



Work Package Final Report

Document information

Work Package Title	Non Avionic CNS System
Work Package Number	15 - Sub Work Package 15.02
WP Leader(s)	Leonardo and Thales, EUROCONTROL for SWP15.02, Thales for SWP15.03 and Indra for SWP15.04
Deliverable Name	Work Package Final Report
Deliverable ID	Project 15.02 deliverable ID D12
Edition	00.03.00
Template Version	01.00.00

Task contributors

EUROCONTROL, Leonardo, Indra and Thales

Abstract

The Non Avionics CNS (Communication, Navigation and Surveillance) System Work Package (WP15) covered transversal CNS activities as well as activities specific to the COM, SUR and NAV domains. Overall WP15 contained 23 technical projects which addressed the overall CNS system aspects as well as the CNS aspects specific to the ground components, in close coordination with Avionic Work Package WP9 which addressed the aspects for the avionics components. In addition WP15 contained 4 management projects which monitored, steered and facilitated the progress of the WP15 technical projects in order to ensure the achievement of their objectives and the on-time delivery of the outcome and with the required quality.

			SUR SWPMs	
00.01.02	10/06/2016	Draft	WP15 Leaders and COM, NAV and SUR SWPMs	Further updates
00.02.00	14/06/2016	Final	WP15 Leaders and COM, NAV and SUR SWPMs	New handover to SJU
00.02.01	15/06/2016	Draft	WP15 Leaders and COM, NAV and SUR SWPMs	Updates based on SJU feedback
00.02.02	15/06/2016	Draft	WP15 Leaders and COM, NAV and SUR SWPMs	Further updates
00.03.00	15/06/2016	Final	WP15 Leaders and COM, NAV and SUR SWPMs	New handover to SJU

Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
ACAS	Aircraft Collision Avoidance System
ADS-B	Automatic Dependent Surveillance - Broadcast
AEEC	Airlines Electronic Engineering Committee
AeroMACS	Aeronautical Mobile Airport Communication System
AMHS	Aeronautical Message Handling System
AOC	Airline Operations Center (Communications)
ARINC	Aeronautical Radio Incorporated
ATM	Air Traffic Management
ATN/IPS	Aeronautical Telecommunications Network / Internet Protocol Suite
ATS	Air Traffic Services
C, COM	Communication
DME	Distance Measuring Equipment
ECAC	European Civil Aviation Conference
FCI	Future Communications Infrastructure
FMTF	Flight Message Transfer Protocol
GAST	GBAS Approach Service Type
GBAS	Ground Based Augmentation System
GNSS	Global Navigation Satellite System
i-4D	initial 4-Dimension (trajectory operations)
IEEE	Institute of Electrical and Electronics Engineers
ITU-R	International Telecommunication Union - Radiocommunications
LDACS	L-band Digital Aviation Communication System
MASPS	Minimum Aviation System Performance Standard
MON	Minimum Operational Network
MOPS	Minimum Operational Performance Specification

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

MSPSR	Multi Static Primary Surveillance Radar
N, NAV	Navigation
NDB	Non Directional Beacon
PBN	Performance Based Navigation
PCP-IR	Pilot Common Project - Implementing Regulation
PENS	Pan European Network Services
S, SUR	Surveillance
SARPS	Standards And Recommended Practices
SATCOM	Satellite Communications (system)
SBAS	Satellite Based Augmentation System
SBB	SwiftBroadBand (INMARSAT SATCOM system)
SWIM	System Wide Information Management
SWP	Sub Work Package
TBS	Time Based Separation
TMA	Terminal Manoeuvring Area
TRL	Technology Readiness Level
VoIP	Voice over IP
WAM	Wide Area Multilateration
WP	Work Package

1 Work Package Overview

The Non Avionics CNS system Work Package (WP15) covered transversal CNS activities as well as activities specific to the COM, SUR and NAV domains. Overall WP15 contained 4 management projects as well as 23 technical projects: 2 transversal, 6 for COM, 6 for NAV and 9 for SUR. These projects addressed the overall system CNS aspects as well as the CNS aspects specific to the ground components in close coordination with WP9 which addressed the aspects for the avionics components.

The transversal CNS activities included 2 projects.

Project 15.01.06 Spectrum Management & Impact Assessment

Project scope was to ensure that required spectrum, necessary to operate the ATM-CNS systems, is available and that these systems use it in an efficient way.

One of the major tasks of the project, in conjunction with Industry, ANSPs, IATA and states, has been to manage the necessary studies that are required to provide ITU-R, and regional radio regulator bodies, with the appropriate technical results promoting CNS spectrum allocation requirements to allow the future CNS SESAR Concept enablers to operate properly.

Project 15.01.07 CNS System of System definition and roadmap

This project was the federating CNS project, necessary to contribute to the technical systems architecture developments. It also addressed consolidated CNS Roadmap, combining the work of the existing sub-domains and linked to the Avionics roadmap; provided a framework for CNS cross-domain technical study to improve the overall CNS robustness, efficiency and security and also combined with links to spectrum, providing inputs into update cycles of the Master Plan.

Project 15.02 Communication

Project 15.02 covered the management of the WP15 Communication Domain (Sub Work Package 15.02) which included 6 technical projects addressing air/ground and ground/ground communications as well as support to civil/military interoperability. These technical projects worked closely with other relevant SESAR activities and in particular the WP9 projects addressing the avionics aspects.

In relation to the civil/military interoperability, a technical project addressed the feasibility of using Link 16 to support the early integration of military aircraft using existing military equipment.

For the ground/ground COMs, one technical project covered the feasibility of using PENS as a SWIM backbone.

For the air/ground COMs, there were four technical projects focusing the definition and development of the Future Communication Infrastructure (FCI) covering general FCI aspects (multilink and ATN/IPS), AeroMACS, LDACS and SATCOM (both medium and long term, termed respectively Class B and Class A).

