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SUSTAINABILITY IN AIR TRANSPORT

MANAGEMENT AND GOVERNANCE IN THE PROVISION OF AIR NAVIGATION SERVICES

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SUSTAINABILITY IN AIR TRANSPORT

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Abbreviations and acronyms

AIS	Aeronautical Information Service
ACC	Area Control Center
AFIS	Flight Information Service
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATCC	Air Traffic Control Center
ATCO	Air Traffic Controller
ATM	Air Traffic Management
ATSEP	Air Traffic Safety Electronics Personnel
CAA	Civil Aviation Authority
CANSO	Civil Air Navigation Services Organisation
CCO	Continuous Climb Operations
CDM	Collaborative Decision Making
CDO	Continuous Descent Operations
CNS	Communication, Navigation and Surveillance
E-AMAN	Extended Arrival Manager
EASA	European Safety Agency
EC	European Commission
ECU	European Currency Unit
EU	European Union
EUR	Euro (€)
FAA	Federal Aviation Administration
FAB	Functional Air Block
FIR	Flight Information Region
FRA	Free Route Airspace
FUA	Flexible Use of Airspace
GLONASS	Russian Global Positioning System
GPS	Global Positioning System
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IFR	Instrumental Flight Rules
iTEC	Interoperability Through European Collaboration
JU	Joint Undertaking
MTOW	Maximum Take-Off Weight
MUAC	Maastricht Upper Area Control Center
PBN	Performance-Based Navigation
PPP	Public-Private Partnership
P-RNAV	Performance Required Navigation
R&D	Research and Development
SES	Single European Sky
SESAR	Single European Sky Advance Research
SJU	SESAR Joint Undertaking
TANS	Terminal Air Navigation Services
TMA	Terminal Control Area
VFR	Visual Flight Rules
XMAN[1]	Cross-border Arrival Manager

[1] XMAN (Cross-Border Arrival Management, also referred to as Extended Arrival Management - E-AMAN) is a new operational procedure, which aims to improve and optimise arrival management operations for major airports. https://www.eurocontrol.int/articles/xman

1.

Executive Summary

This report presents the results of the project "Sustainability in Air Transport–Management and Governance in the Provision of Air Navigation Services", aiming at studying the sustainability in air transport, in Brazil and in the EU, in order to improve the management of air traffic and improve the efficiency of the sector, addressing especially issues such as governance, regulatory framework, safety and infrastructure. The project identifies the successful European experiences related to best practices and sustainable models for the provision of air navigation services.

The legal rights and obligations of States with respect to the provision of air navigation services were established in the Chicago Convention. The structure and operation of the airspace is an exclusive competence of each individual State, complying basic technical rules established by ICAO. A great part of the effort by the aeronautical community in the last years has been devoted to open new routes, optimize existing ones and develop a better coordination among Civil Aviation Authorities (CAAs), ANSPs, airports, airlines and military authorities who, in many cases, are the owners of airspace zones of dual civil and military use or making frontier with the civil use areas.

Broadly speaking, ANSP business models fall into one of the following categories:

- ANSPs within a government department.
- ANSPs as a separate branch of government.
- Corporatized ANSPs still fully owned by government.
- Corporatized ANSPs partially owned by government.
- Fully privatised ANSPs.

Whether an ANSP is a government department or is privately owned, there is absolutely no argument that the primary objective is the provision of ATM services to facilitate the safe and efficient transition of aircraft within its airspace.

The air navigation service providers of the five largest countries (54 % of the total traffic) plus Ireland are described in detail, since they manage the largest part of the traffic in Europe. They respond to different types of organisational models:

- German DFS, a State-owned limited liability company organised under private law.
- British NATS, a public private partnership between the Airline Group, which holds 42%, NATS staff who hold 5%, UK airport operator LHR Airports Limited with 4%, and the government which holds 49%, and a golden share.
- Irish IAA, a commercial state-sponsored body (commercial semi-state company).
- French DSNA, part of the Ministry of Sustainable Development, through the Direction Générale de l'Aviation Civile (DGAC).
- Italian ENAV, listed on the stock exchange and with the Italian State holding 53.3% of ENAV though the MEF (Ministry of Finance).
- Spanish ENAIRE, a public business entity belonging to the Ministry of Public Works.

Currently there is not a clear conclusion about if any one of these models is better than the others at driving performance that has safety, cost and environmental benefits. In particular, considering the six ANSPs analysed, no clear conclusion can be extracted in terms of financial performance about the benefits of the different type of organisation an ANSP may adopt.

In Europe, the International Convention EUROCONTROL was signed in 1960, creating the International Organization for Air Navigation Safety, with the ultimate objective of achieving the complete unification of the member states services. EUROCONTROL is classified as an International Public Service Organization and their missions are to ensure Air Navigation safety in their coverage zone and to guarantee an equitable cost for all users of the system.

Since 2004, the European Union (EU) has gained competences in air traffic management (ATM) and the decision-making process has moved away from an intergovernmental practice to the EU framework. The EU's main objective is to reform ATM in Europe in order to cope with sustained air traffic growth and operations under the safest, most cost- and flight-efficient and environmentally friendly conditions. This implies de-fragmenting the European airspace, reducing delays, increasing safety standards and flight efficiency to reduce the aviation environmental footprint, and reducing costs related to service provision. Achievements have already been made at operational, technological and institutional levels; efforts are ongoing to maximise the benefits of activities initiated under the Single European Sky (SES) framework.

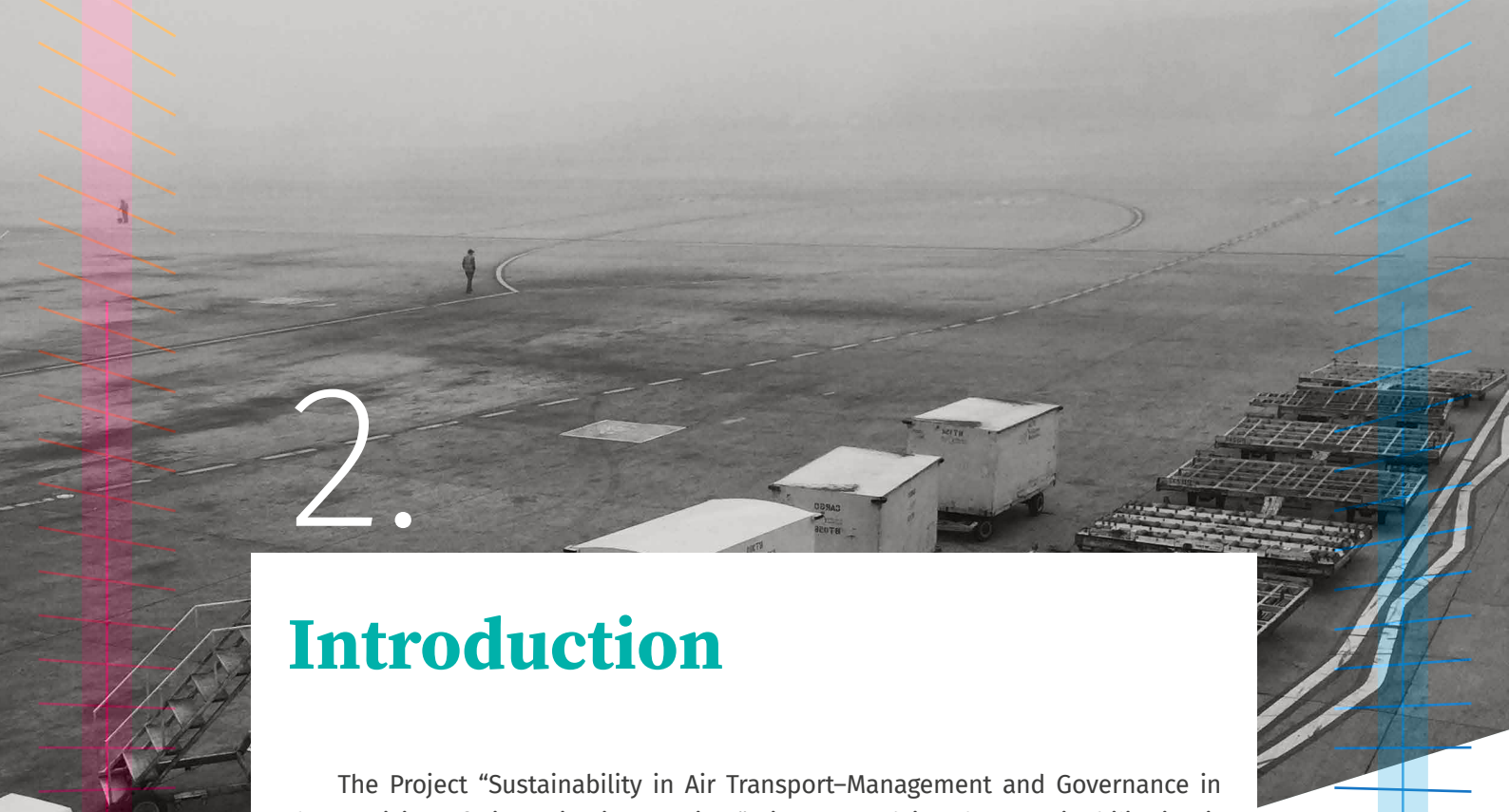
The Public Private Partnership (PPP) consortium SESAR (Single European Sky Advance Research) develops the technical part of the SES program with the following targets:

- Increase three times the European air space management capability.
- Increase safety by a factor of 10.
- Reduce 50% the ATM cost to the users.
- Optimize flight trajectories to save between 8 and 14 minutes per flight, reducing fuel consumption by an average of 300 to 500 kg.

The program started in 2006 and it is assumed to last until 2025. It includes the launching and put into service a global navigation satellite system, named Galileo, to provide a highly accurate, guaranteed global positioning service, interoperable with the similar US system (GPS) and Russian system (GLONASS). The transition from a highly fragmented airspace to a single airspace will be done in several steps that will join neighbour States airspace in commonly operated ATC areas. A total of 9 Functional Airspace Blocks (FABs) are consolidated, including 31 European States:

Examples of SESAR improvements already in place are:

- Extended arrival management horizons operational (E-AMAN) at places such as Munich, Reims and Heathrow, with many more to follow, helping to provide enhanced and more consistent arrival sequences by sharing information across borders.
- New precision area navigation (P-RNAV) approach procedures are in place across the continent, including Dublin, Stockholm Arlanda and Paris Charles de Gaulle (CDG), improving the design and organisation of our busy terminal manoeuvring areas and reducing workload on controllers.
- There is free route airspace in operation across significant volumes of the upper airspace within Europe, allowing airspace users to plan and take the routes they want to take, helping them to save fuel, reduce flying time and lower their costs.
- Whilst the European Commission's Functional Airspace Blocks have not perhaps driven yet the seamless airspace route as was desired, there are new collaborations that are providing additional impetus – from the COOPANS systems grouping through to the Gate One and Borealis Alliance ANSP initiatives.
- As of today, at a technical level, extensive research and development continues through the industry-leading public-private SESAR research programme. There will be many more simulations taking place this year helping take new concepts one step closer to being ready for operational deployment – from wake vortex separation optimisations that will enhance runway throughput, through to testing new means of organising controllers that will better match demand to capacity, reducing congestion and improving traffic flows.
- Alongside this and with the input of its Members, the SESAR Joint Undertaking (SJU) is currently finalising its recommendations to the European Commission in terms of the concepts whose implementation will be mandated via European law through Common Project 2, the follow up to the European Commission's Pilot Common Project.



2. Introduction

The Project “Sustainability in Air Transport–Management and Governance in the Provision of Air Navigation Services” aims at studying the sustainability in air transport, in Brazil and in the EU, in order to improve the management of air traffic and improve the efficiency of the sector, addressing especially issues such as governance, regulatory framework, safety and infrastructure.

The project description, overall and specific objectives and the expected results are given in the Terms of Reference document.

An initial meeting was held on the 13th of March of 2018 in Brasilia, with the participation of representatives from the Secretaria Nacional de Aviação Civil (Ministério dos Transportes, Portos e Aviação Civil) and the designated Expert for this project.

During this meeting the methodology to be followed in this project and the working plan were discussed and agreed. They are included in the Methodology and Working Plan document.

3.

Methodology

The project is expected to identify and meet the successful European experiences related to best practices and sustainable models for the provision of air navigation services. The results will be documented in a report with the main information obtained in the studies. The report will also include the requests and recommendations for best practices of management models that can serve as a reference for the sector, regarding the efficient exploitation of the provision of air navigation services.

The following topics will be addressed in the project:

- Air Navigation Service Provider – ANSP EU.
- Case Studies.
- Single European Sky.
- Air National Service Provider – ANSP Brazil.

4.

Air Navigation Service Providers in EU

4.1 The legal rights and obligations of States with respect to the provision of air navigation services

Air navigation services are, with a small number of exceptions, either part of the State administration departments or corporatized state owned companies, with modest private enterprise participation. ICAO divides world airspace in areas under the control of ATM facilities of individual States, with neither overlapping nor empty zones and efforts are done to improve coordination and collaboration rather than competition.

The structure and operation of the airspace is an exclusive competence of each individual State, complying basic technical rules established by ICAO, and is usually limited by national borders, including the 12 nautical miles area of coastal seawaters. When required, a national Air Navigation Service Provider (ANSP) facilitates ATM beyond national borders over part of high sea (according to an ICAO's agreement) or in part of an adjacent State's airspace, when an airport is very close to the border and it has a difficult access from its own State territory.

The respect to the States sovereignty in their airspace does not preclude the adoption of international measures that need the participation of multiple States, in order to ensemble their frontiers and coordinate the ATM procedures. A number of different procedures have been applied or are in the implementation process to optimize time-related flight sequences and trajectories in the horizontal and vertical planes.

There are also a few cases when there is a multinational ANSP, as ASECNA (L'Agence pour la Sécurité de la Navegation Aérienne en Afrique et à Madagascar, The Agency for Aerial Navigation Safety in Africa and Madagascar), COCESNA (Corporación Centroamericana de Servicios de Navegación Aérea, the Central American Agency for Air Navigation Services) or EUROCONTROL Maastricht Control Center in Europe, providing air navigation in more than one State.

A great part of the effort by the aeronautical community in the last years has been devoted to open new routes, optimize existing ones and develop a better coordination among Civil Aviation Authorities (CAAs), ANSPs, airports, airlines and military authorities who, in many cases, are the owners of airspace zones of dual civil and military use or making frontier with the civil use areas.

Each National Authority can decide which parts of its airspace are available for civil aviation use and in which conditions. Part of the airspace may be reserved for military use, or simply prohibited to fly as it is over military bases, strategic facilities, governmental dependencies or other places that the State is interested into protect and leaving free of undesired interferences.

Civil military cooperation is a good example of the difficulties of airspace refurbishment. Chicago Convention determines that every civil flight has the right of flying inside the air space of any State having ratified that Convention. Notwithstanding the States have the right of blocking air space areas due to specific reasons (security, military use, environmental protection, etc.), with the condition of not discriminate between foreign and national operators.

The amount of airspace reserved for those uses changes from country to country, but it may rise up to 40% of the national total. Civil operators has to avoid military zones, a limitation added to the necessary separation between the two types of flight operations: Visual Flight Rules (VFR) and Instrument Flight Rules (IFR), making difficult the trajectory optimization.

Civil-military cooperation uses to be smooth (EUROCONTROL, for instance, has a permanent coordination committee with representatives of both groups), but proposed changes to the present status may be very expensive if they require to move military facilities to other place or take further away the area of military exercises. Then, the problem becomes budgetary due to the additional time and fuel consumption military aircraft will suffer for flying longer distances in their training missions.

4.2 International regulatory and legal framework in the provision of Air Navigation Services (EUROCONTROL)

Civil aviation air navigation is regulated by the Chicago Convention. As a consequence of the recognition of the sovereignty of each State on their own air space, the elements for the compliance with Annex 11 (where the structure of the air space and the air navigation procedures are established) must be equally provided by each State, covering the air space up to the limits with their neighbours. This statement does not preclude the constitution of multinational agreements to optimize the efficiency of the operation.

Particularizing in Europe, the rapid growth of the international air transport and the introduction in 1957 of the first commercial transatlantic jets produced a certain congestion of the Upper Air Space (above 25,000 ft.), especially acute in the European zone of NATO, where the commercial and military traffic were mixed.

To address this issue, on the 13th December 1960 the International Convention EUROCONTROL was signed, creating the International Organization for Air Navigation Safety, generally known with the name of the Convention itself: EUROCONTROL. The agreement was ratified in March 1963 by six Member States: the Federal Republic of Germany, Belgium, France, Holland, United Kingdom and Luxembourg. Ireland joint later in 1965. Another ten States (United States, Canada, Norway, Sweden, Denmark, Austria, Switzerland, Italy, Spain and Portugal) adhered to the Organization between 1964 and 1967 as associates.

The foundational agreement was initially valid for twenty years (until 1980), renewable for five year periods from that date. The objective was the complete unification of the member states services. However, the differences among the member states and the associates, everyone's own national interests and the high costs of EUROCONTROL limited the ambition of those objectives.

Although initially three Control Centers started to work, covering the Upper Air space of the seven founding states, two of them ultimately reverted to the national authorities, because France and the United Kingdom refused to transfer the control of their respective air spaces. Only Maastricht remained, controlling the Upper Air Space of the Benelux countries and the north of Germany, in the area of the Hamburg Flight Information Region (FIR).

In February 1981 a new conference held in Brussels agreed an extension of five years to the original agreement and a Protocol modifying such agreement. This Protocol was effective on 1st January 1986, opening the Convention to the adherence of new States and establishing as a long term objective a Common Plan covering the complete Air Space (Upper and Lower) of the member states.

In order to face the increasing congestion of the European air space, in October 1990 EUROCONTROL announced the launch of the EASIE (Enhanced Air Traffic Management and Mode S Implementation in Europe) project. Among its objectives, to establish for 2005 a common and automatized control system in Europe, with a cost close to 1,000 million ECU's.

The programme addressed two main aspects:

- EATCHIP (European Air Traffic Control and Harmonization and Integration Program), started in 1990, to propose the technological standards and the future unified system architecture.
- APATSI (Airport / Air Traffic System Interface Strategy), dealing with the development of the at the time current system, trying to optimize the capacity of the existing infrastructures.

In June 1997 the EUROCONTROL agreement is reviewed, and its management capability is enlarged with the inclusion of the gate-to-gate concept. In January 2000 ATM 2000+, a long--term project, is launched. ATM 2000+ aimed at covering the 2015 horizon, when the expected number of movements in the European air space were expected to double the number of movements in 2000. ATM 2000+ was part of the European Single Sky strategy, including among other programmes, the satellite navigation system GALILEO. The strategy was to be developed by grouping gradually the existing national services in 9 Functional Blocks of Air Space (FABs), up to the complete fusion. At the end of 2010 the agreements to put in place the first three FABS were already signed: United Kingdom – Ireland, Denmark – Sweden and the largest, Belgium – France – Germany – Luxembourg – Holland and Switzerland. They three cover more than 50 % of the European flights.

In 2018, 41 States were part of EUROCONTROL (including all the European Union Member States) and participate in the collecting mechanism. This number of states is expected to increase as new agreements for the joint utilization of the existing means are being achieved.

EUROCONTROL is classified as an International Public Service Organization and their missions are:

- To ensure Air Navigation safety in their coverage zone.
- Guarantee an equitable cost for all users of the system.

The governance structure of the EUROCONTROL organisation is composed of two governing bodies, the EUROCONTROL Commission and the Provisional Council, and an executive body: the Agency. The daily functioning of EUROCONTROL is managed by the Agency, reporting to the deciding organism, the Council, who is dependent on the political organism, the permanent Commission. The Council receives reports from four technical committees: coordination between civil and military controls, system security, comparative analysis of the performance of each service provider and common elements development (Maastricht / CEATS).

EUROCONTROL headquarters are in Haren, near Brussels, where their General Data Bank is. In March 1996 the Central Flow Management Unit (CFMU) entered into service in this location. The CFMU is a real time simulation system of all movements in the European air space. It allows obtaining immediate solutions to any unforeseen contingency or the performance of planning studies on the effect of introducing changes in the services distribution.

The following so-called External Services depend also on EUROCONTROL:

- Control centers: Maastricht (Holland), operative from February 1972.
- Experimental center in Bretigny (France), active from January 1967.
- Air Navigation Institute in Luxembourg, inaugurated in October 1969.
- Central European Air Traffic Services (CEATS) in Budapest and Prague, created in 1999.

In 2010 EUROCONTROL had slightly over 3,000 employees and their own operating costs were, approximately, 0.4% of the Member States total Air Navigation Aids costs. The overall budget of the organization is close to 700 million euros. The number of flights in the air space services by EUROCONTROL was 9.5 million, with an average delay of 2.27 minutes. The total amount of invoiced air navigation services was about 7,400 million USD.

From the economic point of view, the EUROCONTROL base is the so-called Harmonized Regional system, created in November 1971, so that all the Member States share the same tariff system, corrected according to specific coefficients representing the cost differences among each State to provide the needed air navigation aids within their respective air spaces.

The way the navigation charges are established and applied to a particular flight is explained next.

The payment unit is called Service Unit, N.

$$N = d \times p$$

being

d a distance coefficient (equal to 1 for a 100 km distance)

p a weight coefficient, calculated according to the following formula:

$$p = \sqrt{\frac{MTOW\ (ton)}{50}}$$

When a certain flight crosses the air space of any State, the charge it has to pay is:

$$r = t \times N$$

Where t is the coefficient corresponding to the air navigation costs of each State. The value of t is calculated automatically dividing the cost of the air navigation services of a given State among the traffic volume forecasted for a certain period of time. EUROCONTROL collects the money directly from airlines and pays back the corresponding amounts to the different States following the previously describe method.

Initially the t coefficient was calculated so that the States recovered just part of their investment. This percentage was 15% at the beginning and was gradually increasing, reaching 100% by 1983 in practically all Member States. This way, the air space users are paying for the totality of the air navigation aids cost.

