SESAR Solution PJ.01-06 TS/IRS for V3

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PJ.01 EAD

ENHANCED ARRIVALS AND DEPARTURES

This TS/IRS is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 731864 under European Union's Horizon 2020 research and innovation programme.

Abstract

This deliverable aims at providing guidance about the SESAR2020 Solution PJ.01-06 and its implementation. It records information to interface the Solution with the EATMA model and to describe high level requirement to perform the solution. This information is about EATMA environment, EATMA interfaces, safety & performance requirements, regulation and any other information that will allow the community to understand the state of the art at the end of SESAR2020.

The work performed in this Solution is to assess and validate the benefit of integrating piloting supporting enhanced vision systems that can increase the safety and reliability of rotorcraft operations through dedicated symbology for specific rotorcraft operations, especially during arrival and departure operations including visual segments. The objective is to assess and validated the benefit of having SBAS based navigation for advanced Point-In-Space RNP approaches and departures to/from FATO by defining the corresponding rotorcraft specific contingency procedures in case of loss of communication. As the SBAS navigation, the corresponding contingency procedures will need to comply as much as possible with profiles adapted to exploit rotorcraft performances, reduce fuel consumption and noise emission. The pilot will be supported during these operations by dedicated symbology presented on a Head Mounted Display system.

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1 Executive summary

This document is the Technical Specifications and Interface Requirements Specification (TS/IRS) for solution PJ.01-06 relating to PJ01 Enhanced Arrival and Departures of the SESAR operational concept.

The SESAR 2020 Maturity Report states "Project 4.10 validated Solution PJ.01-06 (standard PinS approaches are considered as part of the baseline) covering OI step AOM-0104 to a final maturity of V3. Evidence gathered during V2 and V3 validation activities covered the "Standard PinS" concept with straight segments based on RNP APCH specifications (DOC 8168 requirements). The development of "Advanced PinS" with curved procedures in the initial, intermediate, final and missed approach segments, using possible new enablers (e.g. SVS, EVS) have been addressed in this solution.

In fact the OI step AOM-0104 has been split into two: The part that has achieved end of V3 (standards PinS approaches, AOM-0104-A) is in fact a gap in the baseline and should be captured there. The new OI step AOM-0104-B which is covered here should be only V2 since the full scope of the OI step was not addressed (new technologies and advanced PinS approaches).

The work performed in this Solution was to assess and validate the benefit of integrating piloting support of both enhanced vision systems that increase the safety and reliability of rotorcraft operations through dedicated symbology for specific rotorcraft operations including visual segments and automated flight path following by autopilot system. The objective was to assess and validated the benefit of having SBAS based navigation for advanced Point-In-Space RNP approaches and departures to/from FATO by defining the corresponding rotorcraft specific contingency procedures in case of loss of communication. As the SBAS navigation, the corresponding contingency procedures was needed to comply as much as possible with profiles adapted to exploit rotorcraft performances, reduce fuel consumption and noise emission. The pilot was supported during these operations by dedicated symbology presented on a Head Mounted Display system.

This solution should impact the following KPAs:

- Safety should be improved thanks to the use of an HMD during PinS operations (facilitating the VFR-to-IFR transitions during take-off and IFR-to-VFR transitions during approach, which are usually high-workload phases for the rotorcraft pilot), and through the introduction of GNSS contingency loss procedures (in particular in the final curved approach of a PinS procedure where the pilot shall maintaining safe separation during visual segment)
- Human performance should be improved thanks to the use of an HMD during PinS (pilot's eyes-out conformal display of the flight trajectory allows improved performance to follow precisely the allocated trajectory) and automated flight path following by autopilot system (reducing workload down to performance observation)
- Efficiency should benefit from advanced PinS procedures, in detail fuel consumption and respectively noise reduction as well as time consumption.
- Access and equity for rotorcraft users should improve through smaller footprints of advanced PinS connecting more FATOs to IFR routes.

The architecture of the EATMA model was not modified for this solution, all services and functions already exist and are described by the SESAR 1 project 04.10 then only one OI step AOM-0104-B has been added, some enablers and associated requirements were created and some links to existing enablers has been set. Advanced PinS is not a new operation, it's a more accurate and demanding way to implement PinS in challenging environment.

2 Introduction

2.1 Purpose of the document

The TS/IRS describes the impact on the current EATMA architecture, the functional architecture in the EATMA model, the functional requirements, the non-functional requirements and the different implementations on rotorcraft and simulator to prove the SESAR Solution PJ.01-06 Enhanced Rotorcraft operations in the TMA maturity level V3 flying the different use cases.

2.2 Scope

This is the TS/IRS for Solution PJ01.06 for V3 phase, once verification activities and validation exercises EXE-01.06-V3-001, EXE-01.06-V3-002 and EXE-01.06-V3-003 have been performed and their validation results analysed and consolidated.

This TS/IRS covers functional, non-functional and interface requirements related to SESAR Solution PJ.01-06.

The requirements contained herein will cover safety, performance, operational aspects as well as the interoperability aspects related to specific technology to support the SESAR Solution PJ.01-06 Enhanced Rotorcraft operations in the TMA.

2.3 Intended readership

The members of solutions within PJ.01 EAD - Enhanced Arrival & Departures.

The members of the following solutions within S2020:

PJ.02-05 Independent Rotorcraft operations at the airport

Further solutions and interested parties will be defined in the full version of this document.

2.4 Background

Within SESAR 1, the project 04.10 was focused on contributing mainly to the Operational Focus Area (OFA) 02.01.01 “Optimised 2D/3D Routes” and reports its results concerning the “Standard PinS” concept. In fact, in the framework of Sesar 1 project P04.10, all the validation activities have covered the Standard PinS concept with *straight segments based* on RNP APCH specifications (DOC 8168 requirements) being also connected and consistent with the following projects:

- 05.06.03: Approach Procedure with Vertical Guidance (APV)
- 09.09: RNP Transition to xLS (x=G, I or M)
- 09.10: Approach with Vertical Guidance APV
- 09.49: Batch 1, 2 & 3 - Consolidated functional airborne architecture

The P04.10 activities have achieved fully V3 maturity level for the “Standard PinS” only. The development of “Advanced PinS” concept (e.g. curved procedures in the *initial*, *intermediate*, *final* and *missed approach* segments) using possible new enablers such as SVS, EVS, etc, will be addressed in these SESAR 2020 activities.

2.5 Structure of the document

The document follows the following structure:

- **Section 1 Executive Summary:** provides a summary of the key information and elements contained in the document.
- **Section 2 Introduction:** presents the purpose and scope of the document, the intended audience, the structure of the document and the main acronyms and terminology used throughout the document.
- **Section 3 SESAR Solution Impacts on Architecture:** presents the impact on the current EATMA architecture and the functional architecture in the EATMA model.
- **Section 4 Technical Specifications:** presents the functional architecture, the functional requirements and the non-functional requirements.
- **Section 5 Implementation Options:** the different implementations on rotorcraft and simulator
- **Section 6 Assumptions:** presents any assumption made that have an impact on the technical specifications description
- **Section 7 References and Applicable Documents**

2.6 Glossary of terms

Term	Definition	Source of the definition
AIR-REPORT	A report from an aircraft in flight prepared in conformity with requirements for position, and operational and/or meteorological reporting.	ICAO Annex 3

Table 1: Glossary

2.7 Acronyms and Terminology

Term	Definition
ACT/FHS	Active Control Technology / Flying Helicopter Simulator
ADD	Architecture Description Document
AFCS	Automic Flight Control System
AHRS	Attitude Heading Reference System

Term	Definition
AMC	Aircraft Management Computer
AMLCD	Active Matrix Liquid Crystal Display
ATM	Air Traffic Management
CC	Capability Configuration
CCP	Cockpit Control Panel
DPIFR	Dual Pilot Instrument Flight Rules
DMC	Data Management Computer
DTD	Data Transfer Device
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
EC	Experimental Computer
EP	Evaluation Pilot
FAA	Federal Aviation Administration
FADEC	Full Authority Digital Engine Control
FDS	Flight Display Subsystem
FLI	First Limit Indicator
FND	Flight Navigation Display
FTE	Flight Test Engineer or Flight Technical Error
FTI	Flight Test Instrumentation
GC	Graphic Computer
GECO	Generic Experimental Cockpit
HD	High Definition
HDD	Head Down Display
HMD	Helmet Mounted Display
HMI	Human Machine Interface
H-TAWS	Helicopter Terrain Awareness and Warning System

Term	Definition
IDP	Interface Display Processor
IER	Information Exchange Requirement
IESI	Integrated Electronic Stand-by Instrument
ILC	In Line Controller
IMC	Instrument Meteorological Condition
INTEROP	Interoperability Requirements
IRS	Interface Requirements Specification
ISRM	Information Services Reference Model
LNAV	Lateral Navigation
LPV	Localizer Performance with Vertical Guidance
MFD	Multi-Function Display
NAF	NATO Architecture Framework
NSOV	NAF Service Oriented View
NOV	NAF Operational View
NSE	Navigation System Error
NSV	NAF System View
NVG	Night Vision Goggle
OSED	Operational Service and Environment Definition
PDE	Path Definition Error
PIRM	Programme Information Reference Model
QoS	Quality of Service
RNAV	Required Navigation Performance Area Navigation
RNP	Required Navigation Performance
RTS	Real Time Simulation
SAR	Search And Rescue
SBAS	Satellite Based Augmentation System
SDD	Service Description Document

Term	Definition
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SoaML	Service Oriented Architecture Modelling Language
SPIFR	Single Pilot Instrument Flight Rules
SPR	Safety and Performance Requirements
SVS	Synthetic Vision System
SWIM	System Wide Information Model
TAM	Three Axis Magnetometer
TRL	Technology Readiness Level
TS	Technical Specification
UML	Unified Modelling Language
UMS	Usage Monitoring System
VFR	Visual Flight Rules
VMS	Vehicle Management System
VNAV	Vertical Navigation
V&V	Validation and Verification
WSDL	Web Services Definition Language
XSD	XML Schema Definition

Table 2: Acronyms and terminology

3 SESAR Solution Impacts on Architecture

3.1 Target Solution Architecture

3.1.1 SESAR Solution(s) Overview

SESAR Solution ID and Title	Functional Blocks/Role impacted by the SESAR Solution (from EATMA)	Enabler ID (from EATMA)	Enabler Title (from EATMA)	Enabler coverage
PJ01-06 Enhanced Rotorcraft and GA operations in the TMA		A/C-01	Enhanced positioning for LPV/RNP based on Single Frequency SBAS	
		A/C-04b	Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach	
		A/C-05a	APV Barometric VNAV	
		A/C-06	Flight management and guidance for LPV approach based on SBAS	
		A/C-07	Flight management and guidance for RNP transition to ILS/GLS/LPV	
		PRO-250	Rotorcraft procedures for IFR access to VFR FATOs	
		A/C-83	Head Mounted Display	

Table 3: SESAR Solution PJ01-06 Scope and related Functional Blocks/roles & Enablers

3.1.1.1 Deviations with respect to the SESAR Solution(s) definition

One deviation is known for the moment: the fact that flight trials will be performed in low density/complexity airspaces and not in a medium or high density/complexity airspace. The idea to mitigate this issue is to simulate additional traffic onboard the helicopter and to present the combination of real and simulated traffic to the pilot's HMD.

3.1.1.2 Relevant Use Cases

The relevant use cases considered by SESAR solution PJ01-06 to operate advanced PinS procedures using an HMD or an HDD are described in the SESAR Solution PJ.01-06 TS/IRS for V3.

These use cases describe either normal or abnormal situations.

