



## P 09.20.00 Final Project Report

### Document information

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### Abstract

The document finalizes and shortly describes the work that was done within the project SESAR 9.20. The document describes all major activities, outcomes and recommendations of the project for the future use.

The project, together with its ground counterpart developed in WP 15.2.8, has demonstrated the possibility to transport civilian ATC information by means of a military data link (Link 16/MIDS).

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Rational for rejection
None.

## Document History

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00.00.02	21/01/2015	Draft		Draft version distributed to team members for comments
00.01.00	30/01/2015	Final		Final version for submission to S-JU.
00.01.01	12/03/15	Final		Document updated in response to S-JU assessment
00.02.00	26/05/15	Final		Document updated in accordance with the comments provided during

				Closure Gate meeting.
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### Publishable summary

Within the framework of the SESAR Programme it has been recognised the need to ensure the appropriate level of civil-military interoperability, for this purpose four specific military communications, navigation and surveillance (CNS)-related projects were started.

WP 9.20 and WP 15.2.8 focus on the development of an avionic and a ground interface to enable interoperability between military air-ground data communications and ATM CPDLC and ADS-C.

The main objective of SESAR WP 9.20 *Military Datalink accommodation* and SESAR WP 15.2.8 *Civil-Military Data Link Interoperability* was to demonstrate the capacity of a military datalink to support the exchange civilian ATC information.

In order to achieve the objectives, starting from the existing main military aircraft configurations (transport, fighter and trainer), to maximize the technology reuse and reduce impacts on military users, Link16 communication media was selected because it is widely implemented and operative on military platforms in service.

Different solutions for exchanging ATC data messages across Link16 network have been identified and studied.

A system prototype, consisting of an airborne (WP9.20) and a ground (WP15.2.8) segment, was developed to support the CPDLC and ADS-C applications through the exchange of MIDS free text messages (encapsulation approach).

The ATC messages (CPDLC and ADS-C) were exchanged by means of Link16 datalink via a ground gateway prototype.

This prototype is interoperable with existing ATC infrastructure and will be under full military control.

The work done has demonstrated the main objective pursued inside the project that is the capacity of a military datalink (Link 16/MIDS) to transport civilian ATC information.

Particularly interesting results have been achieved during the flight trials activity where the complete set of test performed during the flight met completely the foreseen objectives. In detail, the main flight test objectives that were, positively, achieved during the flight:

- Context Management and CPDLC (Controller Pilot Datalink Communication) applications successfully exchanged uplink and downlink messages in accordance with the ATC procedures.
- ADS-C on event and periodic contracts.

This demonstrates the capability for a military data link (Link 16/MIDS), already installed and largely used for operations on several military platforms, to transport civilian ATC information.

Moreover the results of these projects (P15.2.8 and P09.20), combined with the ADS-B In/Out for Military Aircraft (P09.24) and the flight trial, provide the inputs into the Interoperability of Business Trajectory and Mission Trajectory (P09.03).

# 1 Final Project Report

## 1.1 Project progress and contribution

The activities addressed by P09.20.00 contributed to the following system Enablers as captured in the ATM MasterPlan<sup>1</sup>:

EN Code	EN Title	P09.20.00 activities /contributions	Maturity before project	Maturity after project
A/C-61	Handling of additional military datalink messages in military aircraft for ATM purpose.	The tasks T09 - WA2.3 - Ground tests and T12 - WA3.3 - Flight tests contributed to this enabler in terms of civil ATM messages exchanged over Link16 network.	V1  TRL 2	V2  TRL 5

Table 1 - List of enablers and project contribution

This project actively contributed to the enabler above especially in the tasks T09 and T12 where ground tests and flight test activities were carried out.

## 1.2 Project achievements

Summarizing, the project achievements are the following:

- Feasibility, for a military data link (Link 16/MIDS) already installed on several military platforms, to transport civilian ATC information.
- Possibility to exchange the ATC messages by means of Link 16 datalink via a ground gateway prototype.
- Interoperability of the prototype, under full military control, with existing ATC infrastructure.
- Future usability of the developed prototype in project 9.3 Interoperability of Business Trajectory and Mission Trajectory to enable i4D navigation function.

In order to achieve these objectives the project was structured in three working areas.

In the concept definition (WA1 - V1) the following objectives have been fulfilled:

- Identification of SESAR Data Link applications to be supported by military platforms and capture of related requirements from existing standards. The following typologies of requirements have been analysed:

<sup>1</sup> Data Set 13 is the latest publicly available at the time of writing this report,

- Functional requirements;
  - Architecture requirements;
  - Performance requirements;
  - Safety requirements;
  - Maintainability requirements.
- Feasibility study on the utilization of a ground interoperability with MIDS/Link 16 technology, associated with a ground-based gateway defined in 15.2.8, for CM, CPDLC and ADS-C data exchange applications.

