Landing operations - Aircraft & System functional requirements

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Abstract: This document is the “Aircraft & System Performance and Functional Requirements” related to Initial 4D function. The objective of this document is to capture the on-board operational needs to perform Initial 4D operations, provide on-board operational and functional requirements required to perform. Initial 4D operations according to SESAR 1 concept description in P05.06.01. This document (D57) is an update of D06 (Aircraft & System Performance and functional requirements) integrating the results from last validation exercises (e.g. EXE-05.03-VP708, EXE-05.03-VP-805) and the last versions of OSED and SPR documents in the frame of SESAR 1. It also encompasses formal traceability with OSED and SPR requirements. It covers requirements for mainline, regional, rotorcraft and military aircraft operations.

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1 Overview

1.1 Introduction

1.1.1 Purpose of the document

The aim of this document is to gather and describe the high level functional requirements for airborne implementation of Initial 4D function, based on operational hypothesis. The reference document used to build this functional description was the P05.06.01 (Ground & Airborne Capabilities to Implement Sequence) Step 1 OSED [12].

It has been updated (previous version was D06) to take into account 05.06.01 Step 1 OSED [12] and SPR [13] Final which have been updated following last Initial 4D validation exercises. Some elements have been updated with the last version of OSED, SPR and Interop performed in the frame of 05.06.01 SESAR project.

This document applies to mainline, regional, military aircraft and rotorcraft. Functional Requirements related to the on-board implementation of Initial 4D function are identified using the following format: REQ-<project number>-TS

1.1.2 Inputs from other projects

This document takes into account the following documents issued in the context of SESAR projects:

• 05.06.01 Step 1 OSED – Final [12] (please note that the final version of 05.06.01 OSED is included in 05.06.01 SPR [13])
• 05.06.01 Step 1 – Fully Validated SPR [13]
• 05.06.01 Step 1 – Fully Validated INTEROP [14]

This document is performing a formal traceability with the requirements provided in the here above mentioned OSED and SPR for requirements which are applicable to this airborne functional specification. Requirements which are relevant to operational procedures are not traced because they are not applicable to functional definition. Indeed, the traceability with the following requirements has not been performed since they are related to the airborne or air/ground procedures and not to system functional requirements:

1. REQ-05.06.01-Step 1SPR IT3-SAF1.0006
2. REQ-05.06.01-Step 1SPR IT3-SAF1.0010
3. REQ-05.06.01-Step 1SPR IT3-SAF1.0024
4. REQ-05.06.01-Step 1SPR IT3-SAF1.0080

1.1.3 Glossary of terms

Information / Medium / Verified

In order to clarify some terms used in this document, some definitions are provided in this section.

Term	Definition
4D Trajectory	A set of consecutive segments linking published waypoints and/or pseudo waypoints computed by air or ground tools (Flight Operations Centre system, aircraft Flight Management

	System, ground Trajectory Predictor) to build the lateral transitions and the vertical profiles. Each point is defined by a longitude, latitude, a level and a time.
ADS-C	Automatic Dependent Surveillance-Contract – A means by which the terms of an ADS-C agreement will be exchanged between the ground system and the aircraft, via a data link, specifying under what conditions ADS-C reports would be initiated, and what data would be contained in the reports.
AMAN	Arrival Managed – A planning system to improve arrival flows at one or more airports by calculating the optimised approach / landing sequence and Target Landing Times (TLDT) and, where needed, times for specific fixes for each flight, taking multiple constraints and preferences into account.
ASAS	Airborne Separation Assistance System – An aircraft system that enables the flight crew to maintain separation of their aircraft from one or more aircraft, and provides flight information concerning surrounding traffic.
ASAS S&M	ASAS Sequencing & Merging – An ASAS application that enables flight cre to maintain their position in a sequence previously determined by a controller or to merge their routes onto a single, predefined, route.