In addition to the technical projects, SWP15.02 supported directly the global harmonisation of the systems considered in the various COM technical projects and promoted the international standardisation to achieve interoperability. In particular, SWP15.02 liaised with ICAO, EUROCAE/RTCA and AEEC for standardisation aspects, coordinated with the FAA for a harmonised approach and supported SJU in various activities such as the coordination with US/FAA in the context of Coordination Plan 4.4 and the operational focus area (OFA) for communications (ENB01.01 03).

Project 15.03 Navigation

The purpose of this project was to provide guidelines and recommendations to the Navigation WP15 studies and projects in order to get a comprehensive, cost efficient and modern CNS infrastructure in line with the SESAR concepts and targets.

Project was organized in two main parts: Global Navigation Studies and GNSS. In the first part activities were carried out regarding navigation technologies specifications and study for a back-up to terrestrial Navigation Aids, while in the second part activities were focusing on the GNSS field.

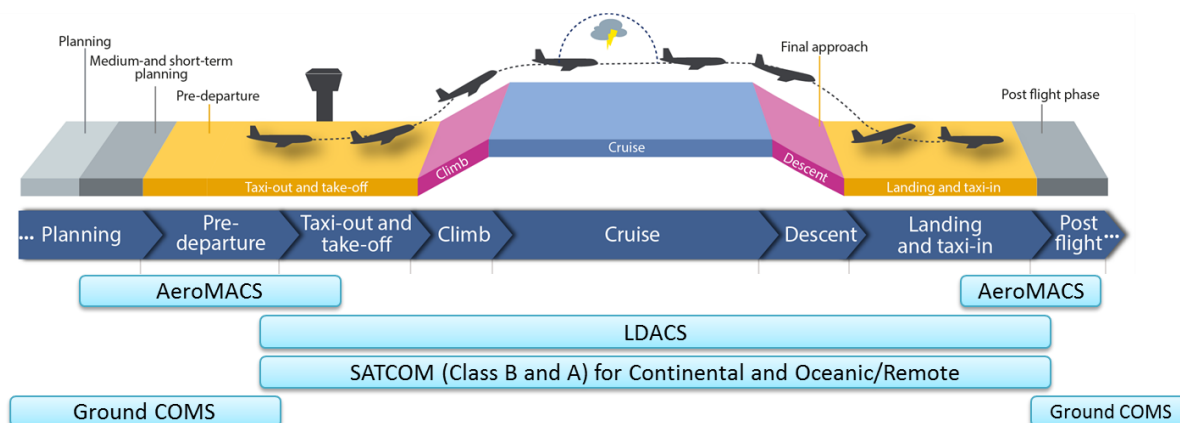
Project 15.04 Surveillance

Surveillance domain activities covered 9 projects addressing the ground segment surveillance and surveillance infrastructure rationalization studies. Weather sensor related projects were also included in this domain, even when at later stages they have been incorporated into "Meteorological Information Services" domain.

1.1 Work Package contribution to the Master Plan

COMMUNICATION

The COM Domain technical projects supported the development of solutions for the ground communications as well as the air/ground communications. The key solutions developed cover: Ground COMS, AeroMACS, LDACS and SATCOM. The figure below depicts the applicability of these key solutions to the various phases of flight.



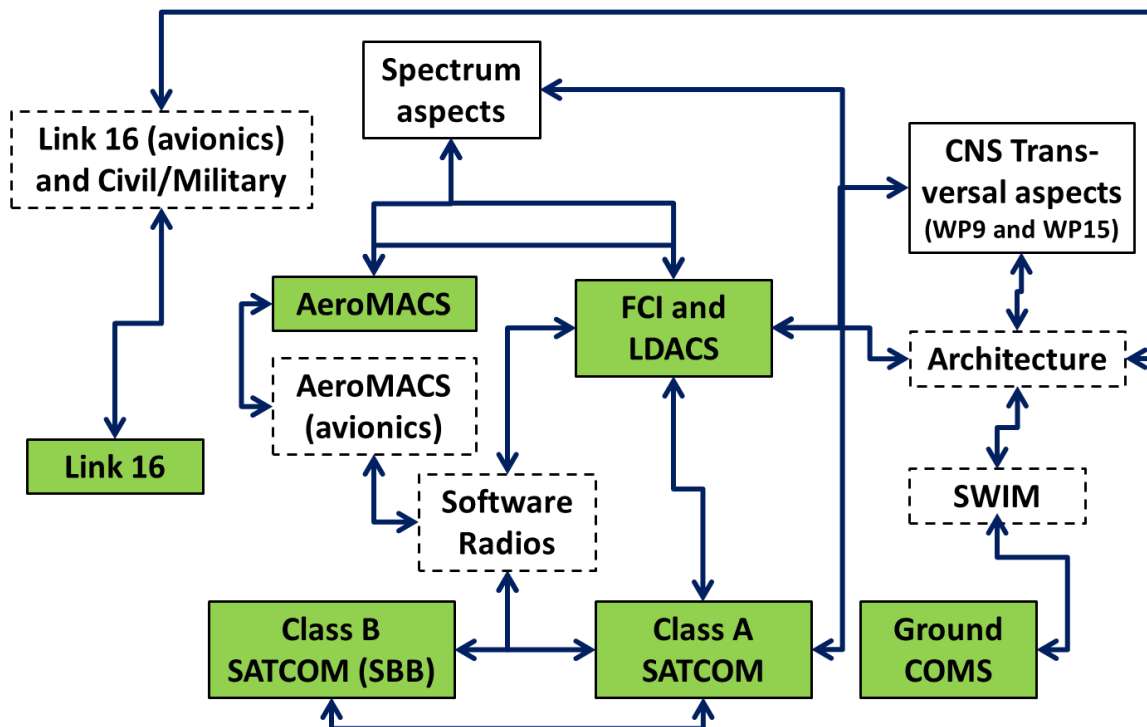
Applicability of key COM solutions for the various phases of flight

In addition the following diagram highlights the key links among the WP15 COM projects and the other relevant SESAR projects.

