D11 – GROUND SYSTEM REQUIREMENTS

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Table of Contents

List of Figures

List of Tables

LIST of ACRONYMS

ACC	Area Control Centre
ADS	Automatic Depended Surveillance
ADSB	ADS Broadcast
AEP	Aeronautical & Environmental data Processing
AFAS	Aircraft in the Future Air Traffic Management System
AIP	Aeronautical Information Publication
AIRAC	Monthly Aeronautical Information Update Sheet
AIS	Aeronautical Information Service
AMAN	Arrival Manager
ANM	ATFM Notification Message
AO	Airline Operator
API	Application Programming Interface
APL	AOC Flight Plan
AOC	Airline Operations Centre
ASAS	Airplane Separation Assurance System
ASD	Air Traffic Situational Display
ASE	Application Service Element
ATC	Air Traffic Control
ATCC	Air Traffic Control Centre
ATFM	Air Traffic Flow Management
ATIS	Automatic Terminal Information Services
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
AVENUE	An ATM Validation Environment for Use towards EATMS
CDM	Cooperative Decision Making
CDTI	Cockpit Display of Traffic Information
CDR	Conditional Routes
CD&R	Conflict Detection and Resolution
CFMU	Central Flow Management Unit
CIS	Co-operative Independent Surveillance
CM	Context Management
CMU	Communication Management Unit
CNS	Communication, Navigation and Surveillance
COSEP	CO-operative SEParation
CPDLC	Controller Pilot Data Link Communications
CTOT	Calculated Time of take-Off
DFIS	Datalink Flight Information Service
DGNSS	Differential GNSS
DLIC	Data Link Initiation Capability
DLL	Data Link Logon
DMAN	Departure Manager
DOP	Daily Operational Plan
DYNAV	Dynamic Route Availability
EAT	Experimental And Trial platform
EATCHIP	European ATC Harmonization and Integration Programme
EATMS	European ATM System
ECAC	European Civil Aviation Conference
EDPD	Environmental Data Processing and Distribution
EEC	Eurocontrol Experimental Centre
EOBT	Estimated Off Block Time
ETD	Estimated Time of Departure
FARADEX	Functional Architecture Reference for ATM Systems and Data Exchange
FARAWAY	Fusion of ADS-B and Radar Data through 2 WAY data link
FAS	Final Approach Segment

FD	Functional Decomposition
FDP	Flight Data Processing
FFAS	Free Flight Air Space
FI	Function Information
FIS	Flight Information Service
FLIPCY	Flight Plan Consistency Check
FMS	Flight Management System
FPL	Flight Plan
FUA	Flexible Use of Airspace
GACS	Generic ATN Communication Service
GBAS	Ground Based Augmentation System
GNSS	Global Navigation Satellite System
GRAS	Ground based Regional Augmentation System
HMI	Human Machine Interface
IFPL	Initial Flight Plan
LADD	Local Area Data Distribution
MA-AFAS	More Autonomous Aircraft in the Future ATM System
MAS	Managed Air Space
MD	MacDonald Douglas
MSP	Multi Sector Planning
NEAN	North European ADS-B Network
NOTAM	Notice To AirMan
NUP	NEAN Upgrade Program
OC	Operational Concept
OCD	Operational Concept Document
ODIAC	Operational Development of Initial Air/ground data Communications
OMT	Object Modelling Technique
PA	Precision Approach
PIB	Pilot Information Briefing
SAR	Search And Rescue
SATCOM	SATellite COMmunication
SAU	Stand Allocation Unit
SDM	Surveillance Data Management
SDPS	Surveillance Data Processing System
SIGMET	Significant Meteorological Information
SMGCS	Surface Movement Guidance and Control System
SoI	System of Interest
SPL	System Flight Plan
SSR	Secondary Surveillance Radar
STDMA	Self-organising Time Division Multiple Access
TIS-B	Traffic Information Service Broadcast
VDL	VHF Digital Link
WADD	Wide Area Data Distribution

1 Introduction

1.1 Purpose and Scope

This document is the deliverable D11 – Ground System Requirements – produced by the MA-AFAS Consortium within the scope of Work Package 1.2.1.
The purposes of this document are the following.

1. To capture the relevant high-level requirements for the MA-AFAS ATM Ground System coming from overall Operational Concept described in the deliverable D9 (ref. [1]) and the airborne functions indicated in D13 (ref. [3]).
2. To provide a functional architecture for the MA-AFAS ATM Ground System. The functional architecture is defined in terms of major functional areas in which the system is partitioned. Each functional area is then decomposed into simpler functions, each of which processes specific information.

   The ATM Ground System identified through this functional model will constitute a reference system and will be consistent with the elements of the MA-AFAS Operational Concept. In deriving the functional model, the approach and the achievement of the FARADEX project are taken into account. FARADEX developed a comprehensive reference functional architecture for the European ATM in the 2005-2010 timeframe, considering planned EATCHIP and early EATMS developments. The FARADEX model will be used to provide the baseline. Within the present document, only the new ground functions that are necessary to provide the services requested by the MA-AFAS aircraft will be described.

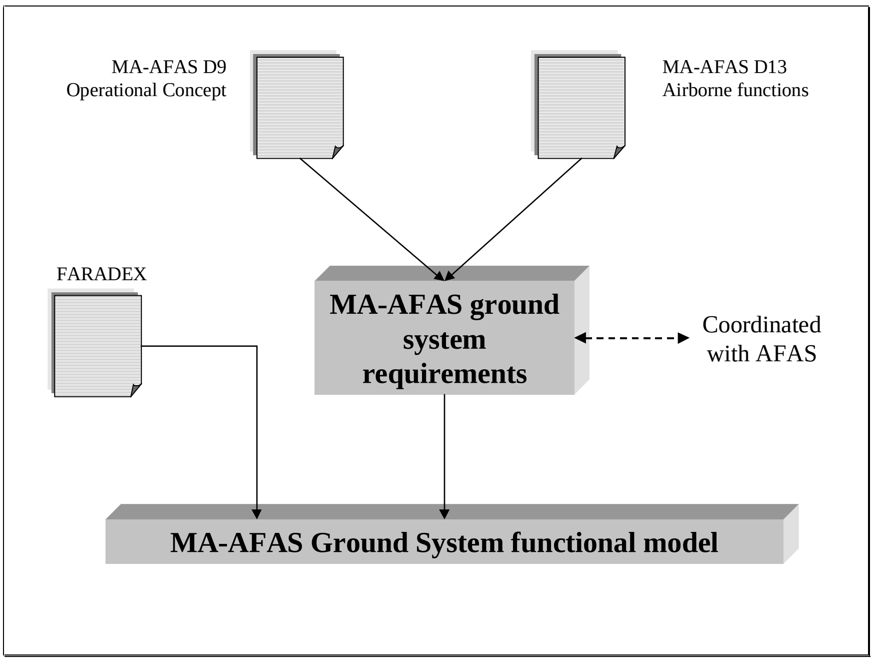


Figure 1.Approach to build the functional architecture of the MA-AFAS Ground System

Moreover, the functional model also has a practical importance as a source of requirements for the simulation/pre-operational ground platforms that will be exploited in the WP3 for validation purposes.

3. To identify which requirements of the reference platform are supported by the actual platforms that will be exploited to validate the MA-AFAS avionic package (WP3). Most of these experimental ATM platforms have been (or are being) developed within the framework of other R&D projects.

    - EAT/ESCAPE platform
    - FARAWAY/MEDUP platform
    - SMGCS platform
    - Precision Approach platform
    - NUP platform
    - VDL Mode 4 ground station
    - AOC platform

    The objective is to identify the necessary enhancements necessary to make those platforms consistent with the reference ground architecture.

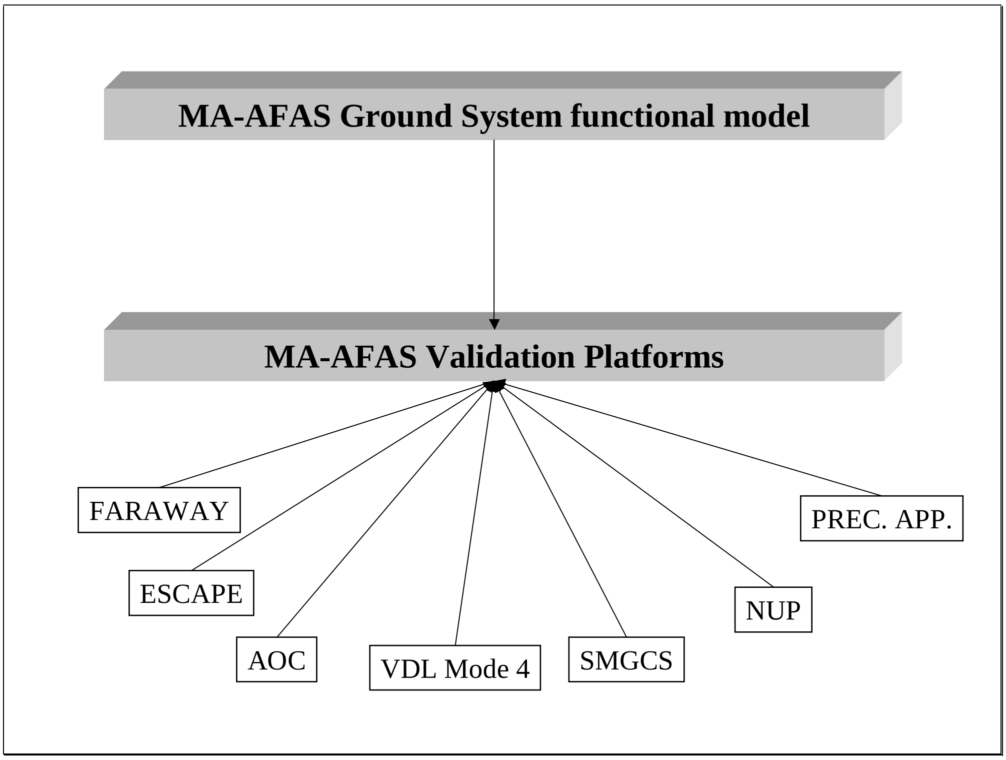


Figure 2.Validation Platforms

1.2 System Overview

The MA-AFAS project aims to implement new airborne ATM functions that belong to the following themes:

- ✓ Cockpit Display of Traffic Information (CDTI) and Airborne Separation Assurance System (ASAS).
- ✓ Flight deck HMI to support 4-D flight path generation and monitoring in a more autonomous environment.
- ✓ Integration of taxiway map and data linked taxi clearances.
- ✓ Validation of GNSS (with ground and space based augmentation) procedures for approach using 4-D flight path control.
- ✓ Evaluation of airborne 4-D flight path generation for integration with ground based flight path planning.
- ✓ Integration of ATN and non-ATN communications stacks in the airborne system to support ATC communications (using ODIAC defined standards) and AOC communications.

The MA-AFAS Ground System (here also referred to as MA-AFAS Ground Platform) is the ATM ground counterpart of the airborne system designed and implemented by MA-AFAS. It is intended to test and validate the new avionic functions providing the peer functions on the ground.
To provide the overall model of the MA-AFAS Ground System, a functional architecture has been derived within this document.
The analysis of the requirements (stated in chapter 2) has led to the inclusion of the following high-level functions (or functional areas according to the FARADEX terminology) in the MA-AFAS Ground Platform:

- Capacity and Flow Management.

  On the basis of the airspace demand and capacity planning, this functional area develops the Daily Operational Plan (DOP). It is updated on any event that can change the demand or capacity and presented to the ATM providers and users the day before operations. This corresponds in part to the function presently performed by the CFMU for the ECAC airspace.

- Air Traffic Services (ATS)
  This includes Air Traffic Control (ATC) services in all the phases of flight (en-route, approach, departure, landing, surface movement), Flight Information Services (FIS) and Traffic Information Service (TIS). In the MA-AFAS scope, these services are provided without interacting with the operational ATM system (*shadow mode*).

- CNS infrastructure.
  This function includes the Communication, Navigation and Surveillance capabilities that transport information throughout the whole system. The MA-AFAS CNS infrastructure is widely based on the use of digital communications, satellite-based navigation and ADS-B based surveillance. Nevertheless, also traditional infrastructures (radar, voice communications) are exploited.

- Data Management.
  The main aspect of this functional area is the process of retrieving and combining data in order to produce in real-time the current and the future Air Traffic Situation (Surveillance Data Processing and Flight Data Processing). Another is aspect is represented by the archiving capabilities to support off-line data analysis.
- Airline Operations Centre (AOC).
  This refers to the aircraft operator participation in co-ordinating the initial flight planning and in-flight re-planning with the ATS. In the MA-AFAS scope, AOC functions are closely linked to ATS due to the involvement of the airline in the 4-D flight plan negotiation.

- Support Functions.
  These include the functions that are instrumental for the whole platform to be used as a validation platform for the objectives of the projects (simulation functions, playback functions, platform management functions, evaluation functions, and so on).

Outside the scope of the MA-AFAS ground platform are the following other functional areas, which exchange information with the platform.

- Airspace Management.
  This is concerned with the definition of the Airspace and the Route Network structure (including areas of Free Routing / Free Flight).

- Weather Service Provider.
  This is the source of aviation weather information for all parties dealing with flight planning and flight operations. The Weather Service Provider will provide various weather forecasts, but may also use weather data down linked from a/c to produce ‘nowcasts’ which can then be provided to the ground platform (e.g. AOC).

1.3 Document Overview

Chapter two contains a list of requirements for the MA-AFAS ground system, extracted from the following documents:

- WP 1.1 – This work package has produced a deliverable (D9 – ATM Operational Concept) that defines the overall MA-AFAS (and AFAS) operational concept, its elements and sub-elements exploiting the EUROCONTROL OCD and the TORCH frameworks.
- WP 1.2.1 – This work package has produced a deliverable (D10 – Candidate Operational Concepts) with the purpose to facilitate the final choice of the operational concept for MA-AFAS. This work permits to derive one or more candidate operational concepts using a framework based on the OCD and the TORCH project.
- WP 1.3 – This work package has selected airborne ATM functions that will be implemented by the MA-AFAS avionics package.

Starting from the mentioned requirement list, chapter 3 proposes a functional model for the MA-AFAS Ground System.

1.4 Referenced Documents

1.4.1 Project Documents

Item	Title	Date
1	MA-AFAS-WP1.1-D9-RE-DERA-1, ATM Operational Concept (Issue No. 1)	27 October 2000
2	MA-AFAS-WP1.1-D10-RE-AIRSYS-YYY, Candidate Operational Concepts (Issue No. 1)	10 October 2000
3	MA-AFAS-WP1.3-D13, Definition of ATM MA-AFAS Airborne and Ground Functions (Issue No. 1 Draft B)	19 January 2001
4	MA-AFAS OSED Version 7.0	10 April 2001

1.4.2 Other Documents

Item	Title	Date
4	FARADEX – WP4: Reference Functional Architecture – Volume 1: Main Report	26 March 1998
5	FARADEX – WP4: Reference Functional Architecture – Volume 2: Function, Organisation & System models	26 March 1998
6	ICAO Doc. 9694 – Manual of Air Traffic Services Data Link Applications – Edition 1 – 1999	
7	ICAO Doc. 9705 Edition 2 Manual of Technical Provision for the Aeronautical Telecommunication Network	
8	EUROCONTROL, *OPERATIONAL REQUIREMENTS FOR AIR/GROUND COOPERATIVE AIR TRAFFIC SERVICES (AGC-ORD-01)*, Edition 1.0, 2 April 2001	

2 MA-AFAS Ground System requirements

This chapter provides the list of requirements for the Ground System extracted from the MA-AFAS Operational Concept document (ref. [1]).
The following coding rule has been assumed for the requirements within this document:

GND_XXX_NNN

where:
- GND stands for "GROUND"
- XXX indicates the functional area
- NNN is a progressive number

2.1 General Requirements

Most of the requirements given in the following table are the ones usually imposed to any experimental pre-operational CNS/ATM platform.

Identification	Requirement description	Notes
GND_GEN_010	The platform shall support the simulation of oceanic, en-route, approach and ground environments.	
GND_GEN_015	The platform shall include air traffic generators.	
GND_GEN_020	The platform shall include pseudo-pilot positions.	
GND_GEN_025	The platform shall include exercise preparation capabilities.	
GND_GEN_030	The platform shall include a supervisor position, which shall allow initiating, monitoring and controlling the system, and controlling data recording and playback.	
GND_GEN_035	The platform shall include Ground ATC System related functions.	
GND_GEN_040	The platform shall include Ground AOC System related functions.	
GND_GEN_041	The ATS and AOC functions shall be capable to exchange data with each other.	
GND_GEN_045	The platform shall be capable to get data from operational ATS units.	
GND_GEN_050	The platform shall be capable to exchange data with multiple live flights.	
GND_GEN_055	The platform shall not interfere with authoritative air traffic operational procedures.	
GND_GEN_060	The platform shall be capable to exchange data with the CFMU.	
GND_GEN_065	The platform shall be capable to exchange data with Airport systems.	
GND_GEN_070	The platform shall include Surveillance Data Processing functions.	
GND_GEN_075	The platform shall include monitoring and CD&R functions.	
GND_GEN_080	The platform shall include Safety Nets functions.	
GND_GEN_085	The platform shall include Flight Data Processing functions for ATC.	
GND_GEN_090	The platform shall include Flight Data Processing functions for AOC.	
GND_GEN_095	The platform shall include AMAN/DMAN functions.	
GND_GEN_100	The platform shall include SMGCS functions.	
GND_GEN_105	The platform shall include Precision Approach functions.	
GND_GEN_110	The platform shall include analogue voice communication systems for air/ground and ground/ground communications.	
GND_GEN_115	The platform shall include digital communication systems for air/ground and ground/ground data communications.	
GND_GEN_120	The platform shall be able to record all the data necessary to allow the performance of the functions to be evaluated.	
GND_GEN_125	The platform shall be able to record all the data necessary to allow the safety of the functions to be evaluated.	

Table 1. Ground system general requirements

2.2 Functional Requirements

2.2.1 Requirements from the OC

The following requirements have been extracted by the overall MA-AFAS operational concept.

Identification	Requirement description	OC sub-element
GND_OPC_005	The ATC System shall be capable to manage MAS and FFAS airspace	E1.1 Airspace Plan Development E1.3 Route Network Management
GND_OPC_010	The ATC System shall be capable to get the updated Daily Operational Plan from the Central Flow Management Unit	E4.1 Central Re-planning
GND_OPC_011	The AOC System shall be capable to get the updated Daily Operational Plan from the Central Flow Management Unit	E4.1 Central Re-planning
GND_OPC_015	The ATC System shall provide capability to manage departure/arrivals along flexible paths with 4-D constraints	E6.1 Arrival Management E6.2 Departure Management
GND_OPC_025	The ATC System shall be capable to negotiate Initial and Revised 4-D Flight Plans with the AOC centre taking into account airspace status and available routes	E3.1 Demand/Capacity Planning E4.2 Local Short Term Optimisation E9.2 G2G Flight Planning
GND_OPC_030	The AOC System shall be capable to negotiate Initial and Revised 4-D Flight Plans with the ATC centre taking into account airspace status and available routes	E3.1 Demand/Capacity Planning E4.2 Local Short Term Optimisation E9.2 G2G Flight Planning
GND_OPC_035	The ATC System shall be capable to negotiate 4-D trajectory with the a/c	E5.1 Multi-sector planning E5.2 En-route metering
GND_OPC_040	The ATC System shall be capable to manage transitions between FFAS and MAS airspace (definition of 4D constraints at entry and exit points	E5.1 Multi-sector planning E5.2 En-route metering
GND_OPC_045	The ATC System shall be capable to negotiate 4-D approach paths with the a/c	E6.1 Arrival Management
GND_OPC_050	The ATC System shall be capable to negotiate 4-D departure routes with the a/c	E6.2 Departure Management
GND_OPC_055	The ATC System shall be capable to negotiate take-off slot time with the a/c	E6.2 Departure Management
GND_OPC_060	The ATC System shall exploit 4-D intent information down linked by the a/c to enhance traffic monitor and control	E7.1 Traffic Monitoring and Control
GND_OPC_065	The ATC System shall exploit 4-D intent information down linked by the a/c to enhance conflict detection and resolution	E7.2 Conflict Identification E7.3 Conflict Resolution
GND_OPC_070	The ATC System shall exploit 4-D intent information down linked by the a/c to support monitoring of fully autonomous a/c operations	E7.4 Airborne Separation Assurance
GND_OPC_071	The ATC System shall be capable to support negotiation of flight clearance through data link	E10.2 Negotiation of Flight Clearance
GND_OPC_072	The ATC System shall be capable to support negotiation of taxi clearance through data link	E10.5 Ground Movement
GND_OPC_075	The AOC System shall provide capability to monitor a/c 4-D flight plan by exploiting position and intent data received from the a/c	E11.1 Flight Operations Monitoring
GND_OPC_076	The AOC System shall be capable to monitor surface movements of a/c to improve planning/ fleet management	E11.1 Flight Operations Monitoring
GND_OPC_080	The AOC System shall be capable to negotiate Revised 4-D Flight Plans with the ATC system	E11.2 Flight Plan Revision
GND_OPC_085	The AOC System shall be capable to uplink revised 4-D flight plan to the a/c	E11.2 Flight Plan Revision
GND_OPC_090	The ATC System shall monitor surface movements of a/c and vehicles to detect potential conflicts	E13.4 Surface Movement Guidance
GND_OPC_091	The AOC System shall monitor the surface movements of ground vehicles, in order to optimise and monitor the company airport resources	E13.4 Surface Movement Guidance

GND_OPC_095	The ATC System shall be capable to gather weather information from the a/c	E16.1 Forecast Services E16.2 Nowcast Services
GND_OPC_096	The AOC System shall be capable to gather weather information from the a/c	E16.1 Forecast Services E16.2 Nowcast Services
GND_OPC_100	The ATC System shall be capable to exchange weather information with the Meteorological Agencies	E16.1 Forecast Services E16.2 Nowcast Services
GND_OPC_101	The AOC System shall be capable to exchange weather information with the Meteorological Agencies	E16.1 Forecast Services E16.2 Nowcast Services
GND_OPC_105	The ATC System shall be capable to transmit weather nowcast to the a/c	E16.2 Nowcast Services
GND_OPC_106	The AOC System shall be capable to transmit weather nowcast to the a/c	E16.2 Nowcast Services

Table 2. General Ground System requirements

3 Functional Model

3.1 Functional modelling overview

This chapter provides a functional model of the MA-AFAS ATM Ground System. The functional analysis methodology, hereafter briefly summarised, is similar to the one applied in the FARADEX framework (ref. [4] and [5]).
The functional analysis models the *System of Interest* (SoI) as a set of interrelated functions belonging to few *functional areas* in which the system can be decomposed. A function can be viewed as any activity that produces outputs, possibly transforming some input.
According to the analysis objectives, some functional areas need to be further decomposed in a recursive process that finishes when the elementary functions of the system have been reached. This process of decomposition is applied to the functional areas that are recognised to define the *scope* of system.
The functional areas considered external to the system scope (and therefore are not further decomposed) represent the *context* in which the SoI operates and permit to define its boundaries.
After the statement of the system context and scope, the functional analysis proceeds with building the hierarchy of functions through the mentioned recursive decomposition.
Another important aspect is the identification of the information items utilised within the SoI. Each information item is associated with the functions (previously identified) that produce and/or consume it.
It should be noted that the functional model neither involves any allocation of functions to logical and/or physical entities nor contains any technological implementation solution.

