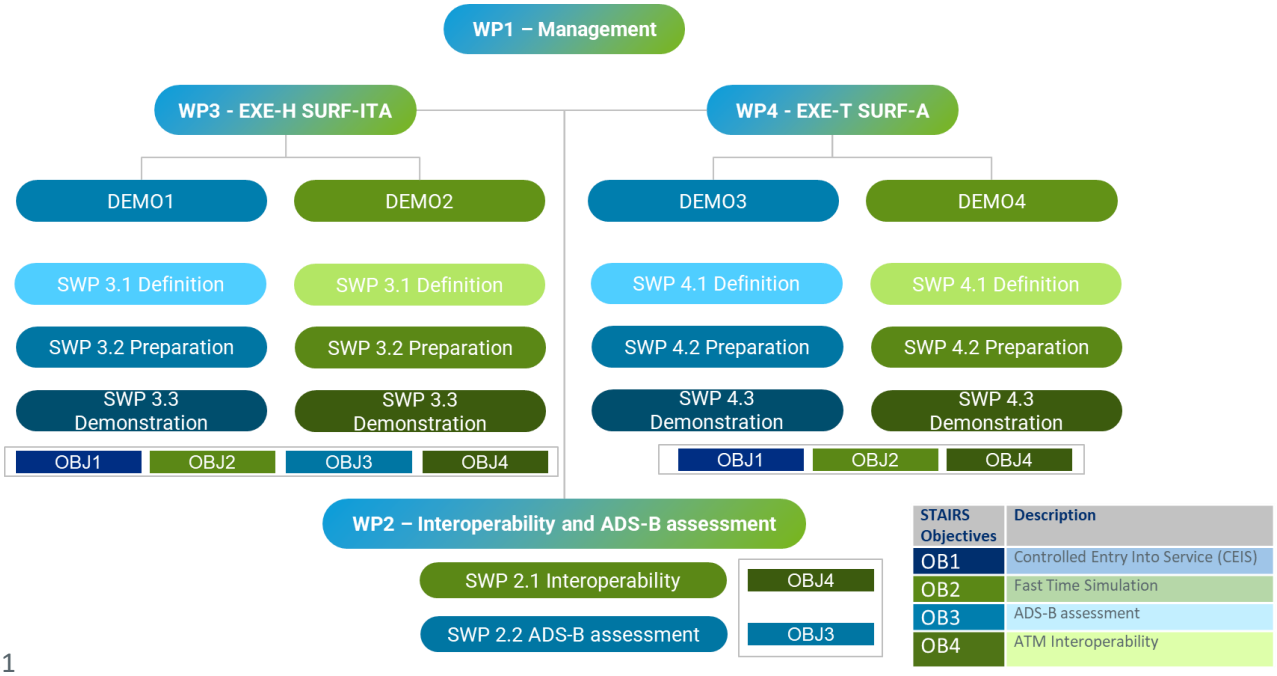

Figure 1: STAIRS program scope

- WP2 Interoperability
  - ATCo/ Pilots workshops – completed
  - Collected/In-service data results assessment - completed
  - ATC operational assessment - completed

- WP3 SURF-ITA
  - DEMO 1 – HW bench test
    - Definition - completed
    - Preparation - completed
    - Demonstration - completed
  - DEMO 2
    - Definition - completed
    - Preparation – Dassault F900EX flight trial - completed
    - Demonstration – Impacted – experimental demo flights postponed beyond SESAR program and complemented by massive ADS-B In-service data evaluation from the biggest airports with new ADS-B filter assessment & testing

- WP4 SURF-A
  - DEMO 3
    - Definition - completed
    - Preparation – completed
      - Airport analysis, system test definition – completed
      - Execution of engineering system lab tests in Thales/ACSS engineering lab – completed

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- Preparation of system intended functional lab tests in Airbus engineering lab – completed
- Preparation of simulator tests in Airbus engineering lab – completed
- Preparation of Airbus Certification Flight Test – completed

▪ Demonstration – impacted
- Thales/ACSS demonstration on HW test bench completed
- Execution of system intended functional lab tests in Airbus engineering lab – partially completed with intermediate version of the SURF-A SW
- Execution of simulator tests in Airbus engineering lab – Not completed
- Execution of Airbus Certification Flight Test – not completed

○ DEMO 4
▪ Definition – completed
▪ Preparation - completed
- Analysis and generate a report with FAA data – completed
- Develop a procedure for recording and analysing the flight data relevant for SURF-A using Data Collection functionality of the system - Completed with modifications

▪ Demonstration – partially completed
- Execute several flights with Airbus experimental fleet - Completed
- Execute flights with airline fleet equipped with SURF-A - not completed
- Analyse and Generate Data Analysis Reports for SURF-A event data
  - Airbus experimental fleet - analyse completed
  - Airline fleet - not completed

At this phase the algorithm does not take into account vehicles and helicopters which limited the scope of interoperability for VLD2 WP2 activities.
Interoperability scope of both systems with ATC from operational and design aspects was part of Work Package 2.

2.3 Background

This SESAR 2020 VLD2 STAIRS project is the continuation of SESAR 2020 PJ03B-05 and SESAR PJ28 VLD-WP3 projects, with a focus on Very Large Demonstration with final maturity phase TRL7.

Previous SESAR PJ28 VLD-WP3 provided ADS-B collected data by airlines on a few thousands of flights and analyses to support confidence during initial algorithms development. This activity proved required design system performance on existing airport ADS-B environment to continue with the SESAR VLD2 STAIRS project.

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Within this VLD2 STAIRS demonstration has been used significant data sample of in-service ADS-B data with millions of operations, collected 7 years during system evolution including billions of ADS-B messages from the biggest airports and using final real HW for system testing. Results from this activity brought additional confidence for certification activities and system demonstration in the most stressful environment before deployment.

Due to project impact and changes on the schedule, there were postponed final demonstration flights and their execution beyond the SESAR program. That delay and change does not impact the effort of deployment with final entry into service of the technical solution supporting a future Airport Safety Net within Europe.

Initially planned within the DEMO Plan, Very Large Demonstration (postponed beyond the Project timeframe) was meant to be considered as a final confirmation of the system maturity and not as a main contributor - 50 000 flights can't be considered as a significant amount to prove performance objectives of 10^-5. The main contributor - analysis of the large amount of real in-service ADS-B OUT data and synthetic data with both SURF-A and SURF-IA algorithm allows to consider the functions as meeting performance criteria and thus mature.

The consortium members were represented by key European players from the aviation industry with synergy orchestration between aircraft manufacturer (AIRBUS), two avionics safety system providers (Honeywell and THALES Avionics) with two different approaches, system diversity and coverage area, ANSPs DSNA, PANSA (B4) providing operational expertise in the ATM environment and technical expertise for ground-based surveillance data, and EUROCONTROL supporting ADS-B data performance analysis and certification/standardization activities.

2.4 Structure of the document

This section describes the document structure and a brief description of the content of main chapters:

- Chapter 2 - Introduction of the document
- Chapter 3 – Describes the VLD2 scope
- Chapter 4 - Describes the DEMO results
- Chapter 5 – Provides conclusion and recommendation
- Chapter 6 – Provides summary of communication and dissemination activities
- Chapter 7 - References
- Appendix A – provides details of Honeywell exercise EXE-VLD-02-001
- Appendix B – provides details of Thales exercise EXE-VLD-02-002
- Appendix C – Safety part II summary
- Appendix D – HPAR part III summary

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286 Appendix E – ENV part IV summary

287 Appendix F – PAR part V summary

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289 2.5 Glossary of terms

Term	Definition	Source of the definition
AIR-REPORT	A report from an aircraft in flight prepared in conformity with requirements for position, and operational and/or meteorological reporting.	ICAO Annex
Advisory	Alert level 1 that requires crew awareness and potential subsequent crew action as defined per DO323 D-4.	AC25.1322 CS25.1322
Alerts	A signal to the crew intended to draw their attention to the existence of an abnormality, system fault or aircraft condition and to identify it.	
Alert levels Advisory/Caution/Warning	Copy here the three definitions	AC25.1322 CS25.1322
Alerts missed/nuisance/false	• **Missed alert**: a missed alert is an alert that is not raised when it should. • **False alert**: a false alert is an alert raised when there is no reason (no threat in the case of Surface alerts) but alerts are not supposed to be inhibited. False alert is caused by a failure of the alerting system, including sensor. • **Nuisance alert**: a nuisance alert is an alert that is raised in the presence of a danger but at a time when it should be inhibited. • **Undue alert:** the sum of False & Nuisance alerts.	AMJ.25-1322: [Nuisance warnings] are warnings generated by a system which is functioning as designed but which are inappropriate or unnecessary for the particular phase of operation.
ATSA-SURF	Airborne Traffic Situational Awareness (ATSA) for Surface (SURF) Operations	RTCA

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Caution	Alert level 2 that requires crew awareness and potential subsequent crew action. Used in Optional version (RTCA DO-323).	AC25.1322 CS25.1322
Collision	A contact between an aircraft and another aircraft/vehicle.	DO-323
Detection rate	Rate of available ADS-B out messages from traffic	
Flight crew	An aircraft cockpit crew including pilot in command and pilot monitoring	
Indication	Indications identify to the flight crew a normal condition that could become a runway safety hazard.	DO-323
Key Performance Area	Key Performance Areas are a way of categorising performance subjects related to high level ambitions and expectations. ICAO Global ATM Concept sets out these expectations in general terms for each of the 11 ICAO defined KPAs: Environment, Capacity, Predictability, Punctuality, Cost Effectiveness, Civil-Military Cooperation and Coordination, Flexibility, Resilience, Interoperability, Access and Equity, Participation	ICAO Doc 9883
Mobile	An aircraft or a ground vehicle.	
Ownship	Own aircraft with SURF-A/ SURF-ITA installed	
Pilot	Pilot in command - a person who controls the flight of an aircraft.	
Risk of collision	A condition that can lead, considering the uncertainty of traffic behaviour, to a collision if no avoidance action is taken.	DO-323
Runway Status Light	Runway Status Light is a surveillance driven system that manages automatically dedicated airfield lights set to indicate to Flight Crews and Vehicle Drivers when it is unsafe to enter, use or cross a runway. Those new airfield lights can be composed of Runway Entrance Lights (REL), Take-off Hold Lights (THL) and Runway Intersection Lights (RIL).	*SESAR 1*

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SURF IA	Enhanced Traffic Situational Awareness on the Airport Surface with Indications and Alerts. SURF IA is the RTCA application DO-323	
SURF-A	Surface Traffic Alerts on runways for pilots without traffic display (CDTI) (Warning alerts on ground with optional Caution/advisory)	
SURF-ITA	Surface Traffic Alerts & Indication for pilots with optional display (CDTI) (Advisory/Caution and Warning alerts)	
SURF-ITA+	Surface Traffic Indication & Alerts on runways and taxiways for pilots including both applications SURF-ITA and TWY-ITA.	
Traffic Indication (TI)	Traffic indications are provided if there could be a collision hazard in the immediate future.	RTCA DO-323
Traffic	At this step of the development of the Airport Surface Alerts function, "traffic" is used in this document only for aircraft other than ownship. It also includes RPAS equipped with ADS-B. It does not include helicopters or ground vehicles.	
UI rate	Update Interval rate	
Warning	Alert level 3 - Immediate recognition and corrective or compensatory action by the crew is required	AC25.1322 CS25.1322

290 **Table 2-1: Glossary of terms**

291 2.6 List of Acronyms

Acronym	Definition
A/C	Aircraft
ADS-B	Automatic Dependent Surveillance – Broadcast
ADS-R	Automatic Dependent Surveillance – Rebroadcast
A-SMGCS	Advanced Surface Movement Guidance and Control System
ATC	Air Traffic Control
ATM	Air Traffic Management

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ATSA-SURF	Enhanced Traffic Situational Awareness on the Airport Surface
CDTI	Cockpit Display of Traffic Information
CEIS	Controlled Entry Into Service
CNS	Communication Navigation and Surveillance
CONOPS	Concept of Operations
DEMOP	Demonstration Plan
DEMOR	Demonstration Report
EATMA	European ATM Architecture
EIS	Entry Into Service
FTS	Fast Time Simulation
HMI	Human Machine Interface
HPAR	Human Performance Assessment Report
HUCL	High Utilisation airports Complex Layout
HUSL	High Utilisation airports Simple Layout
ICAO	International Civil Aviation Organization
INTEROP	Interoperability Requirements
IPR	Intellectual Property Rights
KPA	Key Performance Area
LAHSO	Land And Hold Short Operations
LVP	Low-Visibility Procedures
LUCL	Low Utilisation Complex Layout
LUSL	Low Utilisation Simple Layout
OCD	Operational Concept Description
OI	Operational Improvement
OR	Operational Requirements
OSED	Operational Service and Environment Definition
OSR	Operational Service Requirement
PAR	Performance Assessment Report
RAZ	Runway Alerting Zone
REL	Runway Entrance Lights
RPAS	Remotely Piloted Aircraft System
RTO	Rejected Take-Off

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RTCA	Radio Technical Commission for Aeronautics
RWSL	Runway Status Lights
RWY	Runway
SAC	Safety Criteria
SAR	Safety Assessment Report
SESAR	Single European Sky ATM Research Programme
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
SJU	SESAR Joint Undertaking
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SMGCS	Surface Movement Guidance and Control Systems
SOP	Standard Operating Procedures
SPR	Safety and Performance Requirements
T3CAS	TCAS by ACSS supplier
TCAS	Traffic alert and Collision Avoidance System
THL	Take-off Holding Lights
TI	Traffic Indication
TIS-B	Traffic Information Services - Broadcast
TS	Technical Specification
TWY	Taxiway
UI	Update Interval
V&V	Validation & Verification

292 **Table 2-2: List of acronyms**

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3 Very Large Demonstration (VLD) Scope

The proposed demonstration with the identified SESAR solution PJ03B-05 (AUO-0605 - Runway part) addresses the full scope of the SESAR 2020 IR-VLD WAVE 2.

This Wave 2 VLD2 demonstration addresses the call for proposal referenced H2020-SESAR-2019-1 (SESAR 2020 IR-VLD WAVE 2) as defined in the multi-annual programme of the SESAR JU Single Programming Document 2019-2021.

This solution contributes to one of the key SESAR areas “High-performing airport operations” aiming at significantly reducing risk of collision and incursion on airport surface with other ADS-B traffic by providing indication and/or alerts to pilots.

3.1 Very Large Demonstration Purpose

Airport surface safety with high energy collision on the runway and runway incursions is an important concern identified by aviation authorities worldwide. Despite the introduction of ground surveillance systems (e.g., A-SMGCS) or ground safety nets (e.g., RWSL), the rate of runway incursion remains steady over the last decades. Runway incursions still endanger lives and incur high costs every year for the aviation industry. SESAR 2020 studies showed that most runway incursions could have been prevented. Lives could have been saved, aircraft damages and closed runways avoided. The solution lies in SESAR technologies that have now reached maturity level V3 and require demonstration and validation in a sizeable VLD.

The SESAR 2020 PJ03B-05 (AUO-0605 Traffic Alerts for Pilots during Runway Operations) Solution developed under SESAR 2020 addresses these airport safety concerns. The Accident Incident Model (AIM) in that project focused on pilots as the most critical and the last safety barrier before the accident.

PJ03B-05 aircraft prototypes have already been validated and verified. This was done through several test campaigns on Airbus and Honeywell test benches, in France and Czech Republic, involving also Dassault-Aviation, Airspace Users and EUROCONTROL. The validation tests included real time simulations, fast-time simulations and flight tests. In addition, interoperability workshops were conducted within PJ03B SAFE project, involving airspace users, and ATCos; no showstopper or no additional phraseology requirement to deploy SURF-A was identified so far.

However, before proceeding to full deployment of SURF-A/ITA technology on European fleets, it is necessary to obtain further confidence in the technology. Implementation of safety functions always represents a risk. In the case of SURF-A/ITA, nuisance alerts could result in rejected take-off and go-arounds. In the frame of SESAR Project PJ03B and PJ28, the project teams have acquired a good level of confidence that those risks are limited. However, without the complete certainty one can bring through such large-scale demonstrations, many airlines would still be reluctant to take the operational and business risk of deploying such a technology. In the long run, the deployment of such technology will also help maintain high safety standards at European airport despite the predicted traffic increase.

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3.2 SESAR Solution(s) addressed by VLD

SESAR Solution ID and Title	SESAR Solution Description	OI Steps ref. (coming from the EATMA)	Enablers ref. (coming from EATMA)
SESAR PJ03B-05 SURF-A	Traffic Alerts for Pilots during Runway Operations, no CDTI display (Mainline)	AUO-0605: Traffic Alerts for Pilots during Runway Operations	A/C-43a1 A/C-48a A/C-67 REG-0200
SESAR PJ03B-05 SURF-ITA	Traffic Alerts for Pilots during Runway Operations, with CDTI display (Business aircraft)	AUO-0605: Traffic Alerts for Pilots during Runway Operations	A/C-43a1 A/C-48a A/C-67 A/C-24 A/C-25 REG-0200

Table 3-1: SESAR Solution(s) under Demonstration

Note:

A/C-43a1	Traffic Alerts for Pilots during Runway Operations
A/C-48a	Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B
A/C-67	ADS-B IN
A/C-24	Airport moving map and own aircraft position display in cockpit (for SURF-ITA)
A/C-25	Airborne Traffic Situational Awareness to support surface operations (ATSA-SURF), including reception (ADS-B in), processing and display (for SURF-ITA)
REG-0200	Safety Targets in Relation to Reductions of Runway Incursions

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

Not applicable.

3.3 Summary of Demonstration Plan

3.3.1 Demonstration Plan Purpose

The purpose of the demonstration plan is to define a plan for the SESAR VLD2 STAIRS project demonstration activities including objectives, scope, management, demonstration exercises, communication and dissemination of demonstrated SESAR PJ03B-05 technology.

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3.3.2 Operating method description

The methodology used for the demonstration activities covered the demonstration lifecycle process for the solution and each function. Fully integrated operational target platforms and software prototypes beyond V3/TRL6 maturity level were used. Implementation of prototypes and platforms has been done in reference to prevailing standards reflecting SESAR 2020 validation data package and compliant with certification authority processes, approvals, and inputs for future standardisation activities.

This project aimed to demonstrate the operational and technical scope of demonstration exercises and objectives within two phases DEMO1&3 and DEMO2&4 under work packages WP3 and WP4, complemented by interoperability exercise under work package WP2.

3.3.2.1 DEMONSTRATION EXERCISES

Two solution implementations with two exercises have been held in VLD2: EXE-VLD-02-001 (EXE-H) & EXE-VLD-02-002 (EXE-T).

SURF-A (EXE-T) (WP4)

The activities in frame of WP4/EXE-T (system testing, evaluations, flights, shadow mode certification, installation on airline fleet) are directly dependent on availability of the final version of SURF-A function to Airbus.

Due to COVID crisis and components shortage, resources had to be allocated to most critical topics, significantly delaying development of SURF-A function in ACSS equipment. The final version of the function is still expected to be delivered to Airbus thus some of the initially planned activities are not performed within the project timeframe (see chapter 3.4 Deviations).

Intermediate SURF-A version delivery, assuming same main capabilities but different performance, was delivered, allowing to perform DEMO Plan activities to the furthest extent possible. The rest of the activities will be performed beyond the project time frame and is not included in this DEMO Report.

EXE-T was split into DEMO3 and DEMO4, each with preparation and demonstration phase. The Figure below shows split, which activities were performed (marked with green checkmark) or partially performed (marked with amber P symbol). For more details, see Appendix B.

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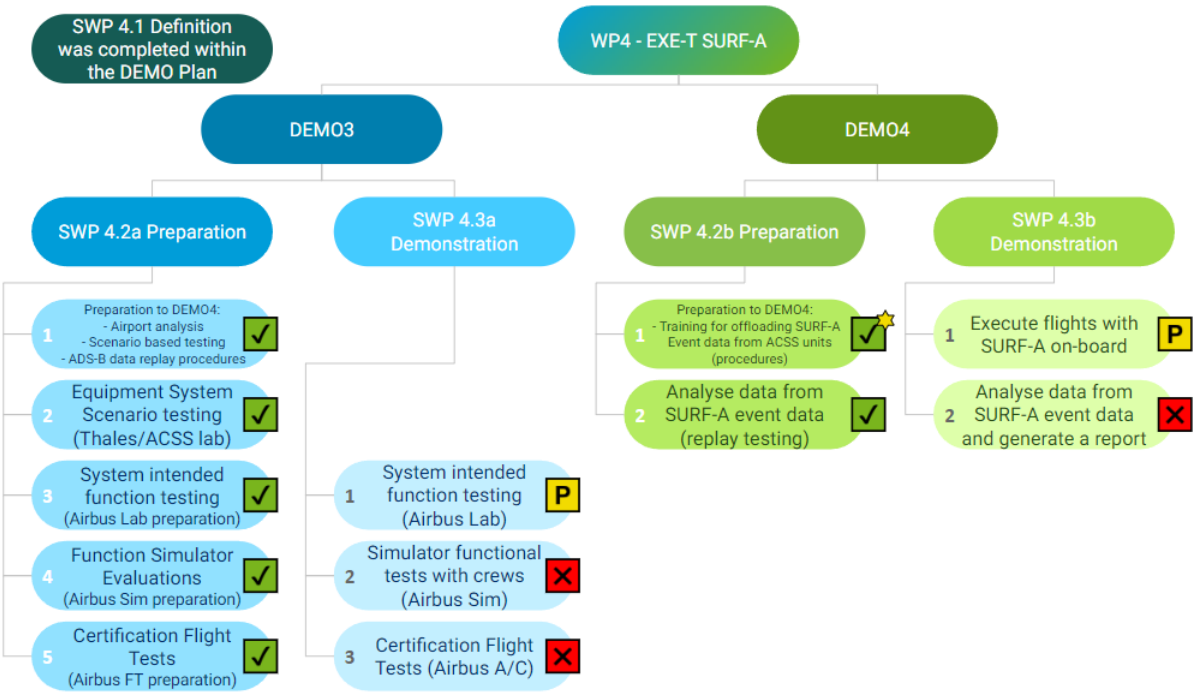

Figure 2: EXE-T/WP4 activities breakdown

SURF-ITA (EXE-H) (WP3)

Based on agreed changes, DEMO2 final demonstration flights have been postponed beyond the SESAR schedule and will not be executed within SESAR STAIRS program and DEMO report. This activity was replaced by demo of significant sample of in-service ADS-B data with newly designed ADS-B filter technology and flight trial with synced cockpit applications. SURF-ITA has been prepared for DEMO2 implementation on business jet aircraft with a full-deployed mode within DEMO1 and WP3.3 and tested with other cockpit surveillance functions to reach demo objectives of business aircraft cockpit pilots' applications alignment on aircraft level.

