Final Project Report

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Abstract

The project proposed a concept for the use of AIS and MET information within the cockpit. The project led EXE-09.48-VP-811 (V2 level) to allow validating the concepts defined by the project. The project achieved a V2 validation of the functions that uses AIS/MET information onboard and formalised a specification of these functions (Functional Requirements and High Level Architecture). The Airspace Users (Pilots) concluded that such functions were very useful and increase situational awareness.

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This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
ACARS	Aircraft Communication Addressing and Reporting System
AFS	Automatic Flight System
AIREP	Air Report (Report of actual weather conditions encountered by an aircraft in flight)
AIRMET	Airmen's Meteorological Information
AIS	Aeronautical Information Services
AOC	Airline Operational Centre
ASHTAM	Special form of NOTAM dealing with ash clouds due to volcano's activity
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
CAT	Clear Air Turbulence
Cb	Cumulonimbus
DL	Data Link
ECAM	Electronic Centralized Aircraft Monitor
EFB	Electronic Flight Bag
ETA	Estimated Time of Arrival
FAA	Federal Aviation Administration
FMS	Flight Management System
F-PLN	Flight Plan
FRD	Functional Requirement Document
GDLP	Ground Data Link Processor
GRIB	GRIdded Binary
HF	Human Factors
ILS	Instrument Landing System

ICAO	International Civil Aviation Organization
MCDU	Multi-purpose Control and Display Unit
MET	Meteorological
METAR	METeorological Aerodrome Report
MFD	Multi Function Display
ND	Navigation Display
NOTAM	Notice To Airmen
OIS	Onboard Information System
OSED	Operational Service and Environment Definition
OTIS	Operational Terminal Information Service
PDF	Portable Document Format
PFD	Primary Flight Display
RMP	Radio Management Panel
RTCA	Radio Technical Commission for Aeronautics
RVR	Runway Visual Range
SAA	Special Activity Airspace
SESAR	Single European Sky ATM Research Programme
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
SIGMET	SIGnificant METeorological
SIGWX	SIGnificant Weather (chart)
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SNOWTAM	Special form of NOTAM dealing with snow and icing conditions
SPR	Safety and Performance Requirements
SUA	Special Use Airspace
TAF	Terminal Aerodrome Forecast
TFR	Temporary Flight Restrictions

TMA	Terminal Manoeuvring Area
TS	Technical Specification
UTC	Coordinated Universal Time
VOLMET	Worldwide network of radio stations that broadcast TAF, SIGMET and METAR reports on shortwave frequencies
WIDS	Weather Immediate Decisions Services
WNDS	Weather Near-term Decisions Services
WPDS	Weather Planning Decisions Services
WX	Weather
WXR	Weather Radar
xLS	x-Landing System

1 Project Overview

The project's goal was to promote the use of up to date AIS and MET information by airborne segment that will improve aircraft operations. The project also promoted the display and the use of the AIS and MET information on both Information systems and Avionics systems

1.1 Project progress and contribution to the Master Plan

AIS and MET information on the flight deck contribute to enhance crew situational awareness, flight safety and efficiency. It is used by pilots frequently and for various tasks during the whole flight.

First, pilots have to monitor short term AIS and MET information. Secondly, pilots analyse mid and long term data in order to be aware of impacts of AIS and MET information on the rest of the Flight and to anticipate and manage potential diversion trajectories.

Nevertheless the access to AIS and MET information remains nowadays very limited and the management of this information remains difficult in flight for pilots.

However, the AIS and MET information on the flight deck are sometimes obsolete or unreliable: most of the AIS and MET information are provided during flight preparation, i.e. almost one hour before take-off, and most often, no update is available during flight. Furthermore, pilots are faced with higher workload related to the acquisition and assimilation of AIS and MET data through voice transmissions or use of text messages. Integration of more AIS and MET information on the flight deck is needed, provided that the information remains legible and concise for pilots' assimilation.

The objective of the 9.48 SESAR project is to define means to improve the current situation by providing the pilots with new cockpit functions using AIS and MET information uplinked on board of aircraft before and during the flight, to enhance performance of flight decision support tools and on-board systems.