3.2 OMT-derived notation

To describe the functional decomposition, a notation derived from the Object Modelling Technique (OMT) object-oriented formalism will be utilised.
An F-class, which does not have any attributes or operations associated as it usually occurs in standard OMT, represents each function.
Each information, on which functions act, is represented by *I-class*, which have *attributes* that define the kind of information (not the data type), but no operations associated.
Interactions among classes are described using OMT relationships: generalisation, aggregation and association.
A *generalisation* is a relationship that states that one entity is “a-type-of” another general entity.
An *aggregation* is a relationship that states that one entity is “part-of” a more complex entity.
An *association* is a relationship that denotes a semantic connection between entities.

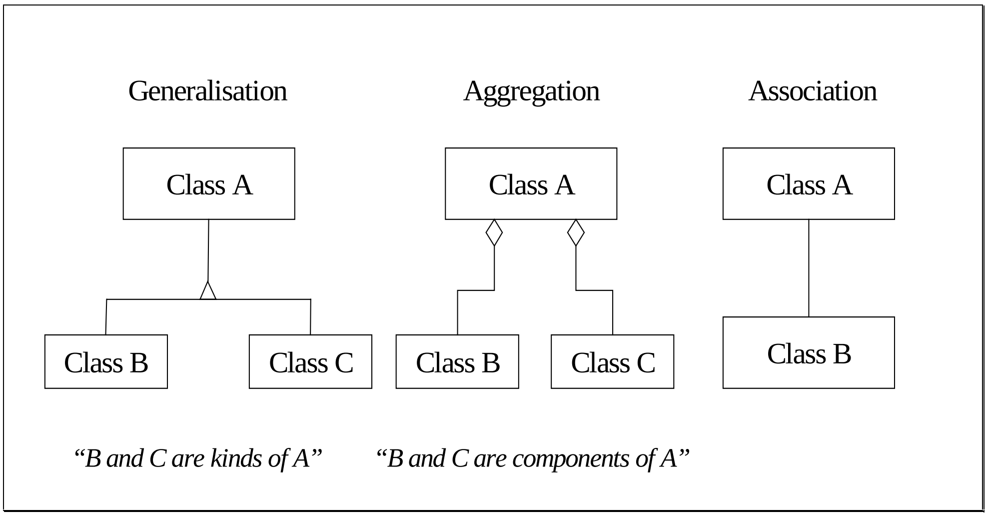


Figure 3. Notation for OMT relationships

Generalisation and aggregation relationships are utilised to build the *Functional Decomposition* (fd) diagram that gives a graphical representation of the f-class hierarchy.
The association relationship is utilised to build the *Function/Information* (fi) diagram that provides a model of interaction among f-classes through association to common i-classes.

3.3 MA-AFAS Ground System functional model

3.3.1 System of Interest (SoI)

The MA-AFAS Ground System represents the System of Interest of the functional analysis.

3.3.2 Context and scope

The approach followed to identify the functional areas to be included in the scope of the MA-AFAS Ground Platform is based on the analysis of the requirements stated in the previous chapter.
The following functional areas are included within the scope of the MA-AFAS ground system:

- Capacity and Flow Management
- Air Traffic Services (ATS)
- Communication, Navigation & Surveillance (CNS)
- Data Management

- Airline Operations Centre (AOC)

Outside the scope of the MA-AFAS ground platform are the following other functional areas, which exchange information with the platform.

- Airspace Management
- Weather Service Provider

The following picture provides the description of the system using the notation previously introduced.

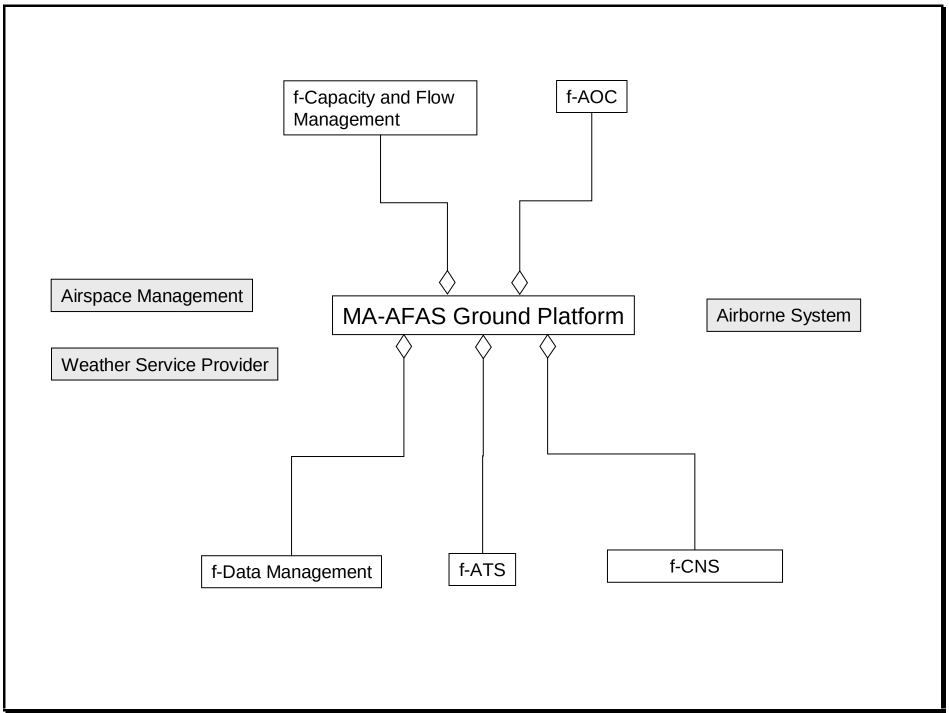
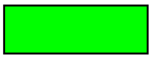


Figure 4. MA-AFAS Ground platform – Functional Areas of interest

The following colours have been chosen in the fd-diagram and fi-diagram presented in the document:

This represents a new MA-AFAS f-class



This represents a new MA-AFAS i-class

This represents a function external to the MA-AFAS scope

3.3.3 Capacity and Flow Management

Air Traffic Flow Management is the current ICAO terminology for Capacity and Flow Management (CFM). It reflects the principle that ATFM exists to support ATC in ensuring an optimum flow of air traffic to, from, through, or within defined areas during times when demand exceeds, or is expected to exceed, the available capacity of the ATC system or relevant airports.

To meet the objectives of balancing demand and capacity in Europe, the CFMU undertakes flow management in three phases. To match these phases of planning, the f-CFM function is split into three sub-functions:

· f-CFM Strategic

· f-CFM Pre-Tactical

· f-CFM Tactical

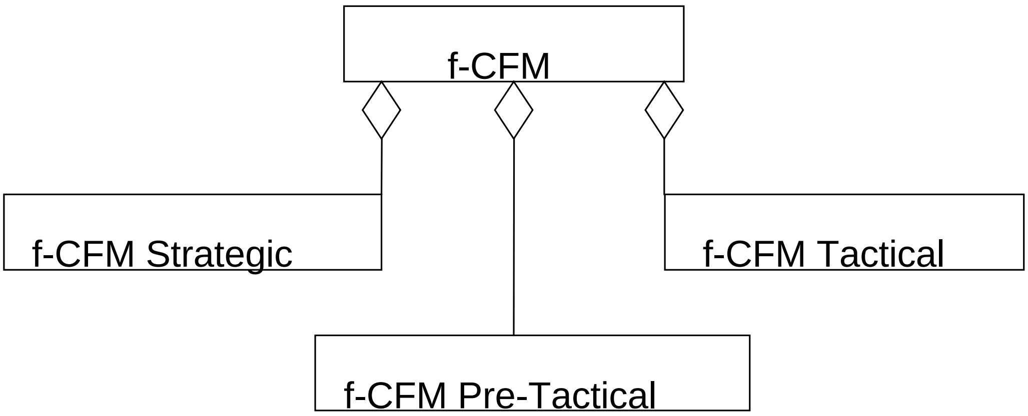


Figure 5. f-CFM (fd diagram)

The figure 5 shows the CFM functional class extracted from FARADEX generic model, in order to have a global view of the main functions involved and to be upgraded according MA-AFAS functions.

- f-CFM Strategic: Strategic activities are research, planning and coordination activities carried out more than two days before the day of operation. Initial flight plan data and the capacity data for sectors, points and routes is used to compose an initial CFM plan for the day of operation based on Demand/Capacity forecasts and the results of Traffic Orientation Schemes (TOS).

- f-CFM Pre-Tactical: f-CFM Pre-Tactical are planning and coordination of activities carried out less than two days before the day of operation, up until the day of operation. Based on the strategic forecasts from f-CFM Strategic, the information received from f-Air Traffic Services via f-Support Services the CFM notification messages (CNM) for the day of operation is prepared. This defines the tactical plan for the next day and informs f-AOC

Functions and f-Air Traffic Services about the CFM measures which will be in force in European airspace on the following day. F-Air Traffic Services is provided with and provides information via f-Support Services. Airspace data variations for the European region are continually updated to provide the f-CFM Pre-Tactical with the latest data to update the CFM plan. Airspace data variations are communicated to the CFM by individual states or local flow management positions via f-Aeronautical Data Management Services.

- f-CFM Tactical: Tactical activities are those CFM activities carried out on the day of operation. Flights taking place on the current operational day receive the benefit of CFM, which includes the allocation of individual aircraft departure times, re-routings to avoid bottlenecks and alternative flight profiles to maximise efficiency. f-CFM Tactical is the real time flexible response of f-CFM to the changing operational status. This includes:
    - Modifying/adding new regulations to cope with changes in demand and available capacity.
    - Slot allocation, amendment and true revision process.

The following picture presents the f-CFM Tactical fd-diagram, in which the new MA-AFAS functions are highlighted.

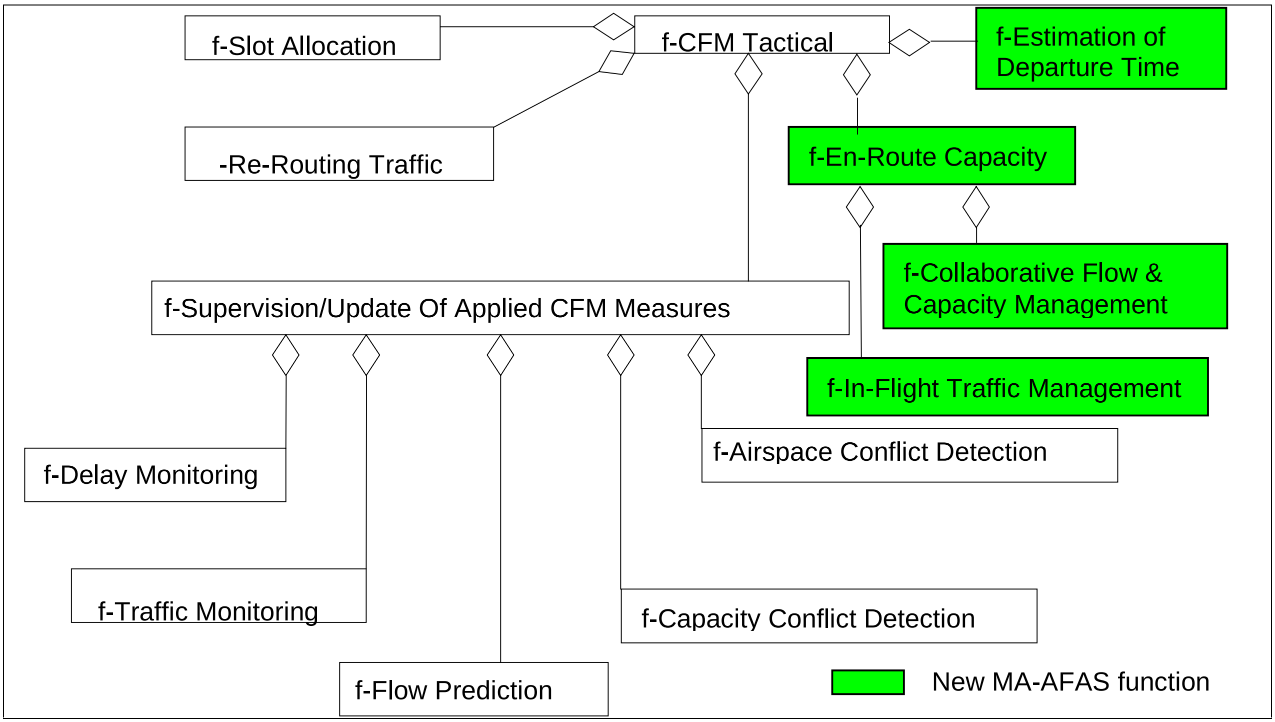


Figure 6. f-CFM Tactical fd-diagram

In the following picture the CFM Tactical fi-diagram is presented, in which there are designed only the new MA-AFAS functions with the related i-classes.

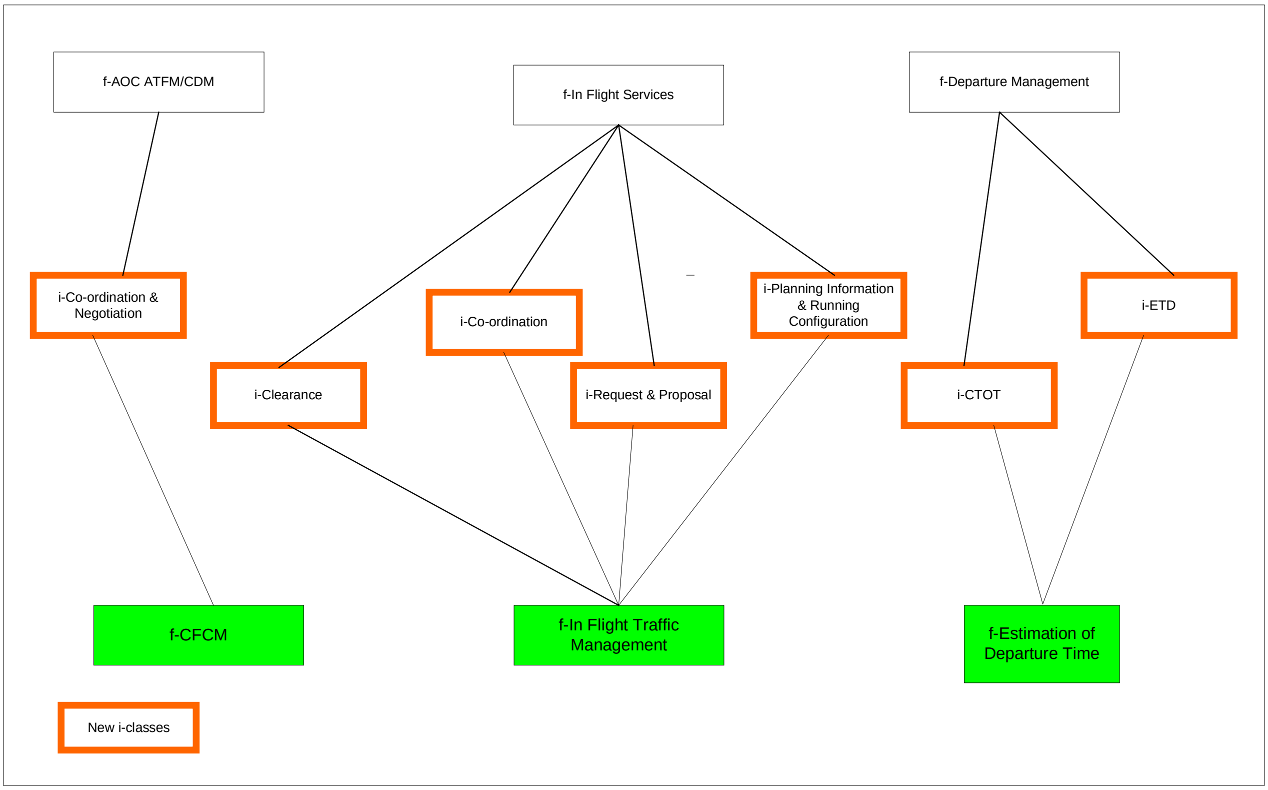


Figure 7. CFM Tactical fi-diagram

3.3.3.1 Capacity & Flow Management functions

3.3.3.1.1 f-En-Route Capacity (GR-01)

This function is related with the En-Route Planning (E5) element used to define the MA-AFAS OC (ref. [1]). En-route Planning acts on the basis of the agreed DOP. It analyses the current and predicted overall traffic situation with a time horizon of up to about 2 hours in advance and a smaller area of responsibility. This element will create a bridge between Flow and Capacity Management (E1 & E4) and tactical ATC (E6 & E7). Multi-sector Planning will be a new function in ATC which will be able to plan traffic and solve potential conflicts.

The particular MA-AFAS interest lies in the tactical phase of En-route Capacity Management. This following function identifies new functionality that could be related to part of f-CFM Tactical function from the FARADEX model.

This functional decomposition is described in the Eurocontrol doc. “Potential Applications of Collaborative Planning and Decision Making”.

3.3.3.1.1.1 f-Collaborative Flow and Capacity Management

3.3.3.1.1.1.1 Description

The ATM system will support a progressive shift from the current practice of managing demand to match a fixed capacity, to a dynamic capacity management process in which Airspace Managers try to match capacity to demand, responding to and accommodating the changing traffic patterns. Capacity Management will be carried out in the pre-tactical and tactical phases, and will provide an optimal distribution of capacity at each time rather than a "best on average" solution.
En-route Capacity Management on its own is not expected to be sufficient to ensure safe ATC capacity is not overloaded. Capacity is inevitably limited, and traffic tends to increase to equal and then exceed available capacity.
The benefit is to improve the effectiveness and efficiency of the foreseen Capacity Management and Flow Management processes by combining them to form a collaborative process in which capacity and demand are co-managed by those actors best placed to contribute.

3.3.3.1.1.1.2 Requirements

Identification	Requirement description
GND_CFM_001	Seasonal Traffic Orientation Scheme (TOS) shall be replaced with the dynamic Standard Routeing Scheme (SRS)
GND_CFM_005	Airspace organization shall incorporate conditional routes within the SRS
GND_CFM_010	The ATC System shall exploit the FUA concept as much as possible
GND_CFM_015	The ATC System shall have the capability to manage dynamic sectorisation
GND_CFM_020	The ATC System shall be capable to manage pre-tactical definition of Free Flight Airspace Areas, in response to changing traffic densities

Table 3. CFCM Requirements

3.3.3.1.1.2 f-In-Flight Traffic Management

3.3.3.1.1.2.1 Description

Re-planning a flight during the en-route airborne phases of flight can be required due to incidental events, forcing a change, or desirable for flight performance or other reasons of efficiency or economy.

Reasons for re-planning include:

1. To maintain an optimal flight schedule, problems arising from delays may require replanning of the flight.
2. To avoid congestion: traffic congestion at arrival and/or at downstream sectors may indicate a search for less constrained flight paths, and a planning that to avoid the aircraft being placed in hold.
3. Free routing options: Airspace availability may suggest selecting a more direct route, e.g. Conditional Routes (CDRs).
4. Arrival capacity at the destination airport: slot availability might be a motive to adapt the planning.
5. To avoid unfavourable weather conditions: received weather information might suggest looking for more optimal flight paths.
6. At pilot's request: the pilot may have other reasons to ask to change the flight plan for his flight and to adapt the planning accordingly.

Especially in the en-route flight phase, there are opportunities to optimise the flight planning and therefore to improve the en-route capacity. However, ATC is tasked to perform a planning process that supports safe, orderly and expeditious control. However, ATC is not in a position to take into account all aspects contributing to optimal planning, because:

- ATC is not tasked to achieve optimisation of the performance of individual flights.
- ATC has insufficient knowledge of what is optimal for individual flights, and this concerns the circumstantial conditions, as well as the individual flight performance conditions.
- ATC, planning in en-route airspace, has no, or very limited, knowledge of arrival conditions, and how to deal with imposed restrictions.

Therefore, other parties (external to ATC) are more appropriate to initiate flight optimisation. The need to optimise a flight comes from the commercial interest of the Airline Operators (AOs). Another reason may be to optimise towards optimal arrival scheduling, which is an Airport ATC´s interest. The result of a CDM application will be that ATC might be able to accept individual flight plan changes on request of AOs and Airport ATCs.

