Release 5 SESAR Solution #23

D-TAXI service for controller-pilot datalink communications (CPDLC) application

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)

The SESAR Solution "D-TAXI service for controller-pilot datalink communications (CPDLC) application" is intended for tower controllers and flight crews, and corresponds to the use of data link communication to support exchanges between air traffic control (ATC) and equipped aircraft during the taxi phases of the flight. This SESAR Solution thus corresponds to a new operational service which uses as its basis the D-TAXI communication service to improve surface operations.

SESAR Solution #23 provides an additional communication means to radio, on which tower controllers and flight crews can exchange information, clearances and requests related to departure, push back, start-up and taxi operations. It is expected that radio will however remain the preferred channel to exchange time-critical or complex messages, as this Solution can slow down communication compared to radio due to the asynchronous nature of exchanges and to the time needed by flight crews and tower controllers to interact with their Human-Machine Interfaces (HMI).

On the ATC side, this Solution is integrated in the controller's working position and D-TAXI messages are automatically uplinked to aircraft when the controllers enter their clearances. In the cockpit, flight crews operate D-TAXI through the Data link Control and Display Unit (DCDU), which is the same interface as for operational CPDLC services, displaying the messages received from ATC as text and allowing sending replies and requests to ATC. If the aircraft is equipped with an airport moving map, the taxi routes received by data link can be interpreted using an airport data base and be displayed as graphical path on the map. Both ground and cockpit systems largely automate the construction of the messages. Tower controllers and flight crews can still make manual inputs, typically to set optional parameters or build more complex messages.

Working procedures for the tower controllers and the flight crews have to be adapted to describe the management of communications over two separate media, clearly identifying when data link can be used preferably to voice and how to handle reversions from data link

to voice and to ensure that detailed taxi clearances given to aircraft are input in the system by the tower controllers.

This SESAR Solution reduces radio frequencies congestion by moving routine and simple communication to data link. As a result, communication tasks require less mental resources. In addition, this Solution improves the safety of surface operations, by providing clear and unambiguous instructions to flight crews, thus reducing the risk of misunderstandings and errors. However, the operational environment dictates how potentially complex clearances, such as push back and taxi, affect human performance as a whole. Indeed, at airports with busy traffic and/or a complex taxiway layout, controllers expect a high reactivity from flight crews and the increased time taken by data link communication, as well as having to manage traffic with mixed data link equipage, can negatively affect the workload of all the actors. Therefore, at such airports, only a subset of D-TAXI messages may be applicable.

Operational Improvement Steps (OIs) & Enablers

The following Operational Improvement is under the scope of SESAR Solution #23:

- AO-0308-A: Datalink Services used for Provision of Ground-related Clearances and Information for Step 1 (fully covered)

The following required enablers are supporting SESAR Solution #23:

- A/C-31a: Controller pilot data link communication (CPDLC) compliant with ATN baseline 2 (FANS 3/C) (fully covered)
- AERODROME-ATC-02a: Surface movement management tools updated to provide the D-TAXI information to the pilot in Step 1 (fully covered)
- AERODROME-ATC-50: Advanced Controller Working Position (A-CWP) supporting A-SMGCS functionalities (partially covered)
- CTE-02c: A/G Datalink over ATN/OSI - Multi frequency (partially covered)
- REG-0100: Regulatory Provisions for Datalink Extension (DLS II) (partially covered)

Applicable Integrated Roadmap Dataset is DS16.

Although not described as such in DS16, the following enablers are optional for the implementation of SESAR Solution #23, in case the airport moving map is used to display taxi routes. There is thus a need to update the integrated roadmap, which has been recorded and should be considered in DS17.

- A/C-24: Airport moving map and own aircraft position display in cockpit (partially covered)
- A/C-42a: On-board graphical display of taxi clearance using common air/ground airport database (partially covered)

This SESAR Solution partly depends on SESAR Solution #22 (Automated assistance to controller for surface movement planning and routing), as the provision of detailed taxi routes assigned to each aircraft by data link requires the availability of the route description in the ATC systems. Other clearances, such as start-up or handovers, do not need SESAR Solution #22.

Background and validation process

Solution #23 has been validated through a series of activities including 13 Real Time Simulations and two Live Trials. Although most of the validations using simulation focused on validating this SESAR Solution from the ATC perspective, three of them also studied cockpit operations. This was also the case of one live trial, which involved an aircraft equipped with industry-supplied prototypes.