Below figure provides the exercise (EXE-H) scope with change impacts to the overall DEMO plan. Activities under DEMO2 SWP3.2 (Demonstration) to be done out of the scope of STAIRS program, therefore they are partial compliant or not executed.

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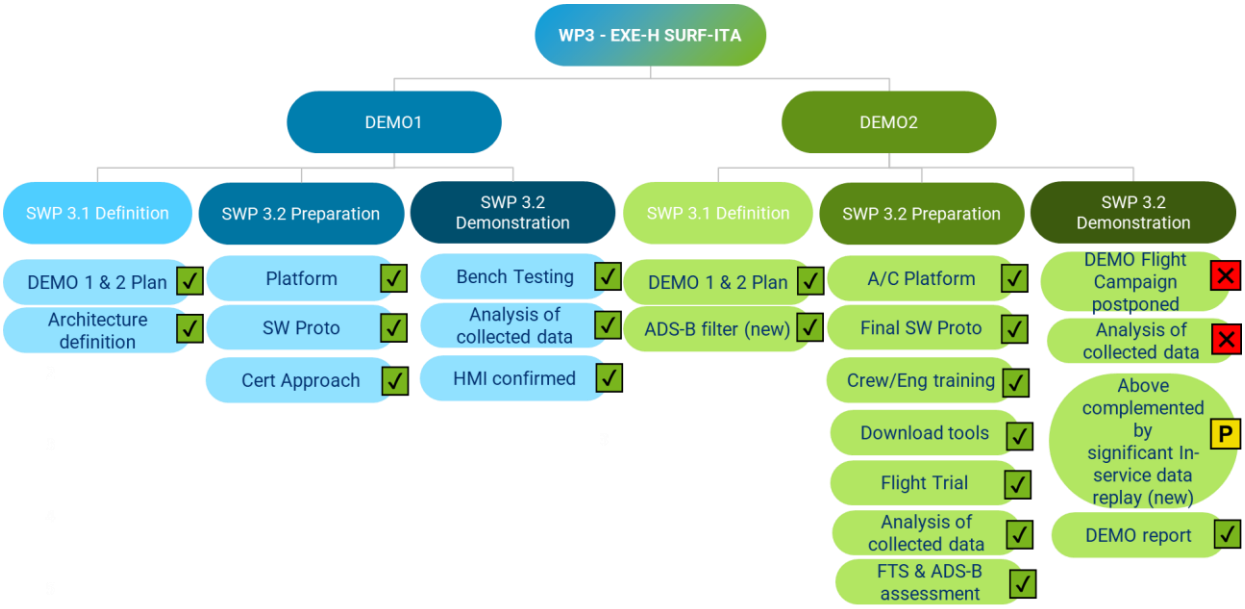

Figure 3: Exercise EXE-H/WP3 activities breakdown

Interoperability review (WP2)

During all phases the WP2 supported the above exercises (EXE-H and EXE-T) with SWPs 2.1 ATC operational expertise of relevant alerting cases and SWP2.2 ADS-B assessment supporting analysis of the real airport environment with collected DSNA/PANSA data.

3.3.2.2 OPERATING ENVIRONMENT

A) Work Package 3
   a. DEMO2 In-service data replay (WP3) - HUCL (High Utilisation airports) - US region 9 biggest airports – heavy traffic and runways complexity
   b. DEMO2 Flight trial preparation (WP3) – LUSL/LUCL (Low Utilisation airport, Low and Complex layouts), US region

B) Work Package 4
   a. DEMO4 In-service data replay (WP4) - HUCL (High Utilisation airports) - US region 9 biggest airports – heavy traffic and runways complexity
   b. DEMO4 experimental exposure flight tests (WP4) – LUSL, France region
      Note that these experimental flight tests are replacing VLD which would expose the function to all 4 categories of airports.

Airport Layout characteristics

The classes identified in the European ATM Master Plan are reported in the following table:

Layout Characteristics	• LUSL: Low Utilisation (<90% utilisation during 1 or 2 peak periods a day) Simple Layout.

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	• LUCL: Low Utilisation (<90% utilisation during 1 or 2 peak periods a day) Complex Layout • HUSL: High Utilisation airports (>90% utilisation during 3 or more peak periods a day) Simple Layout • HUCL: High Utilisation airports (>90% utilisation during 3 or more peak periods a day) Complex Layout

Table 3-2: Airport layout characteristics

SURF-A/ITA system can be used in each of these airport layouts, but the system is expected to bring maximum benefits in major airports with complex surface layout which are more demanding to be monitored by ATCo.

3.3.3 Summary of Demonstration Objectives and success criteria

The STAIRS project (Surface Traffic Alerts Improve Runway Safety) SESAR-IR-VLD-WAVE2-15-2019 aimed to demonstrate SESAR solution PJ03B-05 “Traffic alerts for pilots for airport operations” in the Airport Safety Net domain.

There are 4 high level objectives defined in the demonstration plan to successfully demonstrate the solution and reach the system to TRL7 level of maturity assessment.

STAIRS Objectives	Description	STAIRS KPI	Success criteria
OB1	**Controlled Entry Into Service (CEIS)**	(Safety, Human Performance) Operational: Nuisance, false, missed alerts rate and human performance	Acceptable alert rates, System and HMI acceptance
OB2	**Data replay in fast time**	(Safety) Fast time simulations, replay: Nuisance, false alerts, certification	Acceptable alert rates, System acceptance
OB3	**ADS-B quality assessment**	(Interoperability): transverse analysis of ADS-B performance acceptability	Traffic detection rate of at least 70% Navigation parameters accuracy (position, speed, heading)
OB4	**Interoperability review**	(Interoperability): ANSP operational expertise	Compatibility with ground safety net, alert timing, ATC procedures

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			and phraseology

Table 3-3: STAIRS high level objectives

Below is provided demonstration exercise objectives following from 4 main high-level objectives groups.

Demonstration Objective	Demonstration Success criteria	Coverage and comments on the coverage of Demonstration objectives	Demonstration Exercise 1 Objectives	Demonstration Exercise 1 Success criteria
OBJ-VLD-02-001	CRT-VLD-02-001-01	OB1 System performance	CEIS	Acceptable nuisance alerts rate
	CRT-VLD-02-001-02			Acceptable false alerts rate
	CRT-VLD-02-001-03			Acceptable detection rate
OBJ-VLD-02-002	CRT-VLD-02-002-01	AU feedback DEMO1 and DEMO2		Crew system acceptance during DEMO2 phases
	CRT-VLD-02-002-02			Crew system acceptance during DEMO1 phases
OBJ-VLD-02-003	CRT-VLD-02-003-01	OB2 Fast Time simulation	System performance with simulated and real ADS-B data	Nuisance alert rate
	CRT-VLD-02-003-02			False alert rate
	CRT-VLD-02-003-03			Detection rate
OBJ-VLD-02-004	CRT-VLD-02-004-01	OB3 ADS-B IN	ADS-B IN quality assessment	Quality assessment
	CRT-VLD-02-004-02			Rate of eligible DO-260B
	CRT-VLD-02-004-03			Accuracy assessment
OBJ-VLD-02-005	CRT-VLD-02-005-01		ADS-B IN detection assessment	UI rate
	CRT-VLD-02-005-02			Gap analysis

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OBJ-VLD-02-006	CRT-VLD-02-006-01	OB4 Interoperability	Compatibility	ATCO workload
	CRT-VLD-02-006-02			Compatibility with ATCo formation
	CRT-VLD-02-006-03			No info of equipped A/C presence for ATCo
OBJ-VLD-02-007	CRT-VLD-02-007-01		Reporting	Crew action for non-reported alerts
	CRT-VLD-02-007-02			Reports are well understood by ATCo
	CRT-VLD-02-007-03			No need for additional info when reported alert by crew to ATCo
OBJ-VDL-02-008	CRT-VLD-02-008-01		Phraseology	Conflict resolution using current phraseology
	CRT-VLD-02-008-02			Frequency occupation remains acceptable
OBJ-VLD-02-009	CRT-VLD-02-009-01		Safety Improvement	Additional barrier to ATC safety net
	CRT-VLD-02-009-02			Triggering criteria well understood by crew

Table 3-4: Demonstration exercise objectives

3.3.4 Demonstration Assumptions

Below table provides demonstration assumptions for all exercises.

Identifier	Title	Type of Assumption	Description	Justification	Impact on Assessment
ASS-VLD-02-001	Maturity	Technology	VLD expects demonstration of V3 mature Solution PJ03B-05.	Objective of this VLD is to de-risk future deployment of mature solutions.	High

ASS-VLD-02-002	AU users participation	AU	Trained AU users participate in the project	AU users play key role in the demo, training of the crew is necessary	High
ASS-VLD-02-003	SURF-A/ITA performance	Performance	No/minimum alerts during regular operations	Alert timing below ATC procedures and separation	High
ASS-VLD-02-004	Silent mode	Implementation	Possibility to select silent version of the SURF-A/ITA implementation	Airlines operational procedures and preference	Low
ASS-VLD-02-005	Commercial flights	Range	Number of flights will represent statistically significant sample	Operations	Medium
ASS-VLD-02-005*	Experimental flights	Range	Number of flights will follow regular schedule of experimental aircraft involved	Operations	Medium
ASS-VLD-02-006	ADS-B data	ADS-B	ADS-B data represent reality on existing airport	ADS-B analysis and representative results, existing environment, equipage rate	Medium
ASS-VLD-02-007	ATC	Interoperability	No change to existing ATC procedures	DEMO will not need any change to ATC, ATFM processes	Medium
ASS-VLD-02-009	ANSP data	Interoperability	Comparison of available ATC collected data from specific airport	Comparison of two data samples for main parameters accuracy analysis	Medium

Table 3-5: Demonstration Assumptions overview

**Assumption modified compared to the DEMO plan based on deviation chapter 3.4*

3.3.5 Demonstration Exercises List

Below are provided 2 demonstration exercises executed within SESAR STAIRS program.

- EXE-VLD-02-001 (EXE-H) – Exercise led by Honeywell
- EXE-VLD-02-002 (EXE-T) – Exercise led by Thales

Demonstration Exercise	Demonstration Objectives
EXE-VLD-02-001 (EXE-H)	OBJ-VLD-02-001
	OBJ-VLD-02-002
	OBJ-VLD-02-003
	OBJ-VLD-02-004
	OBJ-VLD-02-005
	OBJ-VLD-02-006
	OBJ-VLD-02-007

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	OBJ-VLD-02-009
EXE-VLD-02-002 (EXE-T)	OBJ-VLD-02-001
	OBJ-VLD-02-002
	OBJ-VLD-02-003
	OBJ-VLD-02-006
	OBJ-VLD-02-007
	OBJ-VLD-02-008
	OBJ-VLD-02-009

Table 3-6: Traceability of demonstration exercises and objectives

[EXE]

Identifier	EXE-VLD-02-001 (Honeywell)
Title	Demonstration of system performance, data collection and interoperability
Description	In-service significant data replay, Live trial, (DEMO2 postponed)
Demonstration Technique	<In-service data/Live Trial>
KPA/TA Addressed	<Safety><Human Performance>
Number of flights	DEMO2 prep 30 operations, (DEMO2 final campaign postponed)
Start Date	01/01/2020
End Date	31/12/2022
Demonstration Coordinator	Honeywell
Demonstration Platform	Dassault F900EX
Demonstration Location	US region
Status	<Completed>
Dependencies	Interoperability WP2 analysis

[EXE Trace]

Linked Element Type	VLD02
<SESAR Solution>	PJ03B-05
<SESAR Solution>	PJ28

Table 3-7: Demonstration Exercise (Honeywell)

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450

451 [EXE]

Identifier	EXE-VLD-02-002 (Thales/ACSS)
Title	Demonstration of system performance, data collection and interoperability
Description	Live trial during experimental flights with Thales implementation
Demonstration Technique	<Live Trial>
KPA/TA Addressed	<Safety><Human Performance>
Number of flights	DEMO4 5 operations, (DEMO4 final campaign postponed)
Start Date	01/11/2022
End Date	31/12/2022
Demonstration Coordinator	AIRBUS
Demonstration Platform	A320, A330
Demonstration Location	France region
Status	<Completed>
Dependencies	Interoperability WP2 analysis

452 [EXE Trace]

Linked Element Type	VLD02
<SESAR Solution>	PJ03B-05
<SESAR Solution>	PJ28

453 **Table 3-8: Demonstration Exercise (Thales)**

454

455 3.4 Deviations

456 3.4.1 Deviations with respect to the S3JU Project Handbook

457 Not applicable.

458 3.4.2 Deviations with respect to the Demonstration Plan

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There are identified deviations in the project caused by Covid crisis impacting schedule and scope for work packages WP3 and WP4.

Impact to WP3

The following sub work packages were removed from WP3 scope:

- SWP 3.1a SURF-A definition (EXE-H)
- SWP 3.2a SURF-A preparation (EXE-H)
- SWP 3.3a – SURF-A demonstration (EXE-H)

Additionally, demo2 with SURF-ITA function will be performed outside of the project timeframe. Preparation activities for demo2 were performed to maximum extent (addressed via STELLAR change request #1785.

Impact to WP4

The activities in frame of WP4 (system testing, evaluations, flights, shadow mode certification, installation on airline fleet) are directly dependent on availability of the final version of SURF-A function to Airbus.

Due to COVID crisis and components shortage, resources had to be allocated to most critical topics, significantly delaying development of SURF-A function in ACSS equipment. The final version of the function was not available to Airbus within the timeframe of the project thus some of the initially planned activities are not performed within the project timeframe (as reported in the Impact Document STELLAR change request #1785).

De-scoped activities to be performed outside of the project are:

- Full system tests campaign
- Cockpit operations/human factor evaluations
- Certification flight tests
- Massive function in-service exposure on airline A/C in shadow mode and analysis of the collected data

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4 Demonstration Results

4.1 Demonstration results - Exercise EXE-VLD-02-001 (EXE-H) – WP3

4.1.1 Summary of Demonstration Results

Below is provided exercise results for the EXE-H and activities related to DEMO1 , DEMO2 under WP3 and sub-work packages.

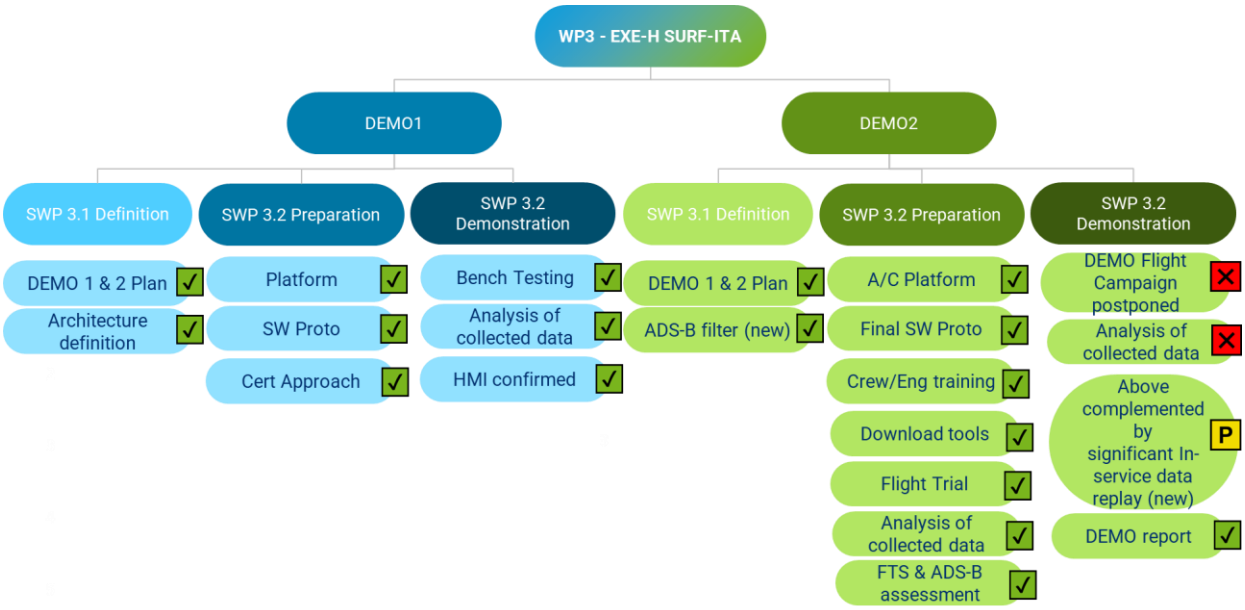

Figure 4: Exercise EXE-H/WP3 activities breakdown

Demonstration results for exercise EXE-H are provided in the table below following demonstration objective with success criterion.

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Demonstration Results	Demonstration Objective Status
OBJ-VLD-02-001	OB1 System performance (operational)	CRT-VLD-02-001-01	Acceptable nuisance alerts rate	Acceptable 0 nuisance alert rate for operational system performance using in-service data and flight trial	OK
		CRT-VLD-02-001-02	Acceptable false alerts rate	Acceptable 0 false alert rate for	OK

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				operational system performance	
		CRT-VLD-02-001-03	Acceptable detection rate	Acceptable detection rate 70%	OK
OBJ-VLD-02-002	AU feedback DEMO1 and DEMO2	CRT-VLD-02-002-01	Crew system acceptance during DEMO2 phases	DEMO2 provided acceptable results. Limited scope for final postponed campaign.	Partially OK
		CRT-VLD-02-002-02	Crew system acceptance during DEMO2 phases	DEMO2 provided acceptable results.	Partially OK
OBJ-VLD-02-003	OB2 Fast Time simulation (Surveillance degraded accuracy)	CRT-VLD-02-003-01	Acceptable nuisance alert rate	Nuisance alert rate with degraded surveillance events provided acceptable rate below 1E-06	OK
		CRT-VLD-02-003-02	Acceptable false alert rate	0 false alerts rate	OK
		CRT-VLD-02-003-03	Detection rate	Acceptable detection rate within 70%	OK
OBJ-VLD-02-004	OB3 ADS-B IN	CRT-VLD-02-004-01	Quality assessment	Identified ADS-B issues and addressed with ADS-B filter	OK
		CRT-VLD-02-004-02	Rate of eligible DO-260B	Based on the latest traffic NACp selection it is acceptable	OK
		CRT-VLD-02-004-03	Accuracy assessment	Accuracy assessment provided final outcomes with Eurocontrol. Acceptable with new design solution	OK
OBJ-VLD-02-005	OB3 Detection rate	CRT-VLD-02-005-01	UI rate	Replaced by OBJ-VLD-02-004 Tested missed detection for static and moving traffic. Tested using ADS-B filter tooling with acceptable results.	OK
		CRT-VLD-02-005-02	Gap analysis	Gap and coasting analysed using ADS-B filter tooling with acceptable results for newly defined “data	OK

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				age" parameters.	
OBJ-VLD-02-006	OB4 Interoperability	CRT-VLD-02-006-01	ATCo workload	With operational analysis of SC-186 ADS-B data the workload is not impacted due to acceptable system performance.	OK
		CRT-VLD-02-006-02	Compatibility with ATCo formation	After data assessment, there has not been identified an impact for closely operating traffic in most stressed environment based on ICAO PANS and FAAO procedures.	OK
		CRT-VLD-02-006-03	No info of equipped A/C presence for ATCo	Should not have an impact with proved system performance	OK
OBJ-VLD-02-007	OB4 Interoperability	CRT-VLD-02-007-01	Crew action for non-reported alerts	N/A (covered by WP2)	
		CRT-VLD-02-007-02	Reports are well understood by ATCo	N/A (covered by WP2)	
		CRT-VLD-02-007-03	No need for additional info when reported alert by crew to ATCo	N/A (covered by WP2)	
OBJ-VLD-02-008		CRT-VLD-02-008-01	Conflict resolution using current phraseology	N/A (covered by WP2)	
		CRT-VLD-02-008-02	Frequency occupation remains acceptable	N/A (covered by WP2)	
OBJ-VLD-02-009	OB4 Interoperability	CRT-VLD-02-009-01	Additional barrier to ATC safety net	System performance proved correct timing of valid alerts below ATC thresholds and runway min separation.	OK
		CRT-VLD-02-009-02	Triggering criteria well understood by crew	Crew has confirmed the triggering criteria are well understood and consistent.	OK

494 **Table 4-1: Summary of Demonstration Exercises EXE-H Results (Honeywell)**

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4.1.2 Detailed analysis of Demonstration Results per Demonstration objective

4.1.2.1 OBJ-VLD-02-001 OB1 System Performance Results

Demonstration results for the objective after program change impact have been completed by two operational activities complementing CEIS main objective.