The pilot's primary concern during the flight is to accomplish tactical flight operations. However the pilot will co-ordinate with AOC, which should be in a position to combine the pilot's interest with information concerning questions like changing weather conditions, capacity at destination, local airspace congestion, ATC planning, and its own scheduling and planning interests. AOC may derive a proposal for re-planning to ATC from the combined knowledge.

In the context of the implementation of advanced 4D and data link concepts, 4D capability might allow the pilot to extend his view and to perform flight planning with an extended scope. This might allow him to communicate this information directly to the ATC as well as the AOC.

In a CDM environment, the AOCs will also be informed of surveillance and planning information, including en-route and arrival demand capacity. With this information AOCs should be capable to request en-route to, for example, have their aircraft re-routed to avoid areas of observed severe weather or to minimise holding. Ultimately at least 10 minutes before the flight enters the area, AOC should be able to propose a flight plan change, which may comprise: level changes, parallel routing, direct routing, and possibly also a routing through military airspace (assuming an airspace status which allows this).

The airport ATC (APP), planning the arrivals sequencing, will receive similar en-route planning information, allowing them to make an early assessment of planning the expected arrival flow. If there is a need to adapt the runway configuration and/or the runway arrival rates, the Airport ATC will be able to take appropriate decisions, monitoring the expected arrival flows.

The process of co-ordination between ATC, AOC and Airport ATC takes place in the context of a Multi Sector Planner (MSP) implementation. This will require the use of 4D trajectory prediction (TP) on the ground, and 4D prediction and guidance capability of the aircraft. The accurate, trajectory-based planning needs to be supported by an ATN for data exchange, satisfying the need for high-capacity, reliable, consistent, digital data link exchange.

The MSP shall be able to solve congestion problems, performing a flow management task, by re-planning individual flights.

The Multi-Sector Planner (MSP), initially envisaged to alleviate the work of planning controllers, will perform these tasks that clearly imply more co-ordination to respond to requests of AOs, Airport ATC and Aircrafts.

Requirements of presentation to Operator (AOC) and/or Controller (ATC):

The operator will consider a flight from its current position to arrival. They should be able to select the airspace of interest for that flight and to be able to judge the opportunities to re-plan the flight. Therefore, information provision be through an Air Situation Display (ASD-like) presentation, comprising:

1. Presentation of the current status of airspace, allowing users to visualise the opportunities for direct routing;
2. Presentation of traffic flow information, allowing users to visualise the flows of traffic and the traffic densities in space and time;
3. An option to filter flow information in 4D, e.g. to apply height and/or time filters;
4. Presentation of available capacity in space and time;
5. Display of detailed flight plan information, concerning an AO´s own flights, and enabling the AOC to create proposals (“what-if” functionality);
6. The optional presentation of available weather now-casts and/or forecasts.

3.3.3.1.1.2.2 Requirements

Identification	**Requirement description**
GND_CFM_025	The pilot will co-ordinate with AOC, which should be in a position to combine the pilot’s interest with information concerning questions like changing weather conditions, capacity at destination, local airspace congestion, ATC planning, and its own scheduling and planning interests. AOC may derive from the combined knowledge a proposal for re-planning to ATC
GND_CFM_030	The airport ATC (APP), planning the arrivals sequencing, will receive en-route planning information, which allows to make an early assessment of planning the expected arrival flow. If there is a need to adapt the runway configuration and/or the runway arrival rates, the Airport ATC will be able to take appropriate decisions, monitoring the expected arrival flows
GND_CFM_035	The MSP shall be able to solve congestion problems, performing a flow management task, by re-planning individual flights
GND_CFM_040	Presentation of the current status of airspace, allowing users to visualise the opportunities for direct routing
GND_CFM_045	Presentation of traffic flow information, allowing users to visualise the flows of traffic and the traffic densities in space and time
GND_CFM_050	An option to filter flow information in 4D, e.g. to apply height and/or time filters
GND_CFM_055	Presentation of available capacity in space and time
GND_CFM_060	Display of detailed flight plan information, concerning an AO´s own flights, and enabling the AOC to create proposals (“what-if” functionality)
GND_CFM_065	The optional presentation of available weather now-casts and/or forecasts

Table 4. In Flight Traffic Management Requirements

3.3.3.1.1.3 f-Estimation of Departure Time

3.3.3.1.1.3.1 Description

Airport Capacity Management is required to manage estimated time of departure (ETD) more accurately than is currently the case. A way to improve this process is to share information that is already available within Airport ATC with the other actors. How the information should be shared in order to lead to earlier and more accurate predictions of departure time is discussed below.

A two-way link is required between CFMU and Departure ATC. There is an existing link from CFMU to Departure ATC (AFTN for delivery FPLs), sometimes via the local ACC´s ATC system. In many cases, an operator is required to transfer the CTOT into the ATC system, although a number of ACCs are currently procuring new interfaces to allow automatic transfer. The existing link from Departure ATC to CFMU is usually via the local FMP, by telephone. A new link shall be required to pass ETD back to CFMU electronically. Automatic transfer would be preferable to minimise ATC workload.

A one-way link is required from CFMU to all the other actors. This link already exists to all European ACCs and Arrival ATC units, as well as to many AOCs. However, few of the existing interfaces allow automatic transfer, new interfaces would be required for efficient use of the incoming information. New links are required to the Stand Allocation Unit (SAU) at the departure airport.
As an alternative to these point-to-point links with CFMU the shared information could be implemented via a shared-access virtual database with network connections for all participants. The database would be physically distributed. Information could be added to this “virtual information pool” by any actor.

Another option to improve this application by using distribution of CTOT and ETD will imply the electronic data exchange between Tower ATC and the ACC’s ATC system, which is already present in some cases.

3.3.3.1.1.3.2 Requirements

Identification	Requirement description
GND_CFM_070	A two-way link shall be set up between CFMU and Departure ATC
GND_CFM_075	A new I/F between CFMU and ACC and Arrival ATCC should implement in order to improve automatic transfer of information

Table 5. Estimation of Departure Time Requirements

3.3.4 Air Traffic Services

3.3.4.1 ATS Functional Model

The Air Traffic Services (ATS) comprise the three following services: the Air Traffic Control (ATC) service, the Flight Information Service (FIS) and the Alerting service.
The ATC service:

- gathers information on the actual progress and intended movement of each flight;
- determines from the information received the relative position of flights with respect to each other;
- issues clearances and information in order to prevent collision between A/Cs under its control and to expedite and maintain and orderly flow of traffic;
- co-ordinates clearances with other units

The MA-AFAS interest in the ATC services lies in:

- limited transfer of responsibility of maintaining separation from the controller to the aircrew (Co-operative Separation function, TIS-B function)
- automated assistance to 4D trajectory negotiation with the aircraft (4D Trajectory Negotiation function) and with the AOC centre (4D AOC Flight Plan Negotiation function)
- monitoring and conflict detection exploiting aircraft-generated 4D positions and intents (4D CD&R function)
- data link-based delivery of clearances and information to the aircrew, including pre-departure, taxi and in-flight clearances (Data Link Clearances function, Data Link Taxi Clearances function)

The FIS service provides advice and information useful for the safe and efficient guidance of flights (e.g. ATIS and meteorological information).
The MA-AFAS interests in the FIS service lies in the automatic provision of related information through data link (DFIS function).

The Alerting Services disseminates information in case of unexpected events, such as aircraft in trouble. The main task is to inform all parties involved of the emergency and to disseminate information needed to execute a Search & Rescue (SAR) mission. When such an event occurs, the ATC unit that receives the emergency call immediately warns the SAR agencies. Information about the alert is distributed to other ATCCs, aircraft in the neighbourhood and, in case the event occurred at the airport, the Airport Surface services. The information used is the current kinematics parameters to disseminate the last position known, and the flight plan of the aircraft.
The Alerting service is not relevant for MA-AFAS and will not be further analysed.

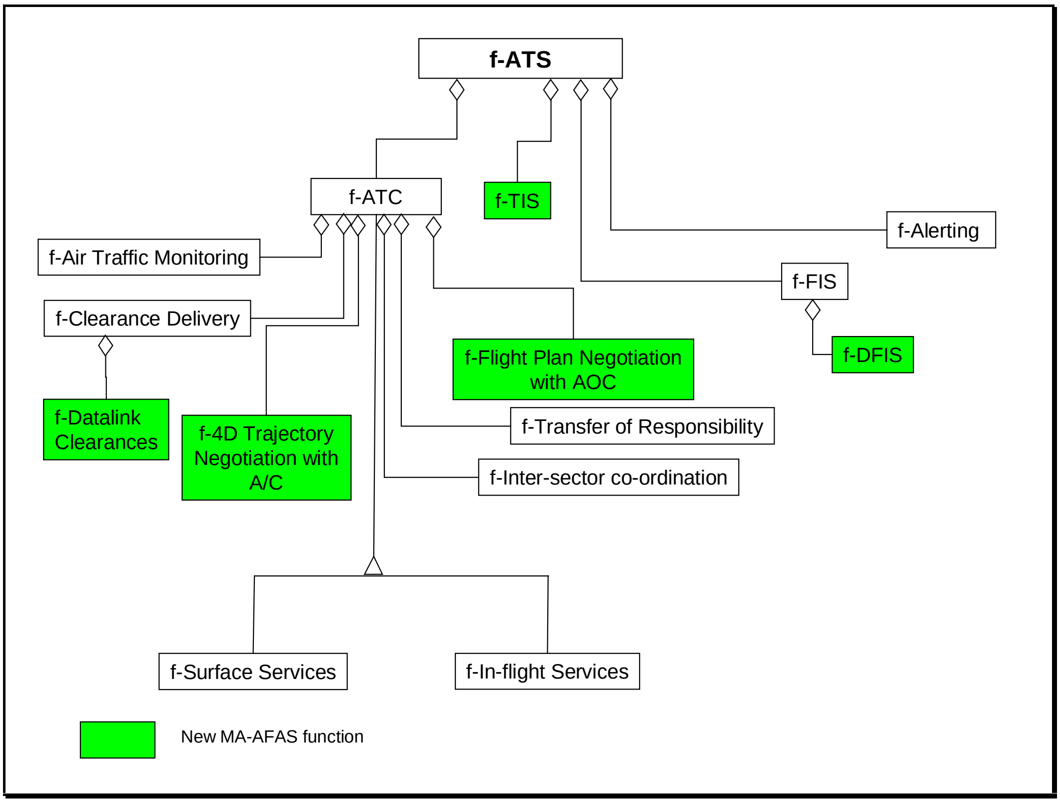


Figure 8. f-ATS fd-Diagram

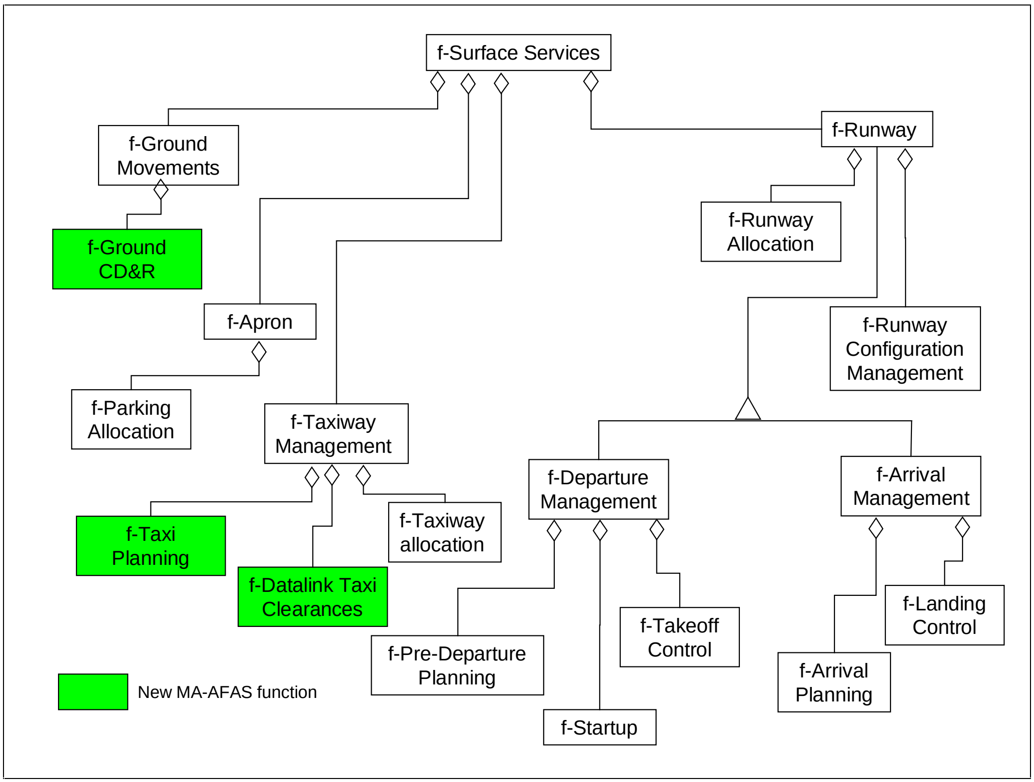


Figure 9. f-Surface Services fd-Diagram

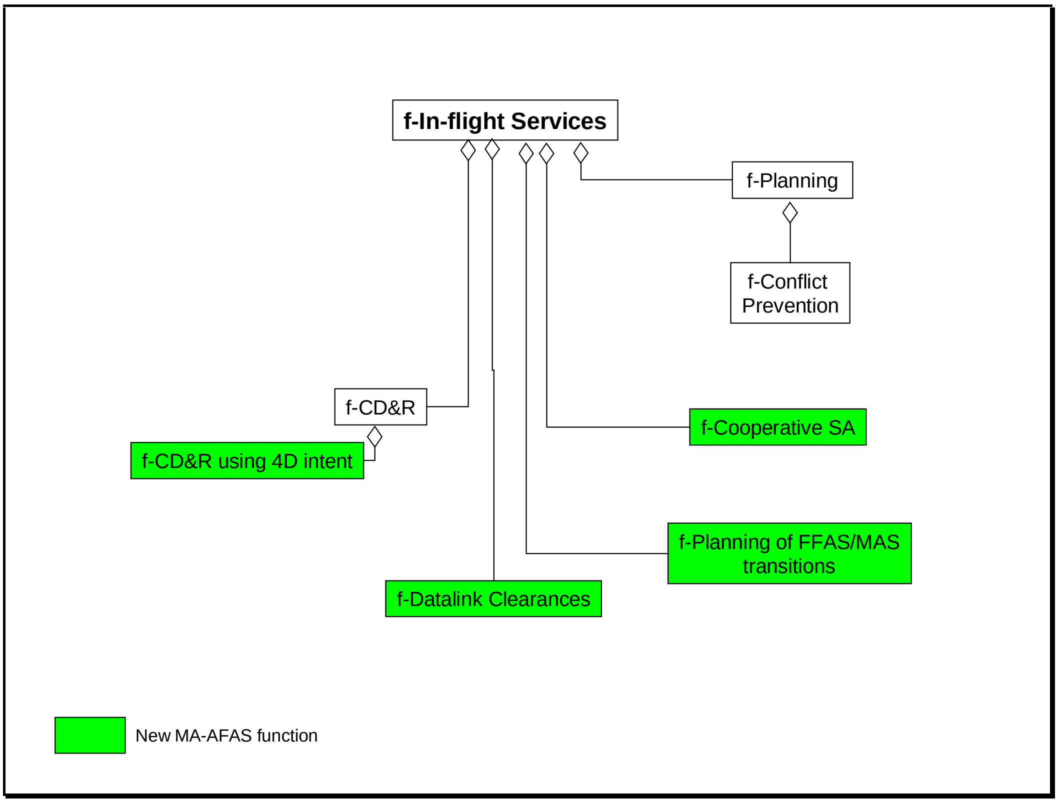


Figure 10. f-In-Flight Services fd-Diagram

Figures (8, 9, 10) show the main sub-functions of f-ATS extracted from the FARADEX generic model. The new MA-AFAS functions that will be exploited in the following chapters are highlighted.

The following tables summarize the i-classes related to the new functions that are foreseen for MA-AFAS.

In the following figure 11 it is presented the detailed content of the i-classes, while the figure 12 represents the fi diagram, in which at each i-class it is associated the related function that utilize its information.

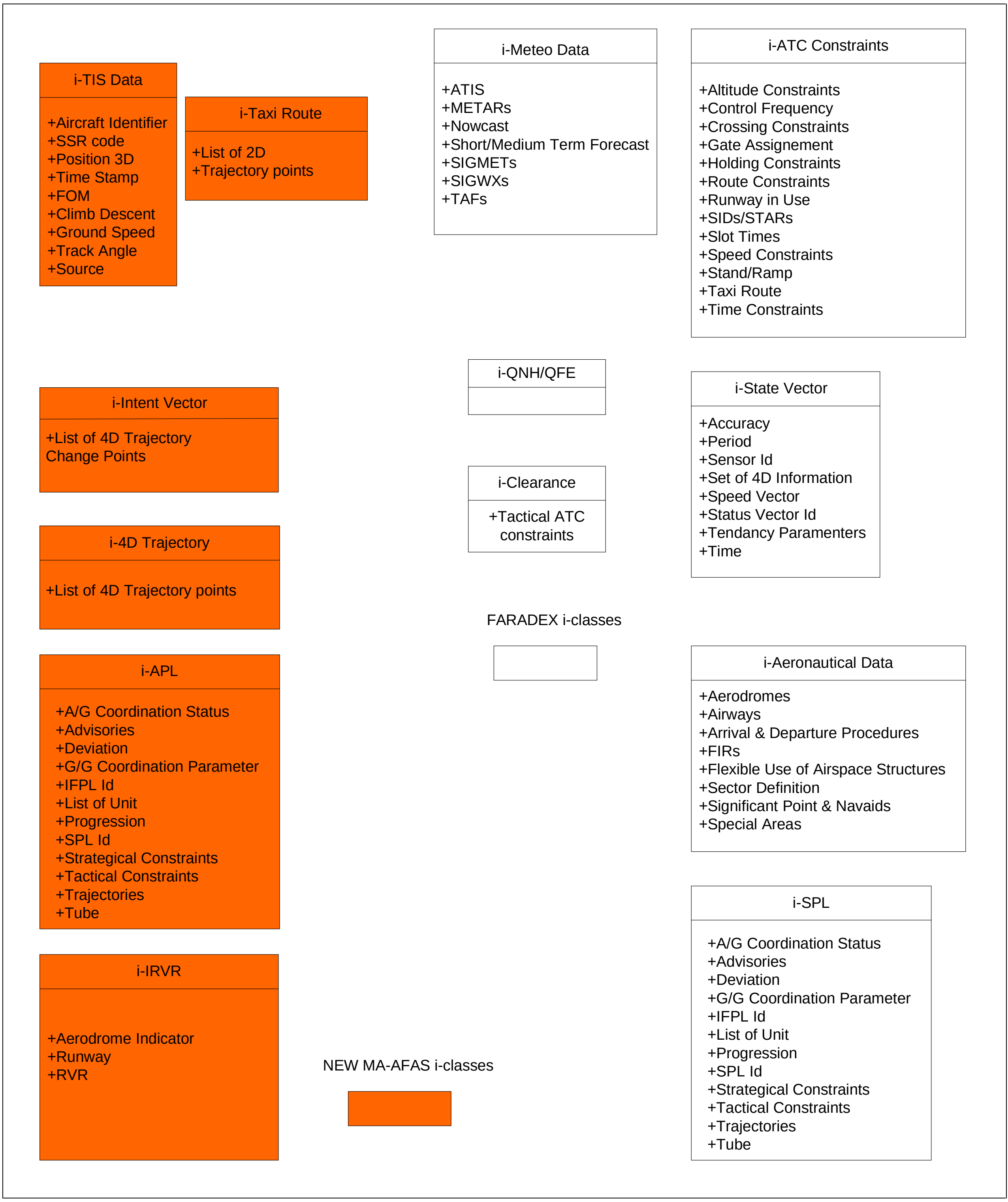


Figure 11. ATS i-classes

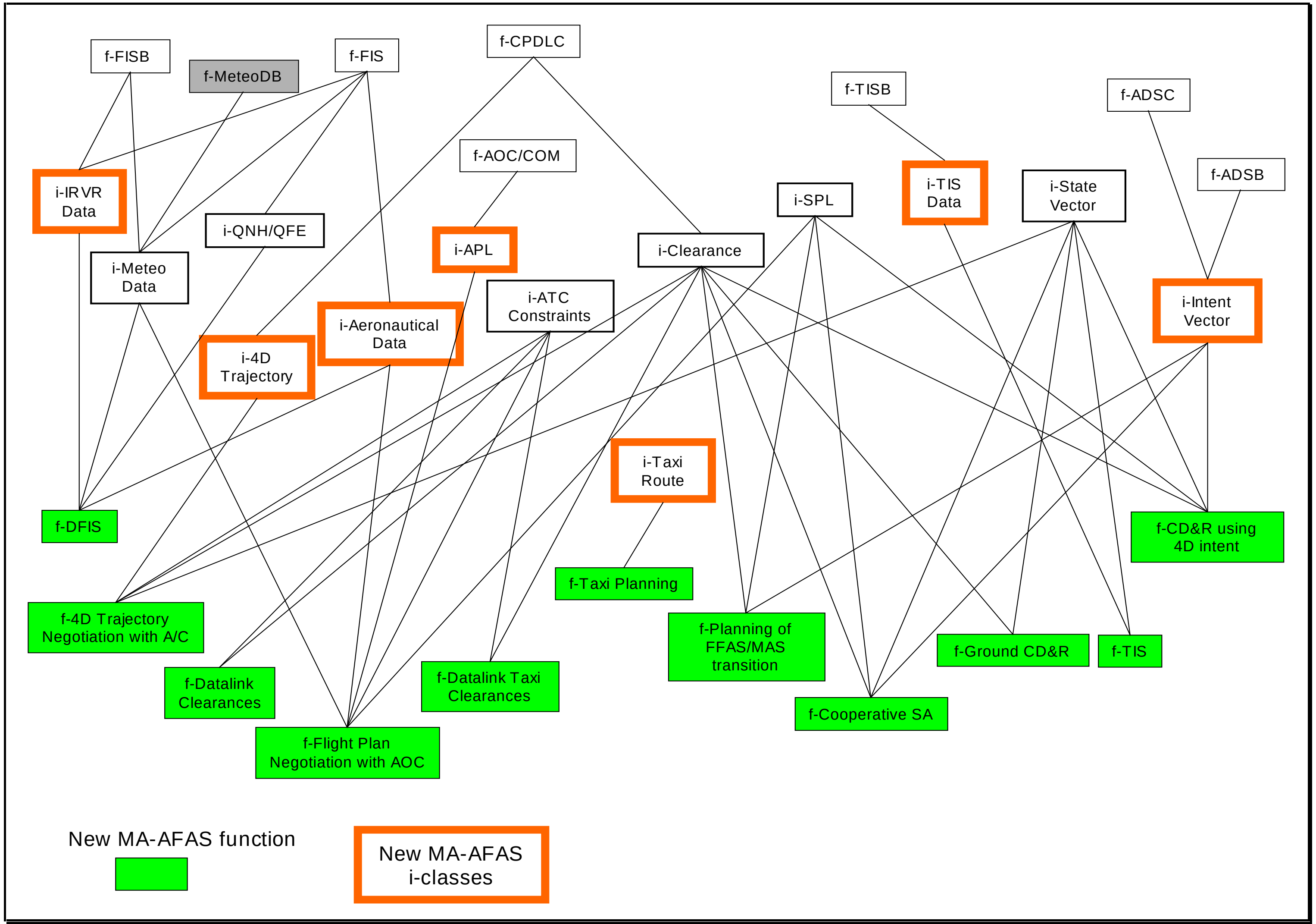


Figure 12. ATS functions fi-diagram

3.3.4.2 ATS Functions

3.3.4.2.1 TIS-B

3.3.4.2.1.1 Description

The TIS-B application consists in the uplink of air/ground surveillance data, through a broadcast mode data link.
The objective of the TIS-B application is to support the reconstruction of a consistent traffic picture on board, which is instrumental to airborne situational awareness applications (CDTI) and co-operative separation assurance applications (station keeping, lateral crossing/passing, and so on).

