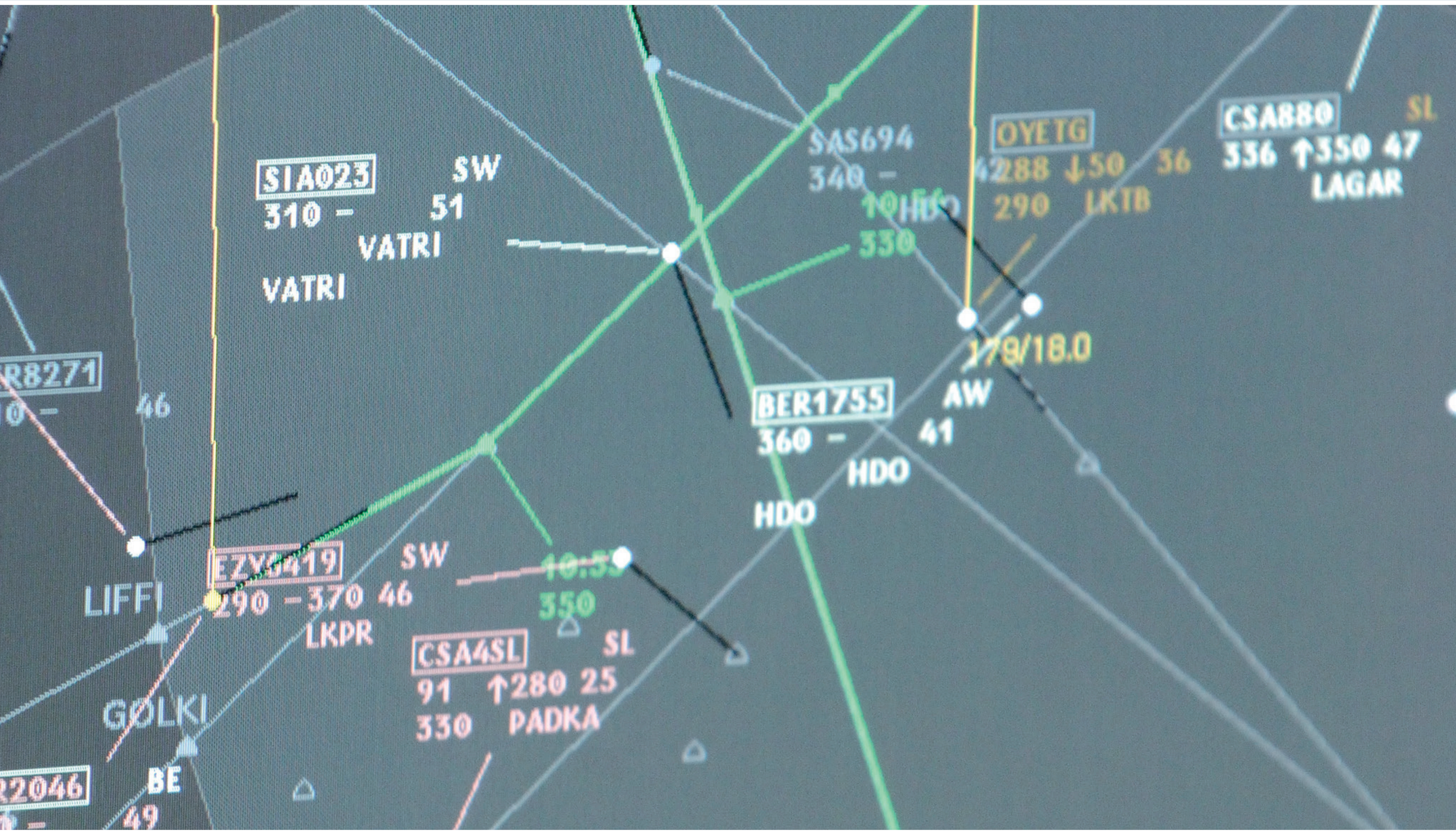
PRR 2015

Performance Review Report

An Assessment of Air Traffic Management in Europe
during the Calendar Year 2015



Performance Review Commission | June 2016

EUROCONTROL

Background

This report has been produced by the Performance Review Commission (PRC). The PRC was established by the Permanent Commission of EUROCONTROL in accordance with the ECAC Institutional Strategy 1997. One objective of this strategy is "to introduce a strong, transparent and independent performance review and target setting system to facilitate more effective management of the European ATM system, encourage mutual accountability for system performance…"

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SUMMARY

This report of the Performance Review Commission analyses the performance of the European Air Traffic Management System in 2015 under the Key Performance Areas of Safety, Capacity, Environment and Cost-efficiency.

Keywords

Air Traffic Management	Performance Measurement	
Performance Indicators	ATM	ANS

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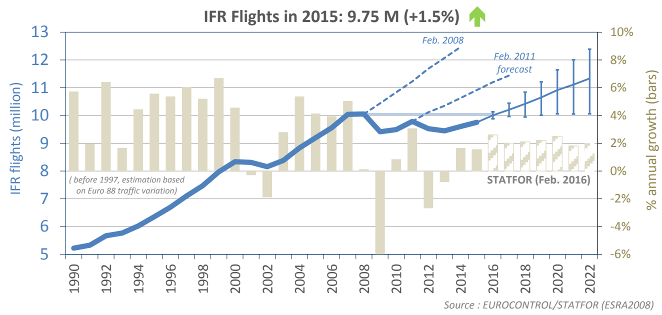
European ATM Performance

	Key Performance Indicator	Data & commentary

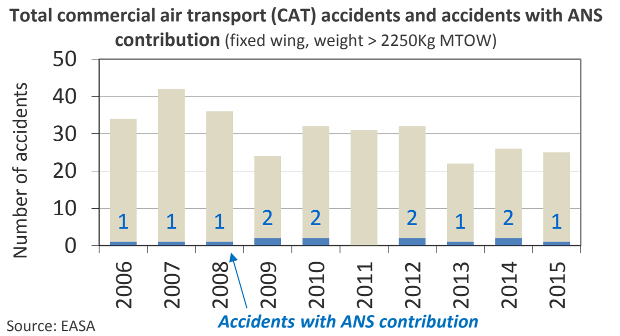
TRAFFIC



IFR flights	ESRA08 area	Variation
2015	9.75 M	+ 1.5% ↑

In 2015, IFR flights increased on average by +1.5% in Europe compared to 2014 which is in line with the STATFOR baseline forecast.
For 2016, the STATFOR 7-year forecast (Feb. 2016) expects European flights to grow by 2.4% in the baseline scenario.

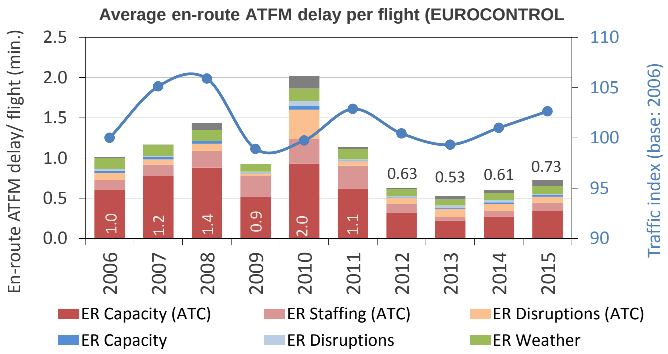
SAFETY



Accidents with ANS contribution	Eurocontrol area	Variation
2015	1	-1 ↓

The number of total CAT accidents in the EUROCONTROL remained low.

CAPACITY

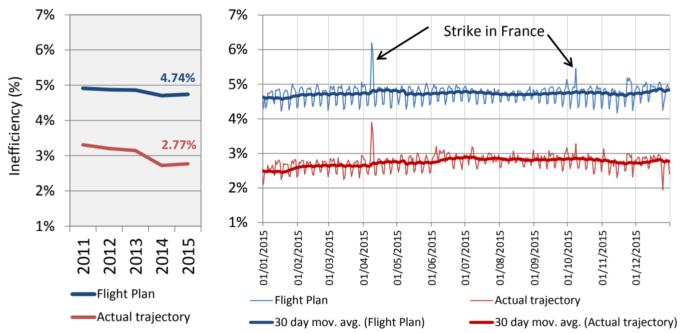


En-route ATFM delay per flight	Eurocontrol area	Variation
2015	0.73 min.	+0.12 ↑

En-route ATFM delays, for the EUROCONTROL area, increased by +23% in 2015 which corresponds to 0.73 minutes of en-route ATFM delay per flight (0.61 in 2014).

The most constraining ACCs in 2015 were Nicosia, Brest, Lisbon, Athinai/Macedonia, Zagreb, Reims, and Barcelona.

ENVIRONMENT

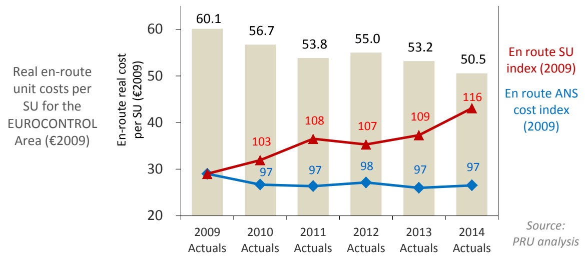


En-route flight efficiency (vs. flight plan)	Eurocontrol area	Variation
2015	4.74%	+0.04%pt. ↑

At European level, the inefficiency in filed flight plans increased from 4.70% to 4.74% in 2015.

Inefficiencies in actual trajectories increased at a slightly higher rate from 2.72% to 2.77% in 2015.

COST-EFFICIENCY



En-route ANS costs per SU (€2009)	Eurocontrol area	Variation
2014	50.5	-5.0% ↓

In 2014, en-route ANS costs increased by 0.6% while en-route service units increased by 5.9% leading to a further decrease in en-route unit costs by 5.0% compared to 2013.

Introduction

PRR 2015 presents an assessment of the performance of European Air Navigation Services (ANS) for the calendar year 2015. Note that the Cost-efficiency data presented in Chapter 6 relate to the calendar year 2014, which is the latest year for which actual financial data are available.

ANS in European Air Transport

Controlled flights in Europe increased for the second year in a row in 2015 (+1.5% vs 2014). The observed growth is in line with the STATFOR (Feb. 2015) baseline forecast scenario (+1.5%) predicted for the area. Total flight distance (+1.8% vs.2014) and flight hours (+1.7% vs.2014) increased at a slightly higher rate due to, on average, longer flights.

According to the latest STATFOR 7-year forecast (Feb. 2016), flights are expected to grow by 2.4% in 2016 (Low: 1.0%; High 3.8%) and to continue with an average annual growth rate of 2.2% between 2015 and 2022 (Low: 0.7%; High 3.8%). Air traffic in Europe is expected to reach pre-economic crisis levels (2008) by 2017.

In absolute terms, Turkey, Bulgaria, Hungary, the UK, and Spain (Continental) experienced the highest year-on-year growth in 2015 and all of the six largest States in terms of traffic volume (Germany, France, UK, Italy, Spain, and Turkey) showed an increase in traffic in 2015. Turkey continued its remarkable traffic growth (average annual growth rate of 7% over the past 5 years) and shows a substantial growth in all segments (domestic, international, overflights).

The growth observed in a number of central European States (Bulgaria, Hungary, Czech Republic, Romania and Slovakia) was mainly related to overflows from traffic avoiding Ukrainian airspace. The shift in traffic patterns following the start of the Ukrainian crisis and the downing of MH17 in July 2014 led to a drastic reduction of traffic in Ukraine (-33.4%) and also Moldova (-19.3%) compared to 2014. The sustained closure of Libyan airspace (as of August 2014) continued to have a notable impact on Greece with traffic flows between Europe and Africa shifting from Maltese airspace to Greek airspace.

After the best year on record in 2013, arrival punctuality in Europe decreased for the second year in a row to 82.1% in 2015. Reactionary delay remains the largest single delay group (45.9%) in 2015, followed by delays due to turnaround issues. The further increase in en-route and airport ATFM delays in 2015 contributed also to the lower punctuality levels in 2015.

The variability of operations determines the level of predictability and has an impact on airline scheduling and also on the provision of ATC and airport capacity (i.e. TMA capacity, en-route capacity, gate availability, etc.). The lower the predictability, the more difficult it is to match capacity to demand without inefficiencies in terms of delay (insufficient capacity) or cost (underutilisation of resources). Whereas a certain level of variability is considered to be normal or even required in aviation, more research to better understand the drivers of operational variability within the system (operational planning, time definitions, tolerance windows, delay causes, etc.) could contribute to reducing system-wide variability with associated positive effects for capacity utilisation.

Aircraft noise has been generally recognised as the most significant environmental impact at airports. Political decisions on environmental constraints can impact operations in terms of the number of movements, route design, runway configuration and usage and aircraft mix (engine types, etc.). The main contributing factors towards reduced noise exposure are expected to come from measures with long lead times outside the control of ANS (land use planning, reduction of noise at source). Noise abatement operational procedures are the main area where ANS can actively contribute to the reduction and/or reshaping of the noise contour and the population affected by aviation noise.

The environmental impact of aviation on climate results from greenhouse gas (GHG) emissions including CO_2, NOX, and contrails (H_2O), formed by aircraft engine exhaust. By far the main contribution to decouple aviation emissions growth from air traffic growth is expected to come from alternative low carbon fuels, market based measures, technology developments (more efficient aircraft, advances in airframe and engine technology) and subsequent fleet renewals. The ANS-related impact on climate is closely linked to operational performance, which is largely driven by inefficiencies in the four dimensional trajectory and associated fuel burn (and emissions).

The total economic evaluation of ANS performance presents a consolidated view of direct ANS costs and estimated indirect ANS-related costs (ATFM delays, additional taxi-out and ASMA time, horizontal en-route flight efficiency) borne by airspace users. Based on the latest available information for 2015, total economic ANS-related costs in the SES area are estimated to increase by 4.8% compared to 2014. The increase is mainly driven by the deterioration of ANS-related operational performance in all areas (most notably in en-route and airport ATFM delays) and the projected increase in en-route ANS costs in 2015.

Safety (2014/2015)

The definition and guidance on the development of Acceptable Levels of Safety Performance (ALoSP) is currently not available in Europe. While there is an urgent need to provide this type of support and guidance to States, it is still not clear how this concept will be introduced within the regulatory environment. A common approach to measuring and managing safety performance from a regulatory perspective would also ensure a harmonised implementation of State Safety Programmes (SSP) and facilitate the exchange of safety information in the future.

The current safety reporting environment is changing and it has to be accepted that the next few years will be a transition phase. During this time, in order to maintain and improve European reporting, it is important that actors responsible for the collection of safety data work together in order to create an optimum solution.

Nevertheless, the PRC has to express its concern that during this transition phase, availability, completeness and quality of safety data may deteriorate due to the lack of arrangements between all parties involved in the process.

Operational En-route ANS Performance (2015)

The growth in traffic (1.5% from 2014) was not homogenous throughout the network, with significant disruption to traffic flows because of, *inter alia*, the continuing Ukrainian crisis and industrial action by air traffic controllers. The temporal spread of traffic was also interesting and 2015 witnessed the highest individual monthly totals for network traffic in July, August & September for ten years.

After the lowest level of en-route ATFM delay per flight on record in 2013, delays have been rising again over the past two years. In 2015, total en-route ATFM delays for the EUROCONTROL area increased by +23% which corresponds to 0.73 minutes of en-route ATFM delay per flight (0.61 in 2014).

The performance deterioration was mainly attributed to ATC capacity issues highlighting previous PRC concerns that ATFM delays could increase when traffic grows again.

As stressed already previously by the PRC, in view of the considerable lead times it is essential to carefully plan and also deploy capacity in line with projected traffic growth. Over-conservative capacity planning removes buffers against traffic variations and increases the risk of significant disruption to aircraft operations.

While capacity constraints can occur from time to time, area control centres (ACCs) should not generate high delays on a regular basis. The most constraining ACCs in 2015 were Nicosia, Brest, Athinai and Macedonia, Zagreb, Lisbon, Reims and Barcelona. Together, they accounted for 58.1% of all en-route ATFM delays but only 14.5% of total flight hours controlled in Europe.

Despite further progress in the implementation of free route airspace in 2015 (more than 20 airspace improvement packages in 2015), horizontal en-route flight efficiency deteriorated in 2015 after the continuous improvement over the past years. At European level, the inefficiency in filed flight plans increased from 4.70% to 4.74% in 2015. Inefficiencies in actual trajectories increased at a slightly higher rate from 2.72% to 2.77% in 2015.

Horizontal en-route flight efficiency improves notably on weekends, which is to some extent linked to lower traffic levels which appear to have a positive effect on flight efficiency but also due to the better availability of segregated and free route airspace on weekends, which are contributing factors towards improved flight efficiency.

In view of the numerous factors and complexities involved, and with traffic levels growing again, flight efficiency improvements will become more and more challenging and will require the continued joint efforts of all stakeholders, coordinated by the Network Manager.

Close civil military cooperation and coordination is a crucial enabler to improve capacity and flight efficiency performance. Although all EUROCONTROL Member States declare to be formally compliant with existing FUA legislation, the results of the civil military coordination and cooperation questionnaire suggest that there is scope for improvement in the underlying processes related to the management of the airspace.

The main identified issues are related to the lack of impact assessments; the definition of clear national strategic objectives at ASM level 1, and the interrupted information flow between the three levels of ASM.

Operational ANS Performance at Airports (2015)

In 2015, controlled movements (arrival + departure) at the top 30 airports in terms of traffic increased for the second year in a row. Overall, average daily movements increased by +2.3% compared to 2014 but with notable differences in growth between airports. Despite the further growth in 2014, traffic levels still remain 1.1% below the pre-economic crisis levels of 2008.

At the same time passenger numbers continued to increase at a higher rate than flights. Compared to 2014, the number of passengers at the top 30 airports increased by +5.3%, and, contrary to the number of flights, passenger numbers are 22.5% higher than in 2008.

Istanbul Sabiha Gökçen and Atatürk airports continued their growth also in 2015 with an increase in average daily traffic of 91 and 67 movements respectively. Over the past 10 years, Istanbul Sabiha Gökçen airport grew at an average annual rate of +29.8% and Istanbul Atatürk at an average rate of 8.2% per year. The continuous strong growth resulted in a substantial increase in airport ATFM arrival delays at the two Istanbul airports in 2015 with a notable impact on the European network. Together, the two airports accounted for 35.7% of all airport ATFM arrival delays in Europe in 2015. The new Istanbul airport presently under construction is expected to improve the situation. The airport is planned to open in different phases with an anticipated capacity for up to six runways, serving 150 million passengers by 2028.

Other airports with substantial traffic growth in 2015 were Athens (+13.9%), Dublin (+9.8%), London Stansted (+7.5%), Madrid (+7.0%), and Lisbon (+6.0%). Of the top 30 airports in terms of traffic in 2015, seven airports showed a traffic decrease.

Despite a number of disruptive events (e.g. industrial action), the average share of operational cancellations at the analysed airports remained at 1.5% in 2015.

Overall, the traffic increase appears to have contributed to the higher levels of operational inefficiency at some airports. As a result, all four indicators measuring operational ANS performance at the top 30 airports showed performance deterioration in 2015.

The top 30 European airports accounted for 45.7% of total European airport movements and 88.7% of total airport ATFM arrival delays in 2015. Despite a higher number of regulated flights, ATFM slot adherence continued to improve in 2015, particularly due to a notable improvement at London Heathrow.

Although not included in the top 30, it is noteworthy to point out that a number of small Greek airports accounted for 5.1% of European airport arrival ATFM delays with average delays per arrival of up to 11.5 minutes. Although the traffic volume at those smaller airports is comparatively low, the network impact in terms of reactionary delay is significant.

The poor performance at Greek regional airports is linked to seasonal traffic in summer. It and was already observed in 2011 when the Network Management Unit successfully worked together with those airports to improve performance. It would be important to revive the measures applied in 2012 in order to avoid high delay levels in 2016.

In order to address a growing stakeholder interest, vertical flight efficiency performance on climb and descent operations at 15 selected airports was measured. This first high-level analysis of continuous climb and descent operations revealed notable performance differences among airports which should be investigated further. The observed differences are caused by a number of reasons including congested airspace, restrictions from neighbouring ANSPs, and traffic density.

ANS Cost-efficiency (2014)

PRR 2015 analyses performance in 2015 for all KPIs, except for cost-efficiency, which analyses performance in 2014 as this is the latest year for which actual financial data are available. On the other hand, PRR 2015 also presents an outlook for 2015-2019 in terms of cost-efficiency trends.

The Pan-European system (38 States) **en-route cost-efficiency performance** in 2014 improved for the second year in a row. Following the -3.3% decrease in 2013, real en-route unit costs decreased further reaching 50.5$€_{2009}$ per service unit which corresponds to a -5.0% reduction compared to 2013.

The overall reduction of real en-route unit costs in 2014 is mainly due to the notable traffic growth (+5.9%) while actual en-route ANS costs increased by +0.6% during the same time. Despite the substantial traffic growth in 2014, it is worth noting that en-route service units are still below the forecasted level for 2014.

In 2014, operating costs accounted for 82% of en-route costs (staff costs for 58% and other operating costs for 24%), followed by depreciation (12%) and cost of capital (6%). Year-on-year, staff costs remained almost stable (+0.4% vs. 2013) while other operating costs increased by +1.8% in 2014.

The evaluation of differences in trends and behaviour between those States operating in the context of the SES Regulations and the other states in the Route Charges System does not yet show a clear cut trend and it is likely that a longer period would need to be considered. Moreover, the trend in non-SES States is to a large extent influenced by Turkey for which a significantly high traffic growth has been observed over the past years.

Under the determined costs method, applied by SES States as of 2012, the amounts ultimately paid by airspace users differ from the actual costs due to the traffic risk sharing, cost-sharing, and other adjustments provided in the Charging Regulation. It is therefore important to monitor not only the actual costs incurred by States/ANSPs, but also the amounts ultimately charged to the airspace users in respect of the activities of that year (a concept also referred to as the **"true cost for users"**). In 2014, the "true costs for users" were +2.8% higher than the actual costs of States/ANSPs but -2.1% lower than the determined costs provided for 2014 in the RP1 performance plans, which suggests that the service providers were able to adjust their costs downwards in line with the lower than predicted traffic level in 2014.

The outlook for 2015-2019 suggests that the en-route unit cost is expected to decrease from 50.5$€_{2009}$ in 2014 to 46.4$€_{2009}$ in 2019, representing a decrease of -1.7% p.a. on average until 2019. Overall, at Pan-European level between 2009 and 2019, the trend in total en-route costs is planned to remain flat, while traffic (SUs) is planned to increase by some +31%, implying substantial cost-efficiency improvements over this 10-years cycle.

European **terminal ANS cost-efficiency** performance (29 states comprising 33 Terminal Charging Zones which include a total of 230 airports in 2014) followed a similar pattern as observed for en-route cost efficiency in 2014. Year-on-year, terminal ANS unit costs decreased by -2.3% versus 2013 due to terminal service units (TNSUs) growing stronger (+2.9% vs. 2013) than real terminal ANS costs (+0.6% vs. 2013).

The outlook for 2015-2019 suggests that SES total terminal ANS costs are planned to slightly decrease over the period 2015-2019 (i.e. on average by -0.5% p.a.), while TNSUs are foreseen to increase at an average rate of +2.0% per year, representing a decrease of -2.5% per year on average in the terminal ANS unit costs. This is a slightly better trend than for en-route.

Detailed benchmarking analysis focusing on ANSPs cost-efficiency at Pan-European system shows that the **gate-to-gate unit economic costs** decreased for the 4th year in a row to reach an amount of €479 per composite flight-hour in 2014, which is the lowest level achieved since the start of the ACE benchmarking analysis in 2001. This performance improvement mainly reflects a decrease in unit ATM/CNS provision costs (-1.9%) while the unit costs of ATFM delays rose by 11.4% compared to 2013.

Overall, despite the impact of the economic recession of the ATM industry in 2009, the cost-effectiveness performance of the Pan-European system significantly improved since 2004. Indeed, in 2014 unit ATM/CNS provision costs are -9.4% lower than in 2004. This performance improvement should be seen in the light of the cost-containment measures initiated in 2009-2010 which continued to generate savings years after their implementation, and for the ANSPs operating in SES States, the implementation of the performance scheme which contributed to maintain a downward pressure on costs during RP1.

PRC Recommendations 2015

Recommendation	*Rationale for the recommendation*
a. The Provisional Council is invited **to note** the PRC's Performance Review Report for 2015 (PRR 2015) and to submit it to the Permanent Commission.	*Standard recommendation*
b. The Provisional Council is invited (i) **to note** the PRC's concerns on the possible deterioration of safety data analysis in ANS/ATM and to act in order to prevent this; (ii) **to request** the PRC to monitor the development of the changing safety reporting environment and to ensure that safety performance review data remains a constituent part of PRC performance review.	*The current safety reporting environment is changing and it has to be accepted that in the next few years will be a transition phase. During this time, in order to maintain and improve European reporting, it will be highly important that the actors directly involved in safety data collection work together in order to create an optimum solution.* *Nevertheless, the PRC has to express its concern that during this transition phase, availability, completeness and quality of safety data and associated safety data analysis will deteriorate due to lack of arrangements between all parties within the process.*
c. The Provisional Council is invited (i) **to request** the PRC to review the implementation of the Acceptable Level of Safety Performance (ALoSP) concept in EUROCONTROL Member States; (ii) **to request** the Member States to assist the PRC to conduct this review; (iii) **to ask** the PRC to report to PC 47 (June 2017).	*The definition and guidance on development of ALoSP is currently not available in Europe.* *A common approach to measuring and managing safety performance from a regulatory perspective ensures harmonised implementation of SSP and facilitates the exchange of safety information in the future.* *Although it is unclear how ALoSP concept will be introduced within European regulatory environment, there is a need to investigate this further in order to provide this type of support and guidance to States.*
d. The Provisional Council is invited **to request** Member States to task their ANSPs to provide capacity to meet demand instead of regulating demand to meet reduced capacity;	*In 2015, the PC "requested Member States…to ensure that capacity is made available during peak demand."* *A review of capacity performance in Croatia, Cyprus, France, Greece, Portugal & Spain in 2015 clearly indicates that ANSPs are regulating traffic for significant periods without providing the maximum capacity published.*
e. The Provisional Council is invited **to request** Member States to task their ANSPs to accurately identify the specific capacity constraints that adversely impact the service provided to airspace users, enhancing capacity provision through better transparency;	*The attribution of delays as being due to ATC capacity should only be applicable if the sector was providing the highest capacity published. At all other times, the reason for the capacity constraint that prevents full deployment of capacity should be the reason for the delay e.g. weather, staffing, special event etc.*
f. The Provisional Council is invited **to request** Member States to task their ANSPs to review sector capacities, both with and without airspace restrictions, to increase network performance.	*The PRC observed that published sector capacities are not necessarily the level of throughput that the airspace users can expect to achieve.* *Reviewing published sector capacities taking into account current ATFCM processes, both with and without military activity would improve transparency and potentially increase network performance.*

g. The Provisional Council is invited **to request** Member States to task their ANSPs to coordinate effectively, with the Network Manager: the planning and implementation of all changes to the ATM system that could adversely affect operations.	*The planning and implementation of system, airspace and equipment changes can have significant impact on the network as a whole.* *Whilst such changes are inevitable, and indeed desirable, airspace users need to be assured that all appropriate measures have been taken to reduce disruption, and that there will be an operational benefit to the users following implementation.*
h. The Provisional Council is invited **to request** Member States to achieve full implementation of Free Route Airspace on a H24 basis throughout the EUROCONTROL area as soon as possible but at the latest by 2021 in line with the ATM Master Plan.	*The network benefits of Free Route Airspace in terms of capacity and flight efficiency will not be totally realised until all Member States implement FRA on a H24 basis.* *Efforts must be made to ensure that the ANSPs are working actively with the Network Manager and the Deployment Manager to deliver this as quickly as possible.*
i. The Provisional Council is invited **to request** the relevant States to ask their ANSPs and airports concerned to work towards a reduction of the ATFM delays at the most constraining airports.	*In 2015, the 10 airports with the highest average airport ATFM delay per arrival (Istanbul (LTFJ), Mikonos (LGMK), Skiathos (LGSK), Kefallinia (LGKF), Zakinthos (LGZA), Santorini (LGSR), Khania (LGSA), Istanbul (LTBA), Iraklion (LGIR), and Amsterdam (EHAM) generated 51.3% of total European airport ATFM arrival delay with a notable impact on the entire network.* *More than 70% of the reported airport ATFM arrival delay at those 10 coordinated airports was related to capacity which suggests a serious imbalance between allocated airport arrival slots and available capacity during certain periods.*

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1 Introduction

1.1 About this report

Air Navigation Services (ANS) are essential for the safety, efficiency and sustainability of civil and military aviation, and to meet wider economic, social and environmental policy objectives.

This Performance Review Report (PRR 2015) has been produced by the independent Performance Review Commission (PRC) with its supporting unit the Performance Review Unit (PRU). Its purpose is to provide policy makers and ANS stakeholders with objective information and independent advice concerning the performance of European ANS in 2015, based on research, consultation and information provided by relevant parties. It also gives some information on other PRC activities in 2015.

It The purpose of the PRC is "*to ensure the effective management of the European Air Traffic Management system through a strong, transparent and independent performance review*", per Article 1 of its Terms of Reference [Ref. 1]. More information about the PRC is given on the inside cover page of this report.

On the basis of PRR 2015, the PRC will provide independent advice on ANS performance and propose recommendations to the EUROCONTROL States.

The PRC's recommendations can be found in the Executive Summary.

1.2 Report scope

Unless otherwise indicated, PRR 2015 refers to ANS performance in the airspace controlled by the 41 Member States[1] of EUROCONTROL (see Figure 1-1), here referred to as "Europe".

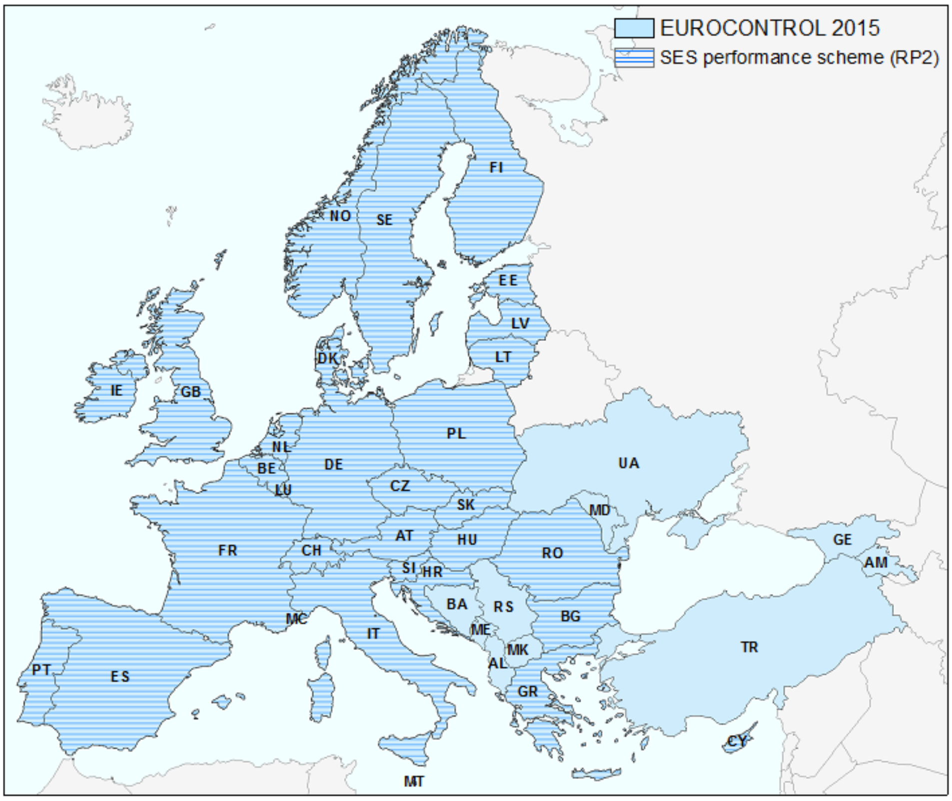

Figure 1-1: EUROCONTROL States (2015)

[1] Estonia became the 41st Member State of EUROCONTROL on 01 January 2015.

The data cited in PRR 2015 relates to the calendar year 2015, with the following exceptions:

- Safety data (chapter 3): some of the 2015 data are still provisional;
- Cost-efficiency data (chapter 6): these data relate to the calendar year 2014 which is the latest year for which actual financial data are available.

1.3 Key events in 2015

Some notable events in 2015 included (source: NM)

2015	**EVENT** (Source: Network Operations Reports, monthly overview [Ref. 2])
January	• Venice airport implemented full A-CDM operations on 20 January.
February	• Non ATC industrial action generated delays at Paris Charles De Gaulle airport on the 12 and 13 February. • Industrial action in Italy on 17 February generated high airport ATFM delay; approximately 150 flights did not operate.
March	• The Lufthansa pilot strike took place on the 18, 19 and 21 March; approximately 855 flights did not operate. • Industrial action in Italy on the 20 March generated some airport ATFM delay.
April	• The French ATC industrial action between 8 and 10 April 2015 generated 391,000 minutes of ATFM delay in the French ACCs. Maastricht, Karlsruhe and Madrid ACCs generated 51,715 min due to ATFM protective measures.
May	• Severe weather impacted operations at London/Heathrow, Amsterdam/Schiphol, Zurich and Barcelona airports and Maastricht, Reims, Zagreb and Karlsruhe ACCs. • Technical issues in Rome (radar failure on 15 May) and Brussels ACCs (electrical power failure on 27 May) generated delays and cancellations. • A fire in terminal 3 at Rome/Fiumicino airport overnight on 6-7 May impacted operations; a 20% airport capacity reduction was applied for the remainder of May. • Time Based Separation (TBS) operations at London/Heathrow airport became fully operational as from 1 May.
June	• Delays at Rome/Fiumicino airport due to ongoing airport capacity reduction after the fire in Terminal 3 in May, with a flight reduction introduced by NOTAM. • Runway/taxiway maintenance at Amsterdam/Schiphol and Brussels airports generated delays. • En-route ATC capacity delays at Maastricht, Zagreb, Brest and Reims; en-route ATC staffing delays at Nicosia and Zagreb ACCs. • Seasonal weather impacted operations at Karlsruhe, Zagreb, London and Reims ACCs. • Technical issues at Reims ACC (On-line Data Interchange (OLDI)/radio problems) and Lisbon ACC (frequency problems). • Delays at Brest and Bordeaux ACCs due to system improvements (ERATO training for system upgrade).
July	• Recurrent capacity problems at Istanbul/Sabiha Gökcen and Istanbul/Ataturk airports which accounted for 12.8% of the total ATFM delays in July. • High traffic growth and capacity/staffing problems resulted in significant ATFM delays in Greece and Cyprus. • En-route ATC capacity/staffing delays at Brest, Zagreb, Reims, Barcelona and Maastricht. • Seasonal weather impacted operations at Maastricht, Karlsruhe, Vienna, Reims and Zagreb ACCs as well as Zurich, London/Heathrow, Amsterdam/Schiphol and Frankfurt/Main airports. • Industrial actions in Spain generated some delays in Barcelona and Canarias ACCs.

2015	EVENT (Source: Network Operations Reports, monthly overview [Ref. 2])
	• Industrial action in Bucharest ACC on 15 July generated delays; Belgrade ACC applied protective measures.
August	• ATFM restrictions on point ODERO in Ankara ACC resulted in 65,000 minutes of delay; the restrictions were relaxed towards end of August. • Several technical issues impacted ATC operations, notably FDPS problems in Bucharest ACC (15,000 minutes of ATFM delay). • ATC industrial action in Athens and Makedonia ACCs on 5 August resulted in en-route ATFM delays, with additional delay generated during the recovery phase. • Thunderstorms and/or turbulence impacted flight operations in Maastricht, Karlsruhe, Barcelona, Zagreb and London ACCs, and Palma de Mallorca, London/Heathrow and London/Gatwick airports.
September	• Seasonal weather impacted flight operations in Barcelona, Paris, Maastricht, London, Langen and Karlsruhe ACCs; both Istanbul airports and Zurich, Amsterdam, Palma de Mallorca and Rome/Fiumicino airports. • System implementation projects generated delays notably TOPSKY system upgrade in Nicosia ACC (14,268 min of delay), Brest software upgrade (17,259 min of delays). • ATC industrial action in Spain on 26 September had some impact on the network: 3,311 min of delay for Barcelona and 875 min of delay for Seville ACCs. • Prague airport fully implemented A-CDM on 2 September.
October	• French ATC industrial action on 8 October resulted in approximately 66,800 minutes of ATFM delay with approximately 16,000 minutes of ATFM delay in Madrid, Maastricht and Karlsruhe ACCs due to ATFM protective measures. • Low visibility, fog and thunderstorms at Amsterdam/Schiphol airport; thunderstorms, heavy rain and low visibility at both Istanbul airports; turbulence at Maastricht ACC and thunderstorms at Lisbon ACC. • Some technical issues impacting operations, notably in Scottish airspace (frequency) and Istanbul/Sabiha Gökçen airport (communications and frequency issues). • A-CDM implementation at Barcelona airport on 20 October.
November	• ATC industrial action in Reims ACC between 23 and 27 November generated 65,000 minutes of ATFM delay and requiring protective measures at Maastricht and Karlsruhe ACCs (5,500 minutes). • Training for ATM system improvements impacted operations at Brest and Langen ACCs, and Vienna airport. • Northern European Free Route Airspace (NEFRA) implementation generated some en-route ATFM delays in Tampere ACC.
December	• Implementation of ERATO system in Brest ACC extended throughout the entire month of December generated 480,639 minutes of ATFM delay with additional delays generated in Madrid, Paris, Seville and, to a lesser extent, Canarias ACCs; • Technical issues impacted operations in Brussels (computer problems on 18 December) ACC, Geneva airport (OLDI failure in conjunction with fog) on 19 December, and Langen ACC (frequency and telephone problems, also impacting Frankfurt/Main airport) on 21 December.

1.4 Structure of the report

PRR 2015 consists of two parts:

Part I: High-level Overview

Chapter 1	is the general Introduction to PRR 2015.
Chapter 2	gives a consolidated high-level view of ANS performance in the wider context of European General Air Traffic operating under Instrument Flight Rules (IFR) in Europe. It addresses four Key Performance Areas (KPA) namely: Safety, Capacity (ATFM Delays) Environment (Flight Efficiency) and Cost-efficiency (ANS costs). Chapter 2 also provides an overall economic evaluation of ANS performance.

Part II: Detailed analysis by KPA

Chapter 3	reviews Safety ANS performance
Chapter 4	reviews operational en-route ANS performance.
Chapter 5	reviews the Operational ANS Performance of the top 30 airports in terms of IFR movements in 2015, as they have the strongest impact on network-wide performance.
Chapter 6	analyses ANS cost-efficiency performance in 2014 (which is the latest year for which actual financial data are available) and provides a performance outlook, where possible.

1.5 Consultation with stakeholders on PRR 2015

As in previous years, stakeholders were given an opportunity to comment on PRR 2015 before it was finalised. The PRC sent the draft final Report to stakeholders, and posted it on the EUROCONTROL internet site, for consultation and comment from 04 - 25 March 2016. In addition, the PRC contacted individual stakeholders to clarify specific aspects of the report, where required.

The PRC reviewed and replied to every comment received, and amended the PRR 2015 where warranted.

1.6 Implementation status of PRC recommendations

The PRC tracks the follow-up of the implementation of its recommendations, in accordance with Article 10.7 of its Terms of Reference [Ref. 1].

The EUROCONTROL States, at the 43rd Session of the Provisional Council, (May 2015) accepted, unamended, all of the PRC's recommendations contained in PRR 2014 [Ref. 3].

#	PC Decision on PRC recommendations in PRR 2014	Status
R-1	The Provisional Council requested the Director General to investigate the factors contributing to the high number of poorly coded, unclassified and undetermined safety occurrences and to propose lines of action to PC 44 (December 2015) on how to improve the situation.	The PRC was pleased to note that the requested investigation has been carried out and that further steps and actions have been taken by the Agency to mitigate the occurrence reporting issue.
R-2a	The Provisional Council requested Member States to task their ANSPs to develop and implement capacity plans which are, at a minimum, in line with the Reference Capacity Profile (from the NOP); and to ensure that capacity is made available during peak demand.	The PRC notes that there are still capacity plans which are not in line with the Reference Capacity Profile (from the NOP) and will continue to closely monitor the situation.
R-2b	The Provisional Council asked the Director General to report on those States that have insufficient capacity plans compared to the Reference Capacity Profile to PC 44 (Dec. 2015).	The PRC welcomes the efforts that have been taken by the Agency and the Network Manager, but observes that capacity performance deteriorated again in 2015.

R-3a	The Provisional Council requested the PRC, in accordance with Article 10h of the PRC's Terms of Reference, to review arrangements for civil military coordination and cooperation in the Member States by the end of 2015.	The PRC developed an online questionnaire and invited all EUROCONTROL Members States (41 States) to provide the necessary information on civil military coordination and cooperation. The initial results are reported in Chapter 4 of this report.
R-3b	The Provisional Council requested the civil and military authorities in the Member States to assist the PRC to conduct this review.	Of the 41 Member States, 38 States are considered to have Airspace Management (ASM) components. Overall, 31 of the 38 States (82%) completed the questionnaire:
R-3c	The Provisional Council invited the PRC to report to PC 44 (December 2015).	The PRC reported accordingly to PC 44 in December 2015.

Figure 1-2: Implementation status of PRC recommendations in PRR 2014

1.7 Performance Benchmarking with major non-EUROCONTROL States

The PRC is working with China, Brazil, and Singapore to apply the existing Predictability, Efficiency and Capacity indicators for ANS performance benchmarking purposes, using only publicly-available data. The PRC's purpose is twofold:

(i) To improve airlines' operational efficiency when using these airspaces. Reduced fuel burn and flight time will give environmental benefits and cost-savings. Beneficiaries will include those European airlines using these airspaces.

(ii) To gain global benchmarking experience in order to support ICAO in establishing common principles and related guidance material for ANS performance benchmarking. The draft Global Air Navigation Capacity & Efficiency Plan (GANP) 2016 will include initial guidance from ICAO on a performance-based approach at global level [Ref. 4, 5].

1.8 PRC as Performance Review Body of the Single European Sky

Since 2010, EUROCONTROL through its PRC supported by the PRU has been designated by the European Commission as the Performance Review Body (PRB) of the Single European Sky (SES). The PRB Chairman is appointed separately and is not a member of the PRC. The PRB advises and assists the European Commission in the implementation of the SES performance scheme.

In September 2014, the European Commission extended [Ref. 6] the designation of the PRC supported by the PRU as the Performance Review Body (PRB) of the Single European Sky (SES) until 31 December 2016.

The PRC uses shared procedures, tools and data for the SES performance scheme and for the EUROCONTROL performance review system. These synergies avoid overlaps between the two systems and help to ensure consistency. The PRC's goal is to contribute to the improvement of the performance of Pan-European air navigation services, in the interests of all stakeholders.

The first reference period (RP1) ran for three years from 2012 to 2014. 2015 is the first year of the second reference period (RP2) which runs from 2015-2019.

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2 ANS in European Air Transport

KEY POINTS

- In 2015, IFR flights increased on average by +1.5% in Europe compared to 2014 which is in line with the STATFOR baseline scenario for 2015.
- As in previous years, en-route service units used for route charging purposes showed a stronger growth than controlled flights in 2015 (+4.2%) due to a continuous growth of flight distance and average aircraft size.
- After the best year on record in 2013, arrival punctuality in Europe decreased for the second year in a row to 82.1% in 2015. The further increase in en-route ATFM delays contributed to the lower punctuality levels in 2015.
- Based on the latest available cost projections for 2015, estimated total economic ANS-related costs are estimated to increase by +4.8% compared to 2014 (Single European Sky area). The increase is negatively affected by a deterioration in all areas of operational performance in 2015.

KEY DATA 2015

Traffic demand & Punctuality	2015	change vs. 2014
IFR flights controlled (ESRA08[2])	9.75M	+1.5% ↑
Flight hours controlled (ESRA08)	14.8M	+1.7% ↑
En-route Service Units (CRCO[3])	137.7M	+4.2% ↑
Arrival punctuality (*% of flights arriving within 15 min. after their schedule*)	82.1%	-1.6%pt. ↓
Economic evaluation (M€ 2009) - (SES area)		
Projected total ANS costs (en-route + terminal)	7,435	+1.7% ↑
Estimated cost of inefficiencies in the gate-to-gate phase[4]	1,860	+9.2% ↑
Estimated cost of en-route and airport ATFM delay	1,005	+23.0% ↑
Total estimated ANS-related economic costs (M € 2009)	10,300	+4.8% ↑

2.1 Introduction

This chapter puts Air Navigation Services (ANS) performance in the wider context of European air transport to provide background information on overall trends and to set the scene for the more detailed chapters on Safety (Chapter 3), Operational ANS performance (Chapters 4,5) and ANS cost efficiency (Chapter 6) in the second part of the report.

With 9.75 million controlled flights and an estimated more than 800 million passengers per year, the European air transport sector is a major driver of direct and indirect economic growth. The industry is estimated to directly generate 2.6 million jobs, of which some 2.5% are employed within the Air Navigation Services (ANS) sector [Ref. 7].

The first section of this chapter provides an overview of Pan European air traffic trends and characteristics with relevance for ANS performance review, followed by an overview of ANS-related accidents and incidents in the EUROCONTROL area.

The third part of the chapter addresses operational ANS performance. In order to provide an estimate of the ANS-related contribution towards operational performance in Europe, the chapter reviews operational performance from three different perspectives: (1) Airspace user perspective (punctuality), (2) Societal/environmental perspective (emissions & noise), and (3) the ANS provider perspective (efficiency of operations).

The last part of the chapter provides a synopsis of key findings from the more detailed analyses of ANS performance in Chapters 3-6 to establish an overall picture of ANS performance and to provide a high level economic evaluation of ANS performance.

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2 EUROCONTROL Statistical Reference Area 2008 (ESRA08) (see Glossary).

3 CRCO Total Regional Area.

4 Inefficiencies are measured with respect to reference values, which, in view of necessary (safety) or desired (capacity) limitations, are not achievable at system level. Hence, the inefficiencies cannot be reduced to zero.

2.2 European Air Traffic Demand

This section describes trends in Pan-European air traffic demand including air traffic growth, geographical distribution, variability, and complexity.

2.2.1 European air traffic key indices

Figure 2-1 shows the principal air traffic measures for 2015 in the ESRA08 area (STATFOR). The total number of flights increased on average by +1.5% in Europe compared to 2014 which is in line with the STATFOR baseline scenario of +1.5% for 2015.

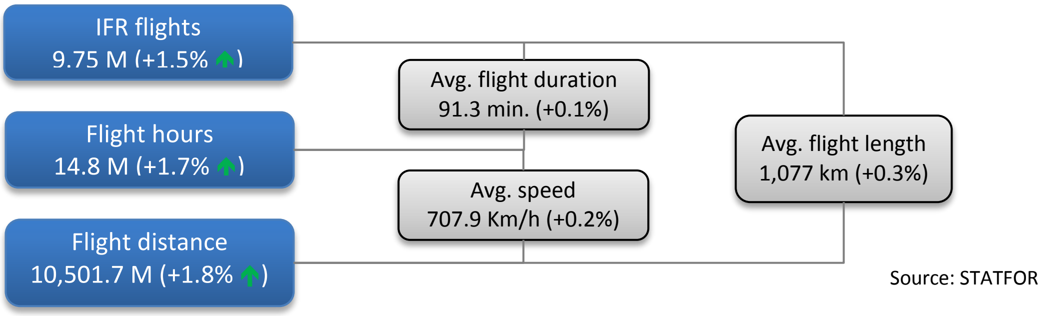

Figure 2-1: European air traffic indices (2015)

Total flight distance within the ESRA08 area (+1.8% vs.2014) and flight hours (+1.7% vs.2014) increased at a slightly higher rate due to longer flights. For statistical purposes, an average flight in European airspace in 2015 flew 1,077 km at a speed of 708 km per hour and a flight time of 91.3 minutes.

Figure 2-2 shows the evolution of European air traffic indices[5] between 2006 and 2015. The positive trend observed in 2014 also continued in 2015 and all high level indicators showed a growth in 2015.

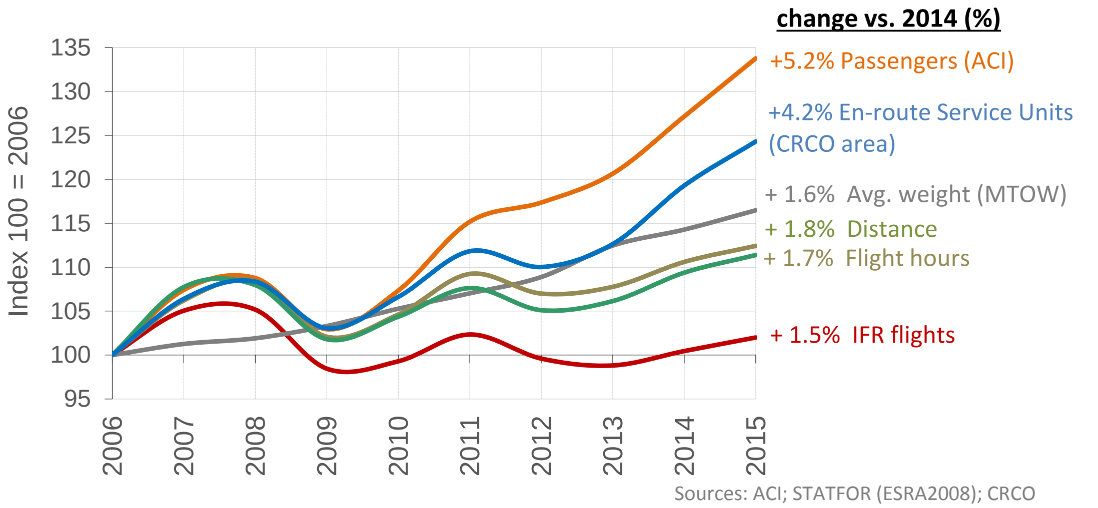

Figure 2-2: European air traffic indices (2006-2015)

The analysis shows a continuous growth of flight distance, aircraft size (maximum take-off weight) and passengers over time. Despite the increase in the past two years, the number of controlled flights in 2015 remained below the level of 2008.

As in previous years, passenger numbers increased at a higher rate than flights (+5.2% vs. 2014).

En-route service units (SU) are used for ANS charging purposes and also as a measure of output for the review of ANS cost efficiency (see Chapter 6). They are determined by the multiplication of the Aircraft Weight Factor (based on maximum take-off weight) and the Distance Factor (distance in

5 Please note that the individual indices can refer to slightly different geographical reference areas.

chargeable airspace) which explains the higher growth (+4.2% vs. 2014) in 2015 compared to the increase in the number of flights (+1.5% vs 2014).

2.2.2 European air traffic growth in focus

This section analyses the evolution of controlled flights in Europe from different angles. It illustrates changes by market segment, aircraft category, and vertical and geographical distribution in 2015.

Traffic by market segment

Figure 2-3 shows a breakdown of flights by market segment in 2015, as classified by EUROCONTROL's Statistics and Forecast Service (STATFOR), and the change versus 2014 and 2005.

Traffic by market segments	2015 flights (M)	2015 % share	% change versus 2014	% change versus 2005
Traditional Scheduled	5.24	53.7%	1.0%	-11.1%
Low-Cost	2.73	28.0%	5.5%	120.7%
Charter	0.44	4.5%	-8.8%	-35.6%
Business Aviation	0.65	6.7%	-2.6%	1.9%
All cargo	0.33	3.4%	0.9%	-2.4%
Other (incl. military)	0.36	3.7%	3.1%	-10.9%
Total	9.75	100.0%	1.5%	6.0%

Figure 2-3: Evolution of IFR flights by market segment

Traditional scheduled traffic remained by far the largest segment (53.7%) in 2015, followed by low cost (28.0%) and business aviation (6.7%).

Over the past 10 years, low cost traffic more than doubled (+120.7% vs. 2005) whereas traditional scheduled traffic decreased by -11.1% during the same period. Although traditional scheduled traffic increased slightly in 2015 (+1.0%), the low cost segment continued its strong growth observed over the past years also in 2015 (+5.5% vs. 2014).

Traffic by aircraft category

Figure 2-4 shows a breakdown of the controlled flights by aircraft category and their requested flight levels in 2015 and the change versus 2014 and 2005.

Aircraft category	2015 flights (M)	2015 % share	% change vs. 2014	% change vs. 2005
Piston	0.2	2.1%	-2.7%	-14.8%
Turbo Prop (ATR, Dash8, etc.)	1.1	12.5%	1.9%	-23.0%
Regional Jet (BAE146, CRJ, ERJ, etc)	1.5	15.9%	-2.1%	-8.7%
Narrow body (A319,320,321, B737, etc)	5.2	56.4%	2.0%	24.3%
Wide & Heavy (A340, A380, B767, B747, etc)	1.0	11.0%	5.4%	22.2%
Helicopter	0.1	1.0%	-12.7%	-3.8%
Other	0.1	1.1%	1.7%	-23.6%

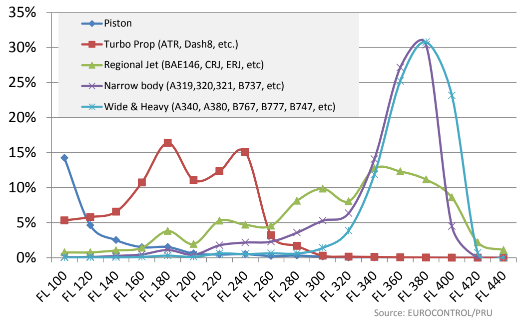

Figure 2-4: Aircraft categories and distribution of requested flight levels (2015)

Narrow body jets (A3X series, B737, etc.) represented the largest group and accounted for 56.4% of controlled flights in 2015 (+2.0% vs. 2014), followed by regional jets which - despite a 2.1% decrease in 2015 - accounted for 15.9% of total European traffic.

In line with the increase of average aircraft weight observed in Figure 2-2, wide and heavy jets increased by 5.4% compared to 2014 which corresponds to 11.0% of controlled flights in Europe. At the same time, the share of smaller aircraft decreased further in 2015.

The right side of Figure 2-4 shows that flight level requests for jet aircraft are principally in the upper airspace. Hence the growing number of jets is placing an increased demand on upper airspace over time.

Vertical distribution: Traffic by flight level

Figure 2-5 (left side) shows the distribution of flight hours by flight level in 2015. The main share of the controlled flight hours is in the upper airspace which is consistent with the observations in Figure 2-4.

Compared to 2010 (right side of Figure 2-5), the number of flight hours in the upper airspace has significantly increased while there has been a decrease in flight hours below flight level 330. This is consistent with the evolution of aircraft categories over time (see Figure 2-4).

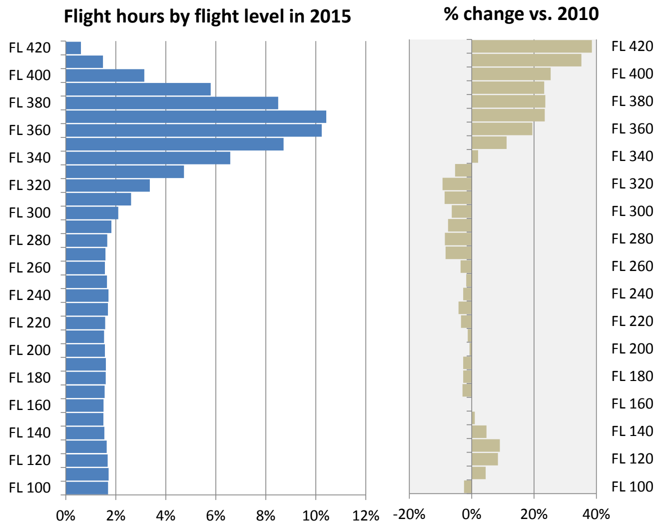

Figure 2-5: Distribution of flight hours by flight level

Geographical distribution: Traffic by State

Overall, traffic increased by +1.5% compared to 2014. Of the 38 States[6] included in the analysis, 32 States showed an increase in traffic compared to 6 States which showed a decline in 2015.

To provide an order of magnitude of the traffic volume, Figure 2-7 shows the number of average daily flights in 2015 by State at the bottom and the change compared to 2014 in absolute (blue bars) and relative (red dots) terms at the top. The figure is sorted according to the absolute change compared to the previous year. Information at ACC level can be found in Annex I on of this report.

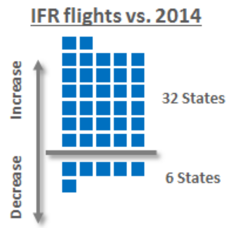

Figure 2-6: States with traffic growth

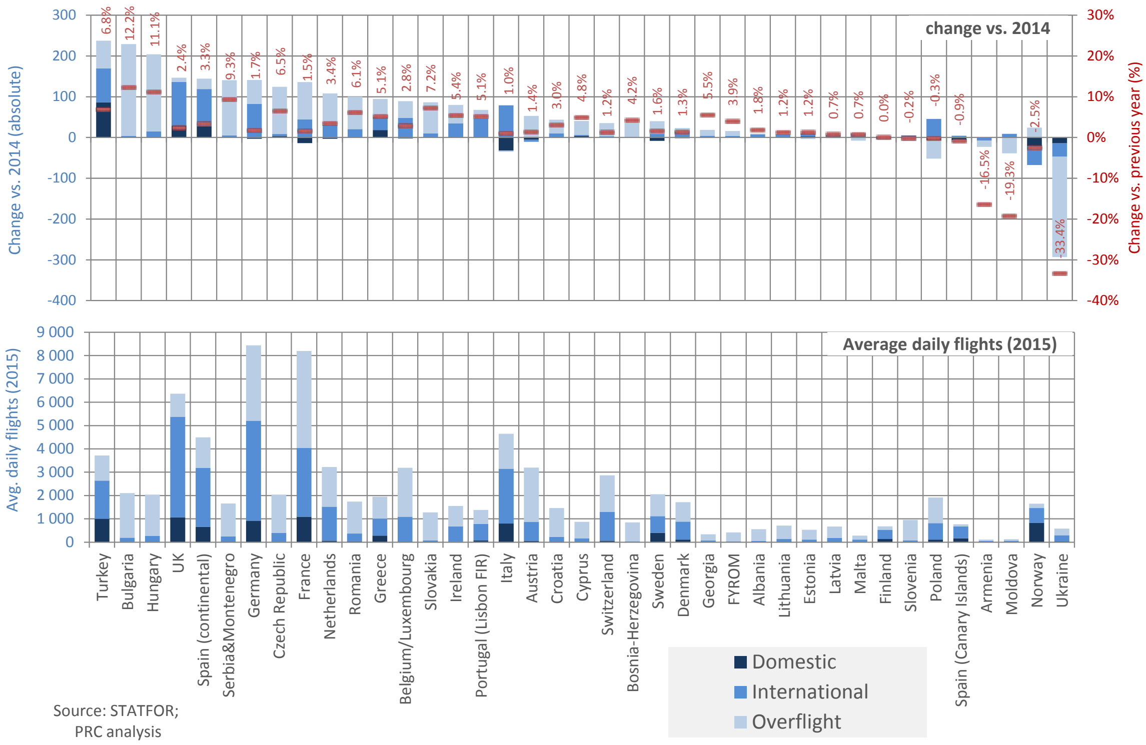

Figure 2-7: Traffic variation by State (2015/2014)

In absolute terms, Turkey, Bulgaria, Hungary, the UK and Spain (Continental) experienced the highest

6 Some States such as Belgium/Luxembourg and Serbia and Montenegro have been grouped in line with the charging areas. Oceanic areas are not shown in the figure.

year-on-year growth in 2015. The six largest States in terms of traffic volume (Germany, France, UK, Italy, Spain, and Turkey) all showed an increase in traffic in 2015.