In order to improve crew situational awareness, AIS/MET cockpit functions should consist in depicting uplinked AIS and MET information to pilots on cockpit displays, either on Avionics Displays or on Information systems such as Electronic Flight Bags (EFB), and when eligible provide pilots with notifications in case of information updates. These new functions should allow providing pilots with relevant depiction of AIS and MET information:

- Representation appropriate to the content of the information and that requires a minimum of interpretation.
- Provision of the right level of information according to specific contexts which determine the nature and quantity of information displayed.

In addition, AIS/MET cockpit functions may be implemented to automatically upload AIS and MET information into cockpit systems (e.g. Flight Management System (FMS), EFB) and to transfer data between aircraft systems in order to replace pilots' manual entry of information into various on-board systems, to ensure uniqueness of information and to avoid duplication of activities for the flight crew.

With respect to the project contributions, firstly the project developed a Functional Requirement Document and a High Level Architecture Document. The project then developed three mock-ups to address the following topics:

- AIS and MET on Avionics Systems

- AIS on Information System (EFB)

- MET on Information System (EFB)

The mock-ups were subsequently validated by Airspace Users during EXE-09.48-VP-811. This was considered a V2 exercise, performed on 3 cockpit simulators. The results of this exercise are available within the Validation Report of the project.

Further to the validation exercise, the specifications (Functional Requirements Documents and High Level Architecture Document) were updated to take into account the outcomes of EXE-09.48-VP-811.

The EXE-09.48-VP-811, performed by Project 9.48, is included within the OFA ENB02.01.02 (AIM/MET) roadmap. The results of this exercise are used by the OFA and will be enhanced under EXE-13.02.02-VP-461.

A close coordination with other SESAR projects was performed to ensure that the project contributed to the SESAR outcomes. The coordination report of the project explains the coordination activities performed with other projects. However, 9.48 project also used inputs available from RTCA SC-206 / EUROCAE WG-76. The outputs of 9.48 project can be used by EUROCAE WG-76 if this group is reactivated.

The activities addressed by Project 09.48 contributed to the following Operational Improvements (OI) as captured within the ATM Master Plan (eATM Master Plan Data Set 13):

Code	Name	Project contribution	Maturity at project start	Maturity at project end
MET-0101	Enhanced MET observations, nowcasts and forecasts provided by ATM-MET systems through information provided by ATM systems and aircraft (Step1)	The 9.48 Project developed mock-ups that use this source of enhanced MET information. The project validated the use of this data in the cockpit. (EXE-09.48-VP-811 – V2 validation)	V1	V2
MET-0201	Enhanced MET observations, nowcasts and forecasts provided by ATM-MET systems through information provided by ATM systems and aircraft for Step 2	The 9.48 Project developed mock-ups that use this source of enhanced MET information. The project validated the use of this data in the cockpit. (EXE-09.48-VP-811 – V2 validation)	V1	V2
IS-0201-A	Digital Integrated Briefing	The 9.48 Project developed three mock-ups that can be used for the briefing and on-board during flight execution. The project validated the use of a common system between briefing and flight execution (EXE-09.48-VP-811 – V2 validation)	V1	V2
MET-0101 / METEO-03	Provision and monitoring of real-time airport weather information, Step 1	The 9.48 Project developed mock-ups that use this source of enhanced MET information. The project validated the use of this data in the cockpit. (EXE-09.48-VP-811 – V2 validation)	TRL 1	TRL 3
MET-0101 / METEO-04b	Generate and provide MET information services relevant for Airport and final approach related operations, Step 1	The 9.48 Project developed mock-ups that use this source of enhanced MET information. The project validated the use of this data in the cockpit. (EXE-09.48-VP-811 – V2 validation)	TRL 1	TRL 3
MET-0101 / METEO-05b	Generate and provide MET information relevant for TMA and	The 9.48 Project developed mock-ups that use this source of enhanced MET information. The project	TRL 1	TRL 3

	En-route related operations, Step 1	validated the use of this data in the cockpit. (EXE-09.48-VP-811 – V2 validation)		

1.2 Project achievements

The 09.48 projects was included in the roadmap of the OFA 02.01.02 AIM/MET:

- EXE-13.02.02-VP-462 validated Digital Enhanced Briefing Services
- EXE-09.48-VP-811 validated the On-board use of AIM/MET information
- EXE-13.02.02-VP-461 aims at validating Digital Integrated Briefing for all phases of flight

The Digital NOTAM enables a radical improvement in the Pre-Flight Information Bulletins. The exercises EXE-13.02.02-VP-462 / EXE-09.48-VP-811 / EXE-13.02.02-VP-461 demonstrated that

- with graphical presentation of the information;
- better filtering; and
- a more logical organization of the pre-flight information bulletins;

These can improve the:

- pilot/dispatcher awareness;
- improve the briefing times;
- and reduce the risk of information being misunderstood or missed (as compared to the current NOTAM text based briefings).