3.3.4.2.1.2 Requirements

Identification	Requirement description
GND_ATS_001	The ATC System shall provide air Traffic Information data
GND_ATS_005	The ATC System shall provide surface Traffic Information data
GND_ATS_010	The ATC System shall be capable to update TIS data with the rate appropriate for the a/c operation
GND_ATS_015	The ATC System shall provide to the a/c description of the airspace region where full traffic picture is guaranteed

Table 6. TIS-B Requirements

3.3.4.2.2 DFIS

3.3.4.2.2.1 Description

The Data link Flight Information Service provides, on pilot request or in broadcast mode, advice and information, regarding meteorological (forecast and nowcast reports) and operational flight information, useful for the safe and efficient conduct of flights.

3.3.4.2.2.2 Requirements

Identification	Requirement description
	See GND_OPC_095, GND_OPC_100, GND_OPC_105
GND_ATS_025	The ATC System shall provide the D-ATIS Service
GND_ATS_030	The ATC System shall provide the D-RVR Service
GND_ATS_035	The ATC System shall provide the D-SIGMET Service

Table 7. DFIS Requirements

3.3.4.2.3 Ground CD&R

3.3.4.2.3.1 Description

This function detects and resolves conflicts for relevant ground vehicles and aircraft that are on the ground.
This function uses:

- The accurate current position of the aircraft (i-State Vector)
- The clearances provided to the aircraft for taxiing between gates, runways and standing areas

3.3.4.2.3.2 Requirements

Identification	Requirement description
	See requirement GND_OPC_90

Table 8. Ground CD&R Requirements

3.3.4.2.4 Taxi Planning

3.3.4.2.4.1 Description

This function is in charge to plan taxi routes for a/c between gates runways and hard standing areas.

3.3.4.2.4.2 Requirements

Identification	Requirement description
GND_ATS_040	The ATC System shall be capable of planning taxi routes

Table 9. Taxi Planning Requirements

3.3.4.2.5 Data Link Clearances

3.3.4.2.5.1 Description

Enables to controller to communicate instructions to pilot via data link. Clearances can be authorisations of departures, take off, landing. En-route clearance is to ensure conflict avoidance or just to progress the aircraft along its route. Taxi Clearances instruct the pilot to drive the aircraft on the ground, from the gate to the runway in a safe way.

This function uses ATC Constraints provided by several ATC functions such as f-Conflict Prevention, f-Take-Off Control. These ATC Constraints are the parameters which controllers have to deliver to vehicles via a clearance.

3.3.4.2.5.2 Requirements

Identification	Requirement description
	See requirements GND_OPC_071, GND_OPC_072
GND_ATS_045	The ATC system shall support delivery of clearances through data link when the a/c is all phases of flight (ground, taxi, en-route)

Table 10. Data Link Clearances Requirements

3.3.4.2.6 Co-operative Separation Assurance

3.3.4.2.6.1 Description

The co-operative separation function involves a limited transfer of the responsibility from the ground to the airborne side for maintaining separation between two aircraft, when feasible, in terms of safety and efficiency.
MA-AFAS airborne applications that involve this function are:

- spacing applications, where the controller creates a “train” of aircraft and delegates to the aircrew the responsibility to maintain a separation
- lateral and vertical crossing/passing applications, where the controller clears the crossing/passing manoeuvre and delegate to the aircrew the responsibility to maintain separation during the manoeuvre

The responsibility of maintaining separation is transferred to the aircrew only for the duration of the associated manoeuvre through specific clearances issued by the delegating ATC unit. Transmission of surveillance information from the ground may be required (TIS-B function) to feed the airborne CDTI/ASAS functions, if air-to-air transmissions are not available.

3.3.4.2.6.2 Requirements

Identification	Requirement description
GND_ATS_050	The ATC System shall support delivery of clearances for spacing application
GND_ATS_060	The ATC System shall support delivery of clearances for Lateral Crossing/Passing application
GND_ATS_065	The ATC System shall support delivery of clearances for Vertical Crossing/Passing application

Table 11. Co-operative Separation Assurance Requirements

3.3.4.2.7 4D Trajectory Negotiation with a/c

3.3.4.2.7.1 Description

4D-trajectory negotiation provides detailed route information to the ATC for clearance or amendment. It shall support all available modes of negotiation between the aircraft and the ATC.
It will be active from push back to landing, but provide the trajectory negotiation without covering taxiing, that is covering by taxiway management function.

3.3.4.2.7.2 Requirements

Identification	Requirement description
See Requirements GND_OCP_35, GND_OCP_45, GND_OCP_50	

Table 12. 4D Trajectory Negotiation with a/c Requirements

3.3.4.2.8 4D AOC Flight Plan Negotiation

3.3.4.2.8.1 Description

4D-AOC Flight Plan Negotiation provides detailed route information from ATC to the AOC for clearance or amendment. It shall support all available modes of negotiation between the ATC and the AOC. It will be active from push back to landing.

3.3.4.2.8.2 Requirements

Identification	Requirement description
	See GND_OPC_025

Table 13. 4D AOC Flight Plan Negotiation Requirements

3.3.4.2.9 CD&R using 4D intent

3.3.4.2.9.1 Description

This function detects if two aircraft are predicted to be in conflict. A conflict situation will be defined for an aircraft pair if at the same time the horizontal (lateral and longitudinal) minimum separation and the vertical minimum separation are infringed.
This function uses the current kinematics data and extrapolates them. It has to predict a conflict situation as soon as possible.
This function uses:

- The accurate current position of the aircraft (i-State Vector)
- The flight plan of the aircraft provided by f-Flight Data Handling (i-SPL)
- The intent information provided by the aircraft (i-Intent Vector)

On the basis of the different parameters of the conflict; e.g. the conflict occurrence estimated time and estimated position with the identification of each aircraft affected, it provides the necessary clearances (i-Clearances) in order to avoid the conflict.

3.3.4.2.9.2 Requirements

Identification	Requirement description
	See requirements GND_OPC_60, GND_OPC_65, GND_OPC_70
GND_ATS_115	The ATC System shall implement conflict detection and resolution tools exploiting intent information provided by the aircraft.

Table 14. CD&R using 4D intent Requirements

3.3.4.2.10 Planning of FFAS/MAS transitions

3.3.4.2.10.1 Description

This function provides a means to the controller for the supervision of the FFAS/MAS transition in a way that s/he will be able to check if the transition is conflict free.

3.3.4.2.10.2 Requirements

Identification	Requirement description
	See requirement GND_OPC_040

Table 15. Planning of FFAS/MAS Transition Requirements

3.3.5 CNS Services

CNS services encompasses all the communications, navigation and surveillance data capture services required to support ATS.

- Communication Services: the bulk of the communication service supports distribution of higher level services. The MA-AFAS Ground System supports air/ground cooperative ATS services provided through the use of data links.

- Navigation Services: provide a service to aircraft which allows them to determine their position. The MA-AFAS Ground System provides augmentation and integrity information supporting GNSS based procedures.

- Surveillance Data Capture Services: supplies ‘raw’ surveillance data to the surveillance data processing function.

The next figure shows the CNS Functional Area.

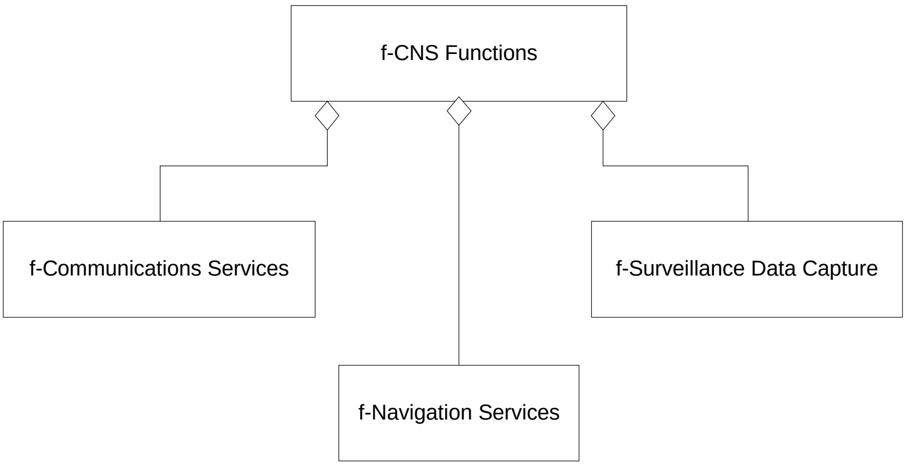


Figure 13. CNS fd-diagram

3.3.5.1 Communication

The following figure shows the fd diagram of the Air/Ground Communications functional area.

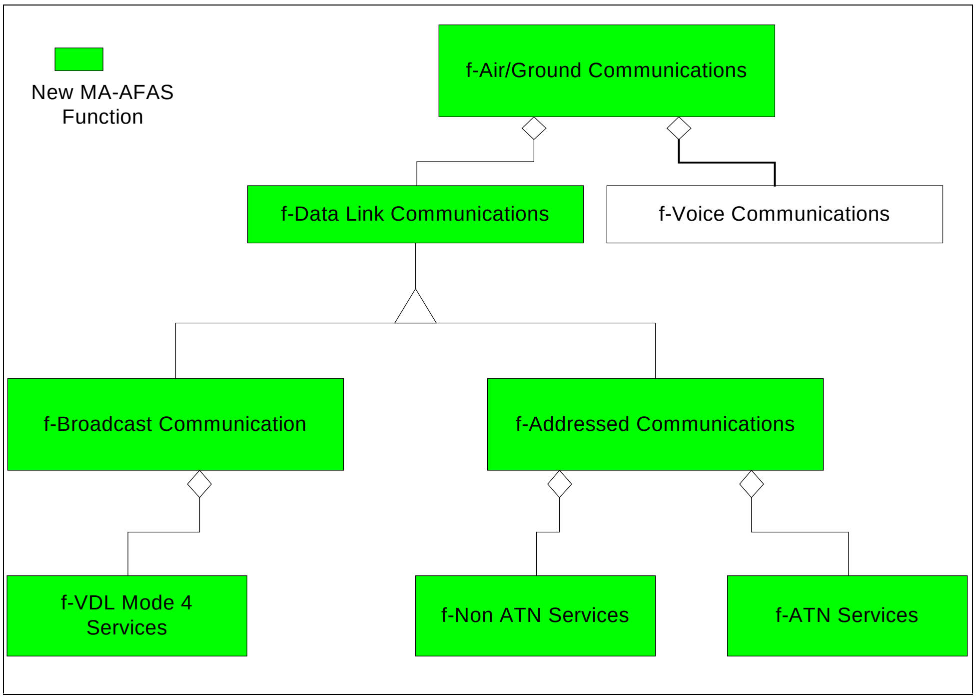


Figure 14. Air/Ground Communications fd diagram

In the following a further decomposition of the sub-functions, which make up the f-Data Link Communication, is presented.

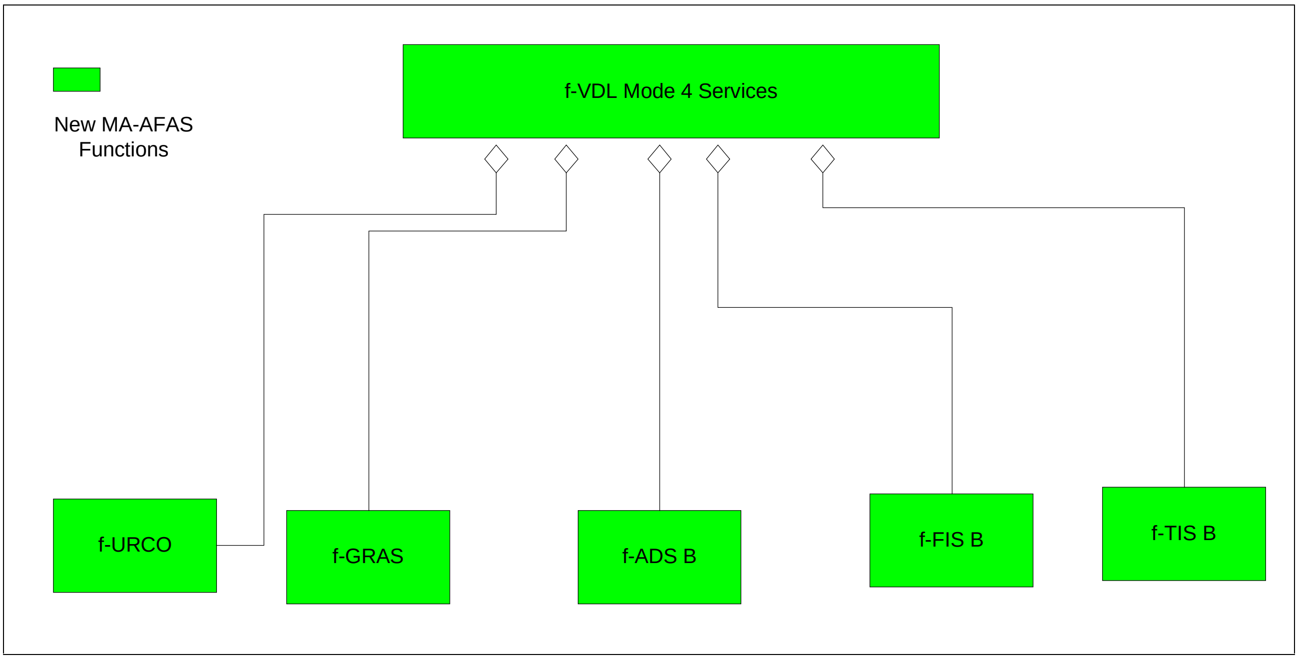


Figure 15. VDL Mode 4 Services fd diagram

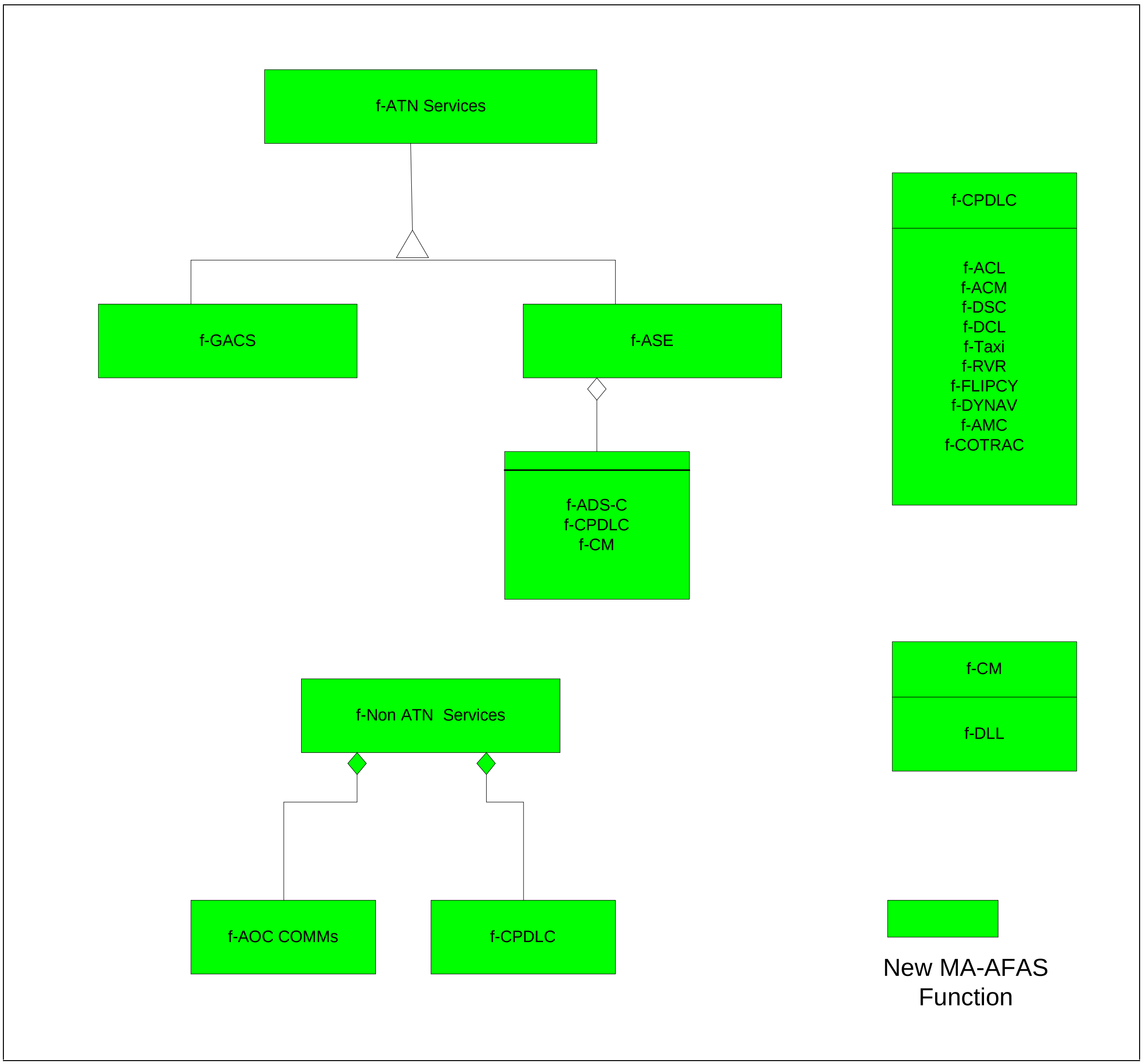


Figure 16. ATN Services fd diagram

These functions will use the same i-classes already foreseen for the ATS Service (see Figure 12), so the relevant diagrams are the same and they will not presented again.

3.3.5.1.1 Broadcast Communications

3.3.5.1.1.1 VDL Mode 4 Services

3.3.5.1.1.1.1 Description

This function consists of the following sub-functions:

- f-GRAS: it provides a means to distribute GNSS augmentation messages over the VDL Mode 4 data link in a wide area through a network of ground reference stations.
- f-ADS-B: this function gathers ADS-B messages generated by mobile VDL Mode 4 users and provide such data to the ground ATM surveillance.
- f-FIS-B: this function broadcast short text messages corresponding to the information currently transmitted to the pilot through periodic voice messages over published VHF frequencies.
- f-TIS-B: this function broadcasts messages containing information on the current air traffic surveillance picture produced by a ground ATM System.

3.3.5.1.1.1.2 Requirements

A list of general requirements is presented below, while for each functions a further specification is necessary, in order to cover the entire avionic requirement presented in the relevant document.

Identification	Requirement description
GND_COM_001	The platform shall provide the VDL Mode 4 air/ground broadcast interface
GND_COM_005	The platform shall provide management interface for air/ground broadcast communications
GND_COM_010	The ATC System shall support reception of ADS-B messages
GND_COM_015	The ATC System shall support transmission of TIS-B messages
GND_COM_020	The ATC System shall support transmission of FIS-B messages
GND_COM_025	The ATC System shall support transmission of DGNSS corrections
GND_COM_030	The ATC System shall transmit link management messages in accordance with ICAO Manual of ATS Data Link Applications

Table 16. VDL Mode 4 Services Requirements

3.3.5.1.1.1.3 URCO

This function provides a mechanism for exchanging urgent message with aircraft that are not yet under ATSU control.