- Flight trial with F900EX with simulated traffic onboard during real scenarios
- In-service ADS-B data (significant sample) replay with the SURF-ITA algorithm from operational aspects and supported by ATCos and Pilots

In flight demonstration – operational assessment (DEMO 2 preparation)

The demonstration has been primarily focused on clarification of main OSED scenarios system performance from PJ03B-05 and final implementation into integrated avionics of Dassault (F900EX) experimental platform with cockpit synchronization of pilots' applications using the same geometrical runway envelope of aural and display alerts.

5 main scenarios (Take-off, Approach, Crossing, TO crossing RWY, Approach crossing RWYs) have been identified, executed and tested with simulated ADS-B traffic onboard the experimental aircraft using flight test instruments connected to integrated avionics and generating ADS-B intruders on ground/ in Air.

The intruder has been directly inserted into ADS-B IN traffic list on display traffic file and assigned with label for the simulated "virtual" traffic to allow flight crew safely lands on the runway.

The system was tested on the airports listed below, primarily in the approach phase, identified as the most critical for cockpit applications.

The airports used for the demonstration have been selected close to Honeywell base with LUSL and LUCL layouts. Airports flight-tested:
KABQ, KBFI, KDVT, KEAT, KIWA, KLGB, KMWH, KPAE, KPHX, KPRC, KSBA, KTUS

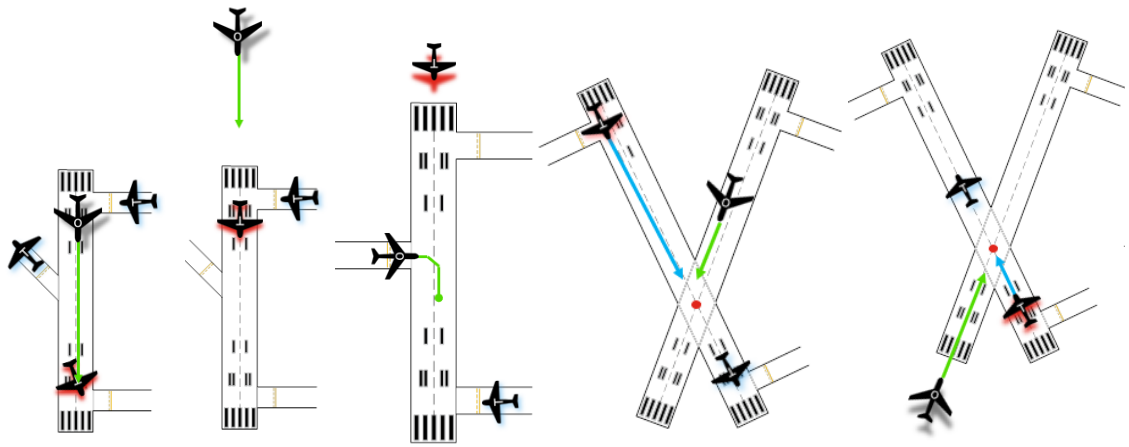

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Figure 5: Flight trial scenarios - identified

The next objective of testing was a synchronization of the cockpit applications for pilots with the same alerting envelope and display indication.

Cockpit applications considered for the demonstration were the TCAS TA/RA, EUROCAE ED-250 ROAAS and TAWS RAAS, all below 450ft AFE with various configuration and setting.

All flight demonstrations have been executed with several operations with different configuration and using different aspects with other tested cockpit applications primarily for runway excursion and incursion.

Figure 6: Honeywell F900EX Dassault Falcon

As final results of the trial, the system has correctly generated alerts with 0 nuisance, missed and false alerts rate. The cockpit application synchronization has been adjusted within alerts priority groups and inhibition for all audio generated alerts and adjusted display indication & alerts as there has been targeting the similar HMI display alerting features for pilots with different meaning for each display application on 3D Smart Vision PDU (Primary Flight Display Unit) and 2D CDTI on MDU (Multifunction Display Unit).

In-service ADS-B data replay – operational assessment (DEMO 2)

As part of transition to deployment and thus certification, it is essential to demonstrate that the SURF-ITA function meets objectives in terms of alerting performance. The rate of nuisance alert is particularly scrutinized by regulatory authorities. The method selected for such demonstration is an operational analysis based on a huge amount of ADS-B in-service data replay. To that effect, the project retrieved ADS-B data sample collected by RTCA SC-186 on 9 major US airports with heavy traffic (HUSL, HUCL), representing several millions of operations. Such a large data set is needed to demonstrate a safety objective of the order of 1E-05 and better. It can be considered as a conservative assessment, considering that the data was collected at airports with dense traffic and complex single and crossing runways layouts, prone to nuisance alerts.

- SC-186 ADS-B data sample
  - 9 major airports in the USA, 7 years data collection (MOPS V1 and V2 traffic)
  - Airports KDTW, KSFO, KCLT, KDCA, KEWR, KJFK, KSEA, KORD, KLAX
  - 2.83 M operations
  - 5.14 B ADS-B SURF-ITA eligible messages

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The tooling has been adjusted to convert the format of the received data into ASTERIX cat21 in csv files.

Each trajectory was used in simulation both as an ownship and as a traffic. The (.kml) graphical interpretation over Google Earth map was applied.

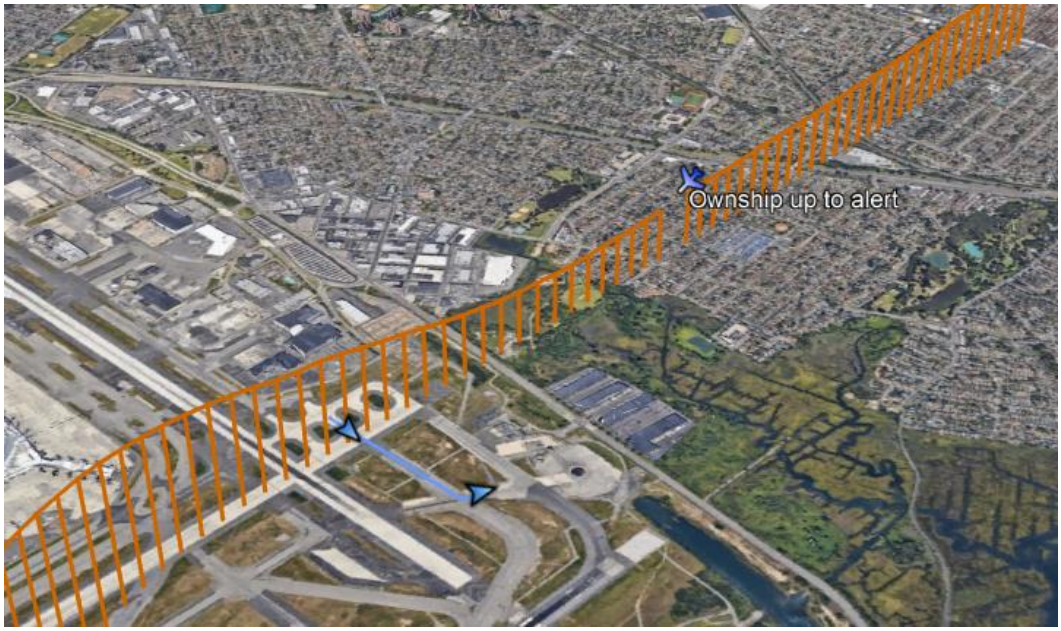

Figure 7: Example of alert from ADS-B data replay as an output for operational assessment

Due to the high volume of collected data the tooling architecture was optimized to run in parallel processes on more processor cores of data servers to be able to iterate and run the data several times.

Final results included alerts with a description of the situation before and after the conflicting situation and possibility to re-play. Final assessment of nuisance alerts, possible missed detections and false alerts have been performed on selected alerting cases using SESAR partners, Honeywell pilots and ATC experts from DSNA and Czech RLP under B4 group.

Below is provided criteria for results assessment with valid, nuisance and false alerts rates:

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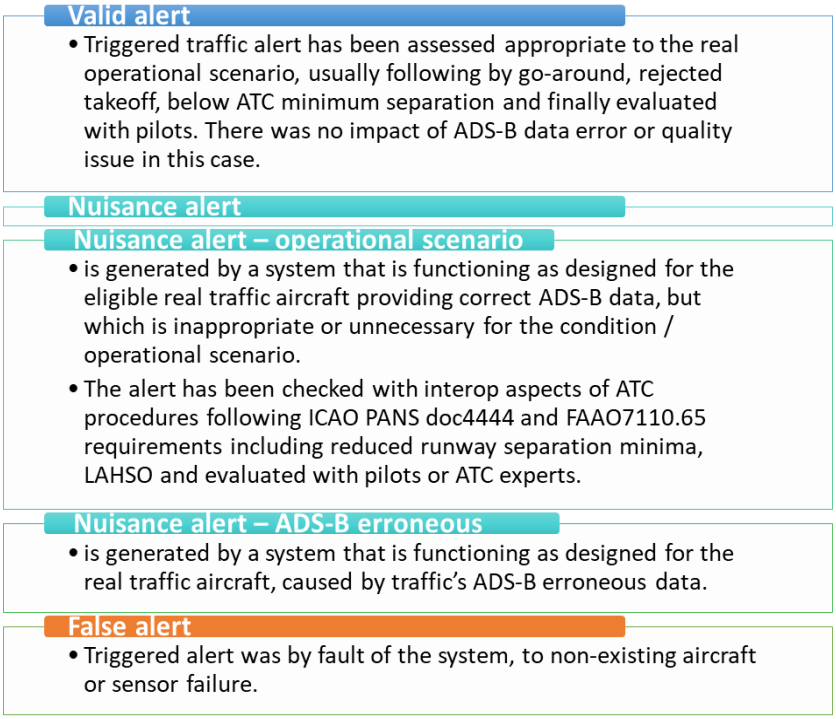

The final result assessment confirmed compliance with operational and degraded surveillance accuracy acceptable rates for system performance below 1E-05 nuisance alert rate, 0 false alerts observed.

Total alert rate in general around 2E-04 included a lot of valid alerts with especially rejected take-offs and go-arounds which operational cases were assessed with pilots and operational experts for valid detection and proper alert timing. In case a nuisance alert was detected, further analysis showed that it was caused by surveillance degraded accuracy described in objective OBJ-VLD-02-003 and not from operational aspects and ATC procedures/ scenarios.

A comparison between SESAR PJ28 data package and newly delivered RTCA SC-186 ADS-B data package was performed. There is a significant difference in the volume of RTCA SC-186 data sample which has been recorded during more than 7 years every day for all airport traffic operational combinations. It brings high confidence in the final results and further certification demonstration.

There have been identified operational differences between US and EU ATM environment and close operational cases for SURF-A which needed an ATC involvement and assessment.

As a complement to past PJ28 and RTCA SC186, ADS-B data collection was performed by PANSA on Warsaw airport with smaller data sample for future assessment and algorithm replay.

4.1.2.2 OBJ-VLD-02-002 AU feedback DEMO1 and DEMO2 Results

During DEMO1 Airspace Users were involved in bench testing and HW implementation review for limited acceptance check.

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DEMO1 has provided full implementation into Honeywell integrated avionics bench for business aircraft validating primarily HW implementation aspects and outputs into displays without Human Factor specialists' involvement at that stage.

Figure 8: Honeywell DEMO1 bench final simulations and measurements

SURF-ITA has been implemented directly into Honeywell integrated avionics architecture accepting ADS-B IN stream and running SURF-ITA algorithms on the final CPU processor. Part of the testing was measurements of CPU budget demand for final HW implementation and latency to comply with DO-317C for worst case with maximum of 127 traffic intruders.

The measured latency between ADS-B reception in the aircraft and display of ADS-B In is confirmed to be below 3.5 seconds (D->G) as per DO-303.

With completed bench setup, the main OSED scenarios (ref to PJ.03b-05 SPR-INTEROP/OSED [18]) were simulated and showed proper and acceptable display outputs and aural alerts.

DEMO2 has been impacted by the program change and therefore AU have been involved in the DEMO2 prep flight trial and in-service ADS-B data replay with alerting scenarios assessment only. These activities have been found as appropriate to meet expected objectives as the final DEMO2 was expected to be silent, therefore final compliance has been marked as "Partially Compliant".

The prep flight trial results concluded on the final display configuration for all cockpit alerting applications and proper setting of aural alerts priority groups.

The SURF-ITA indication and alerts have been found appropriate and acceptable for the main OSED scenarios using simple pilots flight debriefing questionnaires. Pilots confirmed HMI readiness for final demonstration campaign. A temporary manual discrete inhibit switch was used to enable pilots to inhibit aural and display output.

4.1.2.3 OBJ-VLD-02-003 OB2 Fast Time Simulation Results (Surveillance degraded accuracy)

This objective has been primarily focused on fast time simulation with impacts of degraded surveillance accuracy following the objective OBJ-VLD-02-004 and OBJ-VLD-02-001 (covered only operational aspects of validation).

Based on final qualitative assessments results under WP3 and Eurocontrol, Honeywell has added additional design line of defense solution by developing a new ADS-B data filter. The function with the new filter has been tested with simulations and complemented by the final replay of ADS-B data with SURF-ITA algorithm.

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The final ADSB qualitative results assessment with additional filter (including all types of ADS-B issues) confirmed compliance with acceptable rates on system performance with nuisance alert rate below 1E-05 and 0 false alerts rate.

The true positive detection rate is above 70%, as per objective, and missed detection rate (false negative) is below 5% for eligible traffic.

4.1.2.4 OBJ-VLD-02-004 OB3 ADS-B IN Results

Quality and accuracy assessment done under WP2 by Eurocontrol, see chapter 4.3.

The data sample from SC-186 group has been analyzed from ADS-B qualitative perspective under WP3 using a new tooling developed to detect unexpected events. This activity was supported by Eurocontrol and transversal activity from work package 2.

Using operational results from first objective -001 and results from the WP3 ADS-B assessment, several ADS-B degraded accuracy events (issues) were identified for eligible traffic impacting the overall nuisance detection rate. Those events are grouped by root-cause groups as shown below:

- ADS-B issue - Horizontal position Outliers
  - Phase: All, mainly slow or stopped
  - Note: Isolated outliers caused by multipath or transponder processing
  - Risk: Nuisance alert
- ADS-B issue – Jump&Stay
  - Phase: Stopped or very slow
  - Note: Jump into erroneous position and stay for some time, GPS unable to see error
  - Risk: Nuisance alert
- ADS-B issue – Walking Track
  - Phase: Stopped
  - Note: Small step position increment
  - Risk: Nuisance alert
- ADS-B issue – Frozen Heading
  - Phase: All (initial phase of TO, taxiing)
  - Note: Incorrect heading and alert computation using track in low speed (directionality) or frozen heading all phase of operation

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- Risk: Missed, Nuisance alert

- ADS-B issue – Offset
  - Phase: Taxiing
  - Note: Offset from original trajectory,
  - Risk: Nuisance alert

These critical degraded accuracy events caused by combination of GPS multipaths, and transponder data processing have been observed with all data samples collected so far applicable to all MOPS versions and should be removed by proper eligibility rules or additional design solution as an additional line of defense to secure high reliability of a system performance.

This activity complemented Eurocontrol analysis and other data assessment focused on horizontal position accuracy only, using verification exercise focused also on ground speed impact and heading anomalies. All that has been verified using tooling for ADS-B filter assessment.

Simulation results with SC-186 ADS-B data (including MOPS version 1 and 2 from 2013-2019) for eligible traffic based on NACp has provided below results.

- Eligibility rules from NACp9 could remove in average 7% of traffic for SURF-ITA
- Eligibility rules from NACp10 could remove in average 60% of traffic for SURF-ITA

These figures above are highly dependent on operators' compliance in specific location and schedule of mandated RTCA DO-260B requirement and other equipage/environmental factors.

4.1.2.5 OBJ-VLD-02-005 Detection Rate Results

The UI rate analysis has been replaced by detection rate simulation with ADS-B filter re-play and eligibility detection rates (see reference to OBJ-VLD-02-003 and -004) due to limited flight trial operations and postponed final DEMO2 campaign.

For the gap analysis additional tooling has been created to detect system gaps and coasting with a special focus on data age eligibility for specific simulation aspects within OB2 objectives.

The result during replay and simulation with specific scenarios has provided an outcome requesting to decrease existing data age values for "SURF" application (DO-317C) from original 11 sec for moving traffic and 25 sec for static traffic.

The most critical risk has been identified as scenario with possible traffic ADS-B gap will be coasted directly onto the runway from a taxiway system.

Final data age parameter within traffic eligibility has been tested on worst case scenarios with acceptable results.

4.1.2.6 OBJ-VLD-02-006 Interoperability Results

Interoperability assessment workshops were organized by DSNA under WP2, see chapter 4.4.

Work Package 3 with EXE-H activities participated in interoperability workshops.

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WP3 completed the interoperability assessment by the replay of ADS-B data comparing SURF-ITA system performance with regional aspects of ATC procedures mainly in US vs Europe, reviewing FAA Order and ICAO PANS guidelines for ATC procedures.

Several differences identified between those regions are critical. It is essential for SURF-ITA system suppliers to provide a globally interoperable solution consistent for Airspace Users and standardization.

Below are provided outcomes from differences that have been part of the final assessment and design update.

- Minimum runway separations
- Approach with pilot responsibility under VFR condition
- Crossing runways separation thresholds
- LAHSO
- Land after procedure
- Switch over procedure
- Consecutive takeoffs
- Takeoff initiated versus runway exit
- Local operational customs of pilots and ATC

In general, within US region there are lower min separations and higher traffic density in controlled airspace which needs to be reflected in final design.

4.1.2.7 OBJ-VLD-02-007 Interoperability Results

Interoperability assessment under WP2, see chapter 4.4.

Work Package 3 with EXE-H activities participated on interoperability workshops.

4.1.2.8 OBJ-VLD-02-009 Interoperability Results

Interoperability assessment under WP2, see chapter 4.4.

Work Package 3 with EXE-H activities participated in interoperability workshops.

WP3 undertook the update of relevant aircraft manuals for a flight crew with applicable training materials based on the OEM platform, in particular regarding alert triggering criteria.

Simulation and flight trial under DEMO1 and DEMO2 proved these alerting triggering criteria are well understood by the crew with SURF-ITA consistent system design.

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4.1.3 Confidence in Results of Demonstration Exercises

4.1.3.1 Limitations and impact on the level of Significance

All the in-service data replay and flight trials have been executed within European and US region so far which limits the results to the environment in those regions. As these two regions represent heavy traffic environments with high complexity, it is not expected that any deviation of system behavior will happen when the solution is used in other regions. A regional qualitative assessment is recommended to confirm that eligibility rules and system design solutions are compatible with deployed ADS-B and operational airport configurations globally.

The flight trial has involved a limited number of flights. The demonstration was complemented by significant in-service data replay providing confidence in the results.

4.1.3.1.1 Quality of Demonstration Exercise Results

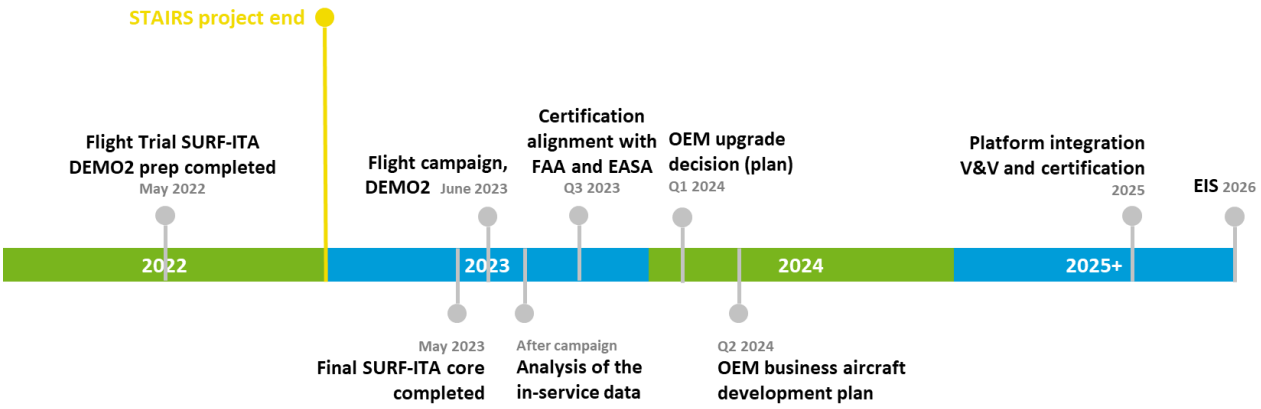
The exercise has been tested using an industrial aircraft HW platform. In-service data replay and simulation followed from previous SESAR activities with gained experience and verified processes supported by Eurocontrol.