The study considered:

- Technical and performance feasibility
  - Interface Identification and Diagrams describing the data flows in applications protocols
  - Design and Construction constraints
  - Spectrum Supportability
  - Operational Integrity and Security Assessment.
- Definition of MIDS/Link 16 system interface in terms of messages, addresses, transmission protocols and security aspects for the airborne part at system level which can support the required ATM data exchange.
  - Identification and description of target aircraft to be employed for flight trials foreseen in the WA3.

In the **Integration Phase (WA2 – V2)** the following objectives have been achieved:

- Definition of the interfaces (e.g. electrical, mechanical) between the validation system and the target aircraft that will be employed during the flight trials foreseen in the WA3.
- Execution of the installation and ground test on the A/C

In the **Technical Validation (WA3 – V3)** the following objectives have been fulfilled:

- Identification of the technical objectives to be verified during flight
- Definition of the scenario for the flight trials and provision of a verification matrix that describes the procedure for the test.
- Execution of flight trials

The System under test has been verified during a flight starting from the Turin airport and conducted by means of a C-27J test aircraft in conjunction with the Ground Gateway counterpart that has been developed within project 15.02.08 and located in the Alenia Caselle site.

## 1.3 Project deliverables

A summary of the project deliverables is presented in the table below:

Del. code	Del.Name	Description	Deliverable output and conclusions	Assessment Decision
D13	Final Progress status report	The deliverable (this document) comprises the P.09.20 Final Project Report.		TBD
D01	WA1.1 - Requirements review document (1st release)	Definition of the operational and technical assumptions used for the project, using as an input intermediate results of the operational WPs: mainly operational assumptions and end-to-end safety analysis results. Strong relationship with project 15.2.8 where ground interface and generic aspects related with civil-military data link interoperability are addressed is also presented.	The functional requirements were defined taking into account the real needs in terms of required ATM information exchanges between military aircraft and ATM systems.	No reservation
D02	WA1.1 - Requirements review document (2nd release)	The present deliverable consists in the definition of the operational and technical assumptions used for the project, using as an input intermediate results of the operational WPs: mainly operational assumptions and end-to-end safety analysis results. There is also a strong relationship with project 15.2.8 where ground interface and generic aspects related with civil-military data link interoperability are addressed.		No reservation (P)
D03	WA1.2 - Feasibility assessment (1st release)	The present deliverable aims at contributing to the demonstration that the technical characteristics of	Analysis of the feasibility to employ Link16 military data link for ATM data	No reservation (P)

		MIDS/Link 16 technology, associated with a ground-based gateway defined in 15.2.8, can support the required ATM data exchanges and can satisfy performance, spectrum, security and other requirements. This study will specifically delineate the basic specifications to be used for the data link change proposals (DLCP) on J-Series message set and for operational use when military aircraft is integrated in the SESAR context.	exchange. The feasibility was assessed as positive based on the following aspects: technical, operational, security, spectrum and functional.	
D04	WA1.2 - Feasibility assessment (2nd release)	The present deliverable aims at contributing to the demonstration that the technical characteristics of MIDS/Link 16 technology, associated with a ground-based gateway defined in 15.2.8, can support the required ATM data exchanges and can satisfy performance, spectrum, security and other requirements. This study will specifically delineate the basic specifications to be used for the data link change proposals (DLCP) on J-Series message set and for operational use when military aircraft is integrated in the SESAR context.		No reservation (P)
D05	WA1.3 - System interface document	The present deliverable aims to define the MIDS/Link 16 system interface in terms of messages, addresses, transmission protocols and security aspects for the airborne part at system level which can support the required ATM data exchange.  The document is intended to be an input for the subsequent phase that will connect the system to the aircraft.	The output of the analysis identified the necessary minor modifications to applied to J12.1 message in order to exchange CPDLC data (both in uplink and downlink) and J12.3 in order to exchange ADS-C data.	No reservation (P)



		A close co-ordination with project 15.2.8 (Civil-Military Data Link Interoperability) is essential to ensure compliance with specific avionics technology to be used to support ATM data exchanges. Other inputs to the airborne system requirements are originated by project 9.3.		
D06	WA1.4 - Target a/c and configuration document	This deliverable has the objective to identify the target aircraft suitable for validation activities and to provide the analysis of target aircraft configuration in order to define capabilities and equipment necessary for validation activities.	Identification of the C-27J A/C as the suitable military platform to be used in the forthcoming working areas	No reservation (P)
D07	WA2.1 - Aircraft system interface document	The purpose of this document is to define the interfaces (e.g. electrical, mechanical) between the validation system and the target aircraft that will be employed during the flight trials foreseen in the WA3.  Industrial partners have considered some of the information necessary to develop this deliverable as sensitive. For this reason this set of data is not included in this release, but in a separate and specific document, as agreed with the SJU.	Identification of the validation system that will be hosted on the target A/C in WA3 and definition of the interfaces between validation system and target A/C.	No reservation
D08	WA2.2 - Installation report	The purpose of the document is to describe the installation activities preliminary to the flight trials.	The activities verified that System Under Test was correctly installed on the A/C and worked as designed at ground test stage. This allowed proceeding with the activities relevant to the flight trials.	No reservation
D09	WA2.3 - Ground tests report	The purpose of the document is to describe the ground test activities preliminary to the flight trials.		No reservation
D10	WA3.1 - Validation plan	This deliverable describes the activities of WP 09.20 that will be conducted in the context of a Verification	Verification objectives to be tested during the flight trials were properly identified.	No reservation (P)