3.3.5.1.1.1.4 URCO Requirements

Identification	Requirement description
GND_COM_035	The ATC System shall support transmission of urgent messages through a VDL Mode 4 link to the a/c
GND_COM_040	The ATC System shall support transmission of urgent messages even while the a/c is on the ground

Table 17. URCO Requirements

3.3.5.1.1.1.5 GRAS Requirements

Identification	Requirement description
GND_COM_045	The ATC System shall have the capability of transmitting GNSS augmentation data compliant with the NUP/MEDUP GRAS Specification

Table 18. GRAS Requirements

3.3.5.1.1.1.6 ADS-B Requirements

Identification	Requirement description
GND_COM_050	The ATC System shall have the capability of receiving, processing and displaying the ADS-B information.

Table 19. ADS-B Requirements

3.3.5.1.1.1.7 FIS-B Requirements

Identification	Requirement description
GND_COM_060	The ATC System shall be capable of transmitting FIS-B information

Table 20. FIS-B requirements

3.3.5.1.1.1.8 TIS-B Requirements

Identification	Requirement description
GND_COM_065	The ATC System shall be capable of transmitting TIS-B information in accordance with the NUP TIS-B service description

Table 21. TIS-B Requirements

3.3.5.1.2 Addressed Communication

3.3.5.1.2.1 ATN Services

3.3.5.1.2.1.1 Description

This function encompasses a number of communication services defined within ref. [7] and the necessary interfaces to access to ATN compliant sub-networks.

3.3.5.1.2.1.2 Requirements

Identification	Requirement description
GND_COM_070	The platform shall be capable to use VDL Mode 2 as ATN sub-network
GND_COM_075	The platform shall be capable to use VDL Mode 4 as ATN sub-network
GND_COM_080	The platform shall be capable to use SATCOM as ATN sub-network
GND_COM_085	The platform shall provide the ATN management interface
GND_COM_090	The ATC System shall provide the CM ASE I/F
GND_COM_095	The ATC System shall provide the ADS ASE I/F
GND_COM_100	The ATC System shall provide the CPDLC ASE I/F

Table 22. ATN Services Requirements

3.3.5.1.2.1.3 GACS

This function allows a user to transfer data transparently across the ATN to one or more other users, moreover it provides a mean for the AOC to communicate information to the aircraft equipment or receive information from the aircraft.

3.3.5.1.2.1.4 GACS Requirements

Identification	**Requirement description**
GND_COM_110	The platform shall support the communication between AOC and a/c through a generic service interface (GACS)
GND_COM_115	The platform shall support GACS in all phases of flight and while the aircraft is on the ground

Table 23. GACS Requirements

3.3.5.1.2.1.5 CM

CM is an ATN application, which provides the necessary information (addresses, requested and supported applications, and version) to those ATS service applications involving a point-to-point data link communication between the a/c and the ATS provider.

3.3.5.1.2.1.6 CM Requirements

Identification	**Requirement description**
GND_COM_120	The ATC System shall manage the following functional capabilities: • Logon function
GND_COM_130	The ATC System shall implement ATN SARPs ICAO 9705/2 Context Management services sufficient to meet the MA-AFAS trials equipment
GND_COM_135	The ATC System shall support the CM service during all the phases of flight and while the a/c is on the ground

Table 24. CM Requirements

3.3.5.1.2.1.7 ADS-C

It is a surveillance technique for use by air traffic services in which aircraft automatically provide, via data-link, data derived from on-board position-fixing and navigation systems. ADS will allow controllers to obtain position data and other information from ADS equipped aircraft in a timely manner in accordance with their requirements, and will allow the aircraft to be tracked even in non-radar airspace. The ADS application allows the implementation of reporting agreements, which, with the exception of an aircraft in an emergency situation, are established exclusively by the ground. The terms of an ADS agreement will be exchanged between the ground system and the aircraft by means of a contract, or a series of contracts. An ADS contract specifies under what conditions an ADS report would be initiated, and what data groups will be included in the reports.

3.3.5.1.2.1.8 ADS-C Requirements

Identification	**Requirement description**
GND_COM_140	The ATC System shall be able to identify the ADS capability of the aircraft and allocate the appropriate ADS contract
GND_COM_145	The ATC System shall have the ability to monitor the flight of the a/c before it enters the airspace under its control

GND_COM_150	The ATC System shall implement all ATN SARPs ICAO 9705/2 ADS-C services, with the exclusion of Emergency Contracts.
GND_COM_155	The ATC System shall support the ADS service during all the phases of flight and while the a/c is on the ground

Table 25. ADS-C Requirements

3.3.5.1.2.1.9 CPDLC

It provides air-ground data communication for ATC service. This includes a set of clearance/information/request message elements that correspond to voice phraseology employed by Air Traffic Control procedures. Controllers and pilots will use CPDLC in conjunction with the existing voice communication. The CPDLC is expected to be used for routine or frequent types of transactions. Sending a message by CPDLC consists in selecting the recipient, selecting the appropriate message from a displayed menu or by other means that allow fast and efficient message selection, and executing the transmission. The received message may be displayed and/or printed.

3.3.5.1.2.1.10 CPDLC Requirements

Identification	Requirement description
GND_COM_160	The ATC System shall implement a compliant subset of ATN SARPs 9705/2 CPDLC Services sufficient to meet the MA-AFAS trial requirements
GND_COM_165	The ATC System shall support CPDLC during all phases of flight
GND_COM_170	The ATC System shall provide ATC Clearances and Information Services compliant with ODIAC AGC-ORD-01
GND_COM_175	The ATC System shall support ATC Communication Management Service compliant with ODIAC AGC-ORD-01
GND_COM_180	The ATC System shall support Downstream Clearance Service compliant with ODIAC AGC-ORD-01
GND_COM_185	The ATC System shall support Departure Clearance Service compliant with ODIAC AGC-ORD-01
GND_COM_190	The ATC System shall support Taxi Management Service
GND_COM_195	The ATC System shall provide Flight Plan Consistency Service compliant with ODIAC AGC-ORD-01
GND_COM_200	The ATC System shall support FLIPCY Service for 2D-3D-4D flight plan checking
GND_COM_205	The ATC System shall provide FLIPCY Service during all phases of flight and while the a/c is on the ground
GND_COM_210	The ATC System shall provide Dynamic Route Availability Service compliant with ODIAC AGC-ORD-01
GND_COM_215	The ATC System shall provide Common Trajectory Co-ordination Service compliant with ODIAC AGC-ORD-01
GND_COM_216	The ATC System shall provide Pilot Preference Downlik compliant with ODIAC AGC-ORD-01
GND_COM_220	The ATC System shall have the capability to interface with AOC through Collaborative Decision Making in order to enable a more effectively coordination of trajectory
GND_COM_225	The ATC System shall support ATS Microphone Check compliant with ODIAC AGC-ORD-01

Table 26. CPDLC Requirements

3.3.5.1.2.2 Non ATN Services

3.3.5.1.2.2.1 Description

This function includes those communication services that are provided by direct access to the VDL Mode 4 Specific Services, without passing through the ATN stack.

3.3.5.1.2.2.2 Requirements

Identification	Requirement description
GND_COM_260	The platform shall be capable to use VDL Mode 4 air/ground non-ATN interface for point-to-point communications
GND_COM_265	The platform shall provide management interface for non-ATN air/ground point-to-point communications
GND_COM_270	The ATC System shall support exchange of CM and CPDLC messages over VDL Mode 4 Non ATN I/F

Table 27. Non ATN Services Requirements

3.3.5.2 Navigation

Airborne navigation is concerned with an aircraft's ability to know its own position and follow a predetermined path. The aircraft is supported in this by the provision of position information. The f-GND NAV Services represents the provision of position information for the purpose of flight guidance.
The following picture only presents the MA-AFAS related Navigation Services.

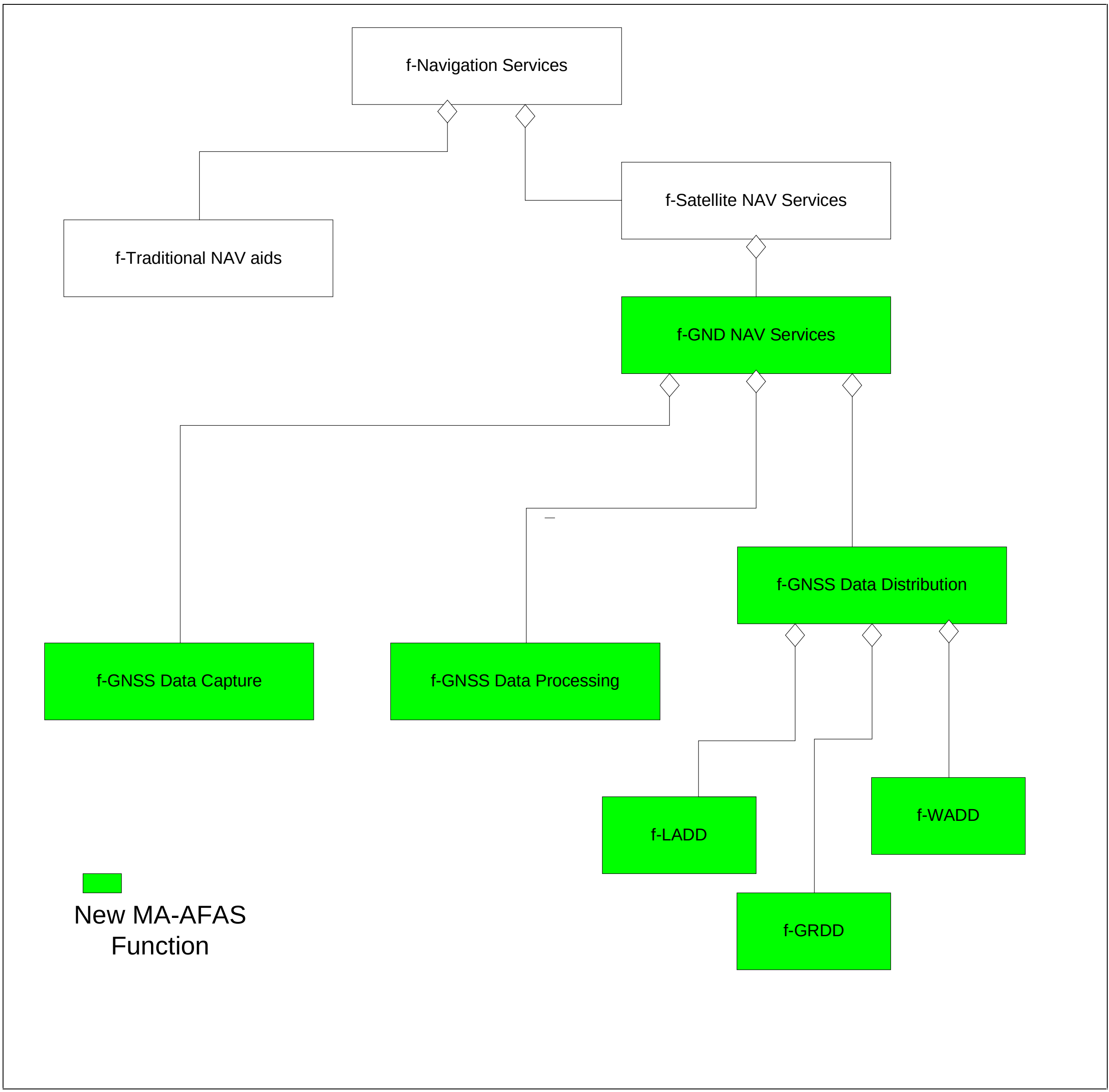


Figure 17. Navigation Services fd diagram

The previous figure shows the functional diagram of the Ground Navigation Services in which has been exploited only the sub-functions related on satellite-based services.

In the next figure it will be presented the i-classes that will be used from the function foreseen in the GND NAV Services.

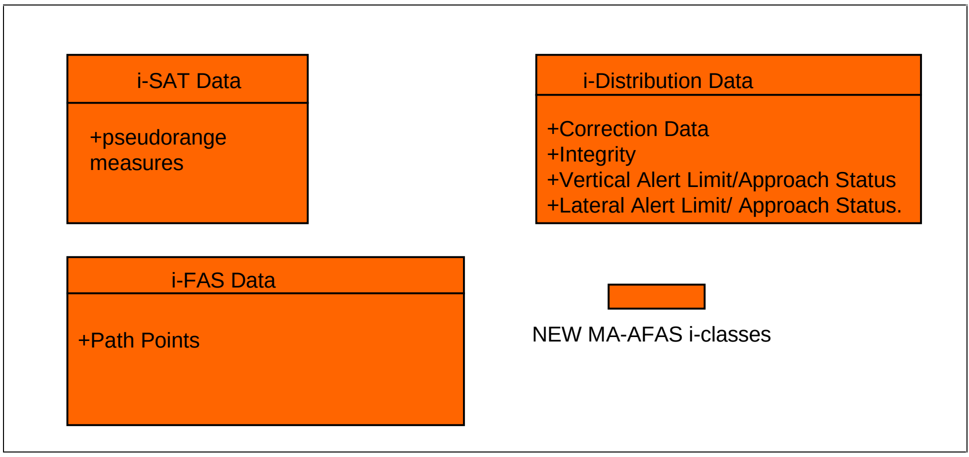


Figure 18. Satellite NAV Services i-classes

Next figure represents the fi diagram related to the f-GNSS NAV Services.

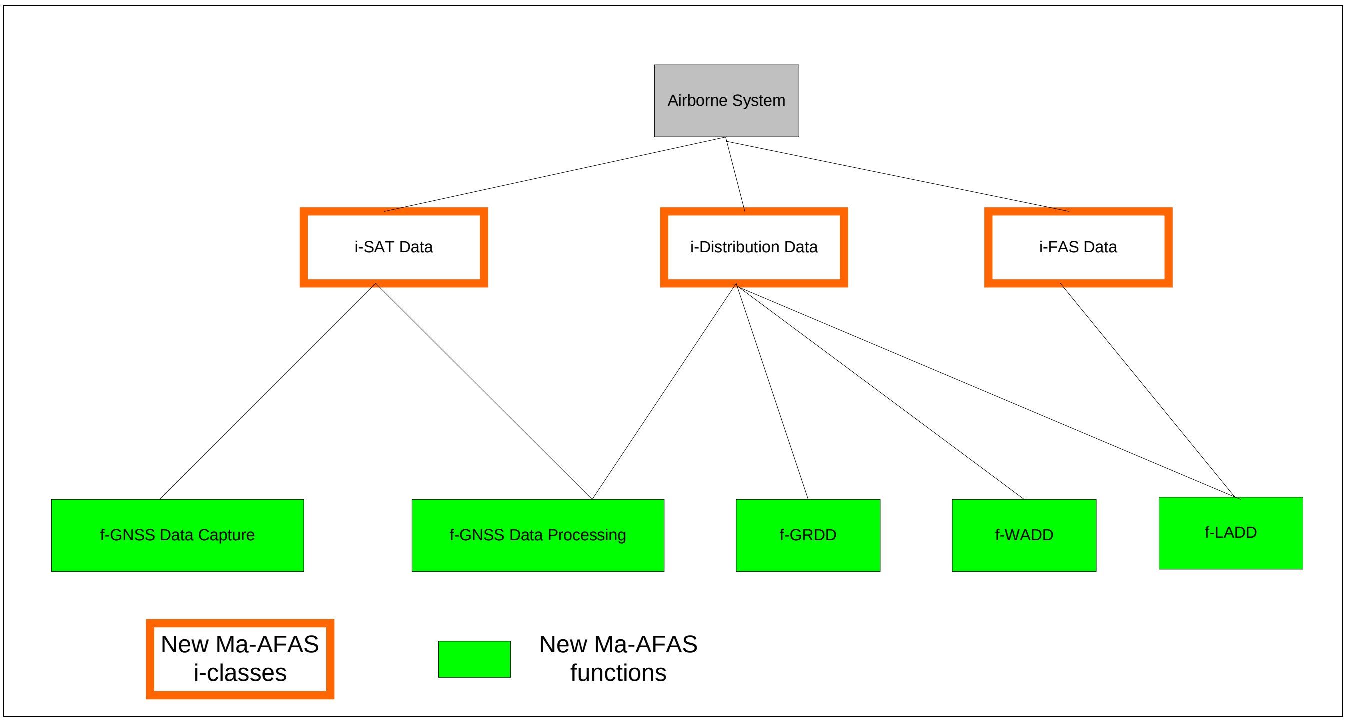


Figure 19. Satellite NAV Services fi-diagram

In the following tables are briefly described the i-classes used by the Satellite NAV Services sub-functions.

3.3.5.2.1 GNSS Data Capture

3.3.5.2.1.1 Description

This function has the aim of acquiring raw measurements from GNSS satellite constellation and to send this data to the GNSS Data Processing. The number and the location of the reference stations depends on the augmentation system (e.g. SBAS reference station are positioned spread over a wide area in order to maximise number of satellite in view, while for the GBAS system there are monitoring station located on the airfield to which the approach is being made).

3.3.5.2.1.2 Requirements

Identification	Requirement description
GND_NAV_001	The platform shall have the capability to acquire and decode data from GNSS satellite signal
GND_NAV_005	The platform shall provide GBAS augmentation data
GND_NAV_010	The platform shall provide GRAS augmentation data
GND_NAV_015	The platform shall provide SBAS augmentation data

Table 28. GNSS Data Capture Requirements

3.3.5.2.2 GNSS Data Processing

3.3.5.2.2.1 Description

Depending on the augmentation system, different kinds of algorithms shall be implemented, in order to provide the necessary information for the user (Differential Correction, Integrity Data), from messages coming from GNSS Satellite (Navigation Data, Ephemeris, Almanacs).

3.3.5.2.2.2 Requirements

Identification	Requirement description
GND_NAV_020	The ATC System shall have the capability to process satellite data in order to provide the necessary information for the navigation procedure
GND_NAV_025	The ATC System shall have the capability to process satellite information for every kind of augmentation system (GBAS, GRAS, SBAS)

Table 29. GNSS Data Processing requirements

3.3.5.2.3 GNSS Data Distribution

3.3.5.2.3.1 Local Area Data Distribution

3.3.5.2.3.1.1 Description

This function has the capability to transmit corrections and integrity information via VHF data link to all users within the line of sight of the transmitter up to range of 20 nautical miles. The performance of the instrumental approach is up to CAT-III procedures.

3.3.5.2.3.1.2 Requirements

Identification	Requirement description
GND_NAV_030	Broadcast navigation data shall be compliant with the GNSS MOPS (RTCA-DO 217)

Table 30. Local Area Distribution Requirements

3.3.5.2.3.2 Ground Regional Data Distribution

3.3.5.2.3.2.1 Description

This function provides a means to broadcast corrections data via a network of VHF ground stations which also act as GNSS reference station. The corrections transmitted by each ground station are intended to be available at distances up to 200 NM range.

3.3.5.2.3.2.2 Requirements

Identification	Requirement description
GND_NAV_035	The ATC System shall have the capability to broadcast GRAS navigation data.

Table 31. Ground Regional Data Distribution Requirements

3.3.5.2.3.3 Wide Area Data Distribution

3.3.5.2.3.3.1 Description

With this function the ATC System shall have the capability to transmit corrections and integrity data over the footprint of the geostationary satellite.

3.3.5.2.3.3.2 Requirements

Identification	Requirement description
GND_NAV_040	Broadcast navigation data shall be compliant with the GNSS MOPS (RTCA -DO 229)

Table 32 Wide Area Data Distribution Requirements

3.3.5.3 Surveillance

This functional area is concerned with surveillance data capture, but not with the processing of that data. Sources may be Independent Surveillance, Cooperative Independent Surveillance, ADS-C or ADS-B.

The function provides its user with ‘raw’ surveillance data covering the environment especially: the traffic, the weather, the relief.

The data provided by this function includes plot and track data, i.e. identification of aircraft and the accurate representation of their position and kinetic characteristics (position, velocity, identification, intentions, etc.).

MA-AFAS does not add any further element in this functional area with respect to the model developed within FARADEX.

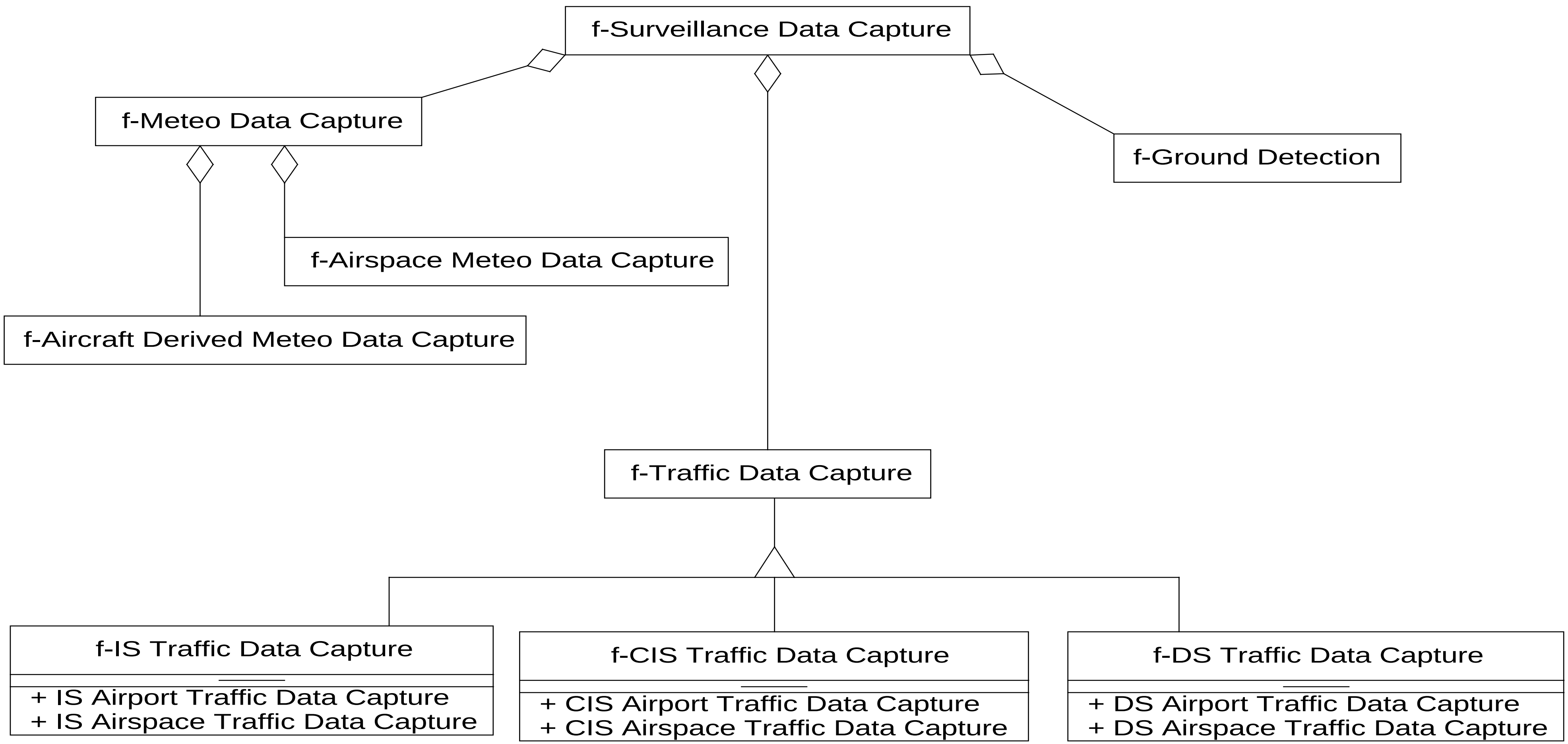


Figure 20. Surveillance Data Capture fd-diagram

3.3.6 Data Management

This functional area concerns the process of combining data into useful products in order to serve users in their construction of the current or future Air Traffic Situation.