In comparison to EXE-13.02.02-VP-462, which was limited to pre-flight briefing in the ARO environment, the EXE-13.02.02-VP-461 exercise involves a significantly larger group of stakeholders, in particular from the flight service provider's community. This exercise also considers all phases of flight, from flight preparation, pre-flight briefing on the ground to pre-flight briefing on board at the gate and in-flight updates. Both aeronautical and MET digital data will be used. The ePIB prototype applications transform the raw digital AIS, NOTAM and MET data in a format that is comprehensive for a pilot and improves his/her ability to gain situational awareness.

The objective of EXE-09.48-VP-811 was to validate the concepts raised by 09.48 project, which are related to the AIS/MET information to be provided to flight crew and to aircraft systems, on-board (on the Information Systems and on the Avionics Systems) and out-board (on Information Systems for flight preparation phase). P09.48 functions are studied for all aircraft categories (mainline, regional, and business) including also helicopters. However, the project 9.48 did not intend to evaluate General Aviation requirements.

This exercise was split in three V2 validation sessions that have been performed by Airbus, Honeywell, Thales and airspaces users coming from various airlines, companies and organizations:

"AIS/MET on Avionics systems" (Airbus) validation exercise, executed in January 2015 on the Airbus MOSART simulator, in Airbus premises. This exercise has enabled the validation of MET information presented on Avionics displays for the "Additional Weather on Navigation Display" function, and AIS information presented on Avionics displays for the "ATIS on Airport Navigation Map" function.

"AIS on EFB" (Honeywell) validation exercise, executed in January and February 2015 in HONEYWELL premises. This exercise has enabled the validation of the ENROUTE function of AIS information, i.e. En-route and Airport/TMA NOTAMs on an EFB.

MET on EFB" (Thales) validation exercise, executed in January 2015 on "The Link By Thales®" bench in THALES premises. This exercise has enabled the validation of MET information displayed on an EFB for ENROUTE function

The specific achievements from the three exercises are:

- "AIS/MET on Avionics systems" (Airbus) validation exercise:

The “Additional weather on Navigation Display” function was globally deemed to bring an added value from an operational and safety point of view. It allows anticipating tactical weather avoidance, and securing the cabin ahead of weather if needed, and it also complements the weather radar limitation by bringing some additional pieces of information in the decision making process of pilots to choose the avoidance strategy.

Some improvements are recommended to enhance the situation awareness that the function brings, and the legibility of the MET information.

The “ATIS on Airport Navigation Map” function was more questioned in terms of operational utility, because it implies a redundancy of information with other avionics displays (MCDU/MFD), because the full ATIS content is not displayed and because the display of ATIS information is not graphical.

The main recommendation is to study further the graphical display of ATIS information; as well as improve the current textual display of the full ATIS content on existing displays (MCDU/MFD).

- "AIS on EFB" (Honeywell) validation exercise :

  For the En-route NOTAMs functionality participants suggested minor design related improvement. Nevertheless, the En-route NOTAM functionality was generally considered by the airspace users as beneficial and useful. On the other hand the perception of the airport/TMA NOTAM functionality by the airspace users was at least ambiguous. On the basis of results obtained the functionality should be reworked and improved.

  It is recommended to implement the changes proposed by the airspace users into the En-route NOTAMs functionality and then to evaluate the design again before deployment. It is also recommended to reconsider the entire context of use of the airport/TMA NOTAM and to rework the functionality accordingly.

- "MET on EFB" (Thales) validation exercise :

  The best quoted validation objectives of the exercised function were the adequacy of the Aircraft position and Flight Plan superposed with MET information, the utility of the “Meteorological information on EFB for En Route” function to anticipate long term weather avoidance, the adequacy of the contract mode of uplink.

  The worst quoted validation objectives of the exercised function were the level of head-down time, the visual channel load, the requirement for minimal actions, the easiness to use the function and the requirement for non-specific training to use the function.

  The involved Airspaces Users have also done a lot of pertinent remarks and suggestions that should help improve the function for the next phases of the project. Among the top requested improvement is the time to get the awareness of the whole meteorological situation along the flight plan that has to be shortened to a minimum.