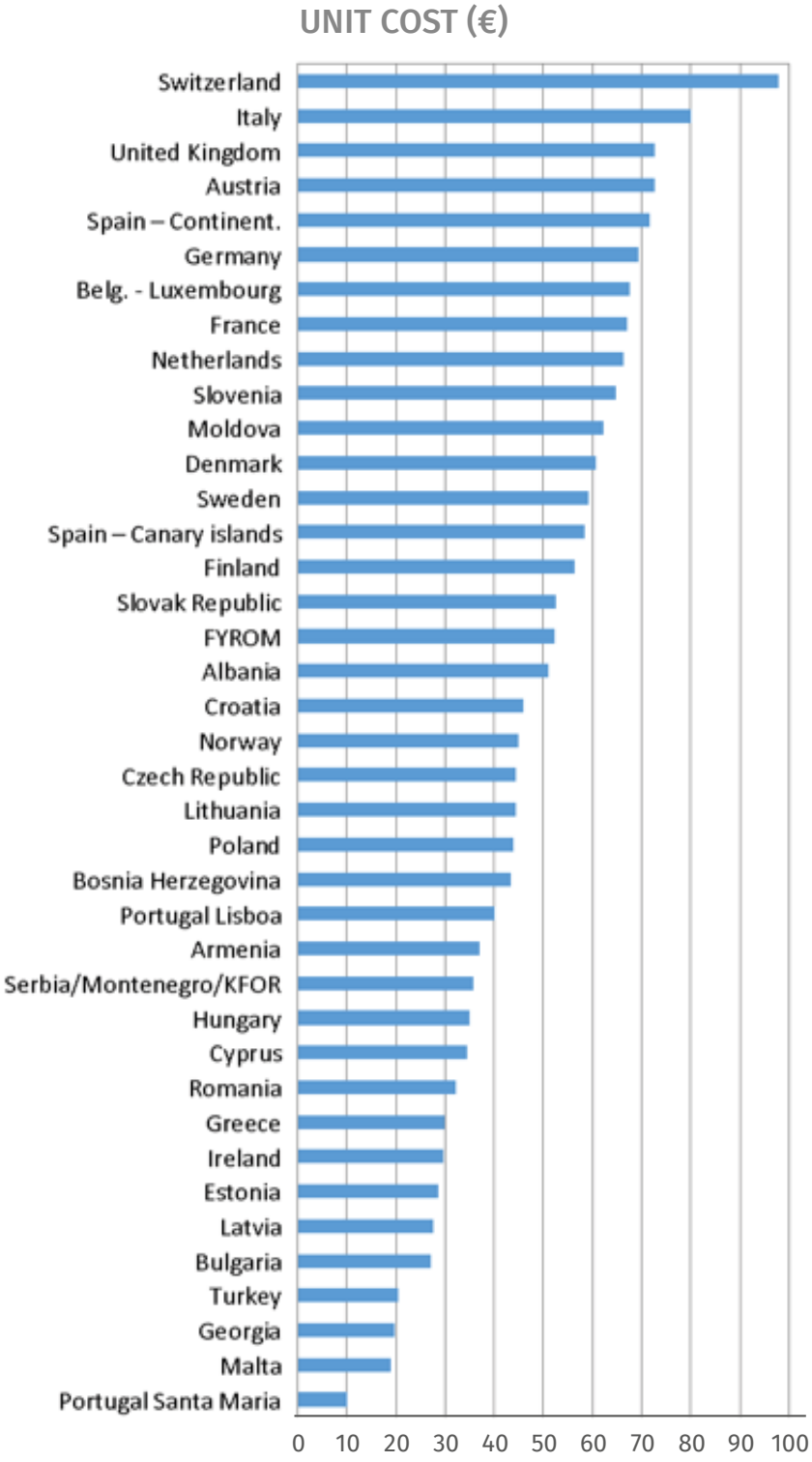
This cost depends strongly on the economic conditions in each country (salaries, prices, interest rates) and the efficiency of their control centers. Generally speaking, it is considered that the EUROCONTROL prices are high, compared to other countries, while the service provided does not reach, especially with respect to congestion levels, the users' expectations. Despite of air navigation charges in Europe being the most expensive in the World, the serious congestion problem in the air space suffered from 1988 have given a new impulse to the role of EUROCONTROL as the only solution to the harmonization of the European air traffic harmonization, fully supported by the European Union.

Price differences among the different States may be very important as it can be seen in Table 4.1 and Figure 4.1.

Table 4.1. EUROCONTROL Adjusted unit rates applicable to December 2017 flights.

Zone	Unit rate (EUR)
Portugal Santa Maria	10.06
Belg. - Luxembourg	67.53
Germany	69.43
Estonia	28.53
Finland	56.30
United Kingdom	72.79
Netherlands	66.33
Ireland	29.61
Denmark	60.58
Norway	44.81
Poland	43.96
Sweden	59.08
Latvia	27.53
Lithuania	44.49
Spain – Canary islands	58.43
Albania	51.09
Bulgaria	26.97
Cyprus	34.39
Croatia	46.00
Spain – Continent.	71.76
France	67.07
Greece	30.02
Hungary	35.05
Italy	80.07
Slovenia	64.67
Czech Republic	44.53
Malta	18.86
Austria	72.78
Portugal Lisboa	40.19
Bosnia Herzegovina	43.32
Romania	32.28
Switzerland	97.80
Turkey	20.42
Moldova	62.33
FYROM	52.24
Serbia/Montenegro/KFOR	35.65
Slovak Republic	52.61
Armenia	36.95
Georgia	19.66

Figure 4.1. EUROCONTROL Adjusted unit rates applicable to December 2017 flights.



Looking at Figure 4.1, no clear relationship can be derived between the cost of the service and the type of organisation that the ANSP of each country has.

4.3 ANSP Business Models

Broadly speaking, ANSP business models fall into one of the following categories:

- ANSPs within a government department.
- ANSPs as a separate branch of government.
- Corporatized ANSPs still fully owned by government.
- Corporatized ANSPs partially owned by government.
- Fully privatised ANSPs.

Whether an ANSP is a government department or is privately owned, there is absolutely no argument that the primary objective is the provision of ATM services to facilitate the safe and efficient transition of aircraft within its airspace.

There is constant demand, however, for more efficient and cost effective ATM, which requires significant investment in new processes, procedures and technologies. The strategic imperatives of reducing delays, addressing environmental impacts and changing global standards – all of which coincide with incessant demands from the aviation community to lower costs or at least provide transparency on the Return on Investment (ROI) being applied – have placed the whole area of ANSP billing, collection and revenue management under a bright spotlight.

In years gone by, many ANSPs were government departments that were not necessarily concerned with balancing investments and costs with their revenues. This was based on the government preferring to take the macro-economic view that safer skies resulted in greater indirect economic growth in other areas – for example, in mining, oil and tourism. However, following the global financial crisis many governments find themselves trying to manage spiralling levels of debt and as a result are forced to cut ANSP spending.

Currently there is not a clear conclusion about if any one of these models is better than the others at driving performance that has safety, cost (as it can be deduced from the previously shown Figure 4.1) and environmental benefits.

Emphasis is been placed on the advantages of the fully commercial model. There are some potential benefits. Innovative strategies and a faster rate of change are more supposedly aligned with commercial practices. However, it is hard to envisage a single business model that can encapsulate the socio-economic and political variety seen not only on the global stage but even in a single region such as Europe. Every ANSP is different and responding to a different culture, a different set of national regulations and different circumstances.

Besides, commercialism may not solve every problem. While it may supply management with a greater range of options, it comes at a cost, both financial and otherwise. The rationalisation of support services, for example, could drive improvements without necessarily being commercially delivered. And even if ANSPs could outsource more of their services, it would not affect the major cost centre in the business: staff. In a truly competitive market, it could be that labour costs would actually rise as organisations sought to avail themselves of highly qualified and relatively scarce personnel.

Furthermore, many ANSPs following other business models seem to be working perfectly well. The Federal Aviation Administration (FAA) is often touted as a benchmark for Europe in terms of operational efficiency, having a single ATCC for an area broadly comparable in size. However, the FAA cannot properly be described as a commercial organisation. Nordic Unified Air Traffic Control (NUAC) – with air traffic control centres in Copenhagen, Malmo and Stockholm – is

one of the more efficient set-ups according to the latest figures [CANSO, 2017] and yet does not have commercial origins.

On the other hand, state-controlled ANSPs are subject to the political will of governments that sometimes look to the headlines of jobs and airspace control without considering the less tangible effects of an efficient airspace system. The incentive to increase efficiency is hard to see and the situation is only made worse if the owners of ANSPs get to decide what their performance targets should be.

Even if it is accepted that no one business model is superior, a larger question looms about the ability of these disparate organisations to collaborate and push airspace improvements on the regional and global level. Can a state-run ANSP get along with a privatised partner, agreeing targets for implementation and investment levels?

Aside from the political will involved – or rather the lack of it – the different procurement, legal and regulatory structures might make co-operation difficult between organisations at opposite ends of the spectrum. They might not agree on the benefits being pursued either. And, of course, two commercial ANSPs could see each other as competitors rather than potential partners.

Examples of "getting along" are growing by the day. As mentioned, NUAC has proved what is possible. It leads the harmonisation initiatives in the Danish-Swedish Functional Airspace Block (FAB) and according to the organisation, has already made progress on harmonising ATM systems, leading to cost savings, airspace efficiency and environmental benefits. Through NUAC, Naviair and LFV each expect to save €13 million annually by the end of 2016.

The COOPANS alliance was established back in 2006. IAA (Ireland), LFV (Sweden), Naviair (Denmark), Austro Control (Austria), Croatia Control (Croatia) and supplier Thales expect to reduce system development costs by 30 %. The COOPANS partners are also benefiting from other operational initiatives based on a harmonised working platform.

Another noteworthy case is the Borealis Alliance, which is a commercial grouping of nine northern Europe ANSPs.

Virtual centres seem to encapsulate this concept. As the name suggests, these are a virtual consolidation of air navigation services and rely on standardisation more than a particular business strategy. Virtual centres allow more innovative operating hours and rostering as well as generate economies of scale and scope.

Skyguide has already done some work on the subject and describes the virtual centre as "a plus for operational flexibility, business continuity and cost-effective technical evolution".

Such developments are only possible with successful and efficient ANSPs and can be further enhanced through cooperative alliances.

Ownership of ANSPs should not matter if they are governed well with a focus on performance outcomes and allowed to operate as normal businesses. The exact business model adopted and the levels of consolidation, co-operation and outsourcing would then be natural and logical consequences rather than dogmatic requirements. And flexibility to meet the diverse and considerable challenges of air traffic management makes much more sense than "One State, One ANSP", "one size fits all" and an over prescriptive regulatory framework.

The different types of legal status of some relevant ANSPs from all over the world are shown in Table 4.2 [CANSO, 2017].

Table 4.2. The different types of legal status of different ANSPs from all over the world.

	STATE-OWNED				
LEGAL SATUS	***A government department or authority that is subject to government accounting and treasury rules, and staff are employed under civil service pay and conditions.***	***A government entity empowered to manage and use the revenues it generates through charges for the services it provides.***	***State body, acting as a legal entity with an autonomous budget.***	***A corporatised entity with special status, not governed by normal commercial law but by a specific founding law or statute (and wholly owned by the government).***	***Limited liability company, 100% state-owned.***
ANSPs	Federal Aviation Administration – Air Traffic Organization (USA)	ENAIRE (Spain)	PANSA Polish Air Navigation Services AgencyAirways	Airways New Zealand	DFS (Germany)
	DSNA (France)	Airports Authority of IndiaIAA	IAA (Ireland)	Air Navigation Services of the Czech RepublicSkyguide	Skyguide (Switzerland)
	Japan Air Navigation Service	Civil Aviation Authority of Singapore		Air Traffic & Navigation Services (South Africa)	Serbia and Montenegro Air Traffic Services SMATSA LLC
	Servicios a la Navegación en el Espacio Aéreo Mexicano	Devlet Hava Meydanları İşletmesi Genel Müdürlüğü (Turkey)		Civil Aviation Authority of Uganda	
	Administration de la navigation aérienne (Luxembourg)	Kenya Civil Aviation AuthorityFinavia		Finavia (Finland)	
		Letové Prevádzkové Služby (LPS SR) (Slovakia)		HungaroControl Pte. Ltd. Co	
		Romanian Air Traffic Services Administration		Isavia Ltd (Iceland)	
				Latvijas gaisa satiksme (Latvia)	
				Oro navigacija (Lithuania)	
				Sakaeronavigatsia (Georgia)	
				Slovenia Control	

	PPP	PRIVATE
LEGAL SATUS	***A government department or authority that is subject to government accounting and treasury rules, and staff are employed under civil service pay and conditions.***	***A government entity empowered to manage and use the revenues it generates through charges for the services it provides.***
ANSPs	NATS (UK)	NAV CANADA
	ENAV (Italy)	
	NAV Portugal	
	AEROTHAI (Thailand)	

4.4 Military and Civil air traffic management coordination

As it has been mentioned in previous sections, each National Authority can decide which parts of its airspace are available for civil aviation use and in which conditions. Part of the airspace may be reserved for military use, or simply prohibited to fly as it is over military bases, strategic facilities, governmental dependencies or other places that the State is interested into protect and leaving free of undesired interferences. On the other hand, the Chicago Convention determines that every civil flight has the right of flying inside the air space of any State having ratified that Convention. Notwithstanding the States have the right of blocking air space areas due to specific reasons (security, military use, environmental protection, etc.), with the condition of not discriminate between foreign and national operators.

In the large European countries, civil-military cooperation uses to be smooth. EUROCONTROL, for instance, has a permanent coordination committee with representatives of both groups, to enhance the capacity, flexibility, efficiency, safety and security of the European aviation network for the benefit of both civil and military users.

Airspace users need to work closely together to ensure that the airspace is used properly at all times. The flexible use of airspace (FUA) concept and airspace management (ASM) coordination are key priorities for EUROCONTROL. Related activities include:

- enhancing civil-military collaborative decision-making;
- increasing civil-military Communication, Navigation and Surveillance (CNS) interoperability;
- coordinating civil-military aspects in the SESAR programme;
- ensuring seamless military integration into the network;
- improving and promoting ATM security;
- organising training courses on the European ATM institutional framework for civil-military ATM cooperation.

While accommodating military aviation requirements, EUROCONTROL manage a number of activities and services such as:

- Civil-Military Airspace Coordination Tool (CIMACT).
- Civil-Military Collaborative Decision-Making Support (MILO function).
- Flexible Use of Airspace and Airspace Performance Management (FUA and ASM).
- Local and Sub-Regional Aispace Management Support System (LARA).
- Pan-European Repository of Information Supporting Civil-Military Performance Monitoring (PRISMIL Programme).
- Unmanned Aircraft Systems (UAS).

The Military Liaison Officer (MILO) position was introduced at the beginning of 2010 into the Network Manager Operations Centre, (NMOC, previously called Central Flow Management Unit). As part of the Network Management's function, the MILO's primary task is to enhance the civil--military ASM (airspace management) coordination process at European network level, with the aim of improving flight efficiency and increasing military mission effectiveness. In this respect, the MILO, in coordination with the other network management actors, uses the draft AUP/UUP (Airspace Use Plan/Update Airspace Use Plan) data to identify opportunities or problems related to airspace allocation. The alternative solutions identified are then proposed to the Network Manager and the local airspace managers. It is worth noting that the decision to implement the MILO's proposals remains the responsibility of the local airspace managers.

The MILO collects and harmonises national information on major military exercises and activities, from long-term schedules to last-minute notifications of events. Their contribution to the Network Operations Plan (NOP) and the updates relating to military events affecting ATFCM (Air Traffic Flow and Capacity Management) are essential. The NOP makes all civil and military airspace users aware of network constraints and successfully assists them in improving the planning process.

The MILO is identified as an entry point for all civil-military issues related to current ASM coordination and network operations. The MILOs are ready to cooperate and assist civil and military airspace managers in their ASM civil-military coordination-related issues.

At country level, the trend is also to increase cooperation between civil and military control, with different levels of integration.

In Germany, for instance, the ANSP DFS (see 5.1) has been entrusted by law with the control of German civil and military air traffic in peacetime, while taking due account of military interests. The law only exempts local military air traffic control services at military aerodromes, including military aerodromes also used by civil aviation. In states of tension and defence, however, the armed forces are entitled to perform air traffic control functions in Germany.

In the rest of the large countries, civil and military controls are independent but highly coordinated:

In the UK (see 5.2) military controllers work closely with their civilian colleagues to provide a fully integrated service to all users. They offer an air traffic service to aircraft in uncontrolled airspace. Military personnel also provide services to aircraft crossing airways and for those flying above 24,500 feet. A priority task for them is helping aircraft in distress.

In France (see 5.4), the DSNA works in close coordination with its military counterpart, DIRCAM and since 2011 military controllers and civil controllers are being integrated into the same control centers using the same systems. The French civil and military authorities are working together to enhance flight safety and to optimise the use of airspace. To improve direct communications between civil and military controllers, DSNA and the French Air Force have successfully assessed a more effective real-time civil-military coordination system, “Military Coordination and Control Center (CMCC)” in Reims Upper Area Control (UAC). This includes military positions in the civil operations room, and allows the civil and military control methods to get closer without modifying their own responsibilities. The system provides military controllers with tools with the same functionalities as civil tools, enhancing the efficiency and the speed of real-time coordination. A Military Control Coordination Officer liaises with the civil supervisor, and can work on the configuration of military areas according to civil or military needs.

In Spain, (see 5.6) all the civilian flights are managed by civilian air traffic controllers and that includes military flights outside their restricted areas. The military flights during training or on operative missions, inside their restricted areas, are managed by military air traffic controllers specifically dedicated to them. The military air traffic controllers also coordinate with the civilian controllers the possible interaction with other flights and, if needs be, the activation of restricted areas. Spanish airspace has yet many areas restricted and reserved to military aircraft, and that coordination is mandatory for civilian traffic across those air spaces. On the operational side, SACTA, ENAIRE’s air traffic control system, shares in real time, information concerning flight plans and radar plots of all civil air traffic with the defense system. Then, the defense system, checks if there is any unidentified aircraft, by comparing this information with the data provided by their primary radars. If that happens, they try to communicate with the aircraft and, if there is no positive identification, they activate their “National Defense protocols”.

4.5 Provision of meteorological services

Aviation Meteorology (MET) is an essential element of the complex system that constitutes Air Traffic Management (ATM). The minimum requirements for the provision of the service are articulated in ICAO Annex 3. However, the technical provisions to meet those requirements is the responsibility of another United Nations Specialised Agency, the World Meteorological Organisation (WMO). Close cooperation between the two specialised organisations resulted in a minimum set of requirements for MET Meteorological Service for International Air Navigation, the 3rd Annex of the Chicago Convention (Annex 3), which shall be provided by all designated MET providers around the globe.

Depending on the countries, the MET Service Provider may be the National Meteorological Service for a State, an element of the national Air Navigation Service Provider (ANSP), the military services of a State or potentially a commercial provider of weather services.

EUMETSAT

In Europe, EUMETSAT is a member of the network of operational meteorological organisations responsible for implementing the European Meteorological Infrastructure (EMI). Fellow members comprise the European Meteorological Network (EUMETNET), the European Centre for Medium-Range Weather Forecasts (ECMWF), and the Member States' National Meteorological Services (NMS).

Working in close co-operation, the network members deploy the operational infrastructures and resources required to provide Europe with a comprehensive meteorological system, including ground-based measurements (NMS and EUMETNET), Numerical Weather Prediction models (NMS and ECMWF) and space-based observations (EUMETSAT).

Being a member of EMI ensures that the investments made by Member States in the organisation are optimised with the investments made in the partner organisations of the EMI, so that the maximum benefit is obtained from their overall contribution in observation and modelling capabilities.

EUMETNET

EUMETNET is a network of 36 European National Meteorological Services (NMS). It provides a framework for organising cooperative programmes between NMS for a range of meteorological activities, including observing systems, data processing, basic forecasting products, research and development and training.

The activities of EUMETSAT and EUMETNET are complementary and the organisations maintain close contact. EUMETNET is responsible for in-situ observing systems, which complement EUMETSAT's satellite observation systems to provide NMS with optimum information for their activities. EUMETSAT holds observer status at the EUMETNET Council and vice versa. EUMETSAT is also an observer at the EUMETNET Policy and Finance Advisory Committee (PFAC) and the Science and Technology Advisory Committee (STAC).

EUMETSAT participates in the European Virtual Organisation for Meteorological Training (EUMETCAL) initiative, lead by EUMETNET. EUMETCAL enables European NMS to enhance their training capabilities through the development and provision of virtual training tools, an extensive virtual training library, training workshops, interactive learning modules and an integrated programme of learning courses.

Since 2010, EUMETSAT is a formal participant in the EUMETRep programme. This optional EUMETNET programme aims to represent the interests of EUMETNET members to the European Union institutions.

ECMWF (European Centre for Medium Range Weather Forecast)

The ECMWF is an independent international organisation supported by 34 States. ECMWF's core mission is to:

- Produce numerical weather forecasts and monitor the Earth-system;
- Carry out scientific and technical research to improve forecast skill;
- Maintain an archive of meteorological data.

In order to deliver this core mission, the Centre provides twice-daily global numerical weather forecasts; air quality analysis, atmospheric composition monitoring, climate monitoring, ocean circulation analysis and hydrological prediction. Further, ECMWF operates two services on behalf of the European Union: the Copernicus Atmosphere Monitoring Service and the Copernicus Climate Change Service.

ECMWF is one of the major users of EUMETSAT data and products, which serve as key inputs to its weather forecasting models. ECMWF has recently demonstrated the growing importance of satellite data assimilated in Numerical Weather Prediction (NWP) models.

EUMETSAT and ECMWF maintain a strong relationship, and meet and exchange information on a regular basis. EUMETSAT holds observer status at the ECMWF Council and vice versa. This strong cooperation facilitates the generation and production of a comprehensive range of meteorological, oceanographic and atmospheric products, whose quality is recognised and valued world wide.

MET Service provision in Europe

The situation in Europe regarding the provision of Aviation meteorology, according to a survey performed by EUMETNET is as follows (Figure 4.2):

- In 70% of the EUMETNET member countries the NMHS (National Meteorological and Hydrological Services) organisation provides the MWO (Meteorological Watch Office) function, in 30% this is the ATS (Air Traffic Service) organization.
- In only 19% of members all MWO, AMO (Aerodrome Meteorological Office) and AMS (Aeronautical Meteorological Station) functions are being provided by the NMHS organization.
- There are many MET ANSPs with varying responsibilities and differing cost structures.
- ECMWF (intergovernmental organisation), DWD, Météo-France (MF) and UK Met Office run global models, some other national MET services run limited area models.
- According to this survey, there is no organization providing all functions:
- France (MF) provides all functions but without WAFC (World Area Forecast Centre).
- UK (UKMO) provides all functions but without AMS and TCAC (Tropical Cyclone Advisory Centre).
- 11 (eleven) organizations provide all the AMS, AMO and MWO functions in their country. No mention is made of a military service.
- 12 (twelve) organizations provide all the AMS, AMO and MWO functions in their country. The Military also provides AMS and AMO services.
- 04 (four) organizations provide all the AMO and MWO functions in their country.
- Luxembourg provides the AMS and AMO functions.