Functions, which are considered relevant to data management, are AEP (AIS & EDPD), Surveillance Data Processing and FDP.

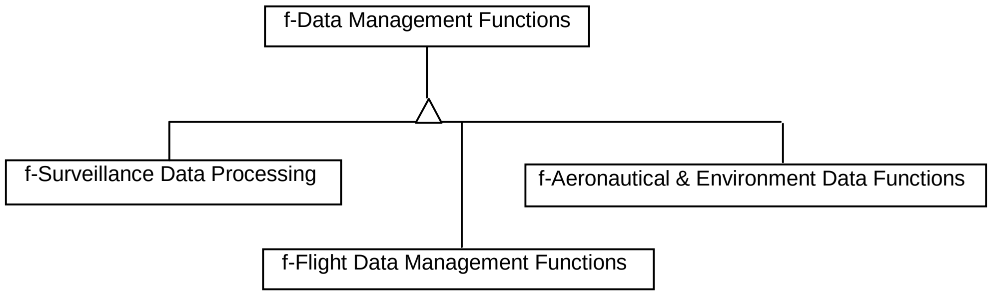


Figure 21.Data Management Functions fd-diagram

The data management for the ground is split in three different parts: Surveillance Data Processing, Flight Data Management and Aeronautical and Environmental Data Management (as it can be seen in figure 21).

- *Surveillance Data Processing:*
  The objective of Surveillance Data Processing is to provide the surveillance Air Traffic 'picture' by elaborating and distributing Status Vector data from the various raw data information extracted by the various surveillance data capture systems, while ensuring continuity with other Surveillance Data Management systems.

- *Flight Data Management:*
  The objective of Flight Data Management is to ensure real time processing, fusion and re-distribution of the various data related to the flights. This includes the three main following functional areas: Air Traffic Situation Compilation, Air Traffic Situation Correction, Data management and Distribution.

- *Aeronautical and Environmental Data Management:*
  The Aeronautical Data Management Service provides an Aeronautical Information Service. It ensures that information is provided to ensure the safety and correctness of air navigation, the regularity and efficiency of which is of very high importance. The information presented to users of the system includes reports regarding the availability of navigational aids and facilities, and the services associated with them. The users of the AIS are services responsible for pre-flight and in-flight dynamic information delivery. The following information services are provided: AIP, NOTAM, AIRAC, AIC and PIB

  Environment Data Management Services mainly manages meteo data. This means: it uses meteo data from various sources in order to provide them to Meteo Service Provider Function, it uses meteo nowcasts and forecasts from the Meteo Service Provider Function in order to provide them to various users. The function also manages aircraft data (e.g. performance).

3.3.6.1 Surveillance Data Processing

The objective of Surveillance Data Processing is to provide the surveillance Air Traffic 'picture' by elaborating and distributing Status Vector data from the various raw data information extracted by the various surveillance data capture systems, while ensuring continuity with other Surveillance Data Management systems.

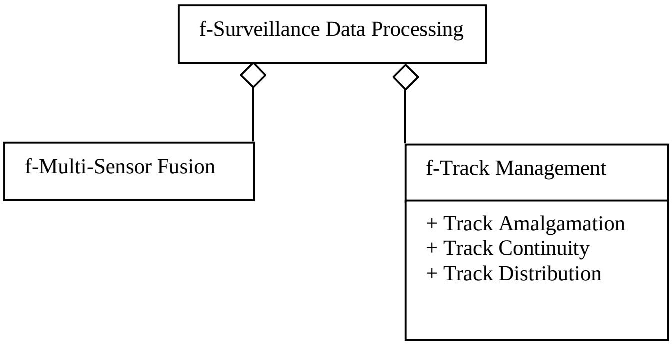


Figure 22. Surveillance Data Processing (fd diagram)

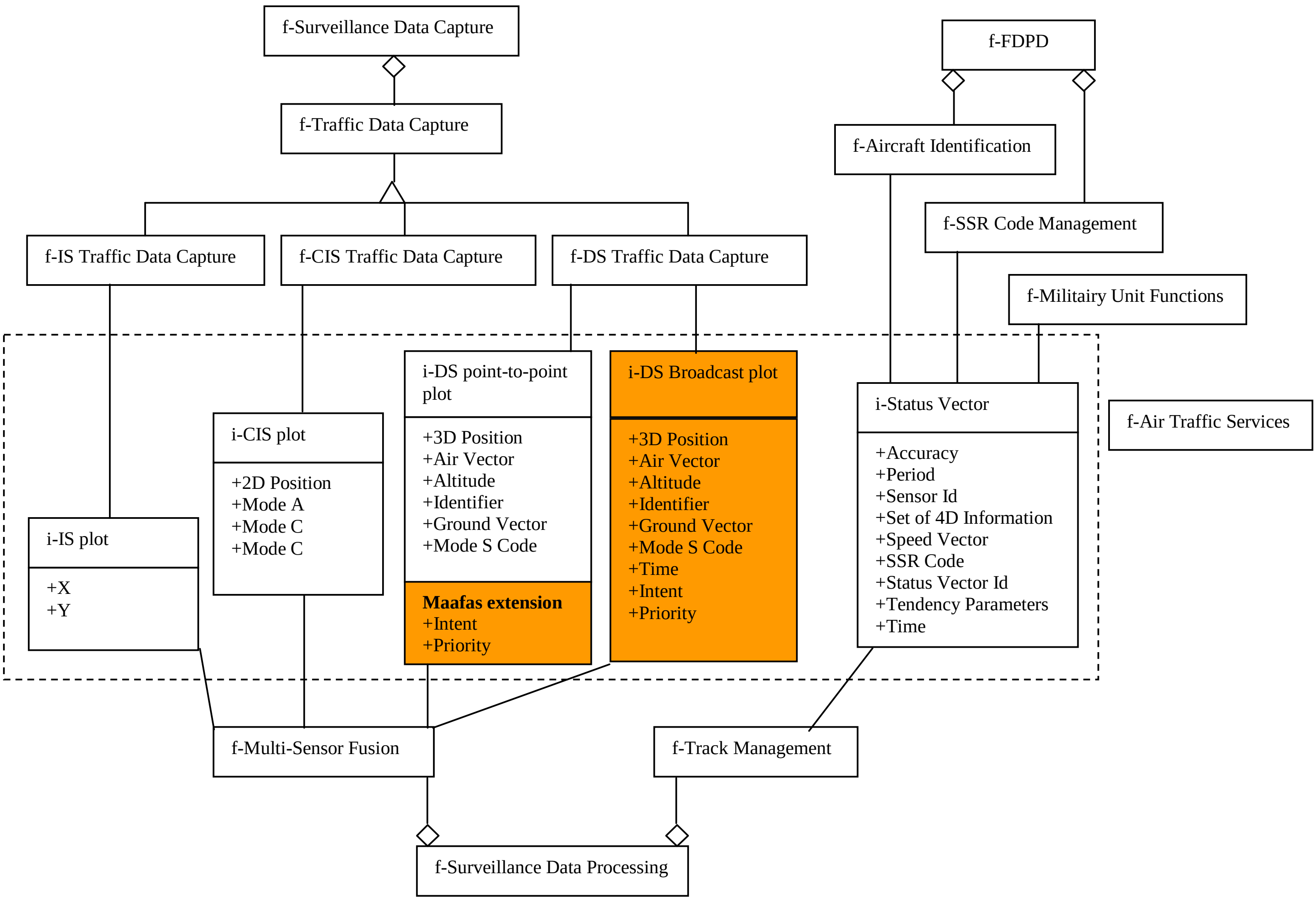


Figure 23. Surveillance Data Processing fi-diagram

3.3.6.1.1 Multi-Sensor Fusion

3.3.6.1.1.1 Description

The objective of this function is to collect the various raw data surveillance data, provided by the CNS f-Traffic Data Capture for the different surveillance sources, either dependent or independent, and to ensure the fusion of all the information related to the same flight to elaborate more accurate and complete elementary surveillance information.

3.3.6.1.1.2 Requirements

Identification	Requirement description
GND_DMG_001	The Multi Sensor Fusion function shall have the capability to manage ADS-B and ADS-C position reports

Table 33. Multi Sensor Fusion Requirements

3.3.6.1.2 Track Management

3.3.6.1.2.1 Description

This function is partitioned into:

- Track Amalgamation
  The objective of this function is to apply tracking algorithms, both in the horizontal and vertical dimensions, to the various elementary surveillance data of a given flight to group them, smooth their related positions while checking the validity limit of the resulting track, which is linked to the loss of raw surveillance information. This function may also have to update sensor biases (corresponds to corrections on sensor parameters to compensate eventual sensor positioning and tuning errors).
  This function then produces flight status vectors from the tracks, deriving kinematic data as well as tendency parameters for the flight. If no new information comes during a certain time the Status Vector might be extrapolated, in order to avoid the deletion of the Status Vector in case of a short temporary loss of the raw data information.

- Track Continuity
  Several SDM may not use the same set of surveillance sensors and/or are not provided with the same elementary data and/or are not using the same tracking algorithms. This may result in some inconsistencies between the Status Vectors they process for a same flight. This is particularly critical in buffer zone where coordinating controllers are provided with vectors from different SDM. The objective of Track Continuity is to correct these inconsistencies so that the surveillance data is provided on a more continuous basis in such cases.

- Track Distribution
  The objective of this function is to ensure the distribution of status vector to the right Controller Working Positions as well as to the client application.

3.3.6.1.2.2 Requirements

Identification	Requirement description
GND_DMG_005	The Track Manager function shall have the capability to exploit intent information contained within ADS

	reports in order to produce a/c Status Vector

Table 34. Track Management Requirements

3.3.6.2 Flight Data Management

The objective of Flight Data Management is to ensure real time processing, fusion and re-distribution of the various data related to the flights.

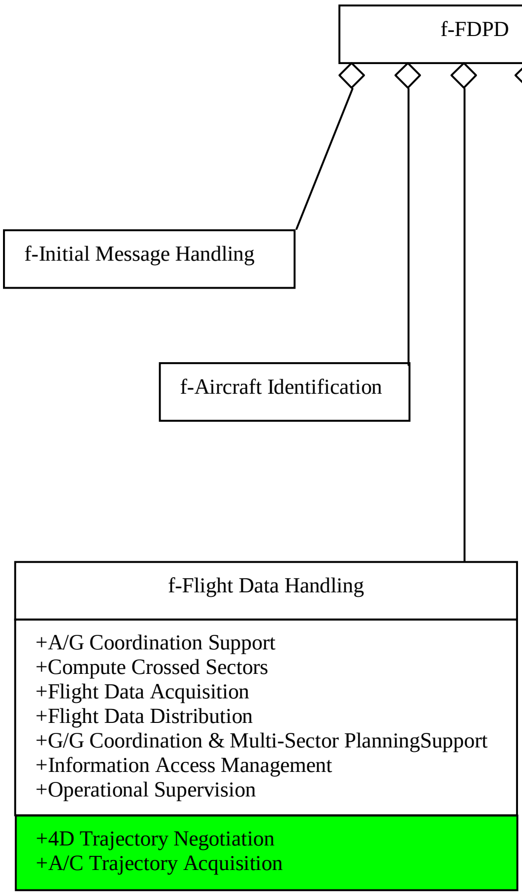


Figure 24. FDPD fd-diagram

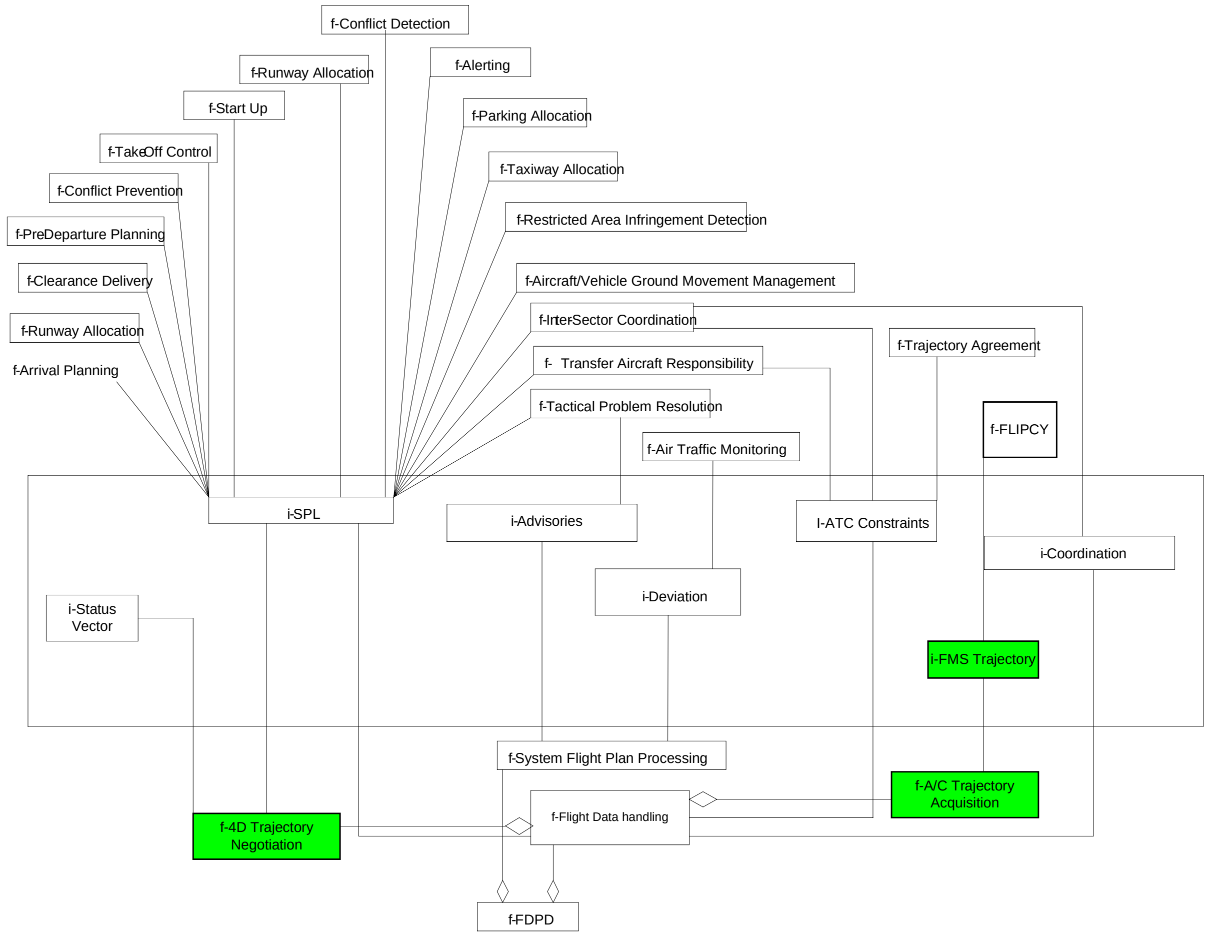


Figure 25. FDPD / ATS fi-diagram

3.3.6.2.1 System Flight Plan Processing

The main objective of f-System Flight Plan Processing is to both elaborate and manage the system view of the flight plan, the System Flight Plan (SPL). The SPL consists of all objects related to flight planning information. It also produces the route the flight has to follow, which meets: the wishes of the airlines, the air traffic control constraints and the environment constraints.
The first information known about the flight plan is what is usually described within an IFPL. This information is mainly sent by airlines or by pilot to the IFPS system but also by other f-FDPD when the flight plan is modified.
This initial flight plan and a part of the environment (airline rules, meteorological conditions, airspace) are transformed in a list of constraints, referred to as the strategic constraints, that the aircraft will respect during the flight. The interest of this transformation is that it will be easier to

combine these constraints with the constraints induced by the orders sent by the controller during the flight control and referred to as tactical constraint.
Using this list of constraints, the system builds an internal representation of the route, called the trajectory, that the flight will follow. This route is a list of segments, each indicates what to do between two points to comply with the constraints. For each segment, a manoeuvre, an exit condition and some constraints are detailed. This transformation is useful for internal processes.
From this trajectory, several other views of the flight data will be derived such as the list of sectors, the coordination parameters and status, the status vector correlation and the deviation.
An additional function is the Conflict Detection which detects potential conflicts between aircraft in the short and medium term exploiting available Status Vector and SPL information.

3.3.6.2.2 Flight Data Handling

3.3.6.2.2.1 Description

The Flight Data Acquisition function objective is to collect in real-time all the information related to the flight but not provided through the IFPL from the Initial Flight Plan Processing, the surveillance data from the SDPS and the environment data from the environment data management services.
The Flight Data Distribution function is in charge of distributing flight information to all interested Units as well as to the Airborne system.
The Information Access Management function manage for every flight the set of possible transactions for every Control Units.
The Operational Supervision function aims at collecting and managing the description of the operational configuration of the ATC centre, and especially the assignation of unitary airspace sector as well as MSP area to Control suite with their related parameters.
Ground to Ground Coordination is a complex process by which ATC controllers use to transfer the control of flights between themselves.
The A/G Coordination function objective is to support coordination between pilots and controllers through their automated systems.
The Compute Crossed Sectors function objective is to compute the list of airspace sector that the flight is planned to cross.
The 4D Trajectory Negotiation function objective is to automatically update the SPL after the controller and the pilot have agreed a new trajectory using data link communication.
The A/C Trajectory Acquisition function objective is to capture the trajectory downlinked by the airborne system on ground system request.

3.3.6.2.2.2 *Requirements*

Identification	Requirement description
GND_DMG_010	The Flight Data Handling function shall have the capability to automatically update the SPL after controller/pilot data link trajectory negotiation
GND_DMG_015	The A/C Trajectory Acquisition shall have the capability to acquire trajectory from the FMS

Table 35. Flight Plan Data Handling Requirements

3.3.7 Airline Operations Centre

3.3.7.1 AOC Functional Model

The basic AOC Functional Model (covering the current AOC functionality) has been developed by extracting the f-classes and i-classes that are relevant to AOC from the FARADEX generic model. The resulting AOC ground system model is shown in the following figure.