Turkey continued its remarkable traffic growth (average annual growth rate of 7.0% over the past five years) and shows a substantial growth in all segments (domestic, international, overflights).

The growth observed in a number of central European States (Bulgaria, Hungary, Czech Republic, Romania, and Slovakia) was mainly related to overflows from traffic avoiding Ukrainian airspace. The shift in traffic patterns following the start of the Ukrainian crisis and the downing of MH17 in July 2014 led to a drastic reduction of traffic in Ukraine (-33.4%) and also Moldova (-19.3%) compared to 2014. Compared to 2013, traffic in Ukraine in 2015 declined by -56.9% (overflights decreased by -67%).

The sustained closure of Libyan airspace (as of August 2014) continued to have a notable impact on Greece with traffic flows between Europe and Africa shifting from Maltese airspace to Greek airspace.

Overflights in Germany in 2015 were to some extent affected by the increase in unit rate in January 2015 with some traffic on a limited number of city pairs shifting to adjacent States in order to avoid Germany or to minimise the distance flown inside Germany.

2.2.3 European air traffic outlook (2015-2022)

Figure 2-8 shows the evolution of European IFR flights since 1990 together with selected traffic forecasts[7]. In response to the economic crisis which started in 2008, forecasts have been continuously revised downwards and, although the third quarter 2015 was the busiest on record, traffic is only expected to reach pre-economic crisis levels (2008) by 2017.

IFR flights increased for the second time in a row in 2015 (+1.5% vs 2014). The observed growth is in line with the baseline forecast scenario (+1.5%) predicted for the ESRA08 area in the STATFOR 7-year forecast - Feb. 2015 [Ref. 8]. Despite the stagnation over the past years, air traffic demand in Europe is expected to reach 14.4 million flights by 2035 which is almost 50% more than in 2014 [Ref. 9].

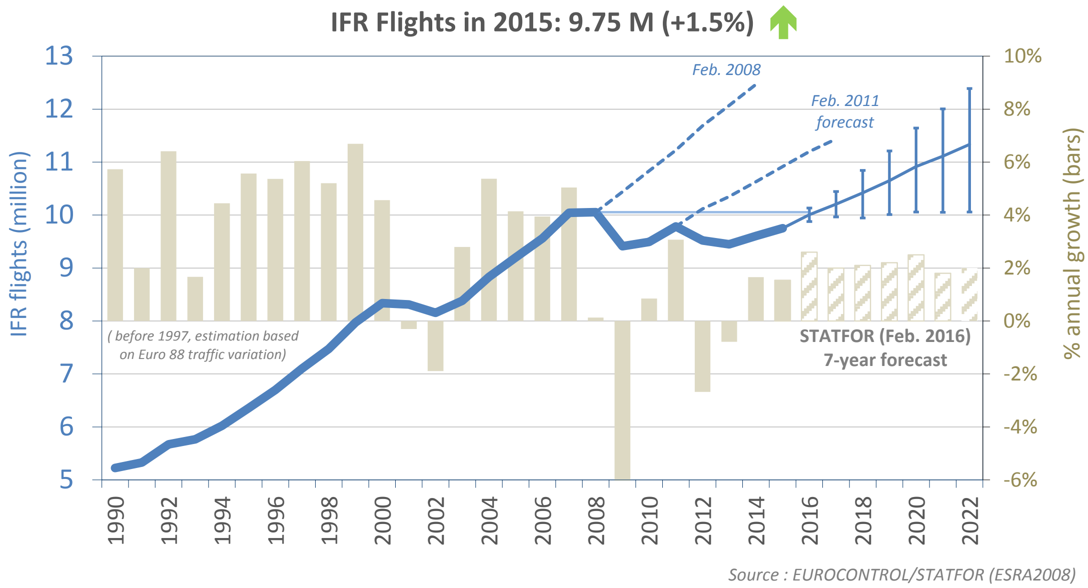

Figure 2-8: Evolution of European IFR flights (1990-2022)

For 2016, the (Feb. 2016) STATFOR 7-year forecast [Ref. 10] predicts European flights to grow by 2.4% under the baseline scenario (Low: 1.0%; High 3.8%). The average annual growth rate (AAGR) between 2015 and 2022 is forecast to be at 2.2% (Low: 0.7%; High 3.8%).

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7 STATFOR 2008 forecast (before the economic crisis), STATFOR 2011 forecast (before the start of the SES performance scheme), and the latest available STATFOR Feb. 2016 forecast.

Figure 2-9 shows an outlook of the forecast traffic growth over the next seven years by State according to the (Feb. 2016) STATFOR baseline scenario. The bars show the estimated number of additional daily flights in 2022 and the dots indicate the annual average growth rate between 2015 and 2022.

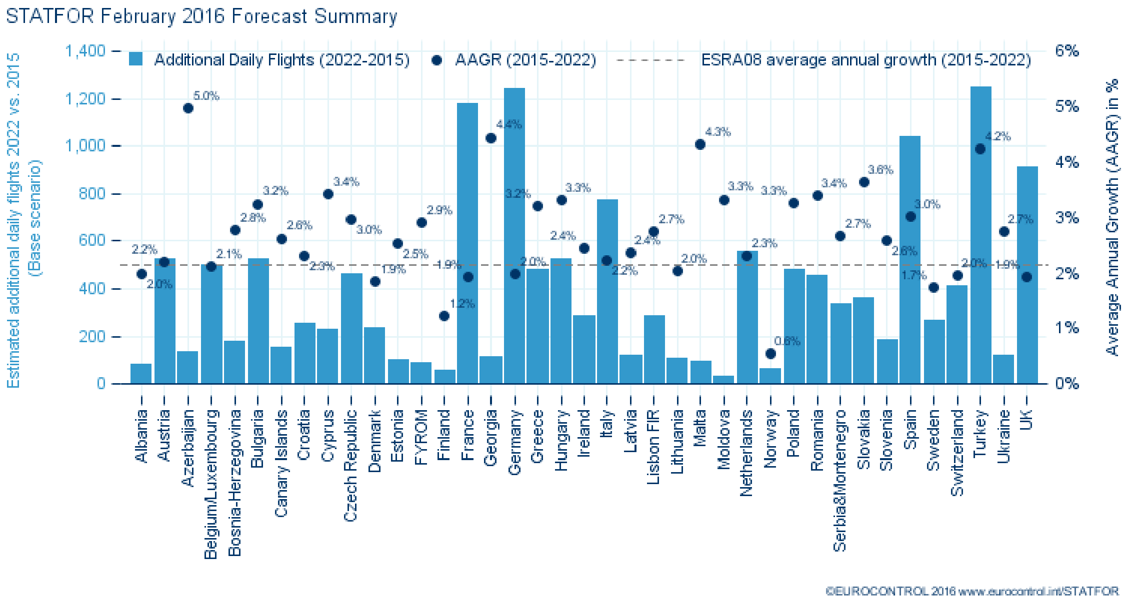

Figure 2-9: Forecast traffic growth 2015-2022

As in previous years, the highest growth rates are expected in Central and Eastern Europe with Turkey being the main driver of growth.

2.2.4 European air traffic characteristics

Traffic variability

Traffic variability is a factor that needs to be taken into account in ANS performance review. If traffic is highly variable and there is limited flexibility to adjust capacity provision according to demand, resources may be underutilised, or made available when there is little demand. Hence, variability in traffic demand is therefore likely to have an impact on productivity, cost-efficiency, service quality and predictability of operations.

Variability can be broadly characterised as temporal (seasonal, daily, hourly) and spatial variability (location of traffic within a given airspace). The various types require different measures related to the ability to adjust capacity in order to ensure high efficiency levels.

To a large extent, variability can be statistically predictable, and therefore adequate measures to mitigate the impact of variability could, in principle, be planned (for example, overtime, flexibility in breaks, and flexibility to extend/reduce shift length). It is acknowledged that there are however limits to the flexibility to adjust to traffic variations at short notice.

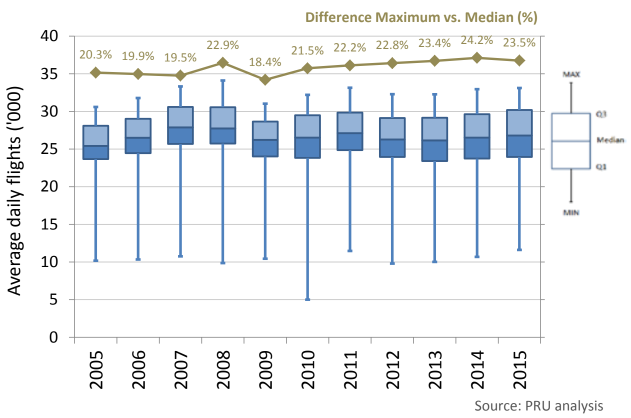

Figure 2-10: Evolution of daily traffic levels in Europe

Figure 2-10 compares the peak day to the average daily number of flights in Europe. The peak day in 2015 was on 28th August 2015 with a total of 33,107 flights. The traffic on the peak day was 23.5% higher than on an average day.

It is interesting to note that the traffic peaks got more pronounced between 2010 and 2014 (difference between maximum and median) despite the overall traffic decline between 2011 and 2013. In 2015, the ratio reduced again, bringing the peak day again closer to the average day.

Figure 2-11 shows the level of daily traffic variation by state in 2015. The top figure shows the daily minimum, maximum and the quartiles to give a first indication of the degree of dispersion. The bottom of Figure 2-11 provides an indication of seasonality by comparing the peak week to the average week.

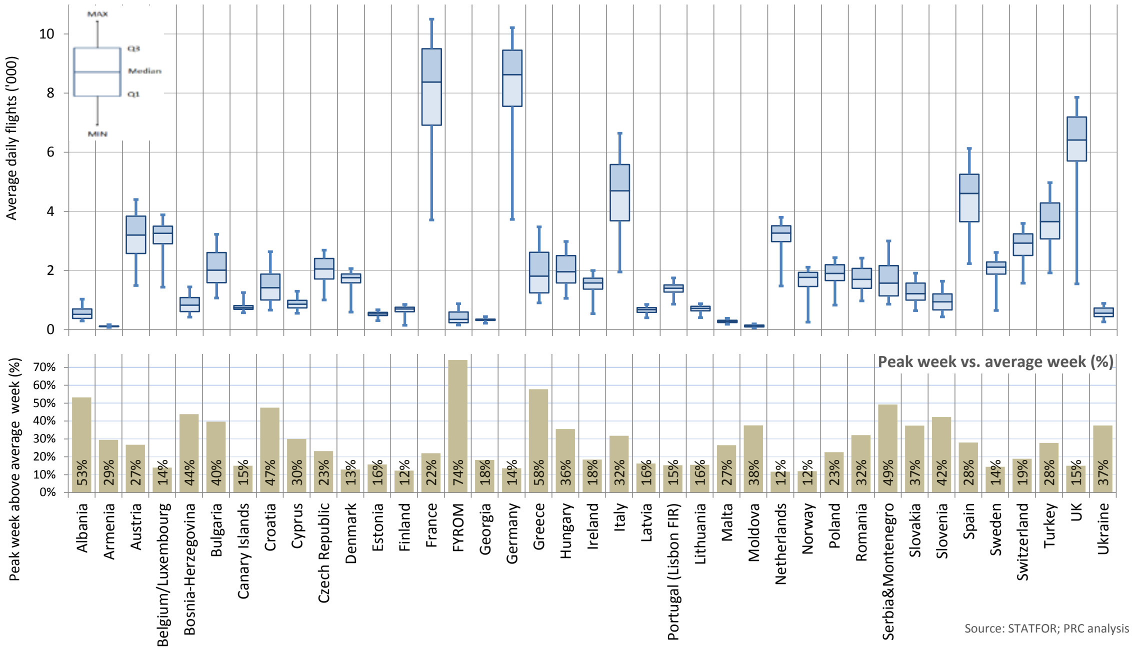

Figure 2-11: Daily traffic levels by Member States (2015)

For instance, daily traffic levels in Greece in 2015 varied between 909 (MIN) and 3,479 (MAX) flights with an average of 1,952 flights per day (top of Figure 2-11). In the peak week (bottom of Figure 2-11), the number of flights in Greece was 58% higher than in an average week which indicates a high level of variability throughout the year.

Overall, traffic variability is higher in South East Europe than in the core area due to the large impact of holiday traffic in the summer.

Traffic complexity

Traffic complexity is generally regarded as a factor to be considered when analysing ANS performance.

In 2005, a composite measure of "traffic complexity" combining traffic density (concentration of traffic in space and time) and the intensity of potential interactions between traffic (structural complexity) was developed together with interested stakeholders (see grey box).

Structural complexity and adjusted density are independent. Traffic in an area can be dense, but structurally simple; equally, traffic can be structurally complex but sparse.

Traffic complexity

The complexity score in this report is a composite measure which combines a measure of traffic density (concentration of traffic in space and time) with structural complexity (structure of traffic flows) [Ref. 11].

The structural complexity is based on the number of potential horizontal, vertical or speed interactions between aircraft in a given volume of airspace (20x20 nautical miles and 3,000 feet in height).

For example, a complexity score of 8 corresponds to an average of 8 minutes of potential interactions with other aircraft per flight hour in the respective airspace.

More information and data on complexity is available online at www.ansperformance.eu.

The relationship between "traffic complexity" and ATM performance in general, is not straightforward. High density can lead to a better utilisation of resources but a high structural complexity entails higher ATCO workload and potentially less traffic.

Figure 2-12 shows the evolution of complexity in Europe between 2008 and 2015. The monthly trend line (brown) shows a seasonal pattern with the highest level of complexity in summer.

As the indicator is influenced by traffic density, the increase in flights since 2013 is also visible in terms of complexity.

In 2015, complexity at European system level increased further to reach 6.74 minutes of interactions per flight hour.

Figure 2-13 shows complexity by flight level[8] in 2015. Horizontal, vertical and speed interactions tend to decrease with altitude until FL 300.

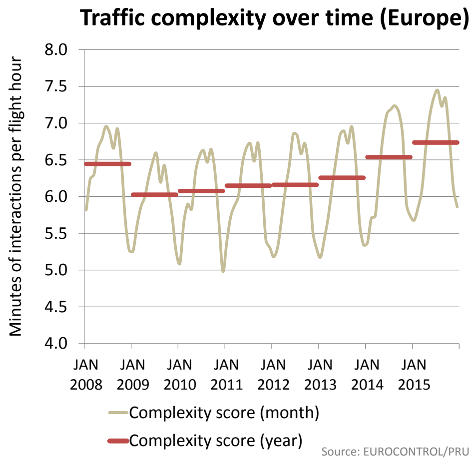

Figure 2-12: Complexity over time (Europe)

Above this level, horizontal interactions increase again which reflects the fact that flights are cruising with few vertical or horizontal interactions.

As can be seen in Figure 2-5, the main share of the flight hours is in the upper airspace but it is more dispersed whereas in the lower levels there are less flight hours but concentrated around airports, which explains the higher level of structural interactions per flight hour.

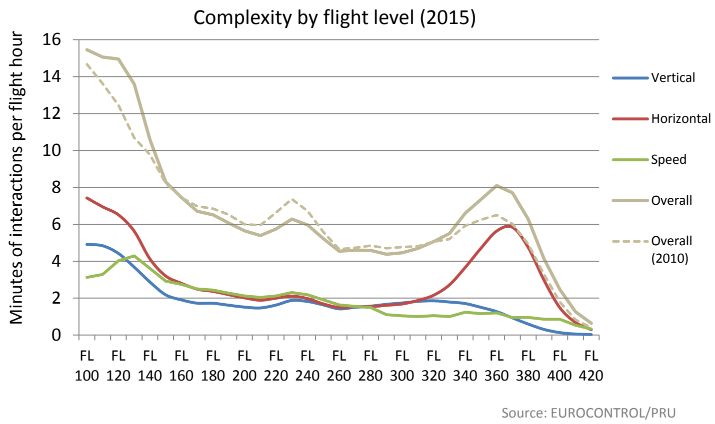

Figure 2-13: Complexity by flight level (2015)

At local level[9] the picture is more contrasted and the complexity scores differ significantly. Figure 2-14 shows horizontal, vertical and speed interactions per flight hour by ANSP in Europe. A more detailed description of the methodology and a table with the data is provided in Annex II.

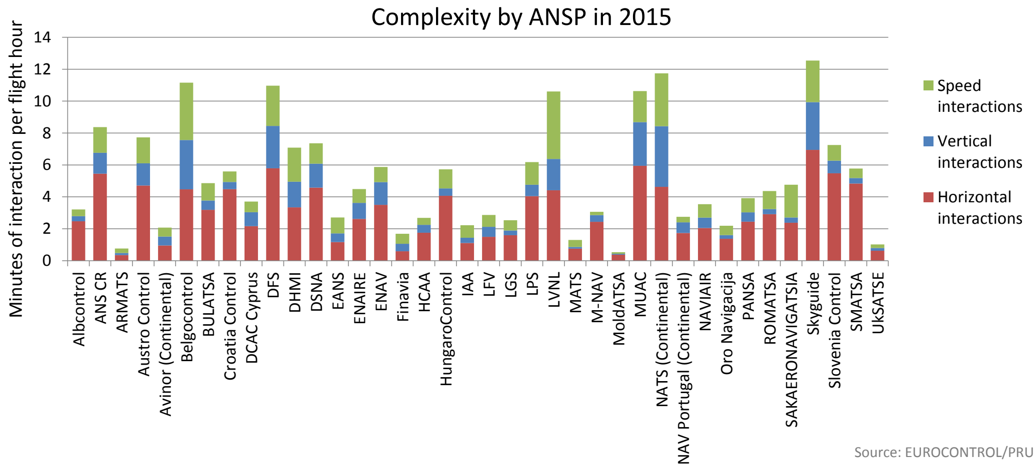

Figure 2-14: Complexity ANSP level (2015)

8 Flight levels are allocated to the centre level of the complexity cells (see also grey box) so that the complexity in layer FL95 - FL125 is allocated to FL110.

9 The complexity score represents an annual average. In areas with a high level of seasonal variability the complexity score may be higher during peak months.

2.3 Safety

Despite several high profile accidents, the year 2015 turned out to be a very safe year for commercial aviation worldwide. For 2015, the Aviation Safety Network recorded a total of 16 fatal airliner accidents with 560 fatalities making 2015 the safest year ever by number of fatal accidents and the 5th safest year ever in terms of fatalities [Ref. 12].

Safety is clearly the primary objective of ANS. However, not all accidents can be prevented by ANS (technical failure, etc.) and there are a number of accidents without ANS involvement.

Figure 2-15 shows the total commercial air transport (CAT) accidents[10] between 2006 and 2015 (grey bars) including those accidents with ANS contribution[11] (blue bars) for the **EUROCONTROL area**.

The positive trend observed in the EUROCONTROL area since 2007 continued in 2015 and the number of total CAT accidents decreased to the third lowest level over the past 10 years.

As can be seen in Figure 2-15, accidents with ANS contribution (blue bars) are generally rare compared to total CAT accidents.

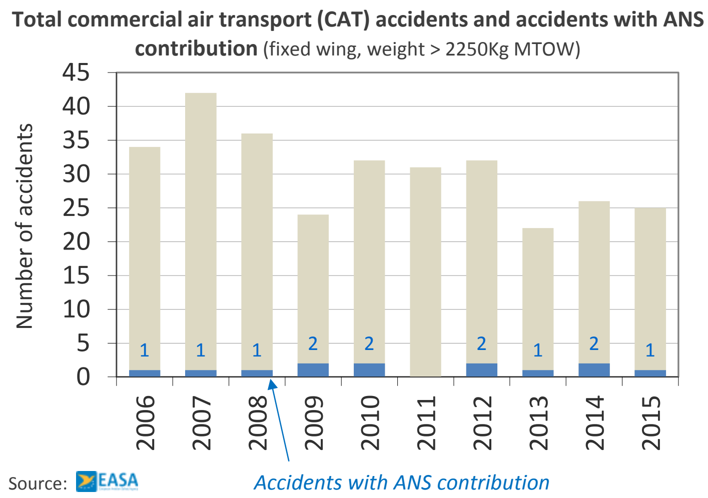

Figure 2-15: Accidents in EUROCONTROL area with ANS contribution (2006-15)

Figure 2-16 shows the total serious incidents between 2006 and 2015 (grey bars), including those with ANS contribution (blue bars) in the EUROCONTROL area.

The trend is largely similar to the trend observed for CAT accidents showing a continuous reduction of the serious incidents over the past years.

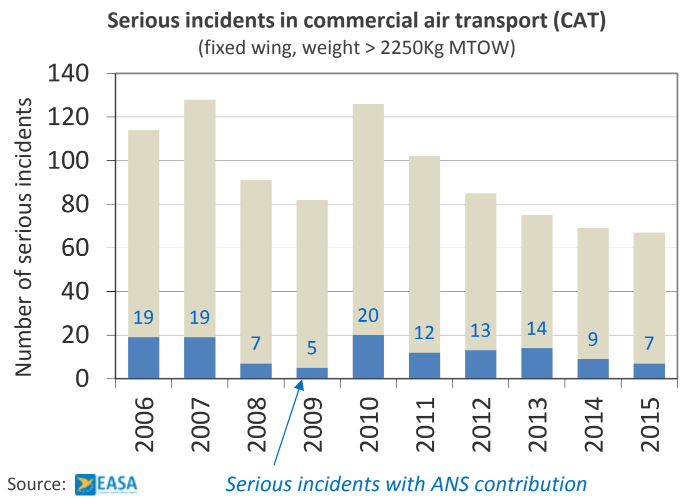

Figure 2-16: Serious Incidents in EUROCONTROL area with ANS contribution (2006-15)

While overall the picture is positive, in view of the rare occurrence of accidents with ANS contribution, a meaningful review of ANS safety performance requires a more in-depth analysis of ANS-related incidents and of the effectiveness of the ANS system in place to prevent accidents and incidents in the future.

This is provided in Chapter 3 of this report.

[10] Commercial Air Transport is defined by ICAO as "aircraft operations involving the transport of passengers, cargo or mail for remuneration or hire".

[11] Accidents with ANS contribution means that at least one ANS factor was in the causal chain of events leading to the occurrence encountered by the aircraft.

2.4 Operational performance in air transport

This section presents a synthesis of operational air transport performance in order to provide an estimate of the ANS-related[12] contribution towards service quality in Europe. Operational performance in air transport relates to more than one of the eleven ICAO key performance areas.

As shown in Figure 2-17, the relevant performance indicators are generally attributed to the KPAs "Efficiency", "Predictability", "Environment", and "Capacity" or simply summarised under "Service Quality".

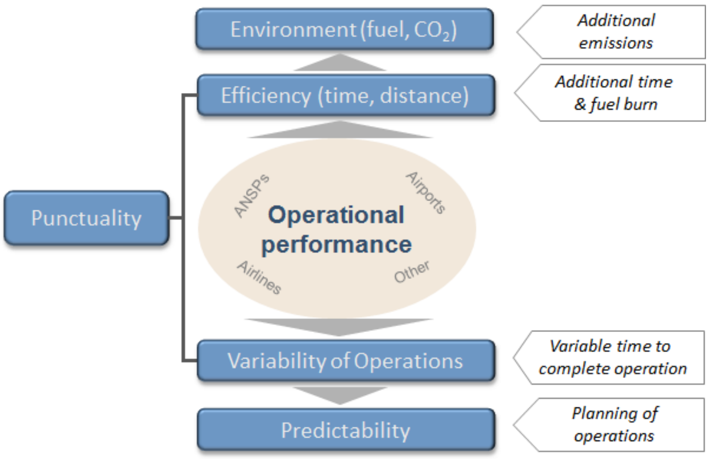

Figure 2-17: Operational performance in air transport

Operational efficiency is usually measured in terms of time or distance which can be converted into fuel burn and/or emissions and associated costs.

It can be influenced by and is therefore the result of complex interactions between airlines, airport operators and ANS, from the planning and scheduling phases up to the day of operation.

While ANS may not always be the root cause for an imbalance between capacity and demand (which may also be caused by other stakeholders, weather, military training and operations, noise and environmental constraints, etc.), depending on the way traffic is managed and distributed along the various phases of flight (airborne vs. ground), ANS impacts differently on airspace users (time, fuel burn, costs), the utilisation of capacity (en route and airport), and the environment (emissions).

This chapter reviews the ANS contribution towards operational performance in air transport from three different perspectives: (1) Airspace user perspective (punctuality), (2) Societal/environmental perspective (emissions & noise), and (3) the ANS provider perspective (efficiency of operations).

2.4.1 Air transport punctuality (airspace user perspective)

From an operational perspective, "time" is arguably the most important dimension connecting all the individual players operating within the air transport network.

Although it is the "common language" for operational planning and the execution of those plans, the definition of "time" can vary by stakeholder.

From an airline and passenger point of view, flights arriving/ departing within 15 minutes after the scheduled arrival/ departure time are generally considered punctual.

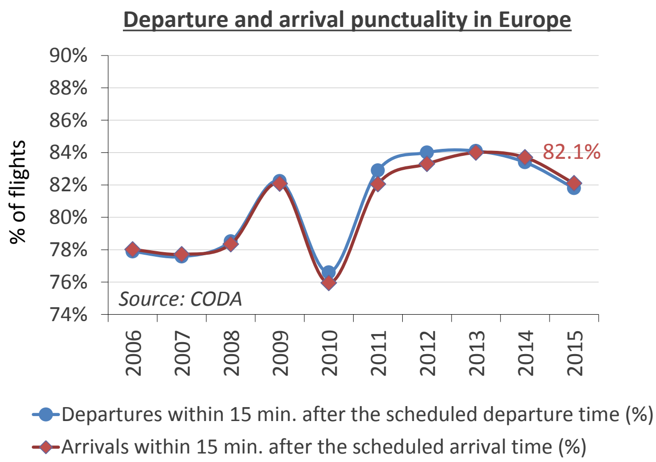

Figure 2-18: European On time performance (2006-15)

Figure 2-18 shows arrival and departure punctuality in Europe between 2006 and 2015. Arrival punctuality (red line) continues the negative trend observed in 2014 and

[12] In this report, "ANS-related" or "ANS-actionable" means that ANS has a significant influence on the operations.

decreased further to 82.1% in 2015. It is clearly driven by departure punctuality (blue line) with only comparatively small changes once the aircraft has left the departure stand.

To better understand the drivers of departure delays[13] and the contribution of ANS towards operational performance, Figure 2-19 provides a causal breakdown of the delays reported by airlines. Average departure delay in Europe increased for the second year in a row to reach 10.4 minutes per departure in 2015.

Although there has been an increase in ANS-related delays in 2015, around three quarters of the primary delays in Europe are not related to ANS[14]. Hence, the improvement of overall air transport performance in Europe clearly requires a joint effort of all involved stakeholders.

A thorough analysis of non-ANS related delay causes is beyond the scope of this report. A more detailed analysis of departure delays reported by airlines is available from the Central Office for Delay Analysis (CODA) [15].

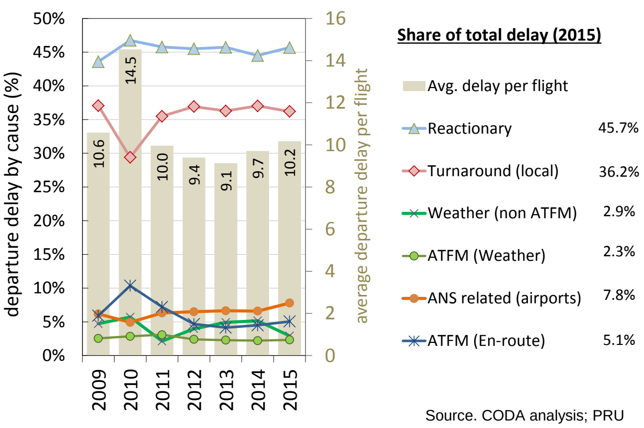

Figure 2-19: Departure delays by cause (2009-2015)

All causes departure delays

Departure delays in this report are measured compared to airline schedule. They are experienced at the stand before the aircraft departs and reported by airlines to CODA according to a set of delay codes defined by IATA. For a better focus on the ANS-related delays the IATA delay codes were grouped:

- En-route ATFM (IATA codes 81,82);
- ANS-related airport delays (Code 83,89);
- ATFM due to weather (Code 73, 84);
- Weather non ATFM such as snow removal or de-icing (Codes 71,72,76,76,77);
- Reactionary delays (Codes 91-96); and,
- Local turnaround delays: Primary delays caused by non-ANS related stakeholders (all other Codes).

Reactionary delay (top of Figure 2-19), caused by delay which could not be absorbed on subsequent flight legs accounted for 45.7% of all reported delays in 2015. Figure 2-20 shows the sensitivity[16] of the air transport network to primary delays (i.e. not limited to ANS). In line with previous observations, the ratio increased further in 2015 (0.80 in 2014 to 0.84 in 2015).

More research is needed to better quantify the ANS contribution towards reactionary delays (which is the largest single delay group) and to identify possible ANS strategies to mitigate the propagation effects in the network.

The more detailed evaluation of ANS-related delay durations in combination with the time of the day when the delay was imposed on flights could provide already some insights of ANS related network effects.

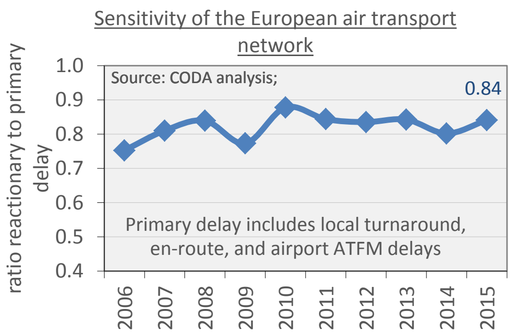

Figure 2-20: Sensitivity to primary delays

In view of the comparatively wide tolerance windows of 15 minutes - which provide a certain level of

[13] Departure delays can be further classified as primary delay (directly attributable) and "reactionary" delay (carried over from previous flight legs).

[14] Where ANS is either the root cause for the delay (i.e. ATC capacity, staffing, ATC equipment) or where an imbalance between capacity and demand (i.e. weather, etc.) was handled by ANS.

[15] The Central Office for Delay Analysis (CODA) publishes detailed monthly, quarterly, and annual reports on more delay categories (see http://www.eurocontrol.int/coda).

[16] Reactionary delay for each minute of primary delay.

flexibility - it is not surprising that the air transport network today operates at a comparatively high level of variability considering a statistical average flight time of 92 minutes within European airspace. In this context, it is important to note that, from an operational viewpoint, flights arriving/departing ahead of schedule may have a similar negative effect on the utilisation of resources as delayed flights.

A large number of factors including departure delays, weather conditions, congestion, and route availability drive operational variability. Figure 2-21 gives an indication of the level of variability[17] from the airspace users' point by phase of flight. Only intra-European flights were included to remove the impact of the jet stream on intercontinental flights which generally show a higher level of variability.

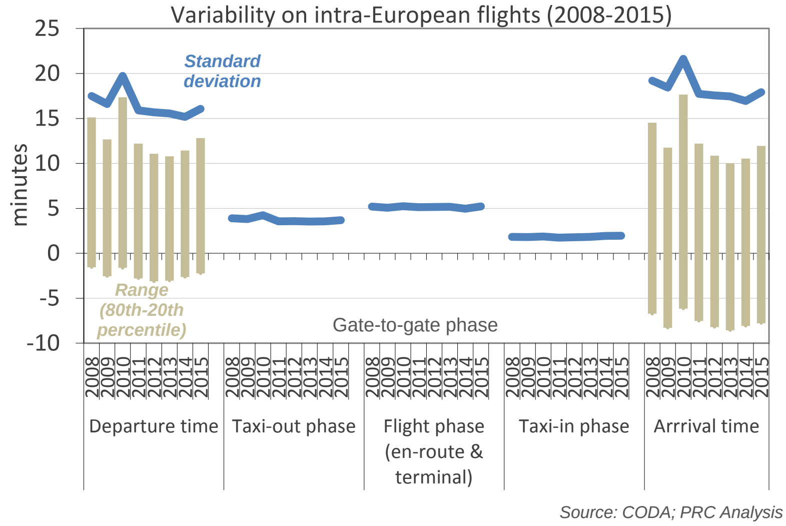

Figure 2-21: Variability of flight phases (2008-15)

The analysis confirms the findings from Figure 2-18 which showed that arrival times are mainly driven by variations encountered at the departure airport, with comparatively small variations in the gate-to-gate phase (taxi-out, en-route, and taxi-in).

Although the viewpoints and priorities can change by stakeholder, there is a clear interrelation between the variability and efficiency of operations and the ability to maximise the use of resources required to keep costs at a necessary minimum.

The variability of operations determines the level of predictability and has an impact on airline scheduling but also on the provision of ATC and airport capacity (i.e. TMA capacity, en-route capacity, gate availability, etc.).

The lower the predictability, the more difficult it is to match capacity to demand without inefficiencies in terms of delay (insufficient capacity) or cost (underutilisation of resources).

For instance, to achieve a satisfactory punctuality level, airlines frequently include time buffers in their schedules to account for a certain level of anticipated delay. Air Navigation Service Providers on the other hand may apply buffers to protect against the likelihood of over-deliveries or potential sector overloads if traffic cannot be predicted within a certain tolerance.

Due to its stochastic nature, a certain level of variability is considered to be normal or even required in aviation. More research to better understand the drivers of operational variability within the system (operational planning, different time definitions, tolerance windows, delay causes, etc.) could contribute to reducing system wide variability with associated positive effects for capacity utilisation.

2.4.2 Operational performance (Societal/Environmental perspective)

Sustainable development is an increasingly important political, economic and societal issue and the aviation industry has a responsibility to minimise its global and local environmental impact.

However, not all aspects of the environmental impact of aviation can be influenced by ANS. This section addresses the role of ANS in reducing aviation's environmental impact. The first part focuses on the local impact in terms of air quality and noise at and around airports. The second part

[17] In order to limit the impact from outliers, variability is measured as the difference between the 80th and the 20th percentile for each flight phase. Flights scheduled less than 20 times per month are excluded.

addresses the global impact and evaluates the ANS contribution towards minimising the impact of aviation on climate.

Reducing aviation's environmental impact at/around airports

Airports strive to balance the need to increase capacity in order to accommodate future air traffic growth with the need to limit negative effects on the population in the airport vicinity. Noise and local air quality (LAQ) are the most important factors from an environmental point of view.

Political decisions on environmental constraints can impact operations in terms of the number of movements, route design, runway configuration and usage and aircraft mix (engine types, etc.).

There can also be trade-offs between environmental restrictions when a different flight paths reduces noise exposure but results in less efficient trajectories and hence increased emissions.

Local Air Quality (LAQ) is affected by a number of drivers including travel from/to airports, airport infrastructure and facilities, aircraft handling, and aircraft emissions during landing and take-off.

Local initiatives usually consist of a wide mix of measures coordinated by the airport operator. The ANS contribution towards improving LAQ is mainly related to operational performance and associated fuel burn in the landing-take-off (LTO) cycle[18], subject to State policy on procedural design and operational restrictions. ANS-related performance at airports is addressed in more detail in Chapter 5.

Local Air Quality (LAQ)

Local air quality LAQ is concerned with potential health effects of air pollution. Aircraft, road vehicles and other sources such as power plants at and around airports emit a number of pollutants, particularly Nitrogen Oxides (NOx) and Particulate Matter (PM) which impact on human health.

Aircraft noise has been generally recognised as the most significant environmental impact at airports. Noise emissions from aircraft operations are airport specific and depend on a number of factors including aircraft type, number of take-offs and landings, route structure, runway configuration, and a number of other factors.

Although modern jet aircraft are more than 70% quieter than first models which continuously reduced the noise footprints, the number of aircraft movements and also people's sensitivity to perceived noise has grown over time. Even though the perceived annoyance for a given noise level depends on a number of cultural and social factors, it is commonly agreed that noise above a certain level has adverse impacts on people's health and quality of life.

Figure 2-22 shows the estimated number of people within Lden[19] 55dB noise contours at 45 major European airports between 2005 and 2025, based on the STAPES[20] noise model which is mainly

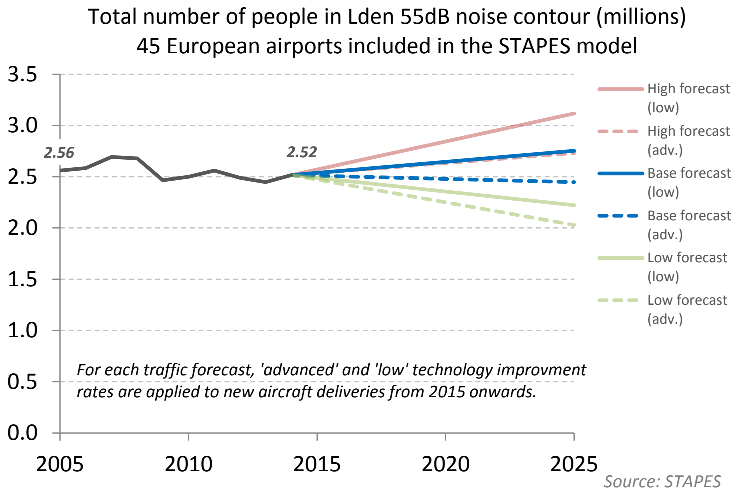

Figure 2-22: Estimated aircraft noise exposure at 45 major airports

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18 The standard LOT cycle is considered by ICAO to be up to 3,000 feet (915 metres) above ground level which is the typical mixing height below which emissions affect local air quality.

19 The Lden indicator represents an equivalent sound pressure level averaged over a day with adjustments for increased annoyance during sensitive night or evening hours to describe noise impacts.

20 System of Airport Noise Exposure Studies (STAPES) is a multi-European airports noise model. It aims to quantify the impact of the noise resulting from current traffic (baseline) and future traffic scenarios based on STATFOR forecasts, taking into account the ongoing evolution of air traffic and fleet mix.

driven by aircraft movements and fleet mix. Overall noise exposure remained at a similar level between 2005 and 2015 and follows mainly the trend observed for traffic. As can be seen, future projections are considerably influenced by traffic forecast scenarios and assumed technology improvement rates.

As illustrated in Figure 2-23, aircraft noise exposure is affected by a number of factors which can be categorised according the ICAO "balanced approach".

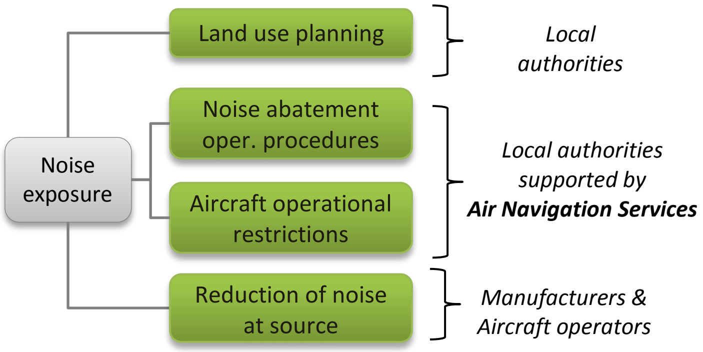


Figure 2-23: Factors affecting noise exposure at and around airports

In Europe, accountability for noise management is generally given to airport operators under rule making and supervision of national authorities but each operational stakeholder has a role to play in reducing noise.

The aim is to address local noise issues at each airport individually in order to identify the most suitable and cost-effective measures for the mitigation of aircraft noise while maximising the use of scarce airport capacity. This includes also the consideration of possible trade-offs with other performance areas or within the environmental domain (noise vs. flight efficiency) when noise restrictions are put in place.

The main contributing factors towards reduced noise exposure are expected to come from measures with long lead times outside the control of ANS (land use planning, reduction of noise at source).

Local and regional authorities are typically responsible for the planning of residential developments in the vicinity of the airport and the reduction of noise at source depends on technological progress and fleet renewal strategies.

ICAO's Committee on Aviation Environmental Protection (CAEP) frequently revises aircraft technical design standards to reflect technological progress and to ensure that the latest available technology is incorporated into aircraft design. For new generation aircraft (e.g. A380-800), the 85 dB footprint (3.47km^2) is around 46% smaller than the B747-400 noise footprint (6.97 km^2). However, it is worth pointing out that, due to the long life cycle of aircraft, it takes some lead time to fully realise the benefits of technical progress.

Quantifying Noise

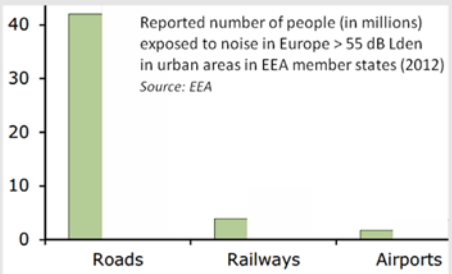
Regulators have almost universally adopted cumulative noise energy averaging metrics with adjustments during sensitive hours to describe noise impacts.

Ground level noise impact is usually quantified by contours of equal noise energy covering the geographic area around an airport and the number of people exposed.

Although noise models based on take-offs and landings, route structure, thrust management practices, and certified aircraft noise levels ensure a consistent approach across airports, it is challenging to accurately characterise community response to aircraft noise.

Aircraft noise in context

Road traffic is by far the most widespread noise source in Europe (exposure >40million people) followed by rail and air traffic.



Aircraft operating restrictions are arguably the most rigorous measures (curfews[21], cap on movements, noise quota[22], runway configuration and use). They are usually imposed on airports by Governments or local Planning Authorities and the level of compliance is monitored at local level.

Noise abatement operational procedures are the main area where ANS can actively contribute to the reduction and/or reshaping of the noise contour and the population affected by aviation noise. The main contribution comes from the management of the arrival and departure procedures and the ability to maximise the use of modern aircraft capabilities, subject to State policy on procedural design and operational restrictions. Broadly, these can be broken down into three categories:

- Noise abatement flight procedures (i.e. Noise Abatement Departure Procedures, Minimum use of reverse thrust after landing, Use of Continuous Descent Approach (CDA), etc.);
- Spatial management (i.e. design and use of noise preferred arrival and departure routes avoiding sensitive areas, flight track dispersion or concentration (performance based navigation), noise preferential runway configurations); and,
- Ground management (i.e. management of aircraft auxiliary power units (APU), taxi without all engines running).

Presently, there are no commonly agreed Europe wide indicators specifically addressing ANS performance is the noise context.

Reducing aviation's environmental impact on climate

The environmental impact of aviation on climate results from greenhouse gas (GHG) emissions including CO_2, NO_X, and contrails (H_2O), formed by aircraft engine exhaust. CO_2 emissions are considered to have the largest cumulative impact on climate because it represents a large fraction of the net radiative forcing and has the longest atmospheric lifetime of any of the combustion products.

Unlike aircraft noise, GHG emissions are not experienced at the point of emission. The impact is global and long term which makes regulation more challenging.

Figure 2-24 shows an estimate of the CO_2 emissions in the European Civil Aviation Conference (ECAC) States, based on the IMPACT model[23]. As can be expected, total CO_2 emissions follow largely the trend observed for traffic growth (compare Figure 2-8 on page 11).

Total CO_2 emissions from aviation in Europe account for approximately 3.5% of total anthropogenic CO_2 emissions in Europe but the relative share of aviation is expected to increase due to anticipated traffic growth and longer lead times (aircraft life cycle) for technological upgrades than other industries which makes the uptake of more efficient technologies generally faster on the ground.

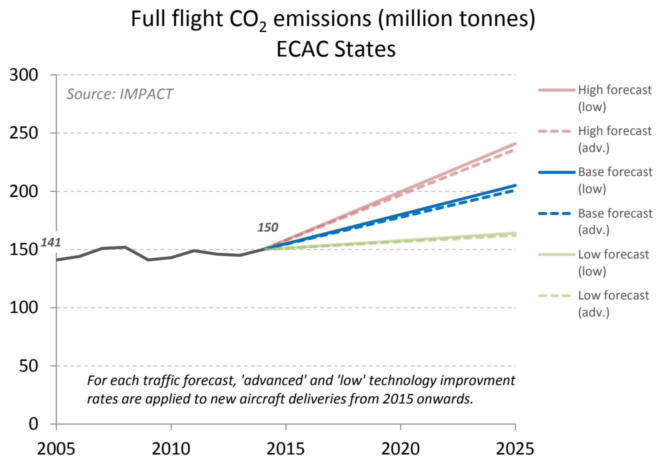


Figure 2-24: Aviation CO_2 emissions (ECAC States)

Similar to noise exposure, the reduction of CO_2 emissions from aviation requires a joint effort from all stakeholders. Figure 2-25

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21 Curfew – an airport curfew is a global or aircraft-specific partial operating restriction that prohibits take-off and/or landing during an identified time period [ICAO Doc 9829].

22 Noise quota – noise quota (sometimes expressed as a "noise budget") caps the total noise level from aircraft operations within a given area over or around the airport to some established total value over a given period of time (six months, a year, etc.) expressed in established noise energy over a period of time [ICAO Doc 9829].

23 IMPACT is an environmental modelling system developed by EUROCONTROL. It allows the assessment of trade-offs between noise and full-flight gaseous emissions based on actual data and STATFOR forecasts.

provides a generic overview of factors and responsibilities in improving aviation CO_2 efficiency which can be measured in terms of CO_2 per output.

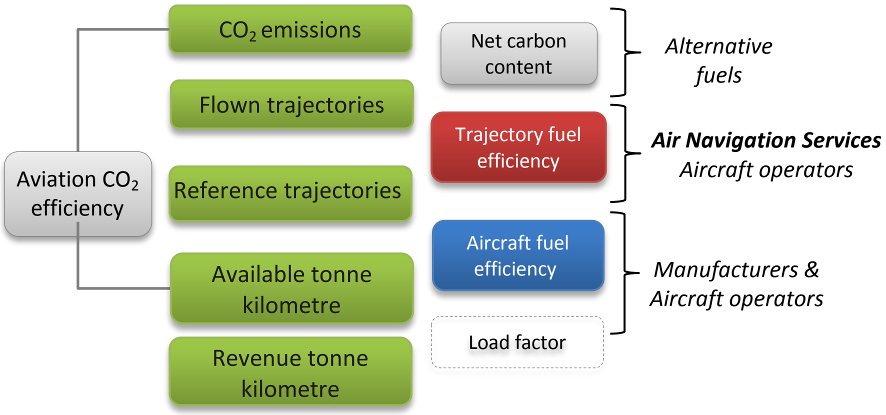


Figure 2-25: Factors affecting aviation CO_2 efficiency

Aviation CO_2 efficiency can be broken down into four areas (net carbon content, trajectory fuel efficiency, and aircraft fuel efficiency), which corresponds to different accountabilities and performance improvement options.

Figure 2-26 illustrates the estimated contribution of measures for reduction aviation related CO_2 emissions by ICAO [Ref. 13].

By far the main contribution to decouple aviation emissions growth from air traffic growth is expected to come from alternative low carbon fuels, market based measures, technology developments (more efficient aircraft, advances in airframe and engine technology) and subsequent fleet renewals.

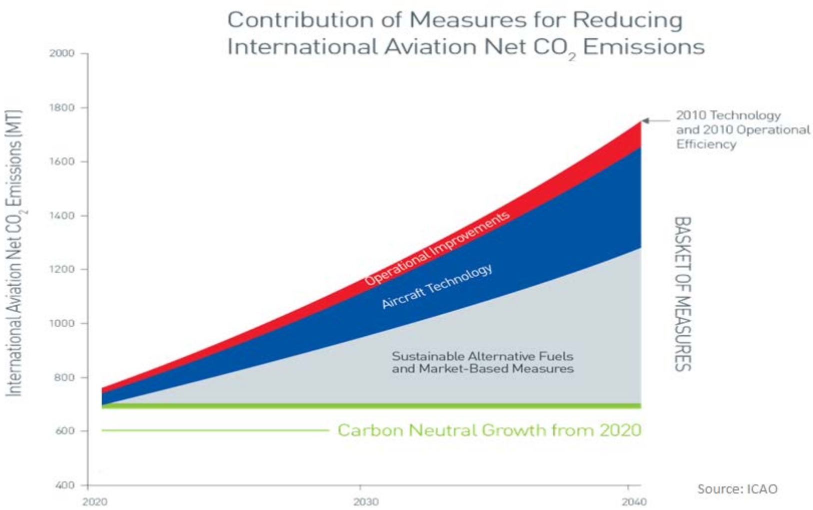


Figure 2-26: Contribution of measures for reducing Int. aviation net CO_2 emissions

At the 37th ICAO Assembly in 2010, governments agreed to set two aspirational goals: to improve fuel efficiency by 2% per year with the objective of stabilising global CO_2 net emissions from international aviation at 2020 levels to make additional growth "carbon neutral". One of the instruments to achieve this ambitious goal is the introduction of a market based measure (MBM) to offset emission elsewhere in the economy.

Already in 2008, the EU decided to include emissions from all flights from, to and within the European Economic Area (EEA) in the EU Emission Trading System (EU ETS) as of 2012. In order to facilitate negotiations of a global agreement at the ICAO 2013 Assembly, the EU ETS requirements were suspended in late 2012 for flights to and from non-European countries, and for 2013-2016, only emissions from flights with the EEA fall under the EU ETS. ICAO subsequently decided on a roadmap for the development of a global market-based mechanism to tackle aviation emissions, to be agreed in 2016 and implemented from 2020.

The ANS-related impact on climate is closely linked to operational performance which is largely driven by inefficiencies in the four dimensional trajectory and associated fuel burn (and emissions). There is a close link between reducing greenhouse gas emissions and airspace user requirements to minimise fuel burn. For every ton of fuel reduced, an equivalent amount of 3.15t of CO_2 is avoided.

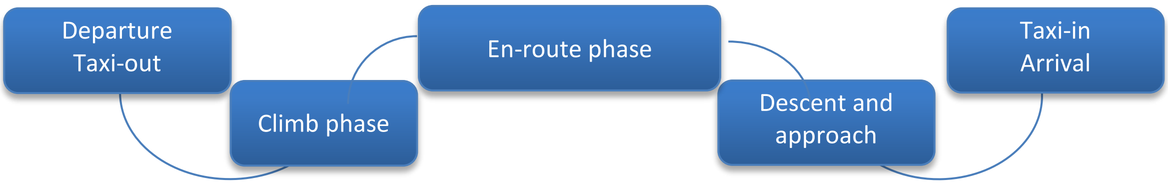
The next section provides a synthesis of ANS-related inefficiencies and an estimate of its total impact on airspace users' operations in terms of time and fuel burn. The respective performance indicators are discussed in more detail in the corresponding chapters on operational en-route ANS performance (Chapter 4) and ANS performance at airports (Chapter 5).

2.4.3 Operational performance (ANS perspective)

Deviations from the "optimum" reference trajectory[24] generate additional flight time, fuel burn, and emissions with a corresponding impact on airspace users' cost and the environment. To better account for differences between the en-route (where the responsibility for providing the right level of capacity is largely in the hand of ANS) and the airport environment (where capacity is largely a function of the infrastructure) ANS performance indicators are broken down by phase of flight.

Figure 2-27 provides an overview of areas where ANS can improve operational performance and associated initiatives also reflected in the ICAO Aviation System Block Upgrade (ASBU) concept which aims at removing barriers to future aviation efficiency and environmental gains.

Inefficiencies in the various flight phases (airborne vs. ground) have a different impact on airspace users in terms of predictability[25], fuel burn (engines-on vs. engines-off) and costs (see also Annex III).



ANS-related operational performance		
Departure airport	**En-route**	**Arrival airport**
PRR 2015 - Chapter 5	**PRR 2015 - Chapter 4**	**PRR 2015 - Chapter 5**
• Minimise ANS-related departure delays (ATFM, ATC); • Optimise push back time sequencing; • Optimum taxi routing (distance & time); • Adherence to ATFM departure slots;	• Improve route network design; • Improved route availability (CDRs); • Improved airspace utilisation (civil/military coordination);	• Reduction of airborne terminal holdings; • Support to fuel efficient descent trajectory; • Maximise airport throughput; • Optimum taxi routing (distance & time);
ANS performance related indicators		
• ATC-pre departure delay; • Additional taxi-out time; • ATFM slot adherence;	• En-route ATFM delays; • En-route flight efficiency;	• Airport ATFM arrival delay; • Additional Arrival Sequencing and Metering Area (ASMA) time; • Additional Taxi-in time;
Supporting projects/initiative		
• Airport Collaborative Decision Making (A-CDM) • Departure manager (DMAN); • Continuous climb operations (CCO);	• Free route airspace • Flexible use of airspace (FUA) • Route network design improvements	• Continuous descent operation (CDO); • Performance based navigation (PBN); • Arrival manager (AMAN/XMAN);

Figure 2-27: Overview of ANS-related initiatives towards improved operational performance

A large part of ANS-related inefficiencies are the result of inefficiencies in the route network design and imbalances between demand and available capacity, coupled with the need to provide sequencing and safe separation (i.e. distribution of the delay between air and ground). For the interpretation of the overview table in Figure 2-28 it is therefore worth recalling that:

- the computations refer to a theoretical reference value which, due to necessary (safety) or desired (capacity) limitations, is not achievable at system level. Hence, the ANS-related

[24] It should be noted that the "optimum" trajectory can change by stakeholder, depending on the point of view and priorities and other factors including weather. Please see the methodologies in the respective chapters for further information on the definition of the used reference for ANS performance measurement.

[25] Some ANS-related inefficiency like for route design issues are predictable and therefore embedded in the airline schedule. Whereas the impact on punctuality negligible, they have a significant impact in terms of additional fuel burn, CO_2 emissions, and associated costs.

inefficiencies cannot be reduced to zero as a certain level of delay is necessary and sometimes even desirable if a system is to be run efficiently without underutilisation of available resources; and,

- a clear-cut attribution between ANS and non-ANS related factors is often difficult in a complex interrelated environment such as air transport. While ANS can significantly help to improve performance in the measured areas, there are inevitably factors and trade-offs from other areas and/or stakeholders which impact on overall performance.

Figure 2-28 provides an overview of the current best high level estimate of operational inefficiencies, where ANS can provide a contribution to improve performance. The underlying data is derived from, and should be read in conjunction with, the analyses provided in Chapters 4 and 5 of this report.

As the relevant data are presently not available for all EUROCONTROL States at the same quality, Figure 2-28 is limited to SES States[26].

Estimated operational inefficiencies where ANS can have an impact (time, fuel burn and CO_2 emissions) SES Performance Scheme			Addressed in chapters in PRR 2015	Estimated total additional (numbers may not add up due to rounding):				
				Operating time (min.)		Fuel burn		CO_2
				2015	% change	2015	% change	2014
ANS-related inefficiencies	At stand	Airport ATFM arrival delay	Ch. 5	4.29 M	25.3%	-	-	-
		En-route ATFM delay	Ch. 4	6.75 M	21.6%	-	-	-
	Gate-to-gate	Additional taxi-out time (77 RP1 airports)	Ch. 5	17.1 M	6.0%	0.2 Mt	7.2%	0.8 Mt
		Horizontal en-route flight efficiency (actual)	Ch. 4	17.5 M	6.6%	0.8 Mt	10.2%	2.4 Mt
		Additional ASMA time (39 RP1 airports)	Ch. 5	9.0 M	14.4%	0.4 Mt	18.0%	1.2 Mt
	Total estimated ANS-related impact			54.6 M	10.6%	1.4 Mt	11.6%	4.3 Mt

Please note that the average additional taxi-out and ASMA time is based on airports included in the first reference period of the SES performance scheme (RP1) for which validated data was available. To get a high level estimate representing all SES RP1 airports, the averages of the validated sample were applied to the total number of departures/arrivals at the SES RP1 airports.

Figure 2-28: Estimated ANS-related operational performance

Compared to 2014, ANS-related operational performance deteriorated in all areas, with the most significant increase in en-route and airport ATFM delays. As Figure 2-28 shows an estimate of the total ANS-related impact, it is important to recall that the results are impacted by relative performance changes (as described in Chapters 4-5) but also by changes in traffic volumes.

Previous research [Ref.14] suggests that the share of CO_2 emissions which can be influenced by ANS is approximately 6% of the total aviation related CO_2 emissions in Europe or around 0.2% of total European anthropogenic CO_2 emissions.

While ANS is not always the root cause of those inefficiencies (weather, airport scheduling, noise restrictions, etc.), the way the inefficiencies are managed and distributed along the various phases of flight has clearly an impact on the environment in terms of greenhouse gas emissions and noise, on airspace users in terms of fuel burn and on the air transport system in terms of capacity utilisation.

Care should be taken to avoid that efficiency gains in one flight phase are offset by equivalent efficiency losses in another phase.

Although limited by safety requirements and additional constraints (noise, capacity, cost, etc.) there is scope for improvements in ANS efficiency (closer to optimum flight profile) and also in optimising the distribution of delays along the trajectory (e.g. ground vs. air).

One of the major challenges in improving ANS-related fuel efficiency will be the improvement of aviation's environmental performance in the face of continuous traffic growth. Maintaining or improving the same level of ANS service quality while absorbing projected demand will be challenging.

[26] Due to changes in data (more complete and higher quality data) and scope (SES States only), the figures in this section are not directly comparable to the analyses in previous PRRs. All time series analyses included in this report are based on the same data sources and methodologies and therefore comparable.

2.5 Overall economic evaluation of ANS performance

An evaluation of economic data from AEA[27] member airlines suggests that the share of air navigation charges account for some 6% of total airline operating costs (2013). This share can change notably depending on the airline business model with low cost airlines having a higher relative share. Furthermore, it should be noted that the relative cost breakdown is subject to fuel price changes which is the single largest cost category.

Figure 2-29 depicts the long-term trend of en-route ANS performance for which a consistent set of data is available over the entire period. It shows the ANS costs per kilometre (bars)[28] together with traffic evolution (blue line) and en-route ATFM delay per flight in summer (red line) between 1990 and 2014.