3.1.1.3 Applicable standards and regulations

- ICAO
  - Procedures for Air Navigation Services — Aircraft Operations, Volumes II (PANS-OPS) (Doc 8168, 6th edition 2 - 2014)
  - Performance-Based Navigation Manual, (Doc 9613, 4th edition)
  - Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM) (Doc 4444)
- RTCA
  - Minimum operational performance standards for global positioning system/wide area augmentation system airborne equipment, DO-229D
- EASA
  - Airworthiness Approval and Operational Criteria related to Area Navigation for Global Navigation Satellite System approach operation to Localizer Performance with vertical guidance minima using satellite bases augmentation system, AMC 20-28
- FAA
  - Airworthiness Approval of Positioning and Navigation Systems, AC 20-138D
  - Airworthiness Approval of Enhanced Vision System, Synthetic Vision System, Combined Vision System, and Enhanced Flight Vision System Equipment, AC 20-167A
  - Stand-Alone Airborne Navigation Equipment Using the Global Positioning System Augmented by the Satellite Based Augmentation System (SBAS), TSO-C146d

3.1.2 Capability Configurations required for the SESAR Solution

SESAR Solution ID and Title	Capability Configurations (CCs) (from EATMA)	Sub-Operating Environment(s) where the CCs operate	Capabilities (from EATMA)	Nodes (from EATMA)	Stakeholders (from EATMA)
PJ01-06 Enhanced Rotorcraft	Civil Aircraft CC	TMA/Airport High, Medium or Low Capacity	Airspace Organisation and	Flight Deck En-Route	Airspace User

SESAR Solution ID and Title	Capability Configurations (CCs) (from EATMA)	Sub-Operating Environment(s) where the CCs operate	Capabilities (from EATMA)	Nodes (from EATMA)	Stakeholders (from EATMA)
and GA operations in the TMA		needs	Management Airspace user operations Traffic synchronisation	approach ATS	
	TWR	TMA/Airport Hight, Medium or Low Capacity needs	Airspace Organisation and Management Traffic synchronisation	Flight Deck En-Route approach ATS	Airspace User
	ER ACC	TMA/Airport Hight, Medium or Low Capacity needs	Airspace Organisation and Management Traffic synchronisation	Flight Deck En-Route approach ATS	Airspace User
	APP ACC	TMA/Airport Hight, Medium or Low Capacity needs	Airspace Organisation and Management Traffic synchronisation	Flight Deck En-Route approach ATS	Airspace User
	Navigation infrastructure Satellite Based	N/A	Airspace user operations	Flight Deck	Airspace User

Table 4: List of Capability Configuration required for the SESAR Solution

3.2 Changes imposed by the SESAR Solution on the baseline Architecture

Enabler ID (from EATMA)	Enabler Title (from EATMA)	Changes
A/C-83	Head Mounted Display	This capability is introduced by PJ01-06 to

Enabler ID (from EATMA)	Enabler Title (from EATMA)	Changes
		evaluate how it improves performance and safety of flight when flying an advanced PinS procedure

Table 5: List of changes due to the SESAR Solution

4 Technical Specifications

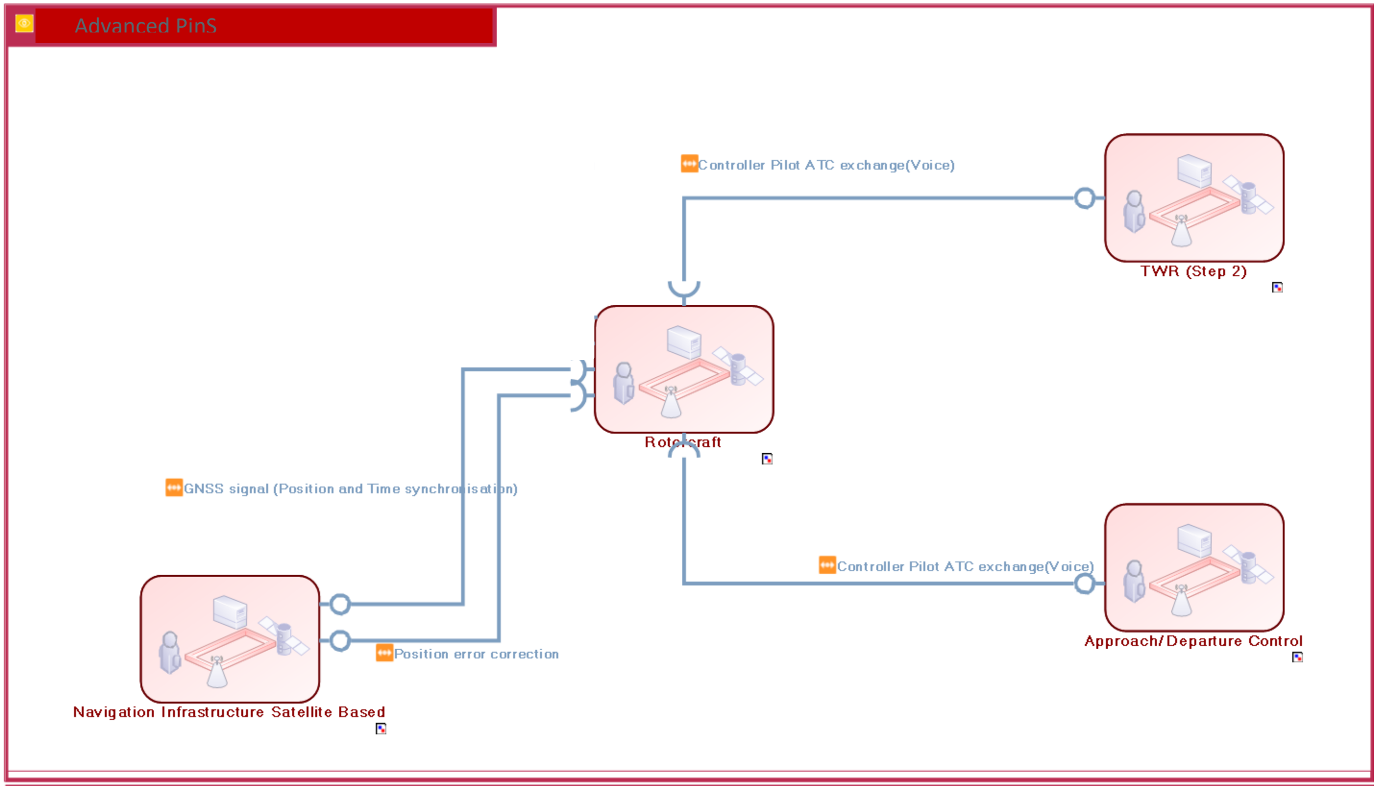
4.1 Functional architecture overview

Role	Functional Block	Function
[NSV-4]Advanced PinS approach (rotorcraft) [Ground]		
ATC Executive Controller (PJ.01-06)		Control and sequence the arrival traffics; Separation Provision, Sequencing, Space Aircraft, Management of mixed operations (fixed wing and Rotorcraft); Transfer Flight to Tower Control;
Tower Runway Controller (PJ.01-06)		Provide Landing Clearance; Surveillance (Monitoring) until PinS\MAPt;
[NSV-4] Advanced PinS approach (rotorcraft) [Airborne]		
	Databases	Databases;
	Displays and Controls	Displays and Controls;
Flight Crew (PJ.01-06)		Acknowledge Landing Clearance; Change Frequency and Contact Tower Controller; Comply to approach clearance and instructions; Fly Rotorcraft Initial Approach Route; Landing or Missed Approach (Pilot Discretion); Monitor Trajectory until PinS/MAPt; Perform Missed Approach;
	Flight Plan Management	Flight Plan Management;
	Lateral and Vertical Guidance	Lateral and Vertical Guidance;

	Lateral Positioning	Lateral Positioning;
	Sensors and Antennas	Sensors and Antennas;
	Vertical Positioning	Vertical Positioning;
[NSV-4] Advanced PinS departure (rotorcraft) [Ground]		
ATC Executive Controller (PJ.01-06)		IFR Clearance to proceed Enroute phase;
Tower Runway Controller (PJ.01-06)		Control Departure Traffics (Rotorcraft and fixed-wing); Provide Departure Clearance; Transfer Flight to TMA (Departures) Controller;
[NSV-4] Advanced PinS departure (rotorcraft) [Airborne]		
	Databases	Databases;
	Displays and Controls	Displays and Controls;
Flight Crew (PJ.01-06)		Change Frequency and Contact TMA (Departures) Control; Comply to IFR clearance (Standard or Low Level IFR routes); Fly according IFR Clearance (Rotorcraft); Proceed Visually or VFR until the IDF point; Request Departure Clearance (SNI PinS Procedure);
	Flight Plan Management	Flight Plan Management;
	Lateral and Vertical Guidance	Lateral and Vertical Guidance;
	Lateral Positioning	Lateral Positioning;
	Sensors and Antennas	Sensors and Antennas;

	Vertical Positioning	Vertical Positioning;

4.1.1 Resource Connectivity Model



[NSV-4] Advanced PinS approach (rotorcraft) [Ground] [A/G Voice Communication, A/G Voice Communication, ATC Executive Controller (PJ.01-06), Controller Human Machine Interaction Management Aerodrome ATC, Controller Human Machine Interaction Management ER/APP, Rotorcraft, Tower Runway Controller (PJ.01-06)]
[NSV-4] Advanced PinS approach (rotorcraft) [Airborne] [Approach/Departure Control, Databases, Displays and Controls, Flight Crew (PJ.01-06, Flight Plan Management, Lateral and Vertical Guidance, Lateral Positioning, Navigation Infrastructure Ground Based, Navigation Infrastructure Satellite Based, Sensors and Antennas, TWR (Step 2, Vertical Positioning, Voice]
[NSV-4]Advanced PinS departure (rotorcraft) [Ground][A/G Voice Communication, A/G Voice Communication, ATC Executive Controller (PJ.01-06), Controller Human Machine Interaction Management Aerodrome ATC, Controller Human Machine Interaction Management ER/APP, Rotorcraft, Tower Runway Controller (PJ.01-06)]
[NSV-4] Advanced PinS departure (rotorcraft) [Airborne][Approach/Departure Control, Databases, Displays and Controls, Flight Crew (PJ.01-06(, Flight Plan Management, Lateral and Vertical Guidance, Lateral Positioning, Navigation Infrastructure Satellite Based, Sensors and Antennas, TWR (Step 2), Vertical Positioning, Voice]

4.1.2 Resource Orchestration view

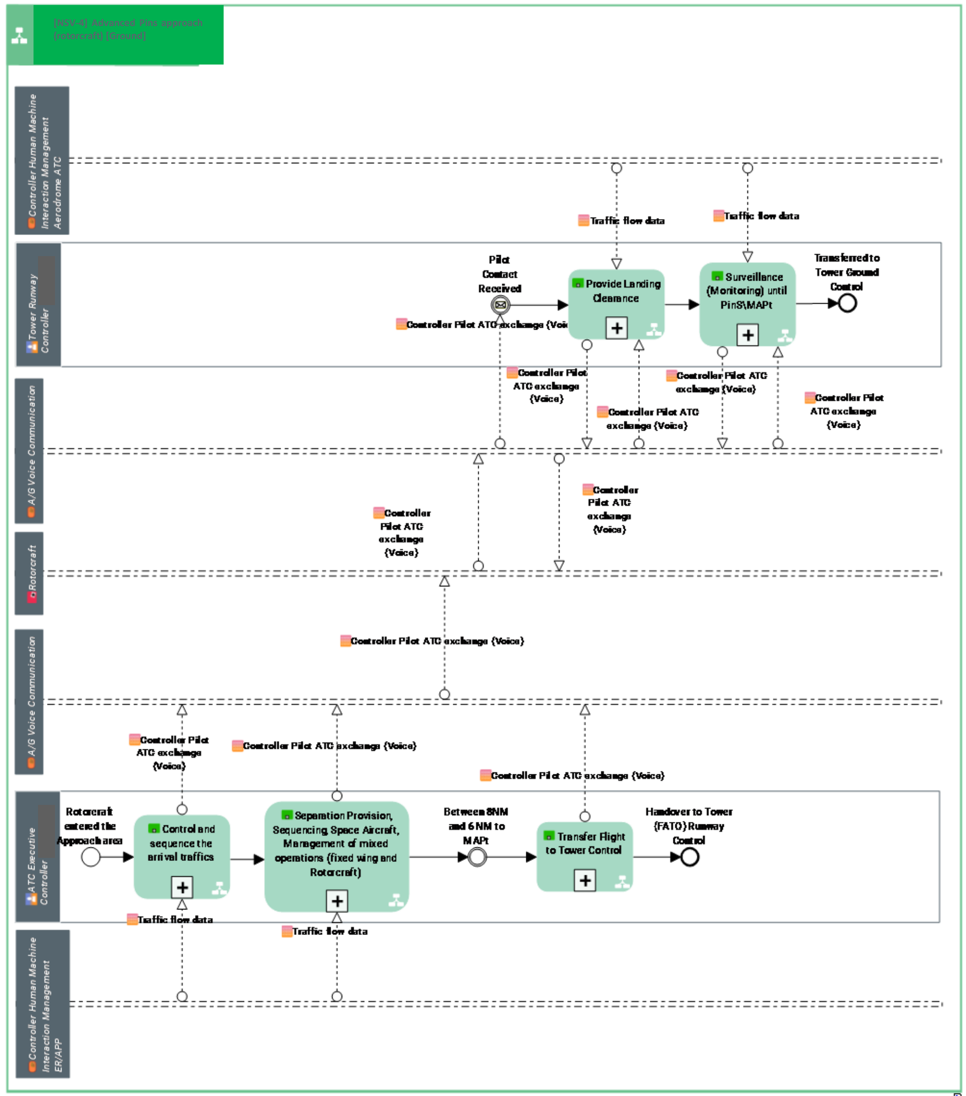
There is no modification on the interaction between Resources for Advanced PinS operations compared to Standard PinS operations.

