

**Release 5 SESAR Solution #102**  
**Aeronautical mobile airport communication system (AeroMACS)**

***Contextual note – SESAR Solution description form for deployment planning***

***Purpose:***

*This contextual note introduces a SESAR Solution with a summary of the results stemming from R&D activities contributing to deliver it. It provides a summary of the SESAR Solution in terms of scope, operational and performance benefits and relevant system impacts as well as additional activities to be conducted during the industrialization phase or as part of deployment. This contextual note is part of the data package prepared for the SESAR Solution for which maturity has been assessed as sufficient to support a decision for industrialization. It complements the technical data pack comprising available deliverables required for further industrialization.*

**Improvements in ATM Operations**

Air Traffic Management (ATM) communications capacity is reaching saturation in Europe and the United States, because of the increasing air-traffic volumes and density. The problem is most severe on the airport surface where the large concentration of aircraft is combined with pre-flight and post-flights operations increasingly relying on the data communications capacity.

The SESAR Technical Solution “Aeronautical mobile airport communication system (AeroMACS)” responds to a specific demand agreed by ICAO in 2008 following the ICAO Air Navigation Conference 2003 and ICAO Future Communication Study (Action Plan 17). AeroMACS is part of the Future Communication Infrastructure supporting the Airport Surface Component and is reflected within the ICAO Global Air Navigation Plan (GANP) and the ICAO Communication Roadmap in the GANP.

The SESAR Technical Solution “AeroMACS” provides a mature and validated option to support the future ANSP, Airline and Airport Authority datalink communication exchanges in the airport environment between mobile and fixed users. It provides worldwide interoperability and integration of critical coms.

The SESAR1 AeroMACS activities (Projects P15.2.7 and P9.16) demonstrated a technical profile and architecture for a new generation of airport surface data link system. The prototyping developments encompassed the integration and testing within both the airport and aircraft environment.

The solution addresses air-ground data communications at airports, which will otherwise continue to experience crowding and ultimately saturation as air traffic grows. In particular AeroMACS can offload the saturated VHF datalink communications in the airport environment, as identified in the recommendations of the EASA Data Link report (2014), as well as enable the future concepts considered in SESAR.

The AeroMACS system will enable:

- high capacity information exchanges, thanks to higher throughput in airport surface communications (considering the synergies among the various stakeholders);

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- worldwide interoperability and integration of critical coms for ANSPs, Airspace Users and Airports;
- support enhanced communications and information distribution at lower costs (synergies of sharing infrastructure);
- advanced security capabilities and increased safety levels;
- advanced surface Communication Navigation Surveillance (CNS) systems, leading to more efficient airport surface operations.

AeroMACS is based on IEEE 802.16 (WiMAX) standard, operates in reserved (aeronautical) frequency bands and is customised for Air Navigation Service Providers (ANSP), Airline Operations Centre (AOC) and Airport Authority communications, in compliance with the SESAR Future Communication Infrastructure (FCI) recommendations. AeroMACS is an international standard and supports globally harmonised and available capabilities according to ICAO GANP.

#### Operational Improvement Steps (OIs) & Enablers

- CTE-C02d: New wireless technology for the Airport Datalink AEROMACS over ATN/IPS, based on IEEE 802.16 WiMAX, as a new standard for airport surface communications (ATS, AOC and APOC) for Aircraft and Vehicles.

The following enablers are indirectly supported by Solution 102:

- AERODROME-ATC-21 Surface movement control workstation equipped with a system to provide alerts for vehicles (and to uplink alarms to those vehicles) in case of risk of collision with aircraft or area infringement.
- AIRPORT-30: Use of airport wireless communication infrastructure to handle the data traffic between mobile and fixed elements of Aircraft Operators, Airport Operators, ATC and other services (e.g. handlers, met, fire and rescue).
- A/C-24: Airport moving map and own aircraft position display in cockpit.
- A/C-31a/b/c: Data link communication exchange for ATN baseline 2 and beyond.
- A/C-42a: Onboard graphical display of taxi clearance using common air/ground airport database.
- A/C-43a2: Traffic Alerts for Pilots during Taxiway Operations.

Potential impacted (enabled) OIs: AO-0104-A/B, AO-0105, AO-0204, AO-0205, AO-0206, AO-0215, AUO-0302-C, AUO-0303-A/C, AUO-0308-A/B,,AUO-0309, AUO-0603-A/B.

In addition, AeroMACS is relevant to the following institutional enablers: AGDLS-STD-04, AGDLS-TECH-2, STD-018, STD-019, STD-038 and STD-042.

#### Background and validation process

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The SESAR Technical Solution “AeroMACS” has been verified through a series of “classical” development activities, namely lab testing followed by on site (airport and aircraft) testing. A high level summary of the verification activities is presented hereafter.

Lab testing

Prior to lab testing, test beds were built with following elements:

- Ground Stations , Mobile Stations, antennas, GPS, network and IT elements (switch, PC), cables, attenuators
- Laboratory test cases and related lab test means (spectrum analyser, protocol analyser, etc.) for Signal & Protocol measurement,
- IP traffic generators.

The test beds were configured to comply with the different lab tests scenarios:

- to perform Radio Frequency (RF) measurements and interoperability evaluation in THALES labs;
- to perform RF measurements and interoperability evaluation in SELEX labs .

Airport testing

Airport tests were split between the two different projects and covered:

- test scenario operated by SELEX & AIRBUS, focused on the airborne segment,
- test scenario operated by THALES & DSNA, focused on ground segment.