In some States, several ICAO Annex 3 functions are (also) provided by other entities:

- In the UK, the AMS function is being provided by aerodromes and ATS ANSP. In Sweden AMS function is also being provided by aerodromes, ATS ANSP and Military.
- In Denmark, Estonia, Ireland, Czech Republic and Finland the AMS function is also being provided by Aerodromes.
- In Belgium, Czech Republic, Finland, Germany, Netherlands, Poland, France, Sweden and Portugal the Military also provides AMS and AMO services.
- In Norway, Hungary and Latvia the AMS function is also being provided by the ATS ANSP.

To summarize, ICAO regulated services are provided by several types of organizations: NMHS, ATS ANSP or Aerodrome operator. In a country, it can either be one or multiple organizations providing the services. All of these organizations can be commercial or non-commercial. In conclusion: already today a complex landscape of different organizations providing several ICAO regulated functions.

Figure 4.2. Situation in Europe regarding the provision of Aviation meteorology

(Green) **MET ANSP = NMHS Organization**
(Blue) **MET ANSP = ATS Organization**
(Red) **MET ANSP = Mix**

5.

Case Studies

The air navigation service providers of the five largest countries plus Ireland are described in detail, since they manage the largest part of the traffic in Europe.

The comparison of their main performance data in 2017 is presented in Table 5.1 and Figures 5.1 to 5.4.

Table 5.1. Comparison of the performance data of the main EU ANSPs in 2017 (except for IAA, 2016 data). Monetary data in euro, except for NATS, in pound sterling.

	Controlled flights (millions)	*Total personnel*	*ATCOs total*	*ATCOs operational*	*Revenues (millions)*	*Net income (millions)*	*Capital expenditure (millions)*	*Staff costs (millions)*
DFS	3,212	5608	2697,448	1716	1103,6	30,8	111,8	862,8
DSNA	3,135	7451	3891	3694	1678	NA	190	NA
ENAIRE	1,992	3778	2010	1796	968,8	152,1	66	433,1
ENAV	1,86	4181	1900		881,8	101,5	115,4	416
IAA	0,348	642	289	253	191,9	32,115	14,1	86,832
NATS	2,45	4216	1670		919,3	114,8	156,4	415,3

	Staff costs / person	*Staff costs / ATCO*	*Controlled flights / ATCO*	*Net income / Revenues*	*Capital expenditure / Revenues*	*Staff costs / Revenues*
DFS	0,15	0,32	1191	2,8%	10,1%	78%
DSNA	NA	NA	806	NA	11,3%	NA
ENAIRE	0,11	0,22	991	15,7%	6,8%	45%
ENAV	0,10	0,22	979	11,5%	13,1%	47%
IAA	0,14	0,30	1204	16,7%	7,3%	45%
NATS	0,10	0,25	1467	12,5%	17,0%	45%

No clear conclusion can be extracted in terms of financial performance about the benefits of the different type of organisation an ANSP may adopt. From Figure

5.1, ENAIRE and IAA, government entities, show better profitability than public-private partnerships such as NATS or ENAV. However, DFS, also 100% state-owned, had a lower profitability compared to those PPPs.

Concerning staff costs, a trend may be identified: with the exception of the Irish IAA, the two big state-owned ANSPs, DFS and ENAIRE, had higher staff costs as a percentage of their revenues (Figure 5.2) compared to the two big PPPs, ENAV and NATS. The same trend is identified comparing the staff costs per person or per ATCO (Figure 5.3). Surprisingly, this conclusion is different than the one we can have looking at EUROCONTROL Unit rates (Figure 4.1), showing the importance in the cost of the service, not only of the personnel costs, but also the efficiency in the utilization of the resources.

Finally, in terms of productivity (number of controlled flights per ATCO, Figure 5.4), again contradictory results can be observed: the PPP NATS shows better performance than state-owned DFS and ENAIRE, which is not the case of the other large PPP, ENAV.

Figure 5.1. Comparison of the financial indicators of the main EU ANSPs.

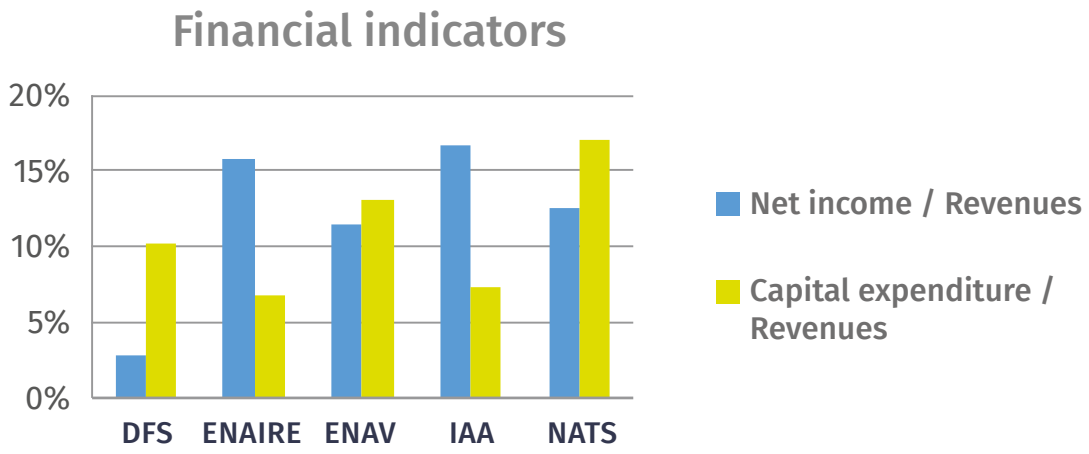


Figure 5.2. Comparison of the staff costs (as a percentage of the revenues) of the main EU ANSPs.

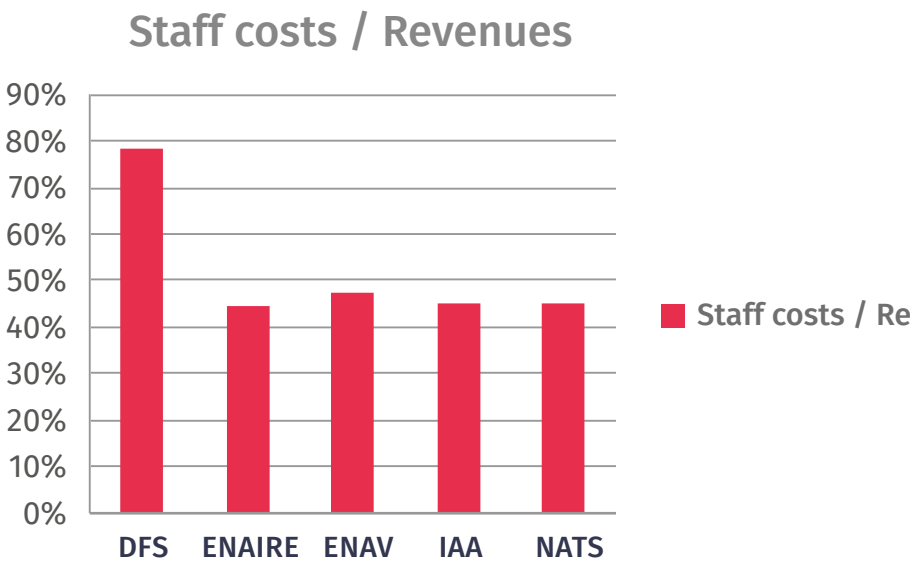


Figure 5.3. Comparison of the staff costs (cost per person or per ATCO) of the main EU ANSPs. Monetary data in euro, except for NATS, in pound sterling.

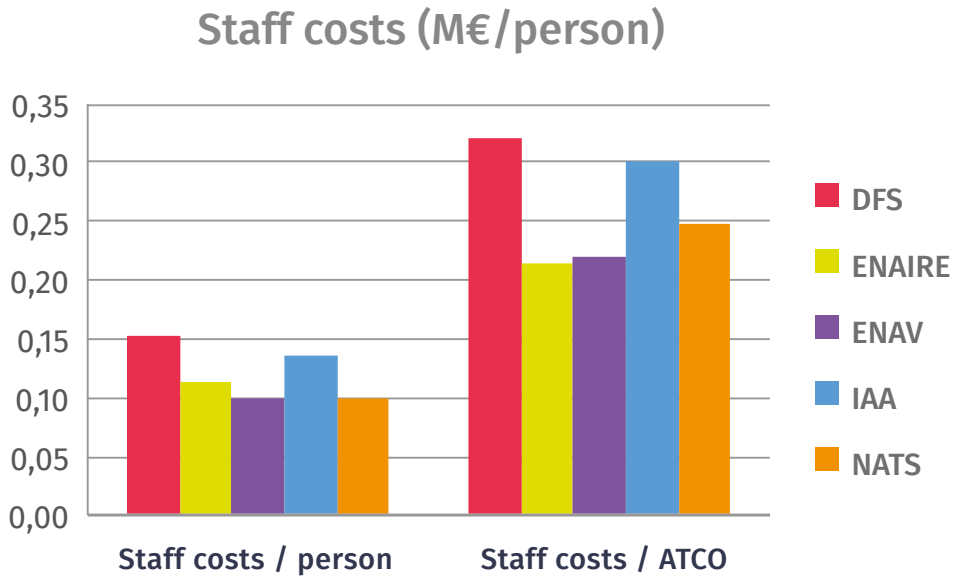
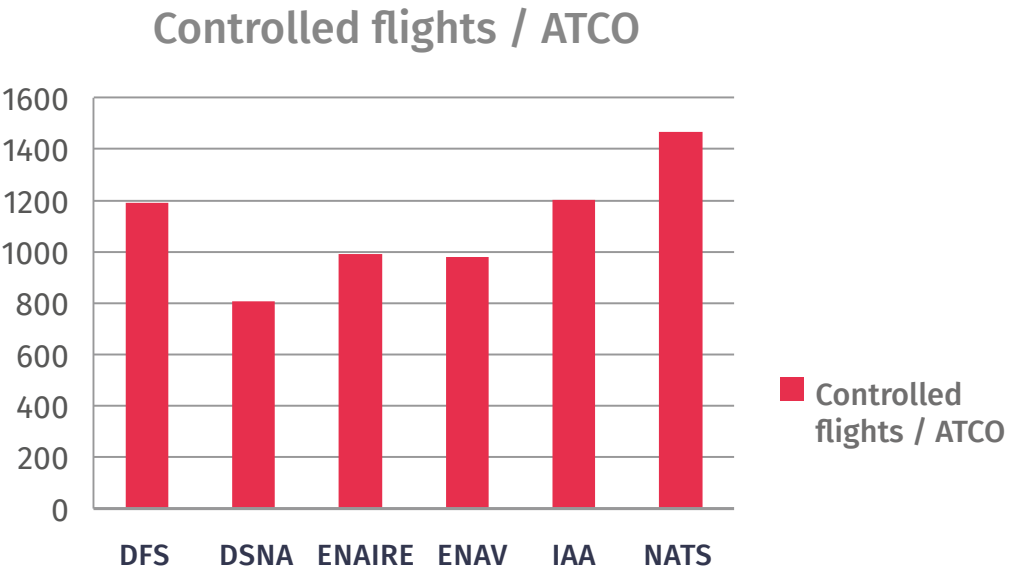


Figure 5.4. Comparison of the performance, in terms of number of controlled flights per ATCO of the main EU ANSPs and the FAA ATO.



It is interesting to analyse and compare the evolution of these indicators for the largest European ANSPs along the last few years. For instance, the evolution of the number of total controlled flights, shown in Figure 5.5. All ANSPs show a growth trend in this indicator, with the sole exception of Italy's ENAV, compatible with the increase in traffic in Europe in those years.

Interestingly, combined with this increase in the activity, in terms of controlled flights, there is a decrease in the number of total personnel, indicative of an improvement in the efficiency of these organisations along the last years (Figure 5.9).

Figure 5.5. Evolution of the number of controlled flights of the largest European ANSPs.

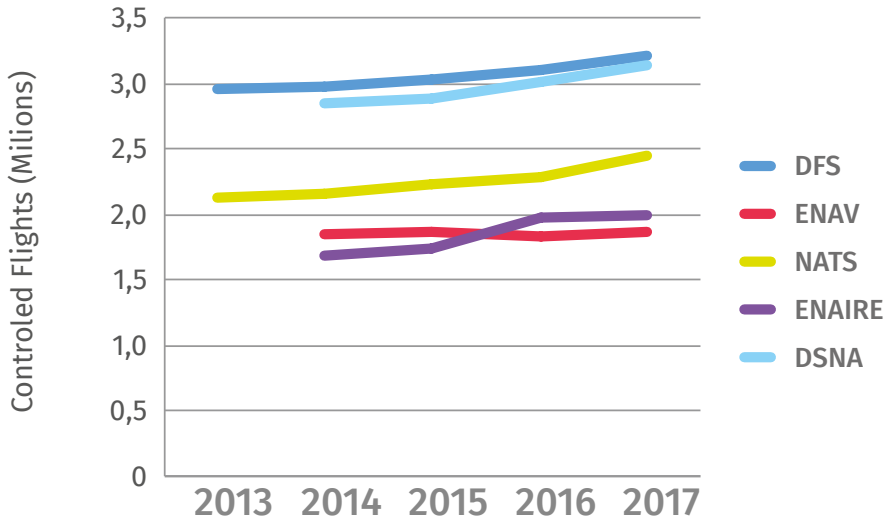
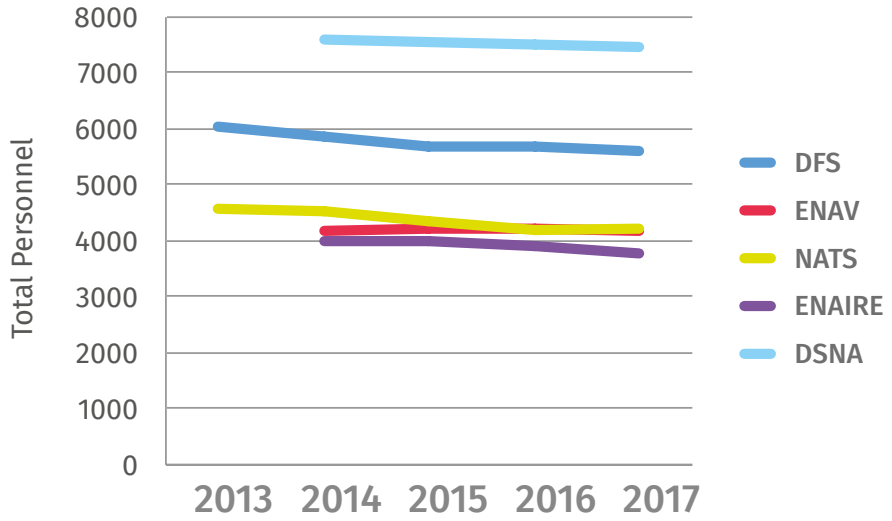


Figure 5.6. Evolution of the number of total personnel of the largest European ANSPs.



To better appreciate this effect, the annual average growth in the number of controlled flights is shown in Table 5.2, together with the annual average growth in the number of total personnel.

Table 5.2. Annual average growth in the number of controlled flights for the largest European ANSPs.

ANSP	*Annual average growth in the number of controlled flights*	*Annual average growth in the number of total personnel*	*Annual average growth in the staff costs*	*Annual average growth in reveues*
DFS	2,2 %	1,8 %	1,7 %	0,1 %
ENAV	0,3 %	0 %	1,1 %	1,8 %
NATS	3,8%	1,9%	1,6 %	0,6 %
ENAIRE	6,2 %	2,0 %	4,2 %	6,0 %
DSNA	3,4%	0,6 %	NA	4,5 %

Looking at the financial indicators, the revenues of the largest European ANSPs show a steady or growth trend (Figure 5.7) consistent with the increase in activity, in terms of the number of controlled flights, meaning that the price of the services has remained relatively constant along the last few years. More in particular ENAIRE (6.2 % increase in the number of controlled flights vs. 6.0 % increase in revenues) and DSNA (3.4 % vs. 4.5 % respectively) show increases in revenues similar to the increase in their activity. Even ENAV, with almost no growth in the number of controlled flights (0,3 %) shows an increase in revenues (1.8 %). However, in the case of NATS (3.8 % vs. 0.6 %) or DFS (2.2 % vs. -0.1 %) the increase in the number of flights does not imply an increase in revenues.

There is a disparity though in the evolution of the net income (Figure 5.8). For some ANSPs (the case of ENAIRE and ENAV there is a significant increase in the net income, while for others like NATS there is a reduction or remain more or less constant, like DFS. It is difficult to extract conclusions from this indicator, because of the different financial factors affecting the net income, in addition to operational expenses: capital expenditures, investments, corporate operations, etc.

Figure 5.7. Evolution of the revenues of the largest European ANSPs. Monetary data in euro, except for NATS, in pound sterling.

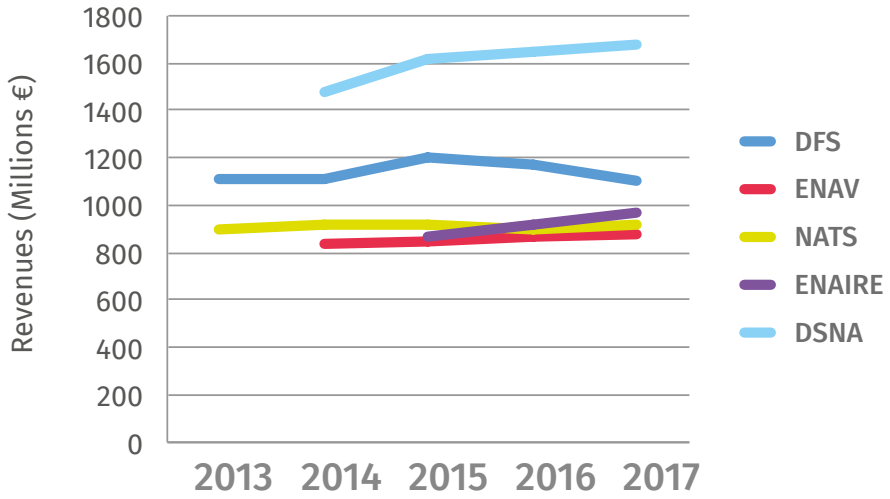
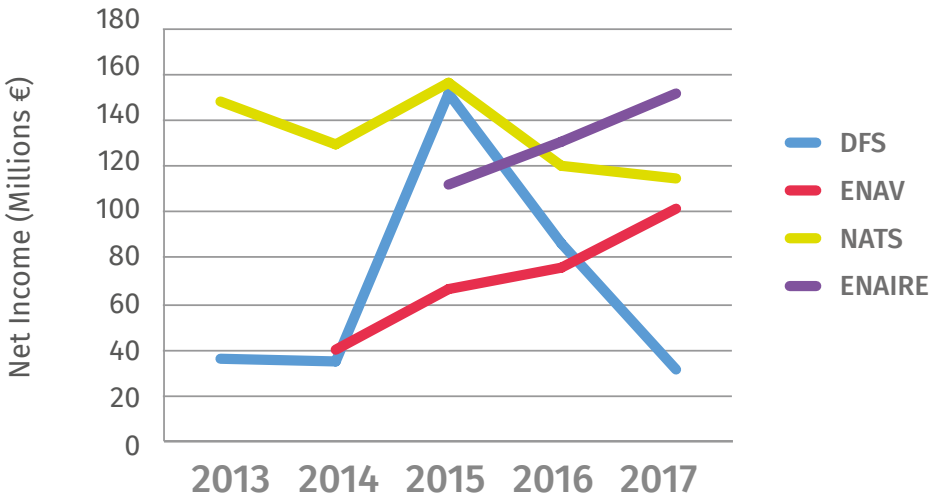
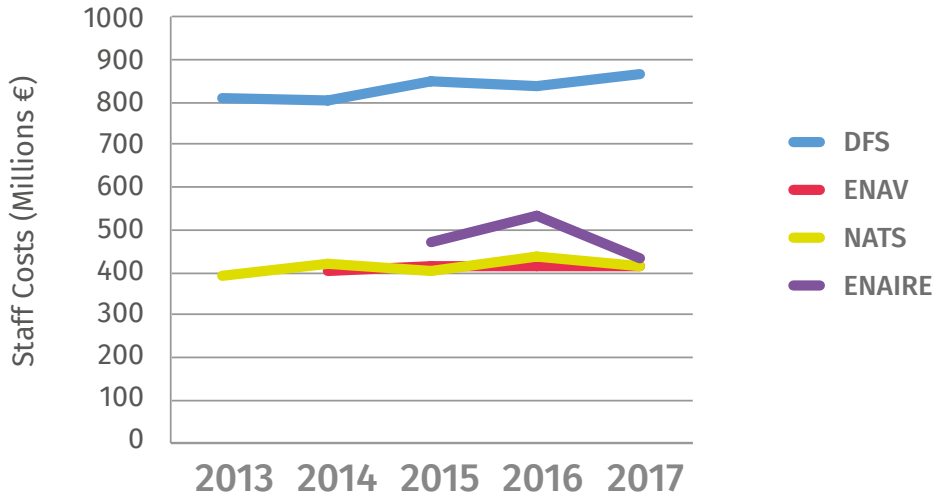


Figure 5.8. Evolution of the net income of the largest European ANSPs. Monetary data in euro, except for NATS, in pound sterling.



It is more significant to understand the evolution of the operational performance of these organisations to analyze the evolution of their staff costs (Figure 5.9) and to compare them with the evolution of the activity (number of controlled flights) and the number of total personnel (Table 5.2). With the only exception of the ENAIRE, (their reduction of the number of total personnel is accompanied of an even larger reduction in the total staff costs) for the rest of the organisations, the staff costs have grown despite of the reduction in the number of total personnel. This indicator gives an idea of the difficulties in the management of the staff for this type of organisations.

Figure 5.9. Evolution of the Staff costs of the largest European ANSPs. Monetary data in euro, except for NATS, in pound sterling.



5.1. Germany –Deutsche Flugsicherung GmbH (DFS)

Organisation Overview

DFS Deutsche Flugsicherung GmbH is a State-owned limited liability company organised under private law. Founded in 1993, DFS Deutsche Flugsicherung GmbH is the successor to the Federal Administration of Air Navigation Services, a government authority that had existed for 39 years. To do this, the German Bundestag had to change the German Constitution and the German Aviation Act. Since January 1993, DFS has been controlling air traffic in Germany.

Staff (5,900 employees) coordinate approximately 10,000 aircraft movements in German airspace every day, and about 3 million movements per year. Germany has the highest traffic volume in Europe. DFS operates control centres in Langen, Bremen, Karlsruhe and Munich. In addition, DFS staff work in the control towers of the 16 international airports in Germany, as well as at the Eurocontrol Centre in Maastricht, the Netherlands. DFS provides training and consultancy services around the world and develops and sells air traffic control, surveillance and navigation systems. The business units of DFS Deutsche Flugsicherung GmbH have to perform a number of different tasks.