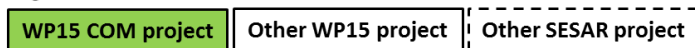
founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu



Legend



COM projects key links

The six WP15 COM technical projects supported the COM enablers identified in the ATM Master Plan. The contributions of these COM projects to the ATM Master Plan enablers are summarised in the following table.

Note: The numbering and references of the Enablers and the Operational Improvements has evolved over the lifecycle of the COM projects. The table below is referring mainly to the data set DS15. For projects that have ended before DS15, the provided information reflects a "translation" of the info from the previous data sets to DS15.

Code	Name	WP contribution
CTE-C02d	New Airport Datalink technology (AEROMACS)	Supported the development and standardisation of new wireless technology for the Airport Datalink, based on IEEE 802.16, as a new standard for airport surface communications (ATS, AOC and APOC) for the Aircraft and Vehicles. Achieved validation and standardisation in ICAO and EUROACE and initiated standardisation in AEEC
CTE-C02e	New A/G datalink using ATN/IPS over L-band	Development of LDACS specification for input to standardisation Testing of interference performance of the LDACS transmitter.
CTE-C02f	Future Satcom for ATM: Precursor /INMARSAT SBB (class B Satcom)	Demonstration of feasibility of using SBB to support end to end i-4D operations in lab and during a flight
CTE-	Future Satcom for	Definition of System Requirements and Validation

founding members



Code	Name	WP contribution
C02h	ATM: Long term Satcom/IRIS (class A Satcom)	Requirements complementing the ESA Iris work on technology specifications
CTE-C04	Future Communication Infrastructure - ATN/IPS and Multilink	Analysis of multilink options and identification of proposals to address mobility for ATN/IPS
CTE-C05a	VoIP for ground telephony	Assessment of the performance of Digital Voice/VoIP (in line with EUROCAE ED137B Vol2) for Ground Telephony over PENS
CTE-C05b	Digital Voice / VoIP for ground segment of Air-Ground voice	Assessment of the performance of Digital voice/VoIP (in line with EUROCAE ED137B Vol1) for ground segment of Air-Ground voice over PENS.
CTE-C06a	PENS - Phase 1	Proposal for a PENS Security Policy and assessment of AMHS, FMTP, Surveillance data exchange, VoIP (radio and telephony) across PENS
AERODR OME-ATC-21	Surface movement control workstation equipped with a system to provide alerts for vehicles	Supported the development and standardisation of technology to enable surface movement control workstations 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.
A/C-61	Handling of additional military datalink messages in military aircraft for ATM purpose.	Ground and Flight tests activities supported the exchange of civil ATM messages over the Link16 network.
MIL-0502	Upgrade of military ground systems to allow bi-directional exchanges with non-military IP networks	Assessment of LARA (Local and sub-Regional Airspace Management Support Military System) across PENS

COM projects contributions to the ATM Master Plan

Note: In the above table, the CTE-Cxxx enablers were primarily addressed by the WP15 COM technical projects. Some of the other enablers have been progressed by other projects with contributions from some of the COM technical projects.

As a result of the COM Domain projects outcome, there are already mature proposals for two technical solutions covering the AeroMACS Datalink (proposed Solution 102) and the Precursor/INMARSAT SBB technology (proposed solution 109). In addition emerging solutions are being identified for Multilink, LDACS and SATCOM Class A. These emerging solutions will be further considered in the relevant SESAR 2020 activities.

NAVIGATION

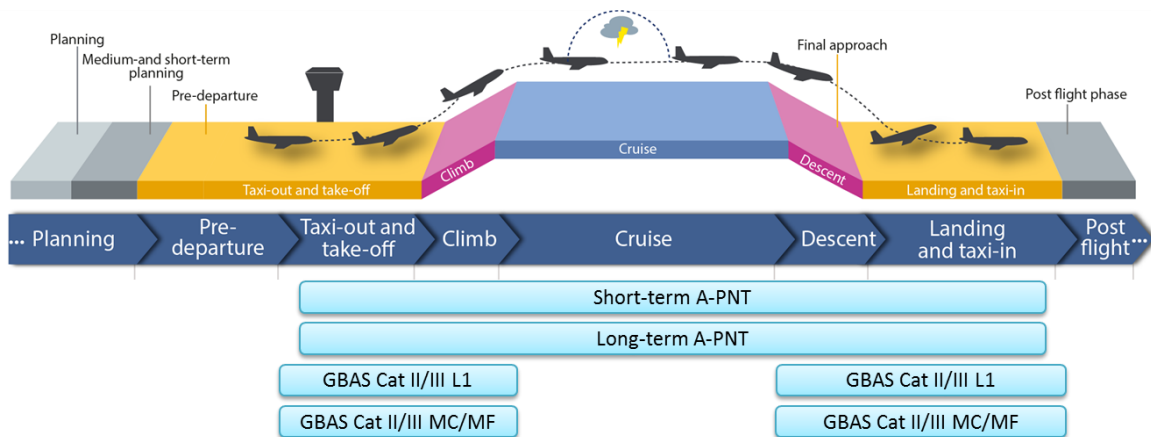
The NAV Domain technical projects supported the development of different solutions for the GNSS-based and ground-based air navigation for the different phases of flight. The key solutions developed

