SESAR Solution PJ.03b-05

Traffic alerts for pilots for airport operations

Contextual note – SESAR Solution description form for deployment planning

Purpose:

This contextual note introduces a SESAR Solution (for which maturity has been assessed as sufficient to support a decision for industrialization) with a summary of the results stemming from R&D activities contributing to deliver it. It provides to any interested reader (external and internal to the SESAR programme) an introduction to the SESAR Solution in terms of scope, main operational and performance benefits, relevant system impacts as well as additional activities to be conducted during the industrialization phase or as part of deployment. This contextual note complements the technical data pack comprising the SESAR deliverables required for further industrialization/deployment.

Improvements in Air Traffic Management (ATM)

As a result of increasingly busy airports, safe runway operation is one of the highest challenges for aviation safety. All main aviation bodies (e.g. IATA, ICAO, CANSO, ACI, EASA, FAA & EUROCONTROL) identify runway incursion as a major safety threat.

Safety has been improved thanks to airport surface management systems: A-SMGCS is available on many major airports and ground safety nets (e.g. RWSL) start to be deployed. However, these systems are not expected to fully resolve the runway incursion risk and are not envisaged to be deployed at smaller airports. Incursion rate remains steady (3/100.000 operations) and events continue to occur (28 near-miss collisions last 5 years).

Although TCAS has been in use since 1981, there is currently no aircraft system to prevent runway collisions. The SESAR Solution PJ.03b-05 “Traffic alerts for pilots for airport operations” is improving safety during airport operations. The flight crew is provided with alert when the on-board system detects a risk of collision with an aircraft on runway or taxiways. The improvement is further split into 2 validated implementations:

- The mainline aircraft implementation consists of an on-board system which detects risk of collision with other traffic during runway operations and provides the Flight Crew with aural alerts (mostly ‘warning’ alert level).
- The business aircraft implementation consists of an on-board system which detects potential and actual risk of collision with other traffic during runway and taxiway operations and provides the Flight Crew with visual and aural alerts (indication, caution and warning alert levels).

Operational Improvement Steps (OIs) & Enablers

Operational Improvement Steps under the scope of the SESAR Solution PJ.03b-05 are:

OI Steps ref. (from EATMA)	Enablers ref.(from EATMA)	Enabler definition
AUO-0605: Traffic Alerts for Pilots during Runway Operations	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 Optional	Airport moving map and own aircraft position display in cockpit.
	A/C-25 Optional	Airborne Traffic Situational Awareness to support surface operations (ATSA-SURF), including reception (ADS-B in), processing and display
AUO-0615: Traffic Alerts for Pilots during Taxiway Operations	A/C-43a2	Traffic Alerts for Pilots during Taxiway 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 Optional	Airport moving map and own aircraft position display in cockpit.
	A/C-25 Optional	Airborne Traffic Situational Awareness to support surface operations (ATSA-SURF), including reception (ADS-B in), processing and display

NB: only A/C-43a1 and A/C-43a2 are aircraft enablers developed by the solution. Following enablers are already deployed technologies:

- AC-48a (ADS-B OUT DO-260B)
- A/C 67 (On board receiving of ADS-B IN)
- A/C 24 : Airport Moving Map
- A/C-25: Cockpit Display Traffic Information

The applicable Integrated Roadmap Dataset is DS19. The following changes should be made in DS20:

- A/C-43a1 V3 date should be postponed from 2016 to 2019;
- A/C-67 V3 and V4 dates should be made consistent.

Background and validation process

SESAR1:

In SESAR1, Traffic Alerts on runway have already been studied. Two concepts of implementation have been studied:

- "SURF-A" (Surface Alerts) provides alerts without traffic display; it can be implemented on most mainline aircraft,
- "SURF-ITA" (Surface Indication and Alerts) including additional levels of alerts and a traffic display; it can be implemented on specifically equipped aircraft like business aircraft.

The SURF-A function has been defined and partly validated for mainline aircraft: real aircraft prototypes have been developed, integrated and tested. Then, SURF-A function has been described in the associated OSED and detailed in the functional requirement document (FRD). The associated KPA (Safety) has been addressed and a positive impact

on safety has been identified. Similarly, SURF-ITA function has been initially studied and partly validated for business aircraft during SESAR1 through dynamic mock-ups.