Controlling air traffic from the towers and control centres is the core business of the German air navigation services. Apart from performing day-to-day activities, DFS also develops air traffic management systems, surveillance systems as well as navigation aids. DFS compiles flight-related data and uses it for its products and services, such as aeronautical maps and charts and its pre-flight information service. In its Academy, DFS trains a large number of new air traffic controllers every year. In addition, DFS shares its know-how with other companies by providing consultancy services.

In Germany, military and civil air traffic controllers work side by side. Since 1994, DFS has been responsible for the handling of both civil and military air traffic in peacetime. Only military aerodromes are exempted from this integration.

Throughout Germany, DFS is represented at 16 international airports and at nine regional airports by its subsidiary DFS Aviation Services GmbH. Controlling air traffic from the towers and control centres is the core business of the German air navigation service provider.

Apart from performing day-to-day activities, DFS compiles flight-related data and uses them in its products and services, such as aeronautical charts, pre-flight information and the development of air traffic management systems, surveillance systems as well as navigation aids. At its Academy, DFS trains a large number of new air traffic controllers every year. In addition, DFS shares its know-how with other companies by providing consultancy services.

Areas of activity:

Control Centre

The task of the Control Centre division is to guide aircraft safely through German airspace. In Langen, near Frankfurt, DFS operates Europe's largest radar control centre. There are additional control centres in Bremen, Karlsruhe and Munich.

Tower

The Tower division ensures that air traffic at German airports is handled safely and punctually. Throughout Germany, DFS is represented at 16 international airports, and at nine regional airports by its subsidiary The Tower Company.

Aeronautical Information Management

DFS compiles and publishes precise aeronautical data and uses them for its numerous aeronautical publications. The company also performs efficient aeronautical information services.

The Aeronautical Information Management division produces and publishes aeronautical publications and products, such as the AIP Germany and aeronautical maps and charts for Germany and Europe. It provides all data and information required for air traffic.

With its Aeronautical Information Service Centre (AIS-C), this division also provides its customers with all of the information they need for their flights. This includes filing a flight plan before the pilot takes off, and providing NOTAM (Notice to Airmen) concerning temporary changes in conditions or procedures, the timely knowledge of which is essential to safe flight operations. The AIS-C also handles requests for the special use of airspace, such as mass ascents of balloons or sky lanterns.

State-of-the-art technical systems are used to compile, prepare and distribute data and information via different communication channels.

DFS subsidiary for regional airports

The EU regulations on the Single European Sky initiative also changed the rules for air traffic control at regional airports. At regional airports, such as Hahn or Dortmund, air traffic control had to be provided by certified companies and no longer by controllers under the supervision of DFS. The German legislator decided to open up the market to competition. Since then, all certified ANSPs in Europe have the right to tender for the provision of air traffic control at regional airports. For this reason, DFS founded its subsidiary The Tower Company (TTC) shortly before Christmas 2005. TTC became a great success. In May 2006, it was able to secure its first customer – Dortmund Airport. Some airports obtained their own certification or opted for Austrocontrol, but the largest regional airports chose DFS. Finally, TTC had nine customers, including the high-traffic regional airports of Hahn, Dortmund, Niederrhein, Karlsruhe/Baden-Baden and Paderborn.

EU regulation of air navigation service charges

At the initiative of the EU Commission, new requirements for laying down a common European charging scheme for air navigation services were introduced in 2012. Until then, DFS charges had been based on actual costs. This principle of full cost recovery became outdated in 2012. Now, the charges DFS is allowed to levy for its services are based on forecast traffic figures for a specific period. This means that the traffic risk was shifted mainly to the ANSP. If traffic grows less than predicted, the revenue from charges is correspondingly lower and the ANSPs must offset this decline somehow. The new regulation has been in force since 2012 for en-route charges and, since 2015, for terminal charges as well. The effect of this risk can be appreciated in the financial results of DFS of the last years (see Table 5.2 and Figures 5.7 and 5.9), where an increase in traffic is accompanied by a decrease in revenues.

FABEC

The Single European Sky initiative provided for the establishment of Functional Airspace Blocks (FABs) in preparation for a Single European Sky. This is why Europe's ANSPs joined forces to form various FAB initiatives. DFS is part of FAB Europe Central (FABEC), the largest FAB project in Europe. FABEC covers the airspace of Belgium, Germany, France, Luxembourg, the Netherlands and Switzerland. In 2013, the participating countries ratified the FABEC Treaty. Within FABEC, numerous projects have been implemented to improve the situation for airspace users – from the introduction of shorter routes and the elimination of bottlenecks on congested city pairs to the introduction of free route concepts, where airlines can freely choose their flight route between pre-defined points of entry and exit.

Remote tower control

The DFS remote tower control project launched its first operational validation at Saarbrücken Airport in 2015. The aim of the project is to control traffic at small airports remotely in the future. Cameras and infrared sensors replace the view from the tower cab. The system, whose development was awarded to the Austrian technology company Frequentis, has additional tools to facilitate the controller's job. Moving objects are marked and can be tracked automatically with the help of swivelling cameras. The remote tower centre will be located in Leipzig. As soon as the system is ready, air traffic control at the airports of Saarbrücken, Erfurt and Dresden will be gradually transferred there.

Gatwick

In March 2016, DFS took over the provision of air traffic control at London Gatwick Airport, the second largest UK airport via its UK subsidiary Air Navigation Solutions Ltd. With up to 950 take-offs and landings per day, London Gatwick is the busiest single-runway airport in the world. From 1 April 2018, Air Navigation Solutions will also be responsible for tower and approach control at Edinburgh Airport. At both airports, the previous service provider was the UK air navigation service provider NATS.

DFS commercial business bundled

With the foundation of the subsidiary DFS Aviation Services, DFS created the conditions needed to further expand its commercial business. DFS Aviation Services markets and sells products and services related to air navigation services. Previously, the commercial business had been handled either by DFS itself or by its subsidiary, TTC. The new subsidiary's primary focus is the provision of air traffic control. Its air traffic controllers today control air traffic at nine regional airports in Germany, about 60 percent of all regional air traffic in Germany. A second focal point is the marketing of products and services related to air navigation services. For example, a radar data processing system developed by DFS is in use in many countries around the world, including Brazil, Canada and the Netherlands. International customers continue to express interest in high-quality German consulting, training and simulations. DFS Aviation Services is headquartered in Langen with representative offices in Singapore and Beijing.

New air traffic control system

Air traffic control infrastructure consists of:

- Stripless and trajectory-based ATC system (P1/iCAS for upper space).
- Paperless strip system (PSS in lower space).
- Digital voice communication systems.
- Radar data processing systems as fallback.
- Tower Human Machine Interface (HMI).

DFS introduced the new iCAS air traffic control system at its Karlsruhe branch, which controls the upper airspace of Germany. It is faster and more powerful than its predecessor is and is backed by a modern technical platform. Over the next few years, DFS will gradually install iCAS at its control centres for lower airspace in Munich, Bremen and Langen. The aim is to use the system across DFS as the standard air traffic control system and thus reduce costs.

ICAS is part of the joint European project iTEC (Interoperability Through European Collaboration). Several ANSPs have joined forces in this alliance to develop a new generation of ATM systems with common core components, together with the Spanish IT company Indra. The aim is to make the ATM systems of the individual countries compatible by means of common standards, reducing development and maintenance costs. DFS is collaborating with the air navigation service providers of the Netherlands (LVNL), Poland (PANSA) and Lithuania (Oro Navigacija). In addition, NATS of the UK and its project partner AVINOR (Norway) and the Spanish ENAIRE belong to the ITEC alliance.

Additional services

In addition to its core business of providing air traffic control, DFS offers other services in the field of aviation. For example, DFS experts prepare and distribute special statistics and publications such as charts and aeronautical information publications containing all information essential to air navigation. DFS markets its technical know-how and sells its systems, such as Phoenix or the Advanced Arrival Management System, on the international market and is also setting up technical air navigation services facilities in other countries spanning from Europe to the Middle East.

At its Air Navigation Services Academy in Langen, DFS not only trains its air traffic controllers, but flight data specialists and briefing officers, too. Technicians and engineers are trained here as well to work on state-of-the-art air traffic control systems. The air navigation services organisations of Croatia, Italy and the Netherlands, to name a few, avail of the know-how and technology of the Academy to train their air traffic controllers.

European Satellite Services Provider (ESSP)

DFS is developing the European Geostationary Navigation Overlay Service (EGNOS) in cooperation with six other European air navigation services organisations. DFS is represented by its DFS International Business Services GmbH, which makes financial contributions and provides infrastructure facilities.

FCS Flight Calibration Services GmbH

Calibration flights are performed to guarantee the precision of the signals transmitted by air navigation systems. DFS holds shares of the company FCS Flight Calibration Services, which is

headquartered in Braunschweig, along with the Swiss air navigation services, skyguide, and the Austrian air navigation services, Austro Control. FCS is a competent and reliable partner in all flight calibration issues.

GroupEAD

EUROCONTROL, the European Organisation for the Safety of Air Navigation, set up the European Aeronautical Information Services Database to provide standardised worldwide aeronautical information. DFS and the Spanish air navigation services organisation ENAIRE and an Austrian manufacturer of air traffic control systems were commissioned to jointly create this database. For this purpose, the partners founded GroupEAD Europe S.L., which has its headquarters in Madrid/Spain and operational centres in Frankfurt/Germany and in Wellington/New Zealand.

Civil-military integration

DFS has been entrusted by law with the control of German civil and military air traffic in peacetime, while taking due account of military interests. The law only exempts local military air traffic control services at military aerodromes, including military aerodromes also used by civil aviation. In states of tension and defence, however, the armed forces are entitled to perform air traffic control functions in Germany.

An interdepartmental agreement between the Federal Ministry of Transport and the Federal Ministry of Defence concerning the cooperation in the field of air traffic control laid the foundation for this law and the necessary amendment of the German Constitution. Previously organised as two separate services, civil-military cooperation has meanwhile developed into an efficient and integrated system. The development of flexible airspace management has brought considerable benefits to both civil and military air traffic. The main aspects of the 1991 agreement are:

- In peacetime, control of Operational Air Traffic (OAT) except at military airbases is performed by the civil Air Traffic Control Services.
- Military area radar control will be integrated into the civil ATC organisation. The military personnel will be seconded by granted leave of absence and will receive a contract from DFS.
- In times of tension and war, ATM falls (according to German Constitution) under the responsibility of MOD as part of the defence mission.
- Granted leave of absence will be revoked in times of tension and war, or when deemed necessary for specific military reasons.
- Arrangements with the unions ensure operations for military, government and emergency flights in the case of industrial action (seconded military personnel may participate at industrial action).
- Principles of placing seconded military personnel into positions in operations and management structure.
- Principles of recruitment and financing.

Through its subsidiary Kaufbeuren ATM Training, DFS took over the training for German military air traffic services on 1 January 2017. DFS will train military air traffic services personnel in the town of Kaufbeuren in cooperation with the Bundeswehr. The subsidiary will conduct the training for 60 to 80 military participants per year. In particular, these will include military air traffic controllers and AIS officers.

Since the civil and military controls are fully integrated, with the exception of tower control at the military air bases, the infrastructure for the provision of the service is unique and therefore

not duplicated, as far as it is known from published information. Even military area radar control is integrated into the civil ATC organisation.

Charges

Regulation and calculation of charges

DFS performs air navigation services for the German government as outlined in Article 27c (2) of the German Aviation Act (LuftVO). The costs incurred must be covered by revenues in the form of air navigation charges, reimbursements and other sources of revenue. Terminal charges, for example, are levied by the air navigation services for providing services and facilities to airlines during take-off and landing at German airports. En-route charges are collected for en-route services and facilities. The following applies to military air traffic: DFS determines the costs incurred for the services provided to military airspace users and the Bundeswehr reimburses DFS. These costs do not fall on civil aviation.

The unit rates are published in the relevant regulations. The actual charge to be paid is calculated as follows:

- For approach and departure services, on the basis of the weight factor:

  Charge = (MTOW/50)0.7 x unit rate

- For en-route services, as per the EUROCONTROL system, by multiplying the weight and distance factors:

$$charge = \sqrt{\frac{MTOW}{50}} \times \frac{distance\ flown\ in\ km}{100} \times unit\ rate$$

Invoices for en-route charges are issued in euro and issued by the Central Route Charges Office (CRCO) of EUROCONTROL in Brussels as a single charge per flight. The revenue is then transferred to the individual States. Apart from including the costs incurred by DFS, this cost-base also comprises the costs of EUROCONTROL and the aeronautical meteorological service financed from the German federal budget.

The unit rate for terminal navigation for 2018 is 127.87 Euro subject to Value Added Tax of 19% at present.

Examples of terminal navigation charges in 2018:

Type: Ikarus C42 / MTOW: 0.450 t / charge: EUR 5.11.

Type: Cessna C 172 / MTOW: 1.157 t / charge: EUR 8.95.

Type: LR 35 / MTOW: 8.3 t / charge: EUR 35.80.

Type: A320 / MTOW: 73.5 t / charge: EUR 167.51.

Traffic development

DFS air traffic controllers handled exactly 3,211,771 flights under instrument flight rules. This represents an increase of 3.3 percent over the previous year. Controlled flights mean more or less all scheduled, charter and cargo flights. They are guided by air traffic control from the moment they take off until the moment they land.

Year	Controlled flights (in million €)	Compared with preceding year
2017	3.212	+3.3%
2016	3.109	+2.6%
2015	3.029	+1.6%
2014	2.980	+0.9%
2013	2.953	-1.4%
2012	2.994	-2.2%
2011	3.060	+3.0%
2010	2.971	+1.5%
2009	2.927	-7.1%
2008	3.149	+1.1%

Personnel

DFS has a workforce of 5,386 (as at 31 December 2017) at DFS locations throughout Germany. DFS has 2,000 air traffic controllers, making them the largest occupational group in the company. The technical systems required in the air navigation services are planned, developed and operated by 900 technicians and engineers, most of whom work in Langen. The rest of the DFS staff work as AIS briefing officers in Frankfurt-Rödelheim, at the Headquarters, at the Air Navigation Services Academy as well as in other areas of DFS. In addition, 150 apprentices and trainees are currently training at DFS in various professions, such as to become air traffic controllers.

Financial performance

In 2017, the DFS group generated revenues under IFRS (International Financial Reporting Standard) accounting standards for EUR 1,103.6 million. Despite an increase in flight movements of around 5.7 percent, revenues remained below the level of the previous year of EUR 1,169.7 million. This is due to lower revenues from charges resulting from a reduction of unit rates. DFS reduced its unit rate for en-route flights by 16 percent in 2017. For terminal charges at German airports, airlines have to pay 18 percent less since the beginning of 2017.

In total, the DFS group generated a net income of EUR 30.8 million in 2017. The company's commercial business contributed EUR 66 million to the group's overall performance.

Extracts from 2017 business year (according to IFRS)	EUR
Revenues	1,103.6 million
Capital expenditure	111.8 million
Balance sheet total	2,251.2 million
Net income	30.8 million

A summary of the evolution of the main operational and financial indicators of DFS is shown in Table 5.3.

Table 5.3. Evolution of the main indicators of DFS. Monetary data in euro.

DFS	Controlled flights (millions)	Total personnel	Revenues (millions)	Net income (millions)	Staff costs (millions)	Staff costs / person	Net income / Revenues	Staff costs / Revenues
2017	3.212	5608	1103.6	30.8	862.8	0.15	2.8%	78%
2016	3.108	5695	1169.7	86.6	835.8	0.15	7.4%	71%
2015	3.029	5672	1204	152.1	850.7	0.15	12.6%	71%
2014	2.98	5879	1106.2	34.9	803.1	0.14	3.2%	73%
2013	2.952	6046	1109.2	35.8	808.5	0.13	3.2%	73%

Punctuality

In 2017, 5.8 percent of the flights were affected by air traffic flow management measures, for example due to bad weather. Roughly, 94 percent of all flights reached their destinations without delay.

DFS defines as “delay-free” those flights that have less than a 15-minute delay under the control of the air navigation services.

Year	IFR aircraft movements (in millions)	Percentage of flights without delay
2017	3.212	94.2%
2016	3.109	96.8%
2015	3.029	98.2%
2014	2.980	97.7%
2013	2.953	97.8%
2012	2.994	95.9%
2011	3.060	92.8%
2010	2.971	90.4%
2009	2.927	94.0%
2008	3.150	93.6%

FABEC – FAB Europe Central

DFS along with its civil (seven) and military (three) partners from Belgium, France, Luxembourg, the Netherlands and Switzerland have joined forces with the transport and defence ministries to launch an initiative to create a functional airspace block at the heart of Europe, known as FABEC. The FABEC Treaty, which was ratified as of 1 June 2013, is the formal basis for this collaboration.

The focus is on cross-border cooperation, both in the civil and the civil-military field. Thanks to its long-standing experience, DFS serves as a role model.

FABEC is one of the busiest and most complex airspaces in Europe. FABEC airspace spans Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland totalling 1,713,442 km2 and is characterised by a dense network of numerous civil and military routes. In addition, the majority of Europe’s largest airports and hubs are located within FABEC. Due to its size and central location, FAB Europe Central plays a key role in the SES programme.

Within FABEC, Free Route Airspace (FRA) is being progressively implemented in all DFS control centers above FL 245. FRA allows the airspace user to plan a free route between a defined entry point and a defined exit point affording a high level of flexibility in route planning.

5.1.1. Germany – Federal Supervisory Authority for Air Navigation Services

In Germany, the National Supervisory Authority (NSA) depends on the Ministry of Transport and is responsible for all state tasks in the field of air navigation services, being therefore the Federal Supervisory Authority for civil air navigation service providers in Germany. It was established in 2009 and it is based in Langen (Hessen). In August 2018, it employed 95 people.

Organised in different departments, NSA carries out the following tasks:

- Certification of ANS providers & training organisations;
- ATCO and ATSEP training, licensing and medical;
- Continuous safety oversight of the ANS organisations and ANS personnel;
- Occurrence Reports;
- APEG (Air Proximity Evaluation Group);
- Technical harmonisation (Interoperability);
- Oversight of flight calibration;
- Type certification of CNS-systems used for ANS;
- Aeronautical radio frequency management;
- Protection of ANS facilities against electromagnetic interferences;
- Establishing of flight procedures;
- Issuing rights of passage for restricted areas;
- Prosecution of airspace related offences;
- Publications in NfL (Aeronautical Information Bulletin);
- Legal department;
- Performance planning (safety, capacity, environment, cost efficiency);
- Performance scheme oversight and reporting;
- Determination of ATC charges (en route and terminal);
- User consultations;
- Human resource management;
- Education and training, qualification;
- Health and safety;
- Budget, organisation, internal services, IT;
- Press and public relations work;
- International and European cooperation (ICAO, EUROCONTROL, EU, EASA, FABEC, MUAC, neighbouring states).

5.2. United Kingdom –National Air Traffic Services (NATS)

Organisation Overview

Founded in 1962, NATS is the leading Air Navigation Service Provider in the UK, operating under licence by the UK Civil Aviation Authority and providing services in over 30 countries internationally; including 14 UK airports, Gibraltar airport and, in a joint venture with Ferrovial, a number of airport towers in Spain. NATS provided air traffic control services to over 2.5 million flights in 2017, and continues to operate up to 7,000 flights a day across UK and eastern North Atlantic airspace.

NATS offers aerodrome, data, engineering, capacity, efficiency and environmental performance solutions to customers worldwide, including airports, airlines, air traffic service providers and Governments.

Air Traffic Control

NATS provides air traffic navigation services to aircraft flying through UK controlled airspace and at numerous UK and international airports.

UK airspace contains a network of corridors, or airways. These are usually ten miles wide and reach up to a height of 24,000 feet from a base of between 5,000 and 7,000 feet. They mainly link busy areas of airspace known as terminal control areas, which are normally above major airports. At a lower level, control zones are established around each airport. The area above 24,500 feet is known as upper airspace.

All of these airways are designated “controlled airspace”. Aircraft fly in them under the supervision of air traffic controllers and pilots are required to file a flight plan for each journey, containing details such as destination, route, timing and height.

Within controlled airspace, pilots must follow controllers’ instructions. Outside controlled airspace, they take full responsibility for their own safety, although they can ask for help.

Military controllers work closely with their civilian colleagues to provide a fully integrated service to all users. They offer an air traffic service to aircraft in uncontrolled airspace. Military personnel also provide services to aircraft crossing airways and for those flying above 24,500 feet. A priority task for them is helping aircraft in distress.

Despite the efforts trying to improve civil and military integration, for the moment the infrastructure for the provision of military control is independent and belongs to the Ministry of Defence, according to known and published information.

NATS services are grouped into six distinct areas:

- Airports – innovative ATC and airport optimisation services.
- Airspace – safe and efficient en route services.
- Engineering – efficient delivery of technology and infrastructure projects.
- Information – helping move from people-based to data-based operations.
- Consultancy – a window to the range of services and capabilities we can offer.
- Defence – joint and integrated civil and military air traffic control services.

Control centres

As the sole provider of en route services in the UK, NATS operates from two centres at Swanwick in Hampshire, England and Prestwick in Ayrshire, Scotland.

NATS Swanwick

This centre started operating in January 2002, when it began handling aircraft flying over England and Wales. The operations room in Swanwick combines:

- London Area Control Centre (LACC), which manages en route traffic in the London Flight Information Region. This includes en route airspace over England and Wales up to the Scottish border.
- London Terminal Control Centre (LTCC), which handles traffic below 24,500 feet flying to or from London's airports. This area, one of the busiest in Europe, extends south and east towards the coast, west towards Bristol and north to near Birmingham.
- Military Air Traffic Control. Military controllers provide services to civil and military aircraft operating outside controlled airspace. They work closely with civilian controllers to ensure safe co-ordination of traffic.
- NATS Prestwick
- With the opening of the new Prestwick Centre in 2010, NATS consolidated its air traffic control centres from four to two – reducing costs, and increasing security and operational efficiency. The operations room in Prestwick combines:
- Manchester Area Control Centre (MACC), which controls aircraft over much of the north of England, the Midlands and north Wales from 2,500 feet up to 28,500 feet.
- Scottish Area Control Centre (ScACC), which controls aircraft over Scotland, Northern Ireland, Northern England and the North Sea from 2,500 feet up to 66,000 feet.
- Oceanic Area Control Centre (OACC), which controls the airspace over the eastern half of the North Atlantic from the Azores (45 degrees north) to a boundary with Iceland (61 degrees north).

A public private partnership

NATS is a public private partnership between the Airline Group, which holds 42%, NATS staff who hold 5%, UK airport operator LHR Airports Limited with 4%, and the government which holds 49%, and a golden share.

