



**UNIVERSITAT POLITÈCNICA DE CATALUNYA  
BARCELONATECH**

**Escola Superior d'Enginyeries Industrial,  
Aeroespacial i Audiovisual de Terrassa**

**Treball de Fi de Màster**

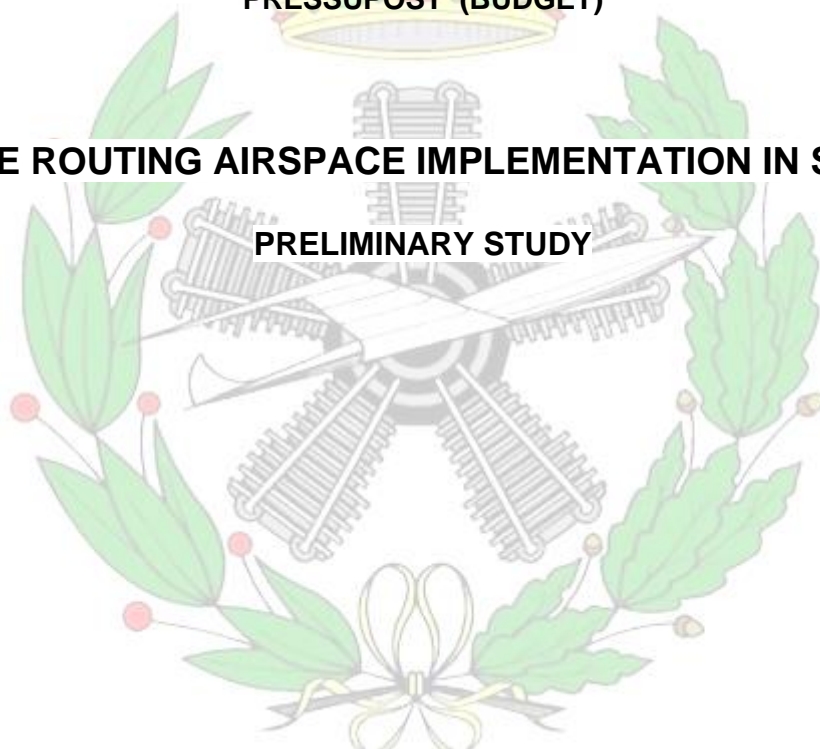
**MÀSTER UNIVERSITARI EN ENGINYERIA AERONÀUTICA**



**PRESSUPOST (BUDGET)**

**FREE ROUTING AIRSPACE IMPLEMENTATION IN SPAIN**

**PRELIMINARY STUDY**



Autor: Adrià Julià Alonso

Director: Dr. Jose Maria Sallan

Codirector: Dr. Oriol Lordan

Convocatòria: Setembre 2020

## Contents

Budget of the study .....	1
Considerations on the real implementation investments .....	2

## List of Figures

Figure 1. aFUA deployment status in 2020 .....	3
Figure 2. Cumulated FRA implementation results over 2019-2040 .....	4

## List of Tables

Table 1. Budget of the project .....	2
--------------------------------------	---

## Acronyms

(A)FUA	(Advanced) Flexible Use of Airspace
AESA	Agencia Estatal de Seguridad Aérea
ANSP	Air Navigation Service Provider
ATM	Air Traffic Management
CBA	Cost Benefit Analysis
EU	European Union
FRA	Free Route Airspace
OI	Operational Improvement
PCP	Pilot Common Project
RP	Reference Period (SESAR)
SES	Single European Sky
SESAR (JU)	SES ATM Research (Joint Undertaking)

## Budget of the study

The study presented is aimed to assess the actual performance of flight operations in the Spanish airspace and evaluate the possible deployment of the Free Routing Airspace (FRA) concept in order to optimize air traffic routes, according to SESAR expectations.

To consider the implications and the effects on the eventual application of FRA in Spain within the SES framework, a revision of the Free Routing implementation process and projects developed in SES participant countries is made, highlighting the stage of maturity of the Free Routing as an operational change to implement in a country or cross-country level for real flight operations. Some clarifications of airspace design and specific FRA concepts and technicalities are included as part of the study in order to ensure the proper comprehension for the readers and potential stakeholders.