In addition to real-time exercise, a 1st data collection and fast-time simulation also took place so as to assess the impacts of erroneous ADS-B (Automatic Dependent Surveillance - Broadcast) data in terms of missed and spurious non-sense alerts using real ADS-B data. A small number of false alerts was identified and led to corrections which supported the future target of false alerts rate.

SESAR2020-wave1:

In SESAR 2020 wave 1, the way of achieving the V3 maturity level was:

- To validate the algorithms developed within SESAR 1 by fast-time and real-time simulations; and then
- To develop system prototypes and validate the overall solution in a flight test. Validation addressed mainline as well as business aircraft operational specificities.

As sufficient ADS-B performance is a key enabler for the solution, the ADS-B performance assessment was conducted at the early stage of the project. The ADS-B data were collected within the SESAR1 project. Additional ADS-B IN data collection campaign including ADS-B data performance assessment and alerting algorithms performance validation with significantly wider scope has be done within SESAR 2020 PJ28 project.

A major quality indicator of alerting system is to ensure that the system provides appropriate alerts on time and only when needed, i.e. to reduce rates of missed and nuisance alerts. It is impossible to make thousands of scenarios during ground and flight tests to validate that the system provides an acceptable rate of missed, false and nuisance alerts. Therefore the validation approach assumed two main validation activities:

- Fast time simulation to assess the rate of missed and nuisance alerts on large number of scenarios. The fast time simulations used:
  - Simulated data generated by a model of environment.
  - Real ADS-B data collected within SESAR2020-Wave 1 PJ28.
- Real time simulations and flight tests to validate that the system provides appropriate alerts on time when operating in real environments. The validation included algorithms performance as well as Human Factors (HF) & Human-Machine Interface (HMI) evaluations and a workshop with Pilots and ATCOs. This was to ensure that the alerts are understood by the flight crew and the associated reaction is appropriate and compatible with the Air Traffic Control (ATC) expectations.
  2 Ground exercises were executed to cover separately mainline and business aircraft aspects. A flight test was executed by using together 2 flight test aircraft: Airbus A320 for mainline aircraft and Dassault Falcon F900 for business aircraft.

Pictures of validation exercises of solution PJ03B-05

Results and performance achievements

Following KPAs is relevant to solution PJ03b-05: Safety.

Results for alerts during Runway Operations (OI: AUO-605)

The results were obtained during Fast Time Simulation, Real Time Simulation and Flight Tests exercises as well as with a workshop gathering Pilots and ATCOs. They are similar for both SURF-A and SURF-ITA configurations. The methodology is based on a series of Validation Objectives consistent with SPR/OSED requirements.

Human performance objectives were: usability, timeliness, intelligibility/HMI, Air/ground respective roles, ATC/Crew communication, workload, traffic display specific for SURF-ITA on business aircraft.

Results demonstrated that these objectives were met. One side issue was identified during the flight test about one specific scenario (conflict between aircraft taxiing at low speed). This led to recommend to trigger the alert a bit earlier. This fine-tuning can be solved easily in software and showed the importance of flight testing because it was not detected in earlier phases.

Function Performance was assessed according to 2 objectives (nuisance and missed alerts) through Fast Time Simulation using generic scenarios or replay of collected data. Results were conclusive relatively to the robustness of algorithms vs. e.g. ADS-B position inaccuracy limits. SESAR-wave 2-VLD2 will allow a wider exposure of the function in operational situations to detect unpredicted situations and configurations.

Results for alerts during taxiing Operations (OI: AUO-615)

Objectives were similar to AUO-605 objectives.

Objectives were also met with some remarks to trigger the alert a bit earlier in specific situations.

Conclusions are similar to runway alerts but with some false alerts due to the specific scenarios on taxiways where aircraft can be closer to each other.

Recommendations and Additional activities

The main recommendation proposed towards deployment is to address the following aspects in a **very large scale demonstration** to reachTRL7/V4:

- Complementarity and interoperability with ground safety nets;
- Phraseology;

- Consider pilots training;
- In-service exposition on revenue flights;
- Expand the ADS-B database and refine the data quality analysis;
- Further study the use of ADS-R and TIS-B as alternative sources to compensate ADS-B masking issues.

After the very large scale demonstration and initial deployment, **standardization** of the functions is recommended to expand benefits. The more aircraft are equipped, the greater coverage of incidents will be.

After some years of in-service exposition and availability of a standard, a SURF-A/IA **mandate** (as for TCAS) is to be considered.