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

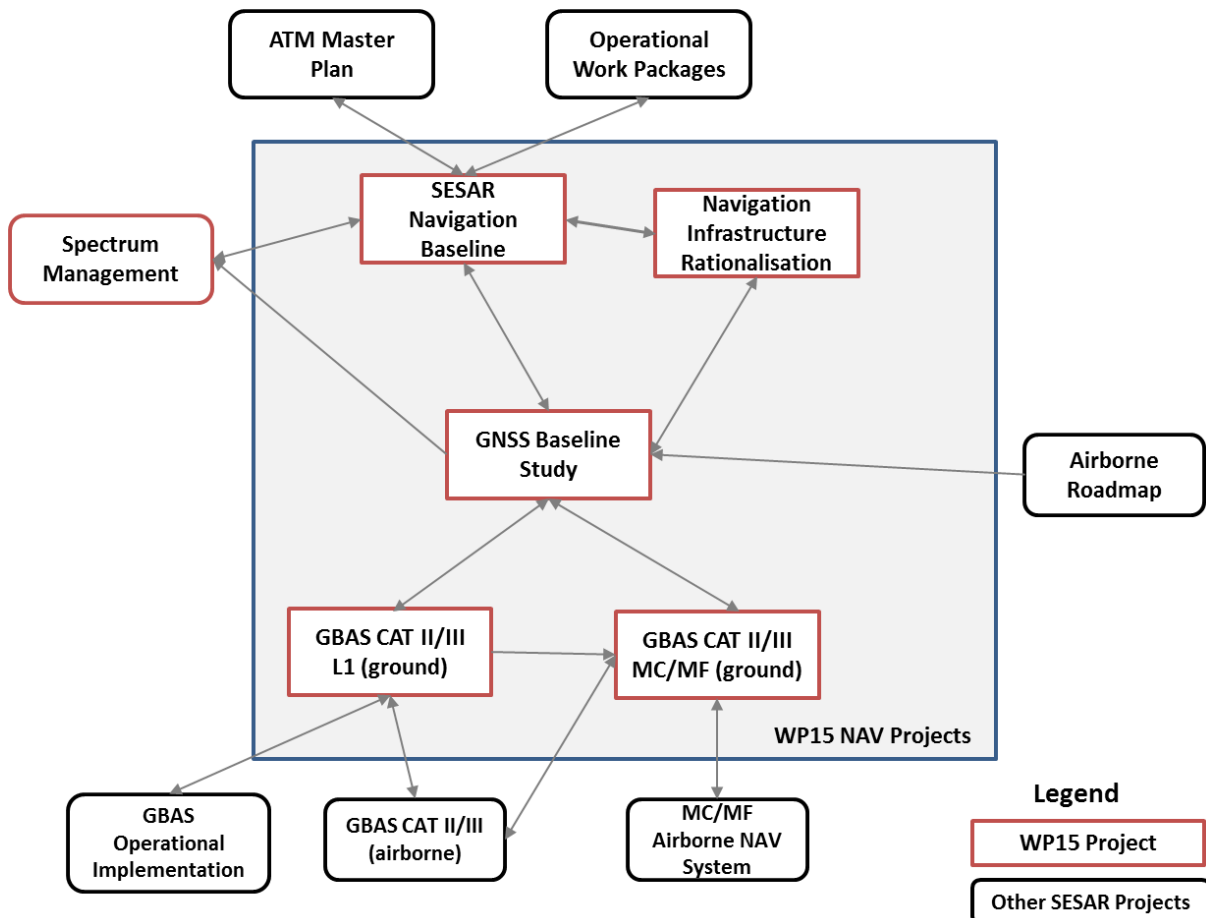
cover: GBAS CATII/III GPS L1, GBAS CATII/III MC/MF, short term A-PNT and long term A-PNT. The figure below depicts the applicability of these key solutions to the various phases of flight.



NAV developments for the various phases of flight

For the NAV domain out of the 5 NAV projects, one (P15.03.02) is addressing conventional navigation infrastructure rationalisation, 2 (P15.03.06 and P15.03.07) are addressing technical developments for GBAS systems, 1 (P15.03.04) is focusing on the overall GNSS system and 1 (P15.03.01) is considering the adequate combination of the different navigation systems being addressed by the other navigation projects for the development of a SESAR navigation roadmap and baseline.

The following diagram highlights the key links among the WP15 NAV projects and the other SESAR projects



founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

NAV projects key links

The following table addresses the status of the NAV related enablers in the ATM Master Plan addressed in the 5 NAV projects

Code	Name	WP contribution
CTE-N08	DME Ground Infrastructure Optimisation	DME ground infrastructure optimisation assessed for ECAC member states in support to En-Route/TMA and Approach/Landing operations. Assessment results for TMA refined for the 24 TMAs identified in the PCP-IR.
CTE-N11	NDB Decommissioning	NDB decommissioning assessed for ECAC member states in support to En-Route/TMA and Approach/Landing operations.
CTE-N12	VOR/DME MON	VOR/DME MON assessed in ECAC area in support to conventional En-Route operations.
CTE-N13a	A-PNT (Alternative Positioning Navigation and Timing)	Short term A-PNT solutions based on existing systems, as well as long term A-PNT alternatives introducing possible new technologies investigated.
CTE-N14	Gradual Rationalisation of Approach and Landing Systems	Rationalisation of Approach and Landing systems assessed for ECAC member states.
CTE-NGOV01	Ground Nav aids Optimisation/Rationalisation Plans	Ground Nav aids Optimisation/Rationalisation Plans assessed for ECAC member states.
CTE-N01	GPS L1-L5	Use of GPS L1 is mature enough, and currently used for GAST-C and GAST-D. Performance of the GPS L5 has been analysed and verified in the project, both at simulation level and real data. Deployment of GPS satellites transmitting L5 is not operational at the end of the project, limiting the verification activities of the processing options.
CTE-N02	GALILEO E1/E5	Performance of the GAL E1/E5 has been analysed and verified in the project, both at simulation level and real data. Deployment of Galileo satellites is not operational at the end of the project, limiting the verification activities of the processing options.
CTE-N05	GNSS performance assessment system	The need for independent GNSS performance monitoring of the GNSS elements included in the GNSS baseline in order to meet the integrity and continuity requirements has been