4.1.3.1.2 Significance of Demonstration Exercise Results

Using multimillion in-service data sample provides statistical significance of results proving safety objectives for the system performance. Bench testing and extensive Flight trial within DEMO1 and DEMO2 (prep) confirmed operational and platform readiness for a future deployment and planned certification.

4.1.4 Validation Plans/Path after the maturity gate: WP3 / EXE-H

Activities initially planned for the SURF-ITA demonstration will be continued by Honeywell beyond the project timeframe.



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4.2 Demonstration results - Exercise EXE-VLD-02-002 (EXE-T) – WP4

4.2.1 Summary of Demonstration Results

Demonstration results for exercise EXE-T are provided in the table below following demonstration objective with success criterion. With the current planning some of the objectives can't be yet assessed and will be finalised in the final version of the DEMO Report.

Demonstration Objective ID	Demonstration Objective Title	Demonstration Objective Content	Success Criterion ID	Success Criterion	Success Criterion Content	Demonstration Results	Demonstration Objective Status
OBJ-VLD-02-001	SURF-A system performance in flight demonstration	To Demonstrate SURF-A system operational performance with acceptable nuisance, false and missed alerts during experimental[1] flights.	CRT-VLD-02-001-01	Acceptable nuisance alerts rate	Nuisance alerts rate: less than 10-5/per ownship operation	No nuisance were raised during 5 flight tests performed with Airbus experimental fleet. Limited scope of the campaign.	OK

[1] Objective of commercial flights was replaced with experimental flights as agreed for SURF-A part.

OBJ-VLD-02-002	SURF-A crew acceptability	To Demonstrate crew acceptability of the SURF-A system	CRT-VLD-02-002-01	Crew system acceptance during flights	SURF-A system performance acceptability by the crew during their flights and standard operational procedures in case of alerts triggered.	N/A	De-scoped
			CRT-VLD-02-002-02	Crew system acceptance during simulation and flight tests	Crew acceptability of HMI and system performance during preparation phase for DEMO.	N/A	De-scoped
OBJ-VLD-02-003	FTS SURF-A system performance fast-time simulation demonstration	To Demonstrate SURF-A system operational performance with acceptable nuisance, false and missed alerts using collected data from ATC (A-SMGCS) or aircraft.	CRT-VLD-02-003-01	Nuisance alert rate	Nuisance alerts rate: less than 10-5/per ownship operation	7.643x10^-6	OK Evaluated during FTS campaign
			CRT-VLD-02-003-02	False alert rate	False alerts rate: less than 10-5/per ownship operation	7.643x10^-6	OK

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OBJ-VLD-02-006	SURF-A compatibility	To demonstrate that SURF-A is compatible with current ATC working methods	CRT-VLD-02-003-03	Detection rate	Detection rate > 7*10-1 / per ownship operation	Missed Alert – Advisory is 3.17% (Requirement is Less than or equal to 5%) Missed Alert – Warning is 1.74% (Requirement is Less than or equal to 5%)	OK
			CRT-VLD-02-006-01	ATCo workload	The use of SURF-A does not lead to an ATCO workload increase.	See section §4.4	OK
			CRT-VLD-02-006-02	Compatibility with ATCo formation	The use of SURF-A is compatible with current ATCO formation level and does not require any additional ATCO training.	See section §4.4	OK

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			CRT-VLD-02-006-03	No info of equipped A/C presence for ATCo	For each aircraft, the ATCO does not need to be informed on the presence of the SURF-A on-board.	See section §4.4	OK
OBJ-VLD-02-007	SURF-A reports	To demonstrate that SURF-A triggered alerts do not require a specific report from aircraft to ground	CRT-VLD-02-007-01	Crew action for non-reported alerts	In case of SURF-A alerts not reported by Flight Crew, Flight Crew actions and intentions are enough for ATCO to understand the situation	See section §4.4	OK
			CRT-VLD-02-007-02	Reports are well understood by ATCo	In case of SURF-A alerts reported by Flight Crew by voice, this report is well understood by ATCOs	See section §4.4	OK

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			CRT-VLD-02-007-03	No need for additional info when reported alert by crew to ATCo	In case of SURF-A alerts reported by Flight Crew, no other information is required from the aircraft (i.e. no automatic aircraft alert downlink)	See section §4.4	OK
OBJ-VLD-02-008	SURF-A phraseology	To demonstrate that SURF-A does not require a specific phraseology	CRT-VLD-02-008-01	Conflict resolution using current phraseology	All the conflicts raised by SURF-A can be resolved using current phraseology without ambiguity between Flight Crew and Air Traffic Control	See section §4.4	OK

748 **Table 4-2: Summary of Demonstration Exercises EXE-T Results**

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4.2.2 Detailed analysis of Demonstration Results per Demonstration objective

More information about preparation activities can be found in Appendix B.

4.2.2.1 OBJ-VLD-02-001 Results

To assess the success criteria CRT-VLD-02-001-01 concerning nuisance alerts detected in flight and considering accepted changes to the DEMO Plan, Airbus has installed TCAS unit equipped in SURF-A (not the final version) in shadow mode on experimental aircraft from A320 family. The intent was to perform non-specific experimental aircraft flight tests with SURF-A in shadow mode (allowing for function exposure).

The Data Collection means implemented in the same TCAS unit allowed to detect any alert raised by the function which was recorded and analysed together with ADS-B data of the traffic around the own-ship. Note: as the function is in shadow mode, there is no output of the information to the crew.

No alerts (neither valid or nuisance) were raised, as expected, allowing to mark the objective as passed. No nuisance alerts were also raised during system lab tests.

It has to be noted that this amount of data is not enough to fully assess the nuisance rate thus excessive Fast Time Simulation supporting OB2 is performed within the Project. Exposure of the function in airline aircraft will be performed and analysed outside of the project.

4.2.2.2 OBJ-VLD-02-002 Results

Due to the delay within the Project, the function couldn't be exposed to the crews neither in simulator nor flight environment not allowing to assess the objective.

Note: All preparation activities for simulator and flight tests were performed within STAIRS project. See B.1.1 for detailed information. Pilot and Flight Test Engineers didn't raise any adverse comments concerning the function during preparation activities.

This objective will be assessed outside of the STAIRS project.

4.2.2.3 OBJ-VLD-02-003 Results

Performance metric data as of 19 October 2022 based on L3Com test campaign performed o Red Label 3 standard

Metric	Requirement	Measured Performance
Missed Alert	Less than or equal to 5x10^-2	1.060x10^-2
Late Alert	Less than or equal to 1x10^-2	0.959x10^-2
Nuisance Alert	Less than or equal to 1x10^-5	7.643x10^-6

Table 4-3: SURF-A performance results

Warning Alerting: 98.26% passing with the following breakdown of per test cases

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Advisory Alerting: 96.88% passing with the following breakdown of per test cases:

Nuisance Avoidance: 99.9991% passing with the following breakdown of per test cases:

4.2.2.4 OBJ-VLD-02-006 Results

This objective is supported by activities in WP2 which were common for SURF-A and SURF-ITA. Objective is considered as passed (see section 4.4).

4.2.2.5 OBJ-VLD-02-007 Results

This objective is supported by activities in WP2 which were common for SURF-A and SURF-ITA. Objective is considered as passed (see section 4.4).

Additionally, during flight tests preparation, flight test engineers and the referent pilot didn't see the need to provide any additional reporting when having SURF-A alerts in the cockpit compared to visual detection of traffic on runway. This gives additional input to assessing the objective.

4.2.2.6 OBJ-VLD-02-008 Results

This objective is supported by activities in WP2 which were common for SURF-A and SURF-ITA. Objective is considered as passed (see section 4.4).

4.2.3 Confidence in Results of Demonstration Exercises

4.2.3.1 Limitations and impact on the level of Significance

The activities connected to OBJ-VLD-02-001 and OBJ-VLD-02-002 were not able to be performed as initially planned with broad exposure of the SURF-A function in real environment with different airport configurations, ADS-B OUT specifics and exposure of the function in active mode in flight.

However, apart from CRT-VLD-02-002 (SURF-A crew acceptability), recovery activities were proposed to assess the objectives of the EXE-T.

Objectives of OBJ-VLD-02-003 were not impacted and could be performed as initially planned with large amount of real in-service FAA data and synthetic data.

4.2.3.1.1 Quality of Demonstration Exercises Results

Not impacted.

4.2.3.1.2 Significance of Demonstration Exercises Results

The real-world exposure of the function is reduced compared to the initial plan thus significance of the demonstration performed within the SESAR frame in real environment is lower than assumed. However, this does not influence global plan to assess the objectives especially with Fast Time simulation activities. It has to be highlighted that during originally planned in-service exposure (50 000 flights), none or at most few dangerous situations are expected to be raised as SURF-A is one of the last safety nets against runway collisions. The Fast Time Simulation allows to expose the function to numerous simulations when two A/C are already in close proximity with varying ADS-B parameters, which wouldn't be possible in real world at this scale. This allows to gain confidence in the function and to consider In-Service Exposure / CEIS only as final confirmation.

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Apart from that, all of the not performed activities will be continued beyond the SESAR STAIRS project to allow assessment of the objectives, certification and introduction of the function in the coming future.

Already performed activities, show readiness to deploy SURF-A function.

4.2.4 Validation Plans/Path after the maturity gate: WP4 / EXE-T

Activities initially planned for the SURF-A demonstration will be continued by Airbus beyond the project timeframe. Note that planning is for information only and might be impacted by different factors.

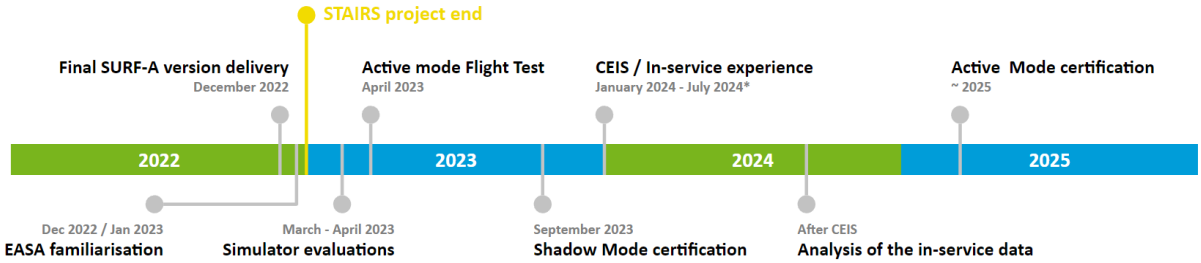

Figure 9 – Estimated planning for SURF-A activities after end of the STAIRS project

4.3 Supporting demonstration results – Eurocontrol - WP2

Eurocontrol supported both exercises EXE-VLD-02-001 (EXE-H) and EXE-VLD-02-002 (EXE-T) to meet objectives OBJ-VLD-02-004 (quality assessment and accuracy) with analysis of collected DSNA ADS-B data.

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion
OBJ-VLD-02-004	OB3 ADS-B IN	CRT-VLD-02-004-01	Quality assessment
		CRT-VLD-02-004-03	Accuracy assessment

Table 4-4: DEMO Objectives supported by Eurocontrol

The exercise objective was to assess the ADS-B position performance during operations relevant for the application, focusing on higher speed operations. The method selected was to compare the ADS-B position data to position measured by a Multilateration (MLAT) system on the airport surface, including also short final approach. The data was collected from an airport system capable of providing both MLAT and ADS-B position data output every second. The analysis covers 22 full days of operation.

The data analyzed was selected based on MLAT data identified to be close to the runway (including between the parallel runways). The MLAT and ADS-B data was correlated based on the 24-bit addresses.

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MLAT and ADS-B position measurements are output every second, however not time synchronized. In order to compare the data time synchronized and interpolation was performed between two MLAT measurements to match the ADS-B time of report. The difference between the two position reports where then calculated as total value as well as the distance along the axis between the (future and past) MLAT points and the distance across this line.

The results were analyzed by using cumulative distribution plots of the position differences. The initial results indicated some occurrences of large differences. The data from these differences were plotted on a map for a relevant time sequence, which allowed to determine the cause of the difference. During this analysis several events were identified where the MLAT data was obviously incorrect, likely suffering from multipath / reflections effects. The data from these events were removed from the data set. At a given point in the process of removing the position differences generated by the MLAT system, which were not relevant for the analysis, the error source was more problematic to isolate and was likely resulting both from causes related to the onboard avionics as well as causes related to noise error from the MLAT system. At this point it was considered that the analysis had approached the limit of assessing the position performance of the ADS-B data.

The ADS-B data was filtered to only include data based on ADS-B version 2 avionics as well as a NACp of 9 or greater, as indicated in the ASTERIX CAT021 data.

The following figures presents the result of the position difference assessment between the MLAT and ADS-B data. Figure 1 present the cumulative distribution function for the total, along and across differences. Figure 2 present the same data in a log-linear plot, allowing to better examine the tails of the distribution.

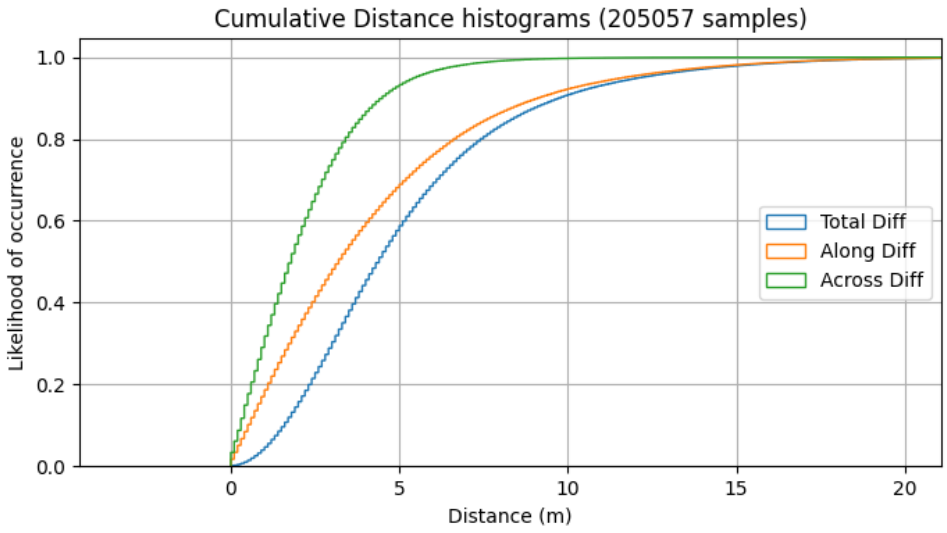

Figure 1 Cumulative distribution function of the measured position difference (total, along and across) between ADS-B and MLAT.

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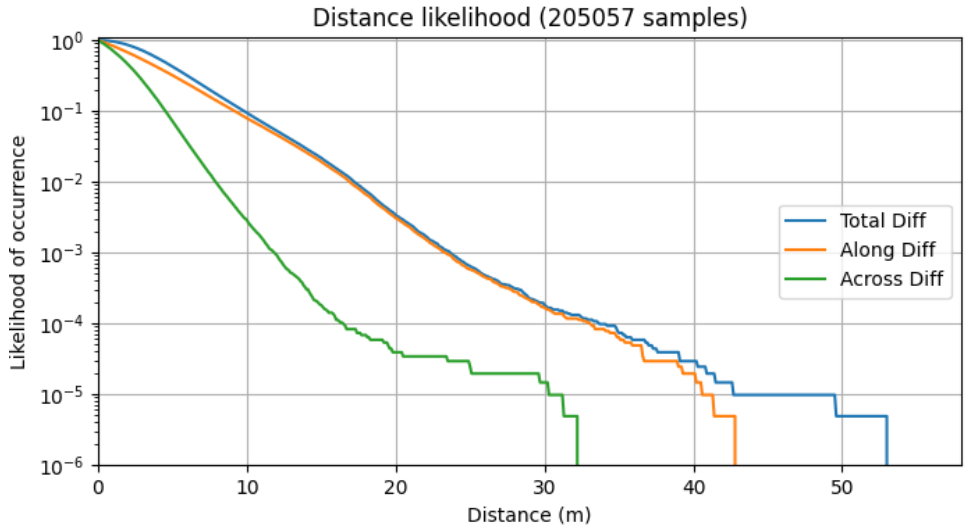

Figure 1 Log-Linear cumulative distribution function of the measured position difference (total, along and across) between ADS-B and MLAT.

Inspecting the across position difference above 20 meters indicate that the majority of the difference is related to MLAT system performance rather than ADS-B performance. Further, after the filtering of the data, the total number of samples used to form the statistics were 205 057, this means that there are only two samples at the 10^{-5} level and twenty samples at 10^{-4} level. As such the results cannot be considered sufficiently reliable below the 10^{-4} level. The results can also be presented for some selected percentiles, as shown in Table 1 below.

Table 1 Selected percentile values for measured position difference (total, along and across) between ADS-B and MLAT.

Percentile	Across difference (m)	Along difference (m)	Total difference (m)
90 (10^{-1})	4.5	9.2	9.8
95	5.5	11.7	12.2
99 (10^{-2})	7.9	16.9	17.2
99.9 (10^{-3})	11.8	23.3	23.6
99.99 (10^{-4})	16.4	32.9	33.6

Table 4-5: Measured position difference between ADS-B and MLAT (Eurocontrol)

4.4 Supporting Demonstration Results – ANSPs - WP2

Two different workshops have been held by the Project, each of them mixing pilots, ATCOs, engineers and experts:

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- On the 27th of February 2020 in DSNA CDG premises, with representatives from DSNA, HONEYWELL, AIRBUS, THAV, PANSA and EUROCONTROL,

- On the 4th of November 2021, by videoconference, due to pandemic restrictions, with representatives from AIRBUS, DSNA, EUROCONTROL, HONEYWELL, PANSA and THALES/ACSS.

Those workshops presented the principles of SURF-A function, and based on real cases of traffic, discussed the outcomes of SURF-A and the way this function could affect each other's duties and working methods.

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Demonstration Results	Demonstration Objective Status
OBJ-VLD-02-006	OB4 Interoperability	CRT-VLD-02-006-01	ATCo workload	The workshops concluded that there should not be any difference in ATCO's workload with SURF-A/ITA, as the alerts are directly managed by the flight crew. Indeed, SURF-A/ITA aircraft behaves exactly in the same way, as if the flight crew detected a potential conflict visually.	OK
		CRT-VLD-02-006-02	Compatibility with ATCo formation	The workshops concluded that there should be no need for additional ATCO formation, except a small briefing explaining SURF-A/ITA principles, as usually with new aircraft equipment. SURF-A/ITA does not affect ATCO's current working methods at all.	OK
		CRT-VLD-02-006-03	No info of equipped A/C presence for ATCo	The workshops concluded that, as the alerts are very rare and do not affect the aircraft's behaviour (rejected take-off or go-around in case of another aircraft on the runway), this information would be useless for ATCOs.	OK
OBJ-VLD-02-	OB4	CRT-VLD-02-	Crew action	The workshops concluded	OK

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007	Interoperability	007-01	for non-reported alerts	that whatever the way flight crew are aware of a danger on the runway (including visually or by SURF-A alert), their action shall be the same. There is therefore no difference with current ATCO's operating method.	
		CRT-VLD-02-007-02	Reports are well understood by ATCo	The workshops concluded that there should be no issues if pilots report a "traffic alert", as usual, and that a prior briefing would be required to make ATCOs aware of the system in case pilots report a "SURF-A/ITA alert".	OK
		CRT-VLD-02-007-03	No need for additional info when reported alert by crew to ATCo	The workshops concluded that there is no specific need for downlinked information in case of a SURF-A alert, as it is a purely on-board alert, not affecting the flying capacities of the aircraft.	OK
OBJ-VLD-02-008		CRT-VLD-02-008-01	Conflict resolution using current phraseology	The workshops concluded that "SURF-A/ITA" should not be mentioned, and that free speech and generic terms should be preferred (e.g. "traffic warning"), so there is no additional phraseology required.	OK
		CRT-VLD-02-008-02	Frequency occupation remains acceptable	The workshops concluded that, as SURF-A/ITA aircraft behaves exactly in the same way as if the flight crew detected a potential conflict visually, there is no risk of additional frequency occupation with the use of normal language.	OK
OBJ-VLD-02-009	OB4 Interoperability	CRT-VLD-02-009-01	Additional barrier to ATC safety net	The workshops concluded that, as SURF-A/ITA is an on-board system completely independent from ground infrastructure, it completes ground based existing safety nets, so adds	OK

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				another REASON's barrier to the airport's surface movement management.	

888 **Table 4-6: DEMO Objectives supported by DSNA**

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5 Conclusions and recommendations

5.1 Summary of Demonstration results from all work packages

Below is provided consolidated summary of demonstration results from both exercises and transversal activities on the SESAR STAIRS program.