Actors impacted by the SESAR Solution

Flight Crew

The on-board system detects potential and actual risk of collision with other traffic during runway and taxiway operations and provides the Flight Crew with the appropriate alert.

AIRBUS flight operations experts evaluated SURF-A/IA training to be level C, i.e. manuals & dedicated support (e.g. e-learning) but no simulator training. During VLD2, the required training level will be more deeply addressed, in particular with airworthiness authorities.

Tower Runway Controller (ATC)

There is no impact on Tower Runway Controller tasks. It appears that PJ03b-05 solution does not involve crew reactions that could go against current practices. Flight crews will report to ATC with usual phraseology. Upon an alert, the crew will react according to the urgency of solving the conflict first – this can lead to contact ATC. In addition, the airborne and ground traffic alerting interoperability has been assessed and validated.

Impact on Aircraft System

Impact on aircraft systems is mostly at software level as the function is implemented in existing systems. This can be done on the opportunity of next systems evolutions and eases the retrofitting of the function.

Impact on Ground System

The solution PJ03b-05 has no impact on ground system.

Regulatory Framework Considerations

The PJ03b-05 solution has emerged from the overall concept presented in RTCA (Radio Technical Commission for Aeronautics) DO-323 document (SURF-IA SPR, Safety, Performance and Interoperability Requirements Document for Enhanced Traffic Situational Awareness on the Airport Surface with Indications and Alerts (SURF IA) prepared by RTCA SC-186, issued 08-Dec-2010). This document can be used to support a certification process.

Standardization Framework Considerations

As said above, standardization would be of a high interest to extend a future implementation on the largest number of aircraft in order to increase the coverage of future incidents. Standardization could consist in building a standard relative to possible implementations (SURF-A, SURF-ITA, TWY-ITA). However, standardization of SURF-A is not seen as a pre-requisite to certification.

Considerations of Regulatory Oversight and Certification Activities

Regulation

ADS-B OUT:

SURF-A/IA & TWY-ITA rely on ADS-B technology. ADS-B OUT equipment rate will therefore be paramount for maximizing the safety impact brought by the function. In US and E.U airspaces, ADS-B OUT DO-260B is mandated for 2020 on aircraft with maximum take-off weight > 5.7t.

It is however foreseen that equipment rate will not reach 100% in E.U at the date of the mandate, 7th of June 2020. Deployment effort is to be pursued.

TIS-B / ADS-R / ADS-SLR:

- TIS-B: Traffic Information Services – Broadcast (TIS-B is a client-based service that provides ADS-B Out/In equipped aircraft with surveillance information about aircraft that are not ADS-B equipped. To qualify as a TIS-B target, an aircraft must be equipped with a transponder and be within radar coverage)
- ADS-R: Automatic Dependence Surveillance Rebroadcast (ADS-R is a client-based service that relays ADS-B information transmitted by an aircraft broadcasting on one link to aircraft equipped with ADS-B In on the other link. For example, the information for an aircraft equipped with a 1090MHz ADS-B Out system will be re-broadcasted to an aircraft equipped with ADS-B In on the UAT (i.e. 978MHz) frequency, and vice versa)
- ADS-SLR: Automatic Dependence Surveillance Same Link Rebroadcast. ADS-SLR is ADS-R with rebroadcast on same link (1090MHz).

SURF-A & SURF-IA rely primarily on ADS-B OUT. Although these 3 technologies *TIS-B / ADS-R / SLR* are not required for SURF-A, they may improve availability of the function and timeliness of alerts on airports with intersecting runways. On single runway or parallel runway airports, these solutions are not expected to bring benefits for SURF-A/IA.
FAA is currently testing the ADS-SLR on 30 major airports, it is recommended during a very large scale demonstration to ask for the results and study the benefits of such solution in Europe.

Certification

SURF-A function aims at being certified end of 2021 for mainline aircraft.

In addition, SURF-A and SURF-ITA alerts are in-line with requirements given by EASA CS-25.13.22. This material will be used for a certification.

Solution Data pack

The data pack for this SESAR Solution includes the following documents:

- D4.1.190 - V3 OSED (Operational Service and Environment Definition) / SPR (Safety and Performance Requirements) -INTEROP (Interoperability Requirements)

- D4.1.200 - V3 TS (Technical Specification)
- D4.1.210 - V3 CBA (Cost Benefit Analysis)

Intellectual Property Rights (foreground)

The foreground is owned by the SJU.