For what concerns the following R&D questions in relation to the investigated concept:

How will the designed systems get AIS-MET information on board?

- The project did not develop any mock-up to answer this question. The project performed an analysis of the means available, their suitability and their limitations. The result of this analysis is available in D01. Further data link considerations are also available in D02 / D08 (section 2.5).

Are input data used by AIS-MET systems mature enough and available?

- The project assessed the maturity of input data (D-NOTAM, D-ATIS and MET products from 11.2 project). Some of the input data are available at study level only, other ones (such as SIGMETs in iWXXM format) are available under deployment. For deployment phase of systems that use AIS MET information on-board, the whole set of input data shall also be deployed.

The project did not mature any AIS/MET datalink services but provided assumptions and recommendations regarding such services (and associated information).

In terms of ATM performance the developments of the project addressed the following KPA / KPI:

KPA / KPI: Environmental – Fuel Efficiency / Change in average Fuel Burn per Flight

- AIS MET information may allow the crew to take preventive action that will allow trajectory optimisation, given latest changes in the conditions under which the flight is performed. However, AIS/MET system may lead to a trajectory change to increase the safety (hazard avoidance). This change may increase the fuel burn but will also increase the safety.

KPA / KPI: Safety / Change in accidents and incidents with ATM contribution per Year

- AIS MET information may enhance the crew's situational awareness about MET and AIS situation which may have a positive effect on safety.

The project performed qualitative assessment of the benefits but no quantitative ones.

1.3 Project Deliverables

The following table presents the relevant deliverables that have been produced by the project.

Reference	Title	Description
D01	State of the Art Description	At the start of the project a clarification of the state of the art was performed. The goal of this deliverable was to formalise the state of the art of AIS / MET services and data distribution
D04	Validation Plan	The Validation Plan describes how three V2 validation sessions were defined to assess the feasibility and benefits of the operational concept of providing up-to-date AIS/MET information to flight crew during the flight execution phase.
D05	Validation Report	The Validation Report provides the results of EXE-09.48-VP-811 and describes the conclusions with respect to the validation objectives.
D08	Functional Requirements Document: Final Release	This document provides the functional requirements for implementing the defined concept. These requirements were updated with the results from the validation exercise VP-811
D09	High Level Architecture: Final Release	This document contains the high level architecture on which the various prototype implementations used in the validation activity were based.

1.4 Contribution to Standardisation

Because of the current dormant state of WG-76, one cannot say that coordination took place. However, the documents already produced by WG-76 and RTCA SC-206 (mainly ED-151, ED-175 and DO-340) were used as inputs throughout the activities of P 09.48, and more particularly during the Functional Definition task (leading to the SESAR 09.48 FRD). Reciprocally, the SESAR 09.48 FRD was taken into account by the WG-76 during its preliminary phase, for identification of specific data link services to be standardized after WG-76 effective re-activation.

Furthermore, some participants to the project were involved in the activities of SC-206 and most of them are engaged in the preliminary phase preparing the Technical Report for the revival of WG-76

1.5 Project Conclusion and Recommendations

The analysis of the exercise EXE-09.48-VP-811 executed in the project shows overall positive results and outcome. When implemented, conclusions and recommendations drawn by the project have the potential to contribute to improve flight efficiency and safety. 09.48 project has allowed to get from a Technical Readiness Levels (TRLs) 1 to a TRL3.

A summary of the project conclusions is presented below:

- AIS / MET on Avionics systems
  - The operational usefulness of displaying on Navigation Display uplinked weather observations as a complement to the on-board Weather Radar, and the benefits it brings regarding tactical management of adverse weather and enhancement of flight safety, have been confirmed.
  - The usability of uplinked weather information as a complement to on-board Weather Radar information has been confirmed, however the resolution and accuracy of current SIGMETs is challenged, and the use of “better” weather observations not limited to SIGMETs is strongly recommended.
  - The uplinked weather information must have an appropriate level of quality (accuracy, reliability, availability, etc…) in order to ensure their usability for display on Avionics displays such as ND. For this purpose, it is recommended to develop standards defining information quality requirements.
  - More globally, it is recommended to develop standards defining the data link services necessary for uplinking any AIS and MET information.
  - The “Additional Weather on ND” function is expected to be designed with the objectives to enhance the flight crews’ situation awareness, and to ensure a good legibility of the Weather information.
  - The operational usefulness of displaying partial ATIS information on the Airport Navigation Map has been confirmed, however via a graphical display and not a textual one in order to avoid redundancy with existing textual display of ATIS information.
  - To enhance the situational awareness of ATIS content and updates, some improvements on the existing textual display of the full ATIS information – on “head-down” Multi-Control Display Units / Multi-Functional Displays – are recommended.