2 General Functional Block Description

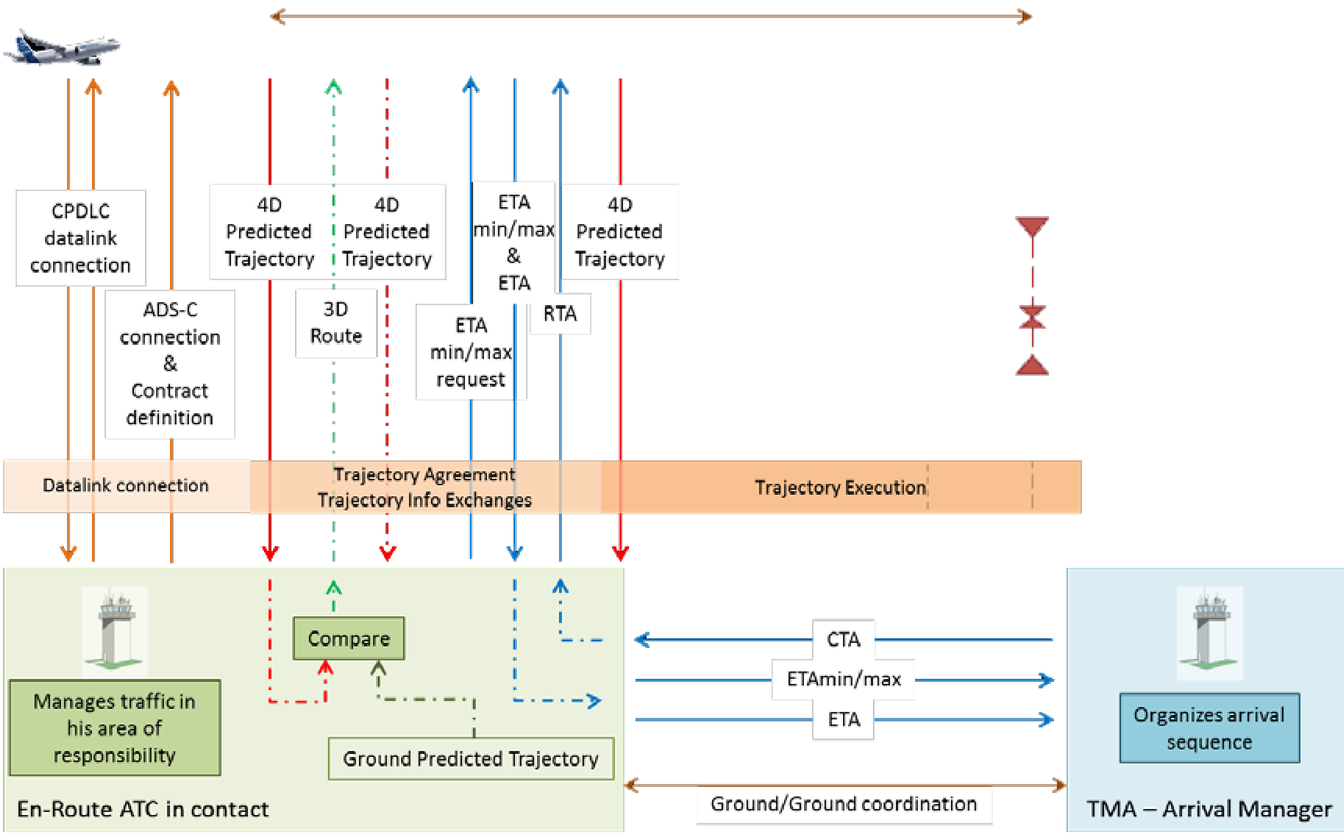
2.1 Context

The Initial 4D function (i4D) provides ATM sector with the capability to monitor aircraft predictions of its trajectory in 4D (i.e. space and time) and to issue time constraint, covering the first part of the Trajectory Based Operations (TBO) concept.

2.2 Controlled Time Arrival (CTA) concept

Functional Requirement / High / Proposed

This airborne document is dealing with the CTA concept as applied with Initial 4D aircraft while CTA concept, as described in P05.06.01 OSED [12], is more widely defined as a time constraint potentially issued to an aircraft with different capabilities (Initial 4D or Basic CTA).



When using Controlled Time of Arrival, ATC shall perform trajectory synchronization when appropriate as a prerequisite for analyzing estimated times and up-linking a time constraint if possible.

This airborne capability aims at supporting several evolutions in the traffic management method explored in the frame of SESAR research projects, such as CTA (Controlled Time of Arrival) which consists in issuing a time constraint in descent while the aircraft is still in cruise (at least 5 to 10 minutes from Top of Descent). The aircraft can then manage its own speed to the constrained waypoint. The on-board function, allowing the crew to comply with the CTA issued by the ground is called RTA (Required Time of Arrival). Thus, in this document, the same time constraint can be either called CTA (when considered from the ground point of view) or RTA (when considered from the airborne side).

Blocks		
blocks	6.4	Airborne Dependent Surveillance – Contract (ADS-C)

Relates		
relates to	4.1.1.3	Reliable RTA interval computation
relates to	4.1.1.1	Time Prediction
relates to	5.1.1.3	Time estimates accuracy

2.3 3D trajectory (lateral and vertical flight plan)

Functional Requirement / High / Proposed

3D trajectory (lateral and vertical flight plan) synchronization is performed during the execution phase through datalink exchanges between the Airspace User (AU) and the ATC in contact. The 4D trajectory consisting in a lateral route, altitude/speed constraints and estimated times of route waypoints sequencing is then updated by the FMS. If relevant, ATC can request the AU to meet a time constraint over a waypoint of the trajectory, within the reliable time window provided by the aircraft.

In order to issue the time constraint, a ground/ground coordination might be necessary between the ATC in contact (in En-Route airspace), the Arrival Manager (in the TMA airspace) who is in charge of organizing the arrival sequence at the destination airport and with any downstream ATC sector that will be overflew by the aircraft.

After the negotiation process, the AU agrees to fly the trajectory and the ATC agrees to facilitate the trajectory (subject to separation provision). During the execution of the optimized trajectory, conformance to the agreed 4D trajectory is monitored by both the flight crew and the ATC. The predicted 4D trajectory is continuously computed on board and downlinked to the ATC based on ADS-C contract request by the ATC.