The interfaces between Capability Configurations are not modified. Only some systems have to be modified in order to perform the new procedure type, but also to sequence and manage the rotorcraft traffic flying on the Advanced PinS procedure:

- Aircraft
- Departure/Arrival data base
- En Route/Approach ATC

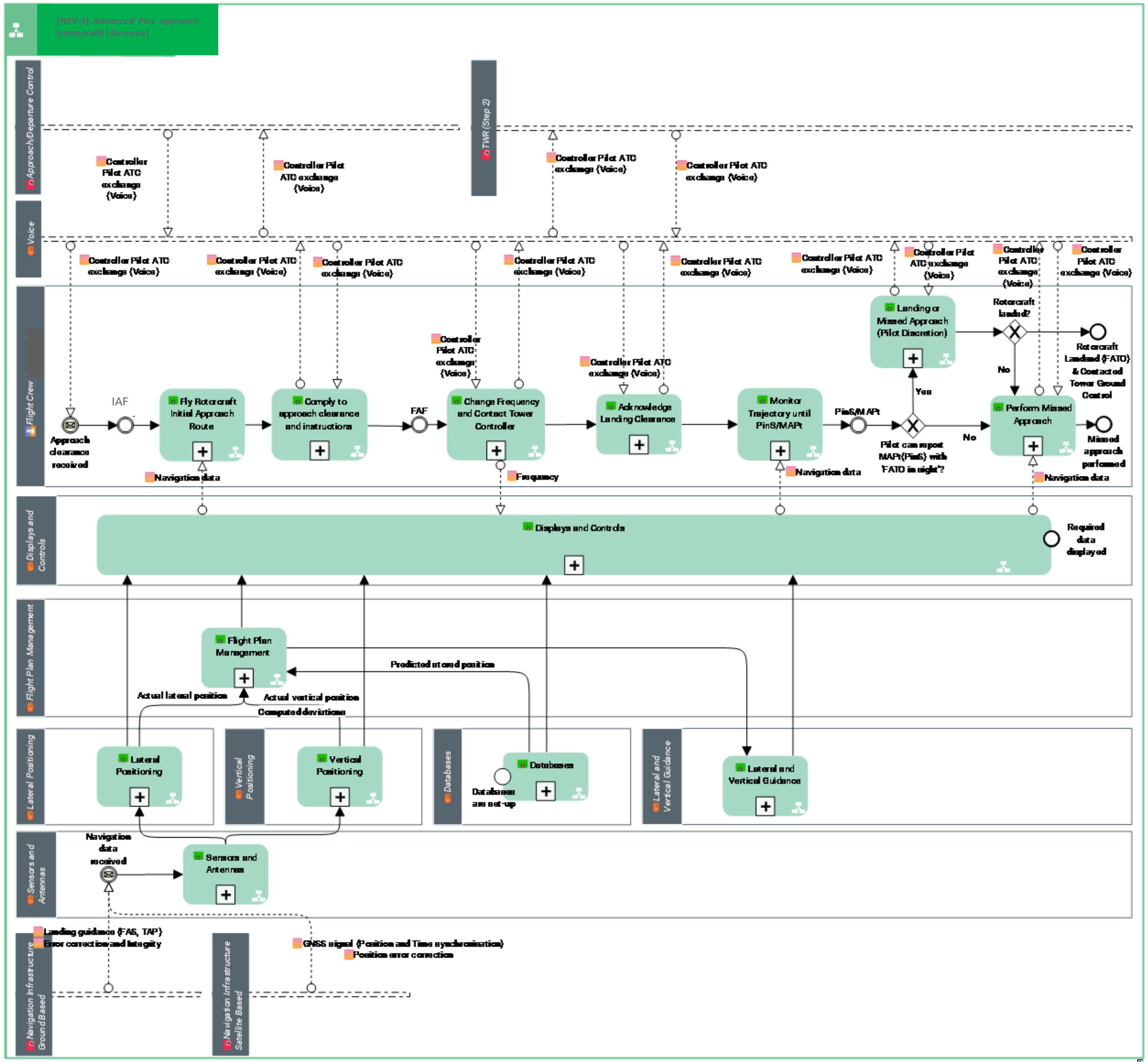
The following figures describe the NSV-4 models.

4.1.2.1 [NSV-4] Advanced PinS approach (rotorcraft) [Ground]


[NSV-4] Advanced Pins approach (rotorcraft) [Ground]
Controller Human Machine Interaction Management Aerodrome ATC
Tower Runway Controller
A/G Voice Communication
Rotorcraft
A/G Voice Communication
ATC Executive Controller
Controller Human Machine Interaction Management ER/APP
Traffic flow data
Traffic flow data
Pilot Contact Received
Provide Landing Clearance
Surveillance (Monitoring) until PinS\MAPt
Transferred to Tower Ground Control
Controller Pilot ATC exchange (Voice)
Controller Pilot ATC exchange (Voice)
Controller Pilot ATC exchange (Voice)
Controller Pilot ATC exchange (Voice)
Controller Pilot ATC exchange (Voice)
Controller Pilot ATC exchange (Voice)
Controller Pilot ATC exchange (Voice)
Controller Pilot ATC exchange (Voice)
Controller Pilot ATC exchange (Voice)
Controller Pilot ATC exchange (Voice)
Controller Pilot ATC exchange (Voice)
Rotorcraft entered the Approach area
Control and sequence the arrival traffics
Separation Provision, Sequencing Space Aircraft, Management of mixed operations (fixed wing and Rotorcraft)
Between 8NM and 6NM to MAPt
Transfer Flight to Tower Control
Handover to Tower (FATO) Runway Control
Traffic flow data
Traffic flow data

Function	Description
Control and sequence the arrival traffics	The controller is responsible for sequencing, separation and speed regulation as long as the rotorcraft is under his responsibility
Provide Landing Clearance	The TWR controller provides a landing clearance to the rotorcraft crew
Separation Provision, Sequencing, Space Aircraft, Management of mixed operations (fixed wing and Rotorcraft)	The controller is responsible for sequencing, separation and speed regulation as long as the rotorcraft is under his responsibility
Surveillance (Monitoring) until PinS\MAPt	If the rotorcraft flies a missed approach procedure the TWR controller provides the handover information to the crew
Transfer Flight to Tower Control	After reaching FAF the controller provides handover information to the rotorcraft crew

4.1.2.2 [NSV-4] Advanced PinS approach (rotorcraft) [Airborne]

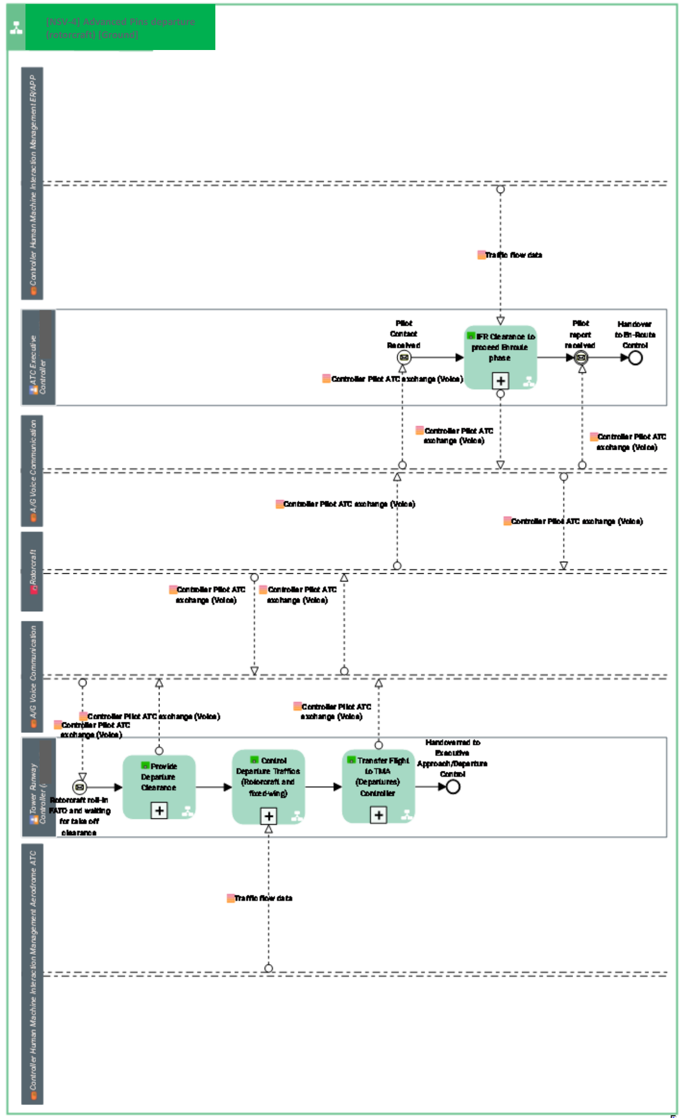

[NSV-4] Advanced Pins approach (rotorcraft) [Aircorne]
Approach/Departure Control
TWR (Step 2)
Voice
Flight Crew
Displays and Controls
Flight Plan Management
Lateral Positioning
Vertical Positioning
Databases
Lateral and Vertical Guidance
Sensors and Antennas
Navigation Infrastructure Ground Based
Navigation Infrastructure Satellite Based
Controller Pilot ATC exchange (Voice)
Approach clearance received
IAF
Fly Rotorcraft Initial Approach Route
Comply to approach clearance and instructions
FAF
Change Frequency and Contact Tower Controller
Acknowledge Landing Clearance
Monitor Trajectory until PinS/MAPt
PinS/MAPt
Pilot can report MAPt(PinS) with 'FATO in sight'?
Yes
No
Landing or Missed Approach (Pilot Discretion)
Rotorcraft landed?
Rotorcraft Landed (FATO) & Contacted Tower Ground Control
Perform Missed Approach
Missed approach performed
Navigation data
Frequency
Displays and Controls
Required data displayed
Flight Plan Management
Predicted stored position
Actual lateral position
Actual vertical position
Computed deviations
Lateral Positioning
Vertical Positioning
Databases
Databases are set-up
Lateral and Vertical Guidance
Navigation data received
Sensors and Antennas
Landing guidance (FAS, TAP)
Error correction and Integrity
GNSS signal (Position and Time synchronisation)
Position error correction

2

Function	Description
Acknowledge Landing Clearance	The rotorcraft pilot receives the landing clearance and confirms this with a read back
Change Frequency and Contact Tower Controller	The rotorcraft crew changes the frequency and contacts the Tower Controller.
Comply to approach clearance and instructions	The rotorcraft crew complies to the approach clearance and instructions
Databases	Onboard A/C databases (e.g. airport, navigation and terrain data bases). Some may require periodic updates based on AIRAC cycle
Displays and Controls	The function centralising HMI related functions for avionics including graphic user interface.
Flight Plan Management	Management of FMS 4D Trajectory (e.g. activ/secondary/alternate flight play waypoints, turn/holding patterns, etc)
Fly Rotorcraft Initial Approach Route	The rotorcraft flies the initial approach route.
Landing or Missed Approach (Pilot Discretion)	The rotorcraft crew decides to perform a missed approach procedure.
Lateral and Vertical Guidance	Flight Control i.e. the control of the aircraft on its lateral and vertical axis (e.g. Autopilot, Flight Director, Head up display)
Lateral Positioning	Elaboration of A/C latitude and longitude based on external means (GNSS)
Monitor Trajectory until PinS/MAPt	The pilot monitors the trajectory until he reaches MAPt
Perform Missed Approach	The rotorcraft crew performs a missed approach.
Sensors and Antennas	The function related Sensors and Antennas capabilities.
Vertical Positioning	Elaboration of A/C vertical position (altitude, height) based on external means (GNSS) or autonomous means (Baro-Altitude, Radio-

	Altitude measurements)