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Demonstration Results Conclusion	Demonstration Objective Status
OBJ-VLD-02-001	OB1 System performance (operational)	CRT-VLD-02-001-01	Acceptable nuisance alerts rate	Acceptable nuisance alert rate for operational system performance below 1E-05	OK
		CRT-VLD-02-001-02	Acceptable false alerts rate	Acceptable false alert rate for operational system performance below 1E-05	OK
		CRT-VLD-02-001-03	Acceptable detection rate	Acceptable detection rate 70%	OK
OBJ-VLD-02-002	AU feedback DEMO1&3 and DEMO2&4	CRT-VLD-02-002-01	Crew system acceptance during DEMO2&4 phases	DEMO1&2 provided crew acceptable results using in-service replay and flight trial, due to limited scope for final campaign it is only “Partial”.	Partially OK
		CRT-VLD-02-002-02	Crew system acceptance during DEMO1&3 phases	DEMO1 (bench test) provided acceptable results with crew acceptance. Not assessed within DEMO3	Partially OK
OBJ-VLD-02-003	OB2 Fast Time simulation (Surveillance degraded accuracy)	CRT-VLD-02-003-01	Acceptable nuisance alert rate	Acceptable nuisance alert rate below 1E-05	OK
		CRT-VLD-02-003-02	Acceptable false alert rate	Acceptable false alerts rate below 1E-05	OK
		CRT-VLD-02-003-03	Detection rate	Acceptable detection rate within 70%	OK
OBJ-VLD-02-004	OB3 ADS-B IN	CRT-VLD-02-004-01	Quality assessment	Identified ADS-B issues and updated design solution	OK
		CRT-VLD-	Rate of eligible	Based on the latest traffic equipage and NACp9	OK

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		02-004-02	DO-260B	selection it is acceptable with detection rate 70%	
		CRT-VLD-02-004-03	Accuracy assessment	Accuracy assessment provided final outcomes with Eurocontrol. Acceptable accuracy with system performance and design solution	OK
OBJ-VLD-02-005	OB3 Detection rate	CRT-VLD-02-005-01	UI rate	Covered by OBJ-004 under WP3 Tested missed detection for static and moving traffic.	OK
		CRT-VLD-02-005-02	Gap analysis	Gap analysis and coasting tested with acceptable results for newly defined data age parameters. Acceptable system performance in OB1 and 2	OK
OBJ-VLD-02-006	OB4 Interoperability	CRT-VLD-02-006-01	ATCo workload	The workshops concluded that there should not be any difference in ATCO's workload with SURF-A/ITA, as the alerts are directly managed by the flight crew. Indeed, SURF-A/ITA aircraft behaves exactly in the same way, as if the flight crew detected a potential conflict visually.	OK
		CRT-VLD-02-006-02	Compatibility with ATCo formation	The workshops concluded that there should be no need for additional ATCO formation, except a small briefing explaining SURF-A/ITA principles, as usually with new aircraft equipment. SURF-A/ITA does not affect ATCO's current working methods at all.	OK
		CRT-VLD-02-006-03	No info of equipped A/C presence for ATCo	The workshops concluded that, as the alerts are very rare and do not affect the aircraft's behaviour (rejected take-off or go-around in case of another aircraft on the runway), this information would be	OK

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				useless for ATCOs.	
OBJ-VLD-02-007	OB4 Interoperability	CRT-VLD-02-007-01	Crew action for non-reported alerts	The workshops concluded that whatever the way flight crew are aware of a danger on the runway (including visually or by SURF-A/ITA alert), their action shall be the same. There is therefore no difference with current ATCO's operating method.	OK
		CRT-VLD-02-007-02	Reports are well understood by ATCo	The workshops concluded that there should be no issues if pilots report a "traffic alert", as usual, and that a prior briefing would be required to make ATCOs aware of the system in case pilots report a "SURF-A/ITA alert".	OK
		CRT-VLD-02-007-03	No need for additional info when reported alert by crew to ATCo	The workshops concluded that there is no specific need for downlinked information in case of a SURF-A/ITA alert, as it is a purely on-board alert, not affecting the flying capacities of the aircraft.	OK
		CRT-VLD-02-008-01	Conflict resolution using current phraseology	The workshops concluded that "SURF-A/ITA" should not be mentioned, and that free speech and generic terms should be preferred (e.g., "traffic warning"), so there is no additional phraseology required.	OK
		CRT-VLD-02-008-02	Frequency occupation remains acceptable	The workshops concluded that, as SURF-A/ITA aircraft behaves exactly in the same way as if the flight crew detected a potential conflict visually, there is no risk of additional frequency occupation with the use of normal language.	OK
OBJ-VLD-02-	OB4	CRT-VLD-	Additional	The workshops concluded	OK

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009	Interoperability	02-009-01	barrier to ATC safety net	that, as SURF-A/ITA is an on-board system completely independent from ground infrastructure, it completes ground based existing safety nets, so adds another REASON's barrier to the airport's surface movement management.	
		CRT-VLD-02-009-02	Triggering criteria well understood by crew	Flight test and simulator preparation, as well as interoperability workshops allowed to review with pilots triggering conditions for different use cases and no design modification was needed for any of the use cases	OK

Table 5-1: Summary of Demonstration results from all work packages

Note: These results will be complemented by WP4 with final version in December.

5.2 Conclusions

Work Package 2

Through the workshops, it can be concluded that SURF-A/ITA function is compatible and complementary with ground-based airport safety nets like Runways Monitoring and Safety Alerts (RAMS), Conformance Monitoring Alerts for Controllers, etc. Besides, SURF-A/ITA functional scope does not extend over current pilots' tasks, therefore no new ATC procedures and neither new phraseology is required; only ATCo need to be familiar with the airborne safety net.

Flight test preparation activities and Interoperability workshop activities allowed to confirm that alert timing is valid. However, it will be substantial assessing pilot understanding of alerts timing while performing another task (e.g., fly, navigate, etc.).

Regarding ADS-B performance, a quality performance assessment has been performed focusing on the position error. Results show that ADS-B performance is good but larger study should be done and possibly taking into consideration other KPIs (ground speed, heading track).

The method used to assess quality performance studied occurrence rate per report whereas the acceptability of SURF-A/ITA application is based on event exposure per operation.

Work Package 3 – SURF-ITA – EXE-H

Activities done within exercise EXE-H under work package 3 with DEMO2 prep flight trial, ADS-B in-service significant data replay and DEMO1 bench test provided outcomes to all defined objectives covering all applicable success criteria for planned certification and deployment. An important outcome from qualitative assessment complementing WP2 with all parameters assessment helped to

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improve design solution to secure demanding safety objectives with ADS-B airport environment and future standardization updates of MOPS development. Using different regional ADS-B data compared to SESAR PJ28 helped with system adjustment unified with global ATC procedures and controlled airspace differences. Using significant ADS-B data set provided results with high significance for means of compliance with regulatory body and helped to assess no impact to existing ATC procedures globally.

The system is expected at "on-going" TRL7 with high level of confidence and to be confirmed at TRL7 after a final flight campaign out of the STAIRS program scope. There is no plan for any design changes, only possibility for configuration of the system with specific scenario and runways inhibit or silent mode.

Work Package 4 – SURF-A – EXE-T

Activities planned initially within the DEMO Plan were impacted due to Covid-19 crisis, resulting in some of the objectives of EXE-T being partially or not assessed. The fact that VLD and some of the peripheral activities (in particular crew acceptability) were postponed beyond the timeframe of the STAIRS projects has an impact on the maturity considerations, nevertheless SURF-A function can be considered as mature.

Most of the objectives are considered as achieved for the Project. For not fully assessed objectives, some confidence factors were identified:

- For crew's acceptability in sim and flight
  - Preliminarily assessed in PJ.03b-05 in sim and in flight
  - Crews' confidence in the design - feedback from the discussions
- For function performance assessment in flight
  - Fast Time Simulations with representative models of functions providing far more coverage of possible nuisance alerts than actual in-service exposure

The Validation Path after this maturity gate will allow to get final confidence on SURF-A function crew acceptability and performance, needed to deploy the function. All of the elements performed in frame of the project will be used for the certification of the function in the coming year.

5.3 Recommendations

5.3.1 Recommendations for industrialization and deployment

Continue activities initially planned in the DEMO Plan beyond the timeframe of the project focusing on:

- Lab test in Airbus with the final version of SURF-A function
- Crew system evaluations/acceptance in simulator and flight environment
- CEIS of SURF-A function in the shadow mode with similar criteria to the ones from DEMO Plan
- Analysing data from CEIS to gain confidence of function's performance in various real environment

It is recommended to assess all ADS-B qualitative assessment done so far as that could impact future system performance sensitive to ADS-B system issues with various traffic equipage and local airports' ADS-B quality.

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It is recommended to properly train the flight crew for the system function within updated flight crew training materials and manuals.

System design shall have configurable parameters to inhibit scenarios/runways in which nuisance alerts are repeatedly raised

Triggered alerts should be recorded for possible troubleshooting and analysis

Air Traffic Controllers briefing should be provided before system deployment

In-service feedback about the function should be logged and analysed to allow for function improvements, if needed

5.3.2 Recommendations on regulation and standardisation initiatives

In reference to existing RTCA DO-323 and DO-317C, SESAR activities should be reflected in future MOPS development with high importance of ADS-B data quality assessment and system performance validation for both SESAR solutions.

Progress should be made with change proposal of ICAO DOC 9994 (Airborne Surveillance Applications) to add SURF-A function description

SURF-A should be considered to be added to ARINC660 “CNS/ATM Avionics, Functional Allocation and Recommended Architectures” - action ongoing.

A recommendation to adjust enablers on SESAR EATMA has been proposed to add REG-0200 (Safety Targets in Relation to Reductions of Runway Incursions) and removing REG-0003 (ATSAW) dependency under SESAR JU change request.

5.3.3 Recommendations for updating ATM Master Plan Level 2

No specific recommendation for update of ATM Master plan level 2.

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6 Summary of Communications and Dissemination activities

6.1 Summary of communications and dissemination activities

The main communication and dissemination activities have been performed around standardisation committees and international organizations like ICAO, and through the participation in international symposiums which reach our target audience (see §6.2). The presentation of SURF-A/ITA has been widely appreciated by the different working groups and international conferences.

Here below the list of the main activities and related achievements:

- ICAO AIRB/WG13 in 2021 and update in 2022.

Draft proposal has been done to include SURF-A in ICAO Doc 9994 which already includes SURF and SURF-IA. The objective was to prepare future stakeholders (ANSPS, Pilots, States …) to the introduction of SURFACE ALERTING once technology is certified.

- EUROCAE WG51 SG3 / RTCA SC186 WG4 in 2022

SURF-A was presented to raise awareness on the current status of the developing technology and the impact it will have in Airports Safety Net. Similar presentation was performed in the two following activities.

- ICAO Emerging Surveillance Technologies Symposium in September 2022

https://www.icao.int/Meetings/SUR-Technologies/Pages/default.aspx

- ICAO 2022 Runway Safety Seminar presentation

SURF-A was presented together with other airborne functions preventing errors on airports. Similar presentation was performed in the following activity.

- Aviation technological week in November 2021
- DSAC Symposium (la direction de la sécurité de l'Aviation civile – France) in 2021

https://www.ecologie.gouv.fr/sites/default/files/Programme_DSAC_Sympo2021_211202.pdf

- ATM interoperability review 2021

Workshop with Air Traffic Controllers and pilots was held to discuss the integration of SURF-A/ITA in the ATM environment (i.e., coexistence of the airborne alert with ground-based alerts) taking into account aspects like training/awareness needed by ATC and pilots or the phraseology to be used during the operations.

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Airbus Safety Conference in 2020

- Workshop with ATC at CDG airport in 2020

Workshop with Air Traffic Controllers to introduce system and validate corner case scenarios.

- World ATM Congress in 2020

Consortium presented expected project outcomes and objectives during walking tours, main communication goal was to raise awareness about the technology and project.

Since the commercial flight campaign will not happen in 2022 to advertise the very largescale demonstration outcomes, major communications to European Airports, Airspace Users, Aviation Authorities, air navigation service providers and even the non-scientific community but air transports users will be reached in the near future.

6.2 Target Audience Identification

There are numerous potential targets in a wide range of organisations, including air navigation service providers, airspace users, European airports, the manufacturing industry, national aviation authorities; standards-setting organisations; professional staff organisations; and the relevant scientific institutions or the relevant scientific community.

Here below it is explained the approach followed for each type of audience.

Target Audience	Relevance	Approach
Standardisation Committees	Ensure alignment of STAIRS with current and future Aerospace/ATM standards	Presentation of SURF-A/ITA was provided to standardization committees
Pilots	Ensure alignment with pilots and their associations	Presentation of SURF-A/ITA was provided in ICAO Events and Airbus Safety conferences which target as well that audience
Airlines	Alignment with airlines	Presentation of SURF-A/ITA was provided in ICAO Events and Airbus Safety conferences which target as well that audience
International organisations, ICAO	Ensure alignment	Presentation of SURF-A/ITA was provided in ICAO Events and Airbus Safety conferences which target as well that audience
Aviation Authorities	Certification and alignment	Presentation of SURF-A/ITA was provided in ICAO Events and Airbus Safety conferences which target as well that audience
European airports	System alignment	Presentation of SURF-A/ITA was provided in European aviation related events (e.g. Aviation Technological week or World ATM Congress)
Scientific institutions	Alignment with scientific community	Presentation of SURF-A/ITA was provided in European aviation related events (e.g. Aviation Technological week or World ATM Congress)

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EU and member states	EU airport and passenger safety	Presentation of SURF-A/ITA was provided in European aviation related events
ATM standardisation	Interoperability aspects	Presentation of SURF-A/ITA was provided to standardization committees
Defence agencies	Alignment with military SES aspects	Presentation of SURF-A/ITA was provided in European aviation related events (e.g. Aviation Technological week or World ATM Congress)

6.3 Project High Level Messages

Within the dissemination and communication activities the STAIRS project main messages have been:

- SURF-A/ITA pioneer the way in the Europe operations and strengthening Airport Safety Net with airborne safety system solutions.
- This Aircraft Safety technology protects the ownership in all the possible situations close to the runway (take-off, landing, line up, runway crossing and taxi on the runway); and
- SURF-A/ITA system can be used in different airport layouts and rate of utilisation. The system based on ADS-B information brings maximum benefits in major airports with complex surface layout which are more demanding to be monitored by ATCo.

6.4 Communication Material

- ICAO Emerging Surveillance Technologies Symposium presentation :
- https://www.icao.int/Meetings/SUR-Technologies/Documents/D2%20JB%20Berthier%20Airbus%20Session%206%20-%20Outlook%20on%20future%20SUR%20capacities.pdf
-
- ICAO 2022 Runway Safety Seminar presentation:
- https://www.icao.int/EURNAT/Other%20Meetings%20Seminars%20and%20Workshops/Safety%20-%20RWY%20SAF/ICAO%20Runway%20Safety%20Seminar%20-%20Technology/3.5%20Airbus%20-%20Runway%20incursions%20and%20collisions%20risk%20prevention%20-%20Onboard%20solutions.pdf
-
- DSAC Symposium (la direction de la sécurité de l'Aviation civile – France) in 2021
- https://www.ecologie.gouv.fr/sites/default/files/Sym_DSAC_Incursions_Piste.pdf

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7 References

S2020 Programme Library

[1] Maturity Assessment Report

[2] Project Handbook

[3] SESAR 2020 Performance Assessment and Gap Analysis Report

[4] EOCVM V3 Volume 2

[5] SESAR Requirements and V&V guidelines

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

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

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

[9] SESAR, Resilience Engineering Guidance, May 2016

[10] SESAR 2020 Communication Guidelines 04.00.00, [19/01/2017]

[11] ATM Master Plan, data set 16, 25/05/2016

[12] SESAR Maturity Report, edition [05/07/2019]

[13] SESAR Release Strategy, edition [2020]

[14] 874476 STAIRS Grant Agreement, [2019]

[15] SESAR 2020 Project Handbook, edition 01.00.00, [14/02/2017]

Reference Documents

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

[17] H2020-SESAR-2019-1 IR VLD WAVE 2 STAIRS Part B section1-3

[18] SESAR PJ03B-05 D4.1.191 OSED/SPR-INTEROP [2019]

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Appendix A Demonstration Report: Exercise EXE-VLD-02-001 (EXE-H) – WP3

In this appendix A is provided demonstration exercise report for exercise EXE-VLD-02-001 (EXE-H) led by Honeywell within work package WP3.

A.1 Summary of the Demonstration Exercise EXE-VLD-02-001 Plan

The exercise has followed the demonstration plan "D1.1 SESAR 2020 VLD2 STAIRS DEMO Plan final" with below identified changes as defined by Impact Change document within SJU process (chapter 3.4).

A.1.1 Exercise description and scope

The exercise EXE-H was primarily focused on demonstrating performance of the solution by using a large amount of in-service data and by executing a flight trial on F900EX. As a complement to these demonstration activities, the team performed an analysis of the interoperability with ATC and an ADS-B quality assessment.

Key demonstration objectives defined in chapter 4.1 have been covered by the exercise.

The scenarios used for in-service data replay followed standard operational procedures and local ATC airport procedures in controlled airspace of 9 of the largest airports worldwide and representing all scenarios defined in the OSED. The flight trial with F900EX involved a limited set of scenarios with simulated intruder traffic during demonstration flights.

A.1.2 Summary of Demonstration Exercise EXE-H Demonstration Objectives and success criteria

Demonstration objectives with success criteria for the exercise are provided in below table.

Demonstration Objective	Demonstration Success criteria	Coverage and comments on the coverage of Demonstration objectives	Demonstration Exercise 1 Objectives	Demonstration Exercise 1 Success criteria
OBJ-VLD-02-001	CRT-VLD-02-001-01	OB1 System performance	CEIS	Acceptable nuisance alerts rate
	CRT-VLD-02-001-02			Acceptable false alerts rate
	CRT-VLD-02-001-03			Acceptable detection rate
OBJ-VLD-02-002	CRT-VLD-02-002-01	AU feedback DEMO1 and DEMO2		Crew system acceptance during DEMO2 phases
	CRT-VLD-02-002-02			Crew system acceptance during DEMO1 phases

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OBJ-VLD-02-003	CRT-VLD-02-003-01	OB2 Fast Time simulation	System performance with simulated and real ADS-B data	Nuisance alert rate
	CRT-VLD-02-003-02			False alert rate
	CRT-VLD-02-003-03			Detection rate
OBJ-VLD-02-004	CRT-VLD-02-004-01	OB3 ADS-B IN	ADS-B IN quality assessment	Quality assessment
	CRT-VLD-02-004-02			Rate of eligible DO-260B
	CRT-VLD-02-004-03			Accuracy assessment
OBJ-VLD-02-005	CRT-VLD-02-005-01		ADS-B IN detection assessment	UI rate
	CRT-VLD-02-005-02			Gap analysis
OBJ-VLD-02-006	CRT-VLD-02-006-01	OB4 Interoperability	Compatibility	ATCO workload
	CRT-VLD-02-006-02			Compatibility with ATCo formation
	CRT-VLD-02-006-03			No info of equipped A/C presence for ATCo
OBJ-VLD-02-007	CRT-VLD-02-007-01		Reporting	Crew action for non-reported alerts
	CRT-VLD-02-007-02			Reports are well understood by ATCo
	CRT-VLD-02-007-03			No need for additional info when reported alert by crew to ATCo
	CRT-VLD-02-008-01		Phraseology	Conflict resolution using current phraseology
	CRT-VLD-02-008-02			Frequency occupation remains acceptable
OBJ-VLD-02-009	CRT-VLD-02-009-01		Safety Improvement	Additional barrier to ATC safety net
	CRT-VLD-02-009-02			Triggering criteria well understood by

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				crew

Table 7-1: Summary of DEMO Objectives with success criteria

A.1.3 Summary of Demonstration Exercise EXE-H Demonstration Assumptions

Below table includes summary of the demonstration assumptions for the exercise EXE-H below work package WP3.

Identifier	Title	Type of Assumption	Description	Justification	Impact on Assessment
ASS-VLD-02-001	Maturity	Technology	VLD expects demonstration of V3 mature Solution PJ03B-05.	Objective of this VLD is to de-risk future deployment of mature solutions.	High
ASS-VLD-02-002	AU users participation	AU	Trained AU users participate in the project	AU users play key role in the demo, training of the crew is necessary	High
ASS-VLD-02-003	SURF-A/ITA performance	Performance	No/minimum alerts during regular operations	Alert timing below ATC procedures and separation	High
ASS-VLD-02-004	Silent mode	Implementation	Possibility to select silent version of the SURF-A/ITA implementation	Airlines operational procedures and preference	Low
ASS-VLD-02-006	ADS-B data	ADS-B	ADS-B data represent reality on existing airport	ADS-B analysis and representative results, existing environment, equipage rate	Medium
ASS-VLD-02-007	ATC	Interoperability	No change to existing ATC procedures	DEMO will not need any change to ATC, ATFM processes	Medium
ASS-VLD-02-009	ANSP data	Interoperability	Comparison of available ATC collected data from specific airport	Comparison of two data samples for main parameters accuracy analysis	Medium

Table 7-2: Demonstration Assumptions overview

A.2 Deviation from the planned activities

Below are provided the main program changes from planned activities.