The Airline Group comprises:

- USS Sherwood Limited.
- British Airways PLC.
- Pension Protection Fund.
- EasyJet Airline Company Limited.
- Virgin Atlantic Airways Limited.
- Deutsche Lufthansa AG.
- Thomson Airways Limited.
- Thomas Cook Airlines Limited.

The Public-Private Partnership for NATS was proposed in June 1998, and enshrined in the Transport Act 2000.

After the war, ATC became the responsibility of the Ministry of Civil Aviation, and the network of air routes we use today began to develop in the 1950s.

NATS forerunner, National Air Traffic Control Services (NATCS), was established in December 1962. It covered civil ATC but liaised with the MoD (RAF) in areas where military traffic needed to cross civilian routes. When the Civil Aviation Authority (CAA) was established in April 1972, NATCS became part of it and shortened its name to NATS.

In 1992, it was recognised that as a service provider NATS should be operated at a distance from its regulator, the CAA. With that in mind, NATS was re-organised into a Companies Act company in April 1996 and became a wholly owned subsidiary of the CAA.

The Public-Private Partnership for NATS was proposed in June 1998, and enshrined in the Transport Act 2000. The Government chose the Airline Group as the preferred partner in March 2001 and the transaction was completed in July 2001 with the sale of 46% to the AG and the devise of 5% to staff. Although the Government retained the balance, the company was finally free of Treasury control.

The aviation industry downturn after 11 September 2001 led to a financial restructuring of NATS. This involved £130 million of additional investment (split between Government and LHR Airports Limited) to reduce borrowings. At the same time, LHR Limited took a 4% shareholding, reducing the Airline Group's holding to 42%. A £600 million bond issue, successfully completed in October 2003, further reduced our debt.

In 2003, NATS launched its ten-year £1 billion investment programme with the announcement of a complete renewal of its radar network. Since then, NATS have worked with Nav Canada on a new system for Oceanic control; became the first in Europe to establish a working Functional Airspace Block (FAB) with Irish counterparts; and launched a Joint Venture company with the Spanish to develop the next generation of air traffic management systems for Europe.

Strategic approach to safety

NATS applies a systematic safety management system to all of its operational activities. NATS was one of the world's first air traffic management providers to implement a safety management system (SMS). This formal approach is founded on documented safety policies, safety principles and safety procedures. The system forms the basis for risk assessment, safety assurance, safety control and safety monitoring.

The Safety Review Committee (SRC) is a top-level Board committee supported by independent experts.

Through the SMS, safety is given the highest priority by rigorous reviews of the safety implications of every activity within the ATM operation. The SMS maintains explicit safety standards that comply with national and international obligations.

NATS is subject to tough safety regulation from the Civil Aviation Authority. The model of independent safety regulation is increasingly being adopted worldwide in the Air Traffic Management industry.

Services

Airspace

- Training.
- ATM modernisation.
- Contingency facilities.

Airports

- ATS Management.
- Tower & approach.
- Training.
- Other services.

Defence

- Aeronautical data.
- Defence consulting.
- End route.
- Military Terminal ATC provision.
- Surveillance.

Engineering

- Control centre systems.
- Airport technology.
- Maintenance.
- System upgrades.

Consultancy

- Airspace design.
- Capacity planning.
- Environmental reporting.
- Occupational health.
- Runway capacity studies.
- Strategy & business planning.
- Safety management & human factors.
- Technology & projects.

Information

- Aeronautical charting.
- Aeronautical Information Management (AIM).
- Procedure design.
- Surveillance data.
- Target Start-up Approval Time (TSAT).

A summary of the evolution of the main operational and financial indicators of NATS is shown in Table 5.4.

Table 5.4. Evolution of the main indicators of NATS. Monetary data in pound sterling.

NATS	Controlled flights (millions)	Total personnel	Revenues (millions)	Net income (millions)	Staff costs (millions)	Staff costs / person	Net income / Revenues	Staff costs / Revenues
2017	2.450	4216	919.3	114.8	415.3	0.10	12.5%	45%
2016	2.278	4196	898.1	120.3	439.1	0.10	13.4%	49%
2015	2.22	4342	922.4	156.9	403.8	0.09	17.0%	44%
2014	2.16	4519	917.6	129.3	419.1	0.09	14.1%	46%
2013	2.126	4562	899.5	148.1	390.9	0.09	16.5%	43%

5.3. Ireland –Irish Aviation Authority (IAA)

The Irish Aviation Authority (IAA) was established as a commercial state-sponsored body (commercial semi-state company) on 1 January 1994 under the Irish Aviation Authority Act, 1993 and employs approximately 650 people at six locations around Ireland. It is responsible for the provision of air traffic management services in Irish controlled airspace (covering some 451,000 square km) and the safety and security regulation of the Irish civil aviation industry.

The ATM Operations & Strategy Directorate of the Irish Aviation Authority provides air traffic management services in airspace controlled by Ireland.

IAA Air Traffic Management services include:

- Air traffic control.
- ATC Flight Information.
- Aeronautical information.
- North Atlantic Communications.

IAA Safety regulatory services include:

- Aircraft airworthiness certification and registration.
- Licensing of personnel and organisations involved in aircraft maintenance.
- Licensing of pilots, air traffic controllers and aerodromes.
- The approval and surveillance of air carrier operating standards.

The oversight of civil aviation security involves inspections and audits of airports, air carriers, cargo companies, airport suppliers and suppliers of in-flight services.

The IAA ensures that Irish civil aviation operates to safety standards set internationally, principally by the International Civil Aviation Organization (ICAO), European Joint Aviation Authorities (JAA), Eurocontrol, The European Civil Aviation Conference (ECAC), The European Aviation Safety Agency (EASA), and the European Union.

The IAA became a shareholder in Entry Point North in December 2013 in partnership with Naviair (Denmark), LFV (Sweden) and Avinor (Norway).

Following an intensive international audit by ICAO in 2010, Ireland was ranked among the best in the world in the safety oversight of civil aviation. Ireland was placed in the top ten countries worldwide ahead of countries like the United States, Brazil and Australia.

The IAA receives no Government funding. Approximately 75% of all IAA revenue comes from en route airspace traffic (over flying Ireland) or from the use of HF Communication services. The IAA has one of the lowest en route user charge unit rates in Europe making Irish airspace economically attractive to airspace users.

As far as it is known and published military air traffic control is performed independently by the Ministry of Defence and with dedicated infrastructure, although efforts are being done in the last years to optimize the utilisation of resources by sharing some new and expensive elements of infrastructure, like long-range radars.

A summary of the evolution of the main operational and financial indicators of IAA is shown in Table 5.5.

Table 5.5. Evolution of the main indicators of IAA. Monetary data in euro.

IAA	Controlled flights (millions)	Total personnel	Revenues (millions)	Net income (millions)	Staff costs (millions)	Staff costs / person	Net income / Revenues	Staff costs / Revenues
2013	0.905	659	173.6	16.1	87.6	0.13	9.3%	50%
2014	0.936	649	177.5	21.7	85.1	0.13	12.2%	48%
2015	0.989	655	183.4	24.8	85.9	0.13	13.5%	47%
2016	1.065	652	191.9	32.1	86.8	0.13	16.7%	45%
2017	1.100	666	193.4	26.3	89.7	0.13	13.6%	46%

5.4. France – Direction des Services de la Navigation Aérienne (DSNA)

The Direction des Services de la Navigation Aérienne (DSNA) is the agency in charge of air traffic control, communication and information for France. It is a part of the Ministry of Sustainable Development, through the Direction Générale de l'Aviation Civile (DGAC), and was created by decree in February 2005. The DSNA is a non-profit agency.

The DSNA works in close coordination with its military counterpart, DIRCAM and since 2011 military controllers and civil controllers are being integrated into the same control centers using the same systems. DSNA is integrated into the Central European Functional Airspace Block (FABEC).

DSNA provides air navigation services (ATS, CNS, AIS) through five area control centres and twelve regional divisions.

The ACCs are located at Athis-Mons (Paris ACC), Reims, Aix-en-Provence (Marseille ACC), Bordeaux and Brest. The nine regional divisions located in the mainland manage 76 airports, and the three regional divisions located overseas manage six airports and one overseas ACC in Guyana (Central America). DSNA also operates two airports (Tahiti, Nouméa) and one overseas ACC (French Polynesia) in French overseas territories.

The French air navigation services controlled 3,015,153 flights in 2016, a 4.4 percent increase compared with 2015. Absolute peak day was recorded on July 8th, 2016 when they handled 10,820 flights thus establishing a new Europe-wide record. Previous peak was recorded on July 17th, 2015, with 10,173 flights.

In the framework of the Single European Sky, DSNA is one of the seven ANSPs implementing the Functional Airspace Block Europe Central (FABEC) and is a member of SESAR JU, which manages the second phase of the European R&D programme (SESAR 2020).

A summary of the evolution of the main operational and financial indicators of DSNA is shown in Table 5.6.

Table 5.6. Evolution of the main indicators of DSNA. Monetary data in euro.

DSNA	Controlled flights (millions)	Total personnel	Revenues (millions)
2017	3.135	7451	1678
2016	3.015	7521	1645
2015	2.887	7562	1613
2014	2.845	7578	1478

Air navigation charges

DSNA is remunerated by two kinds of charges for the provision of air navigation services:

The en-route charges (oceanic charges respectively) compensate the use of facilities and the provision of services over metropolitan France (overseas territories respectively). Beside the unit rate, the charge for a specific flight depends on the distance flown and the maximum take-off weight (MTOW) of the aircraft for that flight.

The terminal charges (one in metropolitan France and one in overseas territories) compensate the use of facilities and the provision of services within 20 km of an airport. Beside the unit rate, the charge for a specific flight only depends on the MTOW of the aircraft for that flight. For charging purposes, approach and departure count as a single flight. Charges will apply on the departing flight only.

DSNA services

DSNA Services provides worldwide consultancy, operational engineering and training services based on DGAC's and ENAC's professional know-how.

CUSTOMERS: Civil aviation, air navigation provider, Airport authorities, Airlines.

DOMAIN: Operation – Regulation – Supervision.

SERVICES: Consultancy – Audit – Project Management – Engineering – Operational training.

PRODUCTS:

- Safety: SMS implementation, Safety studies.
- Air Navigation Operational Concept: CDM, Dynamic ATFM, FUA, Apron Control.
- Airspace Design: Merge Point, CCO-CDO, PBN.
- Solutions: XMAN, Human resources & skills management software, 4D-Trajectography software.
- Technics: studies to implement new material, project management.
- Regulation & Supervision: Corrective Action Plan.
- Operational training.

Running Costs and Fees

The DSNAs running costs are covered by:

- Route charges ("redevances de route ", collected by EUROCONTROL for its 37 participating member states).
- Air traffic terminal charges ("redevance pour services terminaux de la circulation aérienne" –RSTCA).
- Oceanic charges (" redevance océanique" –ROC).
- Civil aviation tax ("Taxe Aviation Civile" – TAC).

Operations

The DSNA Operates 5 en route control centers Located in Brest, Paris, Reims, Aix-en-Provence and Bordeaux. It also operates 9 regional approach and control centers (SNAs)

- Nantes (SNA Ouest);
- Lille (SNA Nord);
- Paris (SNA Région Parisienne);
- Strasburg (SNA Nord Est);
- Lyon (SNA Centre Est);
- Nice (SNA Sud Est);
- Marseilles (SNA Sud Sud Est);
- Toulouse (SNA Sud);

- Bordeaux (SNA Sud Ouest).

The DSNA has 3 regional centers for French overseas territories:

- "Antilles-French Guiana" (SNA AG);
- "Indian Ocean" (SNA OI) et
- "Saint-Pierre-et-Miquelon" (SNA SPM).

Civil – military cooperation

The airspace in Northern France is one of the busiest and the most complex airspaces in the world. To manage a high density of both general and military air traffic, the French civil and military authorities are working together to enhance flight safety and to optimise the use of airspace.

To improve direct communications between civil and military controllers, DSNA and the French Air Force have successfully assessed a more effective real-time civil-military coordination system, "Military Coordination and Control Center (CMCC)" in Reims Upper Area Control (UAC). This includes military positions in the civil operations room, and allows the civil and military control methods to get closer without modifying their own responsibilities. The system provides military controllers with tools with the same functionalities as civil tools, enhancing the efficiency and the speed of real-time coordination. A Military Control Coordination Officer liaises with the civil supervisor, and can work on the configuration of military areas according to civil or military needs.

First generation CMCCs were implemented in Bordeaux, Brest and Marseille ACCs in 2008. Paris ACC will test a more advanced version of the CMCC similar to the one in Reims UAC in March 2014.

As far as it is known from published information this cooperation and integration does not include yet the integration of the civil and military infrastructure (with the already mentioned exception of the control centers and tools), remaining for the moment independent.

5.5. Italy – ENAV

Organisation Overview

ENAV is the Italian air navigation service provider, ensuring safety and reliability for the 1.8 million flights handled yearly from the control towers of 45 airports and 4 Area control centres (Roma, Milano, Padua, Brindisi). With a workforce of 4,200, ENAV provides air navigation services to the airlines that fly over Italian airspace.

ENAV also provides:

- Air traffic services (ATS) including air traffic control service (ATC), flight information service (FIS) and alerting service (ALRS);
- Aeronautical information service and related publications (AIS);
- Meteorological services for air navigation (MET);
- Communication, navigation, surveillance services (CNS);
- Associated supporting services:
- Airspace management, airspace design and air traffic capacity planning;
- Flight procedures design and obstacle analysis;
- ATM system definition, acquisition, operation and maintenance of operational infrastructures;
- Flight inspection services of radio nav-aids, broadcasting and surveillance systems for Air Traffic Services;
- Training of ATM personnel.

In addition to ensuring the provision of all air navigation services, through its subsidiaries, ENAV provides installation, maintenance and constant monitoring of all hardware and software systems, develops and tests new technologies and provides consultancy and services to international markets.

ENAV resulted from the transformation of AAAVTAG (Azienda Autonoma di Assistenza al Volo per il Traffico Aereo Generale) in to a Public Body, the “Ente Nazionale di Assistenza al Volo” in 1996. Subsequently, in 2001, it became a public limited company in the context of the wider process of liberalisation and privatisation of the air transport market. The objective was to achieve efficiency and operational targets, and improve quality and reliability of services, ensuring a high level of safety and quality, as per international standards.

ENAV inherited the job of handling civil air traffic control, which until 1979 was managed by the Italian Air Force and subsequently, from 1982, by AAAVTAG. In 2006, ENAV acquired 100% of Vitrociset Sistemi, today renamed Techno Sky, with the objective of having an efficient maintenance service to enhance and optimise its assets. In 2012 ENAV won a contract to provide consultancy services to the Malaysian Department of Civil Aviation, leading to setting up ENAV Asia Pacific the following year, with the aim of diversification in international markets to provide commercial services.

On July 26, 2016, ENAV was listed on the stock exchange, rising from the status of a single member company to subsidiary companies. The MEF holds 53.3% of ENAV.

In Italy, the provision of the military air traffic control is performed separstely by the Ministry of Defence with their dedicated infrastructure, independent form the civil air traffic control. Italian Air Force (as the military agency responsible for air traffic services) agreed to jointly develop the concept of flexible use of airspace. The Italian Air Force also has responsibility for providing:

- the OAT air navigation service within Italian FIRs;
- the national meteorological service;
- military aeronautical information services;
- the search and rescue service;

In addition, is responsible for:

- the military aeronautical telecommunications service;
- military radio navigation and radio broadcasting;
- the military ATC school;
- military air traffic controller training and licensing.

A summary of the evolution of the main operational and financial indicators of ENAV is shown in Table 5.7.

Table 5.7. Evolution of the main indicators of ENAV. Monetary data in euro.

ENAV	Controlled flights (millions)	Total personnel	Revenues (millions)	Net income (millions)	Staff costs (millions)	Staff costs / person	Net income / Revenues	Staff costs / Revenues
2017	1.860	4181	881.8	101.5	416	0.10	11.5%	47%
2016	1.83	4233	865.3	76.3	414	0.10	8.8%	48%
2015	1.857	4236	849.5	66	412	0.10	7.8%	48%
2014	1.842	4186	835.5	40	403	0.10	4.8%	48%

5.6. Spain – ENAIRE

ENAIRE is the leader in Spain in the provision of air navigation services and fourth provider of air traffic services in Europe by air traffic volume, at around two million flights every year. For En-Route and TMA, ENAIRE is the sole ANSP designated by law in Spain. ENAIRE does not outsource this service to any third party. The service in some airports' towers is liberalized and provided by private entities (like FerroNats and SAERCO). Those who are not (22) are managed by ENAIRE.

ENAIRE is a public business entity belonging to the Ministry of Public Works, the two other key aviation organisations also belong to the Ministry of Public Works:

- **DGAC:** Civil Aviation General Directorate, which designs the strategy, directs the aeronautical policy and act as a regulator in the aviation sector.
- **AESA:** National Aviation Safety / Security Agency, supervising compliance with civil aviation regulations in Spain.

The Act 18/2014 of 8 July established that the Business Public Entity Aena (Aena), created in 1990, was renamed as ENAIRE. By Law 18/2014 of 15 October, there has been a change of name of the corporation Aena Aeropuertos, S.A., which has been renamed Aena S.A. Today, ENAIRE holds 51% of the shares of Aena S.A., being the remaining 49% privatized. ENAIRE continues to exist in the same nature and legal regime under the provision of Article 82 of Law 4/1990 of 29 June, and continue to exclusively exercise the powers and competences on air navigation and airspace management that currently holds. ENAIRE also maintains the national and international operational coordination of the national ATM network and other applications related to the efficient airspace management, taking into account the needs or the users, and functions resulting from its condition of instrumental means and technical service of the General State Administration and the contracting authorities regarding airports.

ENAIRE control an extensive and complex airspace of more than 2 million km2, including a continental area, in the Iberian Peninsula, the Balearic archipelago, Ceuta and Melilla, and Canary Islands.

Due to its geographical situation in the southwest of Europe, in addition to flights whose origin and destination are Spanish airports, ENAIRE manage the flights that enter Europe from two continents, America and Africa, and cover the main entry route for air traffic from South America.

A summary of the evolution of the main operational and financial indicators of ENAIRE is shown in Table 5.8. ENAIRE holds a 51% share of Aena S.A., which is the entity managing the public interest airports in Spain, and therefore the dividend of Aena S.A. is part of ENAIRE's Net income. In order to make figures comparable among the different ANSPs shown in this report, only Net income from the provision of air traffic control services is shown in Table 5.8, i.e. not including the airport activity.

Table 5.8. Evolution of the main indicators of ENAIRE. Monetary data in euro.

ENAIRE	Controlled flights (millions)	Total personnel	Revenues (millions)	Net income (millions)	Staff costs (millions)	Staff costs / person	Net income / Revenues	Staff costs / Revenues
2017	1.992	3778	968.8	152.1	433.1	0.11	15.7%	45%
2016	1.968	3923	922.9	131.3	533.9	0.14	14.2%	58%
2015	1.73	3976	864.7	111.7	472.9	0.12	12.9%	55%

Regulation

ENAIRE is regulated in two ways:

1. Budget and accounts:

Enaire has its own budget line coming from aviation charges and commercial revenues (mainly service provided to airports). Cost accounting (HR, maintenance) and investments (annuity repayment) are planned in advanced. Tax Ministry oversees and approves all the process. In addition, accounts are audited internally by the IGAE (Intervención General de la Administración del Estado) and externally by private companies (i.e. KPMG, etc.)

2. Service provision:

AESA audits the Service provision of ENAIRE. Key factors are supervised: Safety + Performance + Viability + Sustainability.

ENAIRE use the following equipment items and facilities:

- 5 ACC, Air Navigation Regional Directorates;
- 22 Control Towers;
- 237 radio aids supporting En-route/TMA navigation and approach to airports;
- 54 En route/TMA and surface surveillance systems;
- 90 Communication centres;
- 100 REDAN nodes for the voice/data communications system for air navigation applications;
- 126 tower and approach control positions;
- 153 En route control positions;

Concerning key performance indicators, en route ATFCM delay per flight due to airspace restrictions in 2017 was 0.35, representing 60% below European average.

ENAIRE have the following mission:

- The planning, management, co-ordination, operating, preservation and administration of air traffic, telecommunications services and aeronautical information as well as infrastructures, facilities and communications networks for the air navigation sys-tem.
- To ensure that the aircraft moving around Spanish airspace obtain the utmost security, fluidity, efficiency and punctuality.
- To perform the preparation and approval of various types of project, as well as the implementation and management of investment control.
- To evaluate of the needs and proposals for new infrastructures, as well as possible modifications to airspace planning.
- To carry out the participation in specific aeronautical training and subject to the awarding of official licences.

Civil – military control coordination

Coordination between Operational Air Traffic (OAT) and General Air traffic (GAC) is the responsibility of the General Staff of the Air Force, according to Royal Decree 601/2016 of 2 December, which approves the Regulations on Operational Air Traffic (RCAO), and is carried at the levels

laid down in Commission Regulation (EC) No 2150/2005 of 23 December 2005 laying down common rules for the flexible use of airspace:

- EMA/DOP/SESPA (Air Space Section of the Operations Division of the Air Force General) Staff: for planning and strategic coordination.
- GRUCAO (Operational Air Traffic Control Group): for pre-tactical coordination.
- ECAO (Operational Air Traffic Squads): for execution and tactical coordination (located in the different ACCs).
- APP/TWR (Approach Control Service / Aerodrome Control Tower): for execution.

All the civilian flights are managed by civilian air traffic controllers and that includes military flights outside their restricted areas. The military flights during training or on operative missions, inside their restricted areas, are managed by military air traffic controllers specifically dedicated to them. The military air traffic controllers also coordinate with the civilian controllers the possible interaction with other flights and, if needs be, the activation of restricted areas.

Spanish airspace has yet many areas restricted and reserved to military aircraft, and that coordination is mandatory for civilian traffic across those air spaces.

On the operational side, SACTA, ENAIRE's air traffic control system, shares in real time, information concerning flight plans and radar plots of all civil air traffic with the defense system. Then, the defense system, checks if there is any unidentified aircraft, by comparing this information with the data provided by their primary radars. If that happens, they try to communicate with the aircraft and, if there is no positive identification, they activate their "National Defense protocols".

Military air control infrastructure is dedicated and independent from civil air traffic infrastructure.

5.6.1. Spain – AESA

AESA, National Aviation Safety / Security Agency, is the organisation supervising compliance with civil aviation regulations in Spain.