Then, the work developed has been centered in Spain: the characterization of its airspace, constrains and traffic records, the analysis of past year statistics and the determination of the potential traffic in the following years, when FRA implementation is expected. Finally, a simulation with real -past- flight data is performed trough RStudio data science software, comparing a scenario with current waypoints-based trajectories and an artificial To-Be scenario based on FRA procedures specially created for the purpose of this study.

Finally, results obtained are presented in the form of statistical indicators and recommendations are made, based on the results obtained and the possible enhancements of the study in further stages.

To perform the aforementioned process, a person with proper knowledge of SES program and SESAR environment is needed in order to track the deployment of FRA since its early stages to the current status as a SESAR solution to be implemented, according to European Regulations. Multiple transnational organizations have been part of this process and several approaches have been followed to ensure the reliability of the procedures given to the corresponding ANSPs and national authorities.

Also, in the Case Study presented, adequate knowledge of Big Data processing -in this case with R programming language- including geospatial data treatment, parallel programming and data visualization techniques is needed, so a technical background is practically mandatory to develop this section of the study. A proper computational power is also needed and can be a constraint if the case study is intended to be performed with a higher refinement.

Finally, a formation on air navigation procedures and expertise in the field current stage it's more than desirable to achieve a good quality of the study.

Considering the requisites needed to carry on the study presented and the scheduling of its development, an approximated budget can be made to quantify the value of the work performed:

Task	Duration [h]	Unitary cost [EUR] <sup>1</sup>	Task cost [EUR]
Information survey - State of the art revision	135	16	2160,00
Formation of data processing with RStudio	50	13	650,00
Simulation scripts development and testing	150	18	2700,00
Simulation run and results recording	10	18	180,00
Results representation: graphs, maps and statistics	30	18	540,00
Elaboration of study deliverables (report and annexes)	40	16	640,00
<b>TOTAL</b>	<b>415</b>		<b>6870,00</b>

*Table 1. Budget of the project*

## Considerations on the real implementation investments

In order to deploy Free Routing at operational level, some investments need to be made by ANSPs. Despite, there is not any detailed budget of operational deployment costs of FRA in Spain available to general public, two documents hint at the actual cost of implementation.

The first one, is the Spain Draft Performance Plan for RP3 (SES Reference Period 3), published by AESA (Agencia Estatal de Seguridad Aérea) and sourced in the study report, which present a relation of RP3 planned investments -at a preliminary stage- associated to Pilot Common Project ATM Functionalities.

More specifically, it refers to AF3, which correspond to Flexible Airspace Management and Free Route. This PCP element consist of two subfunctionalities:

- S-AF3.1: Advanced Flexible Use of Airspace (aFUA)
- S-AF3.2: Free Route

---

<sup>1</sup> Unitary cost considers the average salary for a junior aviation consultant in Spain -around 30k € annually including taxes- plus the expenses of the additional resources needed to perform the task or discounts in concept of formation received.

Regarding the first one and its Operational Improvements linked, its possible to see that at date of 2020 -beginning of RP3- aFUA is fully implemented in Spain.