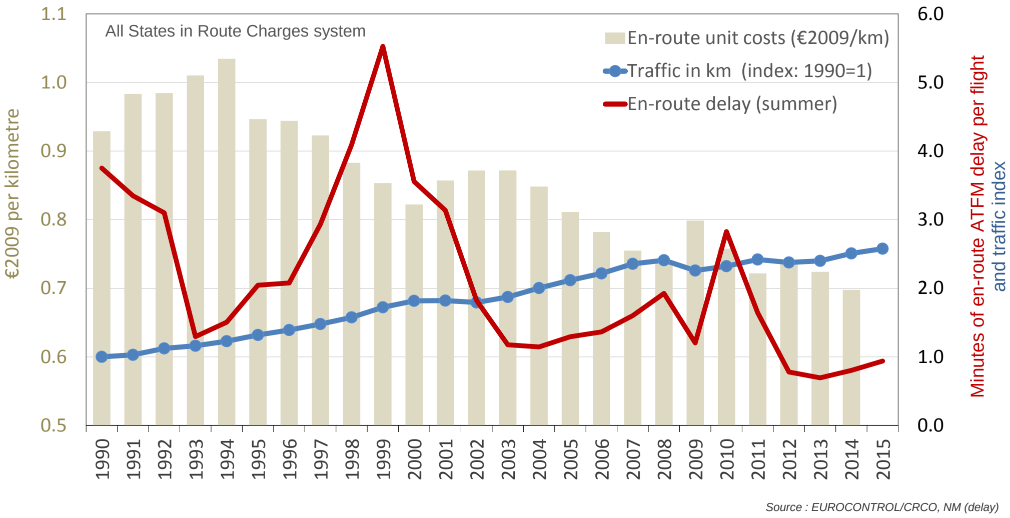


Figure 2-29: Long-term trend of traffic, unit costs and en-route ATFM delay (summer)

The analysis shows cyclic patterns with periods of high delays (capacity related in 1999, capacity and strike related in 2010) and lower unit costs and vice versa with an overall trend of decreasing en-route unit costs at increasing traffic levels over time. With unit rates decreasing further over the past years, a notable increase in en-route ATFM delay can be observed again since 2013 and it is therefore important to ensure that sufficient capacity is deployed while improving overall cost-efficiency in order to avoid excessive delays in the future.

The economic evaluation of ANS performance in the next section combines ANS-related en-route and terminal performance. It shows direct ANS costs (en-route and terminal) and attempts to monetarise also indirect costs due to ANS-related inefficiencies (ATFM delays, additional taxi-out and ASMA time, horizontal en-route flight efficiency)[29] which are both borne by airspace users in Europe. The estimation combines the high-level cost-efficiency results from Chapter 6 with the results from the review of ANS-related operational performance in Chapter 4 and 5.

Whilst it is not considered appropriate to include a monetary value for safety in the economic assessment, its primacy is fully recognised.

The analysis does not consider costs for on-board equipment nor does it provide a full societal impact assessment which would include, for

Costs of ANS-related inefficiencies

The estimated airline delay costs in the University of Westminster study [Ref.15] include direct costs (fuel, crew, maintenance, etc.) the network effect (i.e. cost of reactionary delays) and passenger related costs.

Whilst passenger 'value of time' is an important consideration in wider transport economics, only those costs which impact on the airline's business (rebooking, compensation, market share and passenger loyalty related costs) were included in the estimate. Estimates of future emissions costs from the EU emission trading scheme from 01 January 2012 were not included.

27 Association of European Airlines.
28 Note that the actual 2015 figure is not yet available.
29 The costs of cancellations are not considered in the assessment of total economic ANS costs.

instance, also the cost of delay to passengers and environmental costs. Due to data availability the analysis is restricted to SES States.

The direct ANS en-route and terminal costs were derived from Chapter 6 of this report, where a more detailed analysis is available. It is important to point out that the 2013-2014 ANS cost figures represent actuals whereas the 2015 ANS cost figures were based on the latest available cost projections (P) and might change. The 2015 projections should therefore be treated with caution as the actual figures may differ notably.

ANS-related inefficiencies in operations impact on airspace users in terms of cost of time and fuel. Estimating the costs of such inefficiencies is a complex task requiring expert judgement and assumptions based on published statistics and the most accurate data available. There are inevitably margins of uncertainty which need to be taken into account for the interpretation of the results.

The costs of ANS-related additional time in this report is based on a study from the University of Westminster [Ref. 15]. More information on the applied methodology for the economic evaluation of ANS performance is available in Annex III of this report[30].

Fuel price is a major cost factor when monetarising ANS-related inefficiencies. In order to monitor ANS performance over time without any bias from fuel price changes, the average jet fuel price[31] in 2015 was consistently applied to all years[32].

All costs relate to States subject to the SES Performance Scheme and are expressed in M € 2009		2013 (A)	2014 (A)	2015 **(P)**	2014 vs. 2013	2015 vs 2014
IFR flights (M)		8.9 M	9.1 M	9.2 M	1.9%	1.4%
ANS costs	En-route ANS costs (SES area)	€ 5 945 M	€ 5 945 M	€ 6 170 M	0.0%	3.8%
	Terminal ANS costs (SES area)	€ 1 355 M	€ 1 365 M	€ 1 265 M	0.6%	-7.3%
Service quality	Airport ATFM delays (SES area)	€ 320 M	€ 310 M	€ 390 M	-2.2%	25.3%
	En-route ATFM delays (SES area)	€ 440 M	€ 505 M	€ 615 M	14.4%	21.6%
	Additional taxi-out time (RP1 airports)	€ 580 M	€ 550 M	€ 585 M	-5.1%	6.2%
	En-route extension (actual trajectories)	€ 810 M	€ 790 M	€ 850 M	-2.9%	8.1%
	Additional ASMA time (RP1 airports)	€ 375 M	€ 370 M	€ 425 M	-1.9%	15.9%
Estimated total ANS-related economic costs		€ 9 825 M	€ 9 835 M	€ 10 300 M	0.0%	4.8%

Figure 2-30: Estimated total economic ANS-related costs (SES States)

Figure 2-30 shows the estimated total economic ANS-related costs for the SES States for 2013 and 2014 and the provisional trend for 2015, based on the latest available ANS cost-projections (see also Chapter 6).

Based on the latest available information for 2015, total economic ANS-related costs in the SES area are estimated to increase by 4.8% compared to 2014. The increase is mainly driven by the deterioration of ANS-related operational performance in all areas (most notably in en-route and airport ATFM delays).

2.6 Conclusions

Controlled flights in Europe increased for the second year in a row in 2015 (+1.5% vs 2014). The observed growth is in line with the STATFOR (Feb. 2015) [Ref. 8] baseline forecast scenario (+1.5%) predicted for the area. Total flight distance (+1.8% vs.2014) and flight hours (+1.7% vs.2014) increased at a slightly higher rate due to, on average, longer flights.

According to the latest STATFOR 7-year forecast (Feb. 2016) [Ref. 10] flights are expected to grow by 2.4% in 2016 (Low: 1.0%; High 3.8%) and to continue with an average annual growth rate of 2.2%

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30 The computations are based on the report updated in 2015 which estimates higher ATFM delay costs per minute.

31 Average jet fuel price provided by IATA based on spot price.

32 The "real" cost therefore might have been higher or lower in the individual years, depending on how the 2015 price compares to the price in the respective year and other factors, e.g. airline hedging policies.

between 2015 and 2022 (Low: 0.7%; High 3.8%). Air traffic in Europe is expected to reach pre-economic crisis levels (2008) by 2017.

In absolute terms, Turkey, Bulgaria, Hungary, the UK, and Spain (Continental) experienced the highest year-on-year growth in 2015 and all of the six largest States in terms of traffic volume (Germany, France, UK, Italy, Spain, and Turkey) showed an increase in traffic in 2015. Turkey continued its remarkable traffic growth (average annual growth rate of 7% over the past 5 years) and shows a substantial growth in all segments (domestic, international, overflights).

The growth observed in a number of central European States (Bulgaria, Hungary, Czech Republic, Romania, and Slovakia) was mainly related to overflows from traffic avoiding Ukrainian airspace. The shift in traffic patterns following the start of the Ukrainian crisis and the downing of MH17 in July 2014 led to a drastic reduction of traffic in Ukraine (-33.4%) and also Moldova (-19.3%) compared to 2014. The sustained closure of Libyan airspace (as of August 2014) continued to have a notable impact on Greece with traffic flows between Europe and Africa shifting from Maltese airspace to Greek airspace.

After the best year on record in 2013, arrival punctuality in Europe decreased for the second year in a row to 82.1% in 2015. Reactionary delay remains the largest single delay group (45.9%) in 2015, followed by delays due to turnaround issues. The further increase in en-route and airport ATFM delays in 2015 contributed also to the lower punctuality levels in 2015.

The variability of operations determines the level of predictability and has an impact on airline scheduling and also on the provision of ATC and airport capacity (i.e. TMA capacity, en-route capacity, gate availability, etc.). The lower the predictability, the more difficult it is to match capacity to demand without inefficiencies in terms of delay (insufficient capacity) or cost (underutilisation of resources). Whereas a certain level of variability is considered to be normal or even required in aviation, more research to better understand the drivers of operational variability within the system (operational planning, time definitions, tolerance windows, delay causes, etc.) could contribute to reducing system-wide variability with associated positive effects for capacity utilisation.

Aircraft noise has been generally recognised as the most significant environmental impact at airports. Political decisions on environmental constraints can impact operations in terms of the number of movements, route design, runway configuration and usage and aircraft mix (engine types, etc.). The main contributing factors towards reduced noise exposure are expected to come from measures with long lead times outside the control of ANS (land use planning, reduction of noise at source). Noise abatement operational procedures are the main area where ANS can actively contribute to the reduction and/or reshaping of the noise contour and the population affected by aviation noise.

The environmental impact of aviation on climate results from greenhouse gas (GHG) emissions including CO_2, NOX, and contrails (H_2O), formed by aircraft engine exhaust. By far the main contribution to decouple aviation emissions growth from air traffic growth is expected to come from alternative low carbon fuels, market based measures, technology developments (more efficient aircraft, advances in airframe and engine technology) and subsequent fleet renewals. The ANS-related impact on climate is closely linked to operational performance which, is largely driven by inefficiencies in the four dimensional trajectory and associated fuel burn (and emissions).

The total economic evaluation of ANS performance presents a consolidated view of direct ANS costs and estimated indirect ANS-related costs (ATFM delays, additional taxi-out and ASMA time, horizontal en-route flight efficiency) borne by airspace users. Based on the latest available information for 2015, total economic ANS-related costs in the SES area are estimated to increase by 4.8% compared to 2014. The increase is mainly driven by the deterioration of ANS-related operational performance in all areas (most notably in en-route and airport ATFM delays) and the projected increase in en-route ANS costs in 2015.

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3 Safety

KEY POINTS		AST KEY DATA (2014 & 2015 P)		
• Based on 2015 preliminary information, the number of Unauthorised Penetrations of Airspace (UPAs) and ATM specific events increased whilst reported number of Separation Minima Infringements (SMI) and Runway Incursions (RIs) decreased in 2015; • Final 2014 and 2015 preliminary AST data was received from 40 States; • The definition and guidance on the development of Acceptable Level of Safety Performance (ALoSP) is currently not available in Europe; • The current safety reporting environment is changing and it has to be accepted that the next few years will be a transition phase.	Performance indicators (*AST reporting*)	2014	2015 (P)	% change
	Total number of reported SMIs	2,359	2,316	- 1,8% ↓
	Share of Severity A+B SMIs	11,6 %	10,7 %	- 9,0% ↓
	Total number of reported RIs	1,442	1,397	- 3.1% ↓
	Share of Severity A+B RIs	7 %	6,8 %	- 3,0% ↓
	Total number of reported UPAs	4,325	4,358	0,8% ↑
	Share of Severity A+B UPAs	1,4 %	2,0 %	+ 43,9% ↑
	Total reported ATM Specific Occurrences	12,287	16,587	+ 35.0% ↑
	% of Severity AA+A+B ATM Specific Occurrences	3,8 %	2,8 %	- 25,4% ↓
	Occurrences not severity classified	9 %	11 %	+ 26,5% ↑

3.1 Introduction

This chapter reviews the Air Navigation Services (ANS) safety performance of the EUROCONTROL Member States between 2006 and 2015.

Sections 3.2 and 3.3 in this chapter show the trends in ANS-related accidents and incidents in the EUROCONTROL area. Section 3.4 provides an analysis of the current status of safety data reporting and investigation in EUROCONTROL Member States while Section 3.5 outlines potential benefits of aviation risk modelling for future performance improvements.

The review of ANS-related accidents and incidents in this chapter is based on:

- Accident and serious incidents data from 2006 to 2015 contained in the EASA database; and,
- Incident data from 2006 to 2014 and preliminary 2015 data reported to EUROCONTROL via the Annual Summary Template (AST) reporting mechanism.

The scope of the safety review in this chapter is summarised in Figure 3-1 below.

	Analysis scope	Type	Category	Weight
Accidents and serious incidents (EASA DB)	ANS related ANS contribution	Commercial Air Transport (CAT)	Fixed wing	>2 250 Kg
Incidents (EUROCONTROL AST)	ANS related	All	All	No limitation

Figure 3-1: Sources and scope of ANS safety review in this chapter

Note that final investigation reports for some accidents and incidents might be delayed by more than two years, particularly when the investigation is complex. For this reason, it may be possible that the historic results shown in this report differ slightly from previous Performance Review Reports. In addition, the scope of the review may be changed in future reports depending on the added value for reviewing the ANS safety performance and on the improvement in data granularity and data quality.

3.2 Accidents and serious Incidents (ANS-related and with ANS contribution)

3.2.1 Accidents (ANS-related and with ANS contribution)

Figure 3-2 shows accidents (ANS-related and with ANS contribution) in Commercial Air Transport (CAT) involving fixed wing aircraft with a maximum take-off weight of more than 2,250kg in the EUROCONTROL area between 2006 and 2015.

Following the increase in 2014, ANS-related accidents in the EUROCONTROL area decreased again to seven (7) in 2015. In addition, there was one accident with ANS contribution in 2015.

ANS-related vs. ANS contribution

"**ANS-related**" means that the ANS system may not have had a contribution to a given occurrence, but it may have a role in preventing similar occurrences in the future.

"**ANS contribution**" means that at least one ANS factor was in the causal chain of events leading to an occurrence, or at least one ANS factor potentially increased the level of risk, or it played a role in the occurrence encountered by the aircraft.

Over the past three years (2013-2015), there were no fatal ANS-related accidents (dark blue bars).

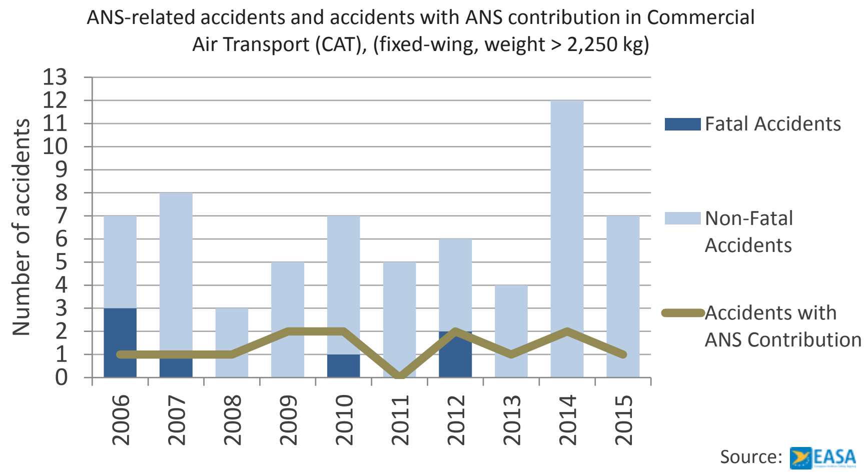
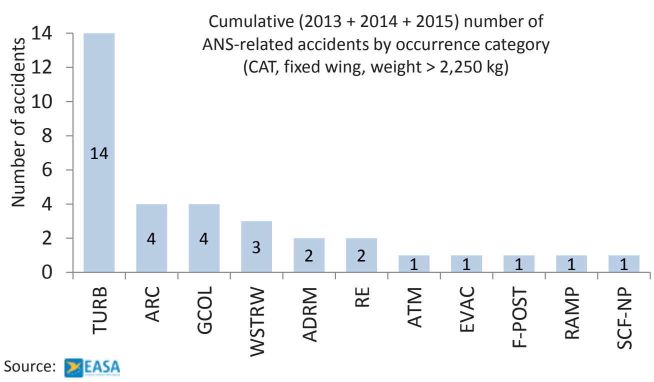


Figure 3-2: ANS related accidents in the EUROCONTROL area

Figure 3-3 shows the cumulative number of ANS-related accidents (2013-2015) by occurrence category[33]. It should be noted that some accidents may have been assigned to more than one occurrence category (see note on the next page).

Similar as in previous years, by far the majority of ANS-related accidents between 2013 and 2015 were related to turbulence (TURB), followed by abnormal runway contact and ground collision.



- TURB: Turbulence encounter
- ARC: Abnormal runway contact
- GCOL: Ground Collision
- WSTRW: Windshear or thunderstorm
- ADRM: Aerodrome
- RE: Runway excursion
- ATM: ATM/CNS
- EVAC: Evacuation
- F-POST: Fire/smoke (post-impact)
- RAMP: Ground Handling
- SCF-NP: System/component failure or malfunction [non-powerplant]

Figure 3-3: ANS-related accidents by occurrence category (EUROCONTROL area)

33 As defined by ICAO Commercial Aviation Safety Team (CAST/ICAO) Common Taxonomy Team (CICTT).

Note that each accident and serious incident may be coded using more than one occurrence category either because several occurrence types are pertinent to the event or due to the presence of several events in the same occurrence report. This is even more relevant for occurrences coded as "ATM/CNS", as this code encapsulates any occurrence that has a relation with the provision of ATM/ANS services and that concurrently occur with other types of occurrence description, such as mid-air collision (MAC) or runway incursion, for instance. This explains why the number of occurrence types present in accidents and serious incidents is higher than the number of accidents/serious incidents reports. It is worth noting that an occurrence type may be coded in isolation without ATM/CNS being mentioned as occurrence type in that report and still be present in the statistics of ANS-related accidents/serious incidents. The reason of this is that the ATM/ANS service may have a role in preventing similar occurrence in the future (a typical case is a mid-air collision or a turbulence encounter). In general terms, when an occurrence is coded as ATM/ANS, it indicates that, either directly or indirectly, ATM/ANS had a contribution in that occurrence (identified as "ANS contribution" occurrence).

3.2.2 Serious incidents (ANS-related and with ANS contribution)

Figure 3-4 shows ANS-related serious incidents[34] and serious incidents with ANS contribution in CAT (fixed-wing aircraft > 2,250kg) in the EUROCONTROL area between 2006 and 2015.

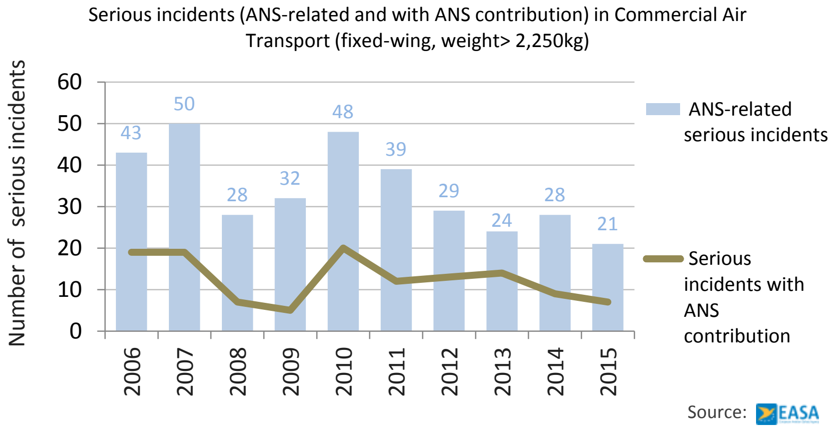
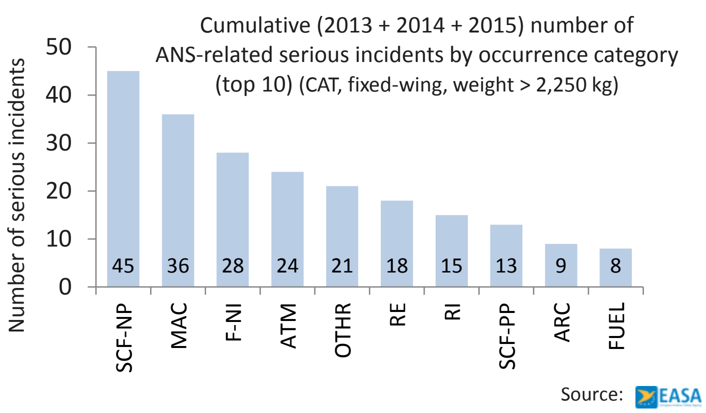


Figure 3-4: Serious incidents (ANS-related and with ANS contribution) in the EUROCONTROL area

Following a small increase in 2014, the positive overall trend observed in the EUROCONTROL area over the past years continued in 2015 and the number of ANS-related serious incidents decreased to the lowest level over the past 10 years. At the same time, serious incidents with ANS contribution (brown line) also decreased further in 2015.

Figure 3-5 shows the cumulative number of ANS-related serious incidents by occurrence category (taxonomy per CAST/ICAO) between 2013 and 2015. Note that only the top 10 categories are shown and that some of the serious incidents might have been assigned to more than one category.



- SCF-NP: System/component failure or malfunction [non-powerplant]
- MAC: Airprox/ ACAS alert/ loss of separation/ (near) midair collisions
- F-NI: Fire/smoke (non-impact)
- ATM: ATM/CNS
- OTHR: Other
- RE: Runway excursion
- RI-VIP: Runway incursion - vehicle, aircraft or person
- SCF-PP: powerplant failure or malfunction
- ARC: Abnormal runway contact
- FUEL: Fuel related

Figure 3-5: ANS-related serious incidents by occurrence category (EUROCONTROL area)

[34] A serious incident is defined as an incident involving circumstances indicating that an accident nearly occurred.

Different from previous years when near Mid-Air Collisions (Near MAC) were the most frequent ANS-related serious incidents, it is of concern that system failures or malfunctions became the most frequent ANS-related serious incidents between 2013 and 2015, even though they were not among the top 5 last year.

Based on the statistics over the past 10 years, it is interesting to note that the share of accidents with ANS contribution (out of all ANS related) was only around 22%, whilst the share of serious incidents with ANS contribution was almost 39%.

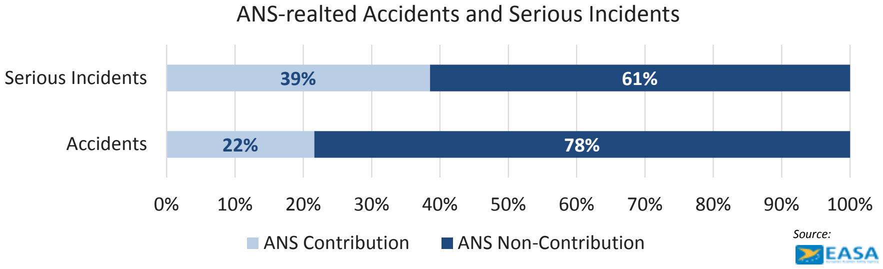


Figure 3-6: Share of ANS contribution occurrences (2006-2015)

3.3 ATM-related incidents

This section provides a review of ATM-related incidents, reported through the EUROCONTROL Annual Summary Template (AST) reporting mechanism. The PRC has made use of, with gratitude, the data provided by the EUROCONTROL Safety Regulation Commission (SRC) in its Annual Reports [Ref. 16] and in its intermediate reports.

The "Severity A" categorisation in the EUROCONTROL AST corresponds to "Serious incident" in the EASA database. The number of "Severity A" incidents in the AST is still slightly higher than the total "Serious incidents" in the EASA database. The reasons for this difference may be related to the criteria used by the Safety Investigation Authorities (SIAs) for selecting serious incidents and by the notification procedures and practices[35] used at national level for notifying about Severity class A.

The inconsistency issue, together with other issues related to the quality and completeness of safety occurrence data should be constantly closely monitored in cooperation between EASA and the EUROCONTROL Directorate Pan-European Single Sky (DPS).

3.3.1 Airspace - Separation Minima Infringements

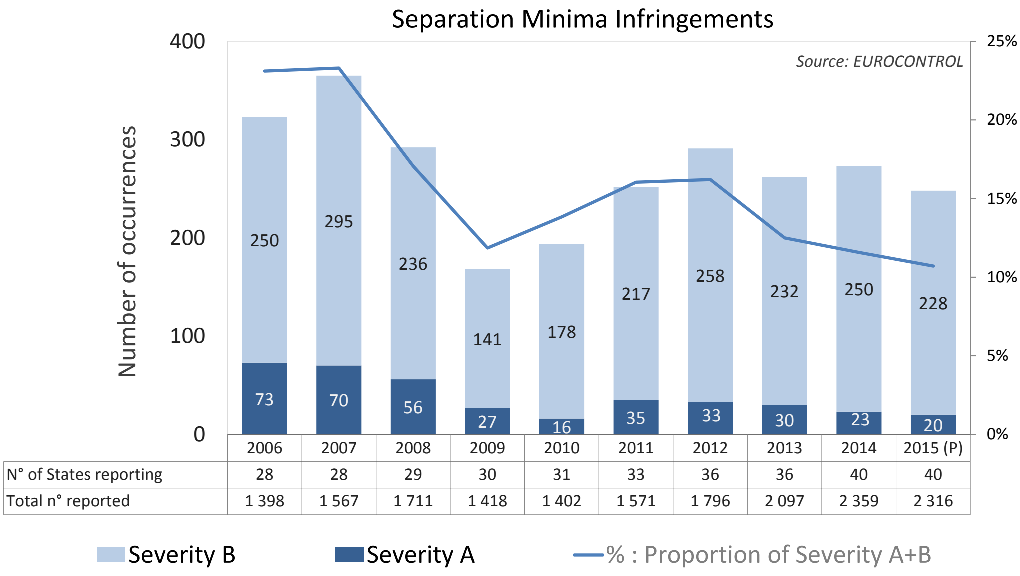
Figure 3-7 depicts the number of reported risk-bearing SMIs (Severity A and B) in EUROCONTROL airspace between 2006 and 2015(P).

Preliminary data suggests a 2% decrease in the total number of reported Separation Minima Infringements (SMIs) in 2015.

Following the increase in 2014, risk bearing SMIs decreased again in 2015 to approximately 10.7% of the total number of reported SMIs (based on preliminary data).

In absolute terms, preliminary 2015 data suggests a small decrease of Severity A SMIs (from 23 in 2014 to 20 in 2015) and also a decrease in the number of Severity B SMIs (from 250 in 2014 to 228 in 2015).

[35] These issues have also been identified in a number of States during ICAO USOAP audits.



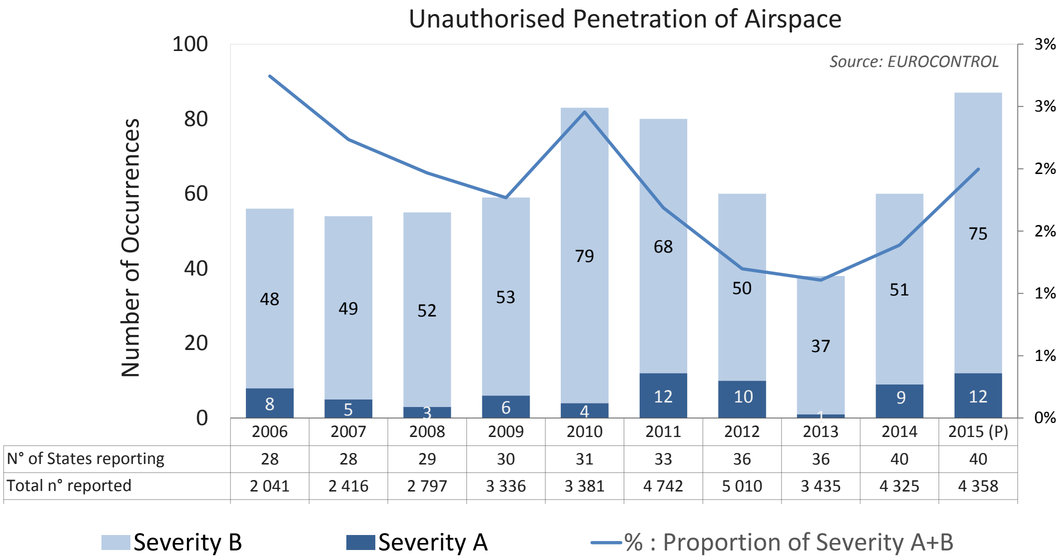
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015 (P)
N° of States reporting	28	28	29	30	31	33	36	36	40	40
Total n° reported	1 398	1 567	1 711	1 418	1 402	1 571	1 796	2 097	2 359	2 316

Figure 3-7: Reported high-risk SMIs in EUROCONTROL States (2006-2015P)

3.3.2 Airspace - Unauthorised Penetration of Airspace

The total number of Unauthorised Penetrations of Airspace (UPAs) in 2015 (based on preliminary data), also known as Airspace Infringements (AIs), reported in EUROCONTROL Member States shows almost no change (0,8%), compared to 2014.

As illustrated in Figure 3-8, the share of risk bearing (Severity A and B) UPAs, within total reported UPAs, increased in 2015 to almost 2%. Based on preliminary data, both risk bearing categories show an increase in absolute terms in 2015 (Severity A from 9 to 12 and Severity B from 51 to 75).



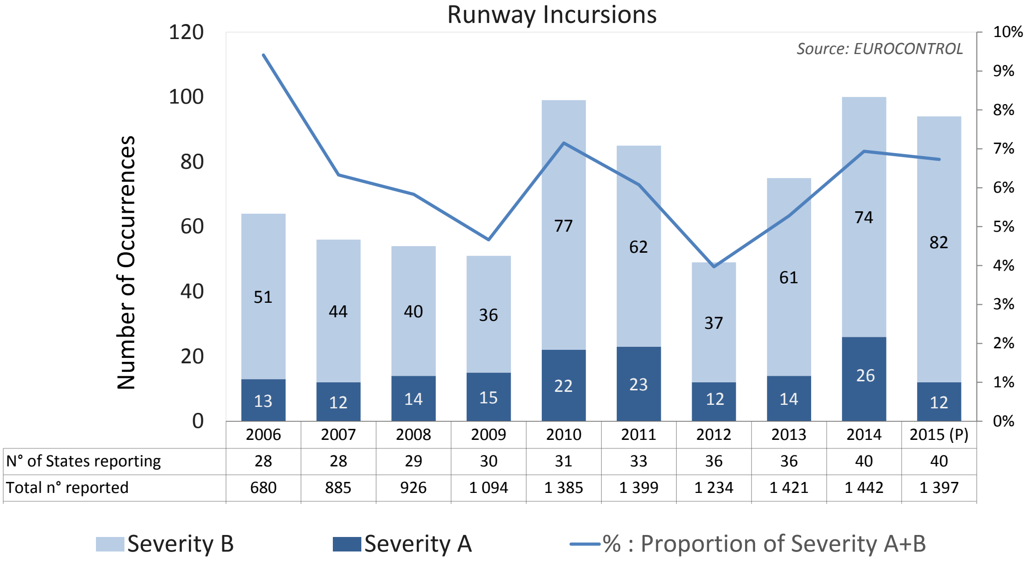
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015 (P)
N° of States reporting	28	28	29	30	31	33	36	36	40	40
Total n° reported	2 041	2 416	2 797	3 336	3 381	4 742	5 010	3 435	4 325	4 358

Figure 3-8: Reported high-risk UPAs in EUROCONTROL States (2006-2015P)

3.3.3 Airports - Runway Incursions

Total reported Runway Incursions (RI) in EUROCONTROL Member States decreased by approximately 3% in 2015 (based on preliminary data).

Overall, risk-bearing RIs (Severity A and B) showed a decrease of approximately 3% in 2015 (Figure 3-9). Severity A RIs decreased from 26 in 2014 to 12 in 2015 whilst the number of Severity B RIs increased from 74 in 2014 to 82 in 2015.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015 (P)
N° of States reporting	28	28	29	30	31	33	36	36	40	40
Total n° reported	680	885	926	1 094	1 385	1 399	1 234	1 421	1 442	1 397

Figure 3-9: Reported high-risk RIs in EUROCONTROL States (2006-2015P)

3.3.4 ATM Specific Occurrences

This section provides a review of the evolution of the risk bearing ATM specific occurrences reported through the AST, as updated in the April 2015 reporting cycle. ATM specific occurrences encompass those situations where the ability to provide safe ATM services is affected. Therefore, this type of occurrence typically includes failures that would affect the ANS providers' capability to deliver safe ATM services.

Based on preliminary 2015 data, the total number of reported ATM specific occurrences increased by approximately 35% in 2015. Figure 3-10 shows that the risk-bearing ATM specific occurrences only increased by 0.6% during the same time.

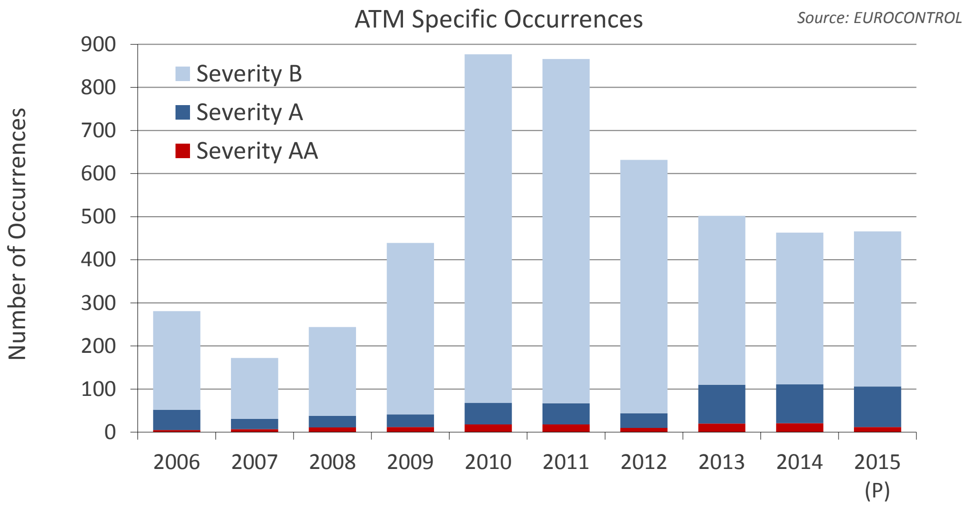


Figure 3-10: Reported high-risk ATM Spec. Occurrences in EUROCONTROL States (2006-2015P)

3.4 Reporting and Investigation

This section provides a review of the quality and completeness of ATM safety occurrences (operational and ATM specific occurrences) reported through the AST reporting mechanism, as updated in September 2015 (where applicable).

3.4.1 Total number of reported occurrences

For each EUROCONTROL Member State, the level of reporting is measured by normalising the total number of reported ATM-related occurrences against the number of flight hours in the State. The main influencing factors for the level of reporting are the level of Just Culture and the effectiveness of the Mandatory Occurrence Reporting Systems (MORS). However, the influencing factors are not presented in this report.

The annual level of ATM-related incident reporting in Figure 3-11 is compared to the average ECAC reporting level in 2003, which represents the brown baseline.

According to preliminary data, the number of Member States reporting above the baseline in 2015 (23) remained the same as in 2014. In addition, the number of States reporting during both periods was also the same. More precisely, both final 2014 and preliminary 2015 data were received from 40 States (a record level achieved in 2014).

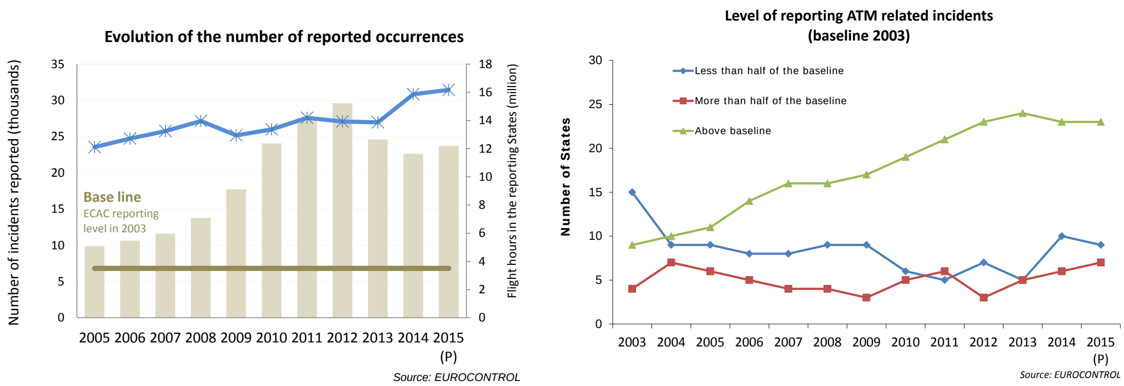


Figure 3-11: Total number of reports and level of reporting (2004-2015P)

After the continuous increase in the total number of incidents reported by Member States between 2004 and 2012, the number of reported occurrences decreased between 2012 and 2014. However, based on preliminary results, the number of reported ATM related incidents slightly increased again in 2015 (+5% vs. 2014).

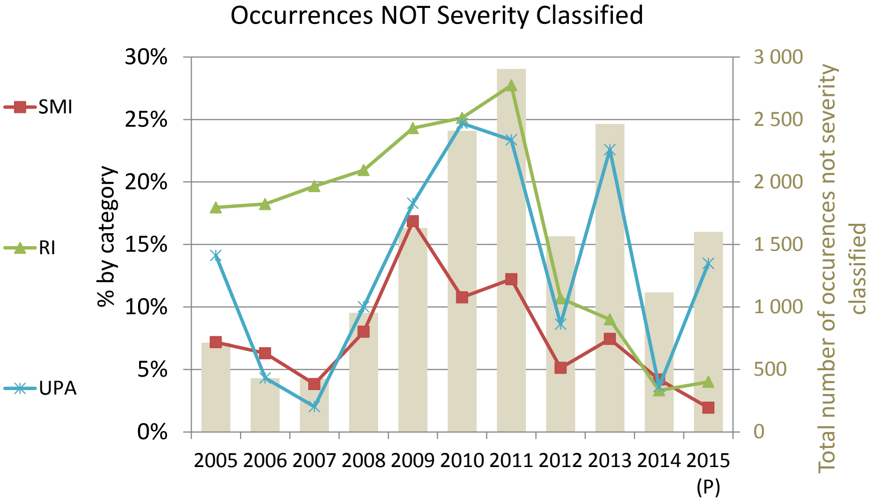
Nevertheless, the available data does not allow drawing conclusions if the observed year on year change represents a genuine safety performance variation or if it is due to different reporting levels.

In 2015, based on preliminary data, a decrease in reporting was observed for States with a low level of reporting (less than half the baseline). At the same time, there was an increase in reporting from States reporting above the baseline. Also note that a number of States which had not reported before 2013 have now started to report, but at low levels.

3.4.2 Unclassified or undetermined occurrences

Figure 3-12 shows the number of ATM-related incidents not severity classified or with severity classification not determined (Severity D) for different occurrences categories. The analysis is based on the data submitted via AST in April 2015, covering the reporting year 2014 (final) and 2015 (preliminary).

Although the situation is much better as in the period 2011-2013, based on preliminary data, 11% of reported occurrences were still not severity classified in 2015. If the occurrences where the severity is 'not determined' are added (i.e. some data provided but insufficient to fully assess the severity), the percentage rises to just above 16%.



Source: EUROCONTROL

Figure 3-12: Severity not classified or not determined (2005-2015P)

Considering each type of occurrence separately (not just SMIs, RIs and UPAs), the percentage varies between 2% and 13%. If the occurrences where the severity is *"not determined"* (i.e. some data provided but not enough to fully assess the severity) are also included, the range increases to 3% and 23% of total number of reported occurrences in each occurrence category.

A decrease of the percentage of occurrences not severity classified in 2014 is reported for all types of occurrences, while preliminary data in 2015 shows increase in UPAs and RIs. Although 2014 results are promising, considering the fact that the application of the severity classification based on the Risk Analysis Tool (RAT) methodology to the reporting of occurrences is a key safety performance indicator of the Single European Sky (SES) Performance Scheme, further actions are needed to ensure the gap is closed.

The percentage of SMI occurrences not severity classified decreased from approximately 4% in 2014 to 2% in 2015. If the SMIs where the severity was not determined (severity class D) are added the percentage rises to 3%.

The percentage of RIs occurrences not severity classified increased from 3.3% in 2014 to 4% in 2015. However, if the situation where the severity is absent is added it amounted to approximately 9%.

Although the number of *unclassified* or *not determined* incidents is still higher than in 2006/7, there has been a notable improvement.

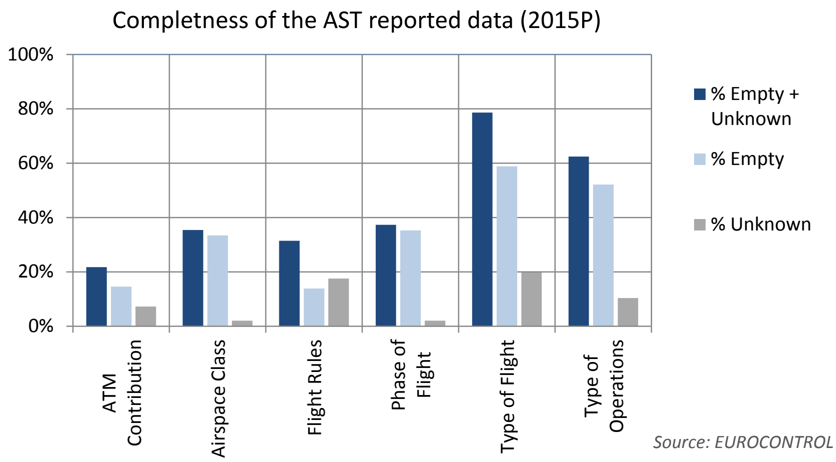
As already pointed out in several previous reports, the situation needs to be monitored as the quality and completeness of safety data can impact the outcome of the analysis at European and national level, the sustainability of the human reporting system[36] and can also have other potential downstream repercussions such as the inadequate prevention of similar incidents or inadequate sharing and dissemination of lessons learned.

3.4.3 Completeness of safety data reported via the AST mechanism

Figure 3-13 shows the typical fields that are either left blank or marked *Unknown* in the AST, submitted by the EUROCONTROL Member States in 2015 (based on preliminary data).

It is of concern that a large share of the data required to populate a number of fields is still missing. This lack of completeness of AST data hampers comprehensive safety analysis at European level.

36 When ATCOs or pilots provide safety reports, if feedback is not provided it can have an adverse impact on the motivation to report.



ATM contribution = direct; indirect; none

Airspace Class = Class of airspace: A,B,C,D,E

Flight Rules = IFR or VFR

Phase of Flight = taxi, take-off, climb to cruise, cruising, approach

Traffic of Flight = General Air Traffic, Commercial, Military

Type operation = GAT or OAT

Figure 3-13: Completeness of AST reported data in 2015(P)

3.4.4 Automatic safety data monitoring - Implementation Status (2015)

In last year's PRR, the PRC reiterated that the current manual reporting should be complemented by independent monitoring based on automatic safety data acquisition tools. Moreover, the PRC concluded that there is a need to accelerate the deployment of automatic safety data reporting tools in Europe in order to improve the reporting culture and consequently the level of reporting and recommended and encouraged States to do so.

This section provides an update of the implementation status of various automatic safety data solutions in EUROCONTROL States.

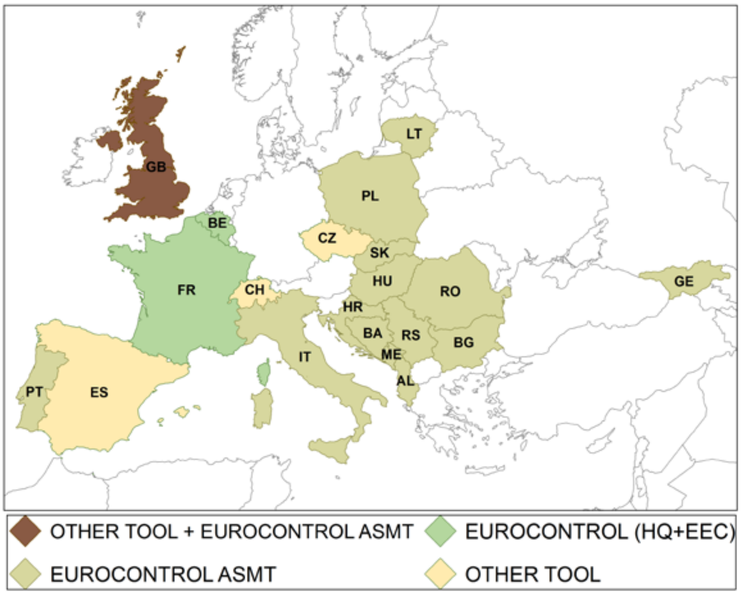


Figure 3-14: States with automatic reporting tools (2015)

Figure 3-14 displays the current status of deployment of the EUROCONTROL Automatic Safety Monitoring Tool (ASMT) as well as equivalent/comparable tools[37] in EUROCONTROL States.

Based on information provided by the Network Manager, the ASMT was deployed and used by 18 Member States in 2015, which represents an increase of +4 States compared to 2014.

As indicated in previous PRRs, one of the widely deployed systems in Europe for the detection of potentially unsafe runway events (runway safety nets for controllers) is provided through the Advanced Surface Movement Guidance & Control System (A-SMGCS).

Similarly to last year's observation, the implementation levels of the A-SMGCS of both Level 1 (Improved Surveillance) and Level 2 (Surveillance + Safety Nets) for 2014 indicate that additional work is still needed in order to achieve the objectives set in the ATM Master Plan by the end of 2017 (even though the majority of the participating airports declared that they will achieve the objectives by the end of 2015) [Ref. 17]. Although, A-SMGCS Level 2 may bring safety benefits, it has to be

37 Note that information on comparable tools might be incomplete, as additional organisations may be using similar tools that PRC was not aware of at the time of publishing of this report.

noted, that it will not enable complete automated reporting of events.

Figure 3-15 shows the implementation status of A-SMGCS Levels 1 and 2. The analysis excludes airports which declared that this objective is "not applicable" to them. The applicability area includes only airports for which the objective is likely to deliver significant benefits.

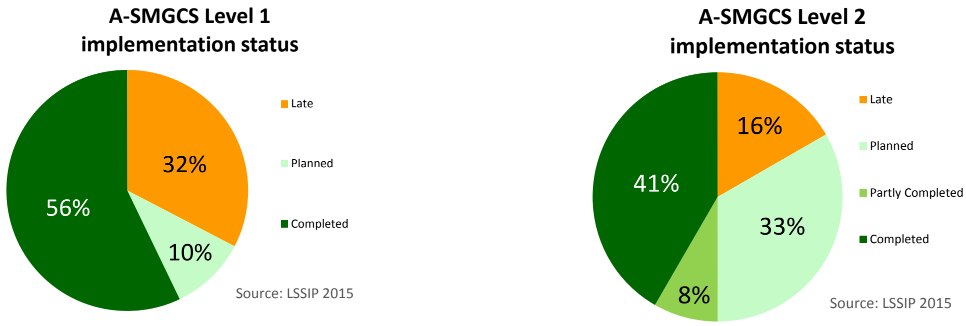


Figure 3-15: A-SMGCS implementation status

Out of 71 airports in EUROCONTROL Member States, which are addressed through the ESSIP/LSSIP process (airports participating in airport implementation objectives and/or are main airports of a Member State), 50 had or have the intention to implement A-SMGCS Level 1 and 49 airports Level 2.

The implementation date for Level 1 was December 2011. LSSIP 2015 states that only 56% of the 50 (applicable) airports have achieved full operational capability. The 21 airports lagging behind with the implementation of A-SMGCS Level 1 are shown in Figure 3-16 below (they are either reported "late" or "planned" level).

Airport	Country	Airport	Country	Airport	Country
Sofia (LBSF)	Bulgaria	Milano Malpensa (LIMC)	Italy	Bucharest (LROP)	Romania
Zagreb (LDZA)	Croatia	Milano Linate (LIML)	Italy	Barcelona (LEBL)	Spain
Toulouse (LFBO)	France	Venezia (LIPZ)	Italy	Palma de Mallorca (LEPA)	Spain
Marseille (LFML)	France	Roma Fiumicino (LIRF)	Italy	Kyiv Boryspil (UKBB)	Ukraine
Düsseldorf (EDDL)	Germany	Chisinau (LUKK)	Moldova	Birmingham (EGBB)	United Kingdom
Athinai Eleftherios Venizelos (LGAV)	Greece	Warszawa (EPWA)	Poland	Manchester (EGCC)	United Kingdom
Thessaloniki/Makedonia (LGTS)	Greece	Lisboa (LPPT)	Portugal	London Heathrow (EGLL)	United Kingdom

Source: LSSIP 2015

Figure 3-16: Airports late for A-SMGCS Level 1 implementation

Insofar as Level 2 is concerned, the deadline for full operational capability is December 2017 (ATM Master Plan). Out of 49 applicable airports, 21 airports (41%) had fully implemented Level 2 by 2015.

The use of A-SMGCS or other equivalent runway safety programmes to improve reporting and safety performance is strongly encouraged by the PRC.

3.5 Aviation Safety Risk

Accidents and incidents in ATM are reducing; ANSPs are reporting extended periods when no incidents are recorded that have an ATM contribution. However, this reduced number of observed occurrences, taken as an indication that safety is increasing, cannot be grounds for complacency. The reduction cannot be taken for granted and neither can the belief that there are no remaining risks in operations. To continue to improve aviation safety might focus on:

- better understanding of successful outcomes to make sure that operations will remain at least as safe as when undergoing changes to the air traffic operations; and,
- detecting unsafe trends before they end up in severe events, such as SMI or RI.

The PRC is actively monitoring developments on the work related to aviation safety risk, including the recent cooperation between the Federal Aviation Administration (FAA) and EUROCONTROL, which includes further development of the Integrated RiSk (IRiS) model (see ANNEX IV for further details).

Models, such as IRiS, enable to focus on factors that indicate in which direction safety is moving, before a 'top event' is registered. They generate a framework that shows how barriers prevent occurrences from propagating into incidents and then accidents (i.e. where safety margins are being protected) and series of pre-cursors could be derived that describe how safety trends are developing over time (i.e. not relying on top events). Focussing on lower level (precursor) events provides the opportunity to monitor safety (a) in the absence of major safety incidents (b) pro-actively not requiring a safety event to happen before understanding the direction of the safety trend. In summary, these types of models can generate a portfolio of indicators that allows ongoing monitoring of eventual unsafe events, but also provide for:

- Safety performance indicators coming out of the success of the ATM barriers / layers;
- Non reliance on voluntary reporting of lagging indicators.

As a result, building on the work of performance monitoring in the past (including Performance Scheme safety indicators) and the establishment of requirements for automated safety operational data monitoring (as of RP2), a future period might:

- Identify safety barriers in operations and understand the events that contribute to their failure;
- Identify hard data points that allow the pre-cursor events leading to top incidents to be monitored; and,
- Identify a mechanism whereby the influences that rapidly move an event from non-significant to a 'near MAC' can be described succinctly using a common framework.

This approach would best be provided for with:

- The development, harmonisation and eventually establishment of the automatic safety/operational data monitoring as supported by the EUROCONTROL PRR 2013 Report [Ref. 18];
- Automatically managed and near-real-time data analysis to providing consistent outputs; and,
- An encapsulating safety risk management framework that provides the structure for the pre-processed data so that it makes sense to the aviation business users and adds value for decision makers.

3.6 Acceptable Level of Safety Performance

The development of a European concept of Acceptable Level of Safety (ALoS), and even additional indicators have been advocated by the PRC for some time now as a requirement to show what exactly is happening to the aviation system and what and where the real risks are. The heart of the matter was previously the ALoS (ICAO Annex 11 para. 2.27) and is now the Acceptable Level of Safety Performance (ALoSP) (ICAO Annex 19 para. 3.1.2) which is also embedded in the ICAO Safety Management Manual (SMM)Doc 9859.

ICAO Annex 19 sets out the requirement for states to establish a State Safety Programme (SSP) in order to achieve an ALoSP in a number of activities including the provision of air traffic services. ICAO standards also explicitly require States to establish an ALoSP to be achieved, as a means to verify satisfactory performance of the SSP and service providers' SMS. ICAO SMM (Doc 9859) [Ref. 19] provides guidance on how to define an ALoSP.

3.6.1 What is ALoSP?

According to ICAO Safety Management Manual (SMM), ALoSP is defined as: "*The minimum level of safety performance of civil aviation in a State, as defined in its State Safety Programme, or of a service provider, as defined in its safety management system, expressed in terms of safety performance targets and safety performance indicators*". A State's ALoSP should be pertinent to its safety policy and objectives.

The ALoSP concept complements the traditional approach to safety oversight that is primarily focused on prescriptive regulatory compliance with a performance-based approach that defines actual safety performance levels within a prescribed SSP framework. The rationale is that the risk mitigation process should reduce the overall safety risk to as low as reasonably practicable and to at least an acceptable level.

The ALoSP definition within the SSP and the Safety Management System (SMS) is important because it indicates what the State and the service provider want to achieve, hence it can be used to verify if the State/service provider is achieving its goals.

3.6.2 Current situation in Europe

The preparation of the SSP safety plans also requires the identification of safety risks and respective safety performance indicators and represents a crucial milestone towards the new performance-based approach of ICAO and EASA.

In 2011, qualitative analysis of SSPs revealed that even States with an advanced SSP implementation, have not yet fully established ALoS in accordance with, at that time, ICAO Annex 11 requirements. This was typically explained by a statement that the approval of the State ALoS awaits the development of a common European approach to ALoS.

More recently, based on results of the EASA SSP Phased Implementation Survey Results from 2014 [Ref. 20], three out of five identified less advanced elements of SSP implementation (which means implementation level is < 35% completed) were related to safety performance monitoring. These critical areas were:

- SSP element 2.2 - Service provider safety performance indicators (21%);
- SSP element 3.1 (ii) - Incorporation of service providers' SMS and safety performance indicators as part of routine surveillance program (31%); and
- SSP element 3.2 (ii) - Establish lower consequence safety indicators with target/alert level monitoring as appropriate (21%).

A lack of guidance on these issues probably still plays a part in the lack of the implementation of these critical elements.

3.6.3 Regulatory issue

The European Commission is responsible for setting the performance targets, including safety, under the Performance Regulation [Ref. 21]. At the same time EASA is working to comply with the ICAO request to make a clear distinction between "performance regulation" and "compliance regulation".

In addition, EASA has also been asked by the European Commission to harmonise European air rules to facilitate the implementation of the Single European Sky and FABs. However, until now the ALoSP concept went untouched by EASA and it escaped both the revision of Commission Regulation 2096/2005 [Ref. 22] and the revision of Commission Regulation 1315/2007 [Ref. 23] (i.e. concept not defined within Commission Implementing Regulation (EU) No 1034/2011 on safety oversight in air traffic management and air navigation services [Ref. 24]). It also escaped the transposition of ICAO Annex 11 in the context of Standardised European Rules of the Air (SERA).

Furthermore, the Performance Review Body (PRB) has also contacted EASA asking that this situation comes to an end. This was expressed in a recommendation for the second reference period of the SES performance scheme (RP2): *A common and harmonised European methodology for development of safety performance indicators and corresponding targets on State level (taking into account EU-wide performance targets) is needed.*

Moreover, the need for guidance material on how to define ALoSP and how to measure performance was constantly cited by the Regulators. Together with the lack of competent technical staff this still represents one of the biggest obstacles to making progress on this matter in Europe.

The Safety Management International Collaboration Group (SM ICG)[38] is working to review and potentially expand the current ALoSP definition and to provide supporting guidance on its meaning and how a State would establish acceptable levels of safety for its industry. However, the outcome and proposal are not yet available.

Europe still lacks a definition and guidance on the development of ALoSP. This puts the aviation community currently in a strange situation where service providers could (and some already are) establish safety targets on their own (although consistency with the national SSP should be ensured, however still at their own ANSP judgement), and NSAs are requested to monitor something which was decided by ANSPs.

An additional element was recently introduced by the concept of the harmonised European Performance Based Environment (PBE) - *an environment based on safety performance indicators (SPIs) on which safety assurance and promotion as well as performance based regulation and performance based oversight can be built*. As such, a PBE depends on the ability of competent authorities and organisations to specify, measure, and monitor performance. The introduction of performance based regulation requires a fundamental change in the safety regulatory mind-set and the concepts enabling a PBE were supposed to be considered in the on-going review of the Basic Regulation.

The work is on-going in the context of the European Plan for Aviation Safety (EPAS) to develop appropriate performance metrics and in that context the EPAS may include - taking into account the objective of the European Aviation Safety Policy - an acceptable level of safety performance to be achieved in the European Union. However, although the current (published in December 2015) revised version of the European Aviation Safety Programme (EASP) [Ref. 25], conforms to the ICAO SSP framework, and introduces the concept of ALoSP, it does not provide any harmonised approach on how to define SPIs and appropriate safety targets. An acceptable level of safety performance to be achieved by the Member States relies on adopted self-imposed national performance targets.

3.6.4 Challenge

The definition and guidance on the development of ALoSP is currently not available in Europe. While there is an urgent need to provide this type of support and guidance to states, it is still not clear how this concept will be introduced within the regulatory environment.

The ALoSP concept could be included in EASA Basic Regulation or in the Performance Scheme. However, whichever route the process takes, it is clear that a common approach to measuring and managing safety performance from a regulatory perspective would also ensure a harmonised implementation of the SSP and facilitate the exchange of safety information in the future.

3.7 Occurrence Reporting Regulation – what to expect

3.7.1 Occurrence reporting promise

As of 15 November 2015, aviation professional staff will be able to report safety incidents under the revised EU-wide regime for occurrence reporting. The new EU Occurrence Reporting Regulation (EU) No 376/2014 (ORR), on 3 April 2014 [Ref. 26] represents a major step towards a pro-active, evidence-based aviation safety management system, aimed at preventing air accidents and incidents in Europe.

Although the previous EU Directive 2003/42/EC [Ref. 27] had already established the basis for mandatory safety occurrence reporting systems, there were several shortcomings related to the lack

[38] Group founded by the United States Federal Aviation Administration (FAA), the European Aviation Safety Agency (EASA) and Transport Canada Civil Aviation represents a joint cooperation between many regulatory authorities for the purpose of promoting a common understanding of safety management and Safety Management System (SMS)/State Safety Program (SSP) principles and requirements, facilitating their implementation across the international aviation community.

of protection of the reporters, the lack of harmonisation in the occurrence data collection and integration, which all led to low quality reports and incomplete information. Lastly, the lack of requirements regarding safety analysis and recommendations (including follow-up by the Member States) was also perceived as a major shortcoming.

The new ORR shifts the focus from a ‘reactive’ system to a pro-active, risk- and evidence-based system. It acknowledges that safety occurrence data is vital to allow the timely identification and management of potential safety hazards – before they turn into an actual accident. It also promises to create a stronger ‘Just Culture’ environment, where employees can benefit from improved provisions against the inappropriate use of safety information and from a stricter protection of the reporter of a safety occurrence (e.g. companies will have to develop internal rules describing how the Just Culture principles are guaranteed and implemented).