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

Code	Name	WP contribution
		analysed considering certification and legal recording requirements. Additionally a set of Key Performance Indicators (KPIs) have been defined in order to monitor a GNSS core constellations.
CTE-N06	Space Based Augmentation System (SBAS)	Technical results on satellite based augmentation coming from the performance assessment are contributing to this enabler supporting the understanding of this augmentation technology. The GNSS baseline complements this view by economic assessment results.
CTE-N06a	EGNOS V2.4.X	Technical results coming from the performance assessment are contributing to this enabler supporting the understanding of this augmentation system. The GNSS baseline complements this view by economic assessment results.
CTE-N06b	EGNOS V3	GNSS baseline derived in Step 2 recommends EGNOS V3 adoption in the scope of long term research. The deployment of EGNOS V3 shall be considered as part of the overall navigation roadmap and will be further handled by studies or projects such as SESAR 2020.
CTE-N07	Ground Based Augmentation System (GBAS)	Technical results coming from the vulnerability assessment of ionosphere and radio interference on GNSS are essential elements of GBAS system design. This contribution compliments the GBAS ground segment developments with addressing the above mentioned threats.
CTE-N07a	GBAS Cat I based on Single-Constellation / Single-Frequency GNSS (GPS L1)	Technical results coming from simulations and from vulnerability assessment of ionosphere on GNSS are contributing to this enabler.
CTE-N07b	GBAS Cat II/III based on Single-Constellation / Single-Frequency GNSS (GPS L1)	Two GS PTs (Thales & Indra Navia) were developed and verified within the project. Developed prototypes contributed to the validation of reduced separation minima.
CTE-N07c	Ground Based Augmentation System (GBAS) Cat II/III based on Multi-Constellation / Multi-Frequency (MCMF) GNSS (GPS + GALILEO / L1 + L5)	Advancing in the system concept, solving open issues, verification of the candidate processing options, definition of the specifications and standardisation proposal.
A/C-02b	Enhanced positioning using multi constellation GNSS dual frequency	Verification of the positioning accuracy, integrity, continuity, availability and robustness by trade-off of different processing options identified during the research phase of the

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

12 of 25

Code	Name	WP contribution
		project, specified and verified using mock-ups and GNSS Signal Simulator. Also, real data in airport environment has been used for the verification activities.
AO-0505-A	Improve Low Visibility Operation using GBAS Cat II/III based on GPS L1	Validation within OFA 01.01.01. Contribution by validation exercises #236 linked to release 4 and 644: Validation was performed through Flight Tests conducted at Toulouse and Frankfurt airports using mainline aircraft as well as business aircraft. It has been considered very important to verify several ground and airborne systems from different points of view to be sure that conclusions take into account a wide range of options (e.g airframe and environment influence). The SESAR solution has been assessed on two-runway airports operations in segregated mode (flight tests).
AO-0505-B	Improve Low Visibility Operation using GBAS Cat II/III based on dual GNSS	Preliminary analysis of the evolution of the operations for Cat II/III using GBAS MC/MF has been performed. Concept maturity doesn't allow validation exercises at this stage.

NAV projects contributions to the ATM Master Plan

The NAV domain projects contributed to the following SESAR technological solution which is considered as important outputs to be promoted outside the SESAR 1 program: "GBAS CATII/III based on GPS L1". Important work also on field "Short Term A-PNT" and "Long Term A-PNT" has been done.

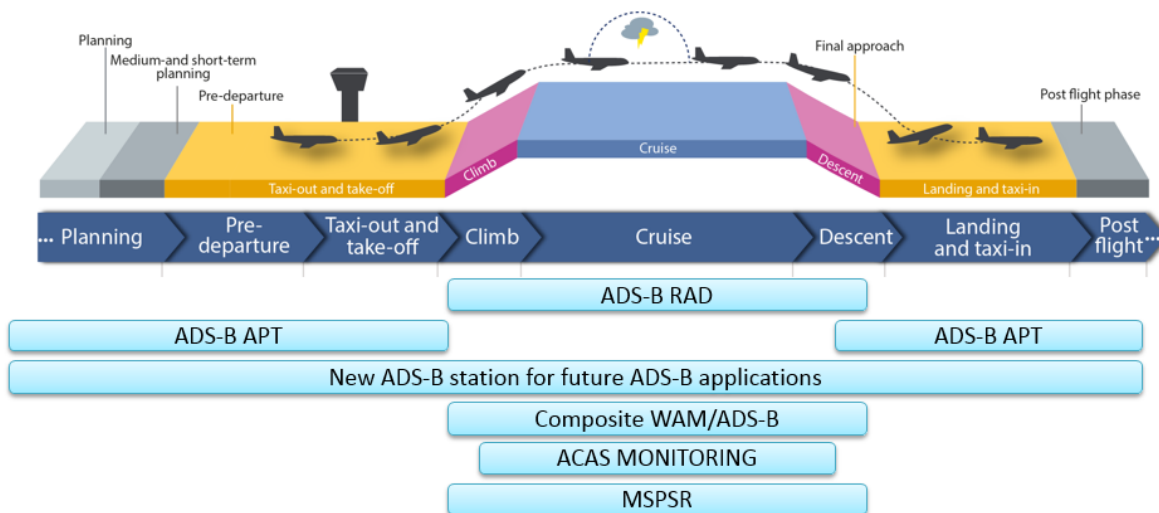
SURVEILLANCE

For the SUR Domain out of the 9 SUR projects, one is addressing infrastructure rationalization studies, 5 are addressing technical developments for ADS-B, ACAS & composite surveillance systems and 3 are addressing weather sensor technology developments. The figure below depicts the applicability of these key solutions to the various phases of flight.

founding members

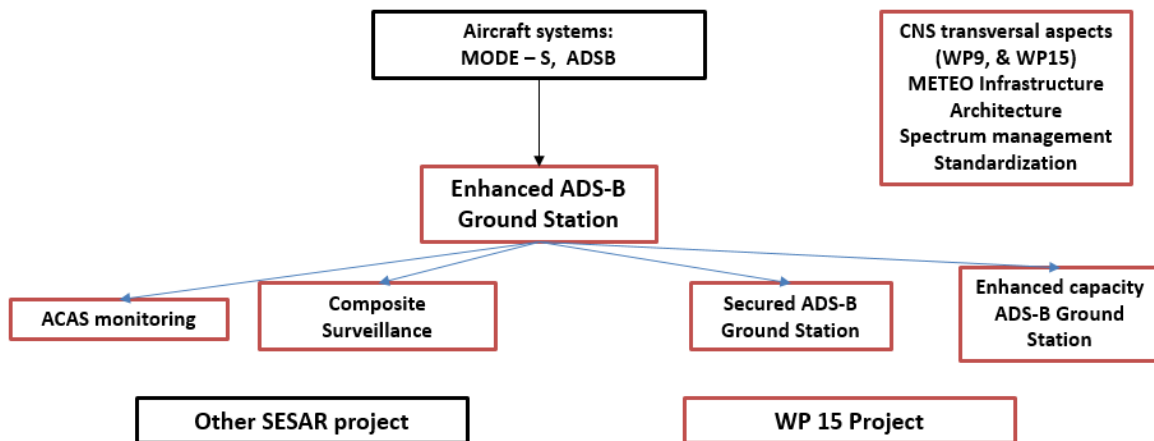


Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu



SUR developments for the various phases of flight

In addition the following diagram highlights the key links among the WP15 SUR projects and the other relevant SESAR projects.