AESA was created on 20th October 2008 (Royal Decree 184/2008, approving the Statutes of the State Aviation Safety & Security Agency). In Spain, State Agencies are legal public bodies, with their own patrimony and autonomous management (Law 28/2006 of State Agencies). As from the 1st January 2012, its budget derives fully (100%) from its charges. The budget in approval process for 2018 is 78,6M€. In 2014, a new safety charge was approved by the Government, fully assigned to AESA for inspection and audit activities. This charge applies to all departing passengers from the Spanish airports. Current charge is 0,58 €.

AESA is responsible for the certification, oversight and inspection of:

- Aircraft;
- Operations;
- Airworthiness;
- Licensing;
- Certifications;
- Aircraft registration;
- Airports;
- Air navigation;

- Security;
- Economic regulation;
- Passenger protection;
- Environment (CO2 and biofuel);
- Quality.

AESA is by law a sanctioning authority.

The Air Navigation Services sector in partially liberalized in Spain. Law 9/2010, of 14 April, established essential measures enabling the provision of air navigation services to be opened to new providers duly certified by a national supervisory authority of a Member State of the European Union. The designation of the ANSP for aerodromes by the Ministry of Public Works shall be made on the proposal of the airport operator. Tasks other than air traffic itself, such as platform management, may be carried out directly by the airport operator or entrusted by the airport operator to civil ANSP at aerodromes.

Today, there are in Spain 4 certified air navigation services providers, 8 certified air traffic controllers training organisations and a total of 5 new AFIS and 12 ATC Towers privatized.

With respect to the Single European Sky, AESA has been nominated as the National Supervisory Authority according to Article 4 National supervisory authorities of Regulation (EC) No 549/2004 of the European parliament and of the council, of 10 March 2004, laying down the framework for the creation of the single European sky (the framework Regulation). Therefore, Air navigation service providers (ANSP) shall comply with the applicable SES regulations and shall report to AESA according with the requirements laid down. In addition, as a result of the inspections they shall provide AESA with acceptable corrective action plans to address the non-compliances.

Air Navigation Service Providers are subject to certification, designation and inspection by AESA according to regulation (EC) No 550/2004 of the European parliament and of the council, of 10 March 2004, on the provision of air navigation services in the single European sky (the service provision Regulation).

AESA has to preserve the safety of the facilities providing air navigation services in accordance with the rules and principles in force in the field of civil aviation.

The ways to achieve this include identification, analysis and control of any information that may reveal the existence of latent threats and risks that may compromise security. AESA has adopted a risk-based oversight model (preventive approach) in the field of air navigation safety management at all levels: strategic, operational and alert.

The methodology adopted by Spain to evaluate the ATS unit risk involves dividing its units (airports and navigation service providers) into groups. Units are sorted into clusters based on the service provided (TWR, ACC+TACC (Terminal Area Control Centre), RADAR, AFIS, SSCC (main headquarters of ANSPs)) and then further divided into 7 groups depending on number of flights and operational staff needed, among other parameters.

6. Single European Sky

The role that the Singe European Sky initiative is playing and will play in the future in the air traffic management in Europe is analysed in detail, especially with respect to the implementation programme, SESAR, a joint undertaking initially between the European Commission and EUROCONTROL, that has become a truly international public-private partnership.

Additionally, the Galileo European global satellite-based navigation system is described, in particular the role it may play in the future of air navigation services in Europe.

6.1 Single European Sky (SES)

Since 2004, the European Union (EU) has gained competences in air traffic management (ATM) and the decision-making process has moved away from an intergovernmental practice to the EU framework. The EU's main objective is to reform ATM in Europe in order to cope with sustained air traffic growth and operations under the safest, most cost- and flight-efficient and environmentally friendly conditions. This implies de-fragmenting the European airspace, reducing delays, increasing safety standards and flight efficiency to reduce the aviation environmental footprint, and reducing costs related to service provision. Achievements have already been made at operational, technological and institutional levels; efforts are ongoing to maximise the benefits of activities initiated under the SES framework.

Some background statistics

- The European ANS system covers 37 air navigation service providers (ANSPs), which is a business of EUR 8.6 bn with some 57 000 staff and 16 900 are air traffic controllers (ATC) compared to 13 000 ATC in the USA.
- In 2014, the European ATM system controlled 26 800 flights on an average daily basis.

- As a result of the SES policy, average delays for en-route air traffic flow management are now close to 0.5 min per flight, which is a remarkable achievement compared to the heavy delays that occurred in the 1990s and 2000s.
- On average, each flight is 49 km longer than the direct flight.
- European airspace: 10.8 million km², 60 control centres - fragmentation of airspace.
- Estimated costs of fragmentation of airspace amounts to EUR 4 bn a year.
- Five biggest ANSPs (DFS for Germany, DSNA for France, ENAIRE for Spain, ENAV for Italy and NATS for the UK) bear 60 % of total European gate-to-gate service provision costs and operate 54 % of European traffic.
- As consequence, 40 % of remaining gate-to-gate costs are borne by 32 other smaller ANSPs.
- Big divergences in the economic cost-effectiveness of the ANSPs. This approach is based on the Community method, especially the power of initiative of the European Commission (EC), the monitoring of compliance by Member States with the legislation in force and the involvement of a regulatory Committee made of representatives from Member States (known as Single Sky Committee) with its advisory and regulatory powers.

The SES legislative framework consists of four Basic Regulations (N° 549/2004, 550/2004, 551/2004 and 552/2004) covering the provision of air navigation services (ANS), the organisation and use of airspace and the interoperability of the European Air Traffic Management Network (EATMN). The four Regulations adopted in 2004 (the SES I Package) were revised and extended in 2009 with Regulation (EC) n° 1070/2009 aimed at increasing the overall performance of the air traffic management system in Europe (the SES II Package). On this basis, the Commission adopted and implemented extensive and comprehensive implementing legislation; this framework also includes more than 20 Implementing Rules and Community Specifications ("technical standards") adopted by the European Commission in view of ensuring the interoperability of technologies and systems.

Major developments have been possible due to the extensive involvement of stakeholders from the ATM community: industry partners, air navigation service providers (ANSPs), national supervisory authorities (NSAs), social dialogue with staff unions, airport authorities, the military and the certification authorities, and enhanced cooperation with EUROCONTROL.

The foundation of the National Supervisory Authorities (NSAs) is established in Art.4 of the Framework Reg. According to it, Member States shall nominate or establish one or several bodies as their NSA (individually or jointly), independent of ANSPs (separation at least at functional level), and shall ensure necessary resources and capabilities of their NSAs.

Art. 2 of the Service Reg. establishes the following tasks for NSAs:

- Appropriate supervision of the application of the regulation (incl. ANSP certification, designation on behalf of States of ANSPs).
- Inspections and surveys to verify compliance with the requirements.
- Agreements on the supervision of ANSPs providing services relating to functional airspace blocks and appropriate arrangements for close cooperation between NSAs to ensure adequate supervision of Cross Border ANSPs.

The SES framework has been supplemented by an integrated approach towards safety by the extension of the competencies of the EASA in the field of aerodromes, air traffic management and air navigation services, through the establishment of a joint undertaking (JU) on research & development, the SESAR JU (SESAR standing for the Single European Sky ATM Research) and

of a SESAR Deployment Manager. A Network Manager for the European ATM network has been created, while an independent Performance Review Body (PRB) supports the Commission in the development and management of the SES performance scheme in which Functional Airspace Blocks (FABs) have a key role to play.

The overall SES objectives will be achieved through a holistic approach that encompasses five interrelated pillars: the performance-based regulatory framework, the safety pillar, the technological contribution, the human factor and the optimisation of airport infrastructure.

The SES does not stop at the border of the European Union. Its extension to third 'neighbouring' countries primarily relies on the EU's policy in the field of international relations. This policy, which gives priority to the association and/or integration of third countries into the EU legal framework, also considers the added value of regional cooperation activities carried out at the level of international organisations, such as the ICAO and EUROCONTROL. EU representatives are active in these organisations to ensure overall consistency between its action in the external field and action undertaken under the aegis of such organisations. Cooperative operational arrangements with ANSPs from key partners of the EU are also being promoted by the Commission as a significant task of the Network Manager in order to better manage intercontinental traffic to/from the EU and improve the performance of the European ATM network.

6.2 SESAR

An interesting approach to increase efficiency improving navigation procedures is the integration of several national ANSPs in a single organization with common equipment and procedures, eliminating the differences among airspace management in neighbour countries. This is the EU approach with the Single European Sky (SES) program that intends to move from an airspace with 40 ANSPs to a single unified ATM region.

The Public Private Partnership (PPP) consortium SESAR (Single European Sky Advance Research) develops the technical part of the program with the following targets:

- Increase three times the European air space management capability.
- Increase safety by a factor of 10.
- Reduce 50% the ATM cost to the users.
- Optimize flight trajectories to save between 8 and 14 minutes per flight, reducing fuel consumption by an average of 300 to 500 kg.

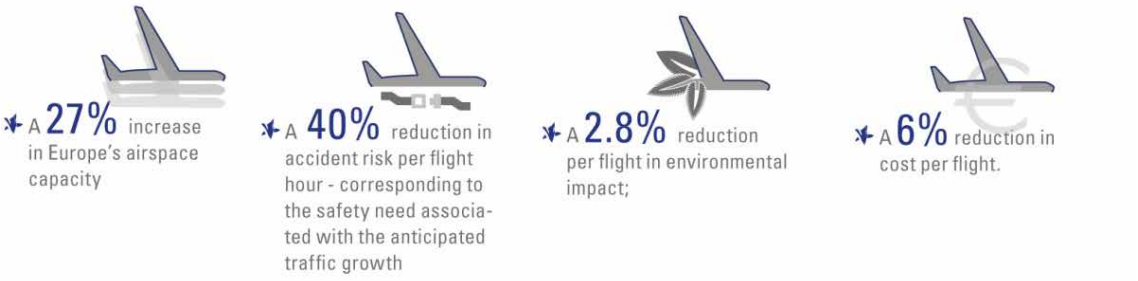
As the technological pillar of Europe's ambitious Single European Sky (SES) initiative, SESAR is the mechanism which coordinates and concentrates all EU research and development (R&D) activities in ATM, pooling together a wealth experts to develop the new generation of ATM. Today, SESAR unites around 3,000 experts in Europe and beyond.

In 2007, the SESAR Joint Undertaking was set up in order to manage this large scale and truly international public-private partnership. The EU and EUROCONTROL are founding members, but there are another 15 regular members and 34 associated organisations (see https://www.eurocontrol.int/about/member-states)

The total estimated cost of the development phase of SESAR is € 2.1 billion, to be divided equally between the European Union, EUROCONTROL and the industry. Given the nature of the programme and its scope, the Community contribution will come from Research and Trans-European Network funds.

It is in this context that the programme aims to contribute to the SES high-level goals, by the end of STEP ONE of the European ATM Master Plan (Figure 6.1).

Figure 6.1. SESAR objectives (SESAR).



These performance results are forecast to be achieved via R&D on improvements to ATM operations, including technical systems, procedures, human factors and institutional changes as part of STEP ONE of the European ATM Master Plan. These targets represent approximately 50% of the SES High Level Goals for STEP ONE.

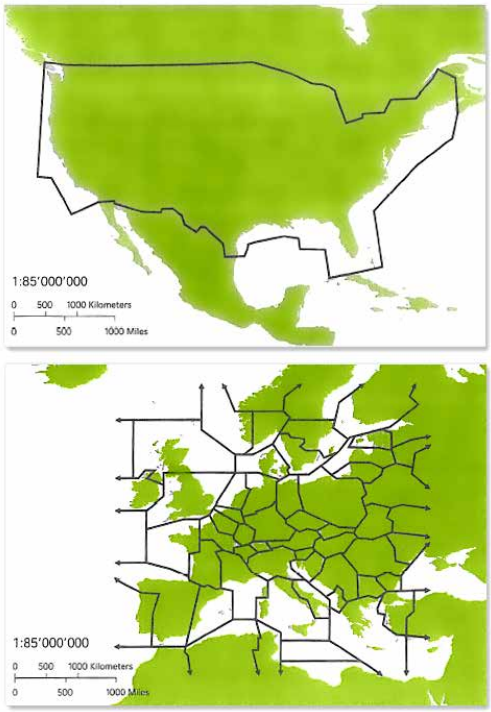
In other words, the SESAR concept of operations will drive improvements to the procedures being used by all stakeholders, and in particular will start to modify responsibilities between technology, controllers and flight crew.

The program started in 2006 and it is assumed to last until 2025. It includes the launching and put into service a global navigation satellite system, named Galileo, to provide a highly accurate, guaranteed global positioning service, interoperable with the similar US system (GPS) and Russian system (GLONASS). The satellite constellation will have 24 operative units and 6 spares and its enter into service is expected in 2020. Galileo was initially developed by the European Space Agency (ESA), a multinational State scientific body. In July 2017, ESA transferred the formal responsibility for oversight of the Galileo operations and provision of services to a newly created entity, Global Navigation Satellite System Agency (GSA).

The transition from a highly fragmented airspace (see Figure 6.2) to a single airspace will be done in several steps that will join neighbour States airspace in commonly operated ATC areas. In 2014, a total of 9 Functional Airspace Blocks (FABs) were consolidated (Figure 6.3), including 31 European States:

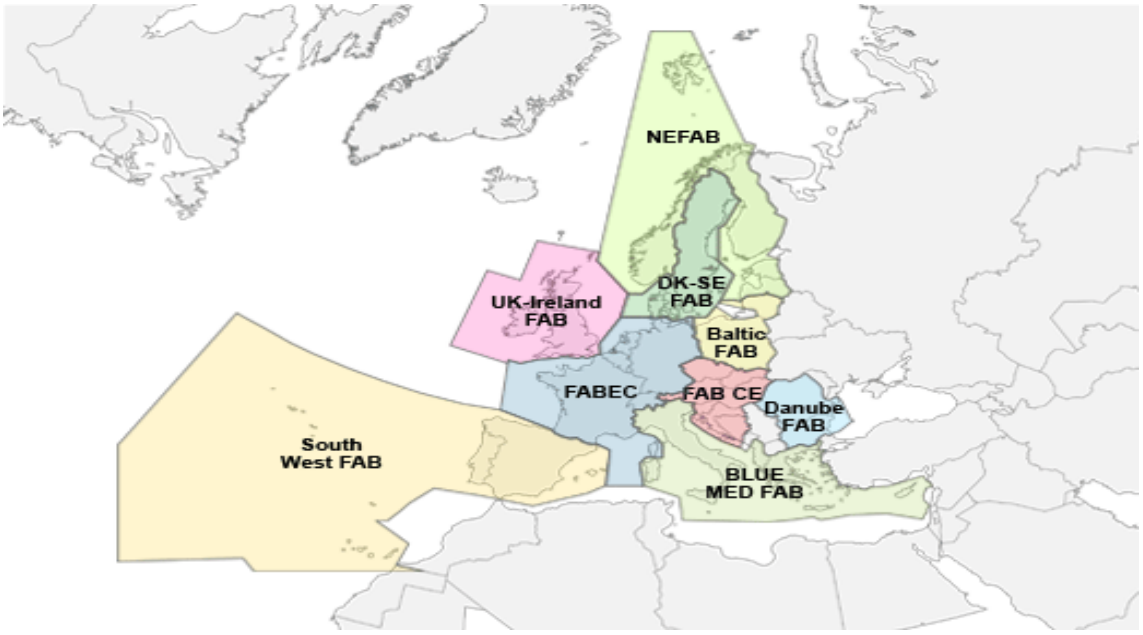
- **North Atlantic FAB:** Ireland, UK.
- **Scandinavian FAB:** Denmark, Sweden.
- **Baltic FAB:** Lithuania, Poland.
- **Blue Med FAB:** Cyprus, Greece, Italy, Malta.
- **Danube FAB:** Bulgaria, Rumania.
- **Central Europe FAB:** Austria, Bosnia & Herzegovina, Croatia, Czech Republic, Hungary, Slovak Republic, Slovenia.
- **FABEC FAB:** Belgium, France, Germany, Luxembourg, the Netherlands, Switzerland.
- **North European FAB:** Estonia, Finland, Latvia, Norway.
- **South West FAB:** Portugal, Spain.

Figure 6.2. ATM regions in the European air space (EU Commission: Single European Sky)



FAB definition has been made as a function of the existing airspace national limits and are not equivalent in terms of traffic volume. FABEC is the most important one, with a 55% of the whole European traffic crossing it.

Figure 6.3. The nine presently existing Functional Airspace Blocks (EU Commission: Single European Sky)



An already proven precedent, at small scale, is the Free Route Airspace Maastricht (FRAM), a program run by the Maastricht EUROCONTROL Centre which gives air navigation services in the upper airspace (over 25,000 ft. altitude) of Belgium, Luxembourg, the Netherlands and the Hamburg FIR. FRAM has opened 142 new direct routes since 2011 with 12,000 tonnes of CO2 savings per year.

United States has already a satellite constellation, GPS that is operating successfully, but is also involved in an ambitious program of ATM improvement, titled NextGen, in order to speed up the transition from former Communication, Navigation, Surveillance (CNS) to the modern satellite-based technology. The NextGen program started in 2003 and its implementation is increasing airspace capacity, improving safety and reducing flying time, with accumulated results until the year 2018, of a 35% delay reduction and 14 million tons CO2 savings.

The United States and the European Union try to coordinate their actions in the area of air traffic management, trying to harmonize their developments. As a result a Memorandum of Cooperation was signed in December 2014, the NextGen – SESAR Prepared by U.S.-EU MOC Annex 1 – Coordination Committee State of Harmonisation Document.

The combination of SESAR and NextGen can offer fuel savings in the order of more than 1.5 million ton per year, according to IATA calculations, not later than 2021.

Examples of SESAR improvements already in place:

There are extended arrival management horizons operational at places such as Munich, Reims and Heathrow, with many more to follow, helping to provide enhanced and more consistent arrival sequences by sharing information across borders. Extended-AMAN (E-AMAN) allows for the sequencing of arrival traffic much earlier than is currently the case, by extending the AMAN horizon from the airspace close to the airport to further upstream and so allowing more smooth traffic management.

New precision area navigation (P-RNAV) approach procedures are in place across the continent, including Dublin, Stockholm Arlanda and Paris CDG, improving the design and organisation of our busy terminal manoeuvring areas and reducing workload on controllers.

There is free route airspace in operation across significant volumes of the upper airspace within Europe, allowing airspace users to plan and take the routes they want to take, helping them to save fuel, reduce flying time and lower their costs.

Whilst the European Commission's Functional Airspace Blocks have not perhaps driven yet the seamless airspace route as was desired, there are new collaborations that are providing additional impetus – from the COOPANS systems grouping through to the Gate One and Borealis Alliance ANSP initiatives.

As of today, at a technical level, extensive research and development continues through the industry-leading public-private SESAR research programme. There will be many more simulations taking place this year helping take new concepts one step closer to being ready for operational deployment – from wake vortex separation optimisations that will enhance runway throughput, through to testing new means of organising controllers that will better match demand to capacity, reducing congestion and improving traffic flows.

Alongside this and with the input of its Members, the SESAR Joint Undertaking (SJU) is currently finalising its recommendations to the European Commission in terms of the concepts whose implementation will be mandated via European law through Common Project 2, the follow up to the European Commission's Pilot Common Project.

6.3 How the future European air traffic management system may evolve.

Free route airspace

Free route airspace permits users to fly their preferred trajectories between a defined entry and exit point. Free route airspace is driving ATM towards a single European sky, promising significant benefits on the way airspace (FRA) is gaining the critical mass necessary to realise significant increases in capacity and important reductions in emissions.

FRA facilitates the more efficient use of a specified airspace by allowing users to fly their preferred trajectories between a defined entry and exit point.

EUROCONTROL estimates that 48 European air traffic control centres had partially or fully implemented free route airspace by the end of 2016. In addition, by the end of 2019, it expects most European airspace to have implemented FRA, with all airspace over FL290 targeted to be covered by 1 January 2022. The North European Free Route Airspace Programme, NEFRA, was successfully completed in May 2017. Launched in 2013, the NEFRA allows airspace users to fly the most efficient trajectories above FL285, irrespective of the borders of Denmark, Estonia, Finland, Latvia, Norway and Sweden.

A number of upgrades in ATM functionality has enabled cross border FRA operations, including common flight planning procedures and collaborative training of air traffic controllers.

FRA's environmental advantages make the headlines. Airspace users might reduce flight distances by as much as 7.5 million nautical miles annually, representing the equivalent of about 45,000 tonnes of fuel saved, or a reduction in CO2 emissions of 150,000 tonnes. That adds up to close to €40 million.

The NEFRA is not an end itself but a stepping-stone to an expanded FRA that will include the UK-Ireland Functional Airspace Block (FAB) and Iceland. In effect, this covers the nine-State Borealis Alliance.

In July 2016, the Alliance received €63.2 million under Connecting Europe Facility (CEF) funding. The aim is to introduce FRA across Northern Europe by 2021, a programme that is forecast to enable an annual reduction in flying distance of 4.7 million nautical miles and save airlines 26,000 tonnes of fuel.

Similar savings are on offer for other FRA developments; Austria will reduce CO2 emissions 15,000 tonnes annually as will Slovenia; Hungary will reach 16,000 tonnes in CO2 savings; and Germany will reach 30,000 tonnes.

Meanwhile, at World ATM Congress 2017, representatives from five ANSPs signed a memorandum of cooperation that will merge two free route airspaces, SAXFRA (Slovenian Austrian Cross-Border Free Route Airspace) and SEAFRA (South-East Axis Free Route Airspace – Croatia, Bosnia-Herzegovina, Serbia and Montenegro).

This South East Common Sky Initiative (SECSI) will give airspace users critical options for routes between Central and South Europe, including the flows to Turkey and further to the Middle East. SAXFRA alone offers estimated savings of 13 tonnes of fuel daily, helping to reduce CO2 emissions 43 tonnes per day.

FRA is due to be implemented in the whole of FAB Central Europe airspace (Austria, Slovenia, Hungary, Croatia, Czech Republic, Slovakia and Bosnia-Herzegovina) by 2019.

EUROCONTROL anticipates substantial benefits accruing to all partners in the aviation value chain because of FRA.

Safety, as ever, is paramount. A fixed route network generates quite specific conflict zones for ANSPs. FRA, on the other hand, spreads potential conflicts, making it easier for controllers to handle, as there is not such a concentration of potential conflicts to unravel.

FRA will also make it easier to accommodate the demands of future airspace users, such as drones, hypersonic transport, spaceplane operations to sub-orbit, "internet balloons" and more.

The environmental advantages make the headlines though. Airspace users might reduce flight distances by as much as 7.5 million nautical miles annually, representing the equivalent of about 45,000 tonnes of fuel saved, or a reduction in CO2 emissions of 150,000 tonnes. That adds up to close to €40 million.