The new EU Occurrence Reporting Regulation sets a comprehensive framework and standards for reporting, collecting, storing, protecting and disseminating the relevant safety information. It also introduces requirements on information analysis and adoption of follow-up safety actions at national level.

The central pillar of Europe’s future occurrence reporting system will be EASA. The ORR preserves EASA’s active involvement in a number of concrete ways:

- Safety occurrences collected will be transmitted to Member States’ competent authorities and to EASA;
- All occurrences collected by Member States, organisations and EASA will be aggregated into the European Central Repository (ECR), and EASA and Member States have access to all data and information contained the ECR database;
- EASA and Member States will analyse (and exchange) the information contained in the ECR, within the ‘Network of Aviation Safety Analysts’ (the NoA is chaired and organized by EASA);
- This analysis will complement what is done at national level, e.g. by identifying possible safety problems and key risk areas at European level, and will be further used to inform the European Aviation Safety Program (prepared by the European Commission) and the European Plan for Aviation Safety (prepared by EASA);
- EASA (as well as Member State and the European Commission) are bound by strict confidentiality requirements related to the safety information and the reporters of such information;
- EASA advises the European Commission (and Member State) in the ‘EASA Committee’, which will cover matters related to occurrence reporting.

A central role for EASA will be necessary for the new occurrence reporting system to run smoothly and in a coordinated manner while still allowing Member States to remain fully involved and engaged.

3.7.2 Occurrence reporting reality

Process-wise, the new ORR introduces many improvements. However the question is whether the quality and completeness of the data in the ECR can support occurrence reporting requirements and the promises it makes. Considering the current shortcomings of the supporting ECCAIRS system (European Co-ordination Centre for Accident and Incident Reporting Systems) and old regulation, it might take a considerable amount of time before ECR can provide results that could support objective safety performance analysis in Europe.

Based on the past analysis performed jointly by EUROCONTROL and EASA, the ECR is presently highly exposed to the risk of storing a considerable amount of duplication because an occurrence taking place in one Member State and involving an aircraft operator from another EU Member State may be reported by both States. It is worth mentioning that such problems do not occur in the EUROCONTROL AST reporting mechanism as the reporting is done for all occurrences taking place in a Member State.

In addition, a considerable number of occurrences reported to the ECR are currently marked 'incident' in respect of the 'Occurrence Class'. This does not represent a detailed severity category and cannot be, for example, mapped against any of the existing severity categories in the AST reporting mechanism.

At the moment JRC Ispra[39] provides technical support and training courses to ECCAIRS users. However, there is no European entity in charge for assessing ECR quality and completeness and to provide continuous support to States for filing information correctly.

3.7.3 Challenge

The current safety reporting environment is changing and it has to be accepted that the next few years will be a transition phase. During this time, in order to maintain and improve European reporting, it is important that several actors need to work together in order to create an optimum solution.

Presently, the ECCAIRS system is not ready to replace the AST reporting mechanism and there is a risk of losing safety intelligence if no appropriate solution is found. For example, the use of the Risk Analysis Tool (RAT) methodology as a performance indicator in the second reference period of the Single European Sky Performance Scheme is currently still mainly reported via the AST mechanism.

Although the ECR allows, as of 2015, reporting of the RAT application as well, a majority of States have indicated that the AST will remain their reporting channel. This situation introduces possible problems in terms of harmonisation of both collection and verification processes. Not finding an appropriate workable solution between two reporting channels and their responsible entities can potentially lead to a significant risk to measuring RAT application, as the quality of the available data might substantially deteriorate.

Moreover, the AST mechanism needs to be adapted to a reporting baseline compatible with the one set by the new Reporting Regulation (EU) No 376/2014 [Ref. 26] and Implementing Regulation (EU) 2015/1018 [Ref. 28] in the ATM domain. The harmonisation of the two systems would ensure an identical reporting baseline for the EU and non-EU EUROCONTROL Member States.

Work is currently ongoing within EUROCONTROL to harmonise the types of occurrences processed via the AST mechanism with the ATM-related safety occurrences defined in Annex 3 of Regulation 2015/1018 [Ref. 28].

3.8 Conclusions

The definition and guidance on the development of Acceptable Levels of Safety Performance (ALoSP) is currently not available in Europe. While there is an urgent need to provide this type of support and guidance to States, it is still not clear how this concept will be introduced within the regulatory environment. A common approach to measuring and managing safety performance from a regulatory perspective would also ensure a harmonised implementation of State Safety Programmes (SSP) and facilitate the exchange of safety information in the future.

The current safety reporting environment is changing and it has to be accepted that the next few years will be a transition phase. During this time, in order to maintain and improve European reporting, it is important that actors responsible for the collection of safety data work together in order to create an optimum solution.

Nevertheless, the PRC has to express its concern that during this transition phase, availability, completeness and quality of safety data may deteriorate due to the lack of arrangements between all parties involved in the process.

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[39] The central repository and exchange of information between the national databases of the EU Member States is supported by the European Commission through the ECCAIRS system (European Co-ordination Centre for Accident and Incident Reporting Systems), managed by the Joint Research Centre of the European Commission.

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4 Operational en-route ANS Performance

KEY POINTS

- Total en-route ATFM delays, for the EUROCONTROL area, increased by +23% in 2015 which corresponds to 0.73 minutes of en-route ATFM delay per flight (0.61 in 2014).
- The most constraining ACCs in 2015 were Nicosia, Brest, Lisbon, Athinai/Macedonia, Zagreb, Reims, and Barcelona. Together they controlled 14.5% of total flight hours in Europe but accounted for 58.1% of all en-route ATFM delays in 2015.
- After the continuous improvement over the past years, horizontal en-route flight efficiency deteriorated in 2015. At European level, the inefficiency in filed flight plans increased from 4.70% to 4.74% in 2015. Inefficiencies in actual trajectories increased at a slightly higher rate from 2.72% to 2.77% in 2015.
- The review of arrangements for civil military coordination and cooperation carried out in 2015 showed a lack of information transfer among involved parties in a number of States.

KEY DATA 2015

	2015	change vs. 2014
IFR flights controlled	9.75M	+1.5% ↑
Capacity: En-route ATFM delays		
Total en-route ATFM delay (min.)	7.2M	+23.3% ↑
Average en-route ATFM delay per flight (min.)	0.73	+0.12 ↑
Flights delayed > 15 min. en-route (%)	2.0%	+0.4%pt. ↑
Environment: Flight inefficiency		
Avg. horizontal en-route inefficiency (flight plan)	4.74%	+0.04%pt. ↑
Average horizontal en-route inefficiency (actual)	2.77%	+0.05%pt. ↑

4.1 Introduction

This chapter reviews operational en-route ANS performance in Europe in 2015.

Section 4.2 reviews Air Traffic Flow Management (ATFM) delays originating from en-route restrictions. Section 4.3 evaluates horizontal en-route flight efficiency in Europe. Civil military arrangements including the results from questionnaire on civil military coordination and cooperation are addressed in Section 4.4.

4.2 En-route ATFM delays

En-route ATFM delays, for the EUROCONTROL area, increased by +23.3% in 2015 which corresponds to 0.73 minutes of en-route ATFM delay per flight (0.61 in 2014).

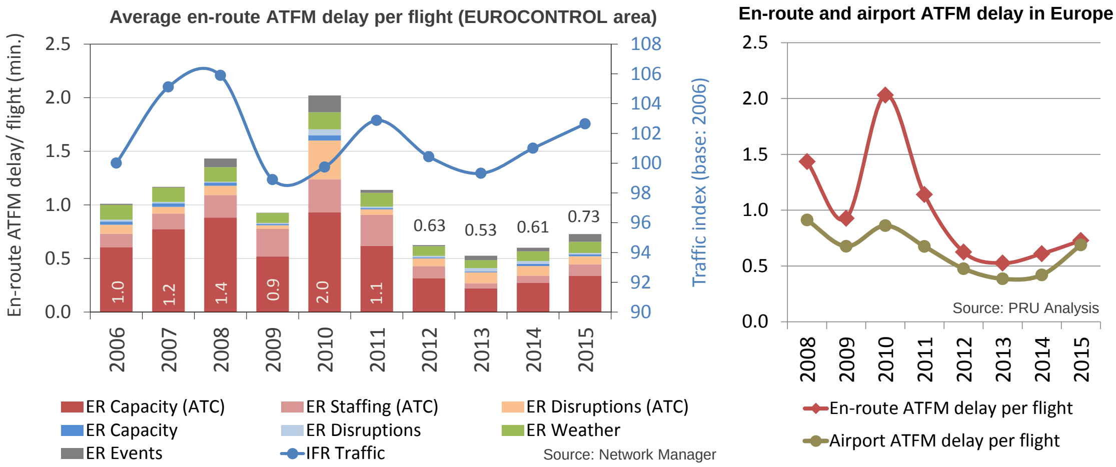


Figure 4-1: Average en-route ATFM delay in Europe

The right side of Figure 4-1 shows average en-route ATFM delays together with airport arrival ATFM delays between 2008 and 2015. After the peak in 2010, en-route ATFM delays decreased until 2013 before rising again since 2014. Although the gap narrowed considerably since 2010, on average, airport arrival delays are still slightly below en-route ATFM delays in 2015. They are addressed in more detail in Chapter 5 of this report.

Capacity (ATC) and Staffing (ATC) related delays increased in 2015. They remain the main driver of en-route ATFM delays, followed by weather, Disruptions (ATC) which comprises, inter alia, ATC industrial actions, and special events.

The number of flights affected by ATFM en-route delays increased further from 3.2% to 3.9% in 2015.

Overall, 2.0% of the flights in Europe were delayed by more than 15 minutes due to en-route ATFM regulations, compared to 1.6% in 2014.

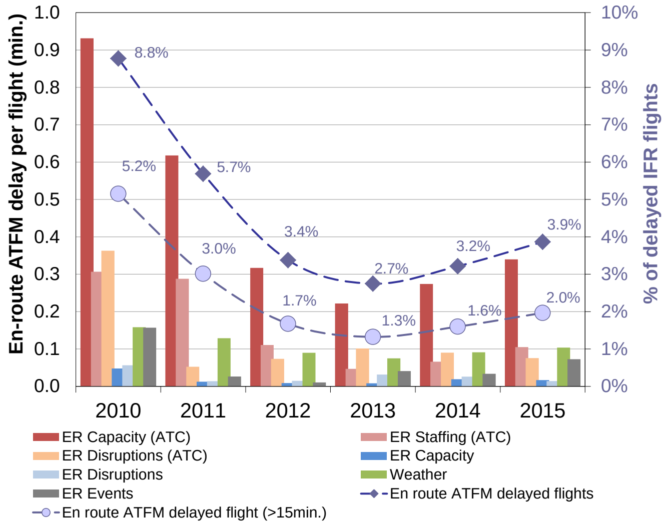
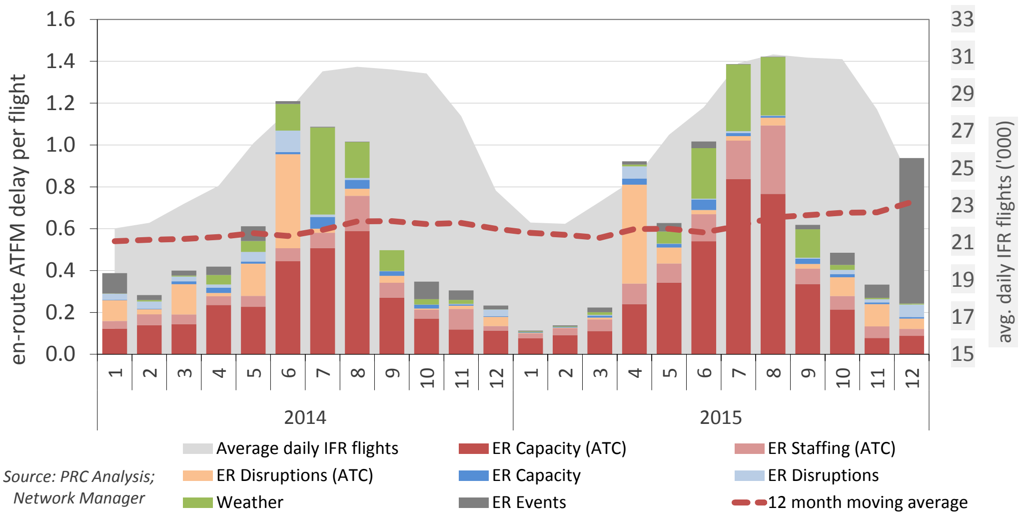


Figure 4-2: En-route delay per flight by classification

Figure 4-3 shows the monthly evolution of en-route ATFM delays and IFR flights in Europe between 2014 and 2015.



Source: PRC Analysis; Network Manager

Figure 4-3: Monthly evolution of en-route ATFM delays (2013-2015)

4.2.1 Local ATFM en-route performance per ACC

While capacity constraints can occur from time to time, ACCs should not generate high delays on a regular basis. Figure 4-4 shows the delay performance in terms of the number of days with significant en-route ATFM delays (>1 minute per flight). As in previous years, the selection threshold for the table in Figure 4-4 was set at greater than 30 days and the most constraining ACCs are analysed in more detail in the next sections of this chapter.

	En-route ATFM delay									Traffic demand		
Most constraining ACCs in 2015	Days en-route ATFM >1 min.	En-route delay /flight (min.)	% of flights delayed >15 min.	En-route delay ('000)	Capacity & Staffing (ATC)	Disruptions (ATC)	Weather	All other delay causes	% of total en-route delay	Traffic growth vs 2014 (%)	5 Year Annual average growth rate (10-15)	% of total flight hours 2015
Nicosia	221	2.47	6.9%	787	90%	4%	0%	6%	**11.0%**	4.8%	2.4%	**1.1%**
Brest	127	1.41	3.8%	1 305	40%	12%	1%	47%	**18.2%**	-0.8%	2.6%	**3.4%**
Lisboa	67	0.51	1.5%	243	83%	6%	1%	10%	**3.4%**	5.1%	3.3%	**2.2%**
Athinai+Macedonia	63	0.99	2.8%	680	99%	1%	0%	0%	**9.5%**	5.4%	1.5%	**3.1%**
Zagreb	61	0.57	1.7%	286	71%	0%	29%	0%	**4.0%**	0.8%	3.0%	**1.3%**
Reims	53	0.55	1.5%	516	62%	24%	14%	1%	**7.2%**	2.1%	3.8%	**1.8%**
Barcelona AC+AP	37	0.46	1.3%	350	77%	5%	18%	0%	**4.9%**	2.1%	0.3%	**2.3%**

Figure 4-4: Overview of most constraining ACCs (2015)

The most constraining ACCs in 2015 were Nicosia, Brest, Athinai and Macedonia, Zagreb, Lisbon, Reims, and Barcelona. Together, they accounted for 58.1% of all en-route ATFM delays but only 14.5% of total flight hours controlled in Europe.

Figure 4-5 shows the evolution of ATFM en-route delays over the past five years at the most constraining ACCs listed above. The delay classifications, as reported by the local flow management positions (FMP), are provided and, in order to give an indication of the traffic level, the number of controlled IFR flights is plotted as a blue line.

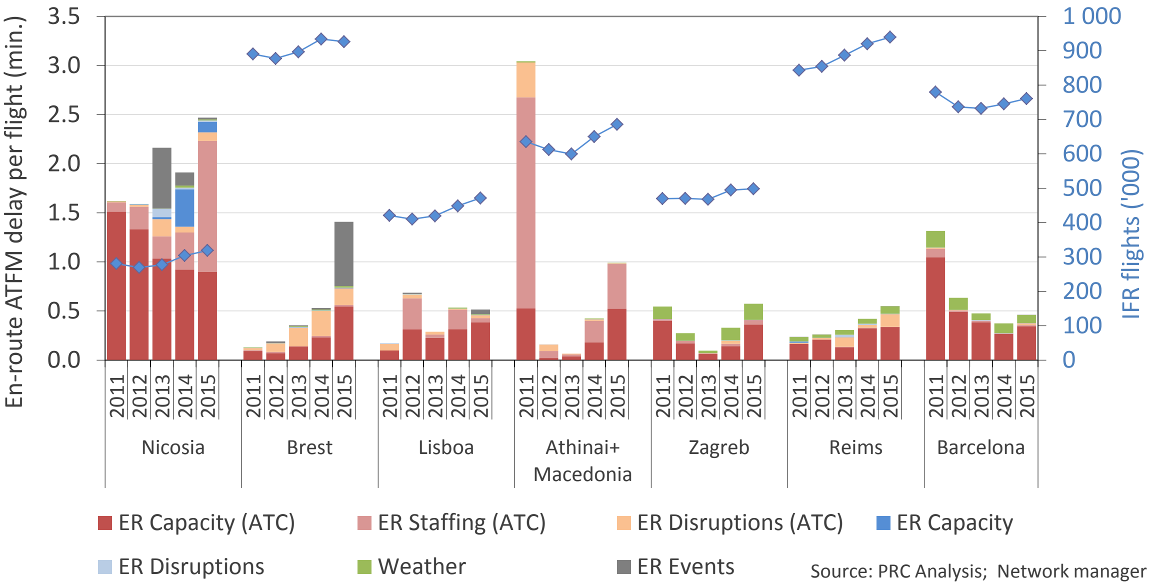


Figure 4-5: Delay categories for most constraining ACCs

Complementary to the overview in Figure 4-4, Figure 4-6 shows a breakdown of en-route ATFM delays by ACC in 2015. The top five ACCs accounted for more than half of all European en-route ATFM delay.

Although not listed in Figure 4-4, it is worth noting that Maastricht UAC was just below the 30 day threshold with 26 days of significant en-route ATFM delay in 2015 which corresponds, due to the high traffic volume handled, to 8.2% of total en-route ATFM delays in 2015.

The next section evaluates the most critical ACCs in terms of en-route ATFM delays in 2015 in more detail in order to provide a better understanding of what is affecting the performance during periods of highest delay.

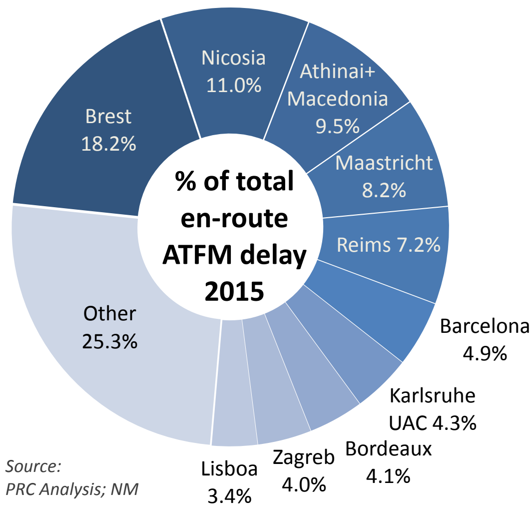


Figure 4-6: ACC impact on European Network (2015)

Detailed review of the most constraining ACCs in 2015

Nicosia ACC

Nicosia ACC experienced a notable increase in en-route ATFM delay in 2015, with an average ATFM delay of 2.47 minutes per flight compared to 1.91 minutes per flight in 2014.

There were 221 days with an average en-route ATFM delay above 1 minute per flight in 2015.

At the same time, traffic levels increased by 4.8% compared to 2014.

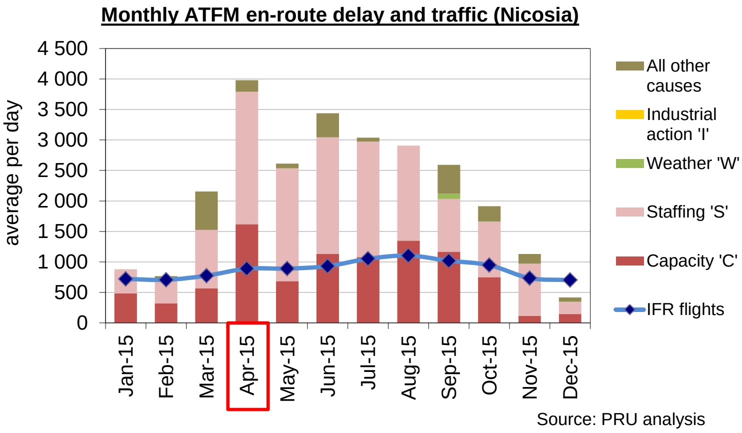


Figure 4-7: Monthly ATFM en-route delay in 2015 (Nicosia ACC)

The PRC has decided to examine the situation in April 2015, since that was the month with the highest delay for Nicosia ACC. The traffic demand and capacity performance for Nicosia ACC during April 2015 is shown below.

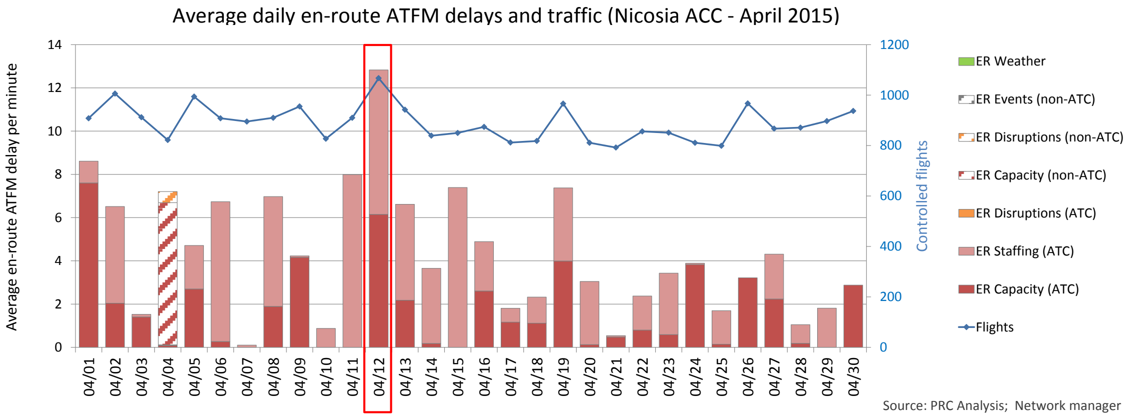


Figure 4-8: Average daily en-route ATFM delay in April 2015 (Nicosia ACC)

The day with the greatest amount of delays was the 12th April 2015. Coincidentally, this was also the day with the highest number of flights handled, 1,070. The regulations that created the delays were attributed either as ATC capacity (5) or ATC staffing (4).

In the regulations referring to ATC staffing on the 12th April 2015, it can be assumed that better availability of operational staff would have enabled the deployment of additional capacity, resolving or mitigating the penalties to airspace users. Three of the staffing regulations were only applied for a period of ten minutes before being cancelled however they still caused noticeable penalties and disruption to the affected flights.

There were five regulations attributed to ATC capacity on 12th April 2015. However, only two of these were applied during the period when 4 sectors were open (16:30 – 18:00) LCS1X12 (946 minutes) and LCES012M (473 out of a total of 3,597 minutes). That left a total of 4,714 minutes of delay attributed to ATC capacity when there were only two or three sectors open instead of the maximum 4, and the promised 5 sectors.

Several of the regulations, attributed to ATC capacity or staffing, were applied at levels below the published capacity.

The activations of the various sector configurations are shown below. CNF2 means 2 sectors open, CNF3 means three sectors open, etc.

The PRC is interested in discovering what are the constraints to opening more sectors for longer periods and providing the needed capacity.

Nicosia ACC also applied three re-routing scenarios from 07:30 – 16:30 which constrained aircraft operators in their choice of route and prevented certain traffic from transiting Cypriot airspace.

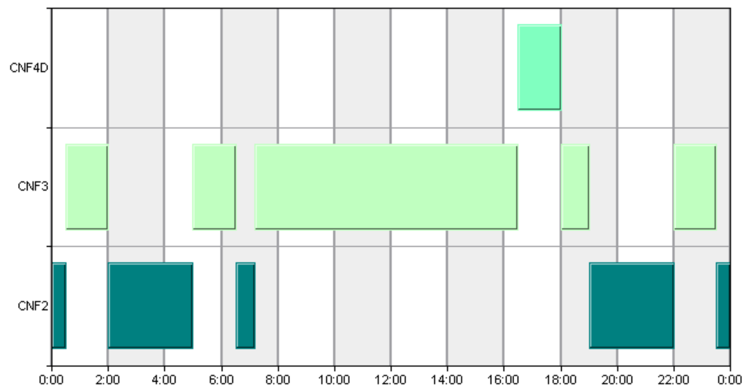


Figure 4-9: Sector configuration Nicosia ACC (12 April 2015)

Brest ACC

Brest had 127 days where en-route ATFM delay was greater than 1 minute. Traffic levels decreased by 0.8% on 2014 figures but average en-route ATFM delay increased from 0.53 minutes per flight in 2014 to 1.41 minutes in 2015.

The stand-out month for poor capacity performance is December 2015, with almost 481,000 minutes of delay attributed to Special event (P), specifically the implementation of the ERATO functional tools for ATCOs.

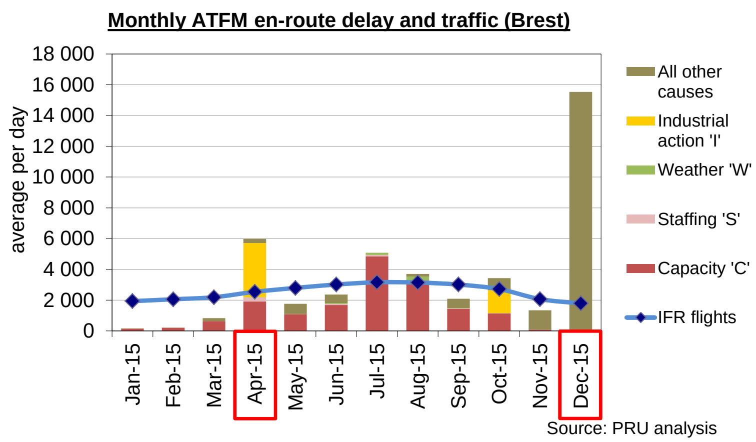


Figure 4-10: Monthly ATFM en-route delay in 2015 (Brest ACC)

The training program for ERATO commenced in autumn 2014 and is scheduled to be completed during 2016. With almost 37,000 minutes of delay attributed to ERATO training in November and 480,806 minutes of delay in December, airspace users experienced additional costs to the extent of approximately €50 million in 2015.

The traffic demand and capacity performance for Brest ACC in December 2015 is shown below.

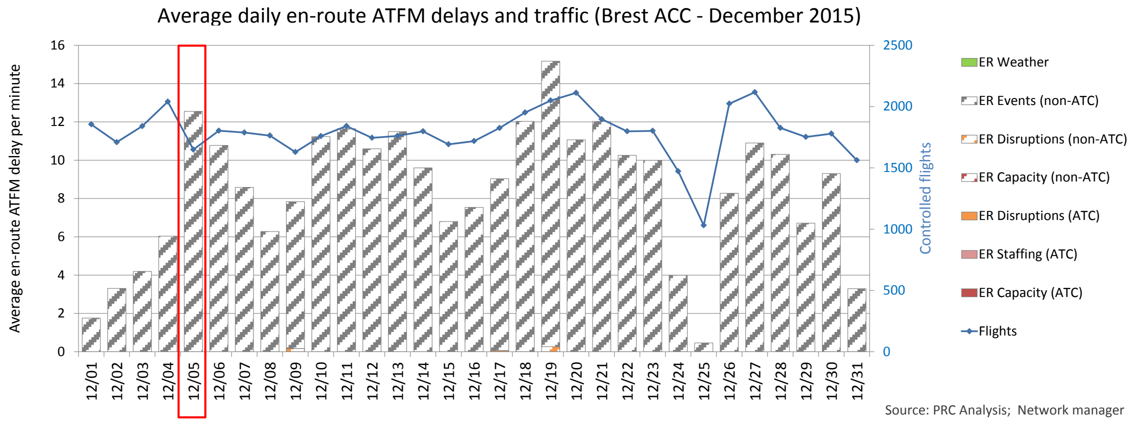


Figure 4-11: Average daily en-route ATFM delay in Brest ACC (December 2015)

Taking Saturday the 5th of December, with delays of 20,681 minutes, as an example for a closer look, a graphical representation of the regulations applied by Brest ACC is shown opposite.

Regulations attributed to ERATO training are in yellow and an additional 3 flight level capping scenarios (forcing flights to avoid certain airspace) are in pink. The reference location, for the specific airspace experiencing the capacity constraint, is listed on the vertical axis.

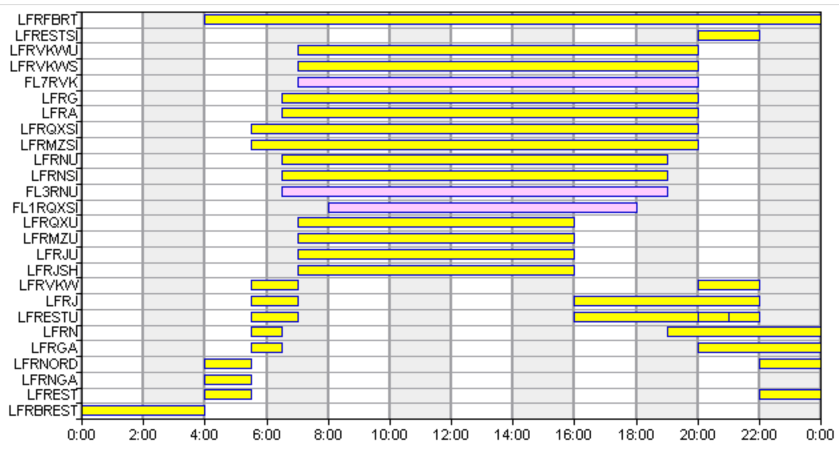


Figure 4-12: Regulations (Brest ACC – 5. December 2015)

Of the 23 different reference locations (excluding the level capping scenarios FL*), two refer to elementary sectors, the remainder being collapsed sectors. All sectors operated at capacity levels well below their published capacity.

REF LOC	Collapsed?	Normal capacity	Regulated capacity	REF LOC	Collapsed?	Normal capacity	Regulated capacity
LFRFBRT	YES	32	20	LFRJU	NO	39	22
LFRESTSI	YES	39	29	LFRJSH	YES	36	20
LFRVKWU	YES	37	21	LFRVKW	YES	40	21
LFRVKWS	YES	37	21	LFRJ	YES	42	24
LFRG	YES	43	28	LFRESTU	YES	39	29
LFRA	YES	39	26	FLRN	YES	42	28
LFRQXSI	YES	36	26	LFRGA	YES	47	31
LFRMZSI	YES	38	29	FLRNORD	YES	42	24
LFRNU	NO	32	22	LFRNGA	YES	36	24
LFRNSI	YES	38	25	LFREST	YES	40	30
LFRQXU	YES	40	27	LFRBREST	YES	36	26
LFRMZU	YES	40	30				

Figure 4-13: Regulated reference locations - Brest ACC (5. December 2015)

Similarly to weather-related capacity constraints, it could be argued that any reduction in capacity, necessitated due to technical issues, could be mitigated by reducing individual controller workload from opening more sectors.

The month with the highest delay, not attributed to the ERATO implementation, was April 2015. In that month l the majority of ATFM delay was attributed to ATC industrial action.

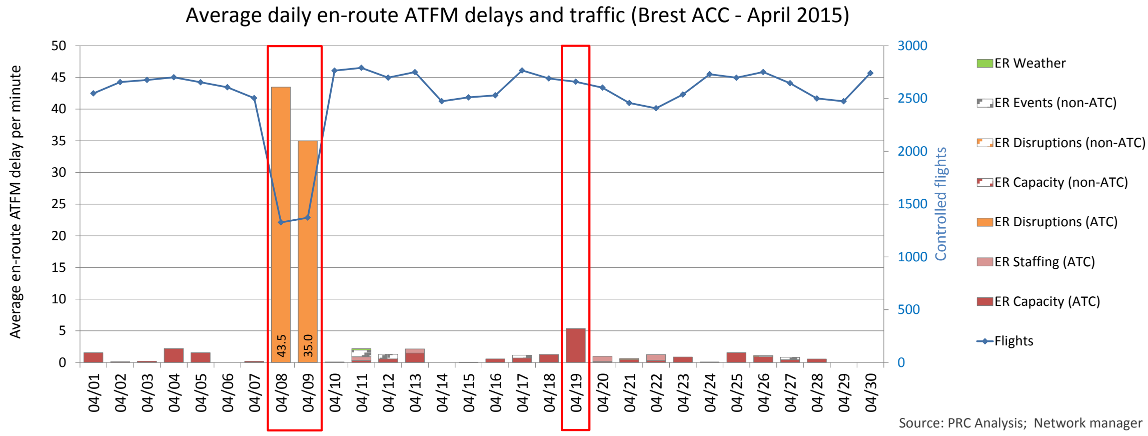


Figure 4-14: Average daily en-route ATFM delay in Brest ACC (April 2015)

The traffic demand and capacity performance in Brest ACC for the month of April 2015 is shown above. The delay per flight on the 8th and 9th of April were 43.5 minutes and 35 minutes respectively: attributed entirely to ATC industrial action. Apart from the dramatic reduction in traffic levels on the days of industrial action, there is no evident pattern in traffic demand - with weekday traffic levels similar to weekend traffic.

On Sunday 19th April, ATFM delay attributed to ATC capacity was greater than 5 minutes per flight. The regulations that were applied by Brest ACC on 19th April are shown below.

REGULATION ID	REFERENCE LOCATION	Published capacity	DELAYED FLIGHTS	TOTAL DELAY	AVG DELAY PER DELAYED	REGULATION REASON	Duration (Cap)
RESTU19A	LFRRESTU	40	75	959	12.8	C-ATC Capacity	13:40 – 16:10 (41) 16:10 – 18:30 (43)
RG19	LFRRG	43	89	1 297	14.6	C-ATC Capacity	10:40 – 15:00 (47)
RGA19	LFRRGA	47	65	1 606	24.7	C-ATC Capacity	06:00 – 08:30 (47)
RJ19	LFRRJ	42	61	1 052	17.2	C-ATC Capacity	10:00 – 12:30 (42)
RJV19	LFRRJV	42	55	1 193	21.7	C-ATC Capacity	05:30 – 09:00 (42)
RJV19A	LFRRJV	42	48	852	17.8	C-ATC Capacity	15:00 – 18:00 (47)
RKW19A	LFRRKW	40	79	1 008	12.8	C-ATC Capacity	10:00 – 15:00 (42) 15:00 – 18:00 (44)
RMZSI19A	LFRRMZSI	38	106	1 602	15.1	C-ATC Capacity	10:00 – 16:08 (42)
RMZU19M	LFRRMZU	40	27	691	25.6	C-ATC Capacity	05:30 – 08:00 (40)
RN19A	LFRRN	42	85	1 940	22.8	C-ATC Capacity	15:00 – 18:30 (47)
RNORD19A	LFRRNORD	42	25	326	13.0	C-ATC Capacity	14:40 – 15:00 (47)
RNU19M	LFRRNU	32	20	283	14.2	C-ATC Capacity	09:00 – 12:00 (36)
RQX19	LFRRQX	42	52	918	17.7	C-ATC Capacity	06:00 – 08:30 (42)
RZMSI19M	LFRRMZSI	36	32	530	16.6	C-ATC Capacity	06:20 – 08:30 (38)

Figure 4-15: ATFM regulations applied by Brest ACC on 19 April 2015

Collapsed sectors, as listed in the French AIP, are highlighted in blue. Since a collapsed sector is the aggregation of two or more individual sectors with a capacity value lower than the sum of the individual capacities, it is obvious that additional constraints prevented Brest ACC from opening the individual sectors during the peak demand period.

It is interesting to note the incidence of significant delays arising when a reduced number of sectors were opened, but where the cause of delay was still attributed to ATC capacity and not ATC staffing.

Brest ACC operates three distinct sector groups: East, North and South. The published maximum configuration for each sector group is East (9); North (8); and, South (7). However, at no time during April or July (the peak month for ATC-capacity related delay) was the maximum number of sectors opened in any sector group.

The PRC examined the overlap between ATFM regulations (attributed to ATC capacity) and the length of time that the ANSP provided their highest capacity configuration (on the specific day). On the majority of days investigated, regulations were applied over twice as long as the time when the maximum capacity was deployed.

ATFM regulations are applied to match air traffic demand with the ATC capacity, to avoid overloads of sectors which could result in potentially unsafe situations. The underlying assumption has always been that the ANSPs would provide up to the maximum capacity to meet demand; and traffic demand above the maximum capacity would be regulated to ensure safety with the associated delays attributed to ATC capacity.

For those instances where internal or external ANS constraints, such as severe weather, military operations and training, staff shortage etc. reduce the available capacity, that can be deployed, from maximum capacity levels, the associated delays would be attributed to the specific constraints that are preventing deployment of maximum capacity.

In essence, (up to maximum) capacity should be provided to meet demand rather than demand being constrained to meet the (reduced) capacity. However, it would appear from the data available that the focus was on reducing traffic levels instead of providing the required capacity.

The Brest FIR contains significant restricted or segregated airspace, most notably the Temporary Segregated Areas (TSAs) TSA6, TSA8 and TSA9 and the Danger Areas D12, D14 & D15. The PRC was interested to note that there were no delays attributed to military operations and training: M-airspace management. Indeed, no activations of these areas were found in the European Airspace Use Plan (EAUP) or updated EAUP (EUUP) as issued by the Network Manager.

This could mean either that there was simply no military activity, or that military activity was not notified to the airspace users. Since the delays were not classified as being due to military activity (M-airspace management) it can only be assumed that military operations and training did not place any constraints on capacity in Brest FIR.

Lisbon ACC

Despite a slight reduction of average en-route ATFM delay compared to 2014, Lisbon ACC had 67 days, with an average delay level higher than 1 minute per flight. Traffic increased by 5.1% on 2014 levels.

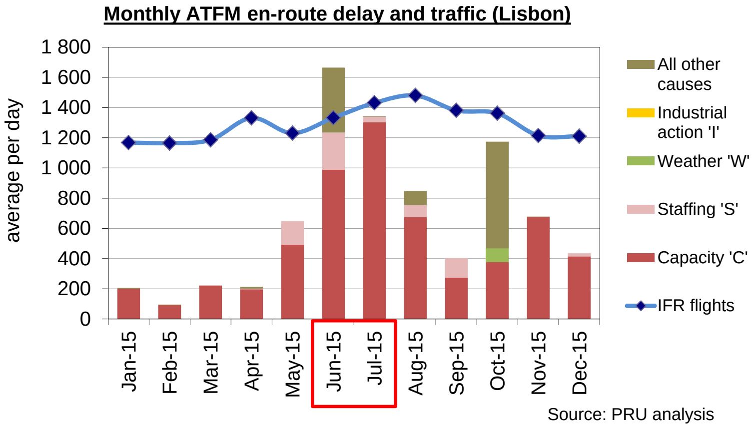


Figure 4-16: Figure 4-16Figure 4-16Monthly ATFM en-route delay in 2015 (Lisbon ACC)

Despite higher traffic levels in August, both June and July saw the greatest amount of delay in Lisbon ACC. The PRC decided to investigate why ATC capacity seems to become a significant problem even though traffic levels are not yet at the maximum for the year.

In PRR 2014, the PRC highlighted the persistent rise in ATFM delay in the period November – December each year from 2011 - 2014, whilst handling similar traffic levels as January – March without associated delay. Because of this, the PRC also reviewed the capacity performance for autumn 2015 below.

The traffic demand and capacity performance for Lisbon ACC in June and July 2015 is shown below.

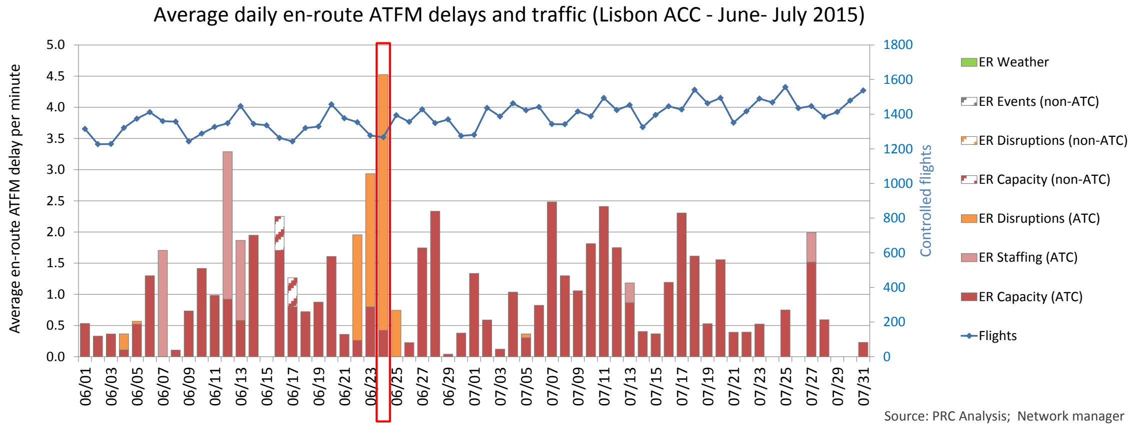


Figure 4-17: Average daily en-route ATFM delay in Lisbon ACC (Jun.-Jul. 2015)

Although there is a consistent peak of traffic on Saturdays, this does not necessarily create a corresponding peak in delays.

The highest delay over the two month period (5,734 minutes) occurred on 24th June and was predominantly attributed to EQUIPMENT (ATC).

The PRC performed further analysis on the capacity configurations for Lisbon ACC on days in June and July when delay per flight exceeded 2 minutes in order to evaluate if the maximum capacity configuration was being deployed during peak periods to satisfy the demand of airspace users.

The analysis shows that Lisbon ACC frequently opens the published number of sectors although on some occasions the timing of this opening is not in synch with the traffic demand (12th June, 7th July, 11th July, and 17th July).

Date	Total delay (minutes)	Delay due ATC capacity (minutes)	Planned sectors at maximum capacity (NOP)	Highest number sectors actually opened	Time of operation at highest configuration (h:mm)	Period of regulations due to ATC capacity. (h:mm)	Overlap between ATC capacity regulations and deployment of highest capacity (h:mm)	
12/06	4433	1243	9	9	7:00	3:20	0:00	0%
16/06	2844	2154	9	8	15:00	5:50	5:50	100%
23/06	3747	1022	9	8	14:20	5:00	5:00	100%
24/06	5734	537	9	8	14:13	3:00	3:00	100%
28/06	3149	3149	9	9	10:00	4:00	4:00	100%
07/07	3334	3334	9	9	9:00	11:31	5:00	43%
11/07	3600	3600	9	9	13:30	7:06	4:30	63%
17/07	3290	3290	9	9	9:00	9:30	4:00	44%

Figure 4-18: Capacity configurations on days with delay > 2 min. per flight - Lisbon ACC (Jun.-Jul. 2015)

Figure 4-16 shows also a notable increase in average en-route ATFM delay for Lisbon ACC in autumn 2015. The main reason for the delay was the large scale NATO multi-national military exercise “Trident Juncture” which was held in Portugal (as well as in Spain, France and Italy) from 21st October to 5th November 2015. The delays associated with the restriction of airspace for military activity are evident from the above graphic, where they show up under “Other causes” in October 2015.

Further analysis of the capacity performance in November 2015 highlighted capacity problems associated with collapsed sectors due to the inability, at times, to open the maximum number of sectors.

High traffic demand above the published capacity levels, in certain sectors, led to significant delays. The incidence of ATC sectors delivering capacity above published values indicates that operational staff were making all efforts to deliver the best possible service to the airspace users. (This also indicates an opportunity to re-evaluate the current sector capacities which provide the balance between throughput and safety.)

Repetitive incidents of significant delays associated with traffic levels higher than the published sector capacities provides a clear indication that capacity enhancement measures are required in the relevant airspace.

Athinai & Macedonia ACCs

August 2015 witnessed a peak in traffic in Greece over the year but also saw a significant rise in ATFM delays, with more than 12,000 minutes of delay daily. The PRC has therefore decided to examine the traffic and capacity performance in August to see what lessons can be learned.

Traffic demand and capacity performance for Athens ACC in August 2015 is shown below.

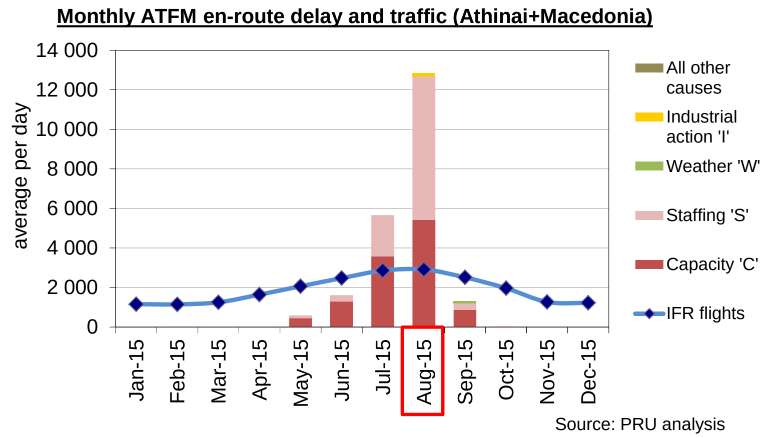


Figure 4-19: Monthly ATFM en-route delay in 2015 (Athinai & Macedonia ACC)

Traffic demand during weekends was consistently higher than demand on weekdays, with approximately 200-300 flights of a difference. With the exception of a portion of the delay on 5th August being attributed to ATC en-route disruptions (and due to industrial action by ATC personnel affecting traffic departing from or arriving at Greek airports), all delays were attributed to either ATC staffing or ATC capacity.

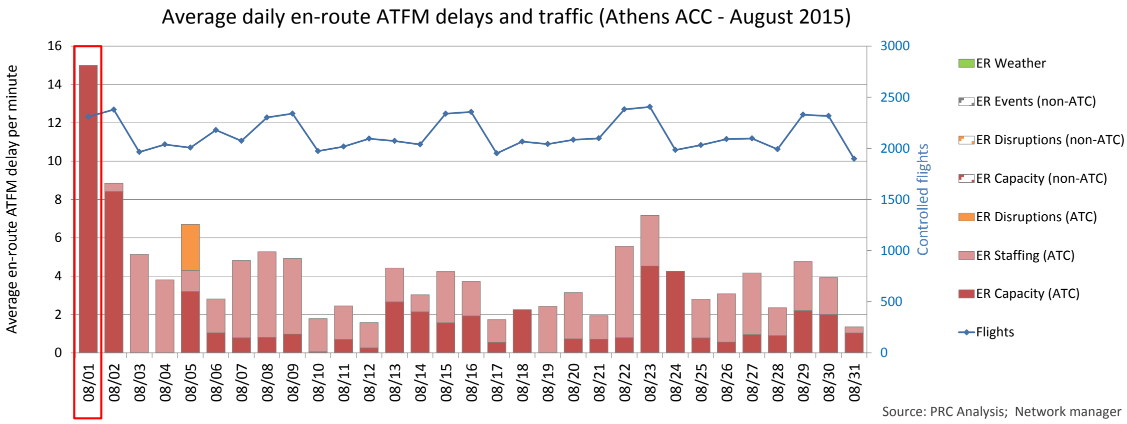
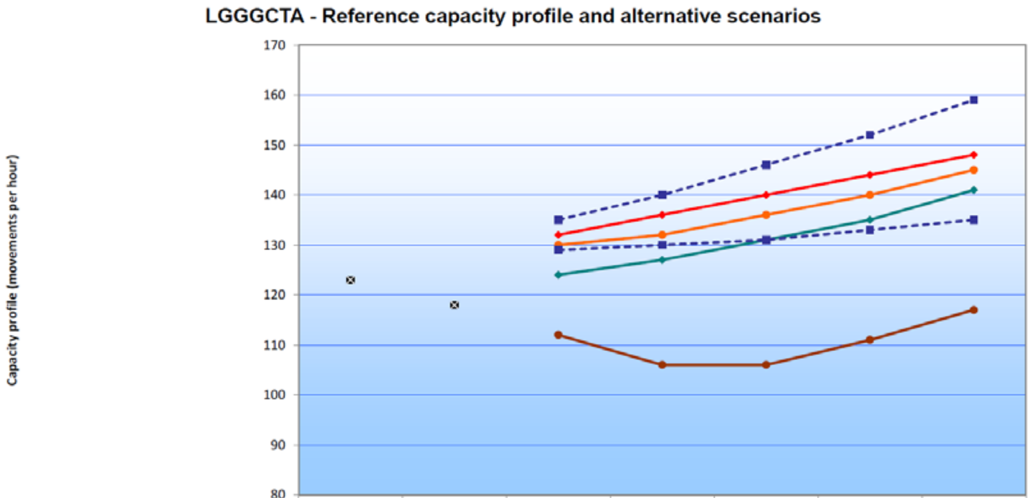


Figure 4-20: Average daily en-route ATFM delay in Athens ACC (August 2015)

The peak of delays attributed to ATC capacity on Saturday the 1st of August was particularly striking. Although analysis suggests that Athens ACC has been operating above the published level of capacity on 1st of August, it must be noted that the published level of capacity was downgraded compared to what was offered by the same ANSP some years ago (see Figure 4-21).

In the Network Operations Plan 2015-2019, Athens ACC reports a maximum capacity configuration of 5 sectors (as opposed to 8 sectors back in 2012).



	2013	2014	2015	2016	2017	2018	2019
2015-2019 Reference Capacity Profile			132	136	140	144	148
Capacity Profile - Shortest Routes (Open)			130	132	136	140	145
Capacity Profile - Current Routes			124	127	131	135	141
Capacity Profile - High			135	140	146	152	159
Capacity Profile - Low			129	130	131	133	135
Capacity Baseline	123	118					
2015 - 2019 Plan			112	106	106	111	117

Figure 4-21: Athens ACC reference capacity profile and alternative scenarios (NOP 2015-2019)

It is evident that capacity constraints attributed to ATC capacity are being exacerbated by the reduction in deployed capacity and/or the inability to open the required configuration of sectors to deploy capacity that already existed.

With 20 of the 31 days in August experiencing higher delays attributed to problems with ATC staffing, rather than to ATC capacity, it is evident that the greatest capacity constraints are due to the inability to deploy staff to open the required number of sectors to cope with the traffic demand. The outlook for Athens ACC, especially if the planned further reduction in capacity materialises, is not good.

Traffic demand and capacity performance for Macedonia ACC in August 2015 is shown below.

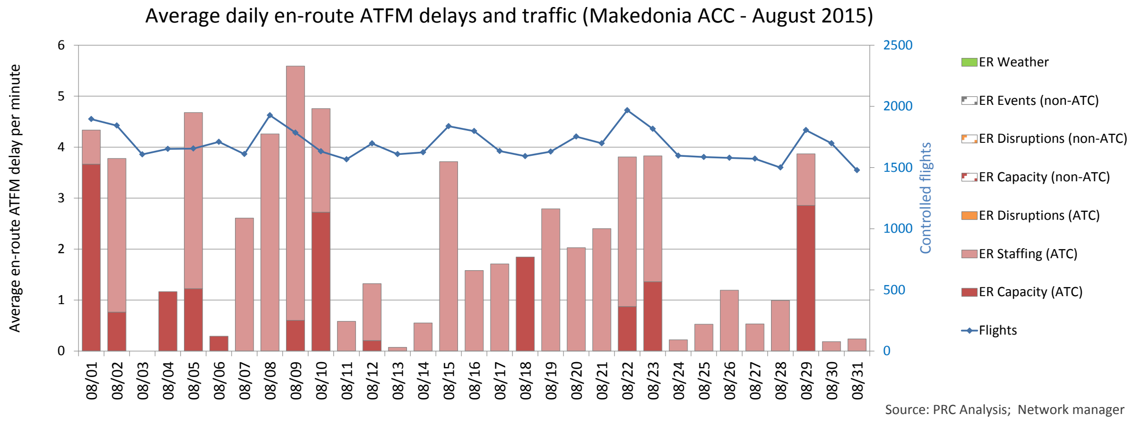


Figure 4-22: Average daily en-route ATFM delay in Makedonia ACC (August 2015)

Similar to the situation in Athens ACC, demand during weekends was consistently higher than during weekdays. Clearly, with 24 of the 31 days in August having the greatest proportion of ATFM delays attributed to problems with ATC staffing, it is evident that the focus on improving operations must be centred on ensuring that an adequate number of ATC personnel is made available to operate the required number of sectors.

The capacity situation in Makedonia ACC, like in Athens ACC, is exacerbated because of the planned reduction in capacity as presented in the Network Operations Plan 2015-2019. Similar to Athens ACC, the outlook for Makedonia ACC is not good as the current capacity plans refer to a maximum of 2-3 sectors being available at maximum capacity configuration instead of the 5 sectors available back in 2012.

Zagreb ACC

Despite higher traffic levels in August, both June and July saw the greatest amount of delay in Zagreb ACC. The PRC is interested in understanding why ATC capacity seems to be a significant problem even though traffic levels are not yet at the maximum for the year.

The traffic demand and capacity performance for Zagreb ACC in June and July 2015 is shown Figure 4-24.

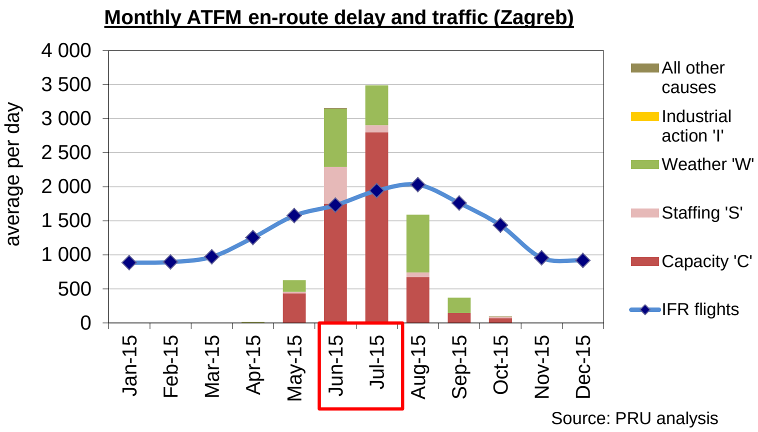


Figure 4-23: Monthly ATFM en-route delay in 2015 (Zagreb ACC)

In June, it is noticeable that a traffic peak occurs every Saturday (06/06, 13/06, 20/06, 27/06). It is also noticeable that there are delays due to staffing issues every Saturday (significantly so on the 6th, 20th and the 27th). For July, whilst the traffic peaks remain on Saturdays (04/07, 11/07, 18/07, 25/07) the staffing issue appears to be somewhat resolved.

The day with the greatest amount of delays (9,353 minutes) over the two month period was the 6th June, with 2,044 flights against the peak traffic level of 2,442 flights on 18th July. The delays were allocated either as ATC capacity or ATC staffing.

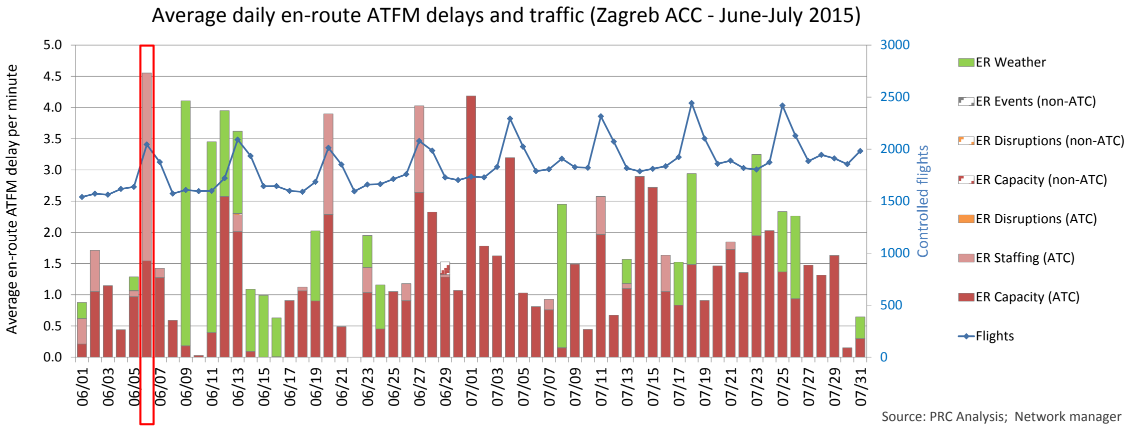


Figure 4-24: Average daily en-route ATFM delay in Zagreb ACC (Jun.-Jul. 2015)

The analysis of the regulations applied by Zagreb ACC on 6th June suggests that the capacity set in the regulation is frequently higher than the official published capacity (in one case an additional 20% higher). While this shows the willingness of operational staff to improve the situation, it also implies that there could be an opportunity to revise the published capacity figures.

Although Zagreb ACC reports a maximum capacity configuration of 10 sectors in the Network Operations Plan (2015-2019), a maximum configuration of 7 sectors was opened on 6th of June.

The sector opening scheme is provided in Figure 4-25.

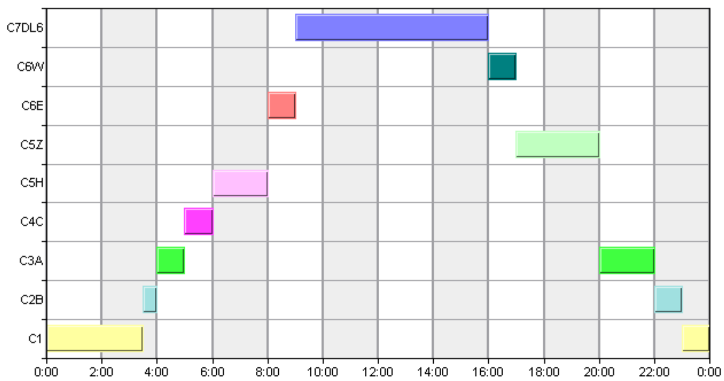


Figure 4-25: Sector opening configuration Zagreb ACC (6 June 2015)

The regulation creating the highest amount of delay (2,279 minutes) and attributed to ATC capacity was imposed between 17:00 and 21:00, when initially only 5 sectors were open, reducing to 3 sectors at 20:00. It would be interesting to better understand the constraints to opening more sectors for longer periods and provide the needed capacity.

A further analysis of the capacity configurations for Zagreb ACC in June and July when delay per flight exceeded 2 minutes shows that there were only three days when the maximum capacity configuration was deployed: 4th July (5 hours), 18th July (3 hours) and 25th July (2 hours). On the remaining days, the highest sector configuration deployed varied from between 6 to 9 sectors.

Moreover, there appears to be a significant mismatch between the application of regulations to regulate demand and the provision of maximum capacity. Applying ATFM regulations to reduce traffic flows into collapsed sectors instead of opening the appropriate number of sectors to provide the required capacity would indicate that there are other constraints impacting Zagreb ACC.

Following contact from the NSA in Croatia, the PRC has been advised that staffing issues including sickness were responsible for the capacity constraints. This confirms the opinion of the PRC that classifying the delays as being primarily due to ATC capacity was inappropriate.