SUR projects key links

The following table addresses the status of the SUR related enablers in the ATM Master Plan addressed in the 6 SUR projects.

Code	Name	WP contribution
CTE-S02c	Multi Static Primary Surveillance Radar	Establishment of design targets for the performance parameters that multi-static independent non-cooperative surveillance (INCS) systems are to meet to ensure such systems are capable of addressing emerging performance requirements and supporting future ATC operations. Definition of the Operational Service and Environment Definition for the application(s) which were determined to place demanding requirements upon such systems.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

Code	Name	WP contribution
		<p>Identification of capabilities, such as the means to be able to provide an indication of the height a non-cooperative target is flying at.</p> <p>Definition of standards, including the ASTERIX format.</p> <p>Implementation of new functionalities</p>
CTE-S03b	ADS-B station for RAD and APT surveillance	<p>Define & implementation new enhanced functionalities for ADS-B.</p> <p>Ensure interoperability with ED102A Extended squitter format.</p> <p>Security:</p> <ul style="list-style-type: none"> • Identification of potential ADS-B security threats and establishment of their associated high-level technical requirements, serving as the basis for the implementation in the corresponding ADS-B Security Ground Sensor prototype. • Description of how the ADS-B Ground Sensor prototypes will detect the threats and how to mitigate, when possible, their associated impact.
CTE-S03c	New ADS-B station for future ADS-B applications	<p>ADS-B Capacity prototype</p> <ul style="list-style-type: none"> • Lab prototype to continue the evolution of 1090ES phase overlay datalink in SESAR2020 <p>ADS-B Security prototype</p> <ul style="list-style-type: none"> • Verified security prototypes prepared for implementation
CTE-S03g	ACAS monitoring technology	Provision of ACAS monitoring system prototypes for evaluation and feasibility studies.
CTE-S06	Composite WAM/ADS-B	<p>Creation of specifications for the Composite Cooperative Surveillance System (WAM/ADS-B).</p> <p>Definition of requirements derived from different standards and guidance material, including ED-142 and ED-129 and provision of feedback for new EUROCAE versions.</p> <p>Study on benefits offered by composite surveillance, such as: Reduction in the 1030 and 1090 Mhz spectrum, information provision not available without composite surveillance and several improvements in performance, security and safety.</p>

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

15 of 25

Code	Name	WP contribution
		Definition of system objectives and test exercises in order Validate & Verify system operation.

SUR projects contributions to the ATM Master Plan

WP15 Contributions to SESAR Solutions

Overall the WP15 projects have supported the development of SESAR technical solutions. The table below summarises the mature and emerging technical solutions to which WP15 has contributed to:

Solution Nbr	Solution name	TRL Level/Release
COM		
#102	AeroMACS (contributions from P15.02.07 and P9.16)	TRL5/6
#109	Precursor INMARSAT SBB for i-4D (SATCOM Class B) (contributions from P15.02.05)	TRL6+
DRAFT SOLUTION TO BE FINALIZED	Future Terrestrial A/G datalink using ATN/IPS over L-Band (LDACS) (contributions from P15.02.04)	TRL2
DRAFT SOLUTION TO BE FINALIZED	Future SATCOM for ATM - Long term SATCOM/IRIS (SATCOM class A) (contributions from P15.02.06)	TRL2
DRAFT SOLUTION TO BE FINALIZED	Multilink (contributions from P15.02.04)	TRL1
SUR		
#101	Improved Hybrid Surveillance	TRL6
#100	ACAS Ground Monitoring system	TRL6
#110	ADS-B Ground Surveillance System	TRL6+
DRAFT SOLUTION TO BE FINALIZED	Composite Surveillance (contribution from P15.04.02)	TRL 3 for MSPSR, TRL 5 for WAM&ADSB
DRAFT SOLUTION TO BE FINALIZED	Improved 1090MHz ADS-B capacity and security (Contribution from P15.04.06 (/09.21/09.22))	TRL4

Solution Nbr	Solution name	TRL Level/Release
NAV		
#55	GBAS CAT II/III L1	TRL6+
DRAFT SOLUTION TO BE FINALIZED	Multi-Constellation/Multi-Frequency GNSS Aircraft Navigation System	TRL4
DRAFT SOLUTION TO BE FINALIZED	GBAS Cat II/III based on Multi-Constellation/Multi-Frequency GNSS (GPS & Galileo)	TRL4
DRAFT SOLUTION TO BE FINALIZED	Long Term A-PNT (Contribution from P15.03.01 /02 / 04)	TRL2

1.2 Work Package achievements

COMMUNICATION

The COM Domain project activities have provided significant contributions for the ground as well as the air/ground communications and supported the realisation of the Future Communications Infrastructure (FCI).

For the ground communications the COM Domain activities supported the feasibility of using PENS to support SWIM type of applications as well as contributed to the technical validation of using VoIP for the ground communications and addressed security and networking (such as multicast) aspects.

For the air ground communications, the COM Domain activities supported the identification of two mature technical solutions one for satellite based communications (Precursor/INMARSAT, SATCOM Class B) and one for airport surface communications (AeroMACS). In addition, the COM Domain activities have progressed work that will continue in SESAR2020 covering the future terrestrial datalink (LDACS), the new Long Term SATCOM (Class A) system, Multilink Operations and ATN/IPS specifications.