Moreover, FRA is an essential part of 4D profiles. By 2019/20, reports EUROCONTROL, additional savings of between 60,000-75,000 nautical miles a day can be expected, with the subsequent fuel, environmental and cost benefits.

To achieve these goals, EUROCONTROL as Network Manager is providing support to ANSPs in the form of airspace design, concept of operations, advice on aeronautical publication and the pre-validation of each new FRA environment to ensure that airspace users can plan flights in line with the concept.

EUROCONTROL is also providing appropriate solutions to further enhance operational performance and resolve any potential problems, which may arise because of the implementation of free route airspace.

NAV Portugal implemented one of the first free route airspace projects in Europe in 2009. Fuel savings are estimated at more than 8,500 tonnes annually, equating to a decrease in CO2 emissions of some 27,000 tonnes. NAV Portugal is now looking to extend free route airspace beyond the South West Functional Airspace Block (shared with Spain). The adjoining Santa Maria FIR is first in line, which would improve North Atlantic airspace efficiency enormously. Portugal's responsibility over the ocean covers an area 55 times larger than its continental jurisdiction. The first phase of the project forecasts an annual reduction of 78,000 nautical miles.

Meanwhile, Malta Air Traffic Services (MATS) has launched a free route airspace (FRA) project in conjunction with Italian ANSP, ENAV, which will allow for more efficient and direct routes passing though both Maltese and Italian airspace.

Liberalisation of terminal air navigation services

Terminal air navigation services (TANS) keep aircraft apart at airports and, depending on the traffic and airspace complexity, on approach to the airport. In the classic ATM service model, these services are provided by air navigation service providers, which, in line with the structure of much of the ATM industry, usually enjoy a long-term, if not statutory, monopoly. This often results in ANSPs adopting a 'one size-fits-all' approach to the services offered. According to a white paper published by the ATM Policy Institute, there is scope for considerably more market-friendly ways to deliver TANS services. The ATM Policy Institute was created to inform the debate on the efficiency and performance of air traffic management that can be achieved through market liberalisation. The primary objective of the Institute is to illustrate the benefits of liberalising ATM to the aviation industry, governments and regulators. Its members include a number of ANSPs, as well as CANSO.

There has been some liberalisation in the TANS area already, particularly in the US and in Europe. Nevertheless, according to this white paper, there is scope for more liberalisation and the numerous benefits to airlines and the travelling public make looking at further market openings of interest.

TANS can be considered separately from the provision of ATM and can often be subject to market forces and competition apart from the consideration of sovereignty and the provision of ATM services by ANSPs.

In any market, a lack of competition tends to lead to services that can be high priced, lack a keen customer focus, and be slow to adapt to customer needs. Currently, the TANS market shows all the behaviour the theory suggests. Following competition theory, liberalising markets and opening them to competition should address the issues outlined above.

In reviewing experiences where there has been liberalisation of TANS, the ATM Policy Institute has found considerable benefits. In examples from both Europe and the US, the white paper outlines how the cost of supplying TANS has reduced between 30% and 74%, achieved through the minimisation of administration and optimisation of productivity.

In one such example, London Gatwick issued a tender with the initial aim of increasing airport capacity and resiliency in peak traffic periods, both customer-driven requirements. The eventual outcome saw the airport find a provider not only able to fulfil its initial operational requirements but also able to do so at a lower cost.

Overall cost is not the sole pricing benefit to be gained from the liberalisation of the TANS market, however (always according to the ATM Policy Institute white paper). Transparency of costings and thus price is also likely to occur. The unbundling of the TANS component of existing ANSP businesses improves pricing transparency, in turn reducing the opportunities for cross-subsidisation of services. It is only when there is a clear and transparent understanding of costs that a frank conversation with ANSP customers, and regulators, is possible.

Incumbent innovation

The ATM Policy Institute argues that liberalising TANS services would not just have a positive impact on pricing. The speed of technological development would also improve.

In the field of innovation, the white paper cites evidence that new TANS suppliers are increasingly responding to customer need in a race to find and deliver their unique selling proposition.

In addition to the Gatwick example given above, a case study from London Heathrow outlines how incumbent providers have responded to the threat of competition and the need to retain market share by increasing customer engagement.

Savings reported by new entrant TANS providers

Country	*Service*	*Process of liberalisation commenced*	*Cost reduction*
Spain	TANS at 13 airports	2010	46.7 %
USA	Contract tower service at 253 low visual activity flight rules (VFR) airports	1982	74 %
Sweden	TANS at 14 airports operated by Aviation Capacity Resources AB (ACR)	2010	30 %

Source: ATM Policy Institute

As airports are equally subject to the laws of competition theory, their own search to find a niche in the market should see technological advances improve, in line with cooperation with TANS providers. Additionally, current technologies are now under severe strain.

Given the rapid development and expansion in the field of unmanned aircraft systems traffic management and autonomy, it is interesting to contemplate what the future form of competition will look like.

Market view

Given current technology and procedures, it is most likely that liberalisation would take the form of competition for the market, in which a TANS provider obtains an exclusive right to supply services to an airport or airspace for a fixed period of time. While competitive tendering focusing on operational requirements and price could be used to select a supplier, it is also possible that the mere threat of competition may galvanise an existing supplier to deliver improved value or quality.

The market for TANS is large and diverse. There appears little reason to exclude an airport from competition for TANS based on its scale of operation, with current examples of competitive supply including both the busiest and relatively quiet locations.

At high intensity locations, an airport may look for experienced suppliers with the resources to ensure business resilience to supply tailored, high-performance services. At lower intensity locations, customers are likely to be more cost sensitive.

Competition theory would suggest that liberalising TANS would encourage providers to tailor-make their services for individual airports, allowing for greater efficiency.

Safety first

There is no reason to suppose that liberalisation would compromise safety. In fact, the ATM Policy Institute argues that it would have quite the opposite effect.

Increased safety is a major point of distinction for a TANS provider, boosting its position in the market. Case studies at the UK's Birmingham Airport and London Gatwick showed that absolutely no safety concerns were raised during the transition to new TANS providers.

Just as they do now, incumbent TANS suppliers would have to comply with State safety regulations on procedures and staff competency, and show that they have the capability and resources to meet certification standards. Indeed, competition may well require increased resources for the regulator too, to monitor a number of different suppliers.

Finally, the Institute emphasises that there is no need to wait for further innovation to liberalise TANS; the existing control tower technology is more than capable.

Although, of course, innovative suppliers may introduce new technology to support the higher quality service, this evolution is far from a prerequisite. At a recent ATM Policy Institute workshop in Dublin, it was noted that new technologies, such as remote towers, could have a significant positive impact on the market for TANS services.

In addition, as the ability to utilise and optimise the available data matures, the balance in the relationship between the airport and the TANS supplier will also change. Airports are likely to become increasingly aware and demanding of better, more focused services from their TANS suppliers.

The white paper concludes that competition for TANS, when appropriately structured, leads to more cost effective, more customer-focussed, and more innovative ATM services for airports and their airline customers. Also, given the local nature of airports, liberalisation can take place piecemeal, commencing in regions and countries interested in taking advantage of these benefits, rather than needing to be addressed as part of more widespread liberalisation and reform.

7.

Air National Service Provider – ANSP Brazil

7.1 Brazilian Civil Aviation System

The Brazilian Civil Aviation System is articulated in different organisations depending on two key Ministries, as it is depicted in Figure 7.1:

Ministry of Transport, Ports and Civil Aviation

The Ministry coordinates and supervises actions for the development of airport and aeronautical infrastructure.

- **ANAC** - Brazilian civil aviation authority that regulates and inspects civil aviation activities and airport and aeronautical infrastructure. ANAC is linked to the Ministry of Transport, Ports and Civil Aviation. The Agency is not hierarchically subordinate to the Ministry and it has administrative independence, financial autonomy and fixed mandate for its directors.
- **CONAERO** - Consultative and deliberative commission composed by bodies that directly work with airport management in order to make airports more efficient.
- **SAC** - The Civil Aviation National Secretariat is responsible for coordinating the Civil Aviation System in cooperation with the Ministry of Defense, when appropriate.
- **Infraero** - Public company responsible for 55 airports in the country, which holds 49% of the following airports: Guarulhos (SP), Viracopos (SP), Brasília (DF), Confins (MG) and Galeão (RJ).
- **Private airports**
- **State and municipality airports**

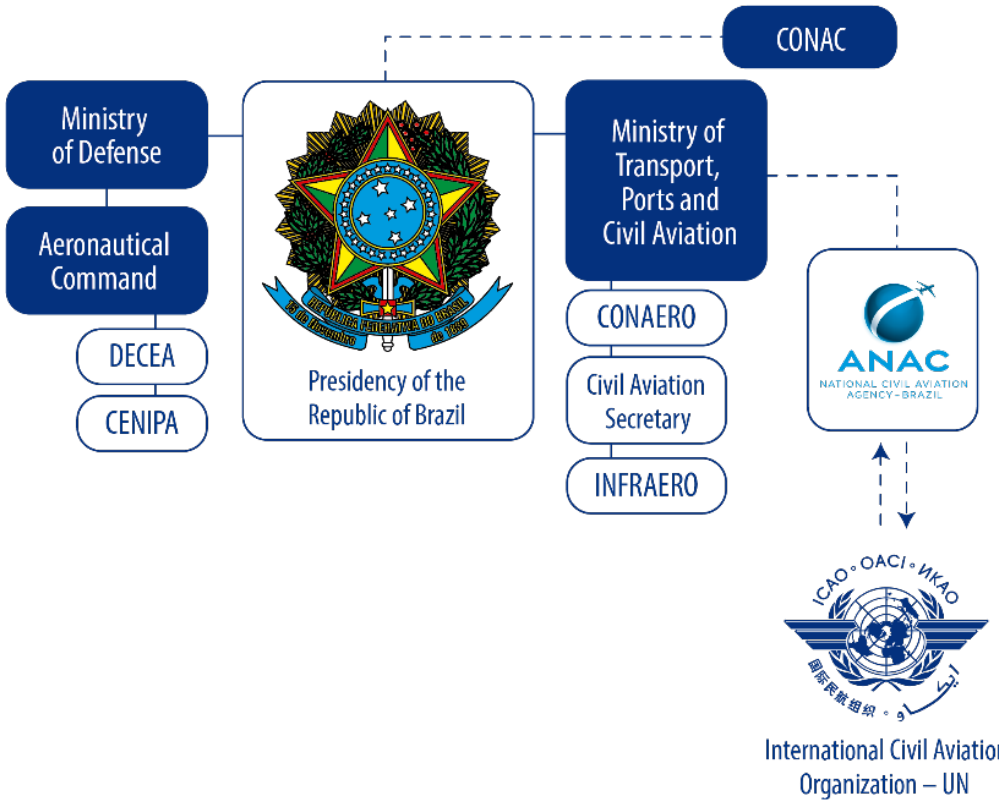
Ministry of Defense

Through the Aeronautical Command the Ministry of Defense controls DECEA, department responsible for the strategic and systemic control of the country's airspace.

- **DECEA -** Department of Airspace Control subordinate to the Aeronautical Command and the Ministry of Defense (subordinate to the Brazilian Air Force, and responsible for the strategic and systemic control of the country's airspace).
- **CENIPA** - Aeronautical Accidents Investigation and Prevention Center subordinate to the Aeronautical Command and the Ministry of Defense and responsible for the investigation and prevention of accidents.

Additionally, **CONAC** is an advising body of the Presidency of the Republic for the formulation of the Brazilian civil aviation policy.

Figure 7.1. Brazilian Civil Aviation System.



7.2 ANAC (Agência Nacional de Aviação Civil)

ANAC is a regulatory agency which was established to regulate and inspect civil aviation activities as well as aeronautical and airport infrastructure in Brazil. The agency was created in 2005, replacing the Department of Civil Aviation (DAC) as the new National Civil Aviation Authority.

The Agency is responsible for the regulation, inspection and certification of aircraft, companies, manufacturers, aircraft maintenance organizations, aerodromes, schools and civil aviation professionals. The government agency works to ensure civil aviation safety and security and to improve the quality of services, fostering a competitive market.

ANAC is linked to the Ministry of Transport, Ports and Civil Aviation, however it is not hierarchically subordinate to the Ministry and it has administrative independence, financial autonomy and fixed mandate for its directors. The Agency has nearly 2,200 employees.

Legislation for reference:

- Law Nr. 11182 of September 27th, 2005.
- Decree Nr. 5731 of March 20th, 2006.

ANAC develops rules to promote safety and the excellence of the Brazilian civil aviation market. The Agency enforces compliance with rules aiming to prevent accidents and improving the quality of services provided by air companies, civil aviation personnel and airports. ANAC also certifies and inspects aircraft, aircraft operators, aircraft manufacturers, aircraft maintenance organizations, airports, training organizations and civil aviation personnel.

Certification

ANAC certifies civil aircraft, aircraft manufacturers and its components, aircraft operators, aerodromes, training organizations, civil aviation personnel and aircraft maintenance organizations in order to verify if they comply with safety rules. Certification is a systematic process involving follow-up and evaluation for ensuring trust and compliance with requirements established by rules and regulations for all civil aviation regulated entities. Certification processes follow the Chicago Convention (1944) and are recognized by many countries with which Brazil has celebrated aviation cooperation agreements, such as the United States of America, Canada, Australia and countries from the European Union, South America and Asia.

Regulation

ANAC develops and issues rules for the appropriate operation of the Brazilian civil aviation, taking into consideration potential regulatory impacts. Additionally, it evaluates contributions sent by the Brazilian society through public consultations. As a member of several international civil aviation organizations Brazil takes into account regulations issued by these institutions when developing its technical rules.

Inspection

ANAC carries out surveillance activities and inspections. Continuous surveillance is a permanent follow-up for verifying performance patterns of products, companies, operations, processes or services and of professionals certified by ANAC in order to guarantee acceptable safety levels and to improve passenger services. Inspections are carried out along with other Brazilian authorities in order to identify and prevent violation of regulations and illegal acts.

Civil Aviation Personnel

Air transport involves pilots, flight attendants, flight dispatchers, aircraft maintenance mechanics, airport screeners and rescue and firefighting personnel. ANAC is responsible for issuing technical licenses and certificates for civil aviation professionals, as well as for performing medical assessments. The Agency inspects civil aviation personnel compliance with safety rules, standards and requirements.

ANAC and society

Citizens are invited to participate in the development of air sector rules by sending their contributions through public consultations or directly to ANAC, which are analyzed and may be incorporated into new regulations. Citizens can also contribute by denunciating the violation of civil aviation rules. ANAC's headquarters are located in Brasília (DF), with regional offices in São Paulo (SP), São José dos Campos (SP) and Rio de Janeiro (RJ) and offices in the most important Brazilian airports.

ANAC and air passengers

ANAC works to ensure that good-quality air transportation services are provided. When purchasing air tickets passengers establish an air transportation contract with the airline. If passengers feel harmed or feel their rights have been disrespected, they must first contact the airline to claim their consumer rights. If this action does not bring positive results, passengers may contact ANAC and register a complaint against the airline. As a result, ANAC will assess the application of penalties to the air company, thus contributing to the improvement of services. Passengers may also contact the Brazilian Consumer Protection and Defense Authorities or the Judiciary Authorities.

Legal and regulatory aspects

Established by Law No. 11.182, dated September 27th, 2005, The National Civil Aviation Agency - ANAC/Brazil started its activities in 2006, with the publication in 2006 of Presidential Decree No. 5.731, replacing the former Department of Civil Aviation (DAC).

According to Law No. 11.182/2005, ANAC:

- Represents Brazil in conventions, treaties, agreements and international air transport acts (excepting for air traffic control and aeronautical accidents investigation matters) together with other countries or international civil aviation organizations;
- Establishes the concession model for airport infrastructure, to be submitted to the President of Brazil;
- Provides air services grants;
- Provides resources for airports of strategic importance, airports of economic interest and airports of importance for tourism;
- Provides grants or permissions for the commercial exploration of air services.

Law Number 11.182/2005 establishes ANAC's main responsibilities:

- To implement the Brazilian civil aviation policy;
- To develop studies, to establish rules, to implement international civil aviation rules and recommendations in accordance with international agreements, treaties and conventions in which Brazil takes part;
- To regulate and inspect services performed by foreign airlines in Brazil;
- To designate Brazilian airlines for international operations;
- To regulate and inspect air services; aeronautical products and processes; the training of specialized personnel; auxiliary services; civil aviation safety; air transport facilitation; crew licensing processes; pollutants emissions and aeronautical noise; reservation systems; transportation of passengers and cargo; and other civil aviation activities;
- To establish security rules for aircraft and airports, including those related to the transportation of dangerous goods;
- To regulate and inspect air services providers and airport operators in order to prevent the use of narcotic drugs or psychotropic substances by crew members or maintenance and operation personnel;
- To authorize, regulate and inspect air services in Brazil;
- To confiscate aeronautical goods and products of civil use which do not comply with legal specifications;
- To inspect civil aviation aircraft, their components, equipment – including crew licenses – and maintenance services aiming at ensuring compliance with flight safety rules;
- To administer the Brazilian Aeronautical Register (Registro Aeronáutico Brasileiro – RAB);
- To regulate landing and take-off permits for civil aircraft;
- To administratively mediate conflicts of interest among air services providers and airport and aeronautical infrastructure providers;
- To approve airport master plans;
- To homologate, register and classify aerodromes; to inspect compliance with technical requirements for the construction, renovation and improvement of aerodromes and also to issue approvals for their operation;
- To issue rules and establish minimum flight safety, performance and efficiency standards to be fulfilled by air services providers and airport and aeronautical infrastructure providers, including equipment, materials, products and processes and services supplied;
- To issue airworthiness certificates;
- To regulate, inspect and authorize air services provided by flight training organizations and other civil aviation courses;
- To take part in the Brazilian Aeronautical Accidents Investigation and Prevention System (SIPAER).

7.3 Secretaria Nacional de Aviação Civil (SAC)

Linked to the Ministry of Transport, Ports and Civil Aviation, the Civil Aviation National Secretariat was created in 2011 by Law 12.462/2011 with the purpose of coordinating and supervising actions aimed at the strategic development of the civil aviation sector and airport and aeronautical infrastructure in Brazil.

Among the attributions of the portfolio are the planning of the air sector, the coordination of infrastructure development funds - in particular the Fnac (National Civil Aviation Fund) - and the coordination of the bodies and entities of the Brazilian civil aviation system - such as ANAC and Infraero - in articulation, where applicable, with the Ministry of Defense.

7.4 INFRAERO

Linked to the MTPA, the Brazilian Airport Infrastructure Company (Infraero) acts to provide airport and air navigation infrastructure and services, contributing to the country's national integration and sustainable development, in a manner articulated with the public policies of the Federal Government. It manages 55 airports, 72 Telecommunication and Air Traffic Service Stations and 28 Freight Logistics Terminals. The Company also has a 49% participation in the Specific Purpose Companies (SPEs) that manage the terminals of Guarulhos and Viracopos (SP), Brasília (DF), Confins (MG) and Galeão (RJ). It is the only Brazilian public company authorized by the National Civil Aviation Agency (ANAC) to offer specialized training for airport professionals.

Infraero provides air navigation services in 63 airports, four of which are helipad, of which three are in maritime platforms. These services include 12 Approach Control Centers (APP), 21 Aerodrome Control Towers (TWR), 39 Aerodrome Flight Information Services (AFIS) and 64 Aerodrome Meteorological Centers (CMA) and 60 Aeronautical Information Rooms Aerodrome (AIS Room). At airports, Infraero operates and maintains air navigation equipment and aids, including: 11 Instrument Landing Systems (ILS), 33 VHF / VO / DME Radio Beacons, 49 Non-Directional Beacons (NDB), (ALS), 74 Precision Approach Path Indicator Systems (PAPI), 17 Visual Approach Ramp Indicator Systems (VASIS), 63 Surface Weather Stations (EMS) and 4 Altitude Weather Stations EMA). Infraero also operates and maintains radio aids (NDBs) isolated in 9 different locations.

7.5 Departamento de Controle do Espaco Aéreo (DECEA)

Subordinated to the Ministry of Defense and the Air Force Command, the Air Space Control Department (DECEA) is the Aeronautical Command's body responsible for planning, managing and controlling Brazilian air traffic. The body is responsible for activities related to flight protection, the search and rescue service and telecommunications of the Aeronautics Command. DECEA, through Administrative Rule 913 / GC3, dated September 21, 2009, is also responsible for providing the necessary means for the management of airspace and the air navigation service, in a safe and efficient manner, as established in national and in the international agreements and treaties to which Brazil is a party.

The Department of Airspace Control (DECEA) is a governmental organisation, subordinate to the Brazilian Air Force, which includes human resources, equipment, systems and infrastructure, responsible for the air traffic control and airspace defence.

The organisation is in charge of a considerable portion of airspace, which exceeds Brazilian 8.5 million square kilometres of territory, reaching the Atlantic Ocean to make up 22 million square kilometres of airspace in its liability. In this way, makes available services such as Aeronautical Information System, Air Traffic Management, Aeronautical Telecommunication, Aeronautical Cartography, Aeronautical Meteorology, Flight Inspection and Search and Rescue.

In a daily basis, more than 12,000 employees carry out multiple activities distributed in 5 Area Control Centres (ACC), 42 Approach Controls (APP), 58 Air Traffic Control Towers (TWR), in addition to more than 900 Navaids.

DECEA has an integrated civilian and military purpose. Accordingly, its mission is to manage and control the air traffic as well as to guarantee the defence of the Brazilian airspace. Therefore, this integration has been conceived to support military and civil operations, resulting in a significant economy of means and resources.

The same communications, navigation and surveillance means are applied to provide air traffic control services and air defence, enabling the country to save resources and to serve both Air Force operational requirements - complying with the rules set by the Brazilian Airspace Defence Command - and the duties to ICAO, satisfying all the annexes referring to air traffic.

No. of Towers Operated: 58

No. of ACCs: 5

No. of Employees: 12,544

Total number of ATCOs: 3,512

7.6 CENIPA

CENIPA (Center for Research and Prevention of Aeronautical Accidents) is the central body of the Aeronautical Accident Investigation and Prevention System - SIPAER. It is responsible for the supervision, planning, control and coordination of aeronautical accident investigation and prevention activities. These actions are carried out in coordination with the three Armed Forces (Navy, Army and Brazilian Air Force), National Civil Aviation Agency (ANAC), Brazilian Airport Infrastructure Company (INFRAERO), airlines and other representatives.

7.7 Comparison between ANSP model in Brazil and EU

Brazilian and European ANSP systems serve to the same purpose: to provide air navigation services in a safe and efficient manner.