3 Major Operational Capabilities

3.1 Operational Scenarios

Capability / Highest / Verified

Initial 4D operational scenarios are described in the following steps

3.1.1 ADSC connection established

Scenario / High / Verified

The ATC centers can initiate an ADS-C connection with the aircraft. Upon the first ADS-C connection, the crew is informed and should be aware that the airborne computed trajectory might be downlinked to the ATC (either for an i4D operation or for any other application using the aircraft 4D trajectory).

Wind and temperature data: weather forecast shall be inserted in the aircraft in order to ensure accuracy of RTA and 4D trajectory. If deemed necessary by the crew, the wind and temperature data can be updated through FOC or entered manually by the flight crew during the flight.

> Note:
>
> The FMS meteorological model has been enhanced to guarantee the time constraint reliability in the specified interval. Up to date wind and temperature data (10 levels of wind and temperature data along the descent) are necessary to perform an i4D operation with the required level of accuracy. It is crew responsibility to maintain wind and temperature FMS data up to date in order to provide ATC with reliable trajectory information.

3.1.2 CPDLC datalink established

Scenario / High / Verified

Once a CPDLC datalink connection has been established between the aircraft and the ATC in contact, the crew and the controller can communicate through CPDLC messages.

> *Note:*
>
> *Unlike ADS-C contract, only one CPDLC connection is possible at a time between the aircraft and its ATC in contact.*

Blocks		
blocks	4.1.1.4	Controller-Pilot Datalink Communication (CPDLC)
blocks	4.1.1.6	Datalink (FOC) capability to uplink wind and temperature data
Relates		
relates to	5.1	Initial 4D Functional Requirements
relates to	5.1.1.2	Computation of Reliable ETAmin and Reliable ETAmax

3.1.3 Traffic Control establishes an ADS-C contract

Scenario / Highest / Verified

ATC establishes an ADS-C contract with the aircraft and requests the downlink of an EPP (Extended Projected Profile) report (demand, periodic or event) as defined in EUROCAE ED228 [8] document.

> *Notes:*
>
> *The ADS-C application is designed to provide automatic reports from an aircraft to an ATC ground system. The ATC specifies ADS-C contract type (on demand, periodic, or triggered by an event) he needs to establish with the aircraft.*
>
> *The Extended Projected Profile (EPP) provides to the ground the 4D trajectory (3D route + Estimated Time of Arrival for all the waypoints included in the EPP) and other information (flight modes, speed scheduled,...).*

The EPP report is based on the predictions computed by the FMS:

- *It includes some general data not associated to waypoints*
- *It includes a list of up to 128 points of significance for the construction of the lateral and vertical trajectory.*
- *The points are reported in the order the A/C will sequence them.*

- *Only the points ahead of the A/C are reported*
- *Waypoints are not only F-PLN waypoints, also other relevant points computed by the FMS.*

An EPP report may contain a maximum number of 128 waypoints.

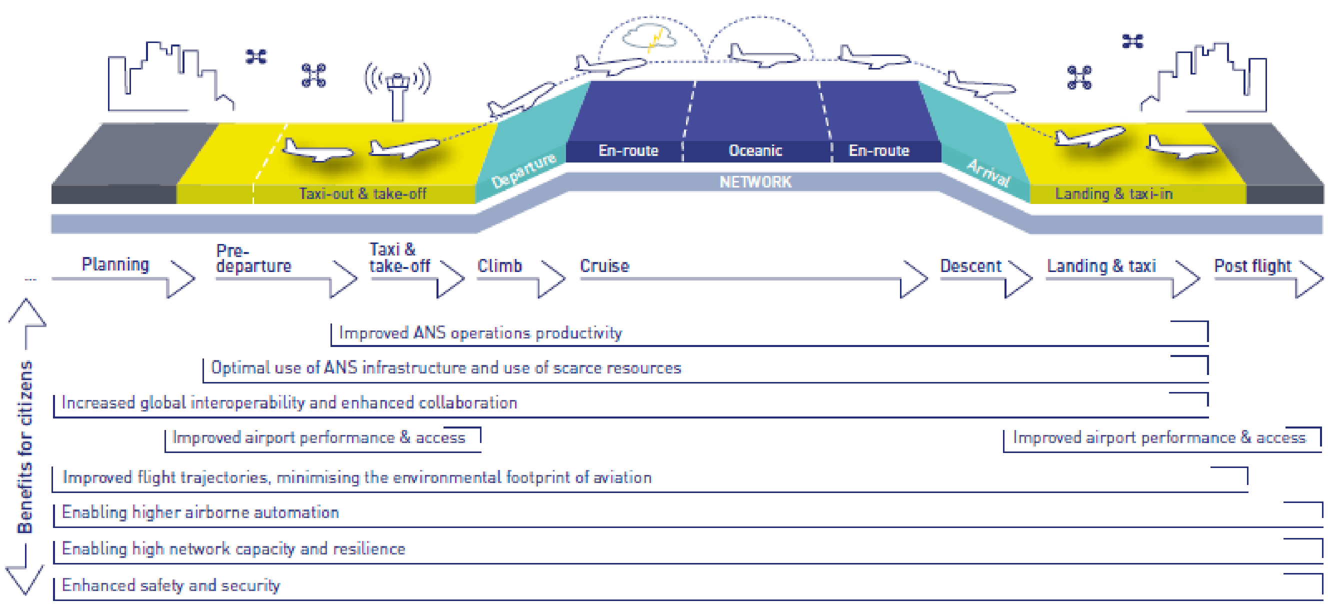
Blocks		
blocks	6.5	Flight Operation Centre (FOC) capability