- AIS on Information System (EFB)
  - The benefits of en-route NOTAM information on improved situational awareness have been confirmed.
  - The utility and usability of en-route NOTAM information on EFB has been confirmed.
  - The utility and usability of Airport and TMA NOTAM has not been fully confirmed.
  - The En-route NOTAM functionality was considered by the airspace users as beneficial and useful.

- MET on Information System (EFB)
  - The utility of MET information on EFB is confirmed
  - The prototype validated during EXE-09.48-VP-811 has a good maturity and is a good basis for the system

A summary of the project recommendations is presented below:

- AIS / MET on Avionics systems
  - The improvement of the current SIGMETs resolution and the use of other weather observations with a better resolution, are recommended for display on Navigation Display as a complement to the on-board Weather Radar.
  - Uplinked weather information quality (accuracy, reliability, availability, etc…) are recommended to be defined at standardization level.

- It is recommended to develop standards defining the data link services (including SWIM as appropriate) necessary for up-linking AIS and MET information.
- It is recommended to further study the graphical display of specific ATIS information (e.g. runways closed, taxiways closed, runways length reduced, etc…).
- Improvements of the existing textual display of ATIS information are recommended.

- AIS on Information System (EFB).
  - The proposed operational context for textual Airport and TMA NOTAM functionality requires some revisions.
  - Additional verification and validation exercises are required to cover also other types of AIS information and the end-to-end data distribution chain.
  - Solutions for integrated display of AIS and MET information should be further investigated.

- MET on Information System (EFB)
  - The functional maturity of the system may be enhanced (eg: reduction of pilot workload, reduction of the training needed to use the system)
  - Connexion between EFB and Avionics may be explored
  - Integration with the SWIM may be implemented

It is recommended for next phases to perform some evolutions of the MET on EFB for ENROUTE function to reach the identified validation objectives for V3. The main efforts should focus on the improvement of the time for the user to get the awareness of the whole meteorological situation along the flight plan and the availability of all the functions with a good level of maturity.

A large scale demonstration exercise is recommended to validate the function before deployment.

2 References

[1] SESAR Programme Management Plan, Edition 03.00.01

[2] European ATM Master Plan

[3] 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

[4] P 09.48 - Latest Project baseline – Date 18/12/2013

[5] P.09.48 - State of the Art Description– D01 – Edition 00.02.05 – Date 18/03/2013

[6] P.09.48 – Functional Requirements Document: Initial Release – D02 – Edition 00.01.00 – Date 14/10/2013

[7] P.09.48 – High Level Architecture: Initial Release – D03 – Edition 00.01.00 – Date 06/11/2014

[8] P.09.48 – Validation Plan – D04 – Edition 00.01.01 – Date 25/11/2014

[9] P.09.48 – Validation Plan – D04 – Edition 02.00.00 – Date 12/06/2015

[10] P.09.48 – Validation Report – D05 – Edition 02.00.00 – Date 01/09/2015

[11] P.09.48 – Coordination Report – D06 – Edition 00.01.00 – Date 24/03/2015

[12] P.09.48 – Final Project Report (or Management Report) – D07 -> This Deliverable

[13] P.09.48 – Functional Requirements Document: Final Release – D08 – Edition 02.00.00 – Date 01/09/2015

[14] P.09.48 – High Level Architecture: Final Release – D09 – Edition 02.00.00 – Date 01/09/2015

[15] EUROCAE ED-151 (RTCA DO-308), Operational Services and Environment Definition (OSED) for Aeronautical Information Services (AIS) and Meteorological (MET) Data Link Services; December; 2007

[16] EUROCAE ED-175 (RTCA DO-324), Safety and Performance Requirements (SPR) for Aeronautical Information Services (AIS) and Meteorological (MET) Data Link Services; January, 2011

[17] RTCA DO-340, Concept of Use for AIS and MET Data Link Services; September, 2012

[18] RTCA DO-349, AIS and MET Services Delivery Architecture Recommendations, December 2013

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