There is a first and obvious difference: while Brazil is a single country, with a single ANSP, there are 28 countries in the European Union, each one with its own ANSP. Overall, the European ANS system covers 37 air navigation service providers (ANSPs) with some 57 000 staff and 16900 are air traffic controllers (ATC). Five biggest ANSPs (DFS for Germany, DSNA for France, ENAIRE for Spain, ENAV for Italy and NATS for the UK) bear 60 % of total European gate-to-gate service provision costs and operate 54 % of European traffic. As consequence, 40 % of remaining gate-to-gate costs are borne by 32 other smaller ANSPs. On average, each flight is 49 km longer than the direct flight. The estimated costs of fragmentation of airspace amounts to EUR 4 bn a year.

The surface of Brazil covers more than 8.5 km2 (22 km2 including the oceanic area), i.e. 2 times the surface of the European Union (4.3 km2). To manage that extension, the Brazilian ANSP employs 3512 ATCOs, managing both civil and military flights, while on the other side only the five largest European ANSPs need more than 12000 ATCOs, and only for civil flights. It is clear that there are many more controlled flights in the EU (12.6 million in the five largest countries in 2017) than in Brazil (1,6 million), but these figures prove the potential advantages and gains in efficiency thanks to the ability to manage a vast territory with a single air navigation service provider (see Table 7.1 and Figure 7.2). However, there might be some room for improvement: in 2017, in the five largest European ANSPs the number of controlled flights per ATCO ranges from 800 to 1400. In Brazil, the ratio is 400.

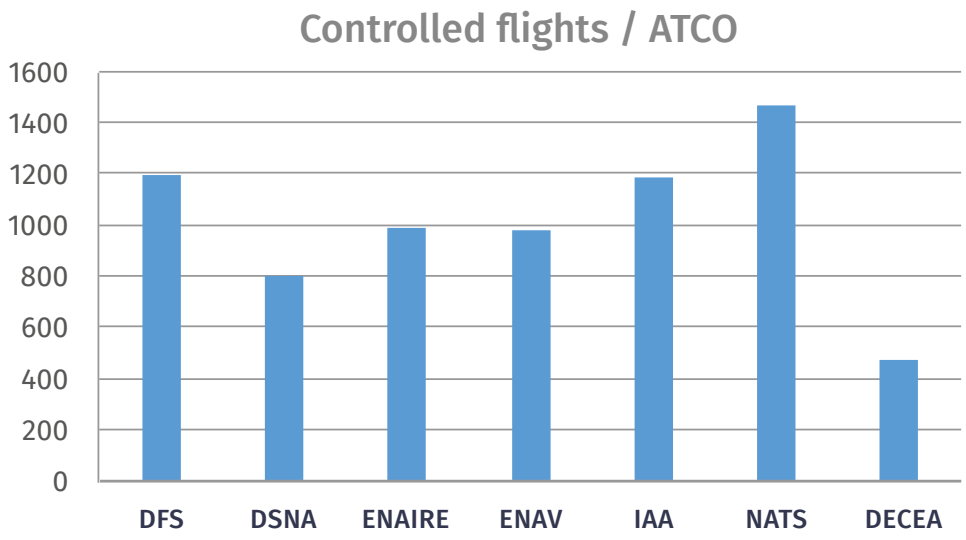
Table 7.1. Comparison of indicators in Brazil and Europe.

	Number of ANPSs	*Country extension (million km²)*	*ATCOS*	*Controlled flights (millions)*	*Controlled flights per ATCO (average)*
Brazil	1	8.5	3512	1,6	455
Europe	37	4.3	16900	23,3	1378

This fact is acknowledged in Europe and as it has been explained throughout the document, different bodies work in different ways to coordinate the action of the different European ANSPs: EUROCONTROL, EASA, and European Commission. Since 2004, the European Union (EU) has gained competences in air traffic management (ATM) and the decision-making process has moved away from an intergovernmental practice to the EU framework. The EU's main objective is to reform ATM in Europe in order to cope with sustained air traffic growth and operations under the safest, most cost- and flight-efficient and environmentally friendly conditions. This implies de-fragmenting the European airspace, reducing delays, increasing safety standards and flight efficiency to reduce the aviation environmental footprint, and reducing costs related to service provision.

This ambitious Single European Sky (SES) initiative has a technological pillar called SESAR. The transition from a highly fragmented airspace to a single airspace will be done in several steps that will join neighbour States airspace in 09 commonly operated ATC areas called Functional Airspace Blocks (FABs).

Figure 7.2. Comparison of indicators in Brazil and Europe.



Considering the organisation and management of the ANSPs organisation, there are important differences between the Brazilian model and the European model. In Brazil, the ANSP is a governmental organisation, subordinate to the Brazilian Air Force. In Europe ANSP are civilian organisations, independently of the different business models they may take (state-owned or public-private partnership).

Civil and military control integration is therefore absolute in Brazil, with the corresponding potential gains in efficiency in the utilization of the resources, both in terms of infrastructure and air controllers. But also taking advantage of the gains in operational performance thanks to the integrated coordination of civil and military flights.

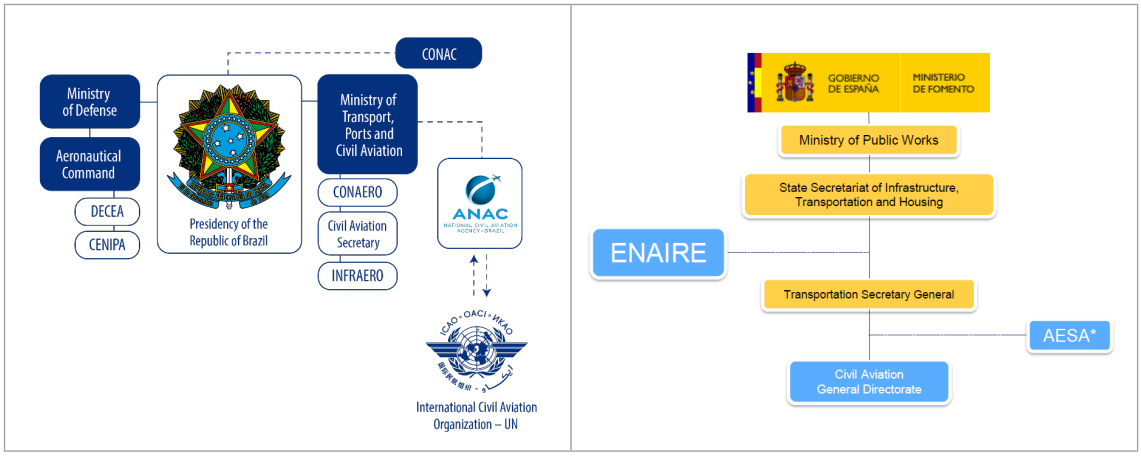
In Europe, there are different degrees of civil and military integration. In Germany they are integrated, by managed by a civilian organisation, DFS and air controllers are civilians. In the other large countries, ANSPs for civil flights work closely with the military controllers. In France, they are even located in the same control centers using the same systems.

At supranational level, EUROCONTROL has a permanent coordination committee with representatives of civil and military controls. The objective in all cases is to enhance flight safety and to optimise the use of airspace.

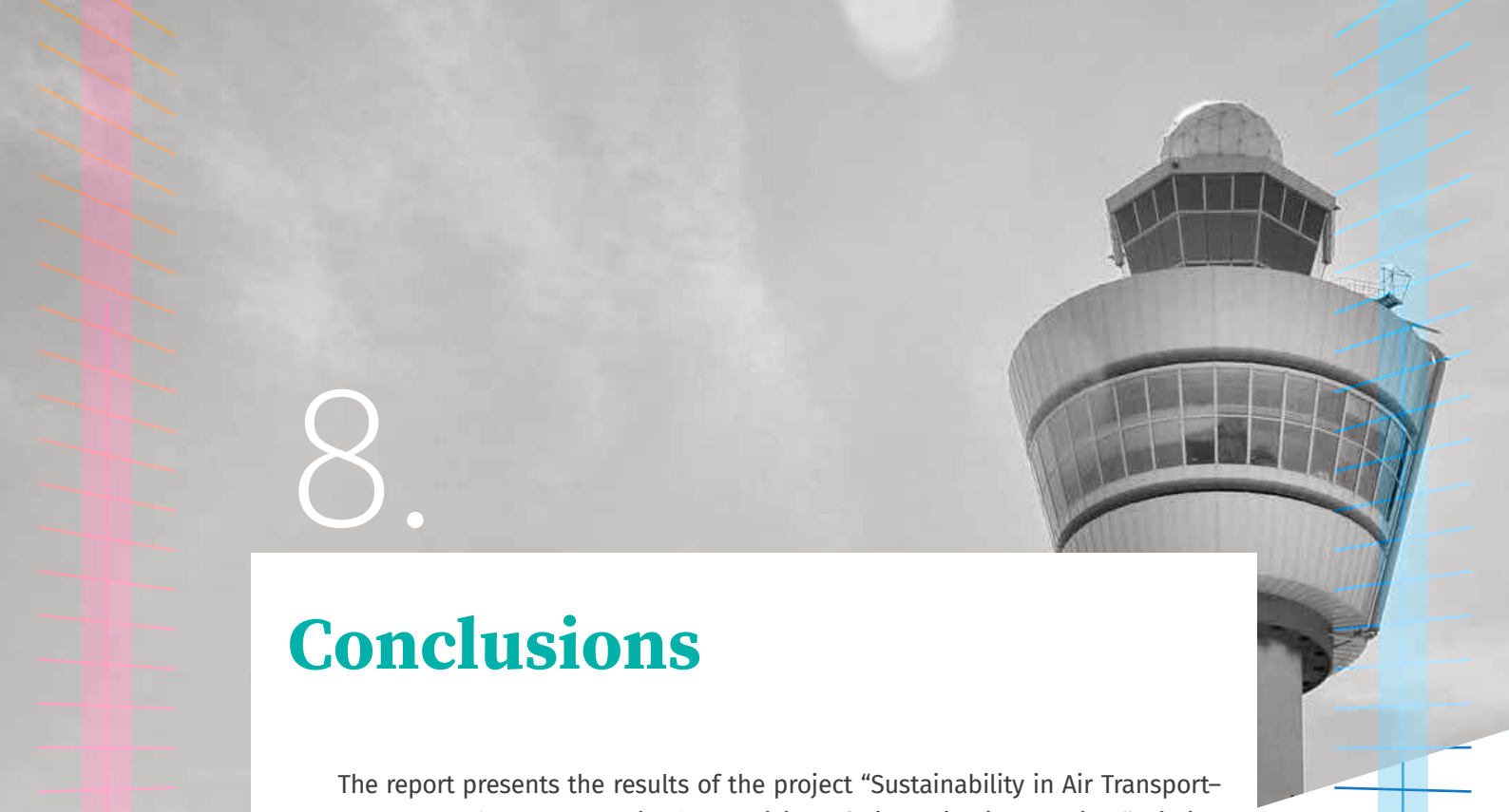
The main difference comes from the dependency of the ANSP: from the Ministry of Defense in Brazil, from the Ministry of Transport (or equivalent) in the European countries. In European countries, typically the Regulator organization (National Supervisory Authority), the Supervisor organization and the ANSP are different entities, subordinated all to the Ministry of Transport. This common dependency possibly facilities the policies and coordination of responsibilities and activities. It also facilitates the efficient utilization of the ANSP organization resources, with a clear and independent supervision of their budgets and accounts. In Figure 7.3 the organisation chart in Brazil is compared with the one in Spain, a typical organization chart in Europe.

In Europe, the supervision of the ANSP is key to ensure different indicators of the service provision: safety, performance (in terms of delays, for example), capacity, cost efficiency, viability, and sustainability. This supervision is performed independently of the type of the business model of the ANSP and is carried out through Key Performance Indicators (KPIs).

Figure 7.3. Comparison of the organisation chart of the ANSP provision in Brazil and in Spain (typical structure in Europe).



An advantage of an ANSP with civilian air controllers under civilian authorities control is the organizational flexibility it provides: different types of state-owned business models can be adopted (as the European case shows) and of course, it allows ultimately the possible entrance of private investors and the constitution of a public-private partnership. However, as it has been explained through the report, there is not currently evidence on the superiority in terms of efficiency or any other indicator of any particular business model for an ANSP.



8.

Conclusions

The report presents the results of the project "Sustainability in Air Transport–Management and Governance in the Provision of Air Navigation Services", aiming at studying the sustainability in air transport, in Brazil and in the EU, in order to improve the management of air traffic and improve the efficiency of the sector, addressing especially issues such as governance, regulatory framework, safety and infrastructure. The project identifies the successful European experiences related to best practices and sustainable models for the provision of air navigation services.

The air navigation service providers of the five largest countries (54 % of the total traffic) plus Ireland are described in detail, since they manage the largest part of the traffic in Europe. They respond to different types of organisational models:

- German DFS, a State-owned limited liability company organised under private law.
- British NATS, a public private partnership between the Airline Group, which holds 42%, NATS staff who hold 5%, UK airport operator LHR Airports Limited with 4%, and the government which holds 49%, and a golden share.
- Irish IAA, a commercial state-sponsored body (commercial semi-state company).
- French DSNA, part of the Ministry of Sustainable Development, through the Direction Générale de l'Aviation Civile (DGAC),
- Italian ENAV, listed on the stock exchange and with the Italian State holding 53.3% of ENAV though the MEF.
- Spanish ENAIRE, a public business entity belonging to the Ministry of Public Works.

Currently there is not a clear conclusion about if any one of these models is better than the others at driving performance that has safety, cost and environmental benefits. In particular, considering the six ANSPs analysed, no clear conclusion can be extracted in terms of financial performance about the benefits of the different type of organisation an ANSP may adopt.

ENAIRE and IAA, government entities, show better profitability than public-private partnerships such as NATS or ENAV. However, DFS, also 100% state-owned, had a lower profitability compared to those PPPs.

Concerning staff costs, a trend may be identified: with the exception of the Irish IAA, the two big state-owned ANSPs, DFS and ENAIRE had higher staff costs as a percentage of their revenues compared to the two big PPPs, ENAV and NATS. The same trend is identified comparing the staff costs per person or per ATCO). Surprisingly, this conclusion is different than the one we can have looking at EUROCONTROL Unit rates, showing the importance in the cost of the service, not only of the personnel costs, but also the efficiency in the utilization of the resources.

Finally, in terms of productivity (number of controlled flights per ATCO), again contradictory results can be observed: the PPP NATS shows better performance than state-owned DFS and ENAIRE, which is not the case of the other large PPP, ENAV.

Since 2004, the European Union (EU) has gained competences in air traffic management (ATM) and the decision-making process has moved away from an intergovernmental practice to the EU framework. The EU's main objective is to reform ATM in Europe in order to cope with sustained air traffic growth and operations under the safest, most cost- and flight-efficient and environmentally friendly conditions. This implies de-fragmenting the European airspace, reducing delays, increasing safety standards and flight efficiency to reduce the aviation environmental footprint, and reducing costs related to service provision. Achievements have already been made at operational, technological and institutional levels; efforts are ongoing to maximise the benefits of activities initiated under the Single European Sky (SES) framework.

The Public Private Partnership (PPP) consortium SESAR (Single European Sky Advance Research) develops the technical part of the SES program with the following targets:

- Increase three times the European air space management capability.
- Increase safety by a factor of 10.
- Reduce 50% the ATM cost to the users.
- Optimize flight trajectories to save between 8 and 14 minutes per flight, reducing fuel consumption by an average of 300 to 500 kg.

Examples of SESAR improvements already in place are:

- Extended arrival management horizons operational (E-AMAN) at places such as Munich, Reims and Heathrow, with many more to follow, helping to provide enhanced and more consistent arrival sequences by sharing information across borders.
- New precision area navigation (P-RNAV) approach procedures are in place across the continent, including Dublin, Stockholm Arlanda and Paris CDG, improving the design and organisation of our busy terminal manoeuvring areas and reducing workload on controllers.
- There is free route airspace in operation across significant volumes of the upper airspace within Europe, allowing airspace users to plan and take the routes they want to take, helping them to save fuel, reduce flying time and lower their costs.
- Whilst the European Commission's Functional Airspace Blocks have not perhaps driven yet the seamless airspace route as was desired, there are new collaborations that are providing additional impetus – from the COOPANS systems grouping through to the Gate One and Borealis Alliance ANSP initiatives.
- As of today, at a technical level, extensive research and development continues through the industry-leading public-private SESAR research programme. There will be many more simulations taking place this year helping take new concepts one step closer to being ready

for operational deployment – from wake vortex separation optimisations that will enhance runway throughput, through to testing new means of organising controllers that will better match demand to capacity, reducing congestion and improving traffic flows.

- Alongside this and with the input of its Members, the SESAR Joint Undertaking (SJU) is currently finalising its recommendations to the European Commission in terms of the concepts whose implementation will be mandated via European law through Common Project 2, the follow up to the European Commission's Pilot Common Project.

Comparing the Brazilian ANSP model and the European ANSP model, the following conclusions can be extracted:

- There are clear advantages in managing a large unified airspace: the advantages of the economies of scale are not undermined by the fragmentation of the airspace. This is an advantage of Brazil that Europe have been trying to accomplish since the creation of Eurocontrol in 1960 and lately with the Single European Sky impulse by the European Union.
- In Europe, the ANSPs are regulated and supervised by independent organisations. This supervision affects different kinds of KPIs, not just economic or financial, but also related to safety. ANSPs have clear and transparent budgets that are controlled by external bodies. ANSPs are supervised by the corresponding National Supervisory Authorities, a key organisation put in place under EU Regulation. Probably thanks to this supervision, all KPIs have improved largely in Europe in the last years: capacity, safety, cost. Necessary investments can be better justified when the return can be measured, monitored and ultimately published.
- As it has been mentioned, in European countries typically the Regulator organization (National Supervisory Authority), the Supervisor organization and the ANSP are different entities, subordinated all to the Ministry of Transport (or equivalent). This common dependency possibly facilities the policies and coordination of responsibilities and activities. It also facilitates the efficient utilization of the ANSP organization resources, with a clear and independent supervision of their budgets and accounts.
- The dependency of the Brazilian DECEA from the Ministry of Defense may make this supervisory role more complicated, although not impossible. A high-level coordination commission would be needed between the Ministry of Defense controlling the ANSP and the MTPA controlling all other aspects of civil aviation. The two different roles of air space control (provide a safe and cost effective service to civil aviation and guarantee national security) should be treated independently, trying to optimize the utilization of resources. There are examples of good practices sharing resources in countries like France. Civil air navigation is ultimately a service provided to airlines, national and international, and the associated charges and the perceived quality of the service are elements of competitiveness in any country.
- Experience in a country like Germany prove that civil and military complete control integration can be performed with a civil ANSP.
- An advantage of an ANSP with civilian air controllers under civilian authorities control is the organizational flexibility it provides: different types of state-owned business models can be adopted (as the European case shows) and of course, it allows ultimately the possible entrance of private investors and the constitution of a public-private partnership.
- However, as it has been explained through the report, there is not currently evidence on the superiority in terms of efficiency or any other indicator of any particular business model for an ANSP.

9.

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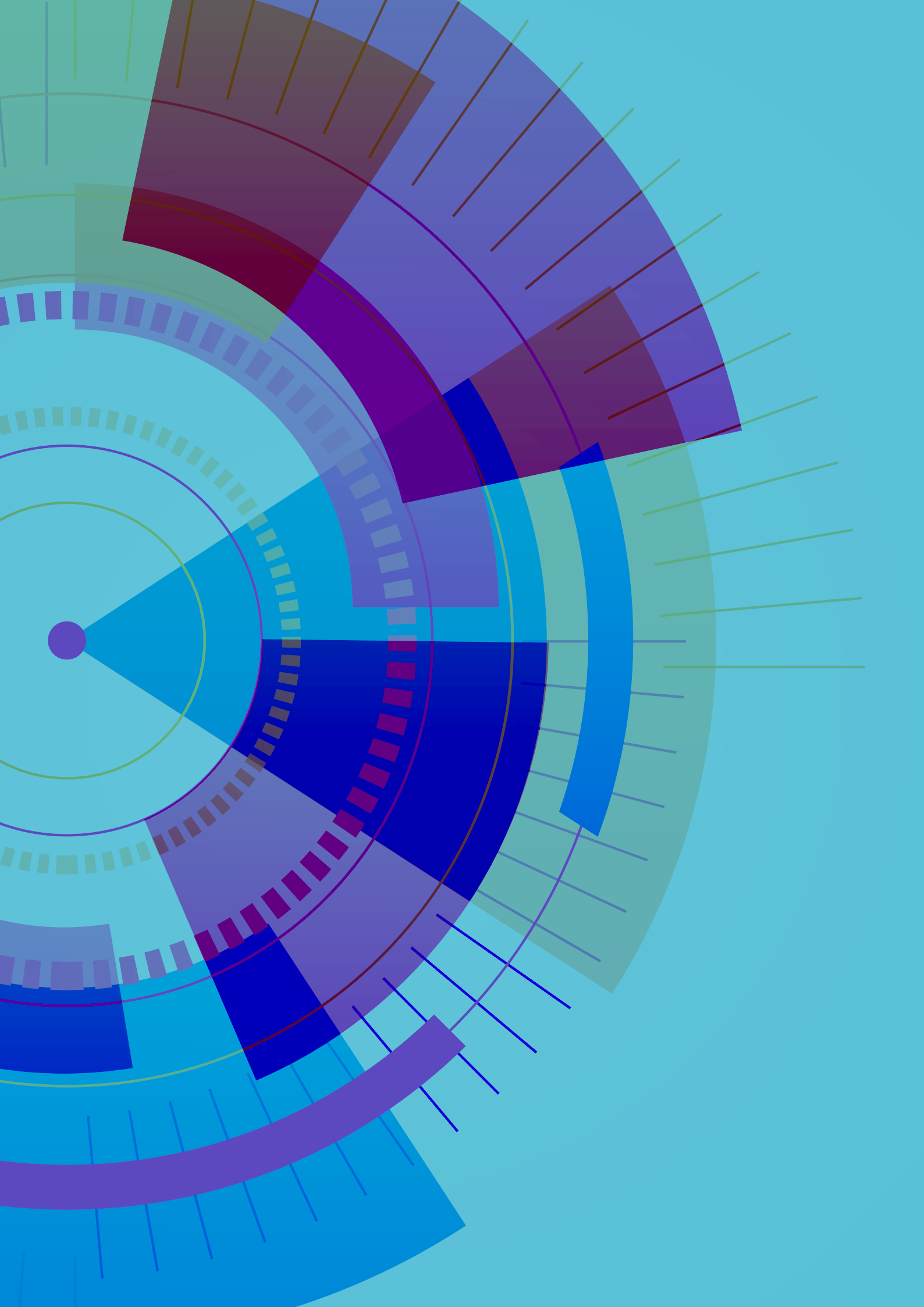

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