3.1.4 Aircraft's current trajectory is not consistent

Scenario / High / Verified

If the current trajectory of the aircraft is not consistent with the trajectory expected by the ground or planned by the ground for it, ATC may elect to either accept the FMS trajectory or ATC may uplink a required route to the aircraft. The uplinked route may also contain speed/vertical elements.

FIGURE 3. IMPROVEMENTS AT EVERY STAGE OF THE FLIGHT



Blocks		
blocks	5.1.1.3	Time estimates accuracy
Relates		
relates to	4.1.1.3	Reliable RTA interval computation

3.1.5 Flight crew updates the ACTIVE flight plan

Scenario / High / Verified

Flight crew complies with the uplinked 3D route clearance and updates the ACTIVE flight plan accordingly.
The flight crew acknowledges the 3D route uplink message with a *"WILCO"* answer.

An automatic downlink of 4D trajectory via ADS-C *“EPP report”* is triggered automatically after the flight plan update (on event ADS-C EPP report) or upon reception of an ATC request (ondemand ADS-C EPP report).

> *Note:*
> *The flight crew may respond to the 3D clearance by “STANDBY” before sending “WILCO” in order to have more time to analyze the 3D route clearance.*

3.1.6 Arrival airport is equipped with an Arrival Manager

Scenario / High / Verified

If the arrival airport is equipped with an Arrival Manager using time constraints to tune and organize the sequence of the arrival flights, a CTA (Controlled Time of Arrival) may be issued to the aircraft. To issue this CTA, in the case of Initial 4D aircraft, the Arrival Manager has at his disposal the following information on the waypoint of interest:

- The ETAmin/max interval, transmitted by the aircraft through an ADS-C on
  demand downlink “ETAmin/max report”,
- The ETA (Estimated Time of Arrival), transmitted by the aircraft through an ADSC EPP report including the waypoint of interest, from the active flight plan.

> *Note:*
> *The "ETAmin/max interval" is displayed to the crew on the RTA page, associated to flight plan waypoints, and is considered as the "RTA reliable interval" and thus both wordings might be used in this document. The RTA interval reliability is guaranteed only within the limit of the Initial 4D horizon defined in the DO-236C Change 1 [9] and detailed in section 2.1.*

4 Functional Capabilities

4.1 Functional decomposition

Capability / High / Verified

Initial 4D function is related to both navigation and communication enhancements allowing the aircraft to operate in future ATM 4D operations (in support of Initial 4D ATM operational concept - horizon 2018-2020).

From an operational point of view, the Initial 4D function supports the following:

- 3D route synchronization and time constraint (on a single waypoint at a time) agreement: Pilot/Controller agreement (via CPDLC) on the 4D trajectory to be flown (lateral route and any associated constraints (altitude/speed/time)).
- Project Number 09.01._ Edition 01.01.00 D57 - Aircraft & System Performance and functional requirements 16 of 55 ©SESAR JOINT UNDERTAKING, 2016. Created by Airbus for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged
- 4D trajectory execution: the on-board system is able to fly the negotiated 4D trajectory with sufficient accuracy (especially regarding RTA).
- 4D trajectory monitoring: crew has the capability to monitor the 4D trajectory including a time constraint.
- 4D trajectory downlink (via ADS-C): the on-board system is able to automatically send to the ground the 4D trajectory based on the contract established with the ATC center.
- Wind and temperature data: Datalink capability for updating wind and temperature data via FOC From an A/C capabilities point of view, in addition to its basic 3D navigation capabilities, Initial 4D requires:

NAVIGATION:

- Time Prediction (flight planning: computation of accurate and reliable time estimates)
- Guidance
- Time Guidance Monitoring
- Reliable RTA interval computation

COMMUNICATION:

- Controller-Pilot Datalink Communication (CPDLC)
- Prediction Reporting (ADS-C)
- Datalink (FOC) capability to uplink wind and temperature data

4.1.1 Functional analysis

Capability / Highest / Verified

This section describes briefly the functions performed by Initial 4D functions.

4.1.1.1 Time Prediction

Capability / Highest / Verified

A basic RTA function is already available on some aircraft types.. However, the Initial 4D concept requires some improvements in the basic RTA function in order to ensure the required level of time reliability and accuracy, not available in current FMS standards:

- Introduction of an accuracy function which allows defining a required accuracy on an RTA in the flight plan, either before or after the RTA has been defined. Only two values can be chosen into the FMS, either manually or through the load functionality: +/10s and +/-30s. A default value will be set automatically by the FMS to +/ 30s.