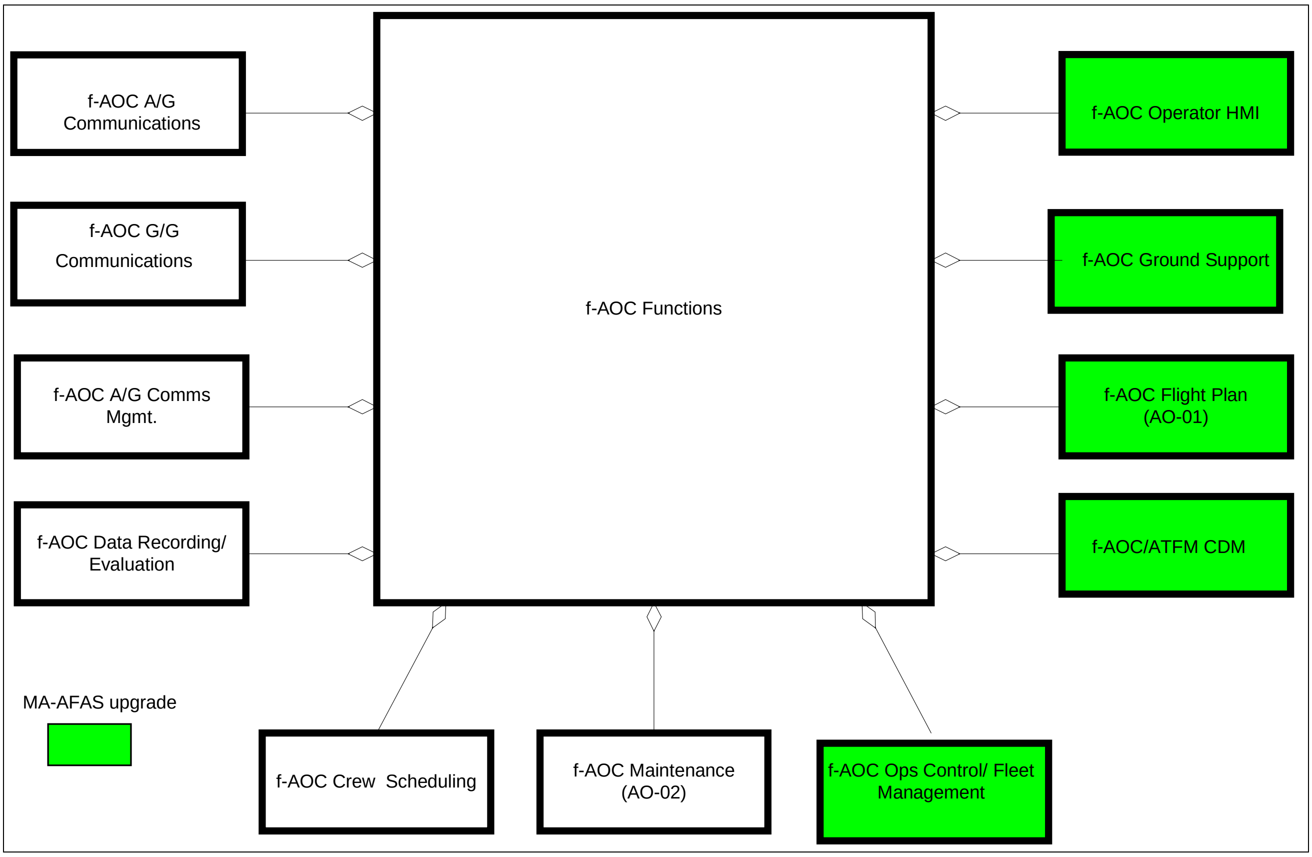


Figure 26. Ground AOC System fd-Diagram

The next figure shows the more detailed AOC system functional diagram, indicating the i-classes exchanged between internal functions.
The data exchanges related to the supporting functions which are not of interest for MA-AFAS (Crew Scheduling, Ground Support) have not been indicated.
The diagram includes the Data Recording/Evaluation. The Operator HMI has been included because of the inherent interaction between the AOC operator and the AOC functions.
The selected MA-AFAS AOC functions (AO-01 ...AO-05) are a part of this AOC model. In the following text these functions will be discussed.
The following data types have been selected as relevant to MA-AFAS:

- AOC Constraints
- Planned Trajectory

- Requests To AOC
- Meteo Data (only the forecast part)
- Flight Progress Info (including OOOI)
- Aircraft Systems Info (including Aircraft Condition Monitoring System-ACMS- and snag report)

Based on this selection the following data classes have been defined:

- i-AOC A/G CDM Data (constructed class)
  - i-AOC Constraints (FARADEX class)
  - i-Requests To AOC (FARADEX class)
  - i-Planned Trajectory (FARADEX class)
- i-AOC Meteo Data (constructed class restricted to the uplinked meteo forecast data of the FARADEX i-Meteo Data class)
- i-Aircraft Systems Info (FARADEX class)
- i-AOC Flight Management Data (constructed class)
  - i-Flight Progress Info (FARADEX class)
  - i-OOOI Reports (new class)

These four classes have been highlighted in the Figure 27.

Following classes have been additionally added, which are related to the additional general requirements for the ground ATM platform:

- i-AOC DL Initialisation Data (constructed class), (REQ_CO_071)
- i-AOC A/G Recording Data (constructed class), (REQ_GE_111, REQ_GE_116)
- i-AOC G/G Recording Data (constructed class), (REQ_GE_111, REQ_GE_116)

The following class has been added as required for managing AOC data link communications:

- i-AOC DL Management Data (constructed class)

Finally, three classes have been added as a background support for the ground CDM and other AOC functions:

- i-AOC G/G CDM Data (constructed class)
  - i-Planned Trajectory (FARADEX class)
  - i-AOC Constraints (FARADEX class)
- i-Meteo Data (FARADEX class)
- i-Aeronautical Data (FARADEX class)

The i-classes have in turn been associated with the AOC-internal functions. The detailed content of the i-classes (constructed classes/ FARADEX classes/ new classes) is indicated in the Figure 28.

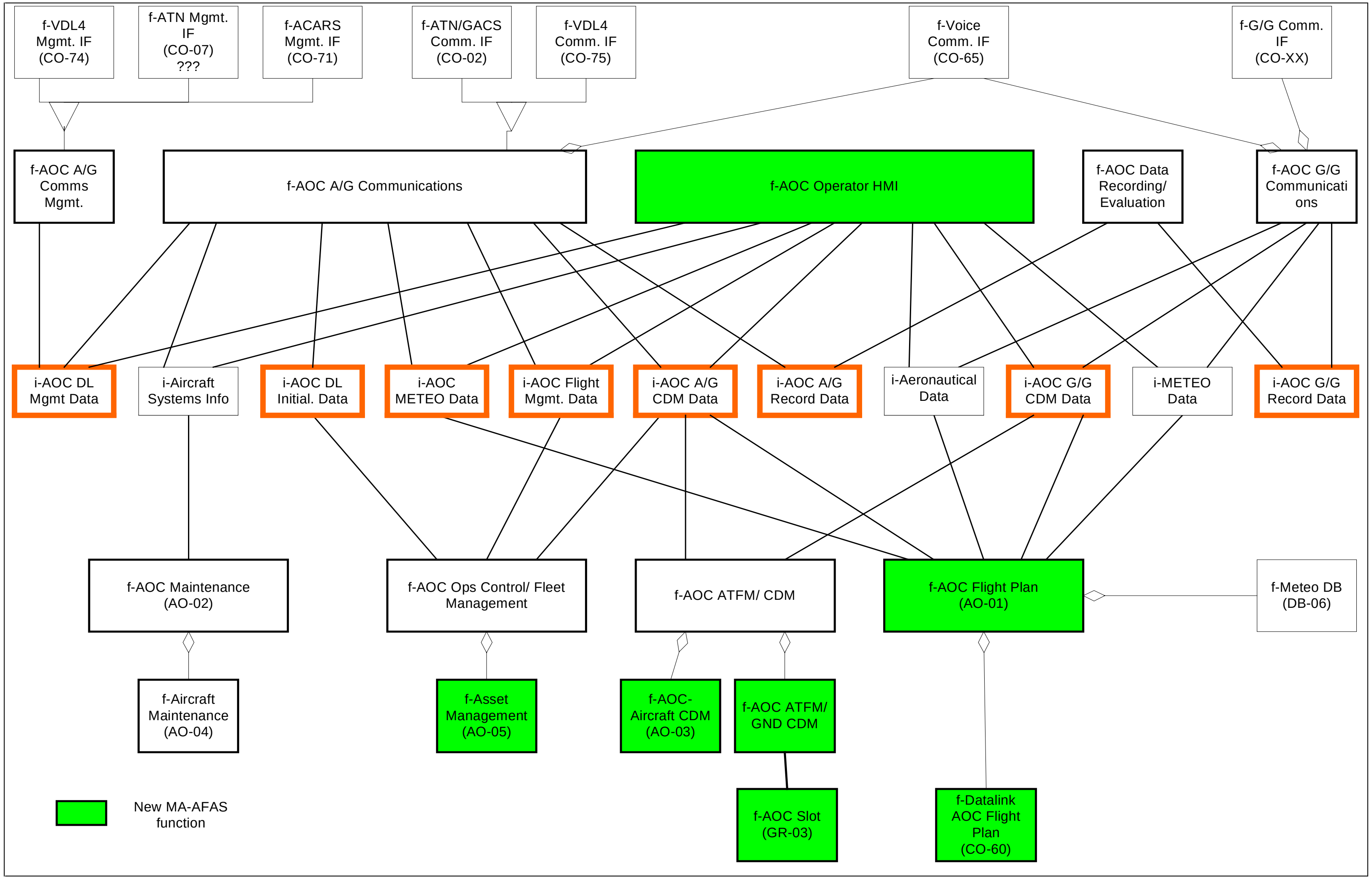


Figure 27. Ground AOC System fi-diagram

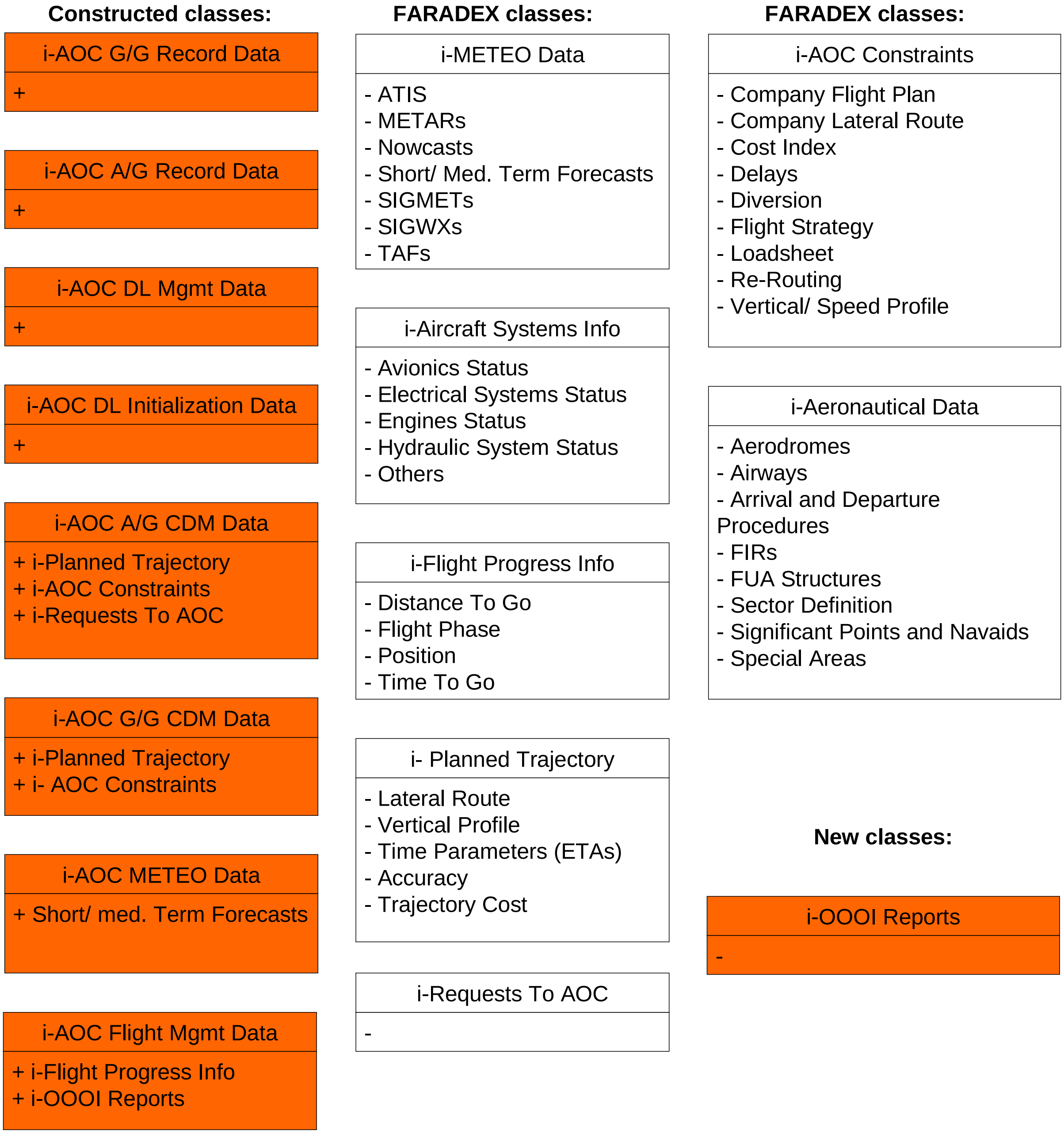


Figure 28. Ground AOC System i-Classes

3.3.7.2 AOC Functions (MA-AFAS Focus)

3.3.7.2.1 AO-01 AOC Flight Plan

3.3.7.2.1.1 Description

The AOC flight planning is a complex process including: payload determination, alternate airport determination, route selection, speed / profile calculations, flight time estimation, re-dispatching

flights for long range flights, en-route alternate selection, fuel requirements, aircraft minimum equipment verification, flight plan co-ordination with the pilot, flight plan filing with the ATS provider and other tasks.
The flight planning function uses different kind of information such as meteo data, maintenance data and requirements, crew schedule, take-off power settings, aircraft data, airport/ station data, navigation data, marketing data, flight schedule data. Some of this information (Take-off performance calculation, Weight & Balance calculation) may be prepared by dedicated support systems.
The f-AOC Flight Plan is an existing function. The following MA-AFAS requirements are covered by the existing AOC functionalities.

- Capability to exchange weather information with the Meteorological Agencies
- Capability to uplink the weather information to the A/C

However, MA-AFAS OC adds some specific requirements to the AOC flight planning as listed below:

- Capability to include the (new) Precision Approach/ Departure procedures in the planning process
- Capability to uplink the 4D Flight Plan to the A/C
- Capability to gather weather information from the A/C

The AOC Flight Plan function (AO-01) is the ground-only function and is dependent on the CO-46/DYNAV, CO-63/ FIS and CO-60/Datalink AOC Flight Plan functions.
It has been assumed here that FIS data and a subset of the ATC constraints provided through the DYNAV service - both being uplinked to the A/C by the ATC ground systems - will be used by the avionics (4D-01/Trajectory Generation function) to produce "new AOC preferred trajectory". This trajectory would in turn be used for the 4D-trajectory negotiation with the ATS ground system, as well as submitted to the f-AOC Flight Plan function to improve the ground AOC planning.
The CO-60/Datalink AOC Flight Plan has been assumed to be used for both uplink and downlink of the 4D trajectory.

3.3.7.2.1.2 Requirements

Identification	Requirement description
	See Requirements GND_OPC_085, GND_OPC_096 , GND_OPC_101, GND_OPC_106
GND_AOC_001	The AOC Flight Planning function shall be capable to generate 4D trajectories within given constraints (set of parameters).
GND_AOC_005	The AOC Flight Planning function shall be capable to file the AOC flight plan with ATC
GND_AOC_010	The AOC Flight Planning function shall be capable to transmit supporting data to the selected a/c, including load-sheet data and takeoff settings.
GND_AOC_015	The AOC Flight Plan function shall be capable to process the 4D trajectory data provided by the A/C

Table 36. AOC Flight Plan Requirements

3.3.7.2.2 AO-02/AO-04 AOC Maintenance/Aircraft Maintenance

3.3.7.2.2.1 Description

The f-AOC Maintenance (AO-02) function deals with the maintenance scheduling and other maintenance tasks for the whole fleet. It assures that the required maintenance activities for each particular A/C are performed on time and according to the specified procedures.

The f-AOC Maintenance function depends on the f-Aircraft Maintenance function (AO-04). The f-Aircraft Maintenance function (AO-04) deals with the maintenance tasks (data collection, data evaluation, advisories...) for the particular A/C. The data collection includes the engine take-off reports, engine en-route data, as well as down linking of other A/C parameters.
Both functions are already existing in the AOC environment and use dedicated AOC A/G communications services which are a part of the existing AOC data link functionality (CO-35). As MA-AFAS has not added any new maintenance-related functionality, the f-AOC Maintenance will not be detailed here.

3.3.7.2.2.2 Requirements

Identification	Requirement description
GND_AOC_016	The AOC Maintenance function shall be capable to receive and process Aircraft System Information received from the aircraft

Table 37. AOC Maintenance/Aircraft Maintenance

3.3.7.2.3 AO-03 Aircraft/AOC CDM

3.3.7.2.3.1 Description

This function involves the AOC ground system and the A/C. It is a part of the general AOC ATFM/CDM function, which also involves the transactions with an ATC ground system.
CDM could be of highest interest (brings immediate benefits) for the Airlines and is applicable to the Pre-flight, En-route, Departure and Arrival flight phases. The prime interest for MA-AFAS is in-flight CDM: it is time-critical and requires new standardised procedures and services for the G/G AOC-ATS interactions (several USA/EUROCONTROL projects/studies proposed a set of such CDM-oriented services).
The particular MA-AFAS interest lies in in-flight re-planning of the 4D trajectory. An aircraft being capable to plan 4D trajectories may initiate the 4D-trajectory negotiation dialogue with the ground ATC system. Once agreed, the new trajectory should also be made available to the AOC ground system to be included in the AOC planning process. The AOC ground system may also initialise the trajectory negotiation process on its own by submitting the initial proposal to the 4D trajectory generation avionics function.
The 4D planning capability is required both onboard aircraft and by the AOC system, additionally the AOC data link (and a dedicated AOC communications service) is required for the reliable transfer of the 4D trajectory information.
As the delay time requirements for such service could be more critical than for the rest of the AOC services, it could be favourable to deploy it by using ATN/ GACS end system.

NOTE. This service may appear to be similar to the negotiation service used between an aircraft and the ATS ground system. However, the AOC 4D flight plans typically include more waypoints than the version that is filed with the ATS ground system, so the detailed content of both services may be different.

3.3.7.2.3.2 Requirements

Identification	Requirement description
	See Requirements GND_OPC_011, GND_OPC_030

Table 38. AOC-Aircraft CDM Requirements

3.3.7.2.4 AO-05 Asset Management

3.3.7.2.4.1 Description

The Asset Management is an existing AOC task. The MA-AFAS OC has foreseen that the AOC system exploits the availability of the position and intent data (e.g. for alerting the dispatcher in case of any significant deviation from the current flight plan or improving the allocation of Airport resources by monitoring the aircraft ground movements).

3.3.7.2.4.2 Requirements

Identification	Requirement description
	See Requirements GND_OPC_075, GND_OPC_076

Table 39. AOC-Asset Management Requirements

3.3.7.2.5 AOC Operator HMI

3.3.7.2.5.1 Description

MA-AFAS interests lies in enhancing existing AOC Operator HMI to take into account new information available from the aircraft.

3.3.7.2.5.2 Requirements

Identification	Requirement description
GND_AOC_020	The AOC System shall provide a map displaying current estimated position of all active aircraft belonging to the airline
GND_AOC_025	AOC ground HMI platform shall display all messages exchanged between aircraft and AOC in current aircraft flight.
GND_AOC_030	AOC ground/air HMI platforms shall be capable to receive files transferred from aircraft to AOC and vice versa.

Table 40. AOC Operator HMI Requirements

3.3.7.2.6 AOC System Communications specific requirements

Identification	Requirement description
GND_AOC_035	The f-AOC A/G Comms function shall provide support (CO-60/Datalink AOC Flight Plan) for the exchange of the 4D trajectory and other A/G CDM data with corresponding A/C system.
GND_AOC_040	The f-AOC A/G Comms function shall provide support (ATN/GACS I/F, FRAME MODE/VDL4 I/F) for the exchange of the AOC Flight Management data with the corresponding A/C system.
GND_AOC_045	The f-AOC A/G Comms function shall provide support (ATN/GACS I/F, FRAME MODE/VDL4 I/F) for the exchange of the AOC Meteo data with the corresponding A/C system.
GND_AOC_050	The f-AOC A/G Comms function shall provide support (ATN/GACS I/F, FRAME MODE/VDL4 I/F) for the Initialisation of the AOC data link (flight plan association[1])
GND_AOC_055	The f-AOC A/G Comms function shall provide support (ATN/GACS I/F, FRAME MODE/VDL4 I/F) for the downlink of the Aircraft Systems Information
GND_AOC_060	The f-AOC G/G Comms function shall provide support (ATN/GACS I/F, FRAME MODE/VDL4 I/F) for the exchange of the ground CDM data with the corresponding ATC system.
GND_AOC_065	The f-AOC G/G Comms function shall provide support (ATN/GACS I/F, FRAME MODE/VDL4 I/F) for the reception of the METEO data from external providers
GND_AOC_070	The f-AOC G/G Comms function shall provide support (ATN/GACS I/F, FRAME MODE/VDL4 I/F) for the reception of the Aeronautical data from external providers
GND_AOC_075	The AOC A/G Comms function shall provide support (ATN/GACS I/F, FRAME MODE/VDL4 I/F) for the uplink

[1] Association of the flight with the flight plan shall be executed prior to any other data link communications between an aircraft and the AOC, assuring that all uplink/downlink messages are properly routed.

	of the Aeronautical and Airport Operational Information (NOTAMS) data from the ground

Table 41. AOC Communications Requirements

4 Traceability of the Avionic Requirements

The following table cross checks the requirements captured within this document against the ones listed within ref. [3]. The requirements in ref. [3] have been grouped into small sets (first column of the table) and the related MA-AFAS ground system requirements have been identified and reported in the second column.