These validation activities shared the following objectives:

- At V2 maturity level, to investigate the utility and usability of D-TAXI as an additional communication means during surface operations, covering all exchanges in nominal operations but also in specific operations (runway configuration change, alternative parallel taxiway routing, de-icing)
- At V2 maturity level, to ensure the completeness and adequacy of the set of D-TAXI messages to support surface operations, as well as the consistency of air and ground information
- At V2 and V3 maturity levels, to assess the integration of the D-TAXI function in the controller's working position and in the cockpit systems
- At V2 and V3 maturity levels, to evaluate the balance of benefits and drawbacks associated to this Solution, in terms of human performance and safety.

These validation objectives have initially been assessed through Real Time Simulations, conducted in Barcelona-El Prat, Hamburg, Milan-Malpensa and Paris-Charles de Gaulle environments, and have then been further addressed in an operational environment, through live trials conducted at Milan-Malpensa and Riga airports.

Results and performance achievements

The above-mentioned validation exercises have provided the following main findings:

- On D-TAXI, as an additional communication means:
    - The set of D-TAXI messages defined by SESAR and available in the existing standard (EUROCAE ED-228) has been found complete enough to support

basic taxi operations. A few additional messages, not retained by SESAR but defined in the standard, have been considered as potentially useful by controllers.
    - Data link communications on the airport have a higher latency than Radio Telecommunication (R/T), which is an issue for the provision of time-critical messages or when traffic is dense. In these cases, R/T should be favoured over D-TAXI. D-TAXI must thus not be used for the management of runway operations.
- From pilots' point of view:
    - Situational awareness is supported by the D-TAXI clearance display, especially when the aircraft is static and flight crews have time to check the messages, but awareness of the surrounding traffic is reduced when R/T is not used.
    - However, in dynamic phases of the flight, head-down time is increased, which may lead to reduced situational awareness.
    - By itself, D-TAXI does not increase the flight crew's workload compared to current operations, except when used at the same time as R/T for time critical messages or in dynamic phases when the flight crew is already very busy.
- From controllers' point of view:
    - D-TAXI effectively reduces voice communication, leaving more capacity for other controller tasks, especially in low traffic.
    - However, controller workload is increased when they have to manage a mixed-equipage fleet or to communicate also via R/T.
    - In terms of controller role, D-TAXI is mostly beneficial to clearance delivery controllers and, depending on the operational context, can also be beneficial to ground controllers.

Recommendations and Additional activities

Operational procedures for controllers and flight crews should be developed to specify how to manage the mixed communication mode.

The efficiency of the controller HMI has to be improved in order to reduce the time the controller spends head down when interacting with the system.

Actors impacted by the SESAR Solution

Airspace Users (Pilots), Tower Clearance Delivery Controllers, Tower Ground Controllers, Apron Managers.

Impact on Aircraft System

The aircraft's CPDLC function needs to be upgraded in order to support the D-TAXI service, allowing receiving and transmitting the messages associated with this service. As D-TAXI is expected to be supported by the Aeronautical Telecommunication Network (ATN), the upgrade of the aircraft's CPDLC function may also include the implementation of this service if it only works with the Aircraft Communications Addressing and Reporting System (ACARS).

In addition, the DCDU may need to be upgraded in order to display D-TAXI messages received from ATC and to allow the flight crew to select and to build answers and requests to ATC.

Impact on Ground Systems

As for the aircraft systems, the airport Air Traffic Service Unit (ATSU) needs to handle communication via data link over ATN and thus to implement a connection to this service. The airport ATSU also needs to provide planned routes to arriving aircraft, which is under the responsibility of approach or en-route ACC, so the ground-ground communication infrastructure needs to allow conveying these messages to the aircraft.

In addition to the connection to the ATN network, the airport ATSU also needs to implement a management of data link communications with aircraft. This allows handling connections with aircraft, receiving downlink messages from connected aircraft and dispatching them to the intended controller working position and providing uplink messages to intended aircraft.

The airport Flight Data Processing System too needs to be upgraded (solution #22) so as to handle data link equipped aircraft and distinguish them from unequipped aircraft.