The PRC considers that, unless capacity constraints are precisely identified, they cannot be resolved and therefore capacity performance is unlikely to improve.

Reims ACC

Reims ACC shows a high level of delay in April and November due to industrial action.

July 2015 witnessed not only the highest level of traffic in Reims ACC but also the highest amount of ATFM delays. The PRC has therefore focussed on the month of July in order to try to identify the reasons behind the operational performance.

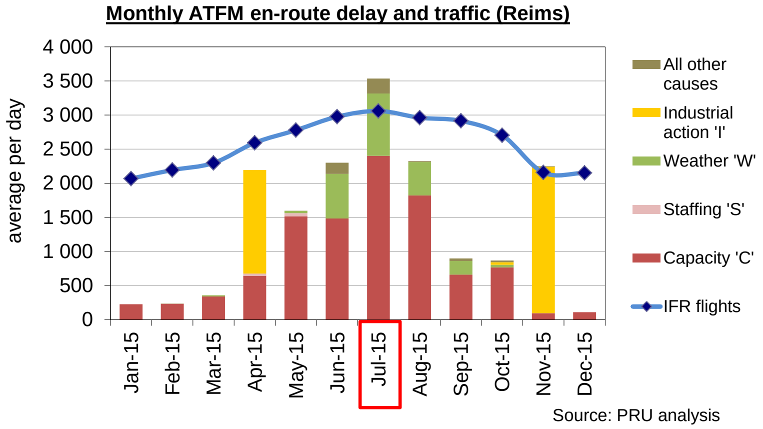


Figure 4-26: Monthly ATFM en-route delay in 2015 (Reims ACC)

Traffic demand and capacity performance for Reims ACC for the month of July 2015 is shown below.

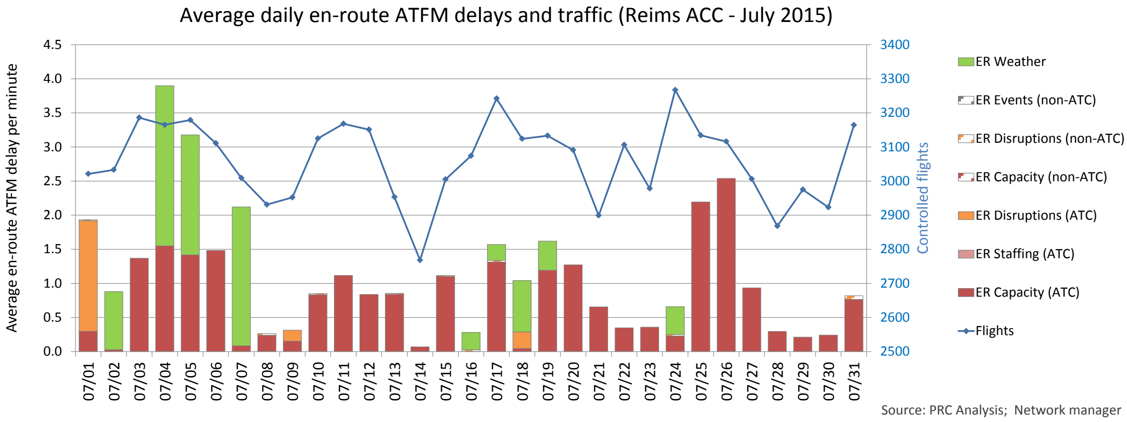


Figure 4-27: Average daily en-route ATFM delay in Reims ACC (July 2015)

There is no clear pattern in traffic distribution: some weekdays are busier than some weekends and vice versa. Peak traffic was handled on Friday 24th July, with 3,267 flights, but peak delays occurred on Saturday 4th July, with 3,165 flights. Nine days, including 4th July show significant portions of delays being attributed to capacity reductions due to en-route weather phenomena, such as thunderstorms.

Capacity constraints due to thunderstorms generally justify a reduction in sector capacities, because of the increased workload of the individual controllers in handling 'more unpredictable' flights.

Closer analysis of the ATFM regulation applied by Reims ACC on the 4th of July show that several of the sectors that applied regulations due to ATC capacity are described as collapsed sectors. Collapsed sectors are generally amalgamations of two or more elementary sectors but with a less capacity than the total of the individual elementary sectors combined. Splitting collapsed sectors reduces individual controller workload and could mitigate the capacity constraint without further penalties to the airspace users. Therefore, it appears that additional constraints were preventing Reims ACC from opening a greater number of sectors, and delivering a higher level of capacity.

Reims ACC is considered as three distinct sector groups for ATFM purposes: Group Central, Group East and Group North. The published maximum aggregated configuration for Reims ACC is 19 sectors with individual maximums for each sector group of Central (3); East (10); and, North (8).

However, according to the information available to the PRC, at no stage was the aggregated number of sectors delivered in July and there were only two occurrences of the maximum number of sectors opened in any sector group: Central sector group opening all three sectors for approximately 2 hours on both the 5th and 6th of July.

In several cases, regulations attributed to ATC capacity were applied at levels below the published capacity value, including several collapsed sectors. This could indicate that there were other constraints either preventing the published capacity to be delivered e.g. military activity (although no ATFM delay due to military activity was reported), or that staffing levels did not permit the opening of the required number of sectors.

A comparison between ATFM regulations (attributed to ATC capacity) and the length of time that the ANSP provided their highest capacity configuration (on the analysed days) shows similar results as already observed for Brest ACC. On a number of occasions, the highest capacity was only available less than half the time that the ATC capacity regulations were limiting traffic flows. Such instances suggest that the focus was on reducing traffic levels instead of providing the required capacity. It is also interesting to note the incidence of significant delays arising when a reduced number of sectors were opened, but where the cause of delay was still attributed to ATC capacity and not ATC staffing.

On the other hand it is interesting to note that several of the regulated capacity values were also higher than the published capacity values. This could be as a result of regulation being applied on an occupancy basis (where the number of aircraft in a sector at any one time is considered, rather than simply the number of entries into the sector over a given timeframe) and/ or the best efforts of operational staff to alleviate the situation for the airspace users. This also indicates an opportunity to re-evaluate the current sector capacities which provide the balance between throughput and safety.

Following communication from the French ANSP (DSNA), the PRC has learned that trials have been conducted in August 2015 on changing ATCO working arrangements, increasing flexibility, to improve capacity performance. The PRC welcomes this initiative and looks forward to seeing the impact of these trials on future performance.

Barcelona ACC

August 2015 saw the greatest amount of delay in Barcelona ACC.

Although traffic levels were lower than in July, September 2015 was the second highest month for ATFM delays. Therefore the PRC has chosen August and September to try and identify the capacity problems.

Traffic demand and capacity performance in Barcelona ACC for the months of August and September 2015 is shown below.

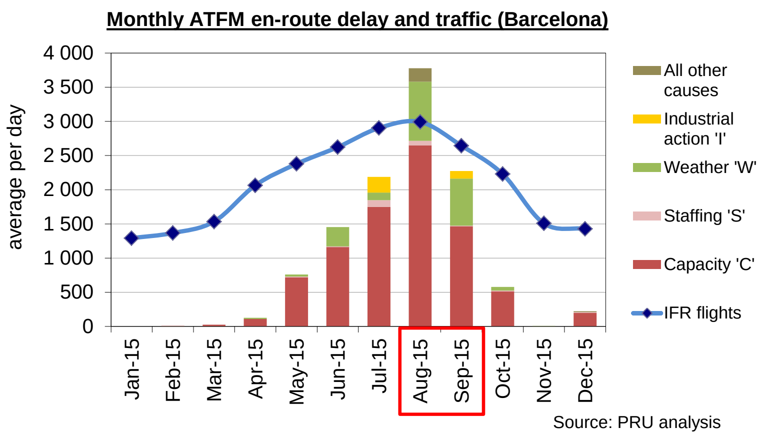


Figure 4-28: Monthly ATFM en-route delay in 2015 (Barcelona ACC)

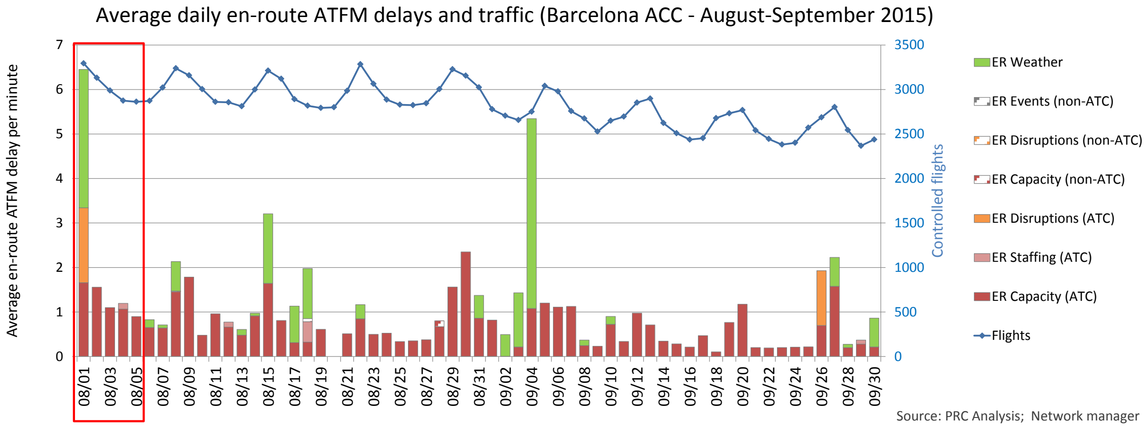


Figure 4-29: Average daily en-route ATFM delay in Barcelona ACC (Aug.-Sep. 2015)

There is a regular rise in traffic at weekends compared to weekdays and delays are predominantly associated with this rise in traffic.

With 3,294 flights, Saturday 1st August was the busiest day over the two month period. Coincidentally, it was also the day with the greatest amount of delays (21,000+ minutes), allocated as en-route weather {48%}; en-route disruptions (ATC) {26%}; and ATC capacity {26%}. The en-route disruptions (ATC) were attributed to problems with the ATC operational radio frequencies, obliging capacity reductions to ensure safety.

Barcelona ACC is considered as two distinct sector groups for ATFM purposes: Group West and Group East. The published maximum aggregated configuration for Barcelona ACC is 12 sectors: 6 sectors in sector group West and 6 sectors in sector group East.

A comparison of the sector opening times and regulations applied in each sector groups for each day in August and September where average ATFM delay was over 2 minutes per flight showed that sector group West regularly operated at maximum configuration for lengthy periods of time (circa 15 hours), whereas sector group East operated at maximum configuration for much shorter periods (maximum 7.5 hours).

Date	Sector Group	Planned sectors at maximum capacity (NOP)	Highest number sectors actually opened	Time of operation at highest configuration (h:mm)	Period of regulations due to ATC capacity. (h:mm)	Delay due ATC capacity (minutes)	Overlap between ATC capacity regulations and deployment of highest capacity on that day (h:mm)	
01/08	West	6	6	11:30	7:20	3205	6:00	82%
	East	6	6	1:40	4:10	1620	0:20	8%
08/08	West	6	6	15:45	4:43	1884	4:43	100%
	East	6	6	7:30	10:40	3238	4:40	44%
15/08	West	6	6	15:00	6:00	3263	6:00	100%
	East	6	6	1:30	4:00	2008	0:05	2%
18/08	West	6	6	7:30	3:00	403	3:00	100%
	East	6	6	1:00	2:20	500	0:00	0%
30/08	West	6	6	15:00	4:40	1911	4:40	100%
	East	6	6	7:30	8:20	4276	4:20	52%
04/09	West	6	6	15:00	2:40	573	2:40	100%
	East	6	6	7:30	1:30	1252	0:00	0%
27/09	West	6	6	7:30	3:00	953	3:00	100%
	East	6	5	8:00	5:10	1220	3:20	65%

Figure 4-30: Sector opening times and regulations applied in Barcelona ACC (Aug.-Sep. 2015)

Although sector group West was generally able to open the maximum number of sectors in response to traffic demand, there appeared to be some additional constraints that prevent sector group East doing the same.

Unless these additional constraints are identified, they cannot be resolved and therefore capacity performance is unlikely to improve.

The PRC noted the fact that the European Airspace Use Plan (EAUP) and updates (EUUP) regularly contained notification of the restriction or segregation of airspace within the Barcelona FIR, associated with the national requirement for military operations and training.

Since there was no reduction in sector capacity published due to such military activity, it appears that the published capacity values reflect the sector capacity when the airspace restrictions are active.

However, there was no increase in sector capacities when the various airspaces were not restricted, meaning that any latent capacity when military activity has ceased is not being made available to airspace users.

This clearly indicates an opportunity to re-evaluate the current sector capacities which provide the balance between throughput and safety, both during and outside periods of military operations and training.

4.2.2 European ATFM performance (network level)

The ATFM function in Europe is jointly executed by local ATFM units and the Network Manager (central unit for ATFM). ATFM regulations are put in place by the Network Manager to protect en-route sectors or airport from receiving more traffic than ATC can safely handle upon request of the local Flow Management Positions (FMP).

Figure 4-31 shows the evolution of the three high-level indicators presently in use to monitor the performance of the ATFM function at system level.

The initiatives promoting better ATFM slot adherence to improve system wide traffic predictability clearly show effect.

The share of take-offs outside the ATFM slot tolerance window (-5min. +10 min.) decreased continuously between 2003 and 2015, reaching its lowest level on record (12%) in 2015.

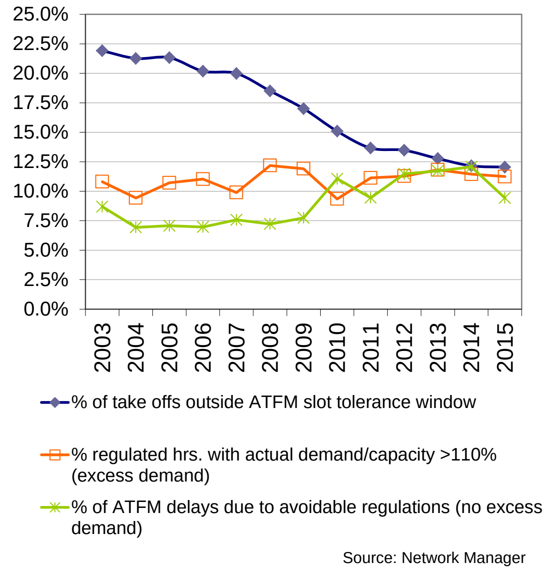


Figure 4-31: ATFM performance (network indicators)

Local ATC at the respective departure airport has a joint responsibility with aircraft operators to make sure that the aircraft depart within the allocated ATFM window in order to avoid over-deliveries which occur when more aircraft than planned enter a protected sector (see also ATFM slot adherence performance at the top 30 European airports in Chapter 5).

The share of regulated hours with over deliveries (actual demand/capacity >110%) in Europe decreased slightly but still remained above 11% in 2015. More reliable system delivery will increase confidence which in turn can free latent capacity kept as a reserve to protect controllers from excessive workload. Further research into the underlying reasons for the stagnation around the 11% mark could help to improve overall performance and to reduce the level of operational variability.

The share of avoidable ATFM regulations (i.e. there was no excess demand) decreased notably in 2015 but is still above the levels observed prior to 2009. The indicator is largely linked to predictability and accuracy of the relevant information when the decision to call for an ATFM regulation is taken (i.e. several hours before the anticipated capacity shortfall).

The lower the predictability, the more difficult it is to match capacity to demand without inefficiencies in terms of delay (insufficient capacity) or cost (underutilisation of resources). Better understanding of the drivers of variability in the system would not only help to improve local performance at airports but also within the system overall.

4.3 En-route Flight Efficiency

Flight efficiency indicators measure performance based on actual and planned trajectories which are the result of complex interactions between stakeholders with different objectives and different constraints, which can be physical, economical or organisational.

The filed flight plan is the ultimate output of the planning process of the airspace users, whose aim is to operate their schedule in the most effective manner, according to their requirements. In order to ensure the safety of operations and to manage traffic flows, ANSPs have to impose limitations in the choices available to the airspace users.

It should be highlighted that the full set of information required to evaluate alternatives is specific to airspace users, which would place a different "value" on the same trajectory based on their internal parameters (operating costs of the aircraft, trade-off with delay etc.). Those values are inherently linked to the whole trajectory of the flight.

ANSPs, on the other hand, impose limitations based on aggregate values (traffic flows vs capacity) at the local level.

Flight efficiency is however a Pan-European issue which requires a holistic approach carefully coordinated by the Network Manager because uncoordinated, local initiatives may not deliver the desired objective. It also requires the correct mechanisms to ensure that updated and correct information is available to the different stakeholders.

The different indicators, while focussing on specific aspects of flight efficiency, provide general insights into the areas of possible improvements. Section 4.3.2 below provides an example based on the horizontal flight efficiency measurement.

Improved flight efficiency has not only an economic impact in terms of fuel savings, which is of direct interest to airspace users, but also a notable environmental impact on climate in terms of reduced carbon dioxide CO_2 emissions. It is recognised that the impact of air traffic on climate is wider than just CO_2 emissions. The impact also depends on emission location, time, and type of emission (CO_2, water vapour, nitrogen oxides).

Of interest for the environmental impact (i.e., ignoring costs and delay, which are subject to separate measurements) is the physical trajectory, which comprises a horizontal (distance) and a vertical (altitude) component.

The focus of this section is on the horizontal component, which, in general, is considered to be of higher economic and environmental importance than the vertical component across Europe as a whole [Ref. 29].

In order to address a growing stakeholder interest to also quantify the vertical component, this edition of PRR contains a possible complementary indicator for the measurement of the vertical dimension. The initial focus of this new indicator is on the climb and descent phases of flights rather than on the cruising phase and it was therefore included in Chapter 5 (evaluation of ANS-related operational performance at and around airports) of this report. A separate study is being performed by the Performance Review Unit looking at the cruise aspect.

4.3.1 Horizontal en-route flight efficiency

The analysis of horizontal en-route flight efficiency[40] is based on the length of the <u>actual</u> or <u>planned</u> flight trajectory. In order to enable consistent comparisons between city pairs and between different areas (which include only a portion of the trajectory), the length is expressed

<u>Horizontal en-route flight efficiency</u>

Horizontal en-route flight efficiency measures the length of flight trajectories as additional distance with respect to the corresponding "achieved" distance, which for the vast majority of flights corresponds to the Great Circle Distance (GCD) between the airports (when the airports

[40] The "En-route" section excludes the 40 nautical mile circles around the airports (terminal areas).

as additional distance with respect to the corresponding achieved distance (see grey box).

The planned trajectory is derived from the flight plans submitted by airspace users to the Network Manager. The actual flown trajectory is based on processed radar track data (Correlated Position Reports) submitted by ANSPs to the EUROCONTROL Enhanced Tactical Flow Management System (ETFMS).

It is acknowledged that the distance-based flight efficiency indicators in this section only serve as proxies for fuel efficiency as the most fuel efficient route depends on wind. However, even the wind-optimal route might not necessarily correspond to the choice of the airspace users because they might use different measures based on total costs (time, route charges, etc.).

are located outside the reference area, the border of the reference area is taken instead).

The methodology ensures that local measurements are consistent with a gate-to-gate perspective. It penalises therefore "directs" when their end points are not aligned with the origin and destination of the trajectory.

The indicator measures additional distance overall and is calculated as the ratio of the two sums (length of trajectories and achieved distances). It is not the average of the individual flight efficiencies (which would give excessive weight to shorter flights).

The full methodology is described in more detail in the metadata which is available online [Ref. 30].

The methodology is fully consistent with the SES Performance Scheme. Differences in values reported are due to (i) the different set of States considered, and (ii) the fact that annual values for the Performance Scheme exclude the ten best and ten worst days from the calculation.

Despite their limitations, the flight efficiency indicators used in this section provide a consistent and stable Europe-wide measure to identify areas for improvement and to monitor progress over time.

4.3.2 Factors affecting horizontal en-route flight efficiency

Several factors are taken into account by airspace users when filing their flight plans:

- Fuel consumption (dependent on aircraft type and wind);
- Crew costs (mainly dependent on time);
- Route charges (dependent on the direct distance between entry and exit points in the charging areas);
- Trade-offs with delays, to adhere to schedules (of aircraft, crew and passengers);

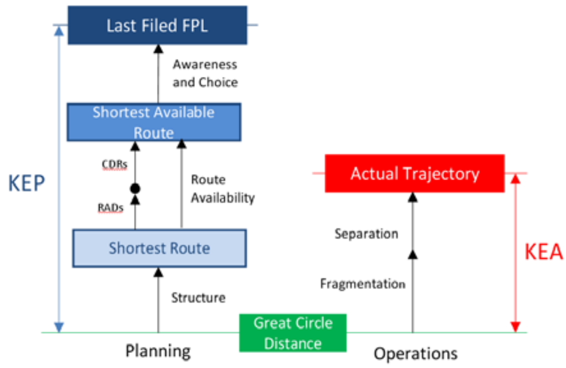


Figure 4-32: Factors affecting flight efficiency

- Business strategies (use of flight planning software and updated information, tight turnaround times, etc.), and;
- Route availability (dependent on constraints imposed by ANS).

It is apparent that several trade-offs will have to be considered and that most of the factors will be specific not only to the airline, but to the specific flight.

At the aggregate level, the flight plans define (expected) traffic flows, which ANS have to match with (expected) available capacity. As restrictions cannot be imposed on specific flights, they are imposed on routes, airspace volumes, and generic traffic flows.

The RAD (Route Availability Document) has the effect of modifying the route network available to specific flows of traffic, while CDRs (Conditional Routes) have the effect of modifying the route network available at specific times. Both reduce the set of available routes available for flight planning.

Differences between the shortest available route and the route in the filed flight plan can arise because airspace users might not be aware that the route is available, or are aware but choose an alternative route for operational or business reasons.

The length of the route is not among the factors considered by the airspace users or by ANS. It is a physical measurement, independent from all the other considerations, which allows to measure the effect of the different constraints imposed by ANS.

Further work is needed to identify the shortest route available for each flight at the time the flight commences, as the flight plan depends by decisions of the airspace users which are completely out of the control of ANS.

4.3.3 Europe-wide en-route flight efficiency

Figure 4-33 shows the horizontal en-route flight efficiency for the actual trajectory and the filed flight plan for the EUROCONTROL area[41]. An "inefficiency" of 5% means, for instance, that the extra distance over 1,000NM was 50NM.

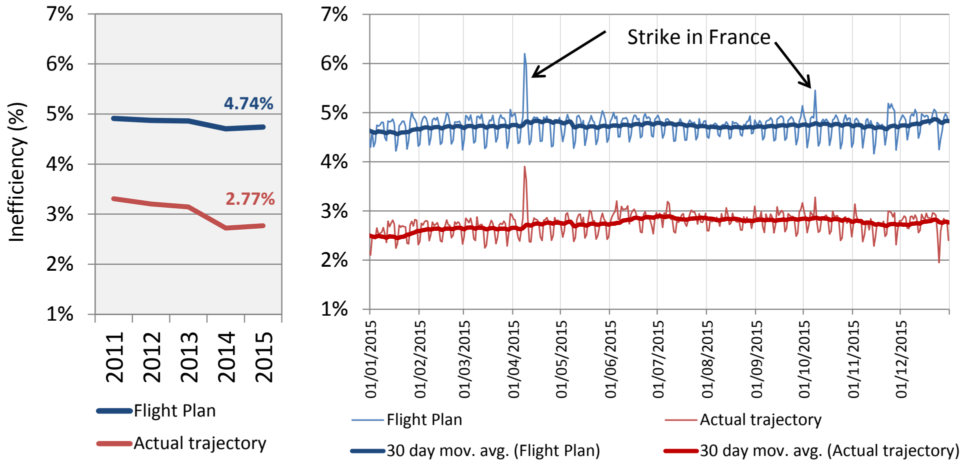


Figure 4-33: Europe-wide horizontal en-route flight efficiency (2011-2015)

After a continuous increase over the past years, horizontal flight efficiency in 2015 showed a slight deterioration compared to 2014. At European level, inefficiencies in filed flight plans increased from 4.70% in 2014 to 4.74% in 2015. Inefficiencies in actual trajectories increased slightly stronger from 2.72% to 2.77% in 2015. The effects of industrial action on flight planning and the actual trajectories on specific days in 2015 are clearly visible on the right side of Figure 4-33.

4.3.4 Horizontal flight efficiency by day of week

Figure 4-34 shows an analysis of inefficiencies in actual flight trajectories by day of the week for the Pan-European airspace. Horizontal en-route flight efficiency improves notably on weekends with the best flight efficiency observed on Saturdays.

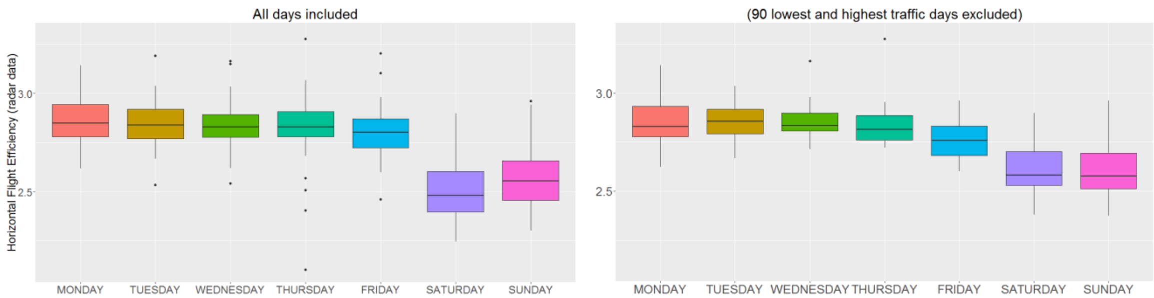


Figure 4-34: Europe-wide horizontal en-route flight efficiency by day of week (2015)

The better flight efficiency on weekends can be due to a number of factors including better availability of segregated and free route airspace (see next section) on weekends and different traffic characteristics.

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41 The Pan-European airspace analysed in this section refers to the CFMU area.

Figure 4-35 illustrates the correlation between traffic levels and horizontal en-route flight efficiency (2015). As can be expected, it shows that the level of inefficiency rises with increasing traffic levels due to increased complexity and the need to ensure safe separations.

In order to reduce the traffic volume effect in the analysis of flight efficiency by day of the week, the 90 days with the highest and the lowest traffic were removed (right side of Figure 4-34). The results still show the same pattern which suggests that factors other than traffic, such as the better availability of segregated and free route airspace on weekends, are driving the improvement in flight efficiency.

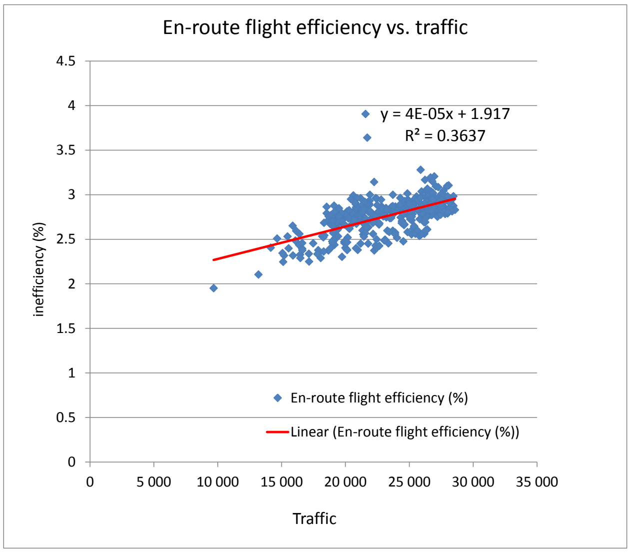

Figure 4-35: Correlation between traffic and flight efficiency

In view of the numerous factors and complexities involved, and with traffic levels growing again, flight efficiency improvements will become more and more challenging and will require the joint effort of all stakeholders coordinated by the Network Manager.

4.3.5 Regional Flight Efficiency

As technology for both aircraft and ATC has advanced, the need for such a rigid en-route structure has diminished, to the extent that free-route airspace (FRA) with a positive effect on flight efficiency would now be possible throughout the entire EUROCONTROL area (see grey box). The airspace is undergoing significant change which requires all stakeholders to adapt.

The implementation of “Free route airspace initiatives” aims at enhancing en-route flight efficiency with subsequent benefits for airspace users in terms of time and fuel as well as a reduction of CO_2 emissions for the environment.

Free Route Airspace (FRA) Concept

Free route airspace (FRA) is a key development with a view to the implementation of shorter routes and more efficient use of the European airspace.

FRA refers to a specified airspace within which users may freely plan a route between a defined entry point and a defined exit point, with the possibility to route via intermediate (published or unpublished) way points, without reference to the ATS route network, subject to airspace availability. Within this airspace, flights remain subject to air traffic control.

The aim of the FRA Concept Document is to provide a consistent and harmonised framework for the application of FRA across Europe in order to ensure a co-ordinated approach.

By the end of 2015, the Network Manager coordinated, through the European Route Network Improvement Plan (ERNIP), the development and/or implementation of more than 20 airspace improvement packages relating to various FRA projects (including Night Routes and direct routes (DCTs)). In 2015, the following States have either fully or partially implemented Free Route Airspace operations:

Free Route Airspace implementation - H24	Hungary - Budapest ACC AoR
	Norway, Finland, Estonia, Latvia - NEFAB FRA
	Lithuania - Vilnius ACC AoR
Free Route Airspace implementation – Night	Hungary / Romania - Cross-border FRA within Budapest ACC AoR and Bucuresti ACC AoR
	Ukraine - FRA individually within L'viv UTA, Kyiv UTA, Odesa UTA and Dnipropetrovs'k UTA
	Bosnia and Herzegovina / Croatia / Serbia / Montenegro - Cross-border FRA within Zagreb ACC AoR and Beograd ACC AoR
	Moldova - within Chisinau ACC AoR
Comprehensive DCT implementation	Italy - Expansion of DCT availability to lower FL
	Czech Republic - Expansion of DCT availability to H24

(Night, Weekend, H24)	UK - within 3 (three) ATC sectors of Prestwick ACC
	Austria - Expansion of DCT availability to H24
	Malta - Cross-border H24 DCTs with Italy
	Greece - Night DCTs within Hellas UIR
	Switzerland - Cross-border DCTs through Geneva ACC AoR and Zurich ACC AoR
	Poland - Warszawa ACC AoR

Figure 4-36: Free route airspace implementation by ACC (2015)

Figure 4-37 shows Europe wide free route implementation by the end of 2015. As can be seen Ireland, Portugal, Hungary and parts of Scandinavia are most advanced in Europe and already operate 24 hour FRA (Free Route Airspace).

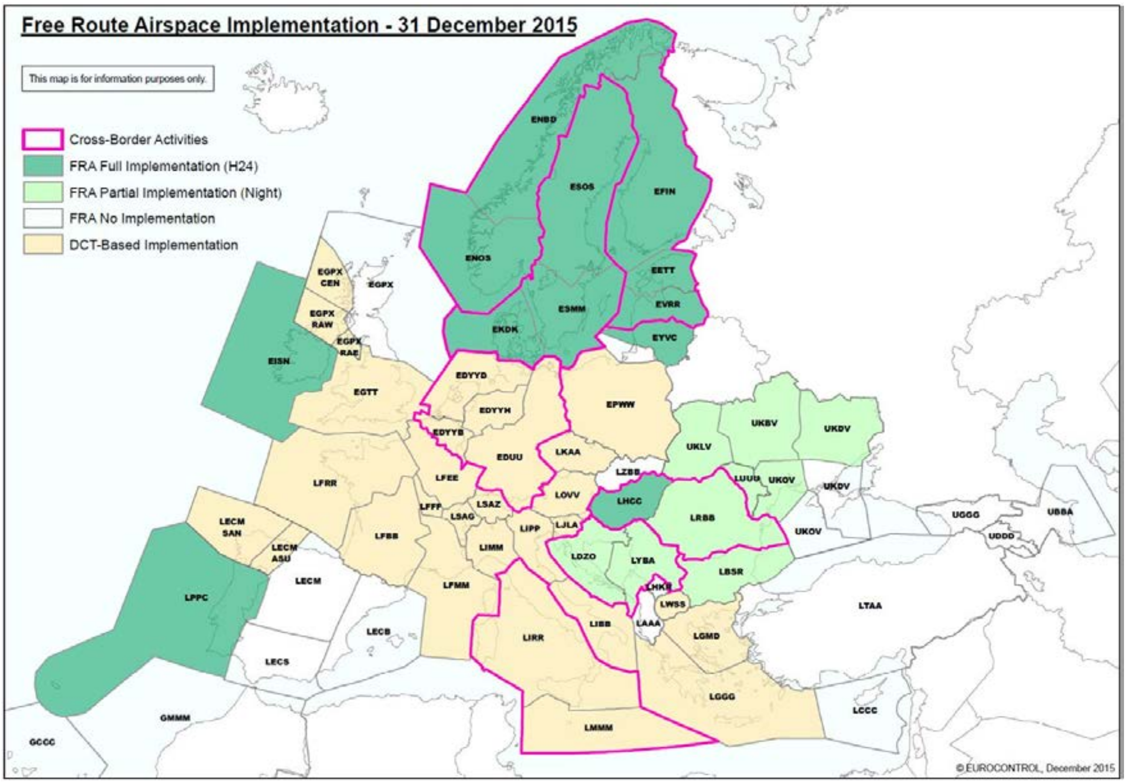

Figure 4-37: Free route development (2015)

Although States adopt different strategies for the implementation of FRA (available during certain times, enter/exit via waypoints, etc.) the improvement of European flight efficiency and the optimisation of the European route network is, by definition, a Pan-European issue which requires a holistic approach carefully coordinated by the Network Manager.

Uncoordinated, local initiatives may not deliver the desired objective, especially if the airspace is comparatively small and a large proportion of the observed inefficiency is due to the interface with adjacent States or FABs.

Figure 4-38 shows the level of inefficiency in filed flight plans and in actual trajectories by Functional Airspace Block (FAB) and State in 2015. As was the case in previous years, there are notable differences between but also within FABs.

Overall, UK Ireland FAB, SW FAB and FABEC show the highest level of inefficiency for actual trajectories in 2015. As already mentioned, flight efficiency is to some extent influenced by traffic volume (see Figure 4-38) which partly explains the higher level of inefficiencies in the denser European core area.

For those States where FRA is already implemented, the difference between the actual and the planned trajectory is comparatively small with a relatively low level of inefficiency. Nevertheless, there are substantial performance differences within the core area which clearly suggests scope for further overall improvements.

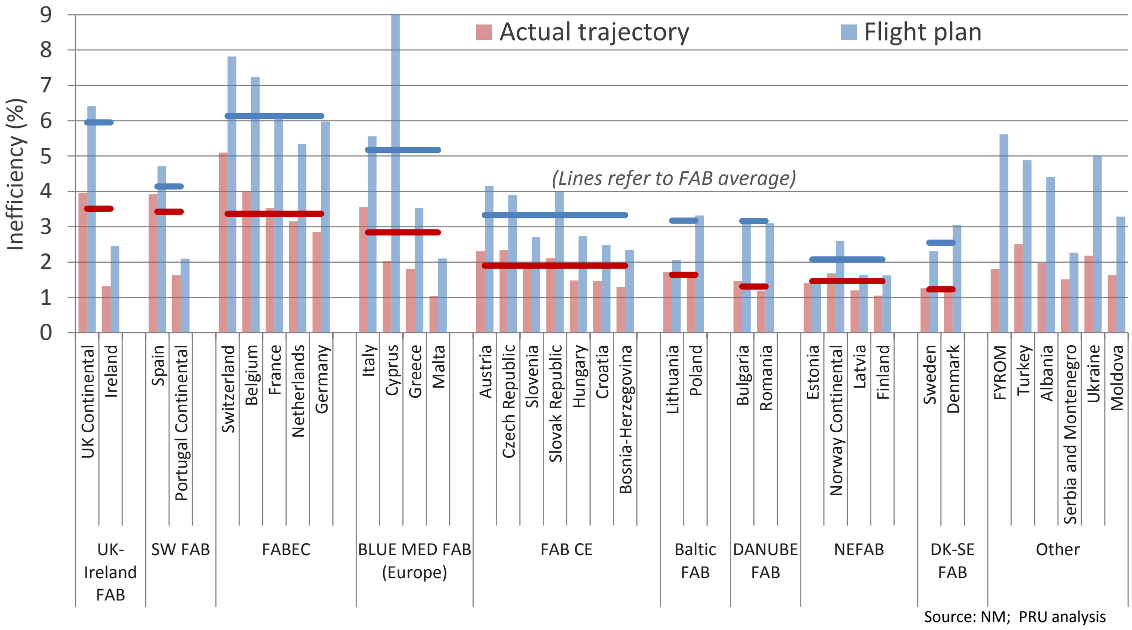

Figure 4-38: Differences flight efficiency by State and FABs (2015)

As already pointed out in previous years, there is a notable gap between flight plans and actual flown trajectories which is clearly more prominent in States where FRA has not been fully implemented all day. Route availability and the flexible use of airspace appear to be a contributing factor to the significant differences between the planned and the actual trajectory.

Figure 4-39 shows the breakdown of the total additional distance in actual trajectories by FAB in 2015.

As in previous years, FABEC accounted for more than 40% of total additional distance in Europe in 2015; followed by SW FAB (14.6%), BLUE MED FAB (12.6%), and UK Ireland FAB (11.8%). Together, FABEC, SW FAB, BLUE MED FAB, and UK-Ireland FAB accounted for more than 80% of total additional distance in Europe in 2015.

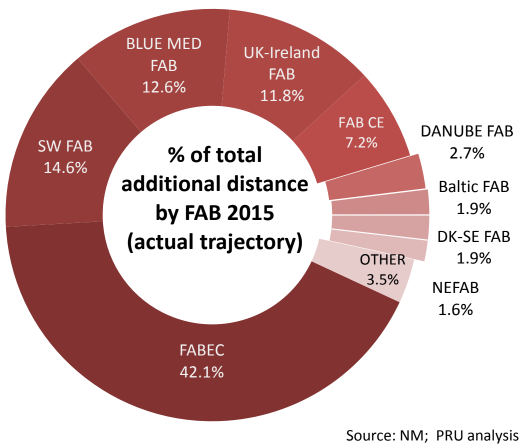

Figure 4-39: Share of total actual additional distance by FAB (2015)

Figure 4-40 shows the average additional distance per flight and the percentage of additional en-route distance by FAB for the actual trajectories in 2015. The level of inefficiency is expressed as a percentage and depends not only on the additional distance but also on the average length of the achieved distance.

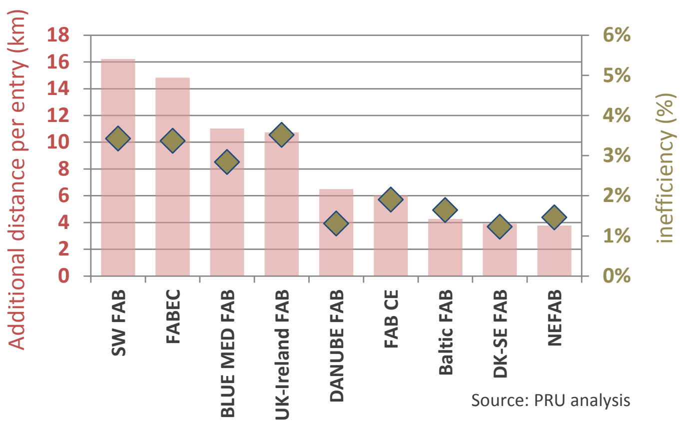

Figure 4-40: Actual additional distance per flight by FAB (2015)

While the route structure is presently the single most constraining factor, the observed inefficiencies are the result of complex interactions between airspace users, ANSPs and the Network Manager.

Research is ongoing to better understand and quantify the individual contributing factors (flight planning, awareness of route availability, civil-military coordination, etc.) in order to identify and formulate strategies for future improvements. A crucial prerequisite for the development of a better understanding is the collection of better data on the activation of special use airspace and on route availability when the flight plan was submitted by airspace users (shortest available route).

4.4 Civil Military cooperation & coordination

States have an obligation to meet national security and operational training requirements. In order to achieve this, it is occasionally necessary to restrict or segregate airspace for the exclusive use of military users. To avoid unnecessary constraints in available capacity and flight efficiency, airspace restrictions should be based on actual use, and should be cancelled when not required.

As a first high-level indication, Figure 4-41 shows a comparison of the number of hours that airspace was actually used for the activities requiring restriction or segregation with the number of hours that restrictions or segregations were applied in EUROCONTROL Member States in 2015.

Pre-tactical restrictions were notified the day before operations, in accordance with the Airspace Use Plan (AUP), NOTAM or as published in the national Aeronautical Information Publication (AIP).

Data is not shown for all States in Figure 4-41, for the following reasons: the requested data was not provided[42] (left blank); there were data quality issues (data issues); the States consider that the restriction or segregation of specific areas has no impact either on the available ATC capacity, or on the route options available for general air traffic (not applicable).

State (2015)	Used / Allocated	Total hours
Albania		
Armenia		
Austria	71%	1,035
Belgium		
Bosnia and Herzegovina.		
Bulgaria		
Croatia	*not appl.*	
Cyprus		
Czech Republic	41%	42,029
Denmark	23%	2,525
Estonia	26%	2,289
Finland		
France	59%	13,033
Georgia	*not appl.*	

State (2015)	Used / Allocated	Total hours
Germany	40%	35,272
Greece		
Hungary		
Ireland	*data issues*	
Italy	51%	3,322
Latvia	42%	921
Lithuania	96%	12,143
Luxembourg	*not appl.*	
Malta	*not appl.*	
Moldova		
Monaco	*not appl.*	
Montenegro	*not appl.*	
Netherlands	68%	14,422
Norway	43%	3,212

State (2015)	Used / Allocated	Total hours
Poland	52%	95,580
Portugal	*not appl.*	
Romania	68%	49,928
Serbia		
Slovakia	57%	68,784
Slovenia		
Spain	60%	6,922
Sweden	87%	377
Switzerland		
FYROM	91%	725
Turkey		
Ukraine		
UK	37%	24,676

Source: States

Figure 4-41: Ratio of time airspace was used vs. allocated in 2015 (pre-tactically)

With a number of States showing the airspace is actually used less than 50% of the time that it is reserved for exclusive use, Figure 4-41 suggests the availability of latent capacity, and flight efficiency opportunities, which could potentially benefit airspace users.

Making the latent capacity and route options available in a predictable manner, when needed by airspace users, will improve the network planning of available capacity and flight efficiency to meet the airspace users requirements, thus providing a better air navigation service.

4.4.1 Questionnaire on Civil/military cooperation

Following a review of the Flexible Use of Airspace (FUA) concept and articles 6-9 of Commission Regulation 2150/2015 (the FUA Regulation) [Ref. 31], the PRC reviewed the arrangements for civil military coordination and cooperation in three Member States in January 2015, summarising the results in PRR 2014 [Ref. 3]. The review identified significant differences in how the States manage airspace to provide the optimum benefit for both civil and military airspace users.

[42] SES States are obliged to provide this information in accordance with the Performance Regulation

Using the same criteria as in January 2015 (illustrated in Figure 4-42), the PRC developed an online questionnaire and invited all EUROCONTROL Members States (41 States) to provide the necessary information on civil military coordination and cooperation. The questionnaire focused on the information available to, and the working practices of, the ASM Level 2 (pre-tactical level) actors of airspace management: civil and military partners in the Airspace Management Cell (AMC). These are the airspace managers primarily involved in the pre-tactical and tactical allocation of airspace to satisfy the requirements of both civil and military airspace users.

The PRC requested the questionnaire to be completed separately by civil and military stakeholders to obtain the different perspectives and better view the coordination between the two.

> **The Flexible use of Airspace (FUA) Concept**
>
> With the application of the Flexible Use of Airspace Concept (FUA), airspace is no longer designated as "civil" or "military" airspace, but considered as one continuum and allocated according to user requirements.
>
> The implementation of the FUA concept is applicable at three separate, but dependent levels: Level 1, at strategic level within the State/ FAB; Level 2, at pre-tactical level; and Level 3, at tactical level.

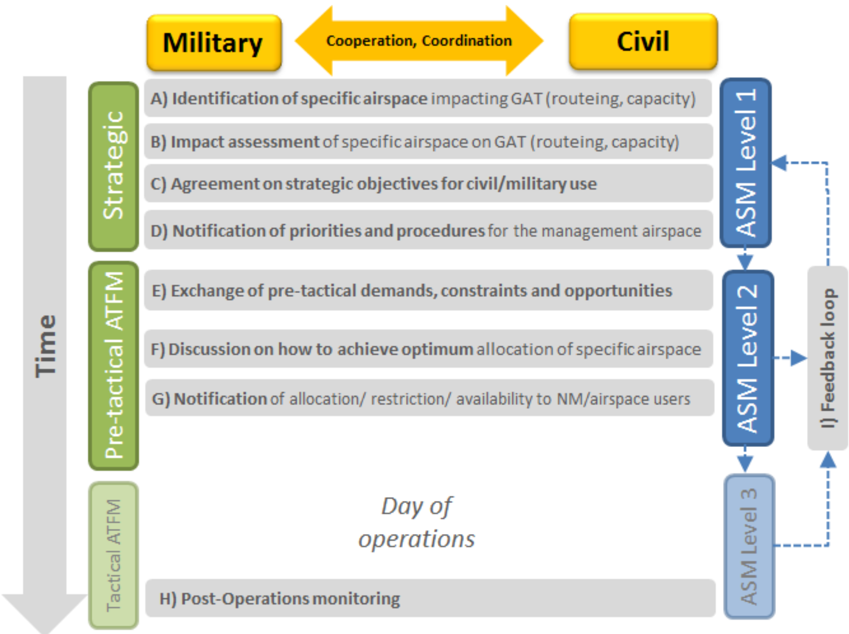

Figure 4-42: Criteria used for the questionnaire on civil/military cooperation

4.4.2 Results – PRC questionnaire on civil military coordination and cooperation

Of the 41 EUROCONTROL Member States, 38 States[43] are considered to have ASM components. Overall, 31 of the 38 States (82%) completed the questionnaire:

- Only one State provided in separate a Civil and Military reply to the questionnaire;
- 4 States provided multiple replies (ANSP or CAA and AMC – Civil and/or Military);
- 26 States provided (single) consolidated replies based on the outcome of a consultation amongst all different actors.

A summary of the results on the questions addressing ASM level 1 is provided in Figure 4-43.

STRATEGIC (ASM level 1)	
A) **Identification of specific airspace** that, when restricted or segregated, can affect the availability of route options or the availability of ATC capacity for general air traffic	
26 | 5	5 out of 31 States (16%) have not yet identified all the airspaces that can affect the availability of route options or the availability of ATC capacity for general air traffic.
B) **Assessment of the impact** of each area listed in (a.) on the availability of route options or on the reduction of ATC capacity for general air traffic;	
20 | 11	11 out of the 31 States (35%), have not performed an impact assessment in terms of flight efficiency;

43 Monaco and Luxembourg (no ASM components); Malta (no ASM component, although one reply received).

19 | 12	12 out of the 31 States (39%) have not performed an impact assessment in terms of ATC capacity.
14 | 17	More than half (17 out of 31 States) do not make impact assessments available to airspace managers.
C) **Strategic objectives**: Agreement between (ASM Level 1) civil and military stakeholders of the strategic objectives to be accomplished within the State / region;	
20 | 11	Only 20 out of the 31 States (65%) have national strategic objectives for GAT;
19 | 12	19 out of 31 States (61%) report that national strategic objectives for OAT are known and available to airspace managers;
13 | 18	13 out of 31 States (42%) report that GAT and OAT strategic objectives have been checked for consistency, however only 11 States review and notify airspace managers of such reviewed conclusions.
13 | 18	Only 13 out of 31 States review the strategic objectives according to feedback received from ASM Level 2 (although 22 States provide this information from ASM level 3 – (see criteria (I) in Figure 4-45).
D) Promulgation of **priorities and procedures** for the management of national / regional airspace in accordance with the strategic objectives stated in (c.) and feedback from (i) below;	
30 | 1	30 out of 31 States (97%) claim that priorities and procedures are established for the allocation of the areas defined in Criteria A (although only 26 States report that they have identified all specific airspace).
29 | 2	29 out of 31 States (94%) report that they consider civil as well as military priorities. However, only 20 report to have national strategic objectives for GAT and 19 for OAT.

Figure 4-43: Findings ASM level 1 – civil military coordination questionnaire

Observations Strategic (ASM level 1):

- Although national AIP's list all potential restricted and segregated airspace, 5 of the 31 States report that not all areas that have an impact on ATC capacity and available route options are identified.
- More than 35% of the reporting States do not perform impact assessments in terms of flight efficiency and in terms of ATC capacity. In more than 50% of the 31 States, impact assessments are not recorded or made available to airspace managers, resulting in limited transparency on how the airspace structures are managed. A considerable number of States indicated that they do not have national strategic objectives for GAT and/or OAT with even less States crosschecking GAT and OAT strategic objectives.

Figure 4-44 provides a summary of the results on the questions addressing ASM level 2 (pre-tactical).

PRE-tactical ATFM (ASM level 2)	
E) Exchange of **pre-tactical demands, constraints and opportunities** for civil and military airspace requirements;	
19 | 12	In general the constraints, opportunities and pre-tactical traffic demand are known for both GAT and OAT; 19 out of 31 States affirm to have a priority list to manage the military constraints.
F) **Discussion,** based on (a) to (e) above, between civil and military airspace managers, with the objective and empowerment to achieve the optimum allocation of airspace in accordance with the national / regional procedures and published strategic objectives;	
In general the received answers provide a positive feedback on discussions between civil and military airspace managers to optimise airspace allocation in accordance with user demands and strategic objectives. However, it is difficult to reconcile this with reports of lack of Strategic Objectives and Impact assessments etc.	
G) **Notification to airspace users** of the allocation / restriction / availability of airspace;	
20 | 11	11 out of 31 States (35%) report that they do not notify the Network Manager, and therefore the airspace users, of ALL airspace management decisions impacting available route options / availability of ATC capacity for general air traffic.
19 | 12	12 States report that they do not notify the Network Manager, and therefore the airspace users, of ALL updates in airspace availability affecting route options and/or ATC capacity.

Figure 4-44: Findings ASM level 2 – civil military coordination questionnaire

Observations Pre-tactical ATFM (ASM level 2):

- Despite the identified lack of national strategic objectives and impact assessments in a number of States (see ASM level 1), the answers received from the 31 States provide in general a positive feedback on the discussions between civil and military airspace managers at national level. It is worth pointing out that more than one third of the States do not share all relevant information with the Network Manager.

Figure 4-45 provides an overview on the results addressing post-operational monitoring and reporting.

Post-operational monitoring and reporting	
H) **Post- Operations Monitoring** of the impact of the airspace management decisions on both general and operational air traffic	
15 / 16	16 out of 31 States (52%) do not do any post-operations (GAT) monitoring.
12 / 19	19 out of 31 States (61%) do not do any post-operations (OAT) monitoring.
14 / 17	In the majority of States (55%), the findings of post-operations monitoring are not recorded.
I) Regular review of (h) and **feedback to ASM Level 1 stakeholders**: including problems, issues and requests for change to the priorities and procedures listed in (d) above.	
22 / 9	22 of the 31 States (71%) report that they do provide feedback to ASM Level 1 stakeholders.

Figure 4-45: Post-operational findings – civil military coordination questionnaire

Observations post-operational monitoring and reporting:

- More than half of the States do not have a post-operations process in place to assess the impact of airspace management decisions on GAT and OAT. It is noteworthy that 22 States (71%) indicated that they provide feedback to ASM level 1 (strategic) on findings and reviews performed as this is not in line with the low number of post-operations monitoring reported.

4.4.3 Findings on Civil Military coordination and cooperation questionnaire

- The FUA concept , and Regulation 2150/2005 for SES States, provide a clear framework for how civil and military stakeholders can work together to meet the requirements of both civil and military airspace users.
- As part of the Local Single Sky ImPlementation (LSSIP) process, Member States report information on the application of FUA principles, as specified in the Regulation No 2150/2005 [Ref.31]. Although all Member States declare to be formally compliant with existing legislation, the results of the civil military coordination and cooperation questionnaire suggest that there is scope for improvement in the underlying processes related to the management of the airspace.
- The main identified issues are related to the lack of impact assessments and the definition of clear national strategic objectives at ASM level 1 and the interrupted information flow between the three levels of ASM (availability of the right information to the relevant parties at the right time).
- The lack of Strategic Objectives in a number of States prevents effective assessment of the airspace management decisions. Even when processes are in place, in some States, the relevant information is not properly recorded, and there are shortcomings in the information flows at local (within parties involved) and at system level (Network Manager, Airspace Users) suggesting scope for improvement.
- Finally, there is a need to ensure an enclosed feedback loop in order to ensure that results and issues observed at ASM level 3 are fed back to the previous two levels (strategic, pre-tactical) in order to ensure review and improve processes where necessary for the benefit of all airspace users.

4.5 Conclusions

The growth in traffic (1.5% from 2014) was not homogenous throughout the network, with significant disruption to traffic flows because of, *inter alia*, the continuing Ukrainian crisis and industrial action by air traffic controllers. The temporal spread of traffic was also interesting and 2015 witnessed the highest individual monthly totals for network traffic in July, August & September for ten years.

After the lowest level of en-route ATFM delay per flight on record in 2013, delays have been rising again over the past two years. In 2015, total en-route ATFM delays for the EUROCONTROL area increased by +23% which corresponds to 0.73 minutes of en-route ATFM delay per flight (0.61 in 2014).

The performance deterioration was mainly attributed to ATC capacity issues highlighting previous PRC concerns that ATFM delays could increase when traffic grows again.

As stressed already previously by the PRC, in view of the considerable lead times it is essential to carefully plan and also deploy capacity in line with projected traffic growth. Over-conservative capacity planning removes buffers against traffic variations and increases the risk of significant disruption to aircraft operations.

While capacity constraints can occur from time to time, area control centres (ACCs) should not generate high delays on a regular basis. The most constraining ACCs in 2015 were Nicosia, Brest, Athinai and Macedonia, Zagreb, Lisbon, Reims, and Barcelona. Together, they accounted for 58.1% of all en-route ATFM delays but only 14.5% of total flight hours controlled in Europe.

Despite further progress in the implementation of free route airspace in 2015 (more than 20 airspace improvement packages in 2015), horizontal en-route flight efficiency deteriorated in 2015 after the continuous improvement over the past years. At European level, the inefficiency in filed flight plans increased from 4.70% to 4.74% in 2015. Inefficiencies in actual trajectories increased at a slightly higher rate from 2.72% to 2.77% in 2015.

Horizontal en-route flight efficiency improves notably on weekends, which is to some extent linked to lower traffic levels which appear to have a positive effect on flight efficiency but also due to the better availability of segregated and free route airspace on weekends which are contributing factors towards improved flight efficiency.

In view of the numerous factors and complexities involved, and with traffic levels growing again, flight efficiency improvements will become more and more challenging and will require the continued joint efforts of all stakeholders, coordinated by the Network Manager.

Close civil military cooperation and coordination is a crucial enabler to improve capacity and flight efficiency performance. Although all EUROCONTROL Member States declare to be formally compliant with existing FUA legislation, the results of the civil military coordination and cooperation questionnaire suggest that there is scope for improvement in the underlying processes related to the management of the airspace.

The main identified issues are related to the lack of impact assessments; the definition of clear national strategic objectives at ASM level 1, and the interrupted information flow between the three levels of ASM.

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5 Operational ANS Performance at Airports

KEY POINTS	KEY DATA 2015		
• On average, IFR movements (arr. + dep.) at the top 30 European airports increased by +2.3% in 2015. Passenger numbers increased at a higher rate of 5.3% compared to 2014. • Despite a number of disruptive events (e.g. industrial action), the average share of operational cancellations at the analysed airports remained at 1.5% in 2015. • The traffic increase resulted in higher levels of operational inefficiency at some airports. As a result, all four indicators measuring operational ANS performance at the top 30 airports showed a deterioration in 2015. • The substantial increase in airport arrival ATFM delay in 2015 is mainly due to Istanbul Atatürk (IST), Istanbul Sabiha Gökçen (SAW), and Amsterdam (AMS) airport. Additionally, a number of smaller Greek airports generated a high level of delay. • Despite a higher number of regulated flights, ATFM slot adherence continued to improve in 2015, particularly due to a notable improvement at London (LHR).	European average (top 30 airports)	2015	change vs. 2014
	Avg. daily movements (dep.+ arr.)	21,852	+2.3% ↑
	Avg. Airport Arrival ATFM Delay	1.49	+0.62 ↑ min/arr.
	Avg. Additional ASMA Time (without the Turkish airports)	2.3	+0.2 ↑ min./arr.
	Avg. ATC Pre-departure Delay (based on airline data)	1.0	+0.1 ↑ min./dep.
	Avg. Additional Taxi-out Time (without the Turkish airports)	3.7	+0.1 ↑ min./dep.

5.1 Introduction

This chapter evaluates ANS related operational performance at European airports. Safety is addressed separately in terms of runway incursions in Chapter2 and airport terminal ANS cost-efficiency is addressed in Chapter 6 of this report.

As part of the regular operational ANS performance review at European airports, this chapter presents an evaluation of the top 30 airports in terms of IFR movements in 2015 which have the strongest impact on network-wide performance. Together those airports accounted for 45.7% of total European movements in 2015. Any unusual performance observed at an airport not included in the top 30 is commented on in the respective sections of the chapter. Data on the ANS-related performance at all reviewed airports is available online at www.ansperformance.eu.

The chapter starts with a review of the traffic evolution at the top 30 airports including the number of operational cancellations in 2015.

In order to address a growing stakeholder interest to better address the vertical dimension of flight efficiency, the chapter presents a possible complementary indicator for the measurement of continuous climbs and descents operations at airports.