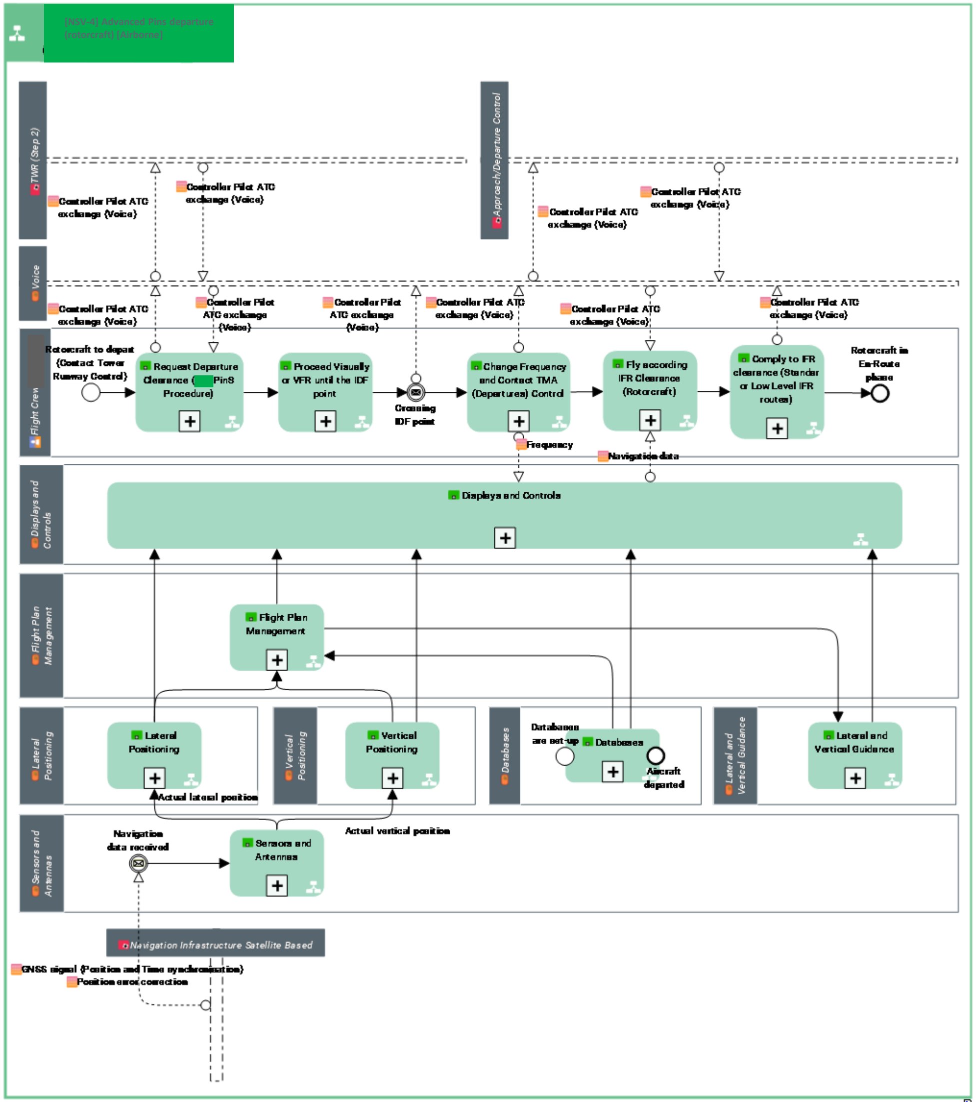
4.1.2.3 [NSV-4] Advanced PinS departure (rotorcraft) [Ground]



[NSV-4] Advanced Pins departure (rotorcraft) [Ground]
Controller Human Machine Interaction Management ER/APP
Traffic flow data
ATC Executive Controller
Pilot Contact Received
IFR Clearance to proceed Enroute phase
Pilot report received
Handover to En-Route Control
Controller Pilot ATC exchange (Voice)
A/G Voice Communication
Rotorcraft
Tower Runway Controller
Rotorcraft roll-in FATO and waiting for take off clearance
Provide Departure Clearance
Control Departure Traffics (Rotorcraft and fixed-wing)
Transfer Flight to TMA (Departures) Controller
Handovered to Executive Approach/Departure Control
Controller Human Machine Interaction Management Aerodrome ATC

Function	Description
Control Departure Traffics (Rotorcraft and fixed-wing)	The controller controls the departure traffic under his responsibility
IFR Clearance to proceed Enroute phase	The controller provides an IFR clearance to the rotorcraft crew
Provide Departure Clearance	The controller provides a departure clearance to the rotorcraft crew
Transfer Flight to TMA (Departures) Controller	The controller transfers the flight to the TMA (departure) controller.

4.1.2.4 [NSV-4] Advanced PiNS departure (rotorcraft) [Airborne]

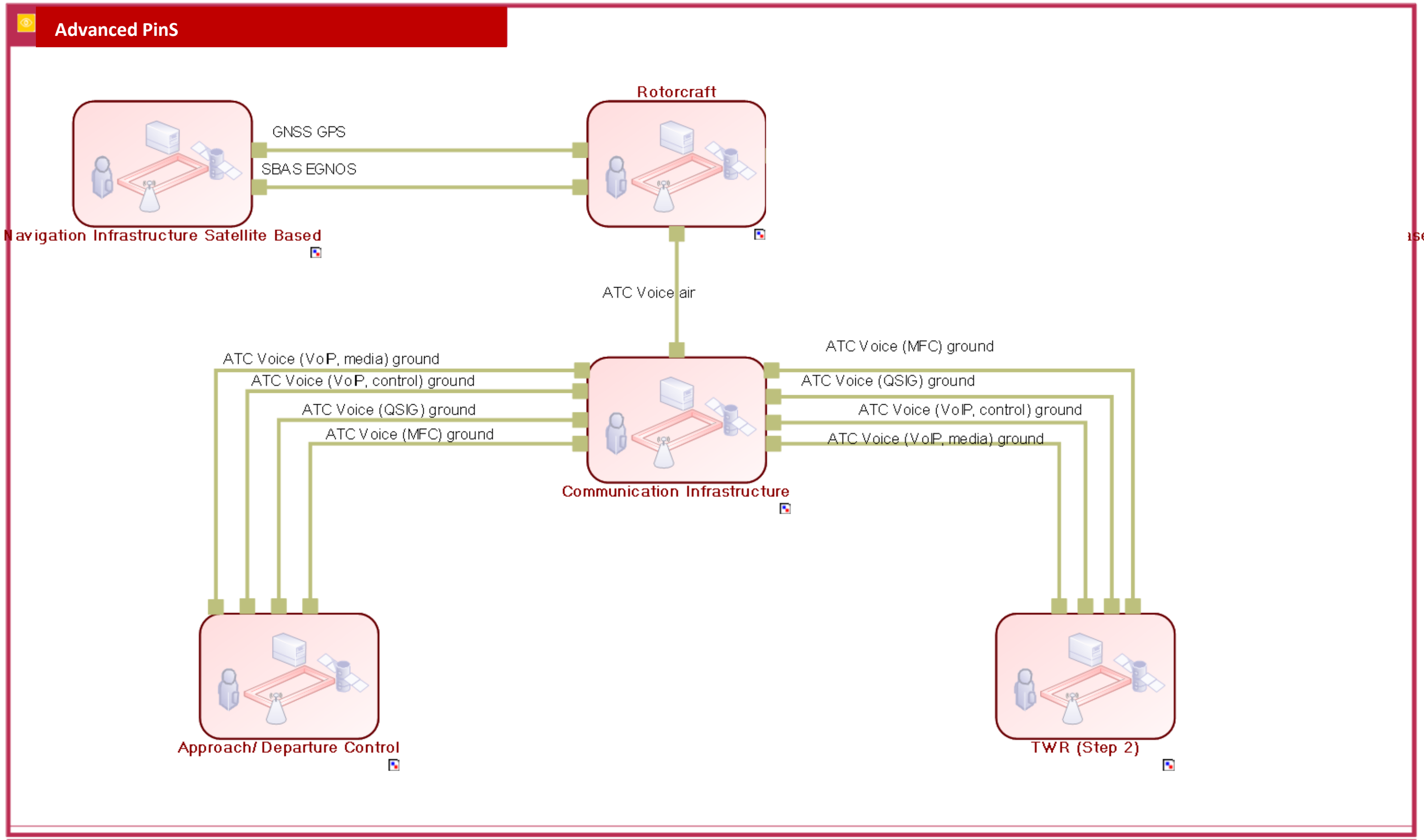


[NSV-4] Advanced Pins departure (rotorcraft) [Airborne]
TWR (Step 2)
Approach/Departure Control
Voice
Flight Crew
Displays and Controls
Flight Plan Management
Lateral Positioning
Vertical Positioning
Databases
Lateral and Vertical Guidance
Sensors and Antennas
Controller Pilot ATC exchange (Voice)
Rotorcraft to depart (Contact Tower Runway Control)
Request Departure Clearance (PinS Procedure)
Proceed Visually or VFR until the IDF point
Crossing IDF point
Change Frequency and Contact TMA (Departures) Control
Fly according IFR Clearance (Rotorcraft)
Comply to IFR clearance (Standar or Low Level IFR routes)
Rotorcraft in En-Route phase
Frequency
Navigation data
Displays and Controls
Flight Plan Management
Lateral Positioning
Actual lateral position
Vertical Positioning
Databases are set-up
Databases
Aircraft departed
Lateral and Vertical Guidance
Navigation data received
Sensors and Antennas
Actual vertical position
Navigation Infrastructure Satellite Based
GNSS signal (Position and Time synchronisation)
Position error correction

Function	Description
Change Frequency and Contact TMA (Departures) Control	
Comply to IFR clearance (Standard or Low Level IFR routes)	
Databases	Onboard A/C databases (e.g. airport, navigation and terrain data bases). Some may require periodic updates based on AIRAC cycle
Displays and Controls	The function centralising HMI related functions for avionics including graphic user interface.
Flight Plan Management	Management of FMS 4D Trajectory (e.g. activ/secondary/alternate flight play waypoints, turn/holding patterns, etc)
Fly according IFR Clearance (Rotorcraft)	
Lateral and Vertical Guidance	Flight Control i.e. the control of the aircraft on its lateral and vertical axis (e.g. Autopilot, Flight Director, Head up display)
Lateral Positioning	Elaboration of A/C latitude and longitude based on external means (GNSS)

Proceed Visually or VFR until the IDF point	
Request Departure Clearance (Advanced PinS Procedure)	
Sensors and Antennas	The function related Sensors and Antennas capabilities.
Vertical Positioning	Elaboration of A/C vertical position (altitude, height) based on external means (GNSS) or autonomous means (Baro-Altitude, Radio-Altitude measurements)

4.1.3 Infrastructure connectivity model



[NSV-4] Advanced PinS approach (rotorcraft) [Ground] [A/G Voice Communication, A/G Voice Communication, ATC Executive Controller (PJ.01-06), Controller Human Machine Interaction Management Aerodrome ATC, Controller Human Machine Interaction Management ER/APP, Rotorcraft, Tower Runway Controller (PJ.01-06)]
[NSV-4] Advanced PinS approach (rotorcraft) [Airborne] [Approach/Departure Control, Databases, Displays and Controls, Flight Crew (PJ.01-06, Flight Plan Management, Lateral and Vertical Guidance, Lateral Positioning, Navigation Infrastructure Ground Based, Navigation Infrastructure Satellite Based, Sensors and Antennas, TWR (Step 2, Vertical Positioning, Voice]
[NSV-4]Advanced PinS departure (rotorcraft) [Ground][A/G Voice Communication, A/G Voice Communication, ATC Executive Controller (PJ.01-06), Controller Human Machine Interaction Management Aerodrome ATC, Controller Human Machine Interaction Management ER/APP, Rotorcraft, Tower Runway Controller (PJ.01-06)]
[NSV-4] Advanced PinS departure (rotorcraft) [Airborne][Approach/Departure Control, Databases, Displays and Controls, Flight Crew (PJ.01-06(, Flight Plan Management, Lateral and Vertical Guidance, Lateral Positioning, Navigation Infrastructure Satellite Based, Sensors and Antennas, TWR (Step 2), Vertical Positioning, Voice]

Figure 1: PinS

Operations Infrastructure Connectivity

4.1.4 Service view

4.1.4.1 Service description

No new services are required to perform the Advanced PinS procedures. Some automatization and improvement (TBC) could help traffic controllers to sequence the traffic.

4.1.4.2 Service Provisioning

ReportAircraftTrajectory: This service has to be deployed to support the automatization of the service ArrivalSequenceManagement.

ArrivalSequenceManagement: This service has to be deployed to assist the controller to sequence the different types of traffic at different speeds. For the Low density traffic airport this service is not required but for the others airport it could be an enabler in order to increase the traffic density.

4.1.4.3 Service Realization

ReportAircraftTrajectory : This service uses ADS-B In and Out technology.

ArrivalSequenceManagement : This service uses i4D technology.

4.2 Functional and non-Functional Requirements

4.2.1 Traffic management requirements

N/A

4.2.2 Safety requirements

The Advanced PinS operation do not necessitate any new safety requirement compared to RNP 0.3 and standard PinS operations.