- Enhanced RTA algorithm, such that when inserted into the FMS within ETAmin/max interval, the RTA will be satisfied, considering its required accuracy in 95% of the cases. The FMS takes enough margins on predicted speed profile taking into account several sources of errors, the most relevant one being the wind/temperature error, based on an improved weather model which includes 10 levels of wind and temperature data. The FMS RTA algorithm will respect any altitude and speed restrictions for RTA speed computation. It also provides pilots with the possibility to modify the maximum allowable speed.
- RTA page HMI such as the Reliable RTA interval, RTA and ETA values are displayed on the RTA page. The FMS displays and allows to manually modify the “RTA Required Accuracy” parameter in the RTA page.

Blocks		
blocks	8.3	Military – Time of arrival in a TMA
blocks	8.3.1	Military – CTA negotiation
blocks	8.2.1	Military – Multiple Controlled Time Over
Relates		
relates to	4.1.1.5	Prediction Reporting (ADS-C)
relates to	2.2	Controlled Time Arrival (CTA) concept

4.1.1.2 Guidance

Capability / Highest / Verified

If the aircraft is in managed mode and an RTA is active, the Guidance Function consists, on top of basically guiding the aircraft along its 3D flight plan, in guiding the aircraft according to the predicted speed profile computed by the FMS to cross the specified waypoint at the specified time.

4.1.1.3 Reliable RTA interval computation

Capability / Highest / Verified

In order to support the time constraint agreement operation between flight crew and ATC, the FMS computes reliable minimum and maximum crossing time values (ETAmin/ETAmax) for any waypoint (on which a RTA can be defined), which are the reliable ETA assuming the aircraft flies respectively at its maximum/minimum allowed speed taking into account some margins. The pilots will use the reliable RTA interval to assess whether or not the time constraint uplinked by the ATC is acceptable.

The FMS computes:

- The reliable ETAmin by using the maximum allowable RTA speed schedule
- The reliable ETAmax by using the minimum allowable RTA speed schedule

The FMS has to ensure that an RTA defined within reliable RTA interval will be met on a 95% probability basis. Thus it computes the RTA reliable interval taking into account wind and temperature uncertainties and any altitude and speed restrictions inserted in the flight plan. The RTA reliable interval displayed to the crew is thus taking into account some margins.

Blocks		
blocks	5.1.1.3	Time estimates accuracy

Relates		
relates to	3.1.4	Aircraft's current trajectory is not consistent
relates to	2.2	Controlled Time Arrival (CTA) concept

4.1.1.4 Controller-Pilot Datalink Communication (CPDLC)

Capability / Highest / Verified

In the context of Initial 4D, the CPDLC application is used by the controller to send dedicated clearances.

A minimum set of uplink messages (UMs), selected from the complete list of messages implemented by the FANS function, has been defined in order to perform Initial 4D operations. These messages allow the ATC to uplink time, altitude and speed constraints as well as route clearance.

The crew will be able to answer the ATC instructions with downlink messages (DMs) through a dedicated interface: the DCDU (Datalink Control and Display Unit). The flight crew may select the appropriate answer on the DCDU and as soon as they confirm the choice by pressing the SEND key, the appropriate DM will be downlinked to the ATC as response to the previous uplink.

In order to facilitate the CPDLC management by the crew, a “LOAD” functionality from the ATSU to the relevant FMS page has been developed in the frame of the FANS function. Some of the Initial 4D uplink messages are loadable into the FMS’s flight plan. A dedicated key exists on the DCDU to inform the flight crew that the message is loadable and perform the corresponding action. This functionality aims to avoid the human errors which may arise if the crew had to manually insert the potentially complex instruction into the FMS. However, validating and activating the data loaded into the FMS remains the pilots’ responsibility after having performed the appropriate assessment.

Blocks		
is blocked by	3.1.2	CPDLC datalink established

4.1.1.5 Prediction Reporting (ADS-C)

Capability / Highest / Verified

In the context of Initial 4D operation, the ADS-C application supports downlinking several reports to the ATC.

There are three types of ADS-C reports:

- On demand report: provide the capability for a ground system to request a single ADS-C report from an aircraft and to specify which information the system should include in the report (as defined in the corresponding standard (ref [8])).

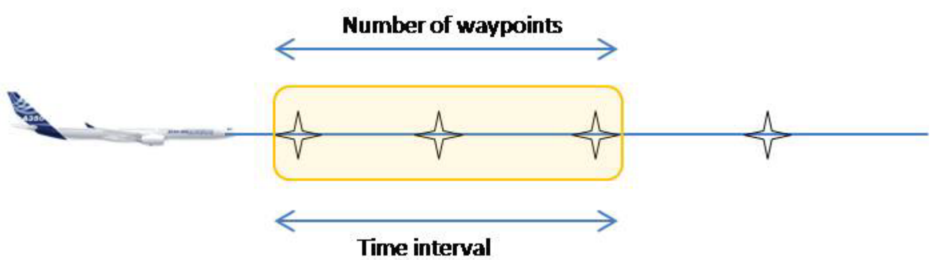
- Periodic report: provide the capability for a ground system to request a periodic ADS-C report from an aircraft and specify which information the system should include in the report (as defined in the corresponding standard (ref [8])) and the rate at which the information is required.
- On event report: allow the ground system to request the avionics to send ADS-C reports when a specified event occurs. The ATC defines the type of events to be monitored.