Lastly, the controller working position also needs to be upgraded to allow displaying aircraft communicating by data link to the controller, displaying the messages received from aircraft to the controller and composing messages to be sent to aircraft. When the controller needs to send a data link message to an aircraft, entering the corresponding clearance in the EFS needs to trigger the uplink of this message to the intended aircraft

Regulatory Framework Considerations

The European Aviation Safety Agency (EASA) has identified a number of Rulemaking Tasks in its Rulemaking Programme for the 2016-2020 timeframe, which correspond to the regulatory enabler associated to SESAR Solution #23 (REG-0100 – Regulatory Provisions for Datalink Extension (DLS II)):

- RMT.0524: this extension of the current DLS regulation (Regulation (EC) No 29/2009) will define the requirements for safety critical message use of various data link services, including D-TAXI.
- RMT.0519: this task is intended to develop and update aircraft-related Community Specifications in support of new operations, including D-TAXI.

Standardization Framework Considerations

The set of data link messages corresponding to the D-TAXI service has been defined jointly by RTCA and EUROCAE (respectively through Special Committee SC214 and Working Group WG-78). It has been published in the following documents:

- DO-350A/ED-228A: Safety and Performance Requirements Standard for Baseline 2 ATS Data Communications (Baseline 2 SPR Standard)
- DO-351A/ED-229B: Interoperability Requirements Standard for Baseline 2 ATS Data Communications (Baseline 2 Interop Standard)

SESAR had set up a coordination with SC-214/WG-78 during the development of these documents to provide the standardisation group with early validation results and guide the definition of the D-TAXI service. Consequently, the existing standards allow implementing SESAR Solution #23.

Considerations of Regulatory Oversight and Certification Activities

SESAR has not identified needs for the regulatory oversight of the new systems.

As this Solution relies on new or upgraded avionics, adequate certification processes have to be defined. It is expected that EASA's rulemaking task updating aircraft-related Community Specifications in support of new operations (RMT.0519) will address this aspect.

However, validation activities carried out by SESAR have identified that this Solution could increase the workload of tower controllers and flight crews, as well as their head-down time. These results are recommended to be considered in the safety argument when implementing this Solution.

Solution Data pack

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

- OFA04.02.01 (Integrated Surface Management) Final OSED; 06.07.02-D46; 00.01.02; 10/11/2016. This document contains the operational requirements of SESAR Solution #23, as part of the new operational service “Provision of planned and cleared route to mobiles by data link”.
- OFA04.02.01 (Integrated Surface Management) Final SPR; 06.07.02-D45; 00.01.01; 24/10/2016. This document contains the safety and performance requirements of SESAR Solution #23, as part of the new operational service “Provision of planned and cleared route to mobiles by data link”.
- OFA04.02.01 (Integrated Surface Management) Final INTEROP; 06.07.03-D28; 00.01.00; 16/09/2016. This document contains the interoperability requirements of SESAR Solution #23, as part of the new operational service “Provision of planned and cleared route to mobiles by data link”.
- WA1 High Level Functional Requirement Definition (FRD) for D-Taxi - Advanced Package - Final Version; 09.13-D47; 00.02.00; 05/04/2016. This document contains the functional requirements of the cockpit systems supporting this SESAR Solution. However, due to the closure of SESAR 1, the document was delivered after the verification results were known and after the last validation activities took place but before the results of these validations were published. Therefore, there may be discrepancies between the operational and the system requirements.
- AGDL System Requirements - Final TS 2016; 10.07.01-D76; 00.01.01; 16/11/2016. This document contains the technical requirements of the ATC system that supports the information exchanges with the aircraft via data link. However, due to the closure of SESAR 1, the document was delivered after the verification results were known and after the last validation activities took place but before the results of these validations were published. Therefore, there may be discrepancies between the operational and the system requirements. Also, project 10.07.01 developed these requirements based on draft versions of WG-78 material. Therefore, there may be discrepancies between the system requirements and the published standards (EUROCAE ED-228 and ED-229).
- Final Technical Specifications for enhanced surface guidance; 12.03.04-D40; 00.02.00; 22/07/2016. This document contains the technical requirements of the surface guidance server supporting this SESAR Solution. However, due to the closure of SESAR 1, the document was delivered after the verification results were known and after the last validation activities took place but before the results of these validations were published. Therefore, there may be discrepancies between the operational and the system requirements.
- Final System Requirements, 12.05.04-D93, 00.03.00, 27/09/2016. This document contains the technical requirements of the controller working position supporting

this SESAR Solution. However, due to the closure of SESAR 1, the document was delivered after the verification results were known and after the last validation activities took place but before the results of these validations were published. Therefore, there may be discrepancies between the operational and the system requirements.

Intellectual Property Rights (foreground)

The foreground is owned by the SJU.