4.2.3 Functional requirements

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0001
Title	RNP 0.3 capability
Requirement	The system shall implement Required Navigation Performance (RNP) 0.3 capability by check/alert availability, accuracy, and integrity of the localisation regarding the RNP value ; by computing and display the lateral cross deviations
Status	<validated>

Rationale	The advanced PinS operation includes RNP 0.3 3 regarding PBN Fourth Edition — 2013
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0012
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0013
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0009
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0014
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0015
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0008
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0002
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0004
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0003
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0007
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0017
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0005
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0001
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0018
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0019
<ALLOCATED_TO>	<Enabler>	A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-05a_APV Barometric VNAV A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-06_Flight management and guidance for LPV approach based on SBAS PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0002
Title	The system shall implement localizer performance with vertical guidance (LPV) GNSS capability by check/alert availability, accuracy, and integrity of the localisation regarding the LPV alert limit ; by computing and display the lateral and vertical angular deviations
Requirement	The helicopter shall support LPV operation
Status	<validated>
Rationale	The advanced PinS operation includes LPV regarding PBN Fourth Edition — 2013
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0005
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0014
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0007
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0010
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0013
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0009
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0003
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0016
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<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0001
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0017
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0019

<ALLOCATED_TO>	<Enabler>	PRO-250_Rotorcraft procedures for IFR access to VFR FATOs A/C-06_Flight management and guidance for LPV approach based on SBAS A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-05a_APV Barometric VNAV A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0003
Title	RF leg capability
Requirement	The system shall implement Radius to Fix (RF) leg capability by computing and display the lateral cross deviations during circle trajectory
Status	<validated>
Rationale	Advanced PinS operation may include RF leg regarding PBN Fourth Edition — 2013
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0003
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0017
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0005
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0015
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0019
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS

		A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-06_Flight management and guidance for LPV approach based on SBAS PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0004
Title	GNSS availability
Requirement	The system shall implement a GNSS availability check and a prediction function or use a SBAS GNSS receiver
Status	<validated>
Rationale	In mountainous area the relief may be an important contributor to the GNSS availability
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0008
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0017
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0005
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0019
<ALLOCATED_TO>	<Enabler>	PRO-250_Rotorcraft procedures for IFR access to VFR FATOs A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-05a_APV Barometric VNAV A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all

		phases of flight, except final approach and initial missed approach A/C-06_Flight management and guidance for LPV approach based on SBAS A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0005
Title	Automatic piloting requirement
Requirement	The system should implement an Automatic piloting abble to control the rotor craft during all phase of flight : climb, descent and during en-route couple to the FMS and to the approach guidance system
Status	<validated>
Rationale	To address the most important number of approaches, and on the other hand due to the difficulties to fly this kind of approach manually, this requirement increase the safety and the availability of the operation.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0017
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0019
<ALLOCATED_TO>	<Enabler>	PRO-250_Rotorcraft procedures for IFR access to VFR FATOs A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-06_Flight management and guidance for

		LPV approach based on SBAS A/C-05a_APV Barometric VNAV

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0006
Title	Vertical deviations
Requirement	The system shall have the capability to compute and display the cross deviations during descent cruise or climb.
Status	<validated>
Rationale	To optimize the vertical profile (i.e. Continuous Descent Final Approach or climbing), and on the other hand due to the difficulties to fly this kind of approach manually, this requirement increase the safety and the availability of the operation.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0015
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0016
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0017
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0018
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-06_Flight management and guidance for LPV approach based on SBAS A/C-05a_APV Barometric VNAV PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0007
Title	Computation of angular deviations
Requirement	To perform an RNAV-GNSS approach (with LPV minima), the system shall compute angular deviations (ILS-Look-Alike).
Status	<validated>
Rationale	Advanced PinS operation may include LPV guidance during the final regarding PBN Fourth Edition — 2013
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0003
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0007
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0008
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0010
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<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0013
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-06_Flight management and guidance for LPV approach based on SBAS PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0008
Title	Reverting from angular deviation to linear scales
Requirement	The system shall revert from angular deviations scales to linear scales with deviations from the flight plan when flying an RNAV-GNSS approach (with LNAV or LPV minima) associated to a missed approach procedure coded in the Navigation Database, at the engagement of the missed approach.
Status	<validated>
Rationale	Advanced PinS operation shall manage missed approach operation. In this case and for safety reason, the system shall compute and display continuously lateral guidance during this phase of flight. Refer PBN Fourth Edition — 2013
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0020
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-06_Flight management and guidance for LPV approach based on SBAS PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0009

Title	Storing RNAV-GNSS Approach procedure in database
Requirement	The system shall store the precision RNAV-GNSS approach procedure (with LNAV or LPV minima) definitions, in the standard navigation database.
Status	<validated>
Rationale	Advanced PinS operation shall use route, waypoint and standards approachs defined by the ARINC 424. Refer PBN Fourth Edition — 2013
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0003
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0007
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0008
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0010
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0011
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0013
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-06_Flight management and guidance for LPV approach based on SBAS PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0010
Title	GNSS-SBAS Equipment according to TSO C145c Class Beta3
Requirement	GNSS-SBAS equipment shall be compliant with the functional, operational and performance requirements defined by the TSO C145c Class Beta3
Status	<validated>
Rationale	TSO is the easiest way to get a certification type. Refer PBN Fourth Edition — 2013
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0020
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-06_Flight management and guidance for LPV approach based on SBAS PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0011
Title	FMS proprietary ARINC 424 Format
Requirement	The FMS database will follow the RTCA/DO 200A process to format the ARINC 424 database, supplied by the provider, into the FMS proprietary Format, which shall include the FAS DB.

Status	<validated>
Rationale	DO 200 process is required in the PBN Fourth Edition — 2013
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0001
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0003
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0007
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<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0013
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-06_Flight management and guidance for LPV approach based on SBAS PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0012
Title	Updating Flight Plan
Requirement	The Navigation function shall update the flight plan after inserting the selected RNAV-GNSS approach procedure.
Status	<validated>

Rationale	Flight plan update is a state of the art for the modern FMS
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0003
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0007
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0008
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<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-06_Flight management and guidance for LPV approach based on SBAS PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-0013
Title	Storing FAS Data Block
Requirement	The system shall store the FAS Datablock with its relevant CRC for each RNAV GPS Approach procedure with LPV minima.
Status	<validated>

Rationale	Advanced PinS operation shall use FAS data block in order to perform LPV GNSS-APCH approach. These approach are defined by the ARINC 424 standards and they use a CRC in order to increase the integrity. The system shall manage this level of integrity by checking the consistency of the FAS with the CRC.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0003
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0007
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<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0013
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-06_Flight management and guidance for LPV approach based on SBAS PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

4.2.4 Performance requirements

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-PERF-0001
Title	Autopilot requirement

Requirement	The FTE shall not exceed 0.125Nm during RF leg flight at 95%.
Status	<validated>
Rationale	The automatic pilot coupling requirement is an option. Regarding the performance of the NSE and the PDE, the above FTE is required to maintain a RNP at 0.3 NM and respect the availability requirement of the operation Cf AC 20-138D
Category	<Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0017
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0019
<ALLOCATED_TO>	<Enabler>	PRO-250_Rotorcraft procedures for IFR access to VFR FATOs A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV A/C-06_Flight management and guidance for LPV approach based on SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-05a_APV Barometric VNAV

[REQ]

Identifier	REQ-PJ.01.06-TS-IRS-PERF-0002
Title	Manual piloting requirement
Requirement	The FTE shall not exceed 0.25 during RF leg flight at 95%.
Status	<validated>

Rationale	Regarding the performance of the NSE and the PDE, the above FTE is required to maintain a RNP at 0.3 NM and respect the availability requirement of the operation The HMD is a good enabler to improve the flight guidance and performance
Category	<Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0002
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0001
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0003
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0004
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<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0013
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<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0019
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0018
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-05a_APV Barometric VNAV A/C-06_Flight management and guidance for LPV approach based on SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and

		initial missed approach A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0001
Title	MSAW - clearance information
Requirement	The MSAW shall receive all clearance information.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0002
Title	MSAW terrain/obstacle information
Requirement	The MSAW shall receive all terrain/obstacle information from the database.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0003
Title	MSAW regular calculation minimum distance
Requirement	The MSAW shall regularly calculate minimum distance between rotorcraft trajectory based on clearance data and terrain/obstacle data based on current database.
Status	<deleted>

Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0004
Title	MSAW warning provision
Requirement	The MSAW shall provide warning to the ATCO who is responsible for the rotorcraft which trajectory will penetrate terrain/obstacle on a dedicated interface.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0005
Title	FMS - NAVAID data.
Requirement	The FMS shall receive all relevant data form the NAVAID.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0006
Title	FMS data provision for HMD

Requirement	The FMS shall provide all relevant data including flight trajectory to the HMD.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0007
Title	HMD visually provision of all relevant data including flight trajectory
Requirement	The HMD shall visually provide all relevant data including flight trajectory to the Flight Crew.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0008
Title	FMS alive-check system
Requirement	An alive-check system shall monitor the FMS.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0009
Title	HMD alive-check system
Requirement	An alive-check system shall monitor the HMD.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS_IRS-SAF-0010
Title	GNSS alive-check system
Requirement	An alive-check system shall monitor the GNSS.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0011
Title	Monitoring aid
Requirement	A monitoring aid shall warn of any discrepancy between cleared trajectory and actual trajectory.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0012
Title	Flight Data Processor alive-check system
Requirement	An alive-check system shall monitor the Flight Data Processor.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0013
Title	Terrain Database alive-check system
Requirement	An alive-check system shall monitor the Terrain Database.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0014
Title	MSAW alive-check system
Requirement	An alive-check system shall monitor the MSAW.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0101
Title	FMS data corruption
Requirement	FMS data corruption shall occur less than $6*10^{-8}$.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0102
Title	HMD data corruption
Requirement	HMD data corruption shall occur less than $6*10^{-8}$
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0103
Title	GNSS failure
Requirement	GNSS shall fail to show data less than $6*10^{-8}$
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0104
Title	Flight Data Processor data corruption
Requirement	Flight Data Processor data corruption shall occur less than $3*10^{-8}$
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0105
Title	Terrain Database data corruption
Requirement	Terrain Database data corruption shall occur less than $3*10^{-8}$
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-0106
Title	MSAW failure
Requirement	MSAW shall miss a conflict less than $3*10^{-8}$.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate.
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-1003
Title	HMD symbology
Requirement	The HMD symbology shall help the pilot to control laterally and vertically the trajectory and shall indicate the flight parameters (speed, altitude, velocity vector…) at any time
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report.
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-1004
Title	RNP 0.3 navigation specification
Requirement	RNP system shall be approved in accordance with the RNP 0.3 navigation specification
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report.
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew

<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-1005
Title	FMS system approved for RNP approach down to LPV minima
Requirement	FMS system shall be approved for RNP approach down to LPV minima
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report.
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-1006
Title	RNP system coupled with AP /FD --> RF legs
Requirement	RNP system coupled with AP /FD shall be capable of executing RF legs
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report.
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-1007
Title	FMS provide advanced PinS guidance --> curved segment
Requirement	The FMS shall provide advanced PinS guidance during the curved segment between the Intermediate Fix and the Final Approach Fix, which combines longitudinal, lateral and vertical movements.
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report.
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-1010
Title	Status of GNSS/SBAS
Requirement	The status of GNSS/SBAS (vertical guidance) shall be displayed to the FCRW at any time
Status	<validated>

Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report.
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-1011
Title	HMD visually relevant data provision
Requirement	The HMD shall visually provide all relevant data when approaching the missed approach point to support the FCRW in the decision whether to continue or abort the approach procedure
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report.
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-1014

Title	Status of HMD
Requirement	The status of HMD shall be displayed to the rotorcraft pilot at any time.
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report.
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-TS-IRS-SAF-1101
Title	HMD data corruption
Requirement	HMD data corruption shall occur less than 1*10-7.
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report.
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

4.2.5 Interface requirements

The Advanced PinS operation does not necessitate any new interface requirements compared to RNP 0.3 and standard PinS operations.

4.2.6 Information exchange requirements

The Advanced PinS operation does not necessitate any new information exchange requirement compared to RNP 0.3 and standard PinS operations.

4.2.7 Traceability

[REQ-PJ.01.06-TS-IRS-0001Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0001
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0002
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0003
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0004
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0005
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<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and

		initial missed approach A/C-05a_APV Barometric VNAV A/C-06_Flight management and guidance for LPV approach based on SBAS A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ REQ-PJ.01.06-TS-IRS-0002]

Relationship	Linked Element Type	Identifier
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<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0001
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0002
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0003
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0005
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0006
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<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0029
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0031
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01-06-SPRINTEROP-0032
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01-06-SPRINTEROP-0033
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-06_Flight management and guidance for LPV approach based on SBAS A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ-PJ.01.06-TS-IRS-0003 Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0003
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0006
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0027
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0029
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0031
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01-06-SPRINTEROP-0032
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01-06-SPRINTEROP-0033
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV

		A/C-06_Flight management and guidance for LPV approach based on SBAS A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ-PJ.01.06-TS-IRS-0004 Trace]

Relationship	Linked Element Type	Identifier
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<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0006
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0008
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0013
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<SATISFIES>	< ATMS Requirement>	REQ-PJ.01-06-SPRINTEROP-0032
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<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-06_Flight management and guidance for LPV approach based on SBAS A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ-PJ.01.06-TS-IRS-0005 Trace]

Relationship	Linked Element Type	Identifier

<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0029
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0031
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01-06-SPRINTEROP-0032
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01-06-SPRINTEROP-0033
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-06_Flight management and guidance for LPV approach based on SBAS A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ-PJ.01.06-TS-IRS-0006 Trace]

Relationship	Linked Element Type	Identifier
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<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0026
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<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0028
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0029
<SATISFIES>	< ATMS Requirement>	REQ-PJ.01.06-SPRINTEROP-0030
<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-06_Flight management and guidance for LPV approach based on SBAS A/C-07_Flight management and guidance for

		RNP transition to ILS/GLS/LPV PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

[REQ-PJ.01.06-TS-IRS-PERF-0001 Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
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[REQ-PJ.01.06-TS-IRS-PERF-0002 Trace]

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<ALLOCATED_TO>	<Enabler>	A/C-01_Enhanced positioning for LPV/RNP based on Single Frequency SBAS A/C-04b_Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach A/C-05a_APV Barometric VNAV A/C-06_Flight management and guidance for LPV approach based on SBAS A/C-07_Flight management and guidance for RNP transition to ILS/GLS/LPV PRO-250_Rotorcraft procedures for IFR access to VFR FATOs

Table 6: Requirements layout

5 Implementation Options

5.1 Real Time Simulation (Generic Cockpit Simulator GECO)

5.1.1 Introduction

The Generic Experimental Cockpit (GECO) is a modular cockpit simulator with flight-mechanical models of the DLR test aircraft ATTAS. The flight-mechanical models are interchangeable, depending on the application required.