Each ADS-C report is made of several groups of data, either mandatory or optional.

The initial 4D function supports the following groups:

- Basic group – mandatory
- EPP group – optional
- TOA Range group (ETAmin/max) – optional
- RTA Status group – optional

> *When setting an ADS-C contract for the EPP group, an "EPP reporting window" is defined by the ATC. Data related to the waypoints (up to 128) included into this window will be downlinked. The reporting window can be defined by a time interval or a number of waypoints.*



Relates		
relates to	4.1.1.1	Time Prediction

4.1.1.6 Datalink (FOC) capability to uplink wind and temperature data

Capability / Medium / Verified

Initial 4D function guarantees that the systems will be able to deliver the aircraft at any waypoint in enroute or descent at a given time, provided it is selected from appropriate reliable RTA interval +/- 10s or +/- 30s with a probability of 95%. Thus, the errors linked to the wind and temperature data had to be mitigated and an enhanced wind/temp model is used on board to handle the wind and temperature data:

The Initial 4D function minimizes the discrepancies between FMS-defined wind/temp profile (based on forecast wind and temperature data) and actual wind/temp profile by refining FMS descent wind and temperature modelling.

The FMS takes into account:

- Up to 10 forecast descent winds in active flight plan in order to compute the corresponding descent wind profile.
- Up to 10 forecast descent temperatures in active flight plan in order to compute the corresponding descent temperature profile.

> *Forecast wind and temperatures are entered using the FMS capability to request enhanced Wind/temp data through FOC. It is the crew responsibility to ensure that the Wind/temp data used by the FMS to compute the predicted 4D trajectory are as up to date as possible, in order to ensure an accurate predicted 4D trajectory.*

Blocks		
is blocked by	3.1.2	CPDLC datalink established

5 Functional and non-Functional Requirements

5.1 Initial 4D Functional Requirements

Functional Requirement / High / Proposed

You will find here below the functional requirements linked to the Initial 4D function for civil aircraft (mainline and regional), military aircraft and rotorcraft.

These requirements are lined to the 05.06.01 OSED and SPR document [13] and, in addition, an appendix A is dedicated to rotorcraft operational requirements not contained in any OSED or SPR documents and raised during P04.10 project activities.

The validation of the requirements (defined here below considered as “validated”) corresponds to the following Technology Readiness Levels (TRLs):

- TRL3 ‘Analytical and experimental critical function and/or characteristic proof of concept’ for requirements linked to 04.10 project.
- TRL4 ‘Component/subsystem validation in laboratory environment’ for requirements linked to 09.03 project.
- TRL6 ‘System/subsystem model or prototyping demonstration in a relevant end-to-end environment (ground or space)’ for requirements linked to 09.01 project.

> Moreover, some requirements are considered as validated in the frame of 09.01, 09.03 and/or 04.10 projects; however, additional activities should be considered in order to validate the official release of datalink standardisation document [8].

Relates		
relates to	3.1.2	CPDLC datalink established

5.1.1 Navigation Requirements

Functional Requirement / Highest / Verified

5.1.1.1 RTA function

Functional Requirement / High / Proposed

Initial 4D function shall provide the capability to define an RTA constraint on any waypoint (except pseudo waypoint and FMS computed waypoint).

Rationale:

RTA function is expected to provide operational benefit in all flight phase of a flight. Initial 4D function does not support multi-RTA operations. RTA can be defined in FMS active, temporary (TMPY) and any secondary (SEC) flight plan (FMS offers capability to have 1 RTA defined in active flight plan and 1 RTA defined in each TMPY and SEC flight plan at the same time).

5.1.1.2 Computation of Reliable ETAmin and Reliable ETAmax

Non-functional Requirement / Medium / Verified

Initial 4D function shall include the capability to compute reliable ETAmin and ETAmax values for any flight plan waypoint eligible for an RTA.

Rationale:

Reliable ETAmin and reliable ETAmax values represent the lower and the upper bound of the reliable RTA interval respectively and will be used in support of RTA negotiation with ATC controller. Reliable RTA interval is computed for all flight plan waypoints where an RTA can be defined. Only one reliable RTA interval is displayed on-board the aircraft and downlinked to the ground at a time.

Relates		
relates to	3.1.2	CPDLC datalink established

5.1.1.3 Time estimates accuracy

Non-functional Requirement / High / Verified

Initial 4D function shall provide the capability to compute time estimates for any flight plan waypoint eligible for RTA with a resolution of one second.

Rationale:

The predicted 4D trajectory downlinked to ATC will include ETA for all flight plan waypoint with a resolution of 1s. According to current navigation system design, ETA for RTA constrained waypoint is already computed and displayed on RTA page with a resolution of 1s.