- SURF-A has been withdrawn from work package WP3 and left only in WP4 with EXE-T
- Final demonstration flights with SURF-ITA have been postponed

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A.3 Demonstration Exercise EXE-H Results (Work Package 3)

A.3.1 Summary of Demonstration Exercise EXE-H Demonstration Results

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Sub-operating environment	Exercise Results	Demonstration Objective Status
OBJ-VLD-02-001	OB1 System performance	CRT-VLD-02-001-01	Acceptable nuisance alerts rate	Global	Acceptable 0 nuisance alert rate for operational system performance	OK
		CRT-VLD-02-001-02	Acceptable false alerts rate	Global	Acceptable 0 false alert rate for operational system performance	OK
		CRT-VLD-02-001-03	Acceptable detection rate	Global	Acceptable missed detection rate using ADS-B data filter	OK
OBJ-VLD-02-002	AU feedback DEMO1 and DEMO2	CRT-VLD-02-002-01	Crew system acceptance during DEMO2 phases	Global	DEMO2 provided acceptable results. Limited scope for final campaign.	Partially OK
		CRT-VLD-02-002-02	Crew system acceptance during DEMO1 phases	Global	DEMO1 provided acceptable results.	OK
OBJ-VLD-02-003	OB2 Fast Time simulation	CRT-VLD-02-003-01	Nuisance alert rate	Global	Nuisance alert rate with degraded surveillance events provided acceptable rate below 1E-06	OK
		CRT-VLD-02-003-02	False alert rate	Global	0 false alerts rate	OK
		CRT-VLD-02-003-03	Detection rate	Global	Acceptable detection rate within 70%	OK
OBJ-VLD-02-004	OB3 ADS-B IN	CRT-VLD-02-004-01	Quality assessment	Global	Identified ADS-B issues and addressed with ADS-B filter	OK
		CRT-VLD-02-004-02	Rate of eligible DO-260B	Global	Based on the latest traffic NACp	OK

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					selection it is acceptable	
		CRT-VLD-02-004-03	Accuracy assessment	Global	Accuracy assessment provided final outcomes with Eurocontrol. Acceptable with design solution	OK
OBJ-VLD-02-005	OB3 Detection rate	CRT-VLD-02-005-01	UI rate	Global	Covered by OBJ-004 Tested missed detection for static and moving traffic. Tested using ADS-B filter tooling with acceptable results.	OK
		CRT-VLD-02-005-02	Gap analysis	Global	Gap analysis and coasting tested using ADS-B filter tooling with acceptable results for newly defined data age parameters.	OK
OBJ-VLD-02-006	OB4 Interoperability	CRT-VLD-02-006-01	ATCo workload	Global	With operational analysis of SC-186 ADS-B data the workload is not impacted due to acceptable system performance.	OK
		CRT-VLD-02-006-02	Compatibility with ATCo formation	Global	There has not been identified and impact for closely operating traffic in most stressed environment based on ICAO PANS and FAAO procedures.	OK
		CRT-VLD-02-006-03	No info of equipped A/C presence for ATCo	Global	Should not have an impact with proved system performance	OK
OBJ-VLD-02-007	OB4 Interoperability	CRT-VLD-02-007-01	Crew action for non-reported alerts		N/A	
		CRT-VLD-02-007-02	Reports are well		N/A	

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			understood by ATCo			
		CRT-VLD-02-007-03	No need for additional info when reported alert by crew to ATCo		N/A	
		CRT-VLD-02-008-01	Conflict resolution using current phraseology		N/A	
		CRT-VLD-02-008-02	Frequency occupation remains acceptable		N/A	
OBJ-VLD-02-009	OB4 Interoperability	CRT-VLD-02-009-01	Additional barrier to ATC safety net	Global	System performance proved correct timing of valid alerts below ATC thresholds and runway min separation.	OK
		CRT-VLD-02-009-02	Triggering criteria well understood by crew	Global	Crew has confirmed the triggering criteria are well understood and consistent.	OK

Table 7-3: Exercise EXE-H Demonstration Results

1. Results per KPA

KPA	Objective	Description	KPI	Success criteria	Where & how	CTQ value	Results
Safety	OB1	Controlled Entry Into Service (CEIS)	Operational: Nuisance, false, missed alerts rate and human performance confirmation	Acceptable alert rates, System and HMI acceptance	Flight trial (US) F900EX, In-service FAA data replay	Operational: Nuisance rate below 1E-05, false rate below 1E-05 Missed rate below 3E-02, Cockpit applications synchronized, Pilots confirmed	Using flight trial of main scenarios with simulated traffic on-board and replay of cert in-service data package have confirmed acceptable KPI rates. HMI has been assessed

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					expected V3 solution	acceptable with implementation and synced with other pilots' cockpit system applications.
OB2	Data replay in fast time	(Safety) Fast time simulations, replay: Nuisance, false alerts, certification	Acceptable alert rates, System acceptance	In-service FAA ADS-B data replay (significant sample)	ADS-B qualitative assessment and simulation with impact to algorithms	Analysis of ADS-B data with qualitative assessment and simulation has initiated development of additional defensive design layer with new ADS-B filter. Final results confirmed acceptable alert rates and system behaviour.
OB3	ADS-B quality assessment	(Interoperability): transverse analysis of ADS-B performance acceptability	Traffic detection rate of at least 70% Qualitative assessment / Navigation parameters accuracy	DSNA data	ADS-B accuracy and assessment in line with eligibility rules	Eurocontrol analysis and WP3 FAA ADS-B qualitative assessment have confirmed previous SESAR outcomes and provided inputs for design solution update.
OB4	Interoperability review	(Interoperability): ANSP operational expertise	Compatibility with ground safety net, alert timing, ATC procedures and phraseology	Operational experts, airspace users (ATC, Pilots, surv experts)	Use cases with interoperability objectives confirmed	Supported by DSNA workshops and analysis of operational ATC procedures versus results of OB2 alerting algorithms performance has proved interoperability compliance in all aspects. Confirmed safety improvement as previous SESAR solution at V3 with no impact to ATCo workload.

Table 7-4: Results per KPA

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2. Results impacting regulation and standardisation initiatives

The results from the EXE-H contributes to future standardisation activities by complementing the existing SPR document RTCA DO-323 and RTCA DO-317C with SURF-A/ITA key performance indicators and feasible requirements for future MOPS development. The definition of ADS-B qualitative impacts versus traffic eligibility rules will also be a key input to future standardization and regulatory activities.

A.3.2 Analysis of Exercises EXE-H Results per Demonstration objective

1. OB1 Demonstration Objectives Results (WP3) – CEIS

a. OBJ-VLD-02-001

[OBJ]

Identifier	OBJ-VLD-02-001
Objective	To Demonstrate SURF-A/ITA system operational performance with acceptable nuisance, false and missed alerts during commercial flights.
Title	SURF-A/ITA system performance in flight demonstration
Category	<performance>, <safety>
Key environment conditions	Nominal conditions, Multiple dependent runways, LUSL, LUCL, HUSL, HUCL

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	VLD02
<COVERS>	<Sub-Operating Environment>	Airport, LUSL, LUCL, HUSL, HUCL

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-	SURF-A/ITA System operational performance is within	OK

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001-01	required safety requirements: Nuisance alerts rate: less than 10^{-5}/per ownship operation [2]	
CRT-VLD-02-001-02	False alerts rate: less than 10^{-5}/per ownship operation [2]	OK
CRT-VLD-02-001-03	Detection rate > $7*10^{-1}$ of eligible traffic / per ownship operation	OK

b. OBJ-VLD-02-002

[OBJ]

Identifier	OBJ-VLD-02-002
Objective	To Demonstrate crew acceptability of the SURF-A/ITA system
Title	SURF-A/ITA crew acceptability
Category	<performance>, <safety>
Key environment conditions	Nominal conditions, Multiple dependent runways

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	VLD02
<COVERS>	<Sub-Operating Environment>	Airport, LUSL, LUCL, HUSL, HUCL

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-002-01	SURF-A/ITA system performance acceptability by the crew during their flights and standard operational procedures in case of alerts triggered. (Subjective pilots' description and Likert scale 3/5.) Due to limited data sample, it is not	Acceptable

[2] The number of operations required to demonstrate 10^{-5} was not achieved solely based on the data collected during DEMO2, the demonstration requirement of 10^{-5} was assessed based on a combination of in-flight demonstration (OB1) and fast-time simulation (OB2).

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	expected for DEMO HP assessment.	
CRT-VLD-02-002-02	Crew acceptability of HMI and system performance during preparation phase for DEMO. (Acceptable/Not Acceptable, simulator session for PTS system requirements and selected scenarios).	Acceptable

2. OB2 Demonstration Objective (WP3) – Fast time simulation

This demonstration objective defines capability to replay ADS-B data during DEMO1&3 or from collected flight during final DEMO2&4.

a. OBJ-VLD-02-003

[OBJ]

Identifier	OBJ-VLD-02-003
Objective	To Demonstrate SURF-A/ITA system performance with acceptable nuisance, false and missed alerts using collected data from ATC (A-SMGCS) or aircraft. (Degraded surveillance accuracy)
Title	FTS SURF-A/ITA system performance fast-time simulation demonstration
Category	<performance>, <safety>
Key environment conditions	Nominal conditions, Multiple dependent runways, LUSL, LUCL, HUSL, HUCL

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	VLD02
<COVERS>	<Sub-Operating Environment>	Airport, LUSL, LUCL, HUSL, HUCL

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-003-01	SURF-A/ITA System operational performance is within the safety requirements: Nuisance alerts rate: less than 10^{-5}/per ownship operation	OK
CRT-VLD-02-003-02	False alerts rate: less than 10^{-5}/per ownship operation	OK

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CRT-VLD-02-003-03	Detection rate > 70% per ownship operation	OK

3. OB3 Demonstration Objective (WP2) – ADS-B detection & quality assessment

This demonstration objective focuses on ADS-B data detection and quality assessments of airport environment. The analysis will include ground surveillance data and collected data from revenue flights.

a. OBJ-VLD-02-004

[OBJ]

Identifier	OBJ-VLD-02-004
Objective	To assess ADS-B IN data quality: ○ ADS-B SURF-A/ITA parameters statistics ○ Equipage rate to the ADS-B OUT mandate reference ○ Position, speed & heading accuracy assessment ○ Eligibility requirements
Title	ADS-B In data quality assessment
Category	<performance>, <safety>
Key environment conditions	Nominal conditions, Multiple dependent runways

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	VLD02
<COVERS>	<Sub-Operating Environment>	Airport

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-004-01	Provide an overview of observed ADS-B In quality assessment in reference to defined eligibility requirements	Delivered under WP2 and WP3
CRT-VLD-02-004-02	Positive/improving rate of RTCA DO-260B equipped A/C	Detection rate using NACp9 confirmed as acceptable
CRT-VLD-02-	Accuracy assessment of position, speed, heading parameters with MLAT, A-SMGCS	Accuracy assessment completed Eurocontrol and

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004-03	and A/C data	WP3 results for all parameters

b. OBJ-VLD-02-005

[OBJ]

Identifier	OBJ-VLD-02-005
Objective	To analyse observed ADS-B IN data detection with below aspects: ○ Update rate intervals ○ ADS-B gaps analysis ○ Line of sight loss (e.g. building) and requirement for ADS-B repeater ○ Detection rate
Title	ADS-B IN data detection assessment
Category	<performance>, <safety>
Key environment conditions	Nominal conditions

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	VLD02
<COVERS>	<Sub-Operating Environment>	Airport

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-005-01	Observed Update Interval rate	Acceptable rates for filtered and eligible data sample with static and moving traffic
CRT-VLD-02-005-02	Observed ADS-B gaps and analysis (detection rate 70%)	Gaps and coasting analysis done. Update of data age eligibility parameters. Prove acceptable detection rate and sys performance.

4. OB4 Interoperability Demonstration Objectives (WP2)

a. OBJ-VLD-02-006

[OBJ]

Identifier	OBJ-VLD-02-006

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Objective	To demonstrate that SURF-A is compatible with current ATC working methods
Title	SURF-A compatibility
Category	<safety>, <operational feasibility>, <human performance>
Key environment conditions	

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-006-01	The use of SURF-ITA does not lead to an ATCO workload increase.	OK Confirmed by WP2 and WP3
CRT-VLD-02-006-02	The use of SURF-ITA is compatible with current ATCO formation level and does not require any additional ATCO training.	OK
CRT-VLD-02-006-03	For each aircraft, the ATCO does not need to be informed on the presence of the SURF-ITA on-board.	OK

b. OBJ-VLD-02-007

[OBJ]

Identifier	OBJ-VLD-02-007
Objective	To demonstrate that SURF-ITA triggered alerts do not require a specific report from aircraft to ground
Title	SURF-A reports
Category	<operational feasibility>, <human performance>
Key environment conditions	

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-007-01	In case of SURF-ITA/A alerts **not reported** by Flight Crew, Flight Crew actions and intentions are enough for ATCO to understand the situation.	OK (WP2)
CRT-VLD-02-007-02	In case of SURF-ITA/A alerts **reported** by Flight Crew by voice, this report is well understood by ATCOs	OK (WP2)
CRT-VLD-02-007-03	In case of SURF-ITA/A alerts **reported** by Flight Crew, no other information is required from the aircraft (i.e. no automatic aircraft alert downlink)	OK (WP2)

c. OBJ-VLD-02-008

[OBJ]

Identifier	OBJ-VLD-02-008
Objective	To demonstrate that SURF-A does not require a specific phraseology
Title	SURF-A phraseology
Category	<operational feasibility>, <human performance>, <acceptability>

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Key environment conditions	

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-008-01	All the conflicts raised by SURF-ITA/A can be resolved using current phraseology without ambiguity between Flight Crew and Air Traffic Control	OK (WP2)
CRT-VLD-02-008-02	Frequency occupation remains acceptable in case of SURF-ITA/A alert with the use of normal language (without any dedicated phraseology)	OK (WP2)

d. OBJ-VLD-02-009

[OBJ]

Identifier	OBJ-VLD-02-009
Objective	To demonstrate that SURF-A improves ground safety
Title	SURF-A safety improvement
Category	<safety>, <human performance>
Key environment conditions	

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-009-01	SURF-A adds another REASON's barrier to the airport's surface movement management, that is independent from Ground based safety nets	OK (WP2)
CRT-VLD-02-009-02	SURF-A triggering criteria are well known and understood by Flight Crew with regards to other airport safety nets.	OK, confirmed by WP3 and 4

A.3.3 Unexpected Behaviours/Results

There were no unexpected behavior results unless specified in the qualitative assessment of ADS-B issues provided in OBJ-VLD-02-004. With detailed issues analysis and solution design update, the system performance provides acceptable results.

A.3.4 Confidence in the Demonstration Results

1. Level of significance/limitations of Demonstration Exercise Results

Flight trial has represented a limited number of flights, which were complemented by significant in-service data sample replay proving confidence of the results for certification means of compliance and CEIS objective.

2. Quality of Demonstration Exercise Results

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The exercise has been tested on the industrial aircraft platform HW. In-service data replay and simulation followed from previous SESAR activities with gained experience and verified processes supported by Eurocontrol.

3. Significance of Demonstration Exercises Results

Using significant in-service data sample provides statistical significance of results proving safety objectives for the system performance. Bench testing within DEMO1 and and extensive Flight trial within DEMO2 (prep) confirmed operational and platform readiness for a future deployment and planned certification with expected system performance.

A.4 Conclusions

Activities done within exercise EXE-H under work package 3 with DEMO2 prep flight trial, ADS-B in-service significant data replay and DEMO1 bench test provided outcomes to all defined objectives covering all applicable success criteria for planned certification and deployment. An important outcome from the qualitative assessment helped to improve the design solution to secure demanding safety objectives, preparing future standardization updates (e.g. MOPS). Using different regional ADS-B data compared to SESAR PJ28 helped improve the solution and demonstrate that it is ready for a wide deployment , accounting for differences in ATC procedures, airport configurations and transmitted ADS-B quality.. Using a multimillion ADS-B data set helps build confidence in the function and constitutes a candidate means of compliance for future certification.

A.5 Recommendations

A.5.1 Recommendations for industrialization and deployment

It has been demonstrated acceptable system performance and readiness which is crucial for the system deployment.

It is recommended to track and take into account all ADS-B qualitative assessments done so far as they could help to improve future system performance sensitive to ADS-B system issues with various traffic equipage and local airports' quality.

Compatibility of SURF-ITA with other cockpit functions was addressed in STAIRS, however when implementing the function in a given business aircraft, there is still a need to ensure compatibility of the function with the flight deck and its cockpit philosophy.

A.5.2 Recommendations on regulation and standardisation initiatives

In reference to existing RTCA DO-323 and DO-317C, SESAR activities should be reflected in future MOPS development with a particular emphasis on the ADS-B data quality assessment and the system performance validation for both SESAR solutions, taking into account differences between versions with and without traffic display.

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Appendix B Demonstration Exercise Report: EXE-VLD-02-002 (EXE-T) – WP4

This appendix B provides demonstration exercise report for exercise EXE-VLD-02-002 (EXE-T) led by Thales/ACSS within work package WP4.

B.1 Summary of the Demonstration Exercise EXE-VLD-02-002 Plan

The exercise has followed the demonstration plan "D1.1 SESAR 2020 VLD2 STAIRS DEMO Plan final" with below identified changes as defined by Impact Change document within SJU process (chapter 3.4).

B.1.1 Exercise description and scope

Following Figure shows breakdown of WP4/EXE-T activities:

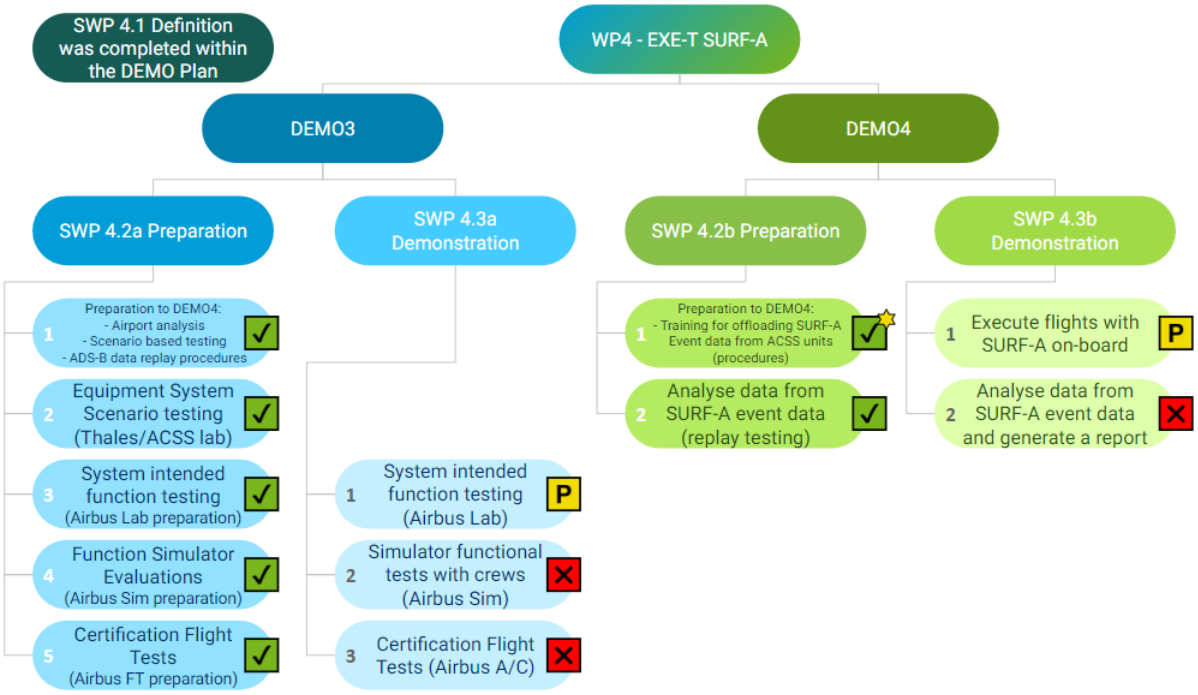

Figure 10 – Activities in frame of EXE-T / WP4

Paragraphs below present the status of activities performed compared to the DEMO Plan.

SWP 4.1

Completed within the DEMO Plan activities.

SWP 4.2a DEMO3 Preparation

Thales & ACSS have fully completed a lab test campaign on the third lab test standard (final SURF-A version) using a full representative Airport Database (including LFLX airport planned for the flight tests). Performance measurements in term of Missed alerts, Late alerts & Nuisance alerts are compliant with performance requirements and objectives.

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To prepare for DEMO3 Demonstration phase, Airbus has fully completed SWP 4.2a:

- system test procedures creation for shadow mode and active mode
- simulator evaluations functional testing preparation: briefings, scenarios, questionnaires for OPS/HF evaluations
- flight test requests and preparation for shadow mode (exposure flights) and active mode (flight test with two A/C <planned A320 and A330> both equipped in SURF-A to assess scenarios from DEMOPlan) with definition of the scenarios, units installation; NOTAMs provisions for the airport; flight test rehearsal planning

These preparation was meant to allow for execution of the SWP 4.3a (DEMO3 demonstration) as soon as final version of SURF-A function is available in Airbus facility – postponed beyond the project timeframe.

It is important to note that these activities will be used with no alteration for certification of SURF-A function both in shadow and active mode.