The GECO is particularly used to conduct simulations with human test subjects in order to evaluate new display and control concepts. Research also focuses on the development and evaluation of innovative operational procedures that can be applied in the future using new technologies. Examples include systems for the GPS-based determination of position, maneuvering area lighting, air-ground communication, collision detection and avoidance as well as new sensors.

Figure 2: Generic Cockpit Simulator GECO in helicopter configuration at DLR Braunschweig

The outside view is simulated using three high-resolution projectors that project an image on a mirror system with a 6-meter diameter. This allows an area of 180° by 40° to be displayed, giving a realistic perception of depth (collimated visual system). To simulate the outside view the DLR tool ALICE is used, which enables the detailed 3D modeling of landscapes, airports and sensor data.

The GECO can be converted into a helicopter simulator. An innovative helmet with a helmet-mounted display is used for research in the field of helicopters. Just as with the HUD, important information is projected into the field of vision of the helicopter pilots, thereby providing support during low visibility.

5.1.2 Technical Architecture for RTS validation excercises

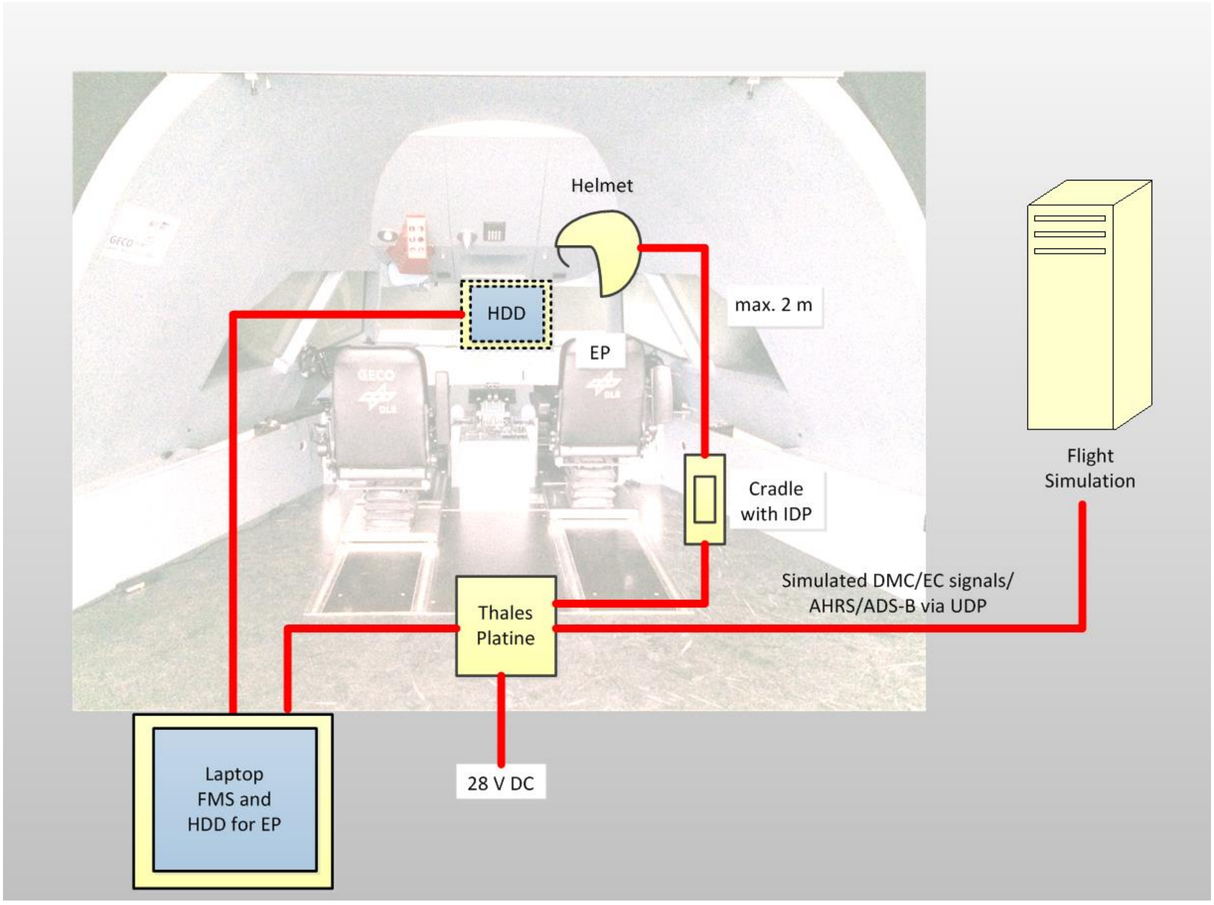

Figure 3: Overview of the different hardware components inside the Generic Cockpit Simulator

The RTS validation will use the same approved hardware components as used in the research helicopter (see Figure 3 and Figure 4). These are essentially a Flight Management System implemented on a laptop providing the Advanced PinS procedure in ARINC 424 (Type 20) format (see chapter 5.1.2.2), an HDD symbology used as a primary and navigation display for the presentation of the entire flight path (see chapter 5.1.2.3), as well as the TopEagle HMD including the necessary hardware (cradle with IDP) for data processing (see chapter 5.1.2.1). All flight data will be provided by an X-Plane flight simulator in real time. The data are transferred via a UDP interface to the THALES hardware (platine).

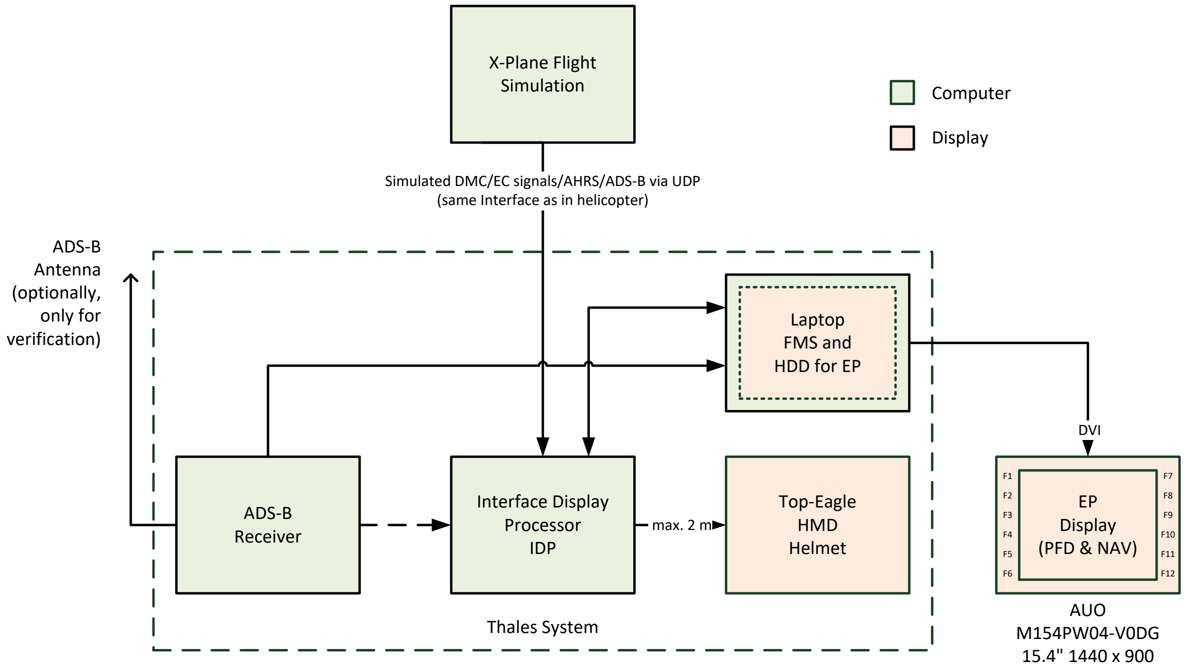

Figure 4: GECO technical architecture and interfaces between the different hardware components

5.1.2.1 Helmet Mounted Display System

The Helmet Mounted Display System that will be integrated inside the Real Time Simulator is a Thales equipment named TopEagle.

It is composed of the following components:

- An Equipped Helmet including :
  - A protective Helmet, including a pair of audio ear cups
  - A Tracker and a Display mechanically installed on the helmet
  - A cable; an In Line Controller (ILC) that enables to control the HMD is included on this cable
- A computer for head tracking computation and graphical generation, based on aircraft data acquisition, called Interface Display Processor (IDP); the IDP is installed close to the cockpit;
- A set of bar code stickers (passive) called Fiducials used as reference by the tracking system

A flight test platine will also be provided, on which the connectors and convertors will be installed, providing the electrical interfaces between the helicopter and TopEagle.

Figure 5: TopEagle headgear and ILC

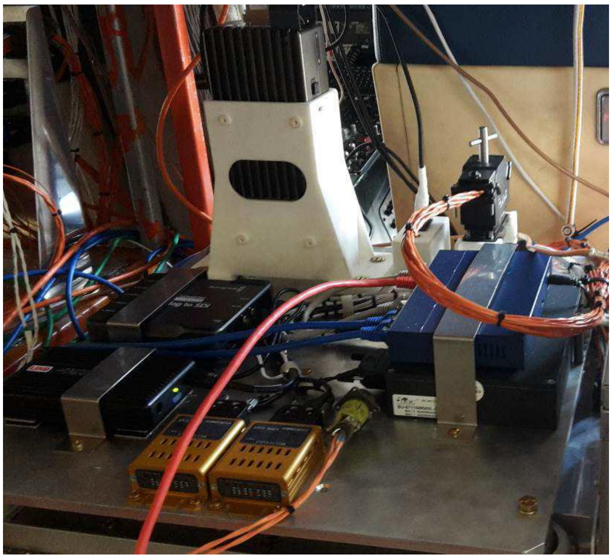

Figure 6: TopEagle flight test platine with the IDP, convertors and connectors

The IDP generates the symbology that is displayed on the TopEagle HMSD, showing in particular the advanced PinS procedure being flown and the RNP corridor.

5.1.2.2 Flight Management System

Thales will also provide a Flight Management System running into a laptop, in order to generate and manage the flight plan containing the advanced Point in Space procedures to be flown. This FMS will be interfaced with the primary reference sensors of the helicopter (GPS, AHRS…) in order to manage the flight plan during the flights. It generates the flight plan data that will be displayed on the head down display (HDD) and on the TopEagle display.

5.1.2.3 Primary Flight Display and Navigation Display

Finally, Thales will provide an application generating a PFD and a ND, as shown below, presenting in particular on the ND the FMS data over a digital map, along with the helicopter mock-up. This video image will be generated by a laptop, and displayed on a screen of the simulator cockpit (HDD screen).

Figure 7: PFD and ND to be displayed on the HDD of the simulator

5.2 Flight Trials (Research helicopter ACT/FHS)

5.2.1 Introduction

The ACT/FHS 'Flying Helicopter Simulator' of the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) is based on a standard Eurocopter EC 135 type helicopter, which has been extensively modified for use as a research and test aircraft. The mechanical controls, for example, have been replaced by a fly-by-wire/fly-by-light (FBW/FBL) flight control system. Now the control commands are transferred by electric cables and fibre optic cables instead of control rods.

The application portfolio of the FHS covers pilot training, trials of new open and closed-loop control systems, up to simulation of the flight characteristics of other helicopters under real environmental conditions. The FHS is equipped with two engines, a bearingless main rotor and a Fenestron tail rotor as standard; its key features are notably quiet operation and high manoeuvrability and safety.

The fly-by-light control system is a groundbreaking new system where, in contrast with fly-by-wire, the control signals between the controls, the flight management computer and the actuators for rotor blade control are transferred optically via fibre optic cables instead of electrically.