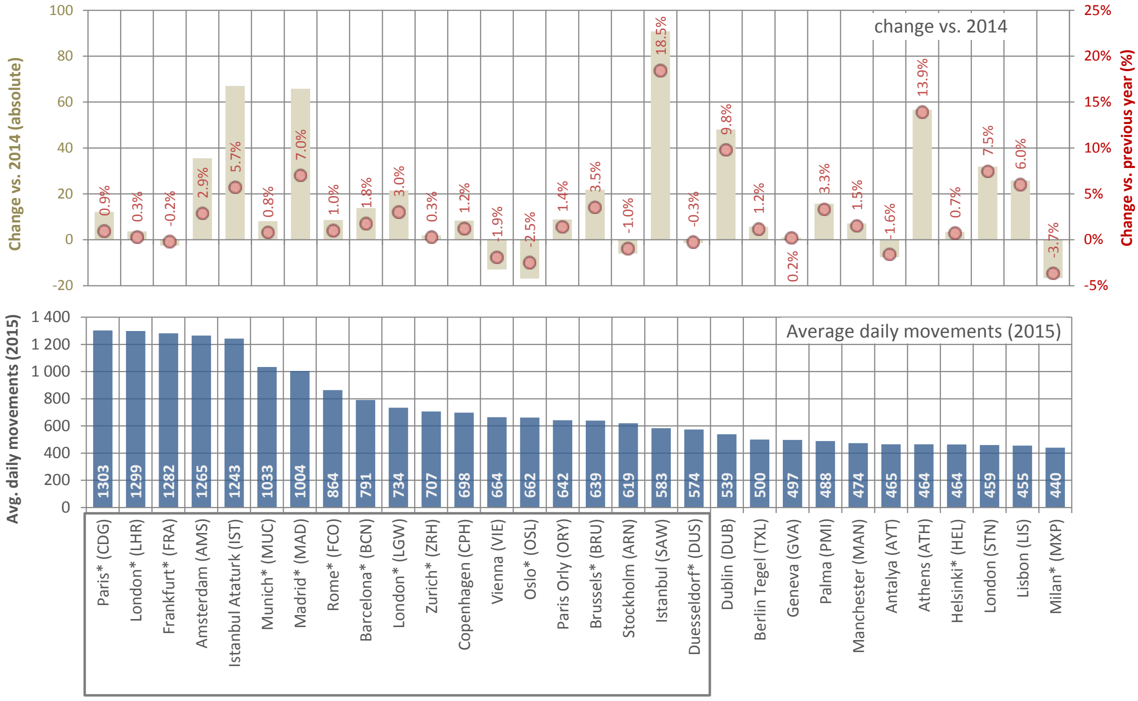
The second part provides an evaluation of ANS-related inefficiencies on the departure and arrival traffic flow at the top 30 airports. The four performance indicators used for the analysis relate to the operational efficiency on the inbound and outbound traffic flow and are also part of the single European Sky (SES) performance scheme. Complementary to the four standard indicators, an analysis of taxi-in efficiency is provided.

For the interpretation of the analysis in this chapter, it is important to point out that the observed outcome is the result of complex interactions between stakeholders (airlines, ground handlers, airport operator, ATC, slot coordinator, etc.) which make a clear identification of underlying causes and attribution to specific actors difficult. While at airports, ANS is often not the root cause for an imbalance in capacity/demand (e.g. adverse weather, policy decisions in the airport scheduling phase, traffic demand variation) the way air traffic is managed impacts on airspace users (time, fuel burn, costs), the utilisation of capacity, and the environment (emissions).

Hence, the analyses in the respective sections of this chapter should not be interpreted in isolation, but as an integral part of the overall operational performance observed at the airport concerned.

5.2 Traffic evolution at the top 30 European airports

Figure 5-1 shows the evolution of average daily movements at the top 30 airports in absolute and relative terms[44]. On average, IFR movements (arrival + departure) at the top 30 airports increased by 2.3% in 2015 compared to 2014, but still range -1.1% below 2008 levels.



** A-CDM implemented airport*

Source: Network manager; PRC analysis

Figure 5-1: Traffic variation at the top 30 European airports (2015/2014)

Istanbul Sabiha Gökçen and Atatürk airports continued their remarkable growth also in 2015 with an increase in average daily traffic of 91 and 67 movements respectively. Over the past 10 years, Istanbul Sabiha Gökçen airport grew at an impressive average annual rate of +29.8% and Istanbul Atatürk at an average rate of 8.2% per year.

Other airports with a substantial growth in 2015 were Athens (+13.9%), Dublin (+9.8%), London Stansted (+7.5%), Madrid (+7.0%), and Lisbon (+6.0%). Of the top 30, seven airports showed a traffic decrease in 2015 (Milan (MXP), Oslo (OSL), Vienna (VIE), Antalya (AYT), Stockholm (ARN), Dusseldorf (DUS), and Frankfurt (FRA)).

Figure 5-2 shows a breakdown of the traffic at the top 30 airports by aircraft category. Narrow body aircraft are by far the largest category (67.4%). The comparison to 2008 shows an overall trend towards larger aircraft over time which is consistent with the continuous increase in average maximum take-off weight observed in Chapter 2 (see also Section 2.2.1).

Aircraft category evolution at top 30 airports	2015		% change vs.	
	flights (M)	% share	2014	2008
Other	0.01	0.1%	-10.2%	-23.6%
Piston	0.01	0.1%	-13.8%	-54.6%
Turbo Prop (ATR, Dash8, etc.)	0.49	6.1%	1.7%	-24.1%
Regional Jet (BAE146, CRJ, ERJ, etc)	1.15	14.4%	-2.6%	-20.4%
Narrow body (A319,320,321, B737, etc)	5.37	67.4%	3.0%	5.0%
Wide & Heavy (A340, A380, B767, B747, etc)	0.96	12.0%	5.8%	10.8%

Figure 5-2: Changes in aircraft category at the top 30 airports

This trend can also be derived from the increase in passenger numbers across Europe that outranges the increase in traffic movements.

44 Please note that the airport ranking is based on total IFR movements which is different from ACI Europe statistics, based on commercial movements only.

Compared to 2014, the number of passengers at the top 30 airports has increased at a higher rate (+5.3%) than flight movements (+2.3%) which is consistent with the further overall increase in passenger load factors reported by airlines over the past years.

Compared to 2008, passenger numbers at the top 30 airports are 22.5% higher in 2015 which is remarkable considering the fact that movements are still -1.1% below 2008 levels.

Figure 5-3 shows the share of operational cancellations at 24 of the top 30 airports[45] in 2015.

Overall, the average cancellation rate in 2015 remained at 1.5% which is the same level as in 2014.

> **Operational cancellations at airports**
>
> In accordance with Regulation (EC) 691/2010, a flight is considered to be cancelled if the following conditions apply:
>
> - the flight received an airport slot;
> - the flight was confirmed by the air carrier the day before operations and/or it was contained in the daily list of flight schedules produced by the airport operator the day before operations; but,
> - the actual landing or take –off never occurred.

Despite a slight improvement compared to 2014, the highest level of operational cancellations (4.1%) was observed at Geneva (GVA) airport, followed by Lisbon (LIS) airport where 2.8% of the planned flights were cancelled in 2015.

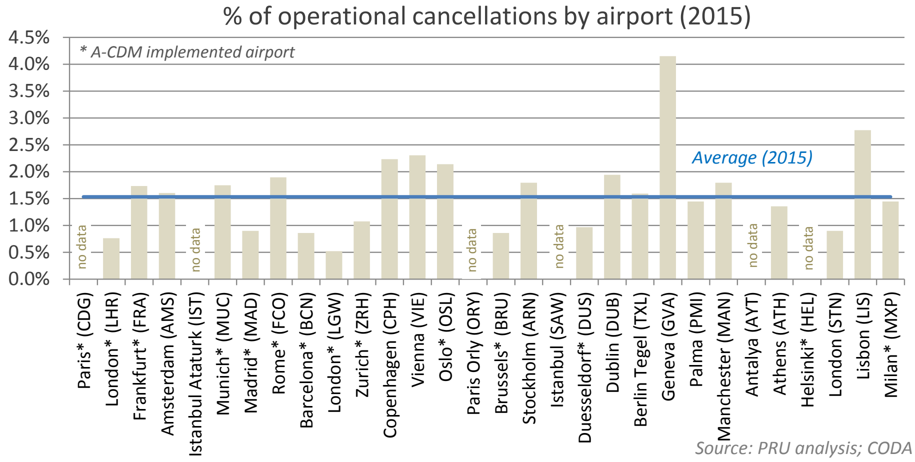


Figure 5-3: Operational cancellations at the top 30 airports in 2015

Although the data provides some first insights, there is a need to better understand the drivers of operational cancellations at the individual airports which can range from disruptive events (e.g. industrial action, extreme weather) to policy related issues linked to the airport slot allocation[46].

5.3 Balancing capacity with demand at airports

The number of operations at airports is usually limited by the runway system capacity. In addition to physical constraints, such as runway layout, there are "strategic" factors (e.g. airport scheduling) and "tactical" factors. The latter include, inter alia, the sequencing of aircraft and the sustainability of throughput in specific weather conditions.

While safe operation of aircraft on the runway and in the surrounding airspace is the dominant factor influencing runway throughput, other influencing factors comprise: airport layout and runway configuration, traffic mix, runway occupancy time of

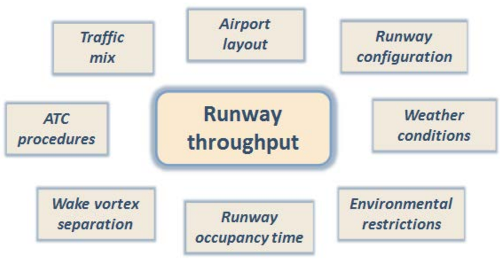


Figure 5-4: Factors influencing runway throughput

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45 No data is available for Paris (CDG), Istanbul (IST), Paris (ORY), Istanbul (SAW), Antalya (AYT), and Helsinki (HEL).

46 In order to keep the same series of slots in the following season, air transport operators are required to use a series of slots at least 80% of the time during the season.

aircraft during take-off and landing, separation minima, wake vortex, ATC procedures, weather conditions, demand loading by departure route, and political and environmental restrictions.

Meteorological conditions can have a major impact on the operational capacity of an airport. As weather conditions deteriorate, separation requirements generally increase and the actual throughput is consequently reduced.

The impact of weather (visibility, wind, convective weather, precipitation, etc.) on operations at an airport and hence on ANS performance can vary significantly by airport and depends on a number of factors such as, inter alia, ATM and airport equipment (instrument approach system, radar, de-icing facilities, etc.), runway configurations (wind conditions), and approved rules and procedures.

In order to avoid frequent and significant excess of demand on the day of operations, airport capacity declaration and the subsequent airport scheduling process regulate traffic in terms of volume and concentration by allocating airport landing and departure slots to aircraft operators months before the actual day of operation. Of the top 30 airports evaluated in this chapter, all but Athens are coordinated airports for which allocated landing and departure slots are required.

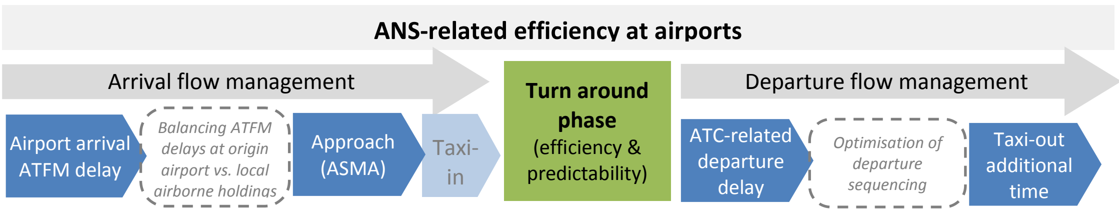
A declared airport capacity close to Instrument Meteorological Conditions (IMC) can support overall stability of operations but there is a risk that resources might be underutilised for considerable periods.

Depending on the economic value of the airport slot for aircraft operators, a higher level of "planned" delay is accepted by airlines at some airports as a trade-off to get access to the airport.

Declared airport capacity

The declared airport capacity is generally decided by the respective States taking into consideration the opinion of a coordination committee reflecting also infrastructure limitations and environmental constraints. It represents an agreed compromise between the maximisation of airport infrastructure utilisation and the quality of service considered as locally acceptable. This trade-off is usually agreed between the airport managing body, the airlines and the local ATC provider during the airport capacity declaration process.

When a mismatch between demand and capacity is anticipated at the airport on the day of operations, a number of air traffic flow management techniques can be applied on the arrival and departure traffic flow, depending on the anticipated duration and severity of the capacity shortfall.



ANS-related operational performance at and around airports		
Arrival flow management	**Turn around**	**Departure flow management**
• Reduction of airborne terminal holdings; • Support to fuel efficient descent trajectory; • Maximise airport throughput; • Optimum taxi routing (distance & time);	• Improve turn-around efficiency and predictability;	• Optimise push back time and departure sequencing; • Minimise ANS-related departure delays; • Optimum taxi routing (distance & time); • Adherence to ATFM departure slots;
ANS performance related indicators		
• Airport ATFM arrival delay; • Additional Arrival Sequencing and Metering Area (ASMA) time; • Additional Taxi-in time;	• None	• ATC-pre departure delay; • Additional taxi-out time; • ATFM slot adherence;
Supporting projects/initiative		
• Continuous descent operation (CDO); • Performance based navigation (PBN); • Arrival manager (AMAN/XMAN);	• Local initiatives • A-CDM • APOC	• Airport Collaborative Decision Making (A-CDM) • Departure manager (DMAN); • Continuous climb operations (CCO);

Figure 5-5: ANS-related operational performance at airports (overview)

The following sections evaluate ANS-related inefficiencies on the departure and arrival traffic flow at the top 30 airports. The four performance indicators used for the analysis are illustrated in dark blue in Figure 5-5. They relate to the optimisation of the inbound and outbound traffic flow and are also part of the SES performance scheme. Complementary to the four standard indicators, an analysis of taxi-in efficiency and a new measure to evaluate continuous climbs and descents are provided.

There is a close interrelation between the management of the inbound and outbound traffic flow and the efficiency and predictability of the turnaround phase at airports. The Airport Collaborative Decision Making (A-CDM) concept was developed to facilitate the sharing of operational processes and data to allow better informed decisions to be made at local but also at network level. One of the fundamentals of the A-CDM Milestone Approach is the real-time sharing of milestones such as Target Off-Block Time, thus creating "common situation awareness" among involved stakeholders and improved utilisation of resources.

Locally, the A-CDM concept aims at improving the overall efficiency of operations at the airport by synchronising activities of all involved players to maximise the departure predictability and to optimise the use of available resources, with a particular focus on the aircraft turnaround (re-fuelling, catering, baggage, boarding, etc.) and pre-departure sequence.

Delays already encountered at the departure airport are by far the main contributor towards arrival punctuality at the destination (see also Chapter 2). In view of the considerable costs involved, many airports have local working groups dedicated to improving the turnaround efficiency.

Barcelona (BCN), Prague (PRG) and Venice (VCN) became fully implemented A-CDM airports in 2015 bringing the number of fully A-CDM implemented European airports up to 18. This corresponds to 27.0% of total European departures in 2015. In the analysis in the next sections, the fully implemented A-CDM airports are marked with an asterisk.

Implementation Status	AIRPORT (IATA CODE)	% of departures in 2015 (%)
Implemented	Barcelona (BCN), Berlin-Schönefeld (SXF), Brussels (BRU), Dusseldorf (DUS), Frankfurt (FRA), Helsinki (HEL), London (LGW), London (LHR), Madrid (MAD), Milan (MXP), Munich (MUC), Oslo (OSL), Paris (CDG), Prague (PRG), Rome (FCO), Stuttgart (STR), Venice (VCE), Zurich (ZRH)	27.0%
On-going	Athens (ATH), Lisbon (LIS), Manchester (MAN)	2.9%
Implementation planned in 2016	Amsterdam (AMS), Bergen (BGO), Copenhagen (CPH), Dublin (DUB), Geneva (GVA), Hamburg (HAM), Istanbul Ataturk (IST), Lyon (LYS), Milan (LIN), Naples (NAP), Palma (PMI), Paris Orly (ORY), Stavanger (SVG), Stockholm (ARN), Trondheim (TRD), Vienna (VIE)	17.7%
Initial contact	Nice (NCE), Bucharest (OTP)	1.3%
	All other European airports	51.1%

Figure 5-6: A-CDM implementation status in Europe (2015)

With A-CDM implemented locally at an airport, the next steps are to enhance the integration of airports with the Network Manager (NM) for the benefit of the entire network.

Exchange of real time data between airports and the NM is already operational at the 18 fully implemented A-CDM airports. The airports are receiving a more accurate arrival estimate for all flights via the Flight Update Message (FUM) and the network is benefiting with enhanced take-off time estimates in tactical operations via the Departure Planning Information (DPI) messages.

This better integration of airports into the ATFM network in turn leads to a higher accuracy of the traffic situation and hence a better utilisation of the entire network capacity.

5.3.1 Continuous climbs and descents

The Arrival Sequencing and Metering Area (ASMA) indicator, developed together with a group of interested stakeholders in 2008, is a time based indicator which aims at measuring inefficiencies due to holdings and sequencing in the vicinity of airports by comparing a reference time to the actual time within a given radius.

In order to address a growing stakeholder interest to better focus on the vertical component of flight efficiency, this section presents possible complementary indicators for the measurement of the vertical dimension of flight efficiency. The methodology (see grey box) can be applied to all flight phases but the focus in this section is on the climb and descent phases of flights rather than on the cruising phase.

A separate complementary study addressing vertical flight efficiency in the cruise phase is currently being carried out by the Performance Review Unit.

The analysis in this section has been limited to the top 15 airports in terms of traffic in 2015.

Istanbul Atatürk airport was not included in the analysis because of the limited amount of radar data available for flights to/from Turkish airports below FL230. These data are presently not provided to EUROCONTROL but the Network Manager and Turkey are working together to resolve this data issue.

Figure 5-7 shows the average share of time flown level within a 200NM radius around the airport. In general, climb outs are less subject to level offs (red bars). For descents (blue bars), a significant share of level flight segments can be observed in Figure 5-7. Airports with higher numbers of traffic show a higher percentage of level segments.

Vertical flight efficiency

In the climb or descent parts of the trajectories the level segments should be determined. This is done by calculating the rate of climb or descent (vertical velocity) between every pair of consecutive data points. If the rate of climb or descent between two data points is smaller than or equal to a chosen vertical velocity, that part of the trajectory is considered as level flight. Doing this for the whole climb or descent trajectory, the distance and time flown level can be calculated.

Assumptions

- The analysis is done for the part of the flight between the departure/arrival airport and the moment where either:
  - the flight crosses the 200NM radius around the airport while it is below the altitude that is in the flight plan at that point; or
  - the flight is inside the 200NM radius around the airport but crosses the altitude that is in the flight plan at the 200NM radius.
- A segment of the trajectory is considered as level flight when its rate of climb or descent is lower than or equal to 300 feet per minute.
- Level segments shorter than 0.5NM are not considered.

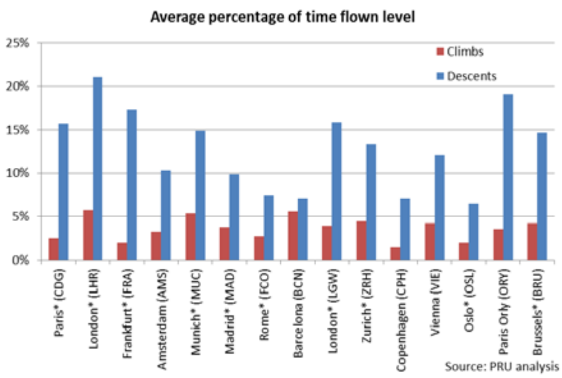


Figure 5-7: Average percentage of time flown level

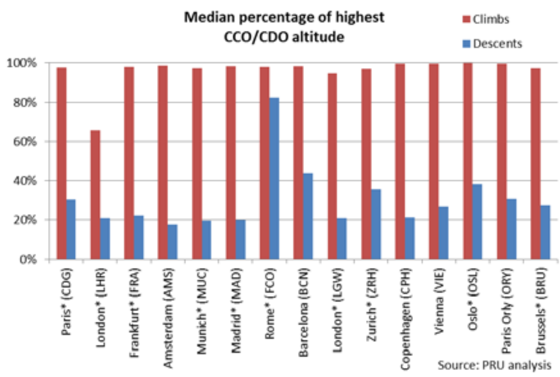


Figure 5-8: Median percentage of highest CCO/CDO altitude

It is worth noting that for Amsterdam (AMS), Madrid (MAD), Rome (FCO), Barcelona (BCN), Copenhagen (CPH), and Oslo (OSL) the share of level segments in the descent phase is comparatively low which might be due to various factors including lower complexity or better procedures.

The share of level segments in climb (red bars) appears to be less related to the amount of traffic. For

Paris (CDG), Frankfurt (FRA), Rome (FCO), Copenhagen (CPH) and Oslo (OSL), the share of level flight segments during climb is notably below average.

Figure 5-8 shows the median altitudes at which continuous climbs ended and continuous descents started. The measure is expressed in terms of percentage with respect to the altitude in the flight plan at the 200NM radius around the airport. If the maximum altitude of the actual flight within the analysed 200NM radius is higher than or equal to this flight plan altitude, its value would be 100%.

It is obvious that climbs (red bars) are performed more efficient than descents (blue bars). Most airports have their average highest Continuous Climb Operation (CCO) altitudes above FL300 which is close to the nominal cruising altitude of jet aircraft. For arriving traffic, the highest Continuous Descent Operation (CDO) altitude is notably lower for all considered airports which is probably due to the application of arrival procedures and the use of holding stacks.

Case study

London Heathrow (LHR) and Rome Fiumicino (FCO) have been chosen for a more in-depth analysis since London (LHR) appears to have the highest share of level flight (both during climb and descent) while Rome (FCO) is performing much better (even better than airports with a lower traffic density).

London (LHR) has published CDO arrival routes which are available all day long. Nevertheless, NATS consider only the parts of the trajectories below 6,000 feet for their analysis of CDO performance[47]. Rome (FCO) has not published CDO arrival routes yet, but is intending to publish them. CDOs are however facilitated by ATC using tactical radar vectoring [Ref. 32].

The analysis of the monthly results for London (LHR) shows that the share of level flight segments is rather constant which appears to be linked to the continuous high throughput levels, close to maximum capacity observed at the airport (Figure 5-9). For Rome (FCO), the results for the climb phase are quite constant throughout the year whereas the share of level flight segments during descent shows a slight variation in summer and in December where it was slightly lower (Figure 5-10).

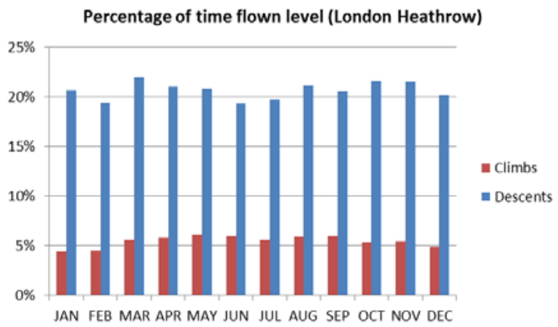


Figure 5-9: Average percentage of time flown level for London Heathrow

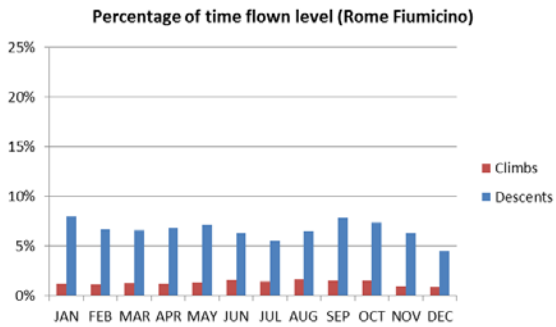


Figure 5-10: Average percentage of time flown level for Rome Fiumicino

Figure 5-11 shows the median percentage of the highest CCO/CDO altitude for London (LHR). With all values around 20% - which corresponds to an altitude range between 7,000 and 8,000 feet - the highest CDO altitude (blue bars) at London (LHR) appears to coincide with the lowest altitude of the holding stacks (7,000 feet). This means that at least 50% of the flights perform a continuous descent after they have left the stacks, which corresponds to the information provided on the website of London Heathrow Airport [Ref. 33]. The median value of the highest CCO altitude (red bars) is quite low from March to October which might be an effect of the higher amount of traffic during these months.

47 Top of Descent for many London (LHR) inbounds occurs outside of NATS airspace.

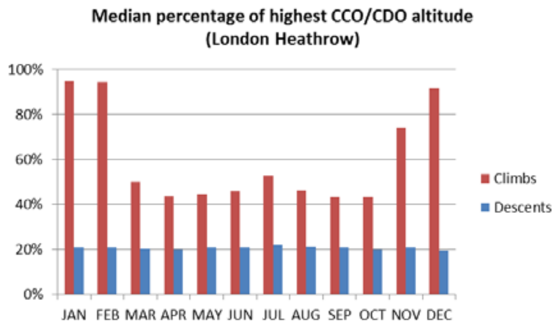


Figure 5-11: Median percentage of highest CCO/CDO altitude for London Heathrow

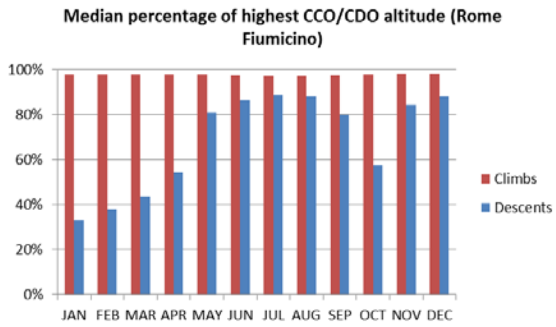


Figure 5-12: Median percentage of highest CCO/CDO altitude for Rome Fiumicino

The median highest CCO altitude for flights from Rome (FCO) is quite constant during the year (Figure 5-12) with almost 100% for all months. This suggests that aircraft are in general able to climb continuously to the altitude that is foreseen in the flight plan at 200NM from the airport which is at or close to nominal cruising altitude. For descents some counterintuitive results are seen. The highest CDO altitude (blue bars) is observed during the summer when traffic levels are higher. Rather the opposite would normally be expected.

To get a better view on the altitudes with level flight segments, the vertical trajectories to/from London (LHR) in July 2015 were plotted in Figure 5-13 (departures) and Figure 5-14 (arrivals). Figure 5-15 and Figure 5-16 show the equivalent plots for the departures and arrivals from/to Rome Fiumicino (FCO). The detected level segments are highlighted in red.

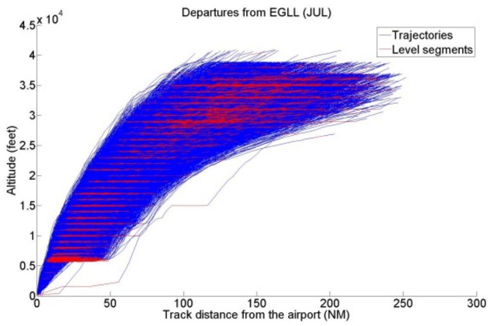


Figure 5-13: Vertical trajectories of Heathrow departures in July

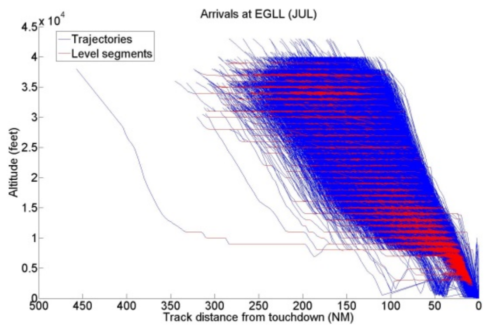


Figure 5-14: Vertical trajectories of Heathrow arrivals in July

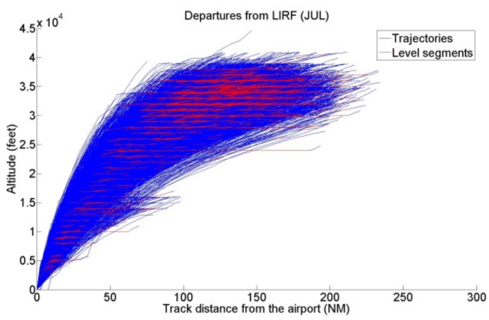


Figure 5-15: Vertical trajectories of Rome departures in July

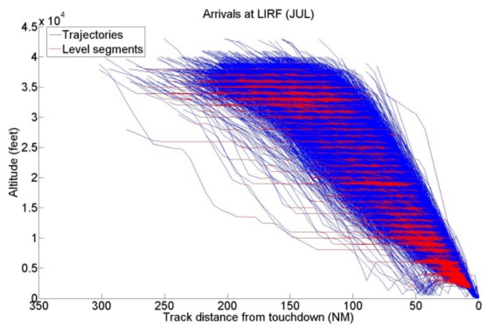


Figure 5-16: Vertical trajectories of Rome arrivals in July

It is apparent that some vertical glitches are present in the data which might result in an underestimation of the amount of level flight segments.

Apart from the numerical results, it is also interesting to know the positions of the level segments as level segments of several flights around the same position might indicate that the level segments are due to specific restrictions. When reviewing plots of the lateral trajectories, it can be noted that, additionally to the expected level segments close to the airport (due to vectoring towards the runway), there are a lot of level flight segments when flights cross national boundaries.

This first high level analysis of continuous climb and descent operations at a selected set of airports revealed notable performance differences among airports which should be investigated further. The observed differences are caused by a number of reasons including, congested airspace, restrictions from neighbouring ANSPs, and traffic density.

The PRC intends to continue developing the vertical flight efficiency metric presented above and to perform detailed analyses for individual airports, or terminal manoeuvring areas, which could be presented in more specific in-depth performance reports in the future.

Note that this vertical measure cannot be used in conjunction with the horizontal efficiency metrics described in Chapter 4.3 to determine 3-dimensional flight efficiency. For these vertical & horizontal elements to be made commensurate, further work would need to be carried out by the Performance Review Unit.

5.4 Management of the arrival flow

Apart from the capacity declaration process in the strategic phase, the primary means to manage arrival flows at airports in Europe in the tactical phase are ATFM regulations centrally implemented by the Network Manager and local flow measures at the airport.

Small imbalances between demand and capacity during peak times are usually managed locally by holdings or vectoring which may also serve as a short-term buffer to ensure a constant reservoir of aircraft to maximise runway throughput. In case of a more severe imbalance when delays cannot be absorbed around the airport, the Flow Management Position (FMP) coordinates with the Network Manager the application of an ATFM regulation which will hold aircraft bound for the capacity constrained airport at their origin airports.

The level of accuracy of the flow measures significantly increases from the application of ATFM departure slots at the origin airports (15 min. time window) to holding or vectoring in the vicinity of the arrival airport.

In the absence of a supporting en-route function in Europe, finding the right balance for the management of the arrival flow can be challenging. Although keeping an aircraft at the gate saves fuel – if it is held and capacity goes unused – the cost to the airlines of the extra delay may exceed the fuel cost by far.

5.4.1 Declared arrival capacity vs. actual throughput

This section compares the declared peak arrival capacity to actual throughput at the top 30 European airports. It provides an understanding of the distribution of the arrival throughput including the “peak service rate” which can be achieved in ideal conditions and with a sufficient supply of demand.

Figure 5-17 shows the declared peak arrival capacity (brown bars) in 2015 together with the observed arrival throughputs (06h00 – 22h00 local time) shown as box plots which gives also an indication of the degree of dispersion. Amsterdam (AMS), Paris (CDG), Frankfurt (FRA), and Munich (MUC) had the highest peak service rates in 2015.

Peak service rate

The airport peak service rate (or peak throughput) is an approximation of the operational airport capacity that was provided in ideal conditions. It is based on the cumulative distribution of the number of movements per hour, on a rolling basis of 5 minutes.

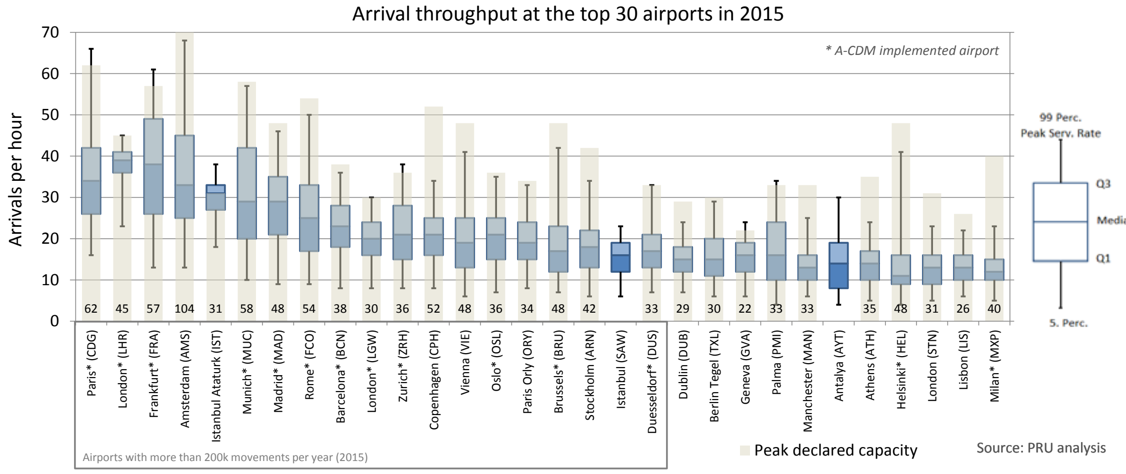


Figure 5-17: Arrival throughput at the top 30 airports

However when looking at the distribution of the arrival throughput, it is interesting to note that London (LHR) had the highest median arrival throughput of all airports with a comparatively narrow range compared to most other airports which suggests a continuous high level of throughout all day long. Moreover it is quite remarkable that this performance was achieved with two runways operated in segregated mode.

Figure 5-18 shows the departure throughput at the top 30 airports in 2015 together with the peak declared departure capacity which shows a similar picture as the arrival throughput.

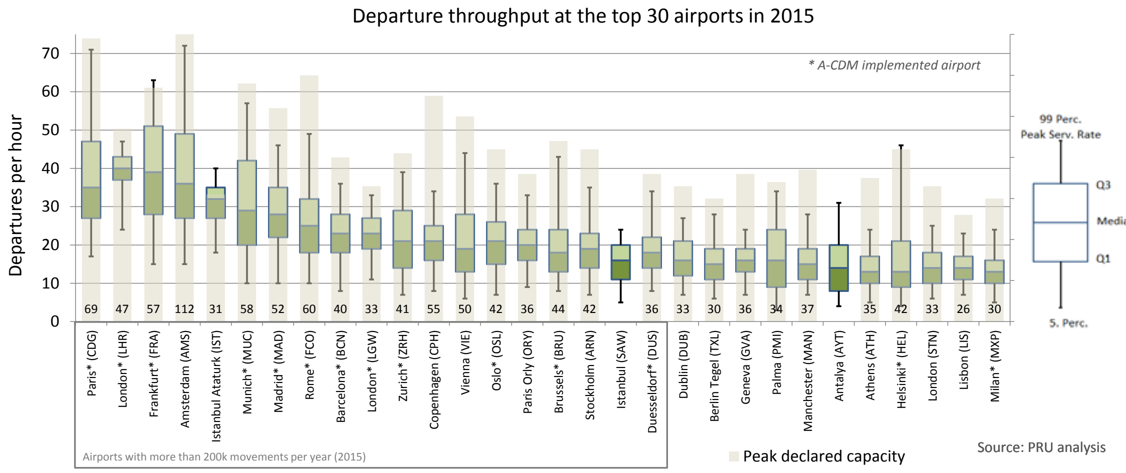


Figure 5-18: Departure throughput at the top 30 airports

Although the analysis in Figure 5-17 and Figure 5-18 provide a first indication of the operations at the airport, it is acknowledged that other factors such as runway layout, mode of operation, and available configurations (many runways may not be operated independently), as well as the societal factors such as noise and environmental policies, would need to be considered in a more detailed analysis.

5.4.2 ANS-related inefficiencies on the arrival flow

This section analyses ANS-related inefficiencies on the arrival flow at the top 30 European airports in terms of **airport arrival ATFM delay** and **additional ASMA time**. Although the direct influence is limited, for completeness reasons and to understand the order of magnitude, the efficiency of the taxi-in performance is also included at the end of the section.

> **Additional ASMA Time**
>
> ASMA (Arrival Sequencing and Metering Area) is the airspace within a radius of 40NM around an airport. The Additional ASMA Time is a proxy for the level of inefficiency (holding, sequencing) of the inbound traffic flow during times when the airport is congested.
>
> More information and data on additional ASMA time is available at www.ansperformance.eu.

ANS in Europe are still largely organised by state boundaries. This means that national service providers are usually able to directly influence an aircraft only once it enters its airspace, which is sometimes close to the destination airport (see also impact of state boundaries on continuous descent operations in previous section). Although there are local initiatives of cross border arrival management, this limits the opportunity to manage the approach already during the en-route or descent phase through the application of speed control and can result in additional time in holding stacks.

Figure 5-19 shows the airport arrival ATFM delay (top of figure) and the additional ASMA time (bottom of figure) per arrival at the top 30 European airports in 2015.

Together the top 30 airports analysed in this chapter accounted for 45.7% of total European airport movements and 88.7% of total airport ATFM arrival delays in 2015. Airport ATFM arrival delays increased for the second time in a row in 2015. Compared to 2014, there was a substantial increase in average airport ATFM arrival delay per arrival from 0.87 minutes in 2014 to 1.49 in 2015.

Frankfurt (FRA) showed a notable improvement in 2015 which was due to a lower level of weather related airport ATFM arrival delays. The performance deterioration in 2015 was mainly driven by capacity issues at the two Istanbul airports and an increase in weather-related delays at Amsterdam (AMS) airport. At the same time, airport ATFM arrival delays at Zurich (ZRH) remained comparatively high in 2015.

Although not included in the top 30 airports, it is worth noting that high levels of airport ATFM arrival delays were reported at a number of small Greek airports during the summer of 2015.

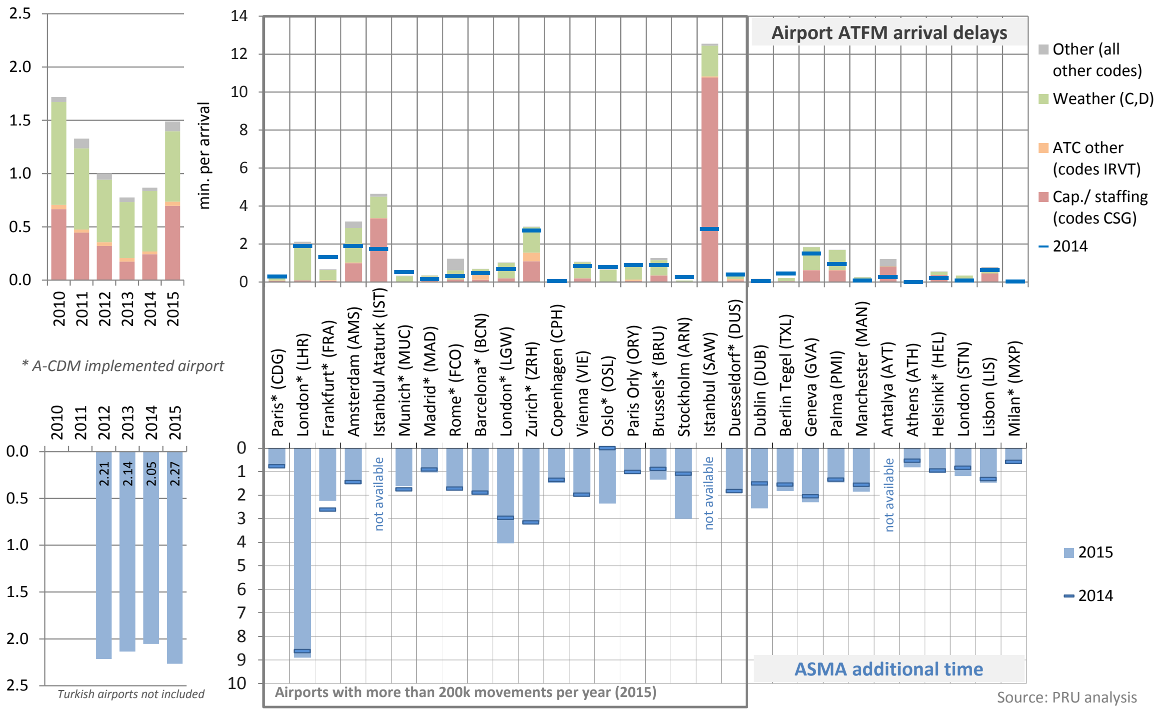


Figure 5-19: ANS-related inefficiencies on the arrival flow at the top 30 airports in 2015

Following the continuous reduction of additional time in the Arrival Sequencing and Metering Area (ASMA) area between 2012 and 2014, average ASMA additional time in Europe increased again notably in 2015 to reach 2.27 minutes per arrival at the top 30 airports[48]. The ASMA performance deterioration in 2015 was largely driven by an increase in average additional ASMA time at London Gatwick (LGW), Stockholm (ARN), Dublin (DUB) [49] and Brussels (BRU).

London Heathrow (LHR) has by far the highest level of average additional ASMA time in Europe[50]. The reduction of ASMA additional time observed at London (LHR) airport in 2014, following the introduction of cross border arrival management (XMAN)[51] on major arrival flows into London (LHR) in March 2014 could not be continued in 2015.

With London Heathrow operating at or close to maximum capacity most of the day, strong headwinds can have a notable impact on arrival throughput and result in high levels of weather related airport ATFM arrival delay. In order to reduce delays during periods when there is strong wind, NATS deployed time-based separation (TBS) at London Heathrow airport at the end of March 2015. The system works by separating arriving aircraft by time, rather than by distance and allows separation distances to be reduced to maintain the landing rate. Although according to NATS TBS allows controllers to land on average up to two more aircraft per hour compared to similar conditions before TBS the weather-related ATFM delay at London (LHR) increased slightly in 2015 which might be due to less favourable weather conditions.

The following section provides a more detailed analysis of airport ATFM arrival delays at the two Istanbul airports and at a number of small Greek airports which had a penalising effect on the European air transport network in 2015.

Airport ATFM arrival delays at Istanbul Atatürk and Sabiha Gökçen airport

Istanbul Atatürk (+5.7% vs. 2014) and Sabiha Gökçen (+18.5% vs. 2014) airports continued their remarkable traffic growth also in 2015.

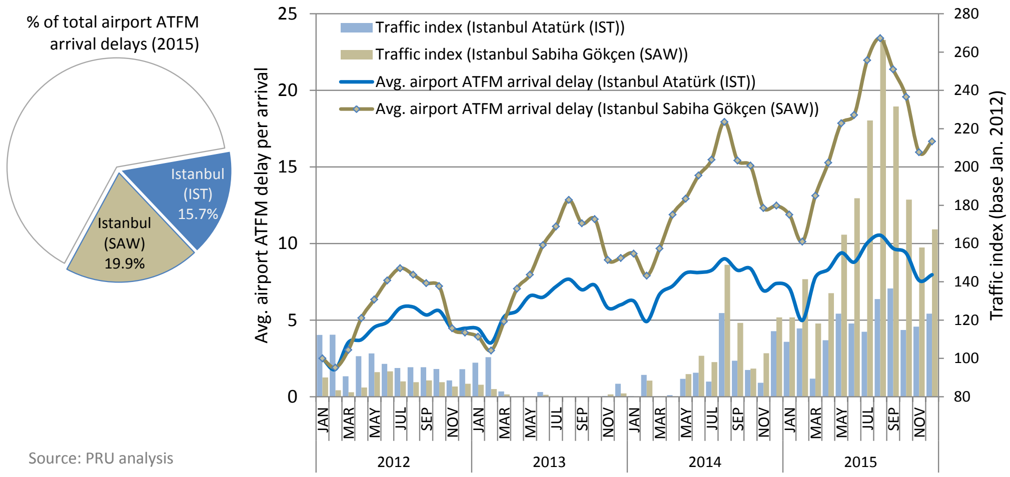


Figure 5-20: Airport ATFM arrival delays at Istanbul Atatürk and Sabiha Gökçen airport

The continuous strong growth resulted in a substantial increase in airport ATFM arrival delays at the two Istanbul airports in 2015 with a notable impact on the European network. As indicated in Figure 5-20, the two airports accounted for 35.7% of all airport ATFM arrival delays in Europe in 2015 (Sabiha Gökçen 19.9%, Istanbul Atatürk 15.7%). By far the main share of the airport ATFM arrival

48 The average for ASMA additional time does not include the three Turkish airports due to data availability.

49 The results for Dublin airport should be seen in the context of a +9.8% traffic growth in 2015.

50 It should be noted that the high level of ASMA additional time is not related to poor ATM performance but due to a deliberate decision taken during the airport scheduling process after consultation with involved parties.

51 The neighbouring ANSPs (DSNA, IAA, MUAC, LVNL) were asked to slow down aircraft up to 350 miles away from London to help minimise local holding delays at London Heathrow.

delay was airport capacity related, followed by some weather related delays and technical issues.

Due to the lack of capacity at the two existing airports, a new Istanbul Airport is presently under construction. The airport is planned to open in different phases with an anticipated capacity for up to six runways, serving 150 million passengers by 2028. Once the new airport is operational, Istanbul Atatürk Airport will be closed down.

Airport ATFM arrival delay at small Greek airports

In 2015, 5.5% of all airport ATFM arrival delays were attributable to Greek airports. The main share was due to some smaller Greek airports where average ATFM delays of up to 11.5 minutes per arrival were observed in 2015. Together those smaller Greek airports accounted for 5.1% of European airport ATFM arrival delays. Although the traffic volume at those smaller airports is comparatively low, the network impact in terms of reactionary delay is notable.

The performance at the Greek regional airports is linked to seasonal traffic in summer and was already observed in 2011 when the Network Management Unit successfully worked together with those airports to improve performance.

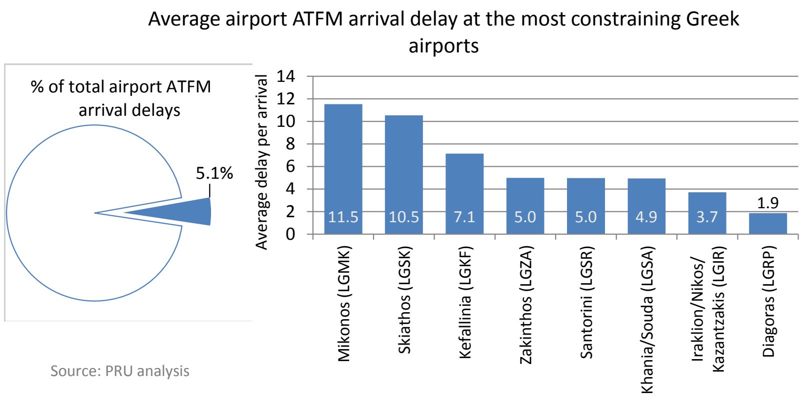


Figure 5-21: Airport ATFM arrival delays at Greek airports

In order to avoid traffic overload, all those smaller Greek airports are coordinated during the summer and the initiative at that time focused on (1) the adjustment of the capacity declaration and subsequent airport slot allocation, (2) consistency between flight plan and airport slots, (3) and a reduction of arrival ATFM regulation through an increased local ATC awareness of the resulting network impact. It would be important to revive the aforementioned initiatives in order to avoid high delay levels in 2016.

5.4.3 Taxi-in efficiency

Although the taxi-in phase in generally considered to be of lower order of magnitude from a performance point of view, for completeness reasons and to provide a better understanding of the order of magnitude of the level of inefficiencies estimated in the taxi-in phase, this section provides an analysis based on a statistical method.

It is acknowledged that the taxi-in phase is affected by a number of factors most of which cannot be directly influenced by ATM. The main influencing factors are considered to be airport layout (runways, taxiways, stands, crossings, etc.) and stand allocation/availability.

Additional taxi-in time

The Additional Taxi-in time aims at evaluating the level of inefficiencies in the taxi-in phase.

The analysis refers to the period between the time when the aircraft landed and the time it arrives at the stand. For each arrival, the additional time is computed as the difference between its actual taxi-in time and the reference taxi-in time based on the 20th percentile of the associated stand-runway combination. In case the actual taxi-in time is equal or less than the reference taxi-in time, the additional time is set to zero.

Figure 5-22 shows the average additional taxi-in times at the top 30 European airports in 2015. On average, the additional taxi-in time in 2015 remained unchanged at 1.6 minutes per arrival which is considerably lower than the observed inefficiencies in the taxi-out phase (see also next section).

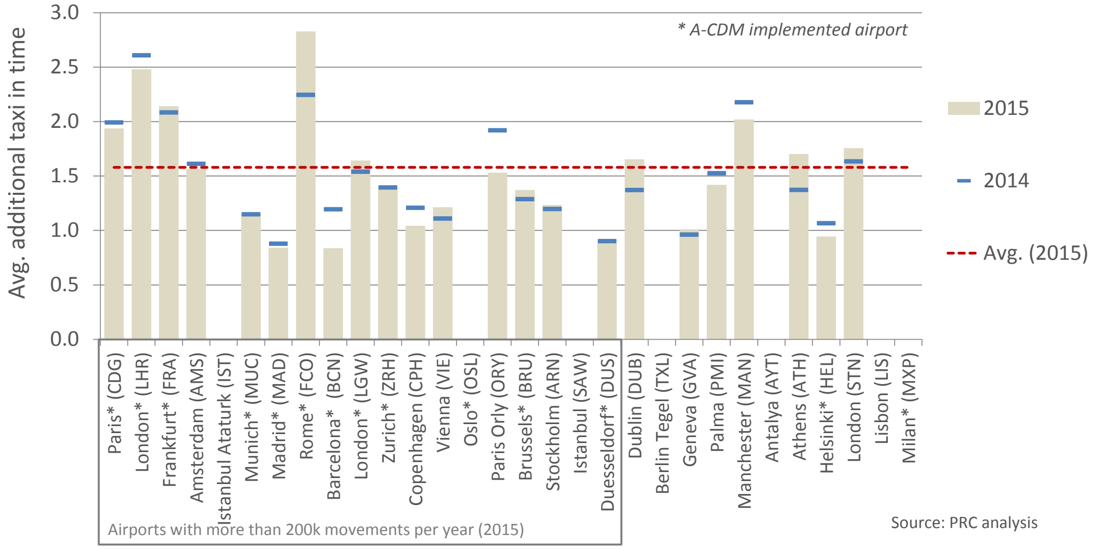


Figure 5-22: Average additional taxi-in time (2015)

A number of airports showed a notable improvement compared to 2014 but those improvements were offset by the significant increase in average additional taxi-in time at Rome Fiumicino (FCO) airport in 2015. Additional taxi-in time at Rome (FCO) increased notably following the fire at Terminal 3 in May 2015 which forced the airport to reduce capacity and to operate with fewer gates.

5.5 Management of the departure flow

Airport Collaborative Decision Making (A-CDM) is generally considered to be a key enabler to increase the efficiency and predictability of the turnaround phase and to better manage the taxi-out phase in order to optimise the departure sequence at the runway.

The real time sharing of milestones such as the target off block time (TOBT)[52] and the resulting higher level of accuracy enables a better optimisation of the departure sequence in order to keep queuing at the runway and subsequent fuel burn to a minimum while maximising runway throughput.

The Target Start-up Approval Time (TSAT)[53] computation is usually a component of the Departure Manager (DMAN) and is supplied and managed by the ANSP. The TSAT should reduce queuing times at the runway hold while maintaining a high runway utilisation. Based on the TOBT, the TSAT computation may consider ATFM departure slots, wake vortex, Standard Instrument Departure (SID) routing, variable taxi times based on stand runway combination, low visibility procedures and other factors. In case of an AFTM regulated flight, local ATC will allocate a TSAT to meet the calculated take-off time (CTOT).

52 The time that an aircraft operator or ground handler estimates that an aircraft will be ready, all doors closed, boarding bridge removed, push back vehicle available and ready to start up/push back immediately upon reception of clearance from the TWR.

53 The time provided by ATC taking into account TOBT, CTOT and/or the traffic situation that an aircraft can expect start up/push back approval.

5.5.2 ATFM departure slot adherence

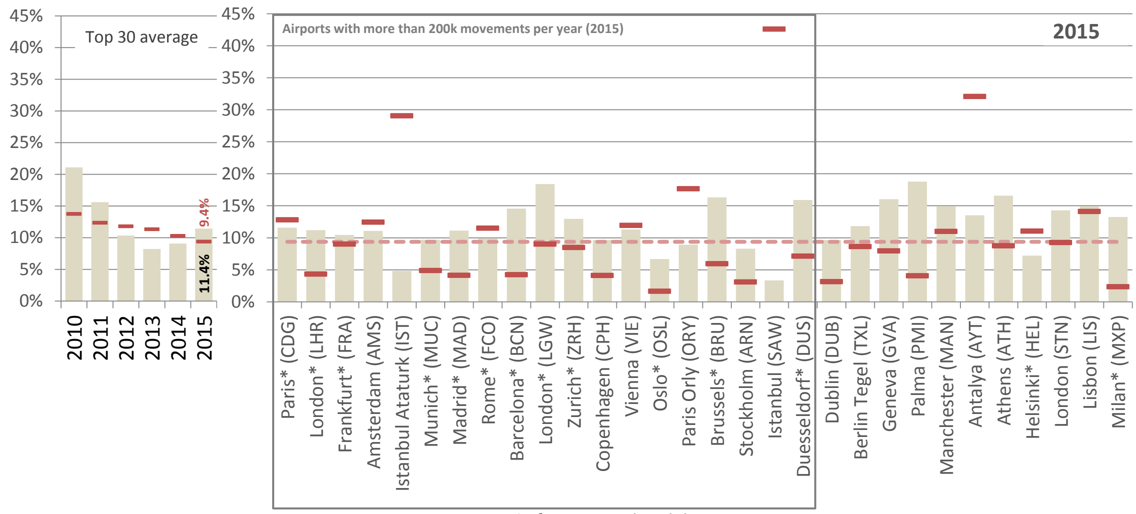
The adherence to the ATFM departure slot is important to increase traffic flow predictability and to ensure that traffic does not exceed regulated capacity en-route or at the destination airport. An ATFM slot tolerance window [-5 min, +10 min] is available to ATC to sequence departures.

Figure 5-23 shows the share of ATFM regulated departures at the top 30 airports in Europe (grey bar) and the percentage of ATFM regulated departures outside the ATFM tolerance window (red line).

ATFM slot adherence

ATFM departure slots are allocated centrally by the Network Manager to hold aircraft on the ground when there is an envisaged imbalance between demand and capacity at airports or en-route.

ATFM slot adherence measures the share of take-offs outside the allocated ATFM window. Within the EU, the monitoring of ATFM slot adherence is required by Regulation 255/2010. ATS units are required to provide information on non-compliance for airports where non-adherence equals or exceeds 20% of regulated departures.



Source: NM; PRU analysis

* A-CDM implemented airport

Figure 5-23: ATFM slot adherence at airports (2015)

Overall, the number of ATFM regulated departures and the share of flights departing outside the allocated ATFM window decreased notably between 2010 and 2013 at the top 30 airports in Europe. Despite a notable increase of ATFM regulated departures from 9.1% in 2014 to 11.4% in 2015 at the top 30 airports in Europe, the share of flights outside the 15 minute tolerance window decreased further from 10.4% in 2014 to 9.4% in 2015.

It is worth noting that, with the exception of Paris (CDG), Rome (FCO), and Helsinki (HEL), all fully A-CDM implemented airports showed an above average performance in terms of ATFM slot adherence.

London Heathrow (LHR) airport was one of the main contributors towards the improved performance, despite the higher number of regulated flights in 2015. Following the comparatively high share of departures outside the ATFM slot tolerance window, the airport launched an initiative at the end of 2014 increasing the awareness of the implications of non-compliance in order to improve ATFM slot adherence performance.

As a result, ATFM slot adherence improved substantially with a positive effect for the entire European air transport network, as can be seen in Figure 5-24.

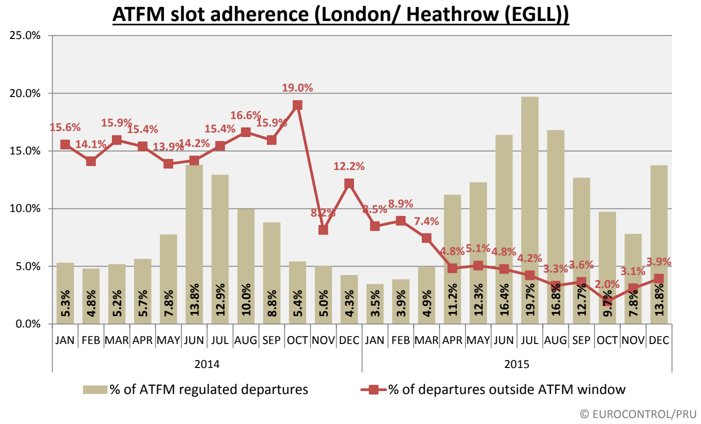


Figure 5-24: ATFM slot adherence at London Heathrow airport

5.5.3 ANS-related inefficiencies on the departure flow

Although the ability of ANS in reducing overall inefficiencies is limited when runway capacities are constraining departures, the goal should be to minimise inefficiencies of the departure process (e.g. apron, taxiway, and threshold queuing) as much as possible by keeping aircraft longer at the stand.

In this respect, the optimisation of the departure queue management through the allocation of an optimised TSAT aims to maximise the runway throughput while keeping the additional fuel burn to the necessary minimum.

The efficiency of this balancing act can be measured by the **additional taxi-out time**. **Local ATC pre-departure delay** addresses the effect of capacity/demand imbalances surrounding the departure process.

Whereas the taxi-out additional time is based on a statistical measure, the local ATC departure delay is derived from universally applicable IATA delay codes reported by airlines.

> **Additional taxi-out time**
>
> The additional taxi-out time is a proxy for the level of inefficiency in the taxi-out phase when the airport is congested.
> More information and data on additional taxi-out time is available at www.ansperformance.eu.

In particular, the analysis is based on the IATA delay code 89 which, besides delays caused by local ATC constraints, also includes delays due to late push-back approval and some other reasons which may introduce a certain level of bias. Moreover, the delay attribution and coding is to some extent dependent on local and/or operator procedures and practices, and may vary across European airports.

Work is in progress to use additional sub-codes to allow for a proper identification of the different causal factors. Further work revolves around the establishment of a local validation process at several airports to assert the usage of delay codes (including sub-codes) identifying the right causal factor. However, it is unlikely that these activities will be implemented consistently at all European airports within the near future.

> **Local ATC pre-departure delay**
>
> Departure delays due to local ATC are a proxy for ATC induced delays at the departure stand as a result of demand/capacity imbalances in the manoeuvring area and/or terminal airspace.

Figure 5-25 shows the local ATC departure delays (top of figure) and the taxi-out additional time at the top 30 airports. Although the level of inefficiencies cannot be reduced to zero, on average, the less fuel efficient taxi-out additional time is almost four times higher than the local ATC departure delays at the gate which suggests scope for further improvement.