Blocks		
is blocked by	4.1.1.3	Reliable RTA interval computation
is blocked by	3.1.4	Aircraft's current trajectory is not consistent

Relates		
relates to	2.2	Controlled Time Arrival (CTA) concept

6 Communication Requirements

6.1 Typical Data Link System architecture for regional aircraft

(i.e. different exchanges with FMS, limited CPDLC, ADS-C and FOC functionalities). CPDLC and ADS-C requirements are based on WG78/SC214 SPR ver. H [7].Communication requirements are analysed in further detail in P09.01 D58 “Interface requirements between the aircraft and the ATC systems” [11].

6.2 Datalink capability availability

Functional Requirement / High / Proposed

Initial 4D function features communication exchanges with ATC via CPDLC and downlink of both 4D trajectory and reliable ETAmin/ ETAmax values via ADS-C.

This requirement is considered as validated in the frame of 09.01 and 09.03 projects; however, additional activities should be considered in order to validate the official release of datalink standardisation document [8].

6.3 Controller Pilot DataLink

Functional Requirement / High / Verified

As a general requirement, the management of all Initial 4D CPDLC messages shall comply with general requirements related to FANS C function.

Rationale:

This is to ensure compatibility between different Airbus functions. Applicable to Airbus aircraft only.

FANS C: Airbus function which manages datalink communication in European continental airspace.

This requirement is considered as validated in the frame of 09.01 project; however, additional activities should be considered in order to validate the official release of datalink standardisation document [8].

6.4 Airborne Dependent Surveillance – Contract (ADS-C)

Functional Requirement / High / Verified

The management of “EPP” ADS-C request and report shall not require dedicated flight crew actions.

This is to minimize flight crew workload. In accordance with current ADS-C functions implementation. This requirement is considered as validated in the frame of 09.01 and 04.10 projects; however, additional activities should be considered in order to validate the official release of datalink standardisation document [8].

Blocks		
is blocked by	2.2	Controlled Time Arrival (CTA) concept

6.5 Flight Operation Centre (FOC) capability

Functional Requirement / High / Verified

The Initial 4D function shall have the capability to uplink wind and temperature data via FOC datalink.

Rationale:

Accuracy and time control authority needs to be fed with up-to-date external data. This requirement requires the availability of MET data uplink request. MET data will be provided to the A/C through FOC. Data for increased number of levels are necessary to ensure sufficient accuracy of time estimates and reliability of operation. Temperature data is included in ARINC 702A-4 [16].

Blocks		
is blocked by	3.1.3	Traffic Control establishes an ADS-C contract

7 Human Machine Interface Requirements

7.1 Required Time of Arrival and Reliable RTA computation

Functional Requirement / Medium / Proposed

Current ETA and reliable RTA interval shall be available for display to the flight crew for any waypoint at which an RTA can be defined prior to actually entering an RTA at this waypoint.

This will allow flight crew to make the system compute reliable RTA interval for any waypoint in support of RTA value negotiation with ATC without having to effectively define a RTA on this waypoint. This means that, in accordance with current FMS design (for ETA only), the current ETA and reliable RTA interval(reliable ETAmin/reliable ETAmax) values shall be computed and displayed to the flight crew as soon as the RTA waypoint identifier is defined on the RTA page.

The ETA and reliable RTA interval is displayed only for one waypoint at a time. Display of reliable RTA interval on regional A/C still needs to be evaluated due to limited MCDU evolution.

7.2 Controller Pilot DataLink

Functional Requirement / High / Under Specification

General mechanization of CPDLC messages (and associated downlinks) should minimize associated flight crew workload.

Rationale:

Initial 4D and any associated messaging needs to have minimum impact on flight crew workload. The use of automatic upload of received clearances should be considered whenever possible. Loadable CPDLC messages are listed in interoperability P09.01 SESAR document D58 [11]. This requirement is a design objective and can be implemented independently from the other requirements. This requirement is considered as validated in the frame of 09.01 and 04.10 projects; however, additional activities should be considered in order to validate the official release of datalink standardisation document [8].

7.3 Automatic Dependent Surveillance-Contract

Functional Requirement / High / Verified

EPP transparency for Flight Crew Status

The management of “EPP” ADS-C request and report shall not require dedicated flight crew actions.

Rationale:

This is to minimize flight crew workload. In accordance with current ADS-C functions implementation. This requirement is considered as validated in the frame of 09.01 and 04.10 projects; however, additional activities should be considered in order to validate the official release of datalink standardisation document [8].

8 Military Functional Requirements

8.1 Military aircraft, transport and/or fighter capabilities

The requirements listed below are applicable to Military aircraft, transport and/or fighter. By default when no precision is provided in the field <ALLOCATED_TO> | <PROJECT> (i.e. P09.03 indicated), it means that the requirement is applicable to both transport and fighter

8.2 Military – RTA communication

Functional Requirement / Highest / Under Specification

As a general requirement in STEP 1 communication related to RTA function should not be managed by using datalink applications but by using voice communication.

By consulting Military Datalink Interoperability roadmap it is possible to see that datalink applications will be available on STEP 2.

8.2.1 Military – Multiple Controlled Time Over Functional Requirement / Highest / Under Specification

Two different single time constraints (CTO) shall be used in order to manage the entry and the exit of military aircraft to a TRA/TSA.