The advantages compared with electrical data transfer are the high transmission bandwidth, high reliability and low weight. The fly-by-light flight control system consists of a quadruple redundant computer and is designed such that the stringent safety criteria of the European aviation authorities are met in full.

The following modifications differentiate FHS from the standard Eurocopter EC 135 helicopter:

- Optical and electronic FBW/FBL flight control system.

- On-board computer system that enables simulation of the flight characteristics of other - real (existing) or virtual - aircraft. In this way, it provides important information for the operational assessment of a helicopter at an early stage of its development. These capabilities are also used in basic research into flight characteristics.
- Modular experimental system: The system consists of flight-control computers, data measurement and pre-processing systems, displays and additional equipment and controls in the cockpit. The system also includes a data analysis station and a simulator for test preparation.

Figure 8: DLR's EC 135 FHS experimental research helicopter

5.2.2 Technical Architecture for validation exercises

5.2.2.1 The experimental system

The Experimental System consists of three computer systems: Data Management Computer (DMC), Experiment Computer (EC), and Graphics Computer (GC). The DMC is responsible for the standard services. It acquires data from all base sensors, all additional non experimental sensors and other systems. It distributes configurable data sets to selected systems such as EC, GC etc. The DMC stores pre-selected data, either continuously or on demand. Analogously pre-selected data is sent to the ground via telemetry. The DMC also handles the user interface via the control and display units of the evaluation pilot (EP) and the flight test engineer (FTE). The DMC operates with a cycle time of 2ms, i.e., the highest data acquisition rate is 500Hz.

The EC operates the interface with the FHS core system. It receives the pilot inputs, actuator positions and status data, and transfers this information to the experimental applications. One of these applications generates the actuator commands, which are sent back to the core system. Additionally, experimental hardware, such as sensors or side sticks, is connected to the EC.

The system software on the EC provides a layer of basic services, e.g., access to signals, transfer of generated data, access to devices connected to the EC, usage of the control and display units, application timing, etc. Above this layer the system is available for the experimental applications, i.e., the customer software. The EC operates with 500Hz; this is the core system transmission frequency. The start of experimental application cycles can be triggered by the arrival of core system data to minimize the latency for controller applications.

The DMC and the EC are VME-bus based systems using the VxWorks operating system. The function of the EC is extended by the Experiment Co-Computer (ECC) which is a Windows based PC, connected to the EC via Ethernet. It is available for non real-time applications, e.g., long term guidance or map displays.

The cockpit layout provides seats for a safety pilot, the test pilot and the flight test engineer. A comprehensive equipment line-up with sensors and systems for onboard data recording and processing is used to record the data from the flight tests. This data is available to users and engineers for analysis both on board and - via telemetry - on the ground.

5.2.2.2 Hardware components used for validation flight trials

For the flight tests with DLR's research helicopter ACT/FHS carried out in Braunschweig, the same hardware components will be used for the GECO simulator as described in chapter 5.1.2.1 and 5.1.2.2 (Figure 9)**Error! Reference source not found.**. During flight, the THALES platine will get the flight status data from DMC and EC, as well as from AHRS-2. For getting information about the aircraft traffic around the helicopter, the ADS-B receiver mounted on the platine is connected to the ADS-B antenna of the helicopter. The SBAS position data will be provided by the DMC as well.

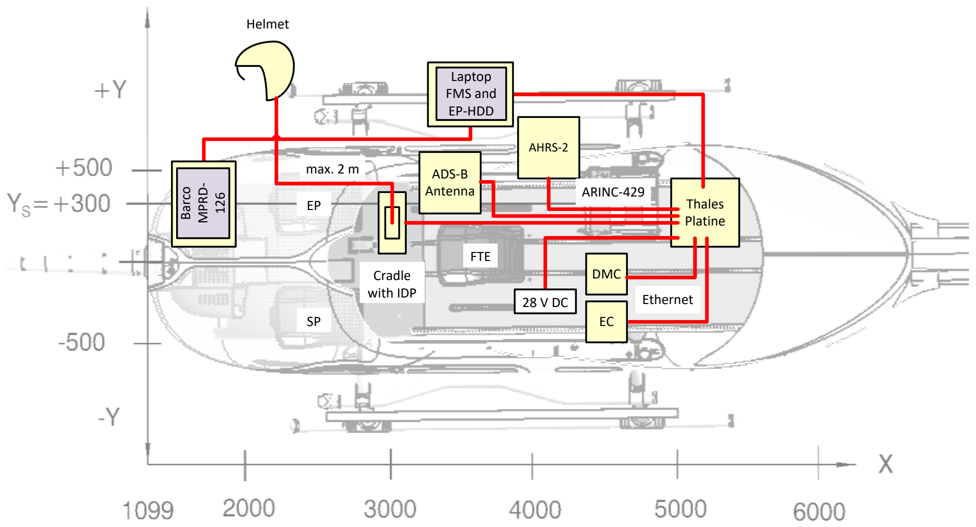

Figure 9: Overview of the different hardware components inside the helicopter

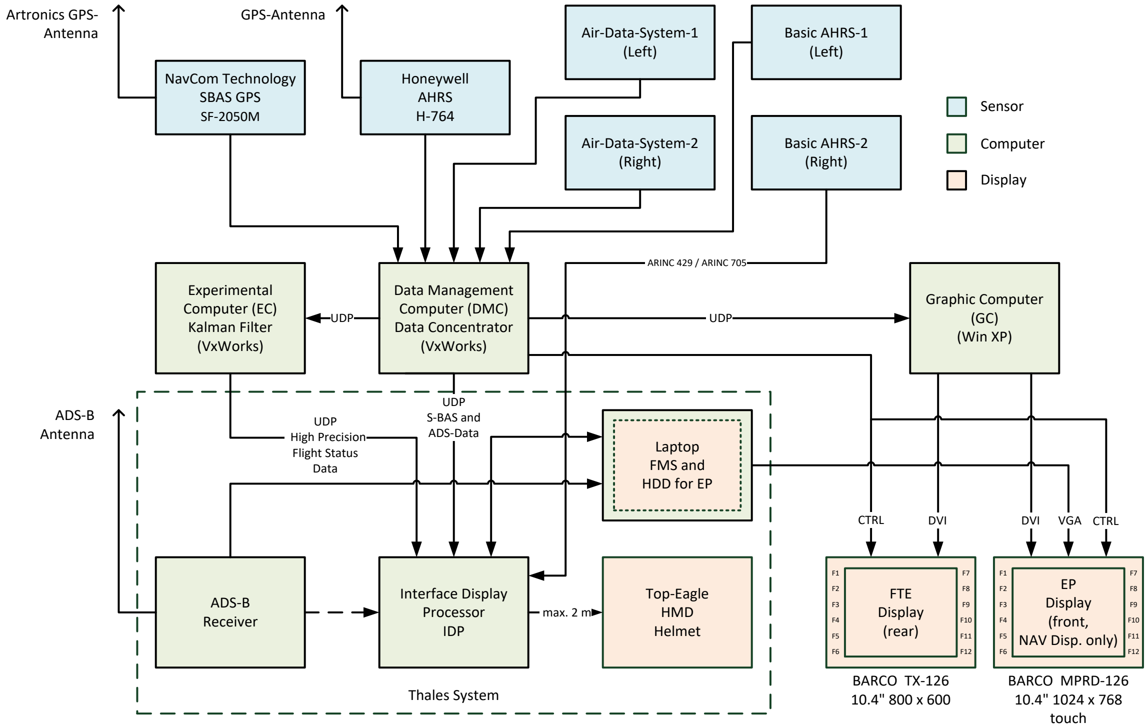

Figure 10: Helicopter technical architecture and interfaces between the different hardware components

The dashed box in Figure 10 also covers the additional hardware equipment provided by THALES for using during both the real time simulation and flight trials in Braunschweig. The blue boxes represent the sensor systems available on board the research helicopter. Most of the sensor data are acquired by the Data Management Computer (SBAS, ADS-Data) and will be transferred to the Interface Display Processor (IDP) via UDP. To obtain the lowest possible latency for the acquisition of the attitude and heading information of the helicopter, the IDP is directly connected to the AHRS-2 sensor system via ARINC 429 and 705.

The laptop onboard the helicopter will provide both the Flight Management System and the symbology of the Head Down Display. The HDD will also be presented on the console display of the flight test engineer. In contrast to the GECO simulator, only a navigation display will be presented for the evaluation pilot during flight due to a limited size and resolution of the BARCO display. For data analysis especially to investigate the accuracy of flight path performances, high precision flight status data will be recorded during flight.

The Interface Display Processer (IDP) will provide the symbology to the helmet mounted display. In order to give the pilot information about the traffic around the helicopter, an ADS-B receiver is also part of the Thales System. The ADS-B traffic will be presented with dedicated symbols on the HMD.

5.2.3 Meteorological Conditions

All flights will be conducted in VMC with different weather conditions (wind, rain). VMC is required due to the experimental status of the rotorcraft and its avionics equipment.

5.3 Flight Trials (Airbus Helicopter H145)

5.3.1 Introduction

The H145® is a 3-4 ton class twin-engine, multi-purpose helicopter. It can accommodate up to 12 seats for pilot/s and passengers. It is certified under the name BK117 D-2. The H145 represents a major evolution in terms of flight performance, mission capability, flight safety and cost of operations.

As a further evolution of the BK117 family, the H145 provides latest technologies, like the advanced cockpit design with the most modern Human Machine Interface (HMI) and state-of-the-art Helionix® avionics, new more powerful engines, an enhanced transmission system and a Fenestron® antitorque- device. These new technologies are combined with the rugged and proven design elements of the EC145® , as for example the main rotor system and the multipurpose cabin.

The innovative Helionix avionics system has an open architecture and modular design with very high redundancy (double duplex) incorporating embedded functions as well as the capability for further integration of mission functions. The most significant embedded function is the 4-axis dual duplex AFCS which is a further evolution of the H225 autopilot. The functionalities, level of safety and the mission capability enhancements offered by this autopilot are the most performing in the helicopter industry.

The H145's hingeless rotor system with its monolithic titanium hub ('System Bölkow') is proven worldwide. Furthermore, the rotor blades are optimized to provide high performance with low sound and vibration levels. These features, combined with a Fenestron with unequal blade spacing makes the H145 the quietest helicopter in its class. In addition to environmental aspects, the rugged rotor system and airframe components together with the enhanced main gear box grant for low maintenance costs and high in-service-time of the helicopter. The new engines also significantly contribute to the reduced maintenance costs through high TBO and an evolved maintenance concept with usage monitoring which increases the availability of the engine.

The H145 is equipped with two very powerful Safran Helicopter Engines Arriel 2E engines, each controlled by a dual channel FADEC, which, in combination with its lifting system, provide outstanding performance in AEO operations and vital power reserves in One Engine Inoperative (OEI) scenarios. The H145 allows Cat. A VTOL operation up to the level of performance class 1 according to EASA OPS with full MTOW at SL and ISA.

Twin-engine reliability is complemented by a fully separated fuel supply system, a duplex hydraulic system, dual electrical system and redundant lubrication for the main transmission. A key safety aspect of the H145 is its inherent crashworthiness thanks to energy absorbing fuselage and seats, as well as crash resistant fuel cells. The Fenestron anti-torque-device increases significantly the safety in flight and on ground.

A wide range of rapidly interchangeable optional equipment, such as emergency floats, rescue hoist, searchlight and cargo hook is available for the H145. Together with its inherently versatile cabin layout, the H145 is ready to take on diverse missions; from EMS and private & business aviation passenger transport, to internal and external load transport, law enforcement and offshore transportation.

Figure 11: Airbus H145 helicopter

5.3.2 Advanced glass cockpit

The H145 offers a glass cockpit solution with a highly efficient HMI designed to reduce the pilot workload and increase the flight safety. The avionics system, Helionix, is the latest generation of Airbus avionics family, designed to provide enhanced safety and mission capability along with simplified maintainability. Helionix benefits from the long experience accumulated by Airbus in the development of innovative avionics.

The Helionix Flight Display Subsystem (FDS) is composed of 3 Smart Multifunction Displays (MFD) providing state-of-the-art quality and precision imaging of flight parameters, as well as mission equipment from a moving map functionality to a High Definition (HD) Electro Optical System.

The pilot display offers all the flight, navigation and vehicle relevant data while the remaining displays are configurable for flight, vehicle or mission data. All Active Matrix Liquid Crystal Displays (AMLCD) feature perfect readability from any angle and in any light condition.

With the Helionix suite, the flight crew will experience:

- Enhanced pilot assistance thanks to the most advanced 4-axis digital AFCS with innovative upper modes expanding the aircraft capabilities in particular in low visibility conditions and over water, SAR, for both day and night mission
- Enhanced situation awareness with integrated Helicopter Terrain Awareness and Warning System (H-TAWS), Synthetic Vision System (SVS) and moving map as optional equipment.