The airport test scenarios used 2 Ground Stations and 3 Mobile Stations developed by Thales and Selex and deployed at the Toulouse airport separately by Thales and by Selex and Airbus. For each test scenario:

- Two Ground Stations were installed on an appropriate building in the Airport. Appropriate means appropriate in terms of propagation (sufficient height to improve the coverage, reduce the masks) and installation capacities (antennas and equipment on the roof, power supply, limited impact on airport normal activities etc...).
- Two MS were installed on vehicles moving in different airport areas at different speeds and collected measurements regarding different propagation conditions. One MS was located on a fixed place.

The scenarios were built regarding the different categories of objective:

- Cell coverage
- Modulation performances / Link adaptation
- Real deployment / Non Line of Site (NLOS) performances
- Mobility performances
- Multi-channel utilization

Aircraft testing

An AeroMACS Prototype Airborne Antenna has been installed on A320 test aircraft in order to check Electro-Magnetic Interferences (EMI) compatibility as well as to perform tests static and dynamic tests.

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Note: The verification process took advantage of the strong points of each of industrial partners (features available, experience, methodology ...). As an example, the industrial partners used different measurement devices, so that tests representativeness was improved.

**Results and performance achievements**

The main findings from the overall verification exercise can be summarised as follows:

- The test campaigns executed suggest further investigations being required in the field of Interoperability, and also confirm the need to identify unambiguously the network protocols and messages formatting involved in the Authentication/Encryption process.
- As a conclusion, the testing allowed collecting positive evidences on the suitability of the prototypes to assess the AeroMACS technology regarding the on-going standardization, to prefigure future realizations, and representative airport deployments, which are highly recommended to complete achievements at the upper layer, namely network layer.

**Recommendations and Additional activities**

AeroMACS is the first of the new data links (Future Communication Infrastructure, FCI) that is being developed, which will be operating under a multilink concept and over a common (IP based) network. While the AeroMACS technology concept is considered mature, the integration of AeroMACS in a common network needs further validation to address aspects non-specific to AeroMACS (such as authentication, security certificates and registration of mobile station to ground stations ).

Further technical activities are proposed in the context of SESAR2020. In addition, a larger scale and fully representative deployment exercise involving at least an ANSP, an Airport an Airline and a relatively high number of Mobile Systems should be envisaged to fully demonstrate and promote the solution. In order to support a deployment decision there is also the need need to progress the establishment of the AeroMACS business case and the development of ground infrastructure implementation strategies and plans.

**Actors impacted by the SESAR Solution**

ANSPs (TWR, ATCOs, ...), Airlines (Pilots, AOC, ...), Airports (emergency airport services, gate, luggage, airport service vehicles, etc).

In addition, frequency managers have to consider allocation of spectrum for AeroMACS.

**Impact on A/C System**

EMI tests on aircraft were performed: no interference was found between AeroMACS and VHF, ATC, DME, MMR, Localizer, VOR and Marker systems

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Further testing should be planned in SESAR2020.

**Impact on Ground Systems**

AeroMACS will need to be integrated within an airport communication network.

**Regulatory Framework Considerations**

EASA material for the implementation of AeroMACS (a/c integration) will be required. Currently AEEC is finalising the AeroMACS avionics standard and standards in ICAO, EUROACE and RTCA are already published.

**Standardization Framework Considerations**

The standardisation bodies and the documents to which SESAR projects have contributed and are continuing is provided below:

- ICAO
  - CP/WGS development of:
    - AeroMACS SARPS
    - AeroMACS Technical Manual
- EUROCAE / RTCA
  - EUROCAE WG-82 and RTCA SC-223 collaboration to develop:
    - AeroMACS Profile
    - AeroMACS MOPS
  - EUROCAE WG-82 development of:
    - AeroMACS MASPS
- WiMAX Forum
  - AWG development of:
    - PICS
    - CRSL
    - Security PKI Guidance
- ARINC AEEC
  - AEEC group for Form Fit and Function (FFF):
    - ARINC AeroMACS Avionics standard

**Considerations of Regulatory Oversight and Certification Activities**

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There is no specific topic in the field of the Regulatory Oversight and Certification Activities to be considered in deployment, beyond the applicable existing ones.

**Solution Data pack**

The Data pack for this Solution includes the following documents:

SESAR Project “New Communication Technology at Airport” (P9.16)

- SESAR P09.16 Final Validation Report, Deliverable D11
- SESAR P9.16 Final Project Report, Deliverable D000

SESAR Project “Airport Surface Datalink” (P15.02.07)

- SESAR P15.02.07 Deployment and Integration Analysis, Deliverable D04
- SESAR P15.02.07 Verification Plans and Reports Phase 1 and Phase 2, Deliverables D06 and D10
- SESAR P15.02.07 Final Project Report, Deliverable D09
- SESAR P15.02.07 Safety and Security Analysis, Deliverable D08
- SESAR P15.02.07 Prototype Description and Verification Strategy, Deliverable D05
- SESAR P15.02.07 Standardisation and Global Interoperability, Deliverable D07-02

Other Documents (containing contributions):

- CP WGS Working paper on Capacity (WGS 17<sup>th</sup> webex WP05)
- AeroMACS SARPs (ICAO Annex 10, Vol III, Ch7)
- AeroMACS Manual (ICAO Doc10044)
- AeroMACS Profile (EUROCAE ED222 and RTCA Do345)
- AeroMACS MOPS (EUROCAE ED223 and RTCA Do346)
- AeroMACS MASPS (EUROCAEEDxxx, publication expected in 2016 Q3)
- AeroMACS Avioncs Standard (AEEC/ARINC7XX, under development, expected to be finalised in 2017 Q2)

**Intellectual Property Rights (foreground)**

The foreground for the identified SESAR project deliverables is owned by the SJU.

The identified ICAO, EUROCAE, RTCA and AEEC documents are publicly available documents (but property of the respective organisations).