The entry in a TRA/TSA and the exit from the TRA/TSA shall be managed by using CTO in order to maximize civil-military interoperability.

Blocks		
is blocked by	4.1.1.1	Time Prediction

8.2.2 Military – TRA/TSA entry and exit waypoints definition Functional Requirement / Highest / Under Specification

3D coordinates (latitude, longitude and altitude) of the entry waypoint and exit waypoint of the TRA/TSA shall be defined and agreed with ATC during mission planning phase.

On a transport-type aircraft the pilot will have access to the navigation database via MCDU and he will plan the route by selecting agreed entry and exit waypoint of TRA/TSA.

On a fighter aircraft the pilot will have access to the planned routes loaded on ground in the Mission Computer via the MPS. Fighter planned route will already involve and entry and an exit waypoint of the TRA/TSA.

8.3 Military – Time of arrival in a TMA Functional Requirement / Highest / Verified

A single time constraint (CTA) should be used in order to manage the arrival of a military aircraft in a busy TMA.

Transport-type aircraft could have the necessity to have access to airports concerning busy TMAs. In this case the aircraft should have means in order to
allow ATC managing the arrival by using a CTA.

Blocks		
is blocked by	4.1.1.1	Time Prediction

8.3.1 Military – CTA negotiation Functional Requirement / Highest / Under Specification

CTA shall be negotiated with ATC via voice communication when the aircraft is in the AMAN horizon.

Negotiation inside the AMAN horizon is in conformance with civil RTA functionality

Blocks

is blocked by	4.1.1.1	Time Prediction

8.3.2 Military – RTA speed information display

Functional Requirement / Highest / Proposed

The speed commanded by the DA/FD to FCS shall be available for display to the crew when the RTA function is engaged.

Need for DA/FD commanded IAS display on flight crew primary field of view is considered crucial in order to allow the pilot monitoring the RTA function and identify possible failures or bad functioning.

8.3.3 The pilot need to know if the RTA function is active or not

8.3.4 Military – Active RTA function indication to the crew

Functional Requirement / Highest / Verified

A label indicating that the RTA function is active shall be available for display to the crew while the RTA function is engaged.

9 Rotorcraft Functional Requirements

9.1 Weather resilience

Functional Requirement / Highest / Verified

The onboard avionic system shall be capable of processing the wind direction/speed and temperature received from the MET provider during the flight at a periodic update rate, in order to re-estimate the ETA in case of evolution of the weather situation along the trajectory.

Rotorcrafts are sensitive (much more than airlines) to the wind and temperature on the trajectory, in such a way that the ETA window may no longer be reachable when these conditions change during the flight.

9.2 Vertical profile adaptation to comply with CTA

Functional Requirement / Highest / Proposed

The ground system should be capable of processing an alternative proposal in case of rotorcraft inability to comply with CTA. An alternative 3D trajectory should be proposed to the rotorcraft before declaration of missed CTA.

Thanks to rotorcraft climb/descent/speed performance, it could be possible to propose another vertical path to join the FATO (rotorcraft can descent at high vertical speed). If this alternate procedure is not available, a new time window will be defined with reference to the merging point determined for the rotorcraft trajectory.

10 Safety Requirements

10.1 Safety Req. memo

The safety requirements below are extracted from the P05.06.01 SPR [13].

10.2 Probability of FMA failing to detect and alert on unachievable RTA

Functional Requirement / Highest / Verified

The probability of FMS failing to detect and alert on unachievable RTA shall not exceed 2.0E-04 per Flight Hour.

Rationale:

Extracted from P05.06.01 SPR [13].

No quantitative analysis has been performed in the scope of P09.01 project to demonstrate the probability defined in SPR. Further analysis must be performed to verify that the aircraft definition and implementation is in line with this requirement.

10.3 Probability of non-detection by aircraft monitoring of RTA un-achievability

Functional Requirement / Highest / Verified

The probability of non-detection by aircraft monitoring of RTA un-achievability shall not exceed 2.0E-04 per Flight Hour.

Extracted from P05.06.01 SPR [13].

No quantitative analysis has been performed in the scope of P09.01 project to demonstrate the probability defined in SPR. Further analysis must be performed to verify that the aircraft definition and implementation is in line with this requirement.

10.4 Probability that an RTA becomes not met due to aircraft failures

Functional Requirement / Highest / Proposed

The probability that an RTA becomes not met due to aircraft failures shall not exceed 1.0E-03 per Flight Hour.

Extracted from P05.06.01 SPR [13].

No quantitative analysis has been performed in the scope of P09.01 project to demonstrate the probability defined in SPR. Further analysis must be performed to verify that the aircraft definition and implementation is in line with this requirement.

10.5 Probability of erroneous EPP message downlink

Functional Requirement / Highest / Verified

The probability of erroneous EPP message downlink shall not exceed 1.3E-04 per Flight Hour.

Extracted from P05.06.01 SPR [13].

No quantitative analysis has been performed in the scope of P09.01 project to demonstrate the probability defined in SPR. Further analysis must be performed to verify that the aircraft definition and implementation is in line with this requirement.

11 END OF DOCUMENT