		<p>exercise jointly performed with WP 15.2.8. These activities are preliminary for a validation that will aim to satisfy SESAR communication needs where MIDS/Link 16 military datalink will be used for CPDLC and ADS-C applications.</p> <p>This document defines the technical objectives to verify that the proposed solutions work properly for communication purpose and as enabler for subsequent Initial 4D application development.</p> <p>For this reason the document is structured as a "Verification Plan".</p>		
D11	WA3.2 - Validation scenario	<p>The purpose of the document is to describe in sufficient detail the operational scenario in which the flight trials, foreseen in the task 'T012 – WA3.3 Flight test', will take place.</p>	<p>Flight test scenario and stakeholders' responsibility and coordination were duly identified.</p>	No reservation (P)
D12	WA3.3 - Validation report	<p>The purpose of this document is to provide the results collected during the flight trials occurred at the end of the project.</p>	<p>The results of the flight tests demonstrated the feasibility for a military data link (Link 16/MIDS), already installed on several military platforms, to transport civilian ATC information. The ATC messages were exchanged by means of Link 16 data link via a ground gateway prototype. This prototype is interoperable with existing ATC infrastructure and will be under full military control and can be used in project 9.3 Interoperability of</p>	No reservation

			Business Trajectory and Mission Trajectory to enable i4D navigation function.	
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## 1.4 Project Conclusions and Recommendations

The positive results collected during the flight trials demonstrated the feasibility for a military data link (Link 16/MIDS), already installed on several military platforms, to transport civilian ATC information.

During the joint activities with WP 15.2.8, alternative solutions for exchanging ATC data messages on the Link16 network were identified and studied, among these, only one was chosen for prototyping implementation and verification, having the benefit of not requiring Link16 network standard modifications.

For this reason, the modification of existing Link 16 messages already partially compliant with ATC needs or even the design of a new set of Link 16 messages to be used only for ATC purposes could be more deeply investigated.

Moreover a solution for interconnecting military classified ICT systems with civil ATM systems for exchanging ATC data will require a proper Information Exchange Gateway, which was outside the scope of the projects, and will require follow-on R&D activities.

All this is important in order to provide the military with technical options for the civil-military interoperability and the re-utilisation of existing equipment.

A further industrialization activity can be initiated only after a preliminary standard definition that requires a strong involvement of the military community.

## 2 References

- [1] 09.20.00 Military Data Link Accommodation, WA1.1 - Requirements review document (2nd release), 9.20.D02, Edition 00.02.01, 24/06/13.
- [2] 09.20.00 Military Data Link Accommodation, WA1.4 - Target a/c and configuration document, 9.20.D06, Edition 00.01.00, date 13/07/12
- [3] 09.20.00 Military Data Link Accommodation, WA2.1 Aircraft system interface document, 9.20.D07, Edition 00.01.00 date 09/11/12
- [4] 15.2.8.D08 - Modelling Report for a Ground Station for Military Data Link with SESAR Edition 00.01.00 date 29/07/13
- [5] 09.20.00 Military Data Link Accommodation, WA3.1 - Validation plan, 9.20.D10, 00.01.00, 11/11/2013
- [6] 09.20.00 Military Data Link Accommodation, WA 3.2 - Validation Scenario report, 9.20.D11 00.01.00, 10/12/2013
- [7] SESAR C-27J NC4033 Ground Test Requirements, Doc. n. 66/RS/0000/T341/130705 Issue 1, 15/11/2013
- [8] SESAR C-27J NC4033 Ground Test Procedure, Doc. n. 04/NT/0000/T866/140046, Issue 1, 30/05/14
- [9] SESAR C-27J NC4033 Ground Test Report, Doc. n. 04/TR/0000/T866/140189, Issue 1, 24/09/14
- [10] 09.20.00 Military Data Link Accommodation, WA 2.2 – Installation report, 9.20.D08 00.01.00, 14/11/2014
- [11] 09.20.00 Military Data Link Accommodation, WA 2.3 – Ground test report, 9.20.D09 00.01.00, 14/11/2014
- [12] 09.20.00 Military Data Link Accommodation, WA3.3 - Validation report, 9.20.D12 00.01.00, 23/12/2014

[13] [SESAR Programme Management Plan, Edition 03.00.01](#)

[14] [European ATM Master Plan, Edition 2](#)

[15] Multilateral Framework Agreement (“MFA”) signed between the SJU, EUROCONTROL and its 15 selected members on August 11, 2009, amended on 14 June 2010, 19 October 2010 and 2 July 2012

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