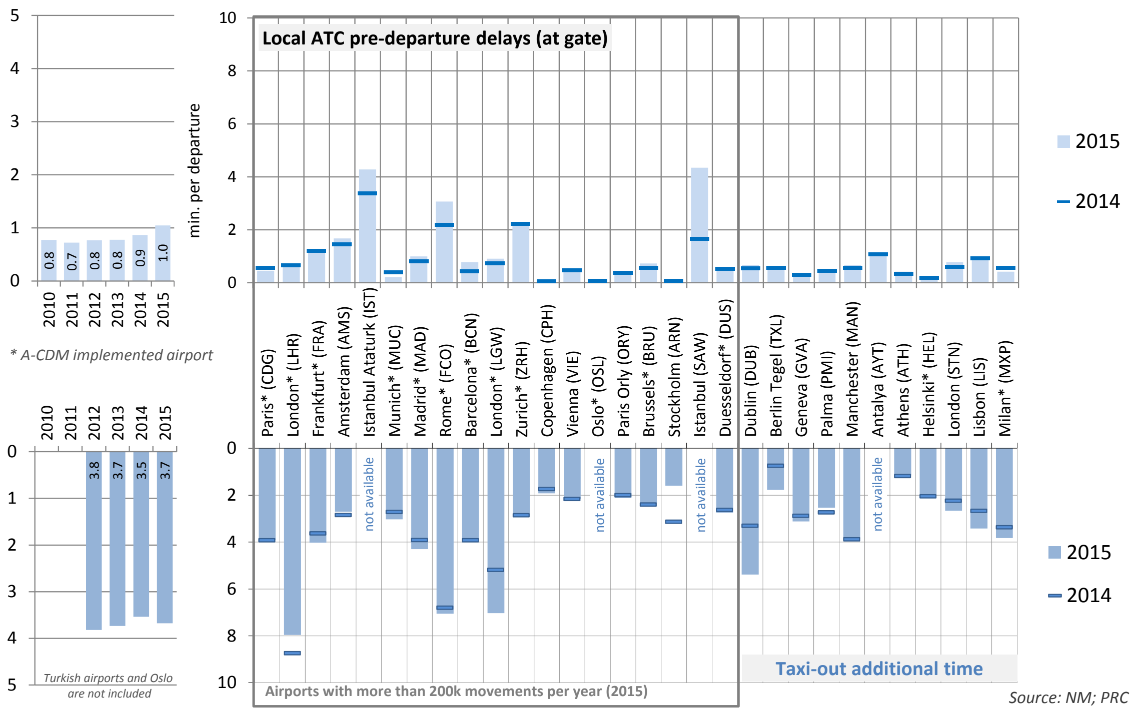


Figure 5-25: ANS-related inefficiencies on the departure flow at the top 30 airports in 2015

Similar to the trend already observed for the arrival traffic flow, local ATC pre-departure delays and taxi-out additional time showed an increase in 2015. The remarkably high continuous traffic growth at the two Istanbul airports (compare also previous section on arrival flow management) affected also performance on the departure flow. Istanbul Sabiha Gökçen and Istanbul Atatürk airport showed the highest level of local pre-departure delay in 2015, followed by Rome (FCO), and Zurich (ZRH) airport.

Despite a notable improvement, London (LHR) remained the airport with the highest average additional taxi-out time per departure in 2015, followed by Rome (FCO), London (LGW), and Dublin (DUB).

In view of the further decrease in additional taxi-out and taxi-in time at Rome (FCO) in 2015, the airport is addressed in more detail in the next section.

Taxi performance at Rome Fiumicino (FCO) airport

Although the mean arrival throughput is far from the airport's peak declared capacity (see Figure 5-17) which suggests only a moderate saturation level, Rome Fiumicino (FCO) airport had again the second highest level of additional taxi-out time after London Heathrow (LHR) in 2015.

Compared to 2014, taxi-out inefficiencies increased even further from 6.8 to 7.3 minutes per departure in 2015 and the airport showed also a notable increase in additional taxi-in time in 2015.

Figure 5-26 shows the variation of the additional taxi-out and taxi-in additional time at Rome Fiumicino (FCO) airport between 2011 and 2015. A clear seasonal pattern peaking in summer is visible for taxi-out times which suggest that the performance is linked to traffic volume.

In order to reduce costly additional taxi-out time at Rome (FCO), an increased effort should be put on the optimisation of the departure sequencing using the information and possibilities available through the A-CDM processes.

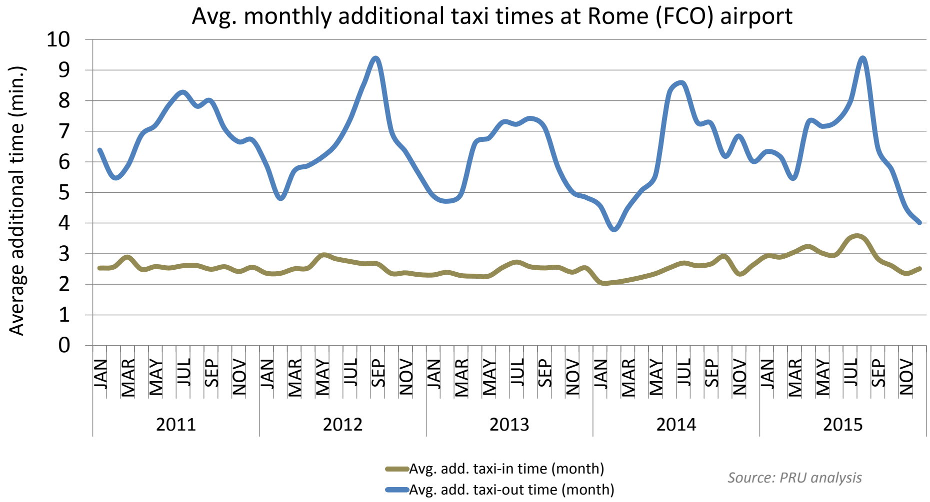


Figure 5-26: Additional taxi-out times at Rome Fiumicino airport

Average additional taxi-in time showed also an increase at Rome Fiumicino (FCO) airport in 2015. The increase in taxi-in time is likely to be linked to the fewer number of gates following the fire at terminal 3 in May 2015.

5.6 Conclusions

In 2015, controlled movements (arrival + departure) at the top 30 airports in terms of traffic increased for the second year in a row. Overall, average daily movements increased by +2.3% compared to 2014 but with notable differences in growth between airports. Despite the further growth in 2014, traffic levels still remain 1.1% below the pre-economic crisis levels of 2008.

At the same time passenger numbers continued to increase at a higher rate than flights. Compared to 2014, the number of passengers at the top 30 airports increased by +5.3% and, contrary to the number of flights, passenger numbers are 22.5% higher than in 2008.

Istanbul Sabiha Gökçen and Atatürk airports continued their growth also in 2015 with an increase in average daily traffic of 91 and 67 movements respectively. Over the past 10 years, Istanbul Sabiha Gökçen airport grew at an average annual rate of +29.8% and Istanbul Atatürk at an average rate of 8.2% per year.

The continuous strong growth resulted in a substantial increase in airport ATFM arrival delays at the two Istanbul airports in 2015 with a notable impact on the European network. Together, the two airports accounted for 35.7% of all airport ATFM arrival delays in Europe in 2015. The new Istanbul airport presently under construction is expected to improve the situation. The airport is planned to open in different phases with an anticipated capacity for up to six runways, serving 150 million passengers by 2028.

Other airports with substantial traffic growth in 2015 were Athens (+13.9%), Dublin (+9.8%), London Stansted (+7.5%), Madrid (+7.0%), and Lisbon (+6.0%). Of the top 30 airports in terms of traffic in 2015, seven airports showed a traffic decrease.

Despite a number of disruptive events (e.g. industrial action), the average share of operational cancellations at the analysed airports remained at 1.5% in 2015.

Overall, the traffic increase appears to have contributed to the higher levels of operational inefficiency at some airports. As a result, all four indicators measuring operational ANS performance at the top 30 airports showed performance deterioration in 2015.

The top 30 European airports accounted for 45.7% of total European airport movements and 88.7% of total airport ATFM arrival delays in 2015. Despite a higher number of regulated flights, ATFM slot adherence continued to improve in 2015, particularly due to a notable improvement at London Heathrow.

Although not included in the top 30, it is noteworthy to point out that a number of small Greek airports accounted for 5.1% of European airport arrival ATFM delays with average delays per arrival of up to 11.5 minutes. Although the traffic volume at those smaller airports is comparatively low, the network impact in terms of reactionary delay is significant.

The poor performance at Greek regional airports is linked to seasonal traffic in summer. It was already observed in 2011 when the Network Management Unit successfully worked together with those airports to improve performance. It would be important to revive the measures applied in 2012 in order to avoid high delay levels in 2016.

In order to address a growing stakeholder interest, vertical flight efficiency performance on climb and descent operations at 15 selected airports was measured. This first high-level analysis of continuous climb and descent operations revealed notable performance differences among airports which should be investigated further. The observed differences are caused by a number of reasons including congested airspace, restrictions from neighbouring ANSPs, and traffic density.

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6 ANS Cost-efficiency (2014)

KEY POINTS	KEY DATA	2014	vs. 2013
EN-ROUTE ANS (EUROCONTROL AREA) – 38 STATES	En-route ANS costs (€2009)		
• In 2014, Pan-European real en-route unit cost decreased for the second year in a row (-5.0% vs. 2013). • At system level, 2014 was a year of significant SUs growth (+5.9%) while en route ANS costs (expressed in €2009) increased overall by +0.6% during the same period.	Total en-route ANS costs (M€2009)	6,465	+0.6% ↑
	Service units (M)	128	+5.9% ↑
	En-route ANS costs per SU	50.5	-5.0% ↓
TERMINAL ANS (SES RP1 AREA) – 29 STATES	Terminal ANS costs (€2009)		
• European terminal ANS cost-efficiency performance followed a similar pattern as observed for en-route cost efficiency in 2014. • Year on year, terminal ANS unit costs (TNSUs) decreased by -2.3% versus 2013 due to terminal service units growing stronger (+2.9% vs. 2013) than real terminal ANS costs (+0.6% vs. 2013).	Total terminal ANS costs (M€2009)	1,365	+0.6% ↑
	Recomputed terminal service units ((MTOW/50)^0.7) (M)	7.9	+2.9% ↑
	Terminal ANS costs per terminal SU (€2009)	171.9	-2.3% ↓
GATE-TO-GATE ANSP (37 ANSPs)	Gate-to-gate ATM/CNS provision costs (€2014)		
• Gate to gate unit ATM/CNS provision costs decreased from €435 in 2013 to €426 in 2014 (-1.9%) as composite flight-hours rose faster (+2.3%) than ATM/CNS provision costs (+0.4%); • Despite an increase in ATFM delays, unit economic costs decreased for the 4th year in a row to reach an amount of €479 per composite flight hour in 2014. This is the lowest level achieved since the start of the ACE benchmarking analysis in 2001;	Gate-to-gate ATM/CNS provision costs (M€ 2014)	7,945	+0.4% ↑
	Composite flight-hours (M)	18,638	+2.3% ↑
	Gate-to-gate ATM/CNS provision costs per composite flight-hour (€2014)	426	-1.9% ↓

6.1 Introduction

This chapter analyses ANS cost-efficiency performance in 2014 (i.e. the latest year for which actual financial data are available) and provides a performance outlook, where possible.

It provides a Pan-European view, covering both the 29 States which are subject to the requirements of the Single European Sky (SES) Performance Scheme ("SES States") and nine non-SES States which are members of EUROCONTROL (see section 6.2 below).

The cost-efficiency performance of SES States in 2014 has already been scrutinised in accordance with the SES Regulations and the results have been published in the PRB's monitoring report in November 2015 [Ref. 34]. The annual Performance Review Report published by the PRC does not seek to duplicate this analysis nor assess performance against SES targets. Instead, it takes the SES data and aggregates it with the data for the non-SES States to reach a Pan-European view. However some SES States have updated their data since the PRB report was published in November 2015. In such cases, this report uses the most up-to-date data in order to provide the most up-to-date information cost-efficiency performance.

The chapter also provides an outlook for 2015-2019. For SES States, the data is taken from the RP2 performance plans submitted in July 2014 and the RP2 revised performance plans submitted in July 2015, where applicable. As with data for 2014, the SES data is aggregated with that for non-SES States to reach a Pan-European view.

For transparency purposes, the reconciliation with the figures reported in the PRB 2014 monitoring report and PRB RP2 assessment report [Ref. 35] is provided in Annex V.

Section 6.2 presents a detailed analysis of en-route cost-efficiency performance in the EUROCONTROL area, including a sub-section on the en-route unit cost ultimately incurred by airspace users for 2014 (sometimes also referred to as the "true cost for users"). Section 6.3 gives an evaluation of terminal ANS costs within the Single European Sky (SES) area.

In order to ensure consistency and comparability with indicators defined in the SES performance scheme and the information provided in national/FAB Performance Plans, the cost-efficiency indicators in Sections 6.2 and 6.3 are expressed in terms of costs per service unit (SU) and in Euro 2009.

Finally, Section 6.4 provides a factual benchmarking analysis of ANSPs' gate-to-gate economic performance focusing on ATM/CNS costs under direct ANSP responsibility and estimated cost of delay attributable to the respective service providers.

6.2 En-route ANS cost-efficiency performance

The analysis of en-route ANS cost-efficiency in this section refers to the en-route charging zones in EUROCONTROL's Route Charges System in 2014 (with the exception of Portugal Santa Maria and Georgia which joined the system on 1 January 2014) but includes Estonia which joined EUROCONTROL on 1 January 2015 and which is part of the SES Performance Scheme.

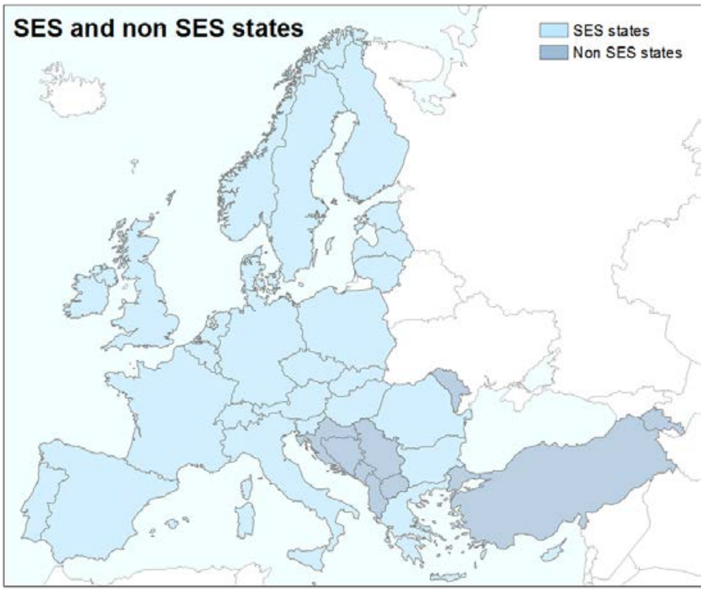


Figure 6-1: SES States (RP1) and non-SES States in RP1

The "RP1 SES States" refer to the 27 Member States of the European Union included in the 1st reference period (RP1) of the SES performance scheme, plus Switzerland and Norway.

Croatia, which joined the EU in July 2013, is not included in the "RP1 SES States" in the analyses in this chapter. For the RP1 SES States, operating in the context of the SES Regulations, 2014 is the 3rd year in which the "determined costs" method with specific risk-sharing arrangements, defined in the Charging Regulation [Ref. 36] aiming at incentivising economic performance, is applied.

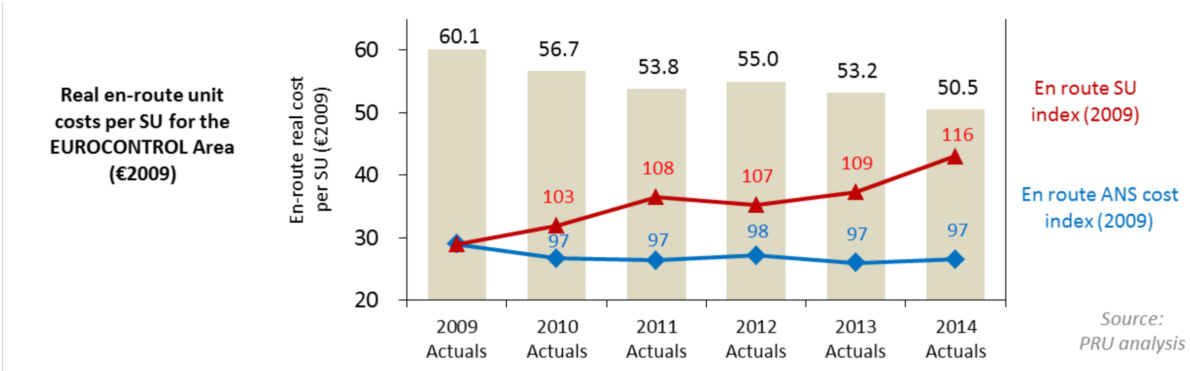
"RP1 non-SES States" refers to nine EUROCONTROL States participating in the Route Charges System in 2014 (i.e. Albania, Armenia, Bosnia–Herzegovina, Croatia, FYROM, Moldova, Serbia, Montenegro and Turkey). For these nine States, the "full cost-recovery method" continued to apply in 2014. The "RP1 SES States" and "RP1 non-SES States" are shown in Figure 6-1).

In order to evaluate possible differences in trends and behaviour between those states operating in the context of the SES Regulations and the other states in the Route Charges System, the results of the 2014 analysis are presented separately for the SES States and non-SES States.

6.2.1 Trends in actual en-route cost-efficiency performance

Figure 6-2 provides a summary view of the actual en-route cost-effectiveness data between 2009 and 2014, including the changes in the en-route ANS costs per SU.

In 2014, at pan-European level actual en-route ANS costs increased by +0.6% while traffic (en-route SUs) increased by +5.9%. As a result, actual en-route unit costs in 2014 decreased by -5.0% compared to 2013. At this stage it is important to note that, although the 2014 traffic is +5.9% higher than in 2013, it is still lower than the forecast taken into account for setting the 2014 unit rates (by -2.6%, see 6.2.6 below).



	2009 Actuals	2010 Actuals	2011 Actuals	2012 Actuals	2013 Actuals	2014 Actuals	2014 vs 2013	2009-14 AAGR
Total en-route ANS costs (M€2009)	**6 648**	**6 477**	**6 453**	**6 510**	**6 425**	**6 465**	**0.6%**	**-0.6%**
SES States (EU-27+2)	6 248	6 069	5 972	6 048	5 947	5 945	0.0%	-1.0%
Other 9 States in the Route Charges System	400	407	481	463	478	519	8.6%	5.4%
Total en-route service units (M SU)	**111**	**114**	**120**	**118**	**121**	**128**	**5.9%**	**2.9%**
SES States (EU-27+2)	98	100	105	104	105	110	4.4%	2.3%
Other 9 States in the Route Charges System	13	14	15	15	16	18	15.6%	7.6%
En-route real unit cost per SU (€2009)	**60.1**	**56.7**	**53.8**	**55.0**	**53.2**	**50.5**	**-5.0%**	**-3.4%**
SES States (EU-27+2)	63.7	60.4	56.9	58.4	56.5	54.1	-4.3%	-3.2%
Other 9 States in the Route Charges System	31.9	29.6	32.5	31.1	30.6	28.7	-6.1%	-2.1%

Figure 6-2: Real en-route unit costs per SU for EUROCONTROL Area (€$_{2009}$)

6.2.2 Trends in actual en-route costs by nature (2014 vs. 2013)

Figure 6-3 shows the trends in total en-route costs broken down by nature. Operating costs accounted for 82% of the en-route costs in 2014 (staff costs for 58% and other operating costs for 24%).

At system level, staff costs remained stable compared to 2013 (+0.4%) and other operating costs showed an increase of +1.8%. At charging zone level, the main variations in operating costs are linked to variations in provisions (pensions, doubtful debt, lawsuit,…), cost-containment measures, increases in salaries & wages in emerging economies (catch-up effect) and adjustments to traffic variations (e.g. overtime).

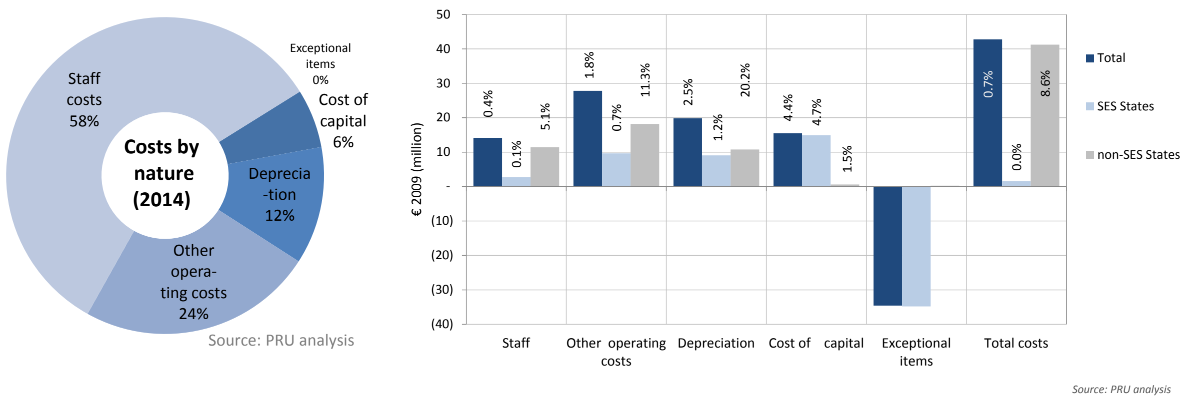


Figure 6-3: Difference between 2013 and 2014 costs by nature (€$_{2009}$) and share of the items by nature in 2014

At charging zone level, the largest variations in **staff costs** (in absolute terms compared to 2013) were observed in the UK (-19.2M€2009 or -7.3% in 2014, following a decrease of -13.6M€2009 in 2013); Germany (+10.6M€2009 or +1.8%); Norway (-9.8M€2009 or -13.4%), and France (-7.0M€2009 or -1.1%).

In relative terms (percentage change), significant variations were also observed in Bosnia & Herzegovina (+79.8%, after an increase of +27.3% in 2013, as its ANSP (BHANSA) is preparing for a complete takeover of all responsibilities now foreseen for "*the end of 2018/beginning of 2019*", while Croatia Control and SMATSA continue to provide ANS in the upper area in the meantime); Moldova (-22.1%, following an increase of +23% in 2013); Bulgaria (+15.3%); FYROM (+14.8%); Estonia (+12.0%);

Albania (+10.7%) and Serbia-Montenegro-KFOR (+10.3%, partially explained by the inclusion of the KFOR sector as of April 2014. The increase for Serbia & Montenegro without the impact of KFOR is reduced to +5.0%).

The main variations in **other operating costs** in 2014 (in absolute terms compared to 2013) occurred in France (+18.4 M€$_{2009}$ or +6.0%); Poland (+17.1M€$_{2009}$ or +70.8% due to an increase in "*provision for compensation according to non-contractual usage of land*"; Sweden (-15.7M€$_{2009}$ or -23.1%, following an increase of +8.2M€$_{2009}$ in 2013); Turkey (+9.7M€$_{2009}$ or +9.9%); Spain (-9.6M€$_{2009}$ or -7.9% compared to 2013 for the two charging zones, mainly reflecting cost-saving measures implemented by Aena/ENAIRE. This follows a decrease of -20.9M€$_{2009}$ in 2012 and -12.5M€$_{2009}$ in 2013) and Italy (+8.5M€$_{2009}$ or +5.9%).

Significant variations in percentages (±10% compared to 2013) were also observed in FYROM (+65.3%, mainly driven by a "*provision for impairment of receivables*"); Serbia-Montenegro-KFOR (+29.4%, partially explained by the inclusion of services to the KFOR sector as of April 2014. The increase for Serbia & Montenegro without the impact of KFOR is +19.5%); Belgium-Luxembourg (-25.5%, explained by a "*provision for legal matters (lawsuit)*" in 2013; Cyprus (+11.5%), Hungary (+10.2%), Malta (+13.7%), Norway (+18.2%), Croatia (+18.0%), Moldova (-32.5%) and Austria (-13.7%)

The right-hand side of Figure 6-3 shows that capital-related costs accounted for 18% of the en-route costs in 2014 (depreciation for 12% and cost of capital for 6%). At system level, depreciation costs have increased by +2.5% compared to 2013 and cost of capital by +4.4%.

The main increases in **depreciation costs** in absolute terms occurred in France (+7.2M€$_{2009}$ or +6.9%, Turkey (+6.8M€$_{2009}$ or +23% and Italy (+6.2M€$_{2009}$ or +6.9%).

The main increase in **cost of capital** in absolute terms reflects Italy's increase (+16.3M€$_{2009}$ or +59.2%), as a result of an increase in ENAV's return on equity. The total asset base at system level increased slightly in 2014 (+1.0% compared to 2013).

The main variation in **exceptional items** relates to the UK, due to the fact that a large exceptional item was recorded in 2013 in relation with NERL's voluntary redundancy programme in 2013. As a result, the exceptional costs for the UK decreased by -38.9M€$_{2009}$, from 55.6M€$_{2009}$ in 2013 to 16.6M€$_{2009}$.

6.2.3 Trends in actual en-route costs by service (2014 vs. 2013)

Figure 6-4 shows the trends in total en-route costs broken down by ANS service. At system level, 67% of en-route costs were attributed to ATM in 2014. Despite a significant increase in the non-SES States (+11.0%), overall ATM costs remained relatively stable in 2014 (+0.2% vs. 2013).

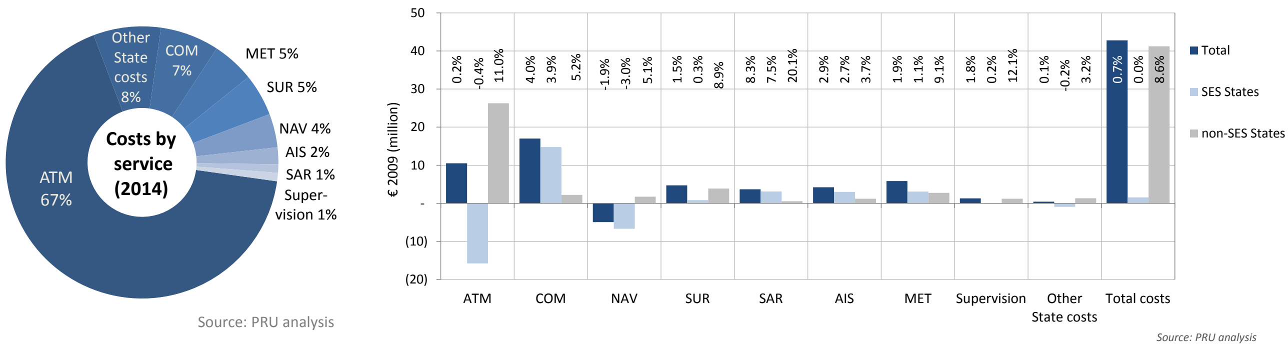


Figure 6-4: Difference between 2013 and 2014 costs by service (€$_{2009}$) and share of the items by service in 2014

At system level, the main increases in 2014 were observed in Communications (COM, accounting for 7% of the en-route costs and showing an increase of +4% compared to 2013), and Search and Rescue (SAR, accounting for 1% of the en-route costs and showing an increase of +8.3%). At the same time, an overall decrease in Navigation costs (NAV, accounting for 4% of the en-route costs) was observed in 2014.

6.2.4 Trends in actual en-route unit costs by State/charging zone (2014 vs. 2013)

The bottom of Figure 6-5 shows the actual unit cost for each individual State (charging zone) in 2014. It ranges from 73.1 €$_{2009}$ in Germany to 18.6 €$_{2009}$ in Malta, a factor of more than three, with an average at system level of 53.2 €$_{2009}$.

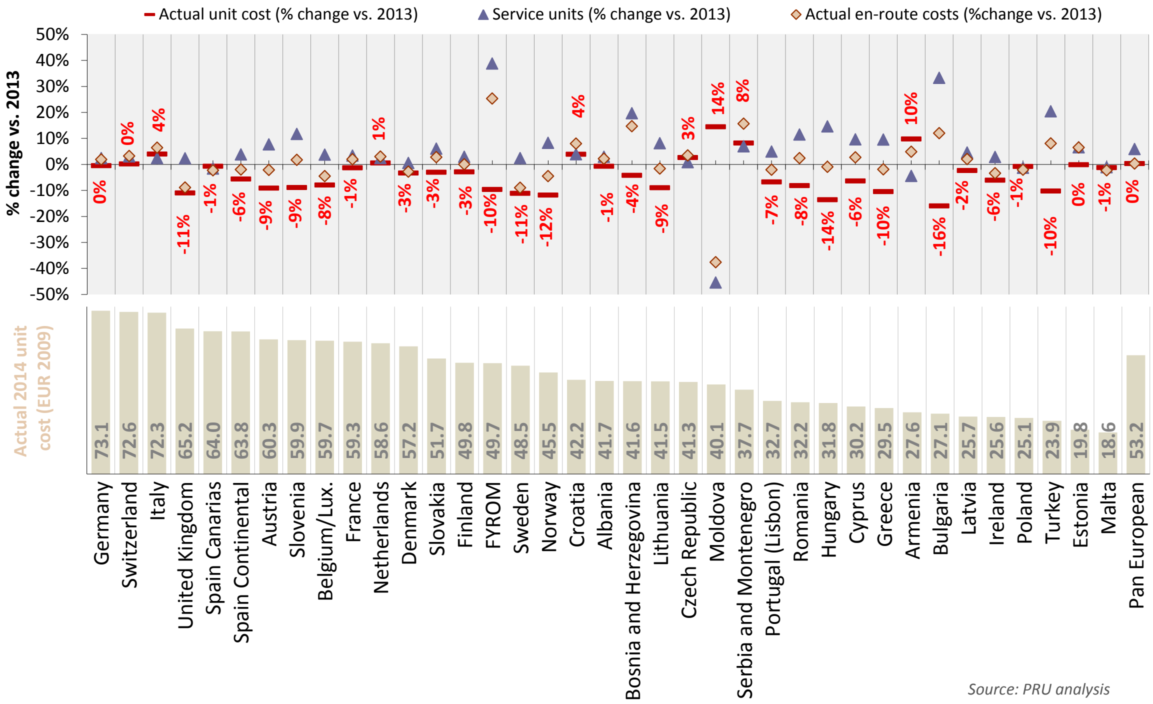


Figure 6-5: 2014 Real en-route ANS costs per SU by charging zone (€$_{2009}$)

Figure 6-5 also presents the changes in actual unit costs, SUs and costs compared to 2013.

While it is to be expected that States' unit costs vary due to, for example, different complexity and different economic factors, some of the observed differences in Figure 6-5 are higher than expected after taking these factors into account. This raises questions about the cost-effectiveness of some 'high costs' providers even more so when it does not seem to tally with the prevailing complexity and economic environment.

Significant reductions in unit costs are observed in a number of States/charging zones, in spite of limited variations in traffic (TSUs). This is the case in the UK, Spain, Belgium-Luxembourg and Sweden.

The efforts made by Spain over the past few years continue showing results, as the en-route unit cost for Spain, which was lower than the average of the other four largest States/ANSPs for the first time in 2013 (by -2.8% for Spain's combined two charging zones) is now lower by -5.4% in 2014, although the average of the other four largest States/ANSPs has also decreased (by -2.4%).

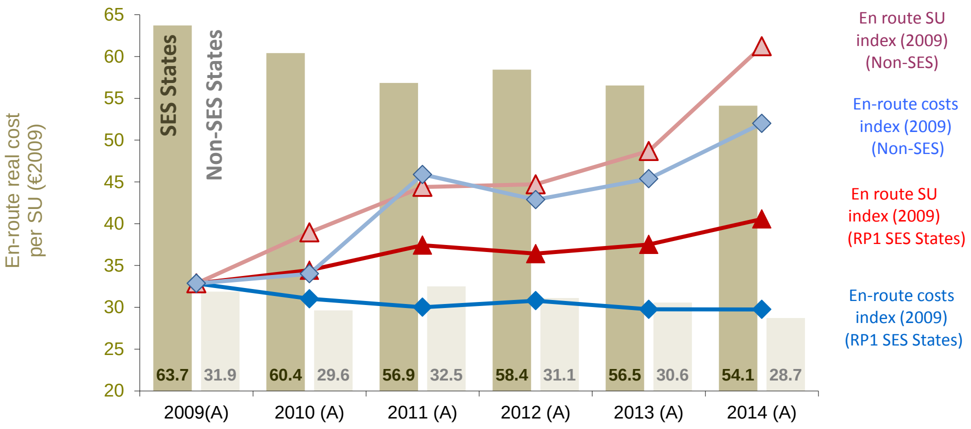
A number of States/charging zones have experienced a significant increase in traffic (over +6.0% in TSUs compared to 2013), which has brought about decreases in the unit costs (Austria, Slovenia, Slovakia, FYROM, Norway, Bosnia and Herzegovina, Lithuania, Romania, Hungary, Cyprus, Greece, Bulgaria, Turkey, Estonia).

On the other hand, the unit costs of Moldova and Armenia have been significantly impacted by large decreases in traffic (due to the situation in the Ukrainian airspace).

The increase in costs for Serbia-Montenegro-KFOR is partially explained by the reopening of the airspace over Kosovo, where services are provided by HungaroControl as of 3 April 2014.

6.2.5 Trends in actual en-route unit costs for RP1 SES States and "non-SES" States

Figure 6-6 shows the evolution of key en-route cost indices for RP1 SES States and non-SES States.



Source: PRU analysis

Figure 6-6: En-route costs and service unit growth (RP1 SES States and non-SES States)

The evaluation of differences in trends and behaviour between those States operating in the context of the SES Regulations and the other States in the Route Charges System does not yet show a clear cut trend and it is likely that a longer period would need to be considered. However, the following observations can be made at this stage.

In the RP1 SES States, overall:

- After a few years of moderate growth (or decline in 2012), TSUs in the SES area increased by +4.4% in 2014 and remained strong in 2015 (+3.1% vs. 2014);
- The costs trend for the RP1 SES States in 2014 is flat (+0.0% vs. 2013);
- As in previous years, the 2014 average unit cost (54.1€$_{2009}$) is significantly higher than for the non-SES States (28.7€$_{2009}$), reflecting both different performance levels and differences in economic and operational environments (e.g., generally higher cost of living and higher traffic complexity, in particular in the "Core Area"); and,
- The trends and indicators are dominated by the "5 largest" States (France, Germany, Spain, Italy and the UK), accounting for 66.2% of the actual costs for the RP1 SES States in 2014 and for 54.5% of en-route service units.

In non-SES States,

- Total costs for the non-SES States increased by +8.6% in 2014. However this increase in costs occurred in the context of a higher traffic growth (+15.6%) resulting in a decrease of -6.1% in unit costs. The lower level of non-SES unit costs compared to the RP1 SES States reflects lower complexity and lower cost of living, although the differences in both the cost of living and the complexity are reducing over time;
- The trends and indicators are largely impacted by Turkey (accounting for 58.8% of the actual costs for the non-SES States in 2014 and for 70.8% in the number of TSUs).

6.2.6 Actual 2014 en-route performance versus 2014 plans/forecasts

Figure 6-7 compares the forecast en-route ANS costs and SUs prepared by the States for setting their 2014 en-route unit rates with the actual costs and SUs provided by the States in November 2015. For the RP1 SES States, the forecasts en-route ANS costs and SUs were determined as part of their adopted national/FAB Performance Plans for RP1 (i.e. 2011 and in some cases early 2012).

It is important to monitor the actual cost data against what was planned or forecasted for the year as it enables to evaluate the response to variations in traffic as well as the maturity of the planning process, two key elements for managing ANS performance.

For the SES States (RP1), the PRB has issued a monitoring report for 2014 in November 2015, including an analysis of the ex-ante and ex-post “profitability” of the main ANSPs in respect of the activities performed in the year.

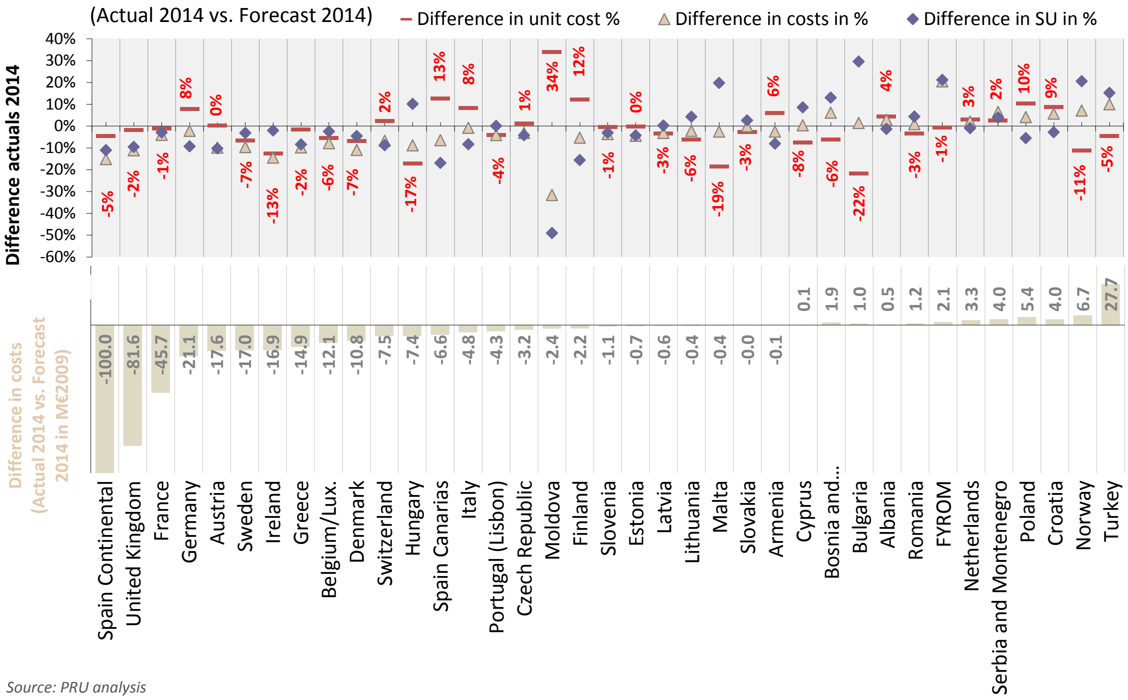
Cost-efficiency (2014)			
€2009 prices	**Planned for 2014**	**Actuals 2014**	**Difference (%)**
Total en-route ANS costs (M€2009)	**6 786 573 691**	**6 464 876 886**	**-4.7%**
SES States (EU-27+2)	6 304 761 083	5 945 420 950	-5.7%
Other 9 States in the Route Charges System	481 812 608	519 455 937	7.8%
Total en-route service units (M SU)	**131 363 375**	**127 926 851**	**-2.6%**
SES States (EU-27+2)	114 964 695	109 834 193	-4.5%
Other 9 States in the Route Charges System	16 398 680	18 092 659	10.3%
En-route real unit cost per SU (€2009)	**51.7**	**50.5**	**-2.2%**
SES States (EU-27+2)	54.8	54.1	-1.3%
Other 9 States in the Route Charges System	29.4	28.7	-2.3%

Figure 6-7: Real en-route ANS costs per SU, 2013 Actuals vs. Forecasts (in $€_{2009}$)

Figure 6-7 indicates that the actual real en-route unit cost per service unit for 2014 was -2.2% lower than planned for 2014, as actual ANS costs were -4.7% lower than expected in response to actual TSUs which were -2.6% lower than those considered for setting the 2014 unit rates.

6.2.7 En-route unit costs by State/charging zone (2014 actuals vs. 2014 plans/forecasts)

The difference in the planned and actual real en-route unit costs for providing the service is shown at individual State level (charging zone) in Figure 6-8.



Source: PRU analysis

Figure 6-8: 2014 Real en-route ANS costs per SU: Actuals vs. Forecasts (in $€_{2009}$) by charging zone

As shown in Figure 6-8 (bottom), the largest reductions in actual 2014 costs compared to what was forecasted were observed in:

- Spain: mainly lower operating costs reflecting austerity measures implemented by Aena;
- UK: mainly in operating costs, reflecting costs reduction measures implemented by NERL, including pay restraint and lower headcount (mainly resulting from NERL’s voluntary redundancy programme), as well as “supply chain savings, reduction in *training costs and lower non-capitalisable* expenditure on investment projects”.
- France: lower staff costs (containment); reduced depreciation as a result of lower actual

capex than planned and change in applied accounting rules, and lower interest on debt;

- Germany: mainly lower staff costs (reflecting a reduction in FTEs and therefore lower remuneration and social security expenses than planned), as well as lower other operating costs following cost containment measures initiated by DFS in 2012 and 2013.

The largest increase in actual costs (in value) compared to what was forecasted occurred in Turkey. However, this increase in costs (by +10.0% compared to forecast) was more than outweighed by higher TSUs than forecasted (by +15.2%).

6.2.8 "True en-route costs for users" for RP1 SES States and "non-SES" States (2014 actuals vs. 2014 plans/forecasts)

Under the determined costs method applied by the SES States since 2012, the costs ultimately charged to airspace users are no longer equivalent to the actual costs incurred by the States/ANSPs (as it is the case for the full cost recovery method applied by the non-SES States).

From 2012 onwards, it is therefore important to monitor not only the performance of the States/ANSPs (actual costs incurred by the States/ANSPs for the activities performed in a given year) but also the amounts ultimately charged to the airspace users in respect of the activities of that year (sometimes also referred to as the **"true cost for users"**).

This objective of this section is to compare the amounts that were planned to be charged to the airspace users through the 2014 unit rates in respect of activities carried out in 2014 (determined costs for SES States and chargeable costs for non-SES States), with the amounts that will ultimately be paid by the users in respect of these activities ("true cost for users").

For the SES States:

- In the "determined costs method", the amounts charged to airspace users for a given year (N) are now fixed prior to the start of the reference period (the "determined costs"). The difference between actual costs and determined costs is borne/retained by the State/ANSP concerned and the difference in revenues due to the difference between actual traffic and traffic forecasted prior to the period for that year is shared between ANSPs and airspace users. This method is expected to drive the ANSPs behaviour to adjust their costs downwards when traffic is lower than planned and the other entities (State, NSAs, MET service providers) to contain the actual costs within the determined costs envelope. This is indeed what happened in 2014: actual SUs were -4.5% lower than forecast and in response the actual costs were -5.7% lower than planned (see Figure 6-7 above).
- Due to the traffic risk-sharing, cost-sharing and other adjustments provided in the Charging Regulation, the amounts ultimately paid by the airspace users differ from the actual costs. As a result, the "true costs for users" in respect of 2014 (estimated at 6,113.7M€$_{2009}$) are some +168.3M€$_{2009}$ (+2.8%) higher than the actual costs of States/ANSPs. However these "true costs for users" (including all the adjustments) are some -131.5M€$_{2009}$ (-2.1%) lower than the amounts that were forecasted to be charged for 2014 activities on the basis of the RP1 performance plans (6,245.7M€$_{2009}$).

For the non-SES States:

- In the "full cost recovery method", the actual costs for the services provided in a given year (N) will ultimately be paid by the airspace users (through the unit rates for year N and adjustments to the unit rates of subsequent years). The "true costs for users" are therefore equal to the actual costs for the services provided in that year (after deduction of actual costs for exempted VFR flights and after deduction of actual other revenues).
- Hence, the PRC computes that the "true costs for users" in 2014 are higher by +37.3M€$_{2009}$ (+7.7%) compared to what was planned to be charged to users in respect of 2014 activities.

The "true costs" per service unit for users in 2014 are summarised in Figure 6-9 below.

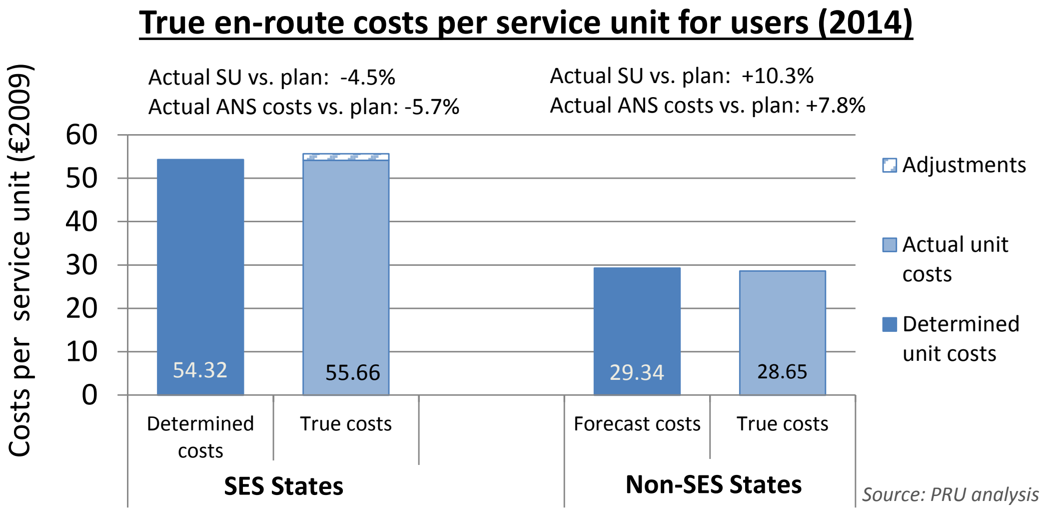


Figure 6-9: "True costs for users" for RP1 SES States and non-SES States in 2014 (€2009)

Although ANSPs adjusted their costs downwards (-5.7% vs. plan) to account for the weaker than foreseen traffic growth in 2014 (-4.5% vs. plan), the true en-route costs per service unit in 2014 were slightly higher than planned in the SES States in 2014.

The true en-route costs per service unit for non-SES States, mainly driven by Turkey, show exactly the opposite trend. Actual SUs were +10.3% above planned levels whereas en-route ANS costs were +7.8% higher than planned. As a result, true costs per service unit in non-SES States were slightly lower than planned in 2014.

6.2.9 Pan-European en-route cost-efficiency outlook for 2015-2019

It should be noted that for RP2 the SES States now include Croatia (hence a total of 30), and the non-SES States amount to eight States. The data for SES States is taken from the RP2 performance plans submitted in July 2014 and the RP2 revised performance plans submitted in July 2015, where applicable. For the other eight States, it reflects the data provided in November 2015. Figure 6-10 below presents the real en-route unit costs calculated from these data, in $€_{2009}$ and using the same metric as in RP2 (i.e. after deduction of costs for services to exempted VFR flights)[54]. Note that Georgia has joined the Multilateral Route Charges System as of 1 January 2014. However, Figure 6-10 below does not include the data for Georgia, so as to have a consistent series from 2009 onwards.

Figure 6-10 indicates that the en-route unit cost is expected to decrease from $50.5€_{2009}$ in 2014 to $46.4€_{2009}$ in 2019, representing a decrease of -1.7% p.a. on average until 2019.

Overall, at Pan-European level between 2009 and 2019, the trend in total en-route costs remains flat, while traffic (SUs) is planned to increase by some +31%, implying substantial cost-efficiency improvements over this 10-years cycle.

[54] This is different from the RP1 metrics (before deduction of costs for services to exempted VFR flights). Hence the figure is not directly comparable to Figure 6-2.

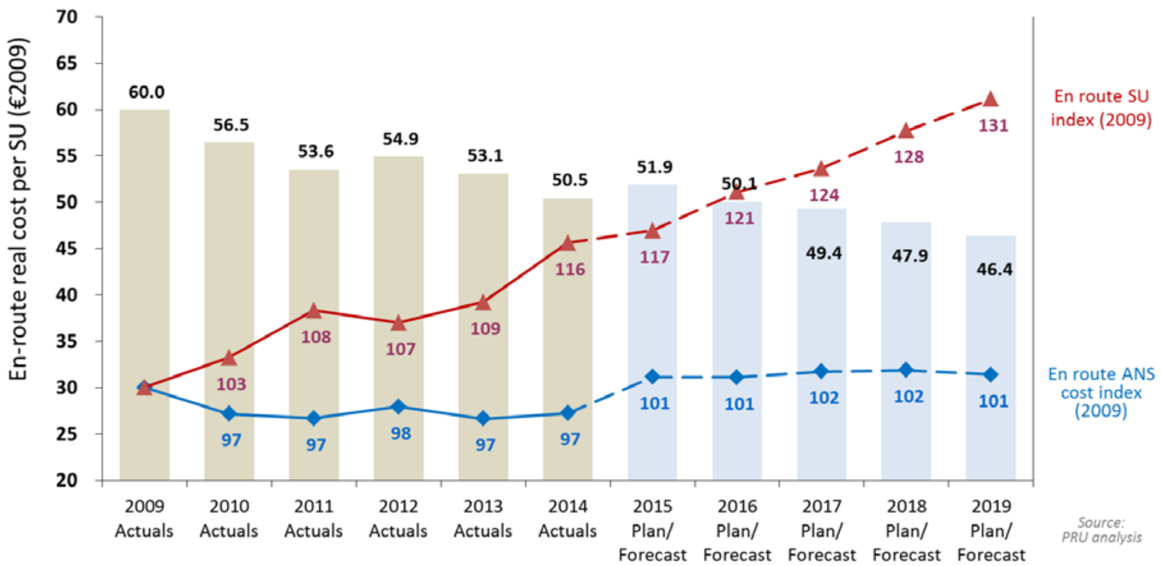


Figure 6-10: Pan-European en-route cost-efficiency outlook 2015-2019 (in $€_{2009}$)

Figure 6-10 shows that States foresee to maintain their en-route cost-bases stable over the next five-year period **2015-2019** (corresponding to RP2 for SES States), with an average traffic increase in service units of 2.9% p.a., resulting in an average annual decrease in the en-route unit cost of -2.8% p.a. at system level between 2015 and 2019.

The **2015 forecast/planned "starting point"** of this period seems however to be set at a high point, considering past actual and future planned/forecasted trends. The 2015 actual unit cost is indeed likely to be lower than the forecast presented above, as the actual en-route TSUs are significantly higher than the forecasts considered at State/charging zone levels (actual en-route service units increased by +3.9% in 2015, compared to a forecast of +1.1% vs. 2014 actuals). The actual en-route costs for 2015 will become available only in June 2016.

6.3 Terminal ANS cost-efficiency performance

The analysis of terminal ANS cost-efficiency in this section refers to the RP1 SES States (see Figure 6-11) which are required to provide terminal ANS costs and unit rates information in accordance with EU legislation [Ref. 36,21,37].

Although gradually improving, terminal ANS cost-efficiency data have a lower level of maturity than en-route ANS cost-efficiency data. There is still some diversity in reporting between States and years which, to some extent, affects time series analyses and comparisons.

Terminal navigation charges are based on Terminal Navigation Service Units (TNSUs) which are computed as a function of the maximum take-off weight ((MTOW/50)^α).

Figure 6-11: Geographical scope of terminal ANS cost-efficiency analysis

Up to 2015, the exponent (α) was not harmonised. However, in accordance with the Charging Scheme Regulation [Ref. 36], all States use a common formula (MTOW/50)^0.7 as of 2015.

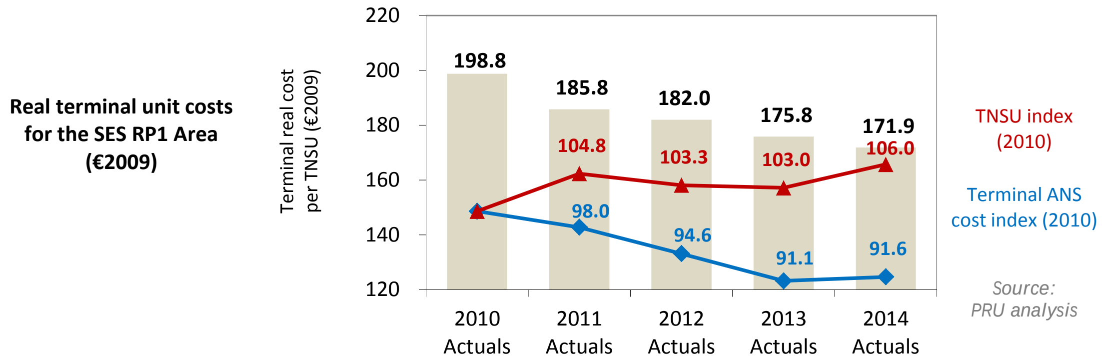
In order to ensure comparisons over time and between States in this section, the TNSUs between 2010 and 2014 for all States were computed by the EUROCONTROL Central Route Charges Office (CRCO) using the formula foreseen as of 2015.

Terminal Navigation Charges vs. Airport Charges

Given the risk for potential misunderstanding, it is useful to differentiate between Terminal ANS charges (also called "TNC" for terminal navigation charges) and "Airport charges", which typically include landing, passenger, cargo, parking and hangar, and noise charges, and are covered by Directive 2009/12/EC [Ref. 38]. While such airport charges amount to some €15 billion/year, **the TNC in the SES represent some €1.5 billion/year.**

6.3.1 Trends in actual terminal ANS cost-efficiency performance

Figure 6-12 provides a summary view of the actual terminal ANS cost-effectiveness data between 2010 and 2014.



Real terminal ANS unit costs for SES RP1 States (€2009)		2010 Actuals	2011 Actuals	2012 Actuals	2013 Actuals	2014 Actuals	2014 vs 2013
Number of	*SES States reporting*	26	28	29	29	29	
	Charging zones	28	30	31	31	33	
	Airports covered	224	226	229	229	230	
Total terminal ANS costs (M€2009)		1 489	1 459	1 409	1 357	1 365	0.6%
Total terminal service units ((MTOW/50)^0.7, M TNSU)		7.5	7.9	7.7	7.7	7.9	2.9%
Terminal real unit cost per TSNU (€2009)		198.8	185.8	182.0	175.8	171.9	-2.3%

Sources: State submissions to the European Commission for costs (November 2015) and CRCO for actual TNSU

Figure 6-12: Real terminal ANS unit costs (€$_{2009}$) for reporting States

The number of reporting States/ Terminal Charging Zones (TCZ) increased between 2010 and 2012 by three States (Malta, Latvia, and Cyprus). As of 2012, a total of 29 States (31 terminal charging zones) reported on terminal ANS costs. In 2014, Italy introduced three TCZs instead of a single TCZ (47 airports), which existed until 2013. For consistency purposes, this section looks at the consolidated terminal ANS costs for the three TCZ in 2014 (equivalent to the single TCZ in 2013).

Figure 6-12 shows that terminal ANS costs (1 365 M€$_{2009}$) increased by +0.6% in 2014, while at the same time traffic (TNSUs) increased by +2.9% to 7.9M TNSUs, leading to a -2.3% unit cost reduction (€171.9 per TNSU).

In absolute terms, the largest increases in terminal ANS costs were observed for:

- France: +5.3M€$_{2009}$ (+2.5% vs. 2013), driven mainly by significant increase in the cost of capital; and,
- Germany: +4.6M€$_{2009}$ (+2.3%), mainly due to significant increase in operating costs.

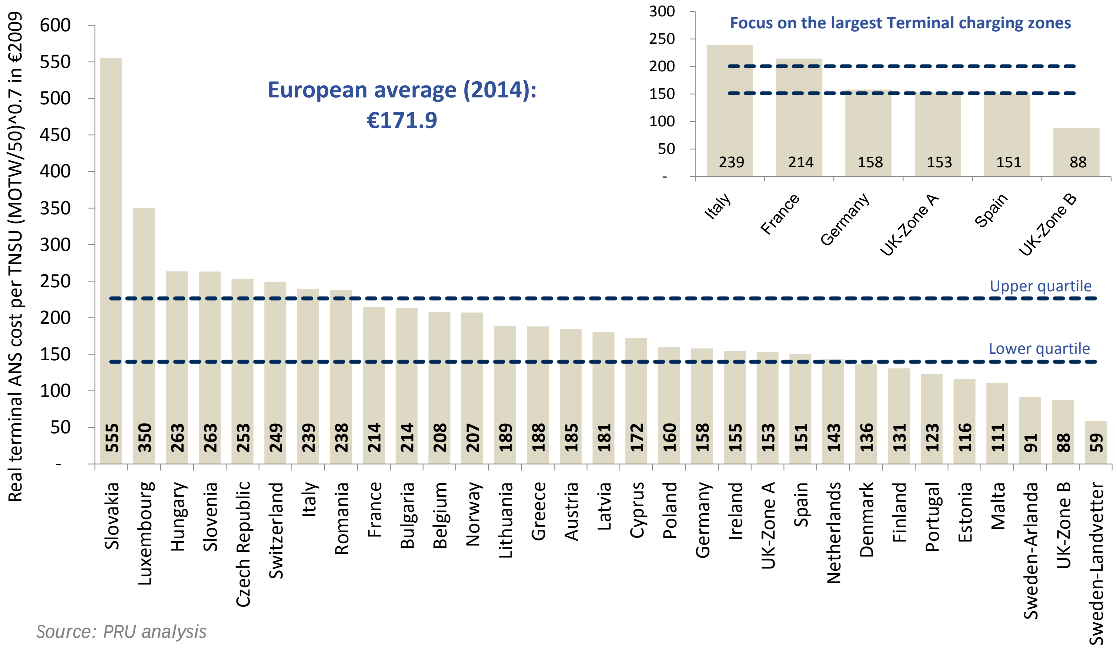
Other significant increases of more than 10% compared to 2013: Romania (+21.2%), Poland (+16.4%) and Lithuania (+11.1%).

On the other hand, the most significant reduction in total costs in 2014 was observed for Spain (-4.5 M€$_{2009}$, or -3.4%). Significant decrease in percentage terms was observed for Sweden (-23.0% for Arlanda TCZ and -11.5% for Landvetter TCZ).

6.3.2 Terminal ANS cost-efficiency analysis: 2014 unit costs by terminal charging zone

Figure 6-13 shows the terminal ANS unit costs for the 31 TCZs in the 29 SES States (RP1) in 2014.

It should be noted that the unit costs presented in the figure below do not consider other revenues reported by a number of States, which are used to reduce the terminal ANS charges billed to airspace users (e.g. Spain, Italy, Greece, etc.).



Source: PRU analysis

Figure 6-13: Comparison of 2014 terminal ANS unit costs by TCZ (SES States (RP1))

In 2014, terminal ANS costs per TNSU range from €555 for Slovak Republic TCZ to €59 for Sweden-Landvetter TCZ, a factor of over nine. The two dotted lines in Figure 6-13 represent the top and bottom quartiles of the dataset, giving an indication of the variance of calculated terminal ANS unit costs. In 2014, there were €87 per TNSU between the upper (€226) and lower (€140) quartiles, with the average of the proxy for the European unit cost amounting to €171.9 per TNSU[55].

Slovakia TCZ's high 2014 unit costs could be the result of relatively low traffic in relation to its total cost base. By comparison, Sweden-Landvetter TCZ handled three times more traffic in 2014, at three times lower cost-base than the Slovakian TCZ. As mentioned below, the scope of the Terminal ANS provided might be very different between the two TCZ.

Among the identified reasons for differences in terminal ANS unit cost are: the States' discretion on defining their Terminal Charging Zones (TCZ), including the number of TCZ and the number and size of aerodromes; the charging policy, including charging formula applied until 2014 and applied cost-allocation between en-route and terminal; the traffic levels and complexity, and the scope of ANS provided. This introduces comparability issues when analysing and benchmarking terminal ANS performance levels across States/TCZ/airports.

Figure 6-13 also shows that terminal ANS unit costs also substantially differ amongst the five largest States (from €239 for Italy TCZ to €88 for UK TCZ-B).

Unit costs for terminal ANS looks particularly low in the UK TCZ B (€88 per TNSU). Firstly, it should be noted that the unit cost is not necessarily the same as the price charged for terminal ANS in the UK because of the contractual arrangements for the provision of terminal ANS. Low terminal ANS unit cost in UK TCZ B could be partly due to the fact that for the London airports (which account for most of the traffic in UK TCZ B), the cost data submitted only covers the aerodrome control service

55 It should be noted that the variation in unit cost between States shown in Figure 6-13 does not vary substantially if calculated using cost per movement instead of cost per TNSU.

provided by NATS Services Ltd (NSL). In fact, Approach control for the London airports is provided by NATS En-Route Ltd (NERL) and recovered through a separate London Approach Charge, for which no cost information is separately reported to the European Commission until 2014.