SWP 4.3a DEMO3 Demonstration

All activities in frame of this SWP were impacted:

- System “Intended function” SURF-A tests were partially performed in Airbus lab with intermediate version of SURF-A function allowing for:
  - Gaining confidence in SURF-A aircraft integration technical feasibility and intended operation (both bench and multi-system simulator testing)
  - Providing flight clearance for SURF-A in shadow mode with intermediate version
  - Preparing for flight test rehearsal and OPS/HF campaign i.a. coupling of two simulators for simultaneous assessment with two crews

  No showstoppers were identified during tests. Full scope of the verification tests is postponed beyond the timeframe of the Project and will be performed on the final version of the function.
- Simulator evaluation sessions with crews (including flight test rehearsal) were not possible with intermediate version of the function and will be performed beyond the Project.
- Certification functional flight tests in active mode was not possible with intermediate version of the function and will be performed beyond the project timeframe.

All activities will be performed based on preparation from SWP 4.2a.

Results from all these activities will be used for certification of SURF-A in both shadow and active mode (MOC 4, 6, 8)

SWP 4.2b DEMO4 Preparation

Best method assumptions concerning the way to collect SURF-A in-service data have changed during the project. Data will not be obtained from PCMIA card as initially assumed, but through Data Collection means involving other aircraft systems.

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Thus offloading procedure definition and training is not applicable. Instead Airbus has prepared means to collect and analyze data using SkyWise platform. As CEIS will still be performed, Airbus will use this platform to gain confidence in the performance of SURF-A function before introducing the active mode.

ACSS has conducted a Replay testing campaign to assess the algorithm.

This campaign has been performed using an FAA/US based set of data. The Real-World Test Scenarios were tested utilizing ADS-B Out messages provided by the FAA sourced from recorders at 9 major U.S. airports.

SWP 4.3b DEMO4 Demonstration

Airbus has installed SURF-A in shadow mode (intermediate version) on an experimental A320 family aircraft for non-specific exposure flights and used Data Collection means to collect and analyze SURF-A and ADS-B OUT data. Five flights were performed providing partial coverage of the activity. No nuisance nor other unexpected function behavior was detected during these flights.

As this amount of data is not sufficient to gain in-service confidence in real environment, Airbus still intends to perform initially planned CEIS in shadow mode with very similar engagement assumptions to the ones defined in the DEMO Plan. This activity will be performed beyond the timeframe of the project on A320 family.

Data collected during the CEIS will be analyzed with SkyWise and Airbus' internal Fast Time Simulation platform and will be used to assess in service performance of the function. This information will be used to decide on activation of the function in active mode. Thus activity is not performed within the project timeframe but after.

More details about each performed activity is contained below:

- Supplier's equipment tests showing proper functioning of the unit (prerequisite to the unit delivery to the aircraft manufacturer)
    - Sub-Status: Impacted with delay on The Fast Time Simulation campaign performed for Red Label 3.
    - Nevertheless, these tests demonstrate compliance with the performance requirements
- Lab system equipment integration tests showing the proper functioning of the equipment integrated into aircraft (prerequisite to the simulator and flight test exposure)

  For preparation part, Airbus has written a procedure covering 33 test cases allowing to test all interfaces of SURF-A function with other systems (display, flight warning, audio system, maintenance, data recording, data collection etc.), behaviour of the function with simulated traffic and alert generation. Test are covering both shadow mode and active mode.

  These tests could not yet be finalised as the final version of the SURF-A SW has not yet been available. Airbus performed a sub-set of SURF-A tests with intermediate version of

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the SURF-A SW. No adverse founding were identified to stop deployment of the function. Minor corrections will be implemented in the final version of the SW.

- Preparation to the simulation campaign assessing operational and human factor aspects with several flight crews (allowing to assess CRT-VLD-02-002-02)

For the preparation part, Airbus has written an operational test procedure, covering 32 operational cases connected to scenarios defined in section B.1.3. The main operational and HF issues/benefits that will be addressed during this evaluation campaign are related to:

- The understanding, the management and the appropriateness of the alerts,
- The benefits provided by the function on flight crew tasks,
- The operational procedures need associated to the function, and
- The integration with other functions in the cockpit.

Main focus was put on operational procedures. List below provides general list of operational cases to be assessed:

- Ownship taxiing toward hold-line or stopped at hold-line
- Ownship entering/crossing runway (not lined-up)
- Ownship at take-off
- Ownship on approach
- Ownship after landing, roll-out on runway
- Ownship stopped or taxiing along runway
- Automatic inhibitions of the alerts

Test cases with degraded visibility conditions were added to assess correct crew behaviour especially having in mind non-availability of the traffic indication on CDTI.

Preparation of this operational and human factors campaign includes the creation of a briefing document and debriefing questionnaire.

The briefing document includes introduction of:

- The context of the evaluation,
- Test objectives,
- Current limitations of the cockpit (if any),
- Agenda of the SURF-A test,
- Expected crew actions like what they will have on the future FCOM/FCTM

Note: The scenarios will not be exposed to the pilots before the evaluation. Only a flight folder (containing maps, flight plan, aircraft characteristics, VHF frequencies and weather conditions) will be provided during the briefing of each scenario.

Validation sessions will be organized with five crews. The first crew will be composed of the pilots involved in the design loop (referring pilots) in order to test the overall protocol and operational relevance of the scenarios and events proposed to test the HF objectives.
The other crews will be composed of pilots experienced with the function and having different backgrounds – airline, flight test and training pilots. The experienced pilots will

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be composed of pilots that already participated to the previous assessments or composed of pilots that will have received the briefing documentation.

The Debriefing Guide is composed of several questions per objectives concerning the scenarios and design of the SURF-A function also some questions will be added based on the pilots remarks made during the session and the observations made by the evaluation team (composed of Cockpit Operations engineers and Human Factors specialist).

Due to the delays, Airbus was not able to perform the planned campaign. As agreed, only preparation is considered in the scope of the project.

- Preparation to the flight test campaign in SURF-A active mode (referred to as Airbus Certification Flight Test) allowing to expose the crew to set of operation scenarios in real environment and assess the CRT-VLD-02-002-01, preceded by Flight Test Rehearsal

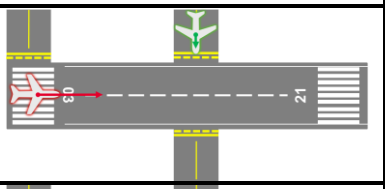
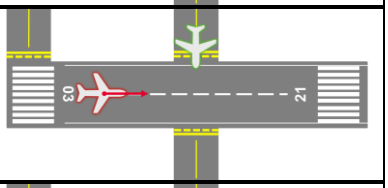
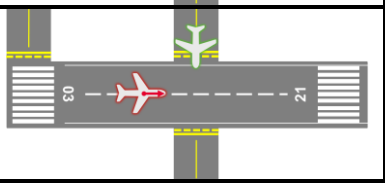
For the preparation part, Airbus has written a flight test procedure with 9 operational cases (doubled if considered 2 A/C equipped in SURF-A function). The flight tests are intended to be performed with one A320 family aircraft and one A330 aircraft, each being the intruder of the other. These tests are to be performed on Chateauroux remote airport with the runway and circuit to be reserved for the test. The tests volume envisaged is:

- 1/2 day of flight per aircraft
- 9 scenarios are proposed

Planned tests consist in performing scenarios involving 2 aircraft in order to:

- Create a situation of conflict (e.g., as if an error had been done by ATC and/or pilot).
- Trigger an alert on board.
- Resolve the conflict with an appropriate maneuver.

Planned ground scenarios are shown in below table:

#	A320neo	A330neo	Scenarios
1	Stopped at holding point C	Take-off runway 03	
4	In Runway Alerting Zone	Take-off runway 03	
3	In Runway Alerting Zone	Taxiing on runway 03	

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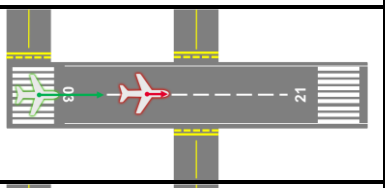
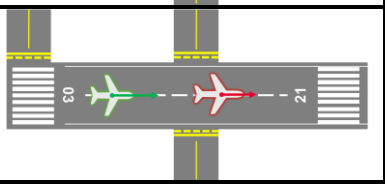
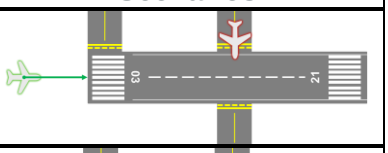
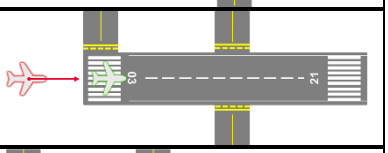
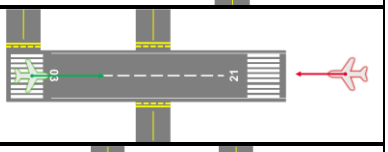
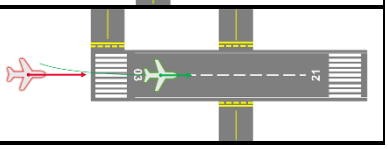
#	A320neo	A330neo	Scenarios
7a	Take-off runway 03	On runway 03 (ahead)	
12	Taxiing on runway 03 (behind)	Taxiing on runway 03 (ahead)	

Planned scenarios with at least one aircraft in-flight are the following:

#	A320neo	A330neo	Scenarios
2	Approach runway 03	In Runway Alerting Zone	
5	Lined-up runway 03	Approach runway 03	
6	Take-off runway 03	Approach runway 21	
10	Taxiing on runway 03	Approach runway 03	

The selected location for these flight tests is LFLX – Châteauroux Deols airport, as:

- This airport & associated airspace are not too busy.
- The runway is quite long, with a TODA & LDA of 3500 m.
- ATC is already familiar with the type of flight tests to be performed, as SURF-A R&T flight tests were performed at the same location.

Before exposing the crew in flight test conditions, due to relatively high precision needed to perform these tests with reduced separation between aircraft, the crew will be exposed to the same operational cases in a representative simulator environment during flight test rehearsal – Airbus has performed a try of coupling two simulators to allow for this rehearsal.

Due to the delays, Airbus was not able to perform the planned campaign nor flight test rehearsal. As agreed, only preparation is considered in the scope of the project.

- In-flight exposure in shadow mode with Data Collection functionality, allowing to collect and analyse SURF-A alerts raised within the project exposure timeframe (OBJ-VLD-02-001) and ADS-B OUT data.

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Broad CEIS with certified SURF-A function (nor mixed, nor active as a consequence) is not possible in the SESAR VLD2 STAIRS timeframe due to delays explained in the previous sections.

Airbus has prepared a procedure to install units with SURF-A function in shadow mode and exposed the function in shadow mode on Airbus experimental A320 aircraft. The data from these tests was collected and analysed to show no nuisance alert objective. As the number of flights is significantly limited compared to assumptions, no analysis of ADS-B OUT data of the surrounding traffic is performed within the Project.

To allow for initially planned Very Large Demonstration in Shadow Mode, Airbus has developed a DataCollection function within the equipment involving other aircraft systems. These means to collect SURF-A specific and ADS-B OUT data from other aircraft were tested on experimental flight test aircraft together with SkyWise platform, allowing to analyse the data in data dashboard.

- FTS SURF-A system performance fast-time simulation demonstration – WP4

Status: finalised for RL1 and RL2 and RL3

FTS campaign description:

1) FTS Warning alert testing:

- Scenarios defined on the types of likely interactions between aircraft and airport
  - Arrivals, Departures, Taxiing
  - Analysis of historical Runway incursions events used to define the number of test cases per scenario, the more common the incursion in history the more test cases
- Creates two aircraft at a generically generated airport
  - Ownship movement defined by a range of speeds, accelerations and starting locations per scenario descriptions
  - Traffic movement defined by a range of speeds, acceleration and starting locations per scenario descriptions
  - Aircraft movement and setup controlled so that the final location is a collision event
- Examples:
  - Taxi onto runway when Traffic on approach
  - Ownship in blue with algorithm states depicted top center
  - Traffic in Green with algorithm states depicted in magenta bottom center
  - Target “On Runway” distance from runway centreline shown in red text
  - Advisory Alerts in Amber, Warning in Red as recorded during testing

2) FTS Advisory alert testing:

- Scenarios defined on the types of likely interactions between aircraft and airport
  - Arrivals, Departures, Taxiing

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- Analysis of historical Runway incursions events used to define the number of test cases per scenario, the more common the incursion in history the more test cases

- Creates two aircraft at a generically generated airport
  - Ownship movement defined by a range of speeds, accelerations and starting locations per scenario descriptions
  - Traffic movement defined by a range of speeds, acceleration and starting locations per scenario descriptions
  - Aircraft movement and setup controlled so that the two aircraft share the same point along the runway axis within 10 to 20 seconds of each other

- Examples:
  - Similar to warning case, but time separation before shared location
  - Taxi onto runway when Traffic on approach
  - Ownship in blue with algorithm states depicted top center
  - Traffic in green with algorithm states depicted in bottom center
  - Target “on runway” lateral position shown in red lines
  - Advisory Alerts in Amber, Warning in Red as recorded during testing
  - Minor code defect: alert left active after traffic is off the runway

3) FTS Nuisance avoidance testing:

- Scenarios defined on the types of likely interactions between aircraft and airport
  - Arrivals, Departures, Taxiing
  - Analysis of likely close interactions between aircraft used to distribute test cases

- Creates two aircraft at a generically generated airport
  - Ownship movement defined by a range of speeds, accelerations and starting locations per scenario descriptions
  - Traffic movement defined by a range of speeds, acceleration and starting locations per scenario descriptions
  - Aircraft movement and setup controlled so that the two aircraft operate in approved non-incursion proximity to each other:

- Examples:
  - Similar to advisory case, but increased time separation before shared location (e.g., greater than 30 seconds)
  - Taxi onto runway when Traffic on approach
  - Ownship in blue with algorithm states depicted top center
  - Traffic in green with algorithm states depicted in bottom center
  - Target “on runway” lateral position shown in red lines
  - Advisory Alerts in Amber, Warning in Red as recorded during testing
  - Minor code defect: alert left active after traffic is off the runway

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- FAA ADS-B Data Playback Testing
  - Performance metric at 14 nuisance alerts over 229.809 test cases (6.09E-5 alerts/test cases) as of Red Label 2
  - Data covers 2013 through 2019 from 9 US airports: Charlotte (KCLT); Washington (KDCA); Detroit (KDTW); Newark (KEWR); Kennedy (KJFK); Los Angeles (KLAX); Chicago (KORD); Seattle (KSEA) & San Francisco (KSFO)
  - Majority of test cases are incursion-free operations, so many nuisance alerts are manually analysed and determined to be either a valid nuisance alert
  - Data already included any error that was present in the ADS-B transmission therefore no additional error needs to be added

Interoperability study – WP2

Status: finalised

Two different workshops have been held by the Project, each of them mixing pilots, ATCOs, engineers and experts with representatives from DSNA, HONEYWELL, AIRBUS, THAV, PANSA, THALES/ACSS and EUROCONTROL,

Those workshops presented the principles of SURF-A function, and based on real cases of traffic, discussed the outcomes of SURF-A and the way this function could affect each other's duties and working methods.

B.1.2 Summary of Demonstration Exercise EXE-VLD-02-002 Demonstration Objectives and success criteria

Demonstration Exercise Objective	Demonstration EXE-T Success criteria	Coverage and comments on the coverage of Demonstration objectives	Demonstration Objectives	Demonstration Exercise EXE-T Success criteria
OBJ-VLD-02-001	CRT-VLD-02-001-01	Controlled Entry Into Service (CEIS) of SURF-A[3]	To Demonstrate SURF-A system operational performance with acceptable nuisance, false and missed alerts during commercial flights.	Acceptable nuisance alerts rate

[3] CEIS target postponed beyond SESAR STAIRS timeframe – replaced by in flight exposure

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OBJ-VLD-02-002	CRT-VLD-02-002-01	SURF-A crew acceptability	To Demonstrate crew acceptability of the SURF-A system	Crew system acceptance in flight environment
	CRT-VLD-02-002-02			Crew system acceptance in simulator environment
OBJ-VLD-02-003	CRT-VLD-02-003-01	Fast Time Simulation (Massive replay of collected data, Analysing performance with simulated inputs)	To Demonstrate SURF-A system operational performance with acceptable nuisance, false and missed alerts using collected data from ATC (A-SMGCS) or aircraft.	Nuisance alert rate
	CRT-VLD-02-003-02			False alert rate
	CRT-VLD-02-003-03			Detection rate
OBJ-VLD-02-006	CRT-VLD-02-006-01	Interoperability (No added communication requirements)	To demonstrate that SURF-A is compatible with current ATC working methods	ATCo workload
	CRT-VLD-02-006-02			Compatibility with ATCo formation
	CRT-VLD-02-006-03			No info of equipped A/C presence for ATCo
OBJ-VLD-02-007	CRT-VLD-02-007-01		To demonstrate that SURF-A triggered alerts do not require a specific report from aircraft to ground	Crew action for non-reported alerts
	CRT-VLD-02-007-02			Reports are well understood by ATCo
	CRT-VLD-02-007-03			No need for additional info when reported alert by crew to ATCo
OBJ-VLD-02-008	CRT-VLD-02-008-01		To demonstrate that SURF-A does not require a specific phraseology	Conflict resolution using current phraseology

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1529 **Table 7-5: Summary of EXE-T Objectives with success criteria**

1530 B.1.3 Summary of Validation Exercise EXE-VLD-02-002
1531 Demonstration scenarios

1532 Following scenarios were defined for DEMO3. There were included in the procedures prepared for
1533 simulator evaluations and flight test in active mode as well as partially performed within initial lab
1534 system testing.

Scenario #	SURF-A Equipped Aircraft	Aircraft #2	Test Type	Success Criteria
1	Departure, cleared for take-off	Taxiing across alerting threshold, clear when SURF-A aircraft > 15 Kts.	Simulation/Flight Test	Zero Alerts Issued
2	Arrival, cleared to land	Holding short of SURF-A equipped aircraft's landing runway	Simulation/Flight Test	Zero Alerts Issued
3	Arrival, cleared to land	Taxiing across alerting threshold, clear when SURF-A aircraft > 0.5 NM from threshold	Simulation/Flight Test	Zero Alerts Issued
4	Arrival, cleared to land	Departure, cleared for take-off and airborne when SURF-A equipped aircraft > 0.5 NM from threshold	Simulation/Flight Test	Zero Alerts Issued
5	Arrival, cleared to land	Arrival, cleared to land, clears runway when SURF-A	Simulation/Flight Test	Zero Alerts Issued
6	Departure, cleared for take-off	Taxiing into alerting threshold (< 10 Kts.)	Simulation	Alert Issued, breaking applied, collision avoided
7	Arrival, cleared to land	Taxiing into alerting threshold (< 10 Kts.)	Simulation	Alert Issued, Go-Around initiated, collision avoided
8	Departure, cleared for take-off	Departure on crossing runway	Simulation	Alert Issued, breaking applied, intersecting never reached
9	Arrival, cleared to land	LAHSO on crossing runway	Simulation	Zero Alerts Issued
10	Departure	Arrival, cleared to land, on crossing runway	Simulation	Alert Issued, breaking applied, intersection never reached

1535 **Table 7-6: Demonstration Exercise Scenarios (EXE-T)**

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For DEMO4, no specific scenarios were defined, as the SURF-A system was installed for non-specific tests on experimental aircraft. The scenarios produced from DEMO4 are a result of the unique configuration of each airport where operations occurred, and the ATC handling of the SURF-A equipped aircraft and surrounding traffic. For performed flights, none of the scenarios was observed as expected.

With respect to DEMO4, it is important to note that the system is designed to have zero impact on normal operations, and while it is an alerting system, it is very likely that during DEMO4, zero alerts was issued.

B.1.4 Summary of Demonstration Exercise EXE-VLD-02-002 Demonstration Assumptions

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment	Identifier	Title
ASS-VLD-02-001	Maturity	Technology	VLD expects demonstration of V3 mature Solution PJ03B- 05.	Objective of this VLD is to de-risk future deployment of mature solutions. Partial compliance during V3.	Airport,	Safety	Expert opinion	N/A	STAIRS VLD 2	High	ASS-VLD-02-001	Maturity
ASS-VLD-02-002	AU users participation	AU	Trained AU users participate in the project	AU users play key role in the demo, training of the crew is necessary	Airport,	Safety, HP	Expert opinion	N/A	STAIRS VLD 2	High	ASS-VLD-02-002	AU users participation
ASS-VLD-02-003	SURF-A/ITA performance	Performance	No/minimum alerts during regular operations	Alert timing below ATC procedures and separation	Airport,	Safety, HP	Expert opinion	N/A	STAIRS VLD 2	High	ASS-VLD-02-003	SURF-A/ITA performance
ASS-VLD-02-004	Silent mode	Implementation	Possibility to select silent version of the SURF-A/ITA implement	Airlines' operational procedures and preference	Airport,	Safety, HP	Expert opinion	N/A	STAIRS VLD 2	Low	ASS-VLD-02-004	Silent mode

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			ation									
ASS-VLD-02-005	Commercial flights	Range	Number of flights will represent statistically significant sample	Operations	Airport,	Safety	Expert opinion	50k operations	STAIRS VLD 2	Medium	ASS-VLD-02-005	Commercial flights
ASS-VLD-02-006	ADS-B data	ADS-B	ADS-B data represent reality on existing airport	ADS-B analysis and representative results, existing environment, equipage rate	Airport,	Safety	Expert opinion	N/A	STAIRS VLD 2	Medium	ASS-VLD-02-006	ADS-B data
ASS-VLD-02-007	ATC	Interoperability	No change to existing ATC procedures	DEMO will not need any change to ATC, ATFM processes	Airport,	Safety, HP	Expert opinion	N/A	STAIRS VLD 2	Medium	ASS-VLD-02-007	ATC
ASS-VLD-02-008	Certification	Regulation	System will be certified before DEMO 4.	Based on existing certification processes.	Airport,	Safety	Expert opinion	N/A	STAIRS VLD 2	Medium	ASS-VLD-02-008	Certification
ASS-VLD-02-009	ANSP data	Interoperability	Comparison of available collected data from specific airport	Comparison of two data samples for main parameters accuracy analysis	Airport,	Safety, HP	Expert opinion	N/A	STAIRS VLD 2	Medium	ASS-VLD-02-009	ANSP data
ASS-VLD-02-010	CAA	Operational	Operational approval before DEMO2 flights.	Operational approval with new safety application	Airport,	Safety,	Expert opinion	N/A	STAIRS VLD 2	Medium	ASS-VLD-02-010	CAA

Table 7-7: Demonstration Assumptions overview

B.2 Deviation from the planned activities

Deviations from the planned activities are explained in §B.1.1

B.3 Demonstration Exercise EXE-VLD-02-002 Results deviations

No deviations within results were identified.