Airborne requirements	Ground requirements
[DESN / ANAL] [M-SS-1171] [DESN / ANAL] [M-SS-1172] [DESN / ANAL] [M-SS-1173]	GND_GEN_010 GND_OPC_005
[DESN / ANAL] [M-SS-1174]	
[DESN / ANAL] [M-SS-2180]	GND_OPC_40
Flight Phases	
[AS-P / DEMO] [M-SS-1597] [TT-B / DEMO] [M-SS-1176] [FT-B / DEMO] [M-SS-1177] [FT-B / DEMO] [M-SS-1179] [FT-B / DEMO] [M-SS-1181] [FT-B / DEMO] [M-SS-1723]	GND_GEN_35 GND_GEN_40 GND_GEN_70 GND_GEN_75 GND_GEN_80 GND_GEN_85 GND_GEN_90 GND_GEN_100 GND_GEN_110
[FT-B / DEMO] [M-SS-1178] [FT-B / DEMO] [M-SS-1180]	N/A
[FT-B / DEMO] [M-SS-1182]	GND_GEN_105
4D trajectory Generation	
[SFT / DEMO] [M-SS-1191] [SFT / DEMO] [M-SS-1188] [SFT / ANAL] [M-SS-1189] [SFT / ANAL] [M-SS-1208] [AS-P / DEMO] [M-SS-1200] [AS-P / DEMO] [M-SS-1192] [AS-P / DEMO] [M-SS-1198] [AS-P / DEMO] [M-SS-1202] [IHT / DEMO] [M-SS-2198] [SFT / MEAS] [M-SS-1199] [AS-R / DEMO] [M-SS-1207 [AS-R / DEMO] [M-SS-1214 [AS-R / DEMO] [M-SS-1215] [IHT / DEMO] [M-SS-1769]	N/A
Spacing	
[AS-R / DEMO] [M-SS-1213] [FT-R / DEMO] [M-SS-1531]	N/A
Passing and Crossing	
[SFT / DEMO] [M-SS-1217] [SFT / DEMO] [M-SS-1219]	N/A
Trajectory Negotiation	

[DESN / ANAL] [M-SS-2185] [DESN / ANAL] [M-SS-1694] [IHT / ANAL] [M-SS-1234] [AS-P / DEMO] [M-SS-1716] [AS-P / DEMO] [M-SS-1718] [AS-P / DEMO] [M-SS-1225] [AS-P / DEMO] [M-SS-1227] [AS-P / DEMO] [M-SS-1224] [AS-P / DEMO] [M-SS-1231] [AS-P / DEMO] [M-SS-1618] [AS-P / DEMO] [M-SS-1230]	GND_OPC_035 GND_OPC_45 GND_OPC_50
A/C Guidance	
[AS-B / DEMO] [M-SS-1246] [AS-B / MEAS] [M-SS-1249] [AS-B / DEMO] [M-SS-1616]	N/A
Progress Monitor	
[AS-P / DEMO] [M-SS-1232] [AS-B / DEMO] [M-SS-1251] [IHT / DEMO] [M-SS-2227] [AS-B / DEMO] [M-SS-1717]	N/A
HMI	
[IHT / DEMO] [M-SS-1342] [IHT / DEMO] [M-SS-1212] [IHT / DEMO] [M-SS-1525] [IHT / DEMO] [M-SS-1742] [IHT / DEMO] [M-SS-1724] [IHT / DEMO] [M-SS-1221] [AS-P / DEMO] [M-SS-1343] [AS-P / DEMO] [M-SS-1222] [AS-P / DEMO] [M-SS-1223] [IHT / DEMO] [M-SS-1252] [AS-R / DEMO] [M-SS-1250]	N/A
[IHT / DEMO] [M-SS-1699]	GND_ATS_040
[TT-R / DEMO] [M-SS-1513]	GND_OPC_090
[IHT / INSP] [M-SS-1260] [IHT / DEMO] [M-SS-1261] [IHT / DEMO] [M-SS-2181] [IHT / DEMO] [M-SS-1262] [IHT / DEMO] [M-SS-1346] [IHT / DEMO] [M-SS-1348] [IHT / DEMO] [M-SS-1264] [IHT / DEMO] [M-SS-1265] [IHT / MEAS] [M-SS-1266]	N/A
Taxi clearances	
[DESN / ANAL] [M-SS-1268] [DESN / ANAL] [M-SS-1269] [IHT / DEMO] [M-SS-2195] [DESN / ANAL] [M-SS-1700] [AS-P / DEMO] [M-SS-2232] [IHT / DEMO] [M-SS-1271] [IHT / DEMO] [M-SS-1274]	GND_OPC_071 GND_OPC_072 GND_ATS_045
Taxi Guidance	

[AS-S / ANAL] [M-SS-1701] [AS-S / DEMO] [M-SS-1272] [AS-S / DEMO] [M-SS-1622]	N/A
Runway warning	
[AS-S / ANAL] [M-SS-1702] [AS-S / DEMO] [M-SS-1349] [AS-S / DEMO] [M-SS-1276] [AS-S / DEMO] [M-SS-1278]	N/A
ASA Conflict Detection	
[AS-S / DEMO] [M-SS-1284] [DESN / ANAL] [M-SS-1285]	N/A
ASA Conflict Resolution	
[DESN / DEMO] [M-SS-1288] [DESN / ANAL] [M-SS-1289] [DESN / ANAL] [M-SS-1609] [DESN / ANAL] [M-SS-1607]	N/A
ASA Manoeuvre Planning	
[SFT / DEMO] [M-SS-2190] [SFT / DEMO] [M-SS-2193] [SFT / DEMO] [M-SS-2191] [SFT / DEMO] [M-SS-2192]	N/A
ASA Surveillance	
[IHT / DEMO] [M-SS-2197]	N/A
ASA CDTI	
[AS-S / MEAS] [M-SS-1691] [AS-S / DEMO] [M-SS-1690] [IHT / DEMO] [M-SS-2196] [AS-S / DEMO] [M-SS-1317] [AS-S / DEMO] [M-SS-1324] [AS-S / DEMO] [M-SS-1325]	N/A
MAS Operations	
[AS-S / DEMO] [M-SS-1326] [AS-S / DEMO] [M-SS-1743] [AS-S / DEMO] [M-SS-1328] [AS-S / DEMO] [M-SS-1329]	N/A
FFAS Operations	
[AS-S / DEMO] [M-SS-1334] [AS-S / DEMO] [M-SS-1335] [AS-S / DEMO] [M-SS-1337] [AS-S / DEMO] [M-SS-1338] [AS-S / ANAL] [M-SS-1339] [AS-S / DEMO] [M-SS-1336]	N/A
Precision Approach and Departure	
[FT-B / DEMO] [M-SS-1294] [FT-B / DEMO] [M-SS-1305]	N/A
GBAS for ILS-like Straight Line Precision Approaches	
[AS-P / DEMO] [M-SS-1298] [FT-B / DEMO] [M-SS-1705]	
Curved Approach	

[AS-P / DEMO] [M-SS-1703] [FT-B / DEMO] [M-SS-1300]	N/A
Curved Departure	
[AS-P / DEMO] [M-SS-1704] [FT-B / DEMO] [M-SS-1304]	N/A
Cockpit HMI	
[AS-P / DEMO][M-SS-1354] [AS-P / SIMI][M-SS-1355] [AS-P / DEMO] [M-SS-1747] [FT-B / DEMO] [M-SS-1748] [DESN / ANAL] [M-SS-1358] [DESN / ANAL] [M-SS-1360] [IHT / DEMO] [M-SS-1361] [DESN / ANAL] [M-SS-1363] [DESN / ANAL][M-SS-1365] [DESN / ANAL][M-SS-1367]	N/A
DLL	
[DESN / ANAL] [M-SS-1399] [DESN / ANAL] [M-SS-1400] [SATC / DEMO] [M-SS-1725]	GND_COM_120 GND_COM_130 GND_COM_135
ACL	
[DESN / ANAL] [M-SS-1383] [SATC / DEMO] [M-SS-1625]	GND_COM_170
ACM	
[DESN / ANAL] [M-SS-1381] [SATC / DEMO] [M-SS-1708]	GND_COM_175
DSC	
[DESN / ANAL] [M-SS-1374] [SATC / DEMO] [M-SS-1626] [FT-B / DEMO] [M-SS-1627]	GND_COM_180
DCL	
[DESN / ANAL] [M-SS-1370] [SATC / DEMO] [M-SS-1628]	GND_COM_185
Taxi Management	
[DESN / ANAL][M-SS-2230] [DESN / ANAL] [M-SS-2231]	GND_COM_190
DATIS	
[DESN / ANAL] [M-SS-1377]	GND_ATS_025
[DESN / ANAL] [M-SS-1640]	N/A
[SATC / DEMO] [M-SS-1726]	N/A
DRVR	
[DESN / ANAL] [M-SS-1643]	GND_ATS_030
[DESN / ANAL] [M-SS-1644]	N/A
[SATC / DEMO] [M-SS-1551]	N/A
DSIGMET	
[DESN / ANAL] [M-SS-1641]	GND_ATS_035
[DESN / ANAL] [M-SS-1642]	N/A
[SATC / DEMO] [M-SS-1549]	N/A
FLIPCY	

[DESN / ANAL] [M-SS-1236] [DESN / ANAL] [M-SS-1237] [DESN / ANAL] [M-SS-1238] [DESN / ANAL] [M-SS-1239] [SATC / DEMO] [M-SS-1727]	GND_COM_200 GND_COM_205
DYNAV	
[DESN / ANAL] [M-SS-1241] [SATC / DEMO] [M-SS-1728]	GND_COM_210
COTRAC	
[DESN / ANAL] [M-SS-1244] [SATC / DEMO] [M-SS-2182]	GND_COM_215
PPD	
[DESN / ANAL] [M-SS-1379] [SATC / DEMO] [M-SS-1729]	GND_COM_216
ATSAW/COSEP	
[AS-S / DEMO] [M-SS-1731] [DESN / ANAL] [M-SS-1763]	GND_ATS_001 GND_ATS_005 GND_ATS_010 GND_ATS_015 GND_ATS_050 GND_ATS_060 GND_ATS_065
AMC	
[DESN / ANAL] [M-SS-1543] [SATC / DEMO] [M-SS-1730]	GND_COM_225
AOC Flight Plan	
[SATC / DEMO] [M-SS-1503] [AS-P / DEMO] [M-SS-1680] [AS-P / DEMO] [M-SS-1710] [SATC / DEMO] [M-SS-1714] [SATC / DEMO] [M-SS-1715]	GND_OPC_085 GND_AOC_001 GND_AOC_005 GND_AOC_010 GND_AOC_015
AOC Meteo Data	
[SATC / DEMO] [M-SS-1712] [AS-P / DEMO] [M-SS-1713]	GND_OPC_096 GND_OPC_101 GND_OPC_106
[N/A / TBD] [M-SS-1506]	N/A
A/C Maintenance	
[AS-P / DEMO] [M-SS-1385] [IHT / DEMO] [M-SS-2214] [IHT / DEMO] [M-SS-2215]	No New MA-AFAS Requirements
Asset Management	
[AS-P / DEMO] [M-SS-1387]	GND_OPC_075 GND_OPC_076
CFMU	
[IHT / DEMO] [M-SS-2165] [IHT / DEMO] [M-SS-2166]	GND_OPC_010 GND_OPC_011
Weather Information	
[IHT / DEMO] [M-SS-2168] [IHT / DEMO] [M-SS-2169]	GND_OPC_095 GND_OPC_096 GND_OPC_100 GND_OPC_101
AOC Trajectory Negotiation	

[IHT / DEMO] [M-SS-1522] [IHT / DEMO] [M-SS-2170]	GND_OPC_025 GND_OPC_030 GND_OPC_035 GND_OPC_080 GND_OPC_085
ATN Communications	
[DESN / ANAL] [M-SS-1390] [AS-P / MEAS] [M-SS-1391] [AS-P / MEAS] [M-SS-1636] [AS-P / MEAS] [M-SS-1635] [AS-P / MEAS] [M-SS-1397] [AS-P / MEAS] [M-SS-1733] [SATC / MEAS] [M-SS-2176] [DESN / ANAL] [M-SS-1402] [DESN / ANAL] [M-SS-1372] [DESN / ANAL] [M-SS-1403] [AS-P / DEMO] [M-SS-1734] [DESN / ANAL] [M-SS-1767] [DESN / ANAL] [M-SS-1768] [DESN / ANAL] [M-SS-2183] [DESN / ANAL] [M-SS-1409] [DESN / ANAL] [M-SS-2177] [DESN / ANAL] [M-SS-1735] [AS-P / MEAS] [M-SS-1709] [SATC / MEAS] [M-SS-2178] [SATC / DEMO] [M-SS-1736]	GND_COM_070 GND_COM_075 GND_COM_080 GND_COM_085 GND_COM_090 GND_COM_095 GND_COM_100 GND_COM_110 GND_COM_115 GND_COM_130 GND_COM_150 GND_COM_160
A/C Broadcast Communications	
[AS-P / MEAS] [M-SS-2153] [SATC / MEAS] [M-SS-2179] [AS-P / MEAS] [M-SS-1564] [AS-P / MEAS] [M-SS-1563] [DESN / ANAL] [M-SS-1407] [DESN / ANAL] [M-SS-2184]	N/A
Ground Broadcast Communications	
[DESN / ANAL] [M-SS-2154] [AS-P / MEAS] [M-SS-1535] [SATC / MEAS] [M-SS-2172] [FT-B / MEAS] [M-SS-1405] [SATC / MEAS] [M-SS-2173] [SATC / MEAS] [M-SS-2171] [FT-B / MEAS] [M-SS-1634] [DESN / ANAL] [M-SS-2236]	GND_COM_001 GND_COM_005 GND_COM_010 GND_COM_015 GND_COM_020 GND_COM_025 GND_COM_045 GND_COM_060 GND_COM_065
GBAS	
[FT-B / MEAS] [M-SS-1411] [DESN / ANAL] [M-SS-2237]	GND_NAV_005 GND_NAV_020 GND_NAV_025 GND_NAV_030
SBAS	

[FT-B / MEAS] [M-SS-1413] [FT-B / INSP] [M-SS-1679] [DESN / ANAL] [M-SS-2238]	GND_NAV_001 GND_NAV_015 GND_NAV_020 GND_NAV_025 GND_NAV_040
Voice Communications	
[FT-B / DEMO] [M-SS-1415] [SATC / DEMO] [M-SS-2174]	GND_GEN_110
Addressed VDL 4 Communications	
[FT-B / DEMO] [M-SS-1419] [SATC / DEMO] [M-SS-2175]	GND_COM_260
All other Requirements	
[DESN / ANAL] [M-SS-1421] [AS-P / DEMO] [M-SS-2207] [IHT / DEMO] [M-SS-2208] [IHT / INSP] [M-SS-2257] [IHT / INSP] [M-SS-2258] [IHT / INSP] [M-SS-2259] [IHT / INSP] [M-SS-2261] [IHT / INSP] [M-SS-2262] [DESN / ANAL] [M-SS-1424] [DESN / ANAL] [M-SS-1426] [IHT / MEAS] [M-SS-1428] [IHT / MEAS] [M-SS-1753] [FT-B / DEMO] [M-SS-1201] [IHT / DEMO] [M-SS-2210] [IHT / DEMO] [M-SS-2211] [DESN / ANAL] [M-SS-1666] [DESN / ANAL] [M-SS-1687] [IHT / INSP] [M-SS-2200] [IHT / INSP] [M-SS-2201] [IHT / INSP] [M-SS-2202] [FT-B / INSP] [M-SS-1752] [AS-P / DEMO] [M-SS-1688] [SOFT / MEAS [M-SS-1438] [AS-B / MEAS] [M-SS-1443] [AS-B / MEAS] [M-SS-1662] [DESN / ANAL] [M-SS-1445] [DESN / ANAL] [M-SS-1446] [DESN / ANAL] [M-SS-1451] [CERT / INSP] [M-SS-2199] [DESN / DEMO [M-SS-2204] [DESN / DEMO] [M-SS-2205]	N/A

[DESN / ANAL] [M-SS-1453] [AS-B / DEMO] [M-SS-1455] [N/A / TBD] [M-SS-1457] [N/A / TBD] [M-SS-1459] [CERT / INSP] [M-SS-1168] [IHT / INSP] [M-SS-1565] [IHT / INSP] [M-SS-1744] [IHT / INSP] [M-SS-1745] [IHT / INSP] [M-SS-1746] [DESN / ANAL] [M-SS-1465] [DESN / ANAL] [M-SS-1663] [DESN / ANAL] [M-SS-1665]	N/A

Table 42. Airborne requirements traceability matrix

5 Trial platforms capabilities

The following table is intended to anticipate the MA-AFAS ground system requirements expected to be met by the trial platforms that will be exploited for the MA-AFAS validation.

The detailed lists of requirements each trial platform will comply with will be the subject of another MA-AFAS document, namely the “CNS/ATM Ground System Requirements Definition” (D38), to be written under the scope of WP3.

Platform	**CFM**				**ATS**							
	CFCM	IFTM	ETD	MD	TIS	DFIS	DLC	COSEP	4DTN a/c	4D AOC FPN	CD&R 4D intent	Planning FFAS/MAS transitions
IHTP					X	X	X	X	X			
EAT												
NUP					X	X	X				X	
PA												
SMGCS												
AOC		X								X		
VDL4 UK												
MEDUP					X	X	X				X	

Platform	**CNS Service**													
	Broadcast Communications					Addressed Communications								
						ATN Services								
										CPDLC				
	URCO	GRAS	ADS-B	FIS-B	TIS-B	ATN	GACS	CM	ADS-C	DLL	ACL	ACM	DSC	DCL
IHTP	X		X	X	X	X	X	X	X	X	X	X	X	X
EAT										X	X	X	X	
NUP		X	X	X	X	X			X					X
PA														
SMGCS			STDMA		STDMA									
AOC						X	X							
VDL4 UK			X											
MEDUP		X	X	X	X					X	X	X		

Platform	**CNS Service**											
	Addressed Communications											
											Non ATN Services	
	CPDLC							FIS			CPDLC	GACS
	Taxi Management	FLIPCY	DYNAV	COTRAC	COSEP	PPD	AMC	D-ATIS	D-RVR	D-SIGMET		
IHTP	X		X	X	X	X	X	X	X	X	X	X
EAT		X				X						
NUP								X	X	X	X	
PA												
SMGCS	X											
AOC												X
VDL4 UK												
MEDUP		X						X			X	

Platform	**CNS Service**				
	Navigation				
	GNSS Data Capture	GNSS Data Processing	GNSS Data Distribution		
			LADD	GRDD	WADD
IHTP					
EAT					
NUP	X	X	X	X	
PA	X	X	X	X	X
SMGCS					
AOC					

VDL4 UK					
MEDUP				X	

Platform	Data Management			
	Surveillance Data Processing		Flight Data Management	
	MSF	Track Management	Flight Data Handling	System Flight Plan Processing
IHTP				
EAT				
NUP	X	X	X	
PA				
SMGCS	X	X	X	
AOC				
VDL4 UK				
MEDUP	X	X	X	X

Platform	AOC				
	AOC Flight Plan	AOC Maintenance	Aircraft/AOC CDM	AOC Asset Management	AOC Operator HMI
IHTP	X	X	X	X	X
EAT					
NUP					
PA					
SMGCS					
AOC	X	X	X	X	X

VDL4 UK					
MEDUP					

Table 43. Trial platform capabilities

6 Aircraft Functional Model

The following fd-diagram summarises the MA-AFAS functions for the avionic equipment.

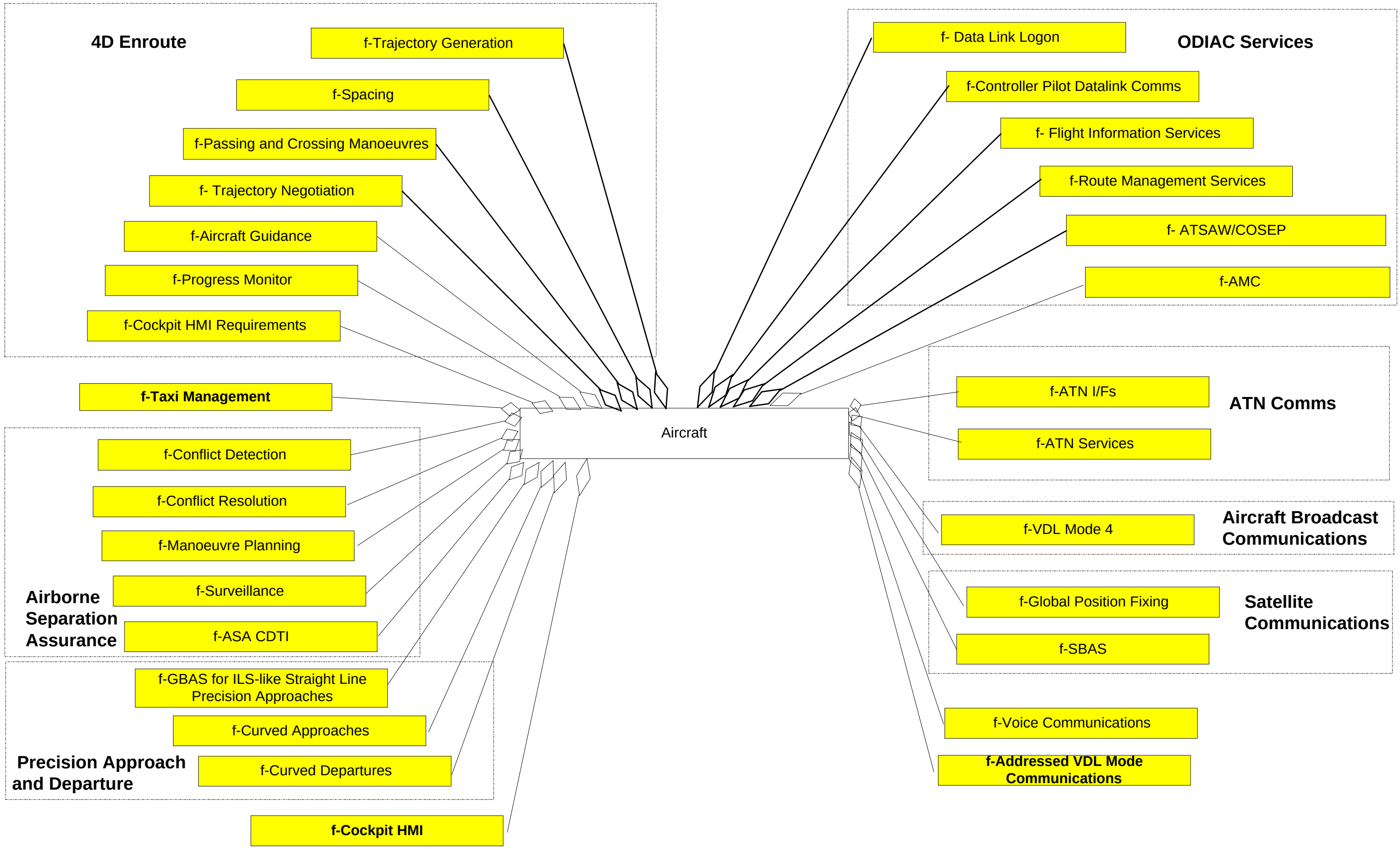


Figure 29. Aircraft fd-diagram