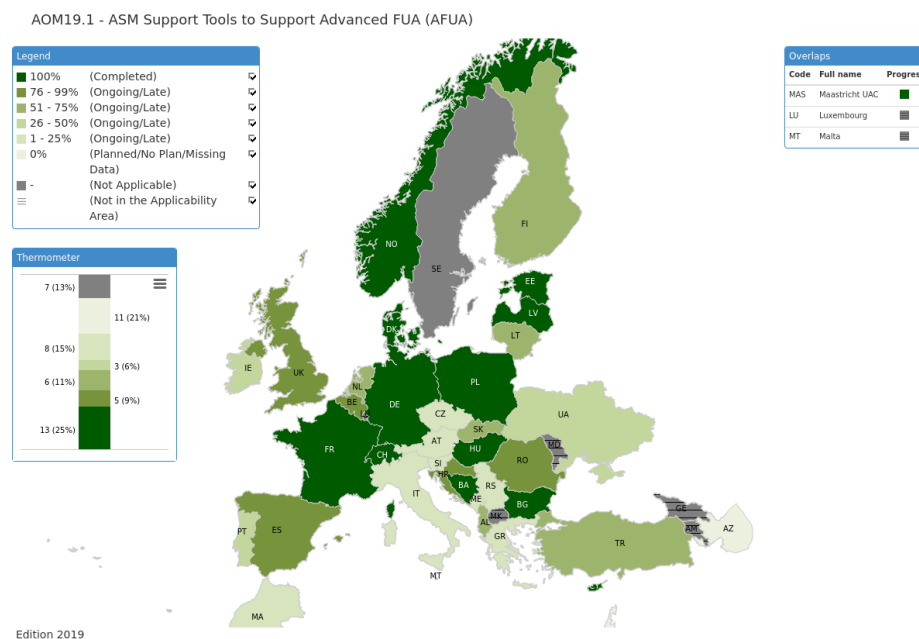


Figure 1. aFUA deployment status in 2020<sup>2</sup>

This means that most of all the investments associated by the mentioned document for AF3 will be destined to FRA deployment.

These investments ascend to 48.05 Million Euro, distributed according to the following table:

	2020	2021	2022	2023	2024	TOTAL
<b>AF3 inv. [MEUR]</b>	2.45	5.92	9.08	13.04	17.56	<b>48.05</b>

These investments will be made by ENAIRE as the Spanish public ANSP, responsible of FRA deployment.

Other cost estimation, which includes benefits obtained from FRA is made by ALG (Advanced Logistics Group, by INDRA), a consultancy firm set in Barcelona leader in aviation projects and participant in the SESAR deployment with several projects developed by its air navigation team, led by UPC-ESEIAAT prof. Rubén Martínez.

This estimation, that can be found in PJ.06-01 CBA oversees a scenario where FRA is deployed at European level between 2019 and 2040 and estimates the necessary investment in 362 MEUR -discounted at 8%- and the benefits expected in 1158MEUR, also discounted.

<sup>2</sup> Source: eATM PORTAL

The following figure show the Cash-Flow analysis developed by the solution PJ06-01:

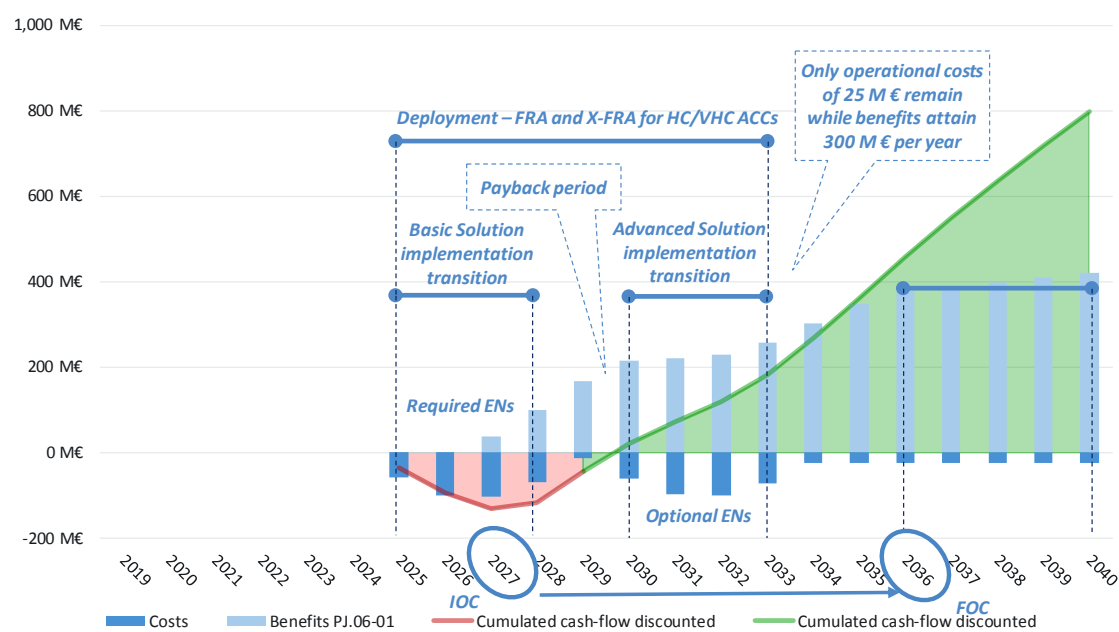


Figure 2. Cumulated FRA implementation results over 2019-2040<sup>3</sup>

<sup>3</sup> Source: PJ.06-01 CBA (ALG)