B.3.1 Summary of Demonstration Exercise EXE-VLD-02-002 Demonstration Results

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Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Sub-operating environment	Exercise Results	Demonstration Objective Status
OBJ-VLD-02-001	SURF-A system performance in flight demonstration	CRT-VLD-02-001-01	Acceptable nuisance alerts rate	LUSL	No nuisance were raised during 5 flight tests performed with Airbus experimental fleet. Limited scope of the campaign.	OK
OBJ-VLD-02-002	SURF-A crew acceptability	CRT-VLD-02-002-01	Crew system acceptance in flight environment	N/A	N/A	De-scoped
		CRT-VLD-02-002-02	Crew system acceptance in simulator environment	TBD	N/A	De-scoped
OBJ-VLD-02-003	FTS SURF-A system performance fast-time simulation demonstration	CRT-VLD-02-003-01	Nuisance alert rate	FTS	OK	OK
		CRT-VLD-02-003-02	False alert rate	N/A	Acceptable	OK
		CRT-VLD-02-003-03	Detection rate	N/A	Acceptable	OK
OBJ-VLD-02-006	SURF-A compatibility	CRT-VLD-02-006-01	ATCo workload	Global	No impact to ATCo workload.	OK
		CRT-VLD-02-006-02	Compatibility with ATCo formation	Global	No need for an additional ATCO formation, expect for a small briefing as usual with new aircraft function. ATCO's methods not affected.	OK
		CRT-VLD-02-006-03	No info of equipped A/C presence for ATCo	Global	Alerts info considered as useless for ATCOs, as alerts very rare and not affecting aircraft's behaviour (RTO and GA are usual procedure in case of runway incursion)	OK

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OBJ-VLD-02-007	SURF-A reports	CRT-VLD-02-007-01	Crew action for non-reported alerts	Global	No difference with the current ATCO's operating method between danger on the runway detected visually out-of-window or through SURF-A	OK
		CRT-VLD-02-007-02	Reports are well understood by ATCo	Global	No issue between reporting "traffic alert" when ATCO briefed about the SURF-A functionality	OK
		CRT-VLD-02-007-03	No need for additional info when reported alert by crew to ATCo	Global	No need of downlink information in case of SURF-A alert as this is purely an on-board function.	OK
OBJ-VLD-02-008	SURF-A phraseology	CRT-VLD-02-008-01	Conflict resolution using current phraseology	Global	Free speech and generic terms should be preferred (e.g., "traffic warning")	OK

Table 7-8: Exercise EXE-T Demonstration Results

1. Results per KPA

a. Safety

KPA	Objective	Description	KPI	Success criteria	Where & how	CTQ value	Results
Safety	OB1	Controlled Entry Into Service (CEIS)	Operational: Nuisance, false, missed alerts rate and human performance confirmation	Acceptable alert rates, System and HMI acceptance	Flight tests with A320/A330 aircraft, simulator evaluations	Operational: Nuisance rate below 1E-05, false rate below 1E-05 Missed rate below 3E-02, Cockpit applications synchronized, Pilots confirmed expected V3 solution	OK

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OB2	Data replay in fast time	Fast time simulations, replay: Nuisance, false alerts, certification	Acceptable alert rates, System acceptance	Fast Time Simulation activity	Fast time simulation with impact to algorithms (see above rates)	See Chapter 4.2.3.2
OB3	ADS-B quality assessment	(Interoperability): transverse analysis of ADS-B performance acceptability	Traffic detection rate of at least 70% Qualitative assessment / Navigation parameters accuracy	DSNA data	ADS-B accuracy and assessment in line with eligibility rules	N/A to EXE-T
OB4	Interoperability review	(Interoperability): ANSP operational expertise	Compatibility with ground safety net, alert timing, ATC procedures and phraseology	Operational experts, airspace users (ATC, Pilots, surv experts)	Use cases with interoperability objectives confirmed	WP2: Supported by DSNA workshops and analysis of operational ATC procedures versus results of OB2 alerting algorithms performance has proved interoperability compliance in all aspects. Confirmed safety improvement as previous SESAR solution at V3 with no impact to ATCo workload.

Table 7-9: Results per KPA

b. Human Performance (HP)

KPA	Objective	Description	KPI	Success criteria	Where & how	CTQ value	Results
Human Performance	OB1	Controlled Entry Into Service (CEIS)	Operational: Nuisance, false, missed alerts rate and human performance confirmation	Acceptable alert rates, System and HMI acceptance	Flight tests with A320/A330 aircraft, simulator evaluations	Operational: Nuisance rate below 1E-05, false rate below 1E-05 Missed rate below 3E-02, Cockpit applications synchronized, Pilots	Using flight trial of main scenarios with simulated traffic on-board and replay of cert in-service data package have confirmed acceptable KPI rates. HMI has been

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					confirmed expected V3 solution	assessed acceptable with implementation and synced with other pilots' cockpit system applications.
OB2	Data replay in fast time	Fast time simulations, replay: Nuisance, false alerts, certification	Acceptable alert rates, System acceptance	Fast Time Simulation activity	Fast Time Simulation with impact to algorithms	N/A to Human Performance
OB3	ADS-B quality assessment	(Interoperability): transverse analysis of ADS-B performance acceptability	Traffic detection rate of at least 70% Qualitative assessment / Navigation parameters accuracy	DSNA data	ADS-B accuracy and assessment in line with eligibility rules	N/A to Human Performance
OB4	Interoperability review	(Interoperability): ANSP operational expertise	Compatibility with ground safety net, alert timing, ATC procedures and phraseology	Operational experts, airspace users (ATC, Pilots, surv experts)	Use cases with interoperability objectives confirmed	WP2: Supported by DSNA workshops and analysis of operational ATC procedures versus results of OB2 alerting algorithms performance has proved interoperability compliance in all aspects. Confirmed safety improvement as previous SESAR solution at V3 with no impact to ATCo workload.

Table 7-10: Results per KPA

2. Results impacting regulation and standardisation initiatives

At the current stage, the results from the EXE-T contributes to future standardisation activity complementing existing SPR document RTCA DO-323 and RTCA DO-317C with SURF-A key performance indicators and feasible requirements for future MOPS development.

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Activities to be performed outside of the Project timeframe are not expected to impact this assumption. CEIS performed beyond the frame of SESAR STAIRS timeframe is expected to bring only a confidence in the solution.

B.3.2 Analysis of Exercises Results per Demonstration objective

1. OB1 Demonstration objective results - Controlled Entry Into Service (CEIS)

a. EXE-T-OBJ-VLD-02-001 Results

[OBJ]

Identifier	OBJ-VLD-02-001
Objective	To Demonstrate SURF-A/ITA system operational performance with required nuisance, false and missed alerts during commercial flights.
Title	SURF-A/ITA system performance in flight demonstration
Category	<performance>, <safety>
Key environment conditions	Nominal conditions, Multiple dependent runways, LUSL, LUCL, HUSL, HUCL

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	VLD02
<COVERS>	<Sub-Operating Environment>	Airport, LUSL, LUCL, HUSL, HUCL

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-001-01	SURF-A/ITA System operational performance is within required safety requirements: Nuisance alerts rate: 10^{-5}/per ownship operation [4]	OK (WP4)

[4] Number 10^5 of ownship operations will not be achieved in DEMO2, the demonstration requirement of the 10^{-5} will be a combination of in-flight demonstration (OB1) and fast-time simulation (OB2).

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b. EXE-T-OBJ-VLD-02-002 Results

[OBJ]

Identifier	OBJ-VLD-02-002
Objective	To Demonstrate SURF-A/ITA system acceptability with a crew
Title	SURF-A/ITA crew acceptability
Category	<performance>, <safety>
Key environment conditions	Nominal conditions, Multiple dependent runways

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	VLD02
<COVERS>	<Sub-Operating Environment>	Airport, LUSL, LUCL, HUSL

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-002-01	SURF-A/ITA system performance acceptability by the crew during their flights and standard operational procedures in case of alerts triggered. (Subjective pilots' description and Likert scale 3/5.) Due to limited data sample it is not expected for DEMO HP assessment.	De-scoped (WP4)
CRT-VLD-02-002-02	Crew acceptability of HMI and system performance during preparation phase for DEMO. (Acceptable/Not Acceptable, simulator session for PTS system requirements and selected scenarios).	De-scoped (WP4)

2. OB2 Demonstration objective results - Data replay in fast time

a. EXE-T-OBJ-VLD-02-003 Results

[OBJ]

Identifier	OBJ-VLD-02-003
Objective	To Demonstrate SURF-A/ITA system operational performance with required nuisance, false and missed alerts using collected data from ATC (A-SMGCS) or aircraft.

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Title	FTS SURF-A/ITA system performance fast-time simulation demonstration
Category	<performance>, <safety>
Key environment conditions	Nominal conditions, Multiple dependent runways, LUSL, LUCL, HUSL, HUCL

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	VLD02
<COVERS>	<Sub-Operating Environment>	Airport, LUSL, LUCL, HUSL, HUCL

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-003-01	SURF-A/ITA System operational performance is within required safety requirements for collected ADS-B data: Nuisance alerts rate: 10^{-5}/per ownship operation	OK (as per RL3 FTS results)
CRT-VLD-02-003-02	False alerts rate: 10^{-5}/per ownship operation	OK
CRT-VLD-02-003-03	Detection rate > $7*10^{-1}$ / per ownship operation	OK

3. OB3 Demonstration objective results - ADS-B quality assessment

N/A to EXE-T

4. OB4 Demonstration objective results - Interoperability review

a. EXE-T-OBJ-VLD-02-006 Results

[OBJ]

Identifier	OBJ-VLD-02-006
Objective	To demonstrate that SURF-A is compatible with current ATC working methods
Title	SURF-A compatibility
Category	<safety>, <operational feasibility>, <human performance>
Key environment conditions	

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-006-01	The use of SURF-A does not lead to an ATCO workload increase.	OK (WP2)

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CRT-VLD-02-006-02	The use of SURF-A is compatible with current ATCO formation level and does not require any additional ATCO training.	OK (WP2)
CRT-VLD-02-006-03	For each aircraft, the ATCO does not need to be informed on the presence of the SURF-A on-board.	OK (WP2)

b. EXE-T-OBJ-VLD-02-007 Results

[OBJ]

Identifier	OBJ-VLD-02-007
Objective	To demonstrate that SURF-A triggered alerts do not require a specific report from board to ground
Title	SURF-A reports
Category	<operational feasibility>, <human performance>
Key environment conditions	

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-007-01	In case of SURF-A alerts **not reported** by Flight Crew, Flight Crew actions and intentions are enough for ATCO to understand the situation.	OK (WP2)
CRT-VLD-02-007-02	In case of SURF-A alerts **reported** by Flight Crew by voice, this report is well understood by ATCOs	OK (WP2)
CRT-VLD-02-007-03	In case of SURF-A alerts **reported** by Flight Crew, no other information is required from board (i.e. no automatic aircraft alert downlink)	OK (WP2)

c. EXE-T-OBJ-VLD-02-008 Results

[OBJ]

Identifier	OBJ-VLD-02-008
Objective	To demonstrate that SURF-A does not require a specific phraseology
Title	SURF-A phraseology
Category	<operational feasibility>, <human performance>, <acceptability>
Key environment conditions	

[OBJ Suc]

Identifier	Success Criterion	Results
CRT-VLD-02-008-01	All the conflicts raised by SURF-A can be resolved using current phraseology without ambiguity between Flight Crew and Air Traffic Control	OK (WP2)

B.3.3 Unexpected Behaviours/Results

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No unexpected behaviour has been detected during activities performed as for objectives OB1 and OB4. No unexpected behaviour detected regarding OB2 (Nuisance alert level) on the FTS campaign run on Red Label 3.

B.3.4 Confidence in the Demonstration Results

1. Level of significance/limitations of Demonstration Exercise Results

The activities connected to OBJ-VLD-02-001 and OBJ-VLD-02-002 were not able to be performed as initially planned with broad exposure of the SURF-A function in real environment with different airport configurations, ADS-B OUT specifics and exposure of the function in active mode in flight.

However, apart from CRT-VLD-02-002 (SURF-A crew acceptability), recovery activities were proposed to assess the objectives of the EXE-T.

Objectives of OBJ-VLD-02-003 were not impacted and could be performed as initially planned with large amount of real in-service FAA data and synthetic data.

2. Quality of Demonstration Exercise Results

Not impacted.

3. Significance of Demonstration Exercises Results

The real-world exposure of the function is reduced compared to the initial plan thus significance of the demonstration performed within the SESAR frame in real environment is lower than assumed. However, this does not influence global plan to assess the objectives especially with Fast Time simulation activities. It has to be highlighted that during originally planned in-service exposure (50 000 flights), none or at most few dangerous situations are expected to be raised as SURF-A is one of the last safety nets against runway collisions. The Fast Time Simulation allows to expose the function to numerous simulations when two A/C are already in close proximity with varying ADS-B parameters, which wouldn't be possible in real world at this scale. This allows to gain confidence in the function and to consider In-Service Exposure / CEIS only as final confirmation.

Apart from that, all of the not performed activities will be continued beyond the SESAR STAIRS project to allow assessment of the objectives, certification and introduction of the function in the coming future.

Already performed activities, show readiness to deploy SURF-A function.

B.4 Conclusions

Activities planned initially within the DEMO Plan were impacted due to Covid-19 crisis, resulting in some of the objectives of EXE-T being partially or not assessed. The fact that VLD and some of the peripheral activities (in particular crew acceptability) were postponed beyond the timeframe of the STAIRS projects has an impact on the maturity considerations, nevertheless SURF-A function can be considered as mature.

Most of the objectives are considered as achieved for the Project. For not fully assessed objectives, some confidence factors were identified:

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- For crew's acceptability in sim and flight
  - Preliminarily assessed in PJ.03b-05 in sim and in flight
  - Crews' confidence in the design - feedback from the discussions
- For function performance assessment in flight
  - Fast Time Simulations with representative models of functions providing far more coverage of possible nuisance alerts than actual in-service exposure

The Validation Path after this maturity gate will allow to get final confidence on SURF-A function crew acceptability and performance, needed to deploy the function. All of the elements performed in frame of the project will be used for the certification of the function in the coming year.

B.5 Recommendations

B.5.1 Recommendations for industrialization and deployment

Same as globally for the project:

Continue activities initially planned in the DEMO Plan beyond the timeframe of the project focusing on:

- Lab test in Airbus with the final version of SURF-A function
- Crew system evaluations/acceptance in simulator and flight environment
- CEIS of SURF-A function in the shadow mode with similar criteria to the ones from DEMO Plan
- Analysing data from CEIS to gain confidence of function's performance in various real environment

It is recommended to assess all ADS-B qualitative assessment done so far as that could impact future system performance sensitive to ADS-B system issues with various traffic equipage and local airports' ADS-B quality.

It is recommended to properly train the flight crew for the system function within updated flight crew training materials and manuals.

System design shall have configurable parameters to inhibit scenarios/runways in which nuisance alerts are repeatedly raised

Triggered alerts should be recorded for possible troubleshooting and analysis

Air Traffic Controllers briefing should be provided before system deployment

In-service feedback about the function should be logged and analysed to allow for function improvements, if needed

B.5.2 Recommendations on regulation and standardisation initiatives

Same as globally for the project:

In reference to existing RTCA DO-323 and DO-317C, SESAR activities should be reflected in future MOPS development with high importance of ADS-B data quality assessment and system performance validation for both SESAR solutions.

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Progress should be made with change proposal of ICAO DOC 9994 (Airborne Surveillance Applications) to add SURF-A function description

SURF-A should be considered to be added to ARINC660 “CNS/ATM Avionics, Functional Allocation and Recommended Architectures” - action ongoing

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Appendix C Safety Assessment Report part II summary

This section specifies the safety assessment activities that are related to VLD2 STAIRS.

C.1 WP2 Safety assessment report

Not Applicable.

C.2 WP3 Safety Report

Exercise EXE-VLD-02-001 (Work Package 3) with executed business aircraft flight trial and bench testing has not requested any operational approvals, certified systems and did not impact any existing ATC procedures.

The final planned demonstration campaign with experimental fleet has been postponed beyond the SESAR STAIRS schedule and did not represent any safety impact to existing ATM architecture or aircraft safety operation.

An experimental aircraft complied with all airworthiness guidelines, requirements with red label regression testing, possibility to switch to certified system configuration and to manually inhibit the system function.

The system performance with the nuisance/false alert rate has been identified as the key driver for the safety impact with future deployment and that requirements and concerns have been addressed within objectives OB1, OB2 and OB3: OBJ-VLD-02-001, -003 and -004.

Other interoperability aspects with safety impact to the ATM architecture have been covered with interoperability objectives of OB4 group.

There were no other specific safety objectives identified.

Based on above information, the Part II safety DEMO report has not been initiated.

C.3 WP4 Safety Report

Mainline aircraft was expected to execute commercial flights with already certified SURF-A systems by EASA, implemented by approved Airbus SB with operational approval of local CAA.

Based on the impact changes as described by the deviation chapter 3.4 to the original plan, the final demonstration has been descoped for campaign including experimental Airbus fleet only.

It was expected minimum false and nuisance alerts impacting pilots' workload based on previous V3 SESAR PJ03B-05 and VLD1 PJ28 development and performances analyses with simulated and real ADS-B data.

For the future deployment and based on internal operational risk evaluation (ORE), each operator will assess the acceptance level of the risks and will decide to apply full/mixed/shadow mode of the system implementation in the cockpit (refer to chapter 3.3.2). This optional configuration could be selected anytime also during final demonstration phase.

For aircraft with full/mixed system implementation, the crew will be properly trained with Airbus FCOM with recommended SOP and training material for the new system function, HMI and get familiar with VLD2 STAIRS program and objectives.

The safety assessment report follows from SESAR PJ03B-05 Safety Assessment Report part II [18] and is aligned within support of the certification activities with a regulatory authority.

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This Safety assessment might need to be updated along the progress of the system design approval, airworthiness approval and operational approval process.

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Appendix D Human Performance Assessment Report (part III) Summary

There were only two minor supporting objectives with Human performance assessment for preparation phase DEMO1&3 and demonstration phase DEMO2&4.

Within preparation phase of demonstration on Honeywell and Airbus bench, there were activities only to confirm V3 readiness for the demonstration phase of DEMO2&4 for both exercises without Human Factors involvement.

Activities under phase DEMO2&4 of this project focused on the observable result of human performance in the context of planned demonstration flights under work packages WP3 and 4 only.

Questionnaires, coordinated between the project partners, were used as the main source of the human performance assessment. The questionnaires were completed by the pilots directly after flight during a debrief session. The discussion focused on triggered alert and unexpected behaviours (nuisance, false and missed alert detection).

During VDL2-DEMO2&4 demonstration flights, it is very unlikely that any SURF-A/ITA alert would be triggered and that has been confirmed with the preparation activities.

Airspace Users have been involved in ADS-B data replay and results assessment manually analysing all alerting cases for proper timing by replay of the scenario on the flight simulator.

AUs pilots and ATC operational expert Feedbacks and responses to questionnaires were collected to address in particular cases when a traffic alert is triggered and runway encounters. TAU pilots and ATC operational experts were also consulted to support post process analysis of ADS-B data replay and during annual STAIRS ATC workshops.

Considering the limited human factors activities planned and conducted in STAIRS that is mostly a technological project, the HPAR report is not applicable.

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Appendix E Environmental Performance Assessment Report part IV Summary

The project has not identified any ATM environmental impact for the demonstrated solution in reference to the SESAR Environment Reference Material for ATM.

Therefore, this appendix is not applicable.

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Appendix F Performance Assessment Report - Part V Summary

STAIRS has not identified any change to the PAR report, i.e. drivers for KPIs and KPAs, developed in previous SESAR projects.

F.1 Security Assessment Report

Due to low-risk impact based on previous ATM security assessment performed under SESAR PJ03B-05 solution, there was no plan for security measures or any other activity impacting the Security assessment report.

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