- Reduced pilot workload with innovative crew alerting concept such as the one hundred feet alert (required by EASA OPS) and Vehicle Management System (VMS)
- Reduced pilot workload with an intuitive Human Machine Interface (HMI)
- Unrivalled level of redundancy with all functions embedded in each MFD, dual duplex aircraft management computers and 3 Attitude and Heading Reference Sensors (AHRS), plus one Integrated Electronic Stand-by Instrument (IESI)
- Full Usage Monitoring System (UMS) included in the basic Helionix package
- A new concept for enhanced maintainability with user-friendly software management, failure codes recording and troubleshooting algorithm

The unique color coding, warning and information concept helps the pilot/s to collect all relevant parameters while suppressing presentation of non-relevant information. Additionally, the H145's unique First Limit Indicator (FLI) considerably simplifies engine and torque monitoring. The pilot/s workload is minimized thus allowing their attention to be concentrated on the mission. A NVG layout is optionally available.

In addition, the H145 digital avionics initialization procedures and self-test sequences are automatically performed in the background, minimizing the time to become airbone.

With the autopilot, the advanced rate command / attitude and heading hold mode and upper modes significantly enhance the capabilities for flight in Instrument Meteorological Conditions (IMC) and other degraded visual environments (e.g with night vision googles).

Figure 12: H145 Flight Deck

Figure 13: H145 Instrument Panel

Figure 14: H145 Avionics Layout Single / Dual Pilot IFR with Dual GTN 750

5.3.3 Avionics system

H145 is equipped with the following avionics system components: •

- Flight Display Subsystem (FDS) composed of 2 smart multifunction displays (6 x 8 inch) providing the following functions:
    - Flight Navigation Display (FND) format (incl. PFD, FLI, Master list, NAV, RPM, mast moment & fuel indication)
    - Vehicle Monitoring System (VMS) format (incl. engine, gearbox, hydraulic, fuel, electrical system, RPM and clock indication)
- Vehicle Management System (VMS) including:
    - 2 duplex Aircraft Management Computer (AMC)
- Reference sensors:
    - 3 Attitude and Heading Reference Systems (AHRS)
    - 2 Air Data sensors (electrically heated pitot tube and static port)
    - 2 Three Axis Magnetometers (TAM)
- Stand-by instruments:
    - Integrated Electronic Standby Instrument (IESI)
    - Stand-by compass
- Usage Monitoring System (UMS)
- „One hundred feet“ alert

- Directional Gyro Free Steering Mode
- Warning unit:
    - Engine fire warning with fuel emergency shut-off
    - Warning lights
    - Fire extinguishing system warning
- Cockpit Control Panel (CCP) for FDS
- Data Transfer Device (DTD)
- Engine switch panel:
    - Digital engine control (FADEC)
- Radar altimeter

The architecture of the avionics system installed on H145, called Helionix, is as such:

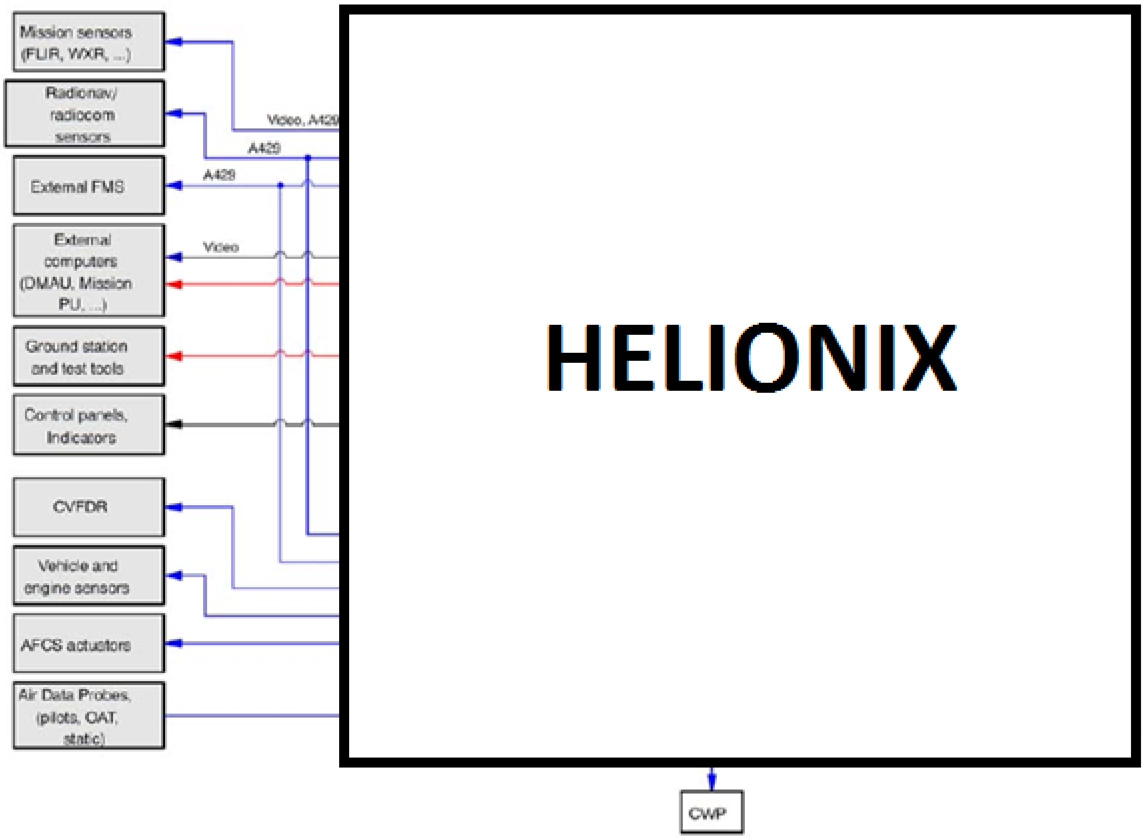

Figure 15: Helionix System architecture

5.3.4 Mission capabilities

The H145 is approved for SPIFR / DPIFR VFR day and night and the following IFR operations:

- RNP APCH down to LNAV (with or w/o SBAS-based advisory vertical guidance)
- RNP APCH down to LP (with or w/o SBAS-based advisory vertical guidance)
- RNP APCH down to LNAV/VNAV (with SBAS-based vertical guidance)
- RNP APCH down to LPV
- RF leg capability

- RNP 0.3
- RNP 1.0
- RNP 2.0
- RNP 4.0
- RNAV 5

5.3.5 Flight test helicopter

The H145 serial helicopter will be put into experimental state. It will be equipped with an experimental navigation database hosting the advanced PinS approach and departure procedures and a FTI recording the flight data for later post flight analysis of the flown trajectory.

The crew will consist of a test pilot and a flight test engineer.

5.3.6 Flight Conditions

All flights will be conducted under VFR in VMC with different weather conditions (wind, rain). Since the advanced PinS procedures are not published and shall be used for experimental flight test only, the flight test validation must be done under VFR in VMC.

6 Assumptions

All flights will be conducted in low traffic density airport then a simulation with high density traffic is required to validate the solution. Additionally Thales will implement an ADS-B traffic display in the HMD in order to increase the situation awareness for the pilot.

7 References and Applicable Documents

7.1 Applicable Documents

Content Integration

[1] B.04.01 D138 EATMA Guidance Material

[2] EATMA Community pages

[3] SESAR ATM Lexicon

Content Development

[4] B4.2 D106 Transition Concept of Operations SESAR 2020

System and Service Development

[5] 08.01.01 D52: SWIM Foundation v2

[6] 08.01.01 D49: SWIM Compliance Criteria

[7] 08.01.03 D47: AIRM v4.1.0

[8] 08.03.10 D45: ISRM Foundation v00.08.00

[9] B.04.03 D102 SESAR Working Method on Services

[10]B.04.03 D128 ADD SESAR1

[11]B.04.05 Common Service Foundation Method

Performance Management

[12]B.04.01 D108 SESAR 2020 Transition Performance Framework

[13]B.04.01 D42 SESAR2020 Transition Validation

[14]B.05 D86 Guidance on KPIs and Data Collection support to SESAR 2020 transition.

[15]16.06.06-D68 Part 1 –SESAR Cost Benefit Analysis – Integrated Model

[16]16.06.06-D51-SESAR_1 Business Case Consolidated_Deliverable-00.01.00 and CBA

[17]Method to assess cost of European ATM improvements and technologies, EUROCONTROL (2014)

[18]ATM Cost Breakdown Structure_ed02_2014

[19]Standard Inputs for EUROCONTROL Cost Benefit Analyses

[20]16.06.06_D26-08 ATM CBA Quality Checklist

[21]16.06.06_D26_04_Guidelines_for_Producing_Benefit_and_Impact_Mechanisms

Validation

[22]03.00 D16 WP3 Engineering methodology

[23]Transition VALS SESAR 2020 - Consolidated deliverable with contribution from Operational Federating Projects

[24]European Operational Concept Validation Methodology (E-OCVM) - 3.0 [February 2010]

System Engineering

[25]SESAR Requirements and V&V guidelines

Safety

[26]SESAR, Safety Reference Material, Edition 4.0, April 2016

[27]SESAR, Guidance to Apply the Safety Reference Material, Edition 3.0, April 2016

[28]SESAR, Final Guidance Material to Execute Proof of Concept, Ed00.04.00, August 2015

[29]SESAR, Resilience Engineering Guidance, May 2016

Human Performance

[30]16.06.05 D 27 HP Reference Material D27

[31]16.04.02 D04 e-HP Repository - Release note

Environment Assessment

[32]SESAR, Environment Reference Material, alias, "Environmental impact assessment as part of the global SESAR validation", Project 16.06.03, Deliverable D26, 2014.

[33]ICAO CAEP – "Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes" document, Doc 10031.

Security

[34]16.06.02 D103 SESAR Security Ref Material Level

[35]16.06.02 D137 Minimum Set of Security Controls (MSSCs).

[36]16.06.02 D131 Security Database Application (CTRL_S)

7.2 Reference Documents

[37]ED-78A GUIDELINES FOR APPROVAL OF THE PROVISION AND USE OF AIR TRAFFIC SERVICES SUPPORTED BY DATA COMMUNICATIONS.[1]

Appendix A Service Description Document (SDD)

This template is the applicable one for SESAR 1 programme and has been approved by the SJU. It has been prepared with the goal of assuring continuity between both programmes and of providing SESAR 2020 projects with a baseline to start with.

PJ.01-06 did not identify any new services, therefore appendix A and B are not applicable for this solution.

A.1 Introduction

A.1.1 Purpose of the document

A.1.2 Intended readership

A.1.3 Glossary of terms

Term	Definition	Source of the definition
Capability	Capability is the ability of one or more of the enterprise's resources to deliver a specified type of effect or a specified course of action to the enterprise stakeholders.	*EATMA Guidance Material*
Capability Configuration	A Capability Configuration is a combination of Roles and Systems configured to provide a Capability derived from operational and/or business need(s) of a stakeholder type.	*EATMA Guidance Material*
Node	A logical entity that performs Activities. Note: nodes are specified independently of any physical realisation.	*EATMA Guidance Material*
Service	The contractual provision of something (a non-physical object), by one, for the use of one or more others. Services involve interactions between providers and consumers, which may be performed in a digital form (data exchanges) or through voice communication or written processes and procedures.	*EATMA Guidance Material*

Service function	A type of activity describing the functionality of a Service.	*EATMA Guidance Material*
Service interface	The mechanism by which a service communicates	*EATMA Guidance Material*

Table 7: Glossary

A.2 Service Identification

Name of the Service	
ID	
Version	
Keywords	
Architect(s)	

Table 8: Service identification (I)

Lifecycle Status	**Date**	**Link**
Identified		
Allocated		
Designed		
Validated		
IOC		
FOC		

Table 9: Service identification (II)

A.3 Operational and Business Context

A.3.1 Information Exchange Requirements

Element Name	**Author**	**Notes**
	Element Tagged Value Name	**Value**
	megaid	
	ref	

	refType	
	Text	
Element Name	**Author**	**Notes**
	Element Tagged Value Name	**Value**
	megaid	
	ref	
	refType	
	Text	

Table 10: Requirements tracing

A.3.2 Other Requirements

1. Non-Functional Requirements

2. Relevant Industrial Standards

3. Nodes

A.4 Service Overview

A.4.1 Service Taxonomy

A.4.2 Service Levels (NfRs)

A.4.3 Service Functions and Capabilities

A.4.4 Service Interfaces

A.5 Service interface specifications

A.5.1 Service XXX Interface YYY Definition

A.6 Service dynamic behaviour

A.6.1 Service Interface YYY

A.6.2 Service Interface ZZZ

A.7 Service provisioning (optional)

A.8 Validation and Verification

A.8.1 Verification

A.8.2 Validation

Appendix B Service Technical Design Document (STDD)

SESAR Technical Service Contract Tem

-END OF DOCUMENT-