Finally the COM Domain activities investigated solutions to support the civil/military interoperability and integration of the military operations considering current military equipment, while for the longer term the solutions considered should be applicable for all type of users (including the military).

In summary, the COM Domain activities and the COM projects achievements provide reliable and validated technologies to enable the future concepts and support the emerging performance requirements.

NAVIGATION

The NAV projects activities have provided significant contribution for the ground as well as the GNSS-based navigation systems.

Both GNSS and ground aspects were addressed at system and sub-system levels. For the overall navigation system, including both conventional and GNSS subsystems, a complete analysis of the navigation performance requirements was undertaken based on published regulations, specifications and standards. A SESAR Navigation Baseline was developed in order to provide a solid basis for reaching consensus with European stakeholders on the strategy for Navigation systems.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

For the ground-based navigation or conventional navigation sub-system, a reversion strategy for conventional navigation aids to evolve towards a complementary support infrastructure for PBN was developed. This reversion strategy allows a full exploitation of PBN benefits while safeguarding continued ATM operations using a DME/DME network to support suitably equipped users, while accommodating non-DME/DME equipped users with a residual VOR/DME capability. Results of this work are related to the Short Term A-PNT technology. Additional studies investigating CNS options being considered as possible mitigations to GNSS for the long term have been performed. These studies are related to the Long Term A-PNT solution.

For GNSS-based navigation sub-system, studies related to GNSS requirement in support to European ATM, configuration of signals and augmentations were undertaken. A valuable contribution related to the SESAR GBAS technological solution was provided. For GBAS CAT III GPS L1, a solution was developed and validated to V3 (TRL6) maturity level, allowing starting the industrialisation, approval and subsequent deployment. Thanks to the performed field demonstrations, it was proven that GBAS provides significant benefits to increase the runway capacity with a cost efficient solution. A GBAS CAT III MC/MF solution was also under development of the NAV package. An initial concept of the system was developed and preliminary verification activities were performed.

SURVEILLANCE

The SUR project activities have provided significant contributions for the ADS-B, ACAS and composite surveillance technologies

For ADS-B, new functionalities have been developed, enhancing the capacity and security of the systems.

The ADS-B Ground Surveillance system developed in this SESAR solution is compliant with the latest version of ADS-B avionics standard which is a means of compliance with the relevant EU Regulation 1207/2011 (Surveillance Performance and Interoperability Implementing Rule SPI IR). Another key improvement included in this SESAR Solution is the security related functionality. This functionality mitigates security risks for ADS-B as sole means of Surveillance as well as for ADS-B in a multi-sensor environment, thus addressing the associated challenges. SESAR has also contributed to the relevant standards, i.e. EUROCAE Technical Specifications incorporating new functionalities developed for the ADS-B Ground station, ASTERIX Interface Specifications as well as to the SDPD specifications.

Also a new format for transmission of ADS-B messages (phase overlay technology) was developed and the content is under refinement. With this new encoding technique, ADS-B datalink capacity is multiplied and data may be used for different purposes. New content definition was also within the scope of the SUR projects.

ACAS monitoring systems have also been developed and tested. This kind of systems provides the ground segment with a real time picture of the ACAS Air-Air encounters. Until now only RA-downlink using Mode S radars was possible, but information using this method is more limited and latency is much bigger than the obtained using ACAS monitoring system.

Composite surveillance systems were developed within the SUR projects, in particular composite WAM & ADS-B and also MSPR. Using composite systems increases the amount of data, reduces the use of radio-frequency and enhances the system security and performances.

Further work on ADS-B, enhanced security & capacity surveillance systems and composite surveillance systems (ADS-B, WAM & MSPR) is proposed for continuation in SESAR 2020.

1.3 Work Package Deliverables

The following table presents the relevant deliverables that have been produced by the Work Package management team (if any).

Reference	Title	Description
D26	15.00_D26_WP15_Management_Report	Final management report for the WP15

AT WP15 level, there was only one deliverable, the WP15 Management Report, which expands on the content of this FRP.

1.4 Contribution to Standards and Reference Material

Communication Projects

Overall the COM projects have provided contributions to various standardisation groups with a varied degree of involvement. The contributions are summarised in the following table

SESAR Project	Standardisation Contributions	Status
P15.02.04: General FCI aspects and LDACS	LDACS 1 specifications Mobility and Security proposals	Supported the establishment of a dedicated group for LDACS in ICAO (CP WGT). However the actual standardisation activities have not started yet. For Mobility and security initial input has been provided to CP WGI.
P15.02.05: Precursor	Contributions to EUROCAE WG82	MOPS and MASPS on-going
P15.02.06: Long Term SATCOM	Contributions to NEXUS, ICAO CP and EUROCAE WG82	MOPS and MASPS on-going SARPS update proposal presented to ICAO
P15.02.07: AeroMACS	Contributions to ICAO CP WGS, EUROCAE WG82, RTCA CS223, AEEC SAI and WiMAX Forum	Profile Completed MOPS Completed MASPS Completed (pending publication)

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

SESAR Project	Standardisation Contributions	Status
		SARPS (Completed) Manual on-going ARINC standard (avionics) on-going
P15.02.08: Link16	Draft contributions to be considered in for Mil (NATO) standards	Not pursued further at this stage
P15.02.10: Use of PENS to support SWIM	Contributions to EUROCAE WG67 (validation of VoIP EUROCAE docs)	VoIP EUROCAE documents are published

COM projects standardisation contributions

Navigation Projects

Overall the NAV projects have provided contributions to various standardisation groups with a varied degree of involvement. The contributions are summarised in the following table

SESAR Project	Standardisation Contributions	Status
P15.03.01 Navigation technologies specifications	Some results presented to ICAO PBNSG and ICAO NSP	Completed
P15.03.02 Navigation Infrastructure Rationalisation	Results presented to ICAO PBNSG and ICAO NSP. As a direct output of the project efforts, new Attachment H in Annex 10 titled "Strategy for Rationalization of Conventional Radio Navigation Aids and Evolution toward supporting Performance Based Navigation"	Completed
P15.03.06 GBAS Cat II/III L1 Approach	ICAO NSP with regular contributions by ~10 papers per meeting IFPP contributions with respect to the definition of GBAS CAT II/III L1 approach procedure criteria EUROCAE WG-28 with contributions to definition and initiation of work to develop ground equipment standard (MOPS ED-114B) RTCA SC159 WG4 with inputs from system and ground side primarily	On-going, GAST D standard should be frozen by end SESAR1

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

SESAR Project	Standardisation Contributions	Status
	related to aspects of the GBAS data broadcast (VDB). Airborne contributions were covered by project 9.12.	
P15.03.07 Multi GNSS CAT II/III GBAS	Preliminary presentation on main outcomes performed to ICAO NSP. Standardisation contribution are focused on ICAO SARPS, Annex 10 Vol. 1	On-going

NAV projects standardisation contributions

Surveillance Projects

Overall the SUR projects have provided contributions to various standardisation groups with a varied degree of involvement. The contributions are summarised in the following table

SESAR Project	Standardisation Contributions	Status
15.04.05.a Surveillance ground system enhancements for ADS-B	EU Regulation 1207/2011 Surveillance Performance and Interoperability Basic input for WG51SG4 Development of ASTERIX CAT 21 & CAT23	Completed. Provides means of compliance for SPI-IR. Work with EUROCAE completed. Used as input for new ED-129 & ED142 specifications. ASTERIX definition of new items completed.
15.04.03 ACAS Monitoring	Development of ASTERIX CAT 04	ASTERIX definition of new items completed.
15.04.06 Improved 1090MHz ADS-B Ground station capacity and security	Coordination with GEN-SUR SEC (input-output). EUROCAE WG-102 Proposal for content of the new data link.	Coordination with GEN-SUR SEC completed. Activities will continue with WG-102 once SESAR2020 activities are launched. Definition of new 1090ES data link content will continue under the SESAR2020 activities.
15.04.02 Integrated Surveillance sensor	GEN SUR & EUROCAE WG51 used as input and feedback to it. New ASTERIX CAT 015 proposed for	Composite deliverables used by WG51-SG4. Content has been integrated when

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

SESAR Project	Standardisation Contributions	Status
technologies	MSPSR EUROCAE WG-103 INCS	possible. Activities will follow on SESAR2020 activities.
15.4.9.c Ground Weather Monitoring system	After SESAR (long term), complete definition/translation of MET products into WXXM (Weather Information Exchange Model) is expected.	After SESAR (long term), complete definition/translation of MET products into WXXM (Weather Information Exchange Model) is expected.

SUR projects standardisation contributions

1.5 Work Package Conclusion and Recommendations

In summary, the WP15 activities have resulted in validated technologies to enable the future concepts and support the emerging performance requirements of the future concepts. In addition the WP15 activities have prepared for future work that will be carried out in the context of SESAR 2020.

Overall, the WP15 projects performed extensive analysis and simulations, developed prototypes, performed testing, achieved verification and validation of system and concepts and supported international standardisation and global harmonisation. The outcome of the WP15 technical projects is documented in the hundreds of deliverables that were produced by the 23 technical projects. WP15 projects consulted with users (such as Airspace Users) to capture their input and align direction and activities.

Recommendations for COM Domain

- Consider operational demonstration and validation for the verified technical solutions (AeroMACS and INMARSAT Precursor) and continue the development of the emerging solutions (LDACS, SATCOM Class A, Multilink and ATN/IPS) in the context of the new SESAR 2020 activities.
- Ensure close involvement of eventual users from early stage of development technical work to achieve alignment between offered technical capabilities and required ops performance and obtain the buy-in of the relevant stakeholders
- Address spectrum threats and ensure availability of required spectrum
- Ensure close coordination with US and globally in ICAO, for areas requiring harmonisation (such as a/g solutions)
- Support standardisation (ICAO, EUROCAE/RTCA) and in particular the timely availability of the avionics standards (AEEC)
- Support solutions to realise a flexible avionics architecture (using software radios and multiband antennas) to enable the integration of the new FCI components on board the aircraft.

Recommendations for NAV Domain

For SESAR 2020 and further follow-on programs activities, a number of recommendations are summarized below:

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

- To bring the infrastructure rationalisation results into implementation;
 - To further mature GBAS GAST-D and provide initial standards to multi-constellation/multi-frequency GBAS;
 - To further mature technical enablers related to MC/MF GNSS;
 - To continue the important collaboration established with EASA within SESAR 1, with the objective to complete the regulation for GBAS in Europe;
- To collaborate with the Galileo deployment responsible (ESA, GSA and EC) with the objective to better understand the performances of the Core Constellation used in the GNSS-based air navigation technologies (ie: GBAS, SBAS, ARAIM);
- To continue activities on A-PNT to provide both a feasible short term solution and long term improvements to support PBN/RNP operations in case of GNSS degradation or outage.

Recommendations for SUR Domain

For SESAR 2020 activities following aspects have been noted:

- To get benefit from infrastructure rationalization across the CNS domains,
- To ensure Civil-Military interoperability,
- To develop new ADS-B data link.
- To include the surveillance performance monitoring concept,
- To develop the surveillance for remote towers,
- To continue with the integration of surveillance technologies (cooperative and non-cooperative),
- To provide new solutions for inter-oceanic areas.
- To address 1090 Extended Squitter Radio-Frequency pollution:
 - Important role of ADS-B towards reducing the spectrum needs (due to its passive character) must be emphasized,
 - Together with the benefits brought by MSPSR and composite surveillance systems.

General WP15 recommendations

In addition to the specific Domain recommendations covered above, the WP15 management team is proposing that the following point is considered, especially in the context of SESAR2020 and other relevant development activities:

- To ensure formal and strong relation between operational requirements and CNS developments.

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu

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



-END OF DOCUMENT-

founding members



Avenue de Cortenbergh 100 | B -1000 Bruxelles
www.sesarju.eu