Another reason could be the significant larger scale of operations at the UK TCZ B (airports > 150 000 commercial movements) compared to any other TCZ. Finally, another explanation could be the greater cost-efficiency provided by the UK model of potential "contestability" (now referred to as "market conditions") for aerodrome ATC services. These particular issues would deserve further analysis and understanding to ensure a fair comparison and to identify genuine best practice performance management.

6.3.3 Terminal ANS cost-efficiency analysis: 2014 actuals versus 2014 forecasts

Figure 6-14 below shows that terminal ANS costs in 2014 were -2.8% (or -39.9 M€$_{2009}$) lower than forecasts used for the establishment of 2014 terminal ANS unit rates as reported in November 2013 by SES States.

SES States	Nov 2013 Reporting Tables	Nov 2015 Reporting Tables	2014A vs 2014F	in %
	2014F	2014A		
Real terminal ANS costs - (in M€2009)	1 404.4	1 364.5	-39.9	-2.8%

Figure 6-14: Comparison of 2014 terminal ANS actual costs vs. 2014 forecasts

Note that a similar trend is observed for en-route, at system level there were no significant cost reallocation from en-route towards terminal ANS, and where the same ANSP provides both en-route and terminal services, the cost-efficiency improvement due to the SES target setting on en-route is likely to also have had a positive impact on terminal ANS costs, mainly due to the level of shared/common costs.

As shown in Figure 6-15 below, overall, actual 2014 terminal ANS costs were in 23 TCZs lower than forecast, and higher than forecast in 8 TCZs. The largest reductions are observed for France (actual costs were lower -12.0M€$_{2009}$ or -5.1% than the planned costs), Italy (-5.8M€$_{2009}$ or -2.7%), Sweden-Arlanda (-3.4M€$_{2009}$ or -21.5%), Denmark (-2.8M€$_{2009}$ or -11.8%), Switzerland (-2.8M€$_{2009}$ or -4.2%) and Czech Republic (-2.6M€$_{2009}$ or -12.3%).

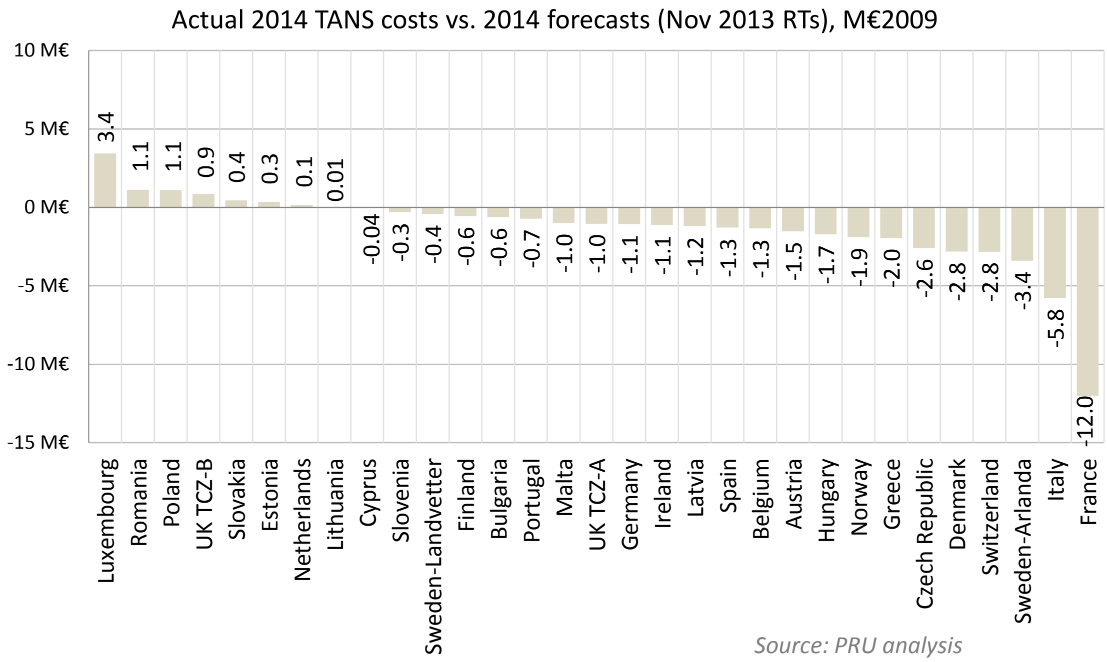


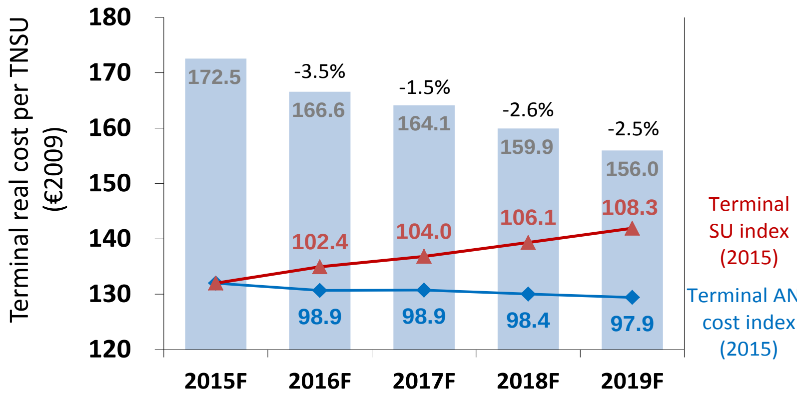
Figure 6-15: 2014 Terminal ANS actual costs vs. 2014 forecast costs at TCZ Level

Note that France was the only State applying the determined cost method for terminal ANS in RP1, which probably had an impact on the difference between the planned and actual 2014 costs, since the determined costs were set prior to RP1 (in 2011), which is not the case for other States. All SES States are subject to the determined cost method as of 1.1.2015.

6.3.4 Terminal ANS cost-efficiency analysis: outlook for 2015-2019

Figure 6-16 shows that SES total terminal ANS costs are foreseen to slightly decrease over the period 2015-2019 (i.e. on average by -0.5% p.a.) while TNSUs are foreseen to increase at an average rate of +2.0% per year.

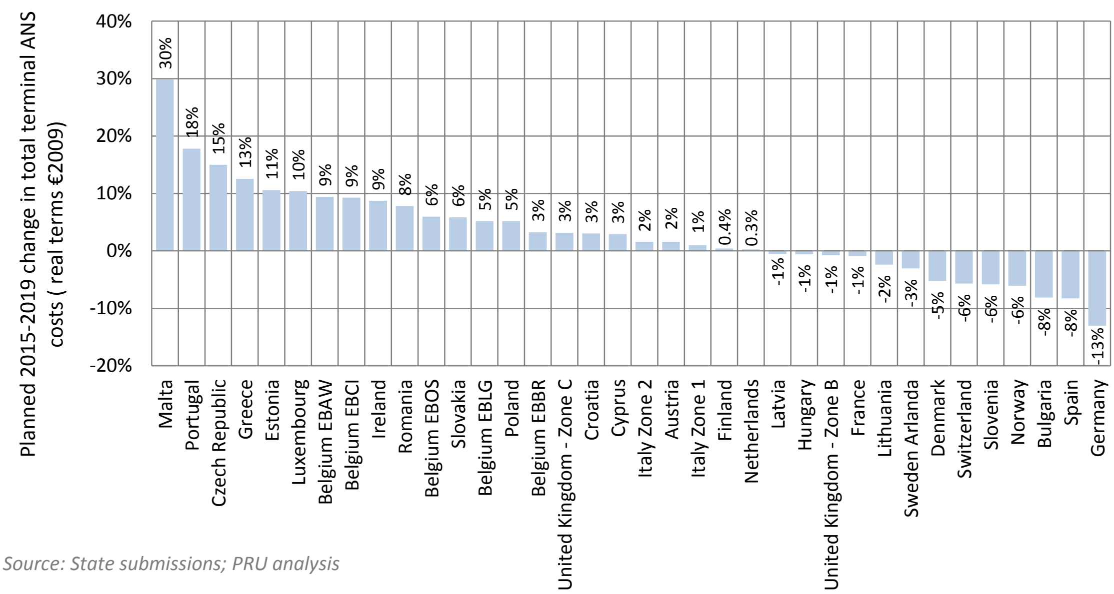
As a result, the forecast terminal ANS unit costs show a decrease from 172.5€$_{2009}$ in 2015 to 156.0€$_{2009}$ in 2019 (or -2.5% per year on average).



Source: NSAs; PRU analysis

Figure 6-16: Real terminal ANS costs per TNSU, total costs (€$_{2009}$) and TNSUs

Figure 6-17 shows the planned change in real terminal ANS costs between 2015 and 2019 for all reporting States and TCZs. As discussed above, SES total terminal costs are expected to slightly decrease (-0.5% p.a.) over the period. However, Figure 6-17 also indicates that some important changes in terminal costs are anticipated for some States/TCZs.



Source: State submissions; PRU analysis

Figure 6-17: Change in real terminal ANS total costs 2015-2019 (real €$_{2009}$)

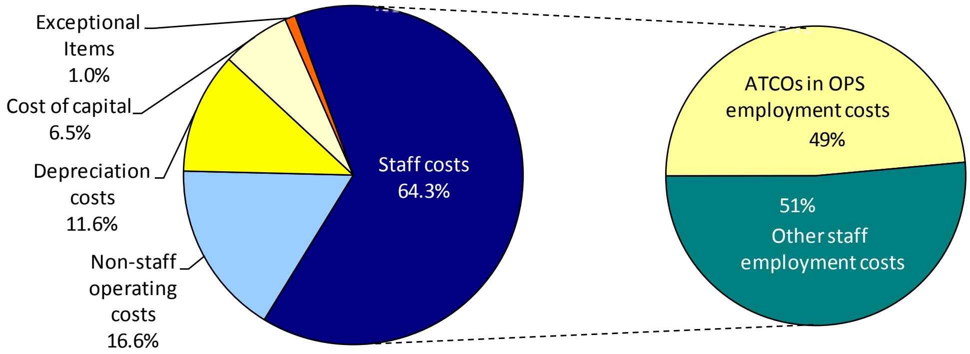
6.4 ANSPs gate-to-gate economic performance

The ATM Cost-Effectiveness (ACE) benchmarking analysis is a Pan-European review and comparison of ATM cost-effectiveness for 37 Air Navigation Service Providers (ANSPs). This includes 30 ANSPs which were at 1st January 2014 part of the SES, and hence subject to relevant SES regulations and obligations. Detailed analysis is given in the ACE 2014 Benchmarking Report [Ref. 39].

The analysis of ANSPs economic performance in this section focuses on ATM/CNS provision costs i.e. those which are under the direct responsibility of the ANSP, plus the cost of delay attributable to ANSPs.

The analysis developed in the ACE Reports allows identifying best practices in terms of ANSPs economic performance and to infer a potential scope for future performance improvements. This is a useful complement to the analysis of the en-route KPI and terminal PIs which are provided in the previous sections of this chapter.

Figure 6-18 shows a detailed breakdown of gate-to-gate ATM/CNS provision costs. Since there are differences in cost-allocation between en-route and terminal ANS among ANSPs, it is important to keep a "gate-to-gate" perspective when benchmarking ANSPs cost-effectiveness performance.



Total ATM/CNS provision costs: € 7 945 M

ATM/CNS provision costs (€ M)	En-route	%	Terminal	%	Gate-to-gate	%
Staff costs	3 957	63.7%	1 153	66.4%	5 110	64.3%
ATCOs in OPS employment costs	1 930	-	552	-	2 482	-
Other staff employment costs	2 028	-	601	-	2 629	-
Non-staff operating costs	1 015	16.3%	306	17.6%	1 320	16.6%
Depreciation costs	749	12.1%	170	9.8%	919	11.6%
Cost of capital	426	6.9%	91	5.2%	517	6.5%
Exceptional Items	63	1.0%	16	0.9%	79	1.0%
Total	6 210	100.0%	1 736	100.0%	7 945	100.0%

Figure 6-18: Breakdown of gate-to-gate ATM/CNS provision costs 2014 (€2014)

Figure 6-18 indicates that in 2014, at Pan-European system level, gate-to-gate ATM/CNS provision costs amount to some €7.9 Billion. Operating costs (including staff costs, non-staff operating costs and exceptional cost items) account for some 82% of total ATM/CNS provision costs, and capital-related costs (cost of capital and depreciation) amount to some 18%.

The analysis presented in this section is factual. It is important to note that local performance is affected by several factors which are different across European States, and some of these are typically outside (exogenous) an ANSP's direct control while others are endogenous. Indeed, ANSPs provide ANS in contexts that differ significantly from country to country in terms of environmental characteristics (e.g. the size and complexity of the airspace), institutional characteristics (e.g. relevant State laws), and of course in terms of operations and processes.

A genuine measurement of cost inefficiencies would require full account to be taken of the exogenous factors which affect ANSPs economic performance. This is not straightforward since these factors are not all fully identified and measurable. Exogenous factors related to operational conditions are, for the time being, those which have received greatest attention and focus. Several of these factors, such as traffic complexity and seasonal variability, are now measured robustly by metrics developed by the PRU.

The quality of service provided by ANSPs has an impact on the efficiency of aircraft operations, which carry with them additional costs that need to be taken into consideration for a full economic assessment of ANSP performance. The quality of service associated with ATM/CNS provision by ANSPs is, for the time being, assessed only in terms of ATFM ground delays, which can be measured consistently across ANSPs, can be attributed to ANSPs, and can be expressed in monetary terms. The indicator of "economic" cost-effectiveness is therefore the ATM/CNS provision costs plus the costs of ATFM ground delay, all expressed per composite flight-hour.

A number of factors affecting aircraft operations and contributing to the quality of service that is provided to airspace users by an ANSP are not accounted for in the economic cost-effectiveness indicator analysed in this report. These include operational aspects such as:

- horizontal flight-efficiency and the resulting route length extension; and,
- vertical flight-efficiency and the resulting deviation from optimal vertical flight profile.

There is no mature and commonly agreed methodology to measure the horizontal and vertical flight-efficiency genuine contribution at ANSP level. Therefore the ACE Benchmarking Report continues to focus on the costs of gate-to-gate ATFM ground delays to benchmark ANSPs cost-effectiveness. The analytical framework is illustrated in Figure 6-19.

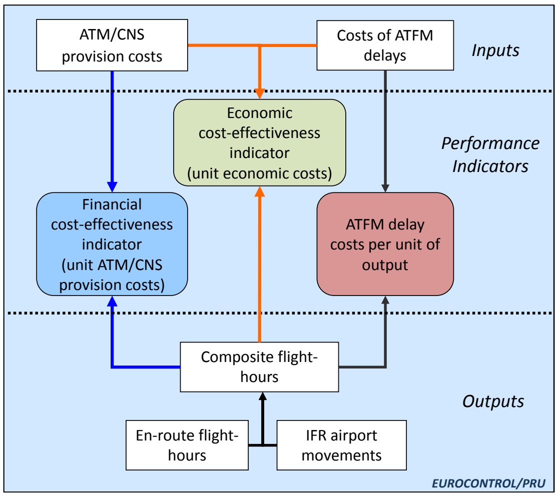


Figure 6-19: Conceptual framework for the analysis of economic cost-effectiveness

6.4.1 Trends in economic cost-effectiveness (2009-2014)

Figure 6-20 below displays the trend at Pan-European level of the gate-to-gate economic costs per composite flight-hour ("unit economic costs" thereafter) between 2009 and 2014 for a consistent sample of 37 ANSPs for which data for a time-series analysis was available. In 2009, the economic recession affected the aviation industry with an unprecedented -7% traffic decrease at system level, basically cancelling three years of traffic growth. It is therefore interesting to look at the changes in performance over the 2009-2014 period to understand how the ATM industry reacted to this sharp decrease in traffic demand.

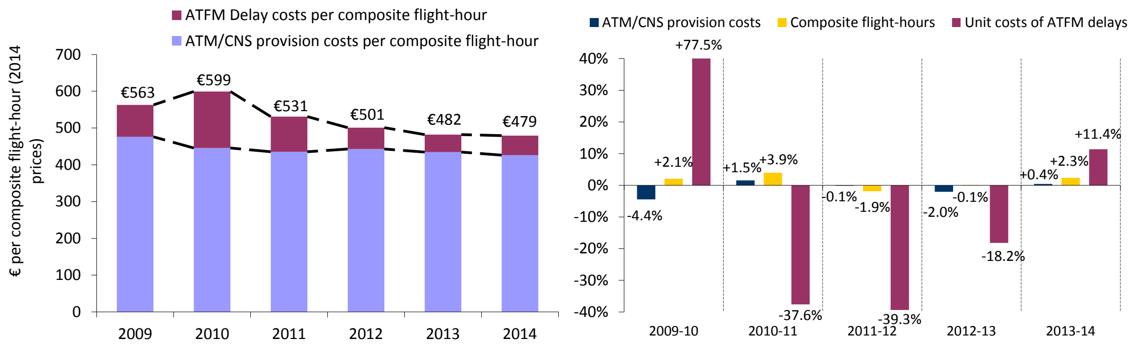


Figure 6-20: Changes in economic cost-effectiveness, 2009-2014 (€2014)

In 2014, despite an increase in ATFM delays, unit economic costs reduced for the fourth consecutive year. Although ATM/CNS provision costs rose by +0.4% in real terms, composite flight-hours increased by +2.3%, resulting in a decrease in unit ATM/CNS provision costs (-1.9%). Since the unit costs of ATFM delays increased by +11.4%, unit economic costs slightly reduced by -0.6% compared to 2013. As a result, in 2014 unit economic costs amount to €479 which is the lowest level achieved since the start of the ACE benchmarking analysis in 2001.

Figure 6-21 below shows the changes in unit economic costs at ANSP level between 2013 and 2014. Between 2013 and 2014, unit economic costs decreased for 20 ANSPs. Some of these ANSPs could achieve a substantial reduction in the unit costs of ATFM delays in 2014 (see red portion of the bar). This is particularly the case for Austro Control and DCAC Cyprus. However, although it reduced, the share of ATFM delays in DCAC Cyprus 2014 unit economic costs (60%) is by far the highest in Europe. In fact, ATFM delays represent more than 50% of DCAC Cyprus unit economic costs since 2008, a clear indication of recurrent ATC capacity issues for this ANSP.

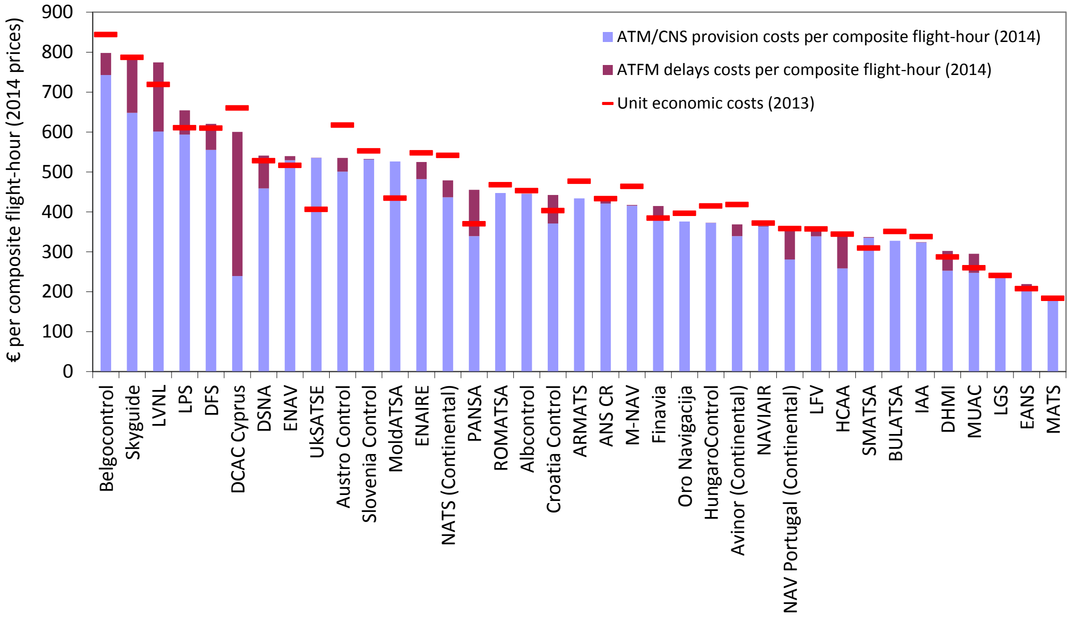


Figure 6-21: Changes in economic cost-effectiveness by ANSP, 2013-2014 (€2014)

Belgocontrol and LVNL are amongst the ANSPs with the highest unit economic costs, ranking first and third in Figure 6-21 above. It is noteworthy that these two ANSPs operate in relatively similar operational (both exclusively provide ATC services in lower airspace) and economic conditions. It should also be noted that these ANSPs own infrastructure which is made available to MUAC. Further details on ANSPs economic cost-effectiveness performance in 2014 are available in the ACE 2014 Benchmarking Report.

Figure 6-22 shows how the unit ATM/CNS provision costs (see blue part of the bar in Figure 6-21 above) can be broken down into three main key economic drivers: (1) ATCO-hour productivity, (2) employment costs per ATCO-hour and (3) support costs per composite flight-hour. Figure 6-22 also shows how these various components contributed to the overall change in cost-effectiveness between 2013 and 2014.

At system level, unit ATM/CNS provision costs fell by -1.9% in real terms between 2013 and 2014. Figure 6-22 shows that in 2014, ATCO-hour productivity rose faster (+2.0%) than employment costs per ATCO-hour (+1.3%). In the meantime, support costs remained fairly constant (-0.2%) while the number of composite flight-hours rose by +2.3%.

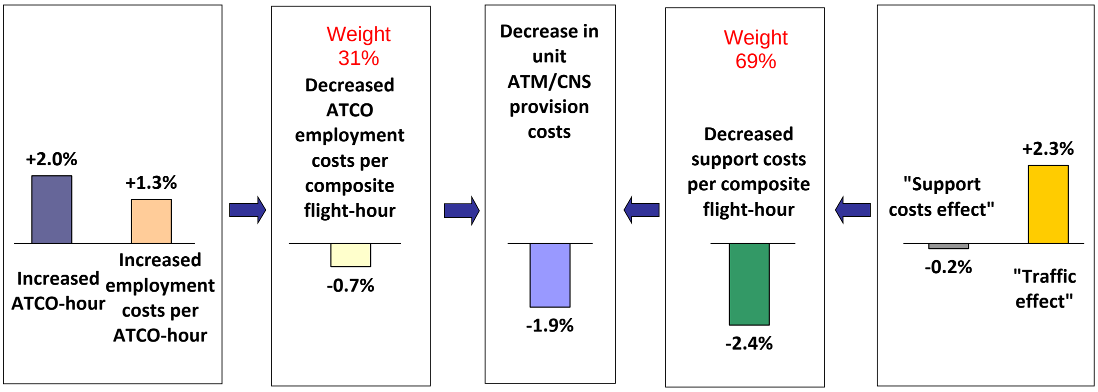


Figure 6-22: Breakdown of changes in cost-effectiveness, 2013-2014 (€2014)

6.4.2 Long-term trends in unit ATM/CNS provision costs and its main economic drivers (2004-2014)

ACE data have been collected since 2001 and it now becomes possible to conduct relevant long-term analysis of ATM cost-effectiveness. This Section provides an analysis of the changes in cost-effectiveness and its main drivers over the 2004-2014 period[56]. This 10-year period is characterised by significant changes in business cycles, the emergence of a new regulatory framework and technological evolution.

Figure 6-23 shows that during this period, ATM/CNS provision costs rose by +0.4% p.a. which was significantly less than the +1.4% p.a. increase in traffic. As a result, unit ATM/CNS provision costs per composite flight-hour decreased by -1.0% p.a. between 2004 and 2014. These average changes mask different trends and cycles over the 10-year period which was marked by a global economic recession in 2009.

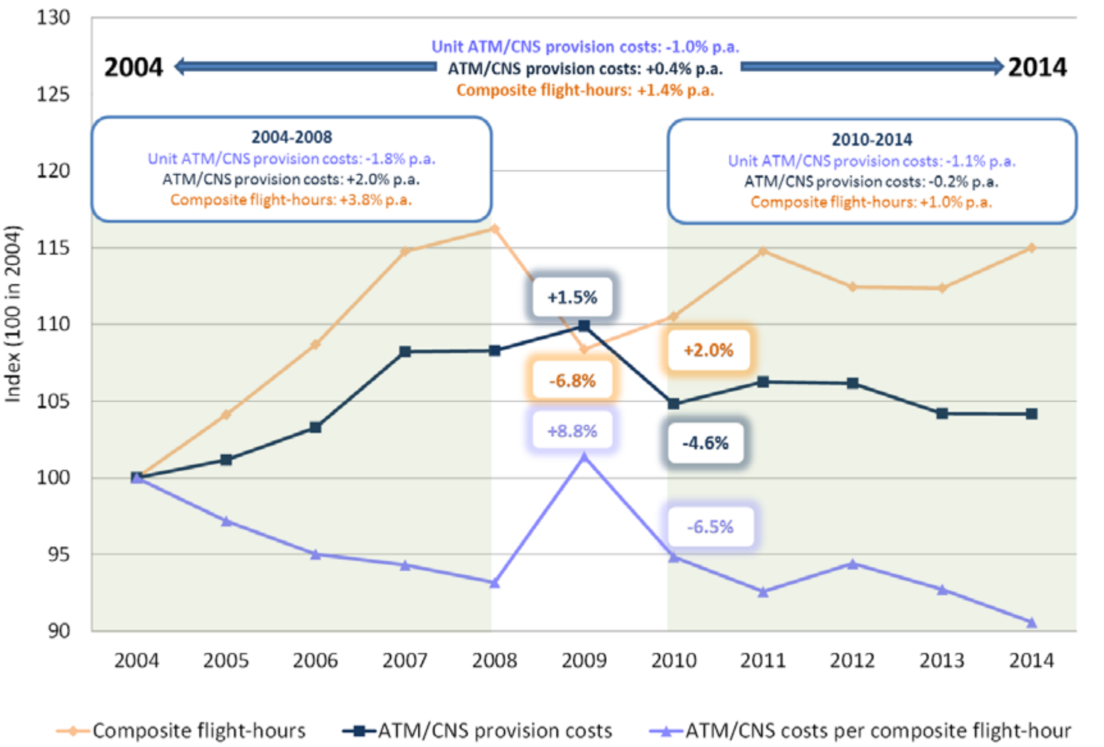


Figure 6-23: Long-term trends in traffic, ATM/CNS provision costs and unit costs

56 The three additional ANSPs joining the ACE benchmarking exercise during the 2004-2014 period were PANSA in 2005, SMATSA in 2006 and ARMATS in 2009.

Between 2004 and 2008, a period of sustained traffic growth, the number of composite flight-hours rose faster (+3.8% p.a.) than ATM/CNS provision costs (+2.0% p.a.). As a result, unit ATM/CNS provision costs reduced by -1.8% p.a. over this period. This demonstrated the ability of the ATM industry to reduce unit costs in a context of robust and continuous traffic growth.

Then came the year 2009 which was pivotal for the ATM system. Indeed, the economic recession struck the aviation industry with an unprecedented -6.8% traffic decrease. In the meantime, ATM/CNS provision costs continued to grow by +1.5% reflecting the short-term rigidities to adjust costs downwards and the unavoidable lead time. As a result, unit ATM/CNS provision costs increased by +8.8% and all the cost-effectiveness improvements achieved since 2004 were cancelled.

However, in 2010, ATM/CNS provision costs reduced by -4.6% in a context of a +2.0% rebound in traffic. It should be emphasised that before 2010, ATM/CNS provision costs had never declined during the decade. This reflects the impact of the cost containment measures implemented by a majority of ANSPs in the wake of the sharp traffic decrease in 2009. This indicates that, as a whole, the ATM industry was reactive and showed flexibility to adjust costs downwards in response to the fall in traffic. This performance improvement was achieved when ANSPs operated under the so-called full-cost recovery regime which provided no strong incentives to reduce/contain costs.

Over the 2010-2014 period, ATM/CNS provision costs remained fairly constant (-0.2% p.a.) in a context of low traffic growth (+1.0% p.a. compared to +3.8% over the 2004-2008 period). As a result, unit ATM/CNS provision costs reduced by -1.1% p.a. between 2010 and 2014. It is noteworthy that this performance improvement was achieved while reducing the overall amount of ATFM delays.

Overall, despite the impact of the economic recession of the ATM industry in 2009, the cost-effectiveness performance of the Pan-European system significantly improved since 2004. Indeed, in 2014 unit ATM/CNS provision costs are -9.4% lower than in 2004. This performance improvement should be seen in the light of (a) the cost-containment measures initiated in 2009-2010 which continued to generate savings years after their implementation, and (b) for the ANSPs operating in SES States, the implementation of the performance scheme and the incentive mechanism embedded in the charging scheme which contributed to change the economic behaviour of these ANSPs and to maintain a downward pressure on costs during RP1.

As indicated in Figure 6-22, the cost-effectiveness indicator is broken down into three main components: ATCO-hour productivity, ATCO employment costs per ATCO-hour and support costs per composite flight-hours. Figure 6-24 below shows the long-term changes for these indicators over the 2004-2014 period.

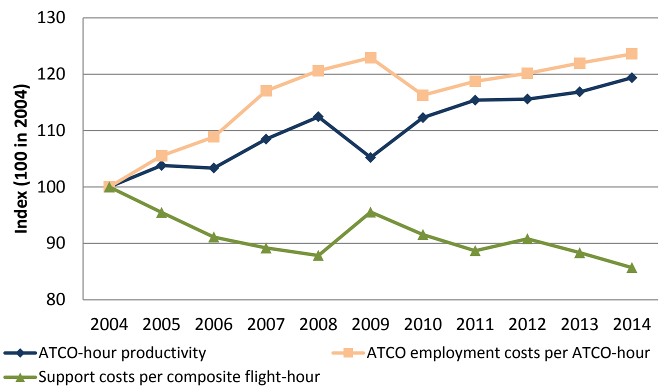


Figure 6-24: Long term trends in productivity, employment costs per ATCO-hour and unit support costs

Figure 6-24 below shows the long-term changes for these indicators over the 2004-2014 period. Employment costs per ATCO-hour rose faster (+2.1% p.a.) than ATCO-hour productivity (+1.8% p.a.). In the meantime, unit support costs fell by -1.5% p.a. since support costs remained fairly constant (-0.1%) in a context of traffic increase (+1.4% p.a.).

As a result, unit ATM/CNS provision costs reduced by -1.0% p.a. over the 2004-2014 period.

Further details about the long-term changes in unit ATM/CNS provision costs, ATCO-hour productivity, employment costs per ATCO-hour and support costs at ANSP level can be found in the forthcoming ACE 2014 Benchmarking Report.

6.5 Conclusions

PRR 2015 analyses performance in 2015 for all KPIs, except for cost-efficiency, which analyses performance in 2014 as this is the latest year for which actual financial data are available. On the other hand, PRR 2015 also presents an outlook for 2015-2019 in terms of cost-efficiency trends.

The Pan-European system (38 States) **en-route cost-efficiency performance** in 2014 improved for the second year in a row. Following the -3.3% decrease in 2013, real en-route unit costs decreased further reaching 50.5€$_{2009}$ per service unit which corresponds to a -5.0% reduction compared to 2013.

The overall reduction of real en-route unit costs in 2014 is mainly due to the notable traffic growth (+5.9%) while actual en-route ANS costs increased by +0.6% during the same time. Despite the substantial traffic growth in 2014, it is worth noting that en-route service units are still below the forecasted level for 2014.

In 2014, operating costs accounted for 82% of en-route costs (staff costs for 58% and other operating costs for 24%), followed by depreciation (12%) and cost of capital (6%). Year-on-year, staff costs remained almost stable (+0.4% vs. 2013) while other operating costs increased by +1.8% in 2014.

The evaluation of differences in trends and behaviour between those States operating in the context of the SES Regulations and the other states in the Route Charges System does not yet show a clear cut trend and it is likely that a longer period would need to be considered. Moreover, the trend in non-SES States is to a large extent influenced by Turkey for which a significantly high traffic growth has been observed over the past years.

Under the determined costs method, applied by SES States as of 2012, the amounts ultimately paid by airspace users differ from the actual costs due to the traffic risk sharing, cost-sharing, and other adjustments provided in the Charging Regulation. It is therefore important to monitor not only the actual costs incurred by States/ANSPs, but also the amounts ultimately charged to the airspace users in respect of the activities of that year (a concept also referred to as the **"true cost for users"**). In 2014, the "true costs for users" were +2.8% higher than the actual costs of States/ANSPs but -2.1% lower than the determined costs provided for 2014 in the RP1 performance plans, which suggests that the service providers were able to adjust their costs downwards in line with the lower than predicted traffic level in 2014.

The outlook for 2015-2019 suggests that the en-route unit cost is expected to decrease from 50.5€$_{2009}$ in 2014 to 46.4€$_{2009}$ in 2019, representing a decrease of -1.7% p.a. on average until 2019. Overall, at Pan-European level between 2009 and 2019, the trend in total en-route costs is planned to remain flat, while traffic (SUs) is planned to increase by some +31%, implying substantial cost-efficiency improvements over this 10-years cycle.

European **terminal ANS cost-efficiency** performance (29 States comprising 33 Terminal Charging Zones which include a total of 230 airports in 2014) followed a similar pattern as observed for en-route cost efficiency in 2014. Year-on-year, terminal ANS unit costs decreased by -2.3% versus 2013 due to terminal service units (TNSUs) growing stronger (+2.9% vs. 2013) than real terminal ANS costs (+0.6% vs. 2013).

The outlook for 2015-2019 suggests that SES total terminal ANS costs are planned to slightly decrease over the period 2015-2019 (i.e. on average by -0.5% p.a.), while TNSUs are foreseen to increase at an average rate of +2.0% per year, representing a decrease of -2.5% per year on average in the terminal ANS unit costs. This is a slightly better trend than for en-route.

Detailed benchmarking analysis focusing on ANSPs cost-efficiency at Pan-European system shows that the **gate-to-gate unit economic costs** decreased for the 4th year in a row to reach an amount of €479 per composite flight-hour in 2014, which is the lowest level achieved since the start of the ACE benchmarking analysis in 2001. This performance improvement mainly reflects a decrease in unit ATM/CNS provision costs (-1.9%) while the unit costs of ATFM delays rose by 11.4% compared to 2013.

Overall, despite the impact of the economic recession of the ATM industry in 2009, the cost-effectiveness performance of the Pan-European system significantly improved since 2004. Indeed, in 2014 unit ATM/CNS provision costs are -9.4% lower than in 2004. This performance improvement should be seen in the light of the cost-containment measures initiated in 2009-2010 which continued to generate savings years after their implementation, and for the ANSPs operating in SES States, the implementation of the performance scheme which contributed to maintain a downward pressure on costs during RP1.

ANNEX I - ACC TRAFFIC AND DELAY DATA (2013-2015)

		3Y-AAGR = Annual average growth rate		IFR Traffic					Total ATFM delay per flight			En route ATFM delay per flight			Causes of en route ATFM delay in 2015			
				Avg. daily			2015/14 growth (%)	3Y-AAGR										
ACC CODE	PRU_ACC	State	ACC	2013	2014	2015			2013	2014	2015	2013	2014	2015	Capacity/ Staffing	ATC Other	Weather	Other reasons
LAAACTA	LAAAACC	Albania	Tirana	550	543	553	1.8%	1.1%										
UDDDCTA	UDDDACC	Armenia	Yerevan	139	130	107	-18.0%	-9.5%										
LOVVCTA	LOVVACC	Austria	Wien	1 916	2 057	2 092	1.7%	2.1%	0.48	0.17	0.26	0.26	0.03	0.09	30.4%	1.4%	68.2%	0.0%
EBBUCTA	EBBUACC	Belgium	Brussels	1 483	1 525	1 602	5.0%	2.0%	0.26	0.21	0.40	0.08	0.02	0.14	28.4%	71.1%	0.5%	0.0%
LBSRCTA	LBSRACC	Bulgaria	Sofia	1 460	1 822	2 046	12.3%	12.8%							0.0%	0.0%	90.0%	10.0%
LDZOCTA	LDZOACC	Croatia	Zagreb	1 281	1 355	1 366	0.8%	1.9%	0.10	0.33	0.58	0.10	0.33	0.57	71.1%	0.0%	28.8%	0.2%
LCCCCTA	LCCCACC	Cyprus	Nicosia	760	834	874	4.8%	5.8%	2.21	1.92	2.48	2.16	1.91	2.47	90.4%	3.6%	0.4%	5.6%
LKAACTA	LKAAACC	Czech Republic	Praha	1 804	1 849	1 976	6.9%	3.2%	0.06	0.03		0.04	0.01		73.0%	0.0%	16.7%	10.3%
EKDKCTA	EKDKACC	Denmark	Kobenhavn	1 459	1 464	1 488	1.7%	1.7%	0.02						0.0%	0.0%	100.0%	0.0%
EETTCTA	EETTACC	Estonia	Tallinn	485	508	516	1.6%	1.5%	0.02	0.03	0.01	0.02	0.03	0.01	100.0%	0.0%	0.0%	0.0%
EFESNEW	EFESACC	Finland	Tampere+	451	459	445	-3.0%	-2.9%	0.03	0.26	0.32		0.16	0.03	0.0%	0.0%	0.0%	100.0%
LFBBCTA	LFBBALL	France	Bordeaux	2 238	2 282	2 349	3.0%	1.8%	0.33	0.24	0.36	0.30	0.23	0.34	37.2%	42.4%	16.4%	3.9%
LFRRCTA	LFRRACC		Brest	2 457	2 559	2 538	-0.8%	1.8%	0.36	0.54	1.41	0.35	0.53	1.41	39.8%	12.1%	1.2%	46.9%
LFMMCTA	LFMMACC		Marseille	2 746	2 730	2 743	0.5%	-0.3%	0.44	0.57	0.20	0.44	0.57	0.20	40.7%	41.7%	17.6%	0.0%
LFFFCTA	LFFFALL		Paris	3 106	3 125	3 205	2.6%	-0.3%	0.42	0.35	0.35	0.17	0.17	0.14	46.0%	13.3%	34.5%	6.3%
LFEECTA	LFEEACC		Reims	2 430	2 522	2 574	2.1%	3.2%	0.33	0.43	0.55	0.31	0.42	0.55	61.7%	23.7%	13.9%	0.6%
LWSSCTA	LWSSACC	FYROM	Skopje	301	389	401	3.1%	9.3%			0.01			0.01	52.6%	29.7%	0.0%	17.7%
EDWWCTA	EDWWACC	Germany	Bremen	1 628	1 683	1 720	2.2%	0.8%	0.16	0.18	0.17	0.06	0.09	0.08	55.2%	10.2%	25.0%	9.6%
EDGGCTA	EDFFALL		Langen	3 318	3 317	3 343	0.8%	-0.4%	0.46	0.53	0.31	0.24	0.24	0.14	47.2%	14.9%	24.9%	13.0%
EDMMCTA	EDMMACC		Munchen ++	2 876	2 846	2 923	2.7%	-9.3%	0.14	0.12	0.10	0.05	0.02	0.04	2.2%	11.0%	52.2%	34.6%
EDUUUTA	EDUUUAC		Rhein (Karlsruhe)	4 501	4 631	4 718	1.9%	6.4%	0.17	0.20	0.18	0.17	0.20	0.18	34.1%	0.5%	46.8%	18.6%
	LGACC	Greece	Athinai+Macedonia	1 643	1 782	1 879	5.4%	3.8%	0.32	0.78	1.56	0.07	0.42	0.99	98.6%	0.8%	0.5%	0.1%
LHCCCTA	LHCCACC	Hungary	Budapest	1 566	1 754	1 951	11.2%	8.4%			0.03			0.03	0.0%	0.0%	100.0%	0.0%
EIDWCTA	EIDWACC	Ireland	Dublin	509	537	578	7.8%	5.5%	0.05	0.02	0.08							
EISNCTA	EISNACC		Shannon	1 074	1 086	1 127	3.7%	1.5%										
LIBBCTA	LIBBACC	Italy	Brindisi	786	730	697	-4.5%	-4.9%	0.05	0.01								
LIMMCTA	LIMMACC		Milano	1 567	1 973	2 166	9.8%	9.2%		0.03	0.01		0.03		0.0%	96.0%	0.0%	4.0%
LIPPCTA	LIPPACC		Padova	1 821	1 854	1 764	-4.9%	-1.6%	0.02	0.02	0.03				0.0%	100.0%	0.0%	0.0%
LIRRCTA	LIRRACC		Roma	2 564	2 239	2 144	-4.3%	-6.1%	0.09	0.12	0.31			0.02	0.0%	100.0%	0.0%	0.0%
EVRRCTA	EVRRACC	Latvia	Riga	642	659	664	0.8%	1.5%							100.0%	0.0%	0.0%	0.0%
EYVCCTA	EYVCACC	Lithuania	Vilnius	565	597	597	0.0%	3.0%										
EDYYUTA	EDYYUAC		Maastricht	4 471	4 579	4 664	1.9%	2.0%	0.07	0.17	0.34	0.07	0.17	0.34	55.2%	0.1%	28.8%	15.9%
LMMMCTA	LMMMACC	Malta	Malta	298	277	279	0.9%	1.8%										
LUUUCTA	LUUUACC	Moldova	Chisinau	198	149	119	-20.0%	-11.6%										
EHAACTA	EHAAACC	The Netherlands	Amsterdam	1 408	1 441	1 499	4.0%	2.4%	0.68	0.94	1.44	0.12	0.13	0.10	71.9%	0.0%	21.9%	6.2%
ENBDCTA	ENBDACC	Norway	Bodo	565	589	590	0.3%	2.0%	0.03	0.03		0.03	0.02		82.5%	0.0%	0.0%	17.5%
ENOSCTA	ENOSACC		Oslo	949	961	811	-15.6%	-3.4%	0.38	0.29	0.29			0.07	94.0%	0.0%	6.0%	0.0%
ENSVCTA	ENSVACC		Stavanger	663	677	580	-14.3%	-2.5%	0.12	0.24	0.06	0.07	0.05	0.03	97.4%	0.0%	0.0%	2.6%
EPWWCTA	EPWWACC	Poland *	Warszawa	1 753	1 775	1 766	-0.5%	0.7%	0.56	0.88	0.21	0.54	0.84	0.20	89.4%	1.5%	4.6%	4.4%
LPPCCTA	LPPCACC	Portugal	Lisboa	1 150	1 229	1 292	5.1%	4.7%	0.43	0.72	0.74	0.29	0.53	0.51	83.0%	6.2%	1.2%	9.7%
	LPPOOAC		Santa Maria	305	315	344	9.4%	5.2%										
LRBBCTA	LRBBACC	Romania	Bucuresti	1 383	1 617	1 716	6.2%	9.4%			0.03			0.03	0.0%	99.5%	0.0%	0.5%
LYBACTA	LYBAACC	Serbia	Beograd	1 393	1 491	1 621	8.7%	4.0%	0.02		0.03	0.02		0.03	65.4%	3.5%	0.0%	31.1%
LZBBCTA	LTBBACC	Slovak Republic	Bratislava	2 215	2 476	2 643	6.7%	8.7%	0.15	0.68	2.45							
LJLACTA	LJLAACC	Slovenia	Ljubjana	703	743	725	-2.5%	-0.5%										
LECBCTA	LECBACC	Spain	Barcelona	2 007	2 042	2 085	2.1%	1.1%	0.49	0.46	0.59	0.47	0.37	0.46	77.4%	4.5%	17.9%	0.1%
LECMCTA	LECMALL		Madrid	2 395	2 514	2 615	4.0%	1.4%	0.22	0.10	0.17	0.18	0.07	0.10	57.1%	0.4%	4.9%	37.6%
LECPCTA	LECPACC		Palma	674	695	721	3.7%	1.8%	0.48	0.49	0.87	0.13	0.11	0.17	94.3%	0.0%	5.7%	0.0%
LECSCTA	LECSACC		Sevilla	879	901	909	0.9%	0.5%	0.07	0.03	0.05	0.05	0.03	0.04	50.9%	6.5%	0.9%	41.7%
GCCCCTA	GCCCACC		Canarias	724	774	767	-0.9%	0.7%	0.56	0.44	0.34	0.44	0.42	0.26	46.2%	3.1%	12.9%	37.8%
ESMMCTA	ESMMACC	Sweden	Malmo	1 377	1 386	1 401	1.2%	0.9%							0.0%	93.6%	0.0%	6.4%
ESOSCTA	ESOSACC		Stockholm	1 069	1 078	1 077	-0.1%	0.4%	0.17	0.16	0.06	0.05	0.05	0.03	0.0%	50.6%	45.2%	4.2%
LSAGACC	LSAGACC	Switzerland	Geneva	1 627	1 654	1 676	1.3%	0.4%	0.41	0.34	0.35	0.10	0.10	0.06	47.1%	4.4%	45.3%	3.3%
LSAZACC	LSAZACC		Zurich	1 975	1 984	2 004	1.0%	-0.5%	0.61	0.56	0.61	0.14	0.08	0.10	68.9%	0.8%	18.2%	12.1%
LTAACTA_11	LTAAACC	Turkey	Ankara	2 037	2 302	2 574	11.8%	10.0%	0.19	0.15	0.26	0.14	0.12	0.12	100.0%	0.0%	0.0%	0.0%
	LTBBACC		Istanbul	2 215	2 476	2 643	6.7%	8.7%	0.15	0.68	2.45							
UKBVCTA	UKBVACC	Ukraine	Kyiv	651	532	398	-25.2%	-14.3%	0.02									
	UKDVACC		Dnipropetrovs'k ALL**	447	226	40	-82.4%	-54.7%										
UKFVCTA	UKFVACC		Simferopol	594	134													
UKLVCTA	UKLVACC		L'viv	502	363	239	-34.1%	-21.0%										
UKOVCTA	UKOVACC		Odesa	299	285	243	-14.6%	-3.3%										
EGTTCTA	EGTTACC	United Kingdom	London AC	4 927	5 033	5 172	2.8%	1.8%	0.14	0.05	0.06	0.14	0.05	0.06	32.7%	0.0%	65.4%	1.9%
EGTTTCTA	EGTTTC		London TC	3 408	3 511	3 625	3.2%	2.2%	0.60	0.48	0.61		0.01	0.06	64.1%	0.0%	35.8%	0.0%
EGPXNEW	EGPXALL		Prestwick	2 397	2 400	2 441	1.7%	0.8%	0.04	0.04	0.04		0.02	0.01	33.2%	63.3%	3.3%	0.2%

ACCs geographical areas might change over time, preventing year on year comparision (e.g. Prestwick, Dnipropetrovs'k ALL)

* does not include EPWWICTA and EPKKTMA

** Dnipropetrovs'k ALL was created in March 2010 replacing Kharkiv, Dnipropetrov'k and Donetsk' ACCs

+ Rovaniemi ACC was merged with Tampere ACC in 2011. ++ Upper airspace was transferred to Karlsruhe in Aug. 2012.

Source: NM

Please note that delay per flight is not an additive measure (on average a flight crosses between 2 and 3 States). Therefore the European value does not transpose directly to individual ACCs.

ANNEX II - TRAFFIC COMPLEXITY SCORES IN 2015

The PRU, in close collaboration with ANSPs, has defined a set of complexity indicators that could be applied in ANSP benchmarking. The complexity indicators are computed on a systematic basis for each day of the year. This annex presents for each ANSP the complexity score computed over the full year (365 days).

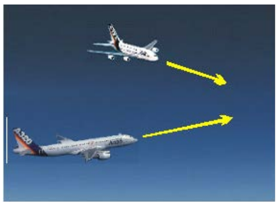
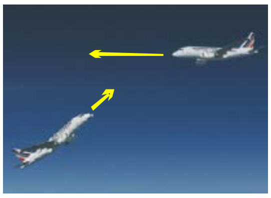
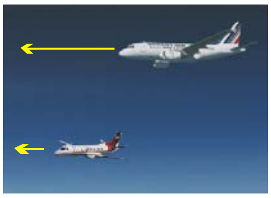
The complexity indicators are based on the concept of "interactions" arising when there are two aircraft in the same "place" at the same time. Hence, the **complexity score** is a measure of the potential number of interactions between aircraft defined as the total duration of all interactions (in minutes) per flight-hour controlled in a given volume of airspace.

For each ANSP the complexity score is the product of two components:

Complexity score = Traffic density x Structural index

The traffic density is expressed in adjusted density which measures the (uneven) distribution of traffic throughout the airspace (i.e. taking into account the relative concentration). The measure relies on dividing the airspace volume into a discrete grid of 20 nautical mile cells. For the purpose of this study, an interaction is defined as the simultaneous presence of two aircraft in a cell of 20x20 nautical miles and 3,000 feet in height.

The structural index originates from horizontal, vertical, and speed interactions and is computed as the sum of the three indicators.

	**Horizontal interactions indicator**: A measure of the complexity of the flow structure based on the potential interactions between aircraft on different headings. The indicator is defined as the ratio of the duration of horizontal interactions to the total duration of all interactions.
	**Vertical interactions indicator**: A measure of the complexity arising from aircraft in vertical evolution based on the potential interactions between climbing, cruising and descending aircraft. The indicator is defined as the ratio of the duration of vertical interactions to the total duration of all interactions
	**Speed interactions indicator**: A measure of the complexity arising from the aircraft mix based on the potential interactions between aircraft of different speeds. The indicator is defined as the ratio of the duration of speed interactions to the total duration of all interactions

More information on the methodologies used for the computation of the complexity score in this report is available from the report on "Complexity Metrics for ANSP Benchmarking Analysis" available on the PRC webpage.

ANSP Complexity score (2015)

The complexity scores in the table below represent an annual average. Hence the complexity score in areas with a high level of seasonal variability may be higher during peak months.

Complexity Score 2015 ANSP and State	Adjusted density		Structural index					Complexity Score	
			vertical	horizontal	speed	Total			
	A	% change	B	C	D	E=B+C+D	% change	F= A * E	% change
Skyguide (CH)	11.38	1.7%	0.26	0.61	0.23	1.10	0.2%	12.54	1.9%
NATS (Continental) (UK)	10.33	2.4%	0.37	0.45	0.32	1.14	1.7%	11.74	4.1%
Belgocontrol (BE)	8.04	6.5%	0.38	0.56	0.45	1.39	0.3%	11.16	6.8%
DFS (DE)	9.99	-2.4%	0.27	0.58	0.25	1.10	2.0%	10.96	-0.4%
MUAC (MUAC)	10.62	1.3%	0.26	0.56	0.18	1.00	2.3%	10.63	3.6%
LVNL (NL)	10.27	0.7%	0.19	0.43	0.41	1.03	3.3%	10.60	4.1%
ANS CR (CZ)	10.32	7.8%	0.13	0.53	0.16	0.81	-1.9%	8.37	5.8%
Austro Control (AT)	8.37	-3.8%	0.17	0.56	0.19	0.92	4.6%	7.72	0.6%
DSNA (FR)	10.58	0.6%	0.14	0.43	0.12	0.70	-0.4%	7.35	0.3%
Slovenia Control (SI)	9.68	-7.5%	0.08	0.57	0.10	0.75	2.8%	7.25	-4.9%
DHMI (TR)	11.80	12.5%	0.14	0.28	0.18	0.60	-7.9%	7.08	3.6%
LPS (SK)	9.13	8.6%	0.08	0.44	0.16	0.68	-4.2%	6.18	4.1%
ENAV (IT)	5.75	0.7%	0.25	0.61	0.16	1.02	1.8%	5.87	2.5%
SMATSA (LY)	9.24	12.5%	0.04	0.52	0.06	0.62	0.5%	5.77	13.1%
HungaroControl (HU)	8.95	2.9%	0.05	0.46	0.13	0.64	0.8%	5.72	3.8%
Croatia Control (HR)	8.34	1.2%	0.05	0.54	0.08	0.67	5.1%	5.60	6.3%
BULATSA (BU)	9.78	13.3%	0.06	0.33	0.11	0.50	0.7%	4.86	14.1%
SAKAERONAVIGATSIA (GE)	7.38	39.1%	0.04	0.32	0.28	0.64	-4.4%	4.76	32.9%
ENAIRE (ES)	6.89	3.0%	0.15	0.38	0.13	0.65	1.9%	4.49	5.0%
ROMATSA (RO)	7.93	6.2%	0.04	0.37	0.14	0.55	2.2%	4.36	8.6%
PANSA (PL)	4.25	-9.9%	0.14	0.57	0.21	0.92	3.3%	3.92	-6.9%
DCAC Cyprus (CY)	5.57	5.7%	0.16	0.39	0.12	0.67	1.5%	3.71	7.3%
NAVIAIR (DK)	3.58	0.5%	0.18	0.57	0.23	0.99	6.1%	3.54	6.6%
Albcontrol (AL)	6.63	-0.3%	0.05	0.37	0.06	0.49	3.1%	3.22	2.7%
M-NAV (MK)	5.55	1.8%	0.08	0.44	0.04	0.55	-3.7%	3.07	-2.0%
LFV (SE)	2.93	-3.5%	0.21	0.51	0.25	0.98	3.3%	2.86	-0.3%
NAV Portugal (Continental) (PT)	4.39	3.7%	0.15	0.40	0.08	0.63	4.4%	2.75	8.4%
EANS (EE)	3.62	-1.5%	0.15	0.32	0.27	0.75	5.7%	2.71	4.1%
HCAA (GR)	4.42	-2.8%	0.11	0.40	0.10	0.61	3.7%	2.68	0.8%
LGS (LV)	3.27	0.7%	0.09	0.49	0.20	0.77	7.4%	2.54	8.2%
IAA (IE)	4.12	4.1%	0.08	0.27	0.19	0.54	9.8%	2.22	14.3%
Oro Navigacija (LT)	2.89	-6.0%	0.08	0.48	0.20	0.76	6.5%	2.19	0.1%
Avinor (Continental) (NO)	2.14	-3.3%	0.26	0.45	0.26	0.97	-1.5%	2.08	-4.7%
Finavia (FI)	1.69	-0.6%	0.28	0.35	0.37	1.00	7.8%	1.69	7.1%
MATS (MT)	2.63	48.0%	0.04	0.29	0.16	0.49	-24.1%	1.30	12.3%
UkSATSE (UA)	2.14	-21.9%	0.08	0.29	0.10	0.48	-20.4%	1.02	-37.9%
ARMATS (AM)	1.16	-7.2%	0.11	0.30	0.24	0.66	1.5%	0.76	-5.8%
MoldATSA (MD)	1.00	-33.5%	0.05	0.38	0.10	0.54	-14.2%	0.54	-42.9%
Average	8.23	3.3%	0.18	0.45	0.18	0.82	-0.2%	6.74	3.1%

* *Note that ENAIRE's (former Aena) complexity score is influenced by the low traffic density of Canarias airspace.*

More information and data on complexity is available online at www.ansperformance.eu.

ANNEX III - FRAMEWORK: ECONOMIC EVALUATION OF ANS PERFORMANCE

In Europe, airspace users bear the total economic costs of ANS services, which consist of ANS costs (en-route and terminal) and quality of service related costs (due to ANS related inefficiencies). This Annex provides background information on the framework applied for the economic evaluation of ANS performance in Chapter 2 of this report.

The economic evaluation of ANS performance is an attempt to monetarise direct and indirect costs borne by airspace users in order to draw a consolidated high-level picture. While its primacy is fully recognised, it is not appropriate to include a monetary value for Safety.

Insufficient capacity has a negative impact on ANS-related service quality performance (high delays, etc.) and on airspace users' costs; while the provision of capacity higher than demand contributes towards higher than necessary ANS charges (underutilisation of resources).

Chapter 2 of this report combines key results from the analysis of ANS cost-efficiency in Chapter 6 and the evaluation of operational performance en-route and at airports in Chapter 4 and 5. The total economic evaluation is useful to provide a simplified consolidated high-level view on ANS performance and to promote discussions on future ANS performance. However, the concept has also drawbacks which limit its suitability at local level and for target setting purposes:

- it relies on assumptions for the monetarisation of the cost of delays;
- trade-offs will inevitably differ at a local/FAB level according to traffic characteristics, and the economic and working environment; and,
- total economic costs do not indicate the scope for improvement in respective KPAs.

While ANS en-route and terminal costs can be directly taken from Chapter 6, estimating costs to airspace users as a result of ANS-related inefficiencies is complex and requires expert judgement and assumptions, based on published statistics and robust data wherever possible. There are inevitably margins of uncertainty which need to be taken into account for the interpretation of the results.

ANS-related inefficiencies impact on airspace users in terms of cost of <u>time</u> and <u>fuel</u>.

The monetarisation of ANS-related inefficiencies <u>in terms of time</u> in this report is based on the study from the University of Westminster [Ref.15] which addresses estimated costs to airspace users. It does not consider costs for on-board equipment nor does it provide a full societal impact assessment which would include, for instance, also the cost of delay to passengers.

Inefficiency costs are calculated separately for "strategic" delays (those accounted for in advance during the scheduling phase by adding buffer to the airline schedule) and "tactical" delays (those incurred on the day of operations and not accounted for in advance).

<u>Costs of ANS-related inefficiencies</u>

The estimated airline delay costs in the University of Westminster study include direct costs (fuel, crew, maintenance, etc.) the network effect (i.e. cost of reactionary delays) and passenger related costs.

Whilst passenger 'value of time' is an important consideration in wider transport economics, only those costs which impact on the airline's business (rebooking, compensation, market share and passenger loyalty related costs) were included in the estimate. Estimates of future emissions costs from the EU emission trading scheme from 01 January 2012 were not included.

Hence, in this report, en-route and airport ATFM delays were considered as being "tactical" (infrequent with a low level of predictability) and inefficiencies in the gate-to-gate phase (taxi out, en-route, terminal) were considered to be "strategic".

Although the main share of ANS-related inefficiencies in the gate-to-gate phase is largely predictable (route network, congestion, etc.), it is acknowledged that some of the inefficiencies are not fully predictable and therefore could be considered as being "tactical". As there is presently no validated methodology for the quantification of "tactical" delay in the gate-to-gate phase, all inefficiencies in the gate-to-gate phase were considered to be "strategic" in this report.

Cost of "tactical" delays

"Tactical" delays occur infrequently and are therefore difficult to predict for airlines during the scheduling phase. While the fuel burn is quasi nil, the impact on airspace users' schedules is significant. Due to the lower level of predictability and resulting passenger related (compensation, rebooking, etc.) and network (reactionary delay) related cost, the cost of one minute of tactical delay is considered to be higher than for "strategic" delay (excluding fuel burn).

The cost of ATFM delay in this report is based on the European airline delay cost reference values, published by the University of Westminster. Based on the initial work published in 2004, the report was updated in 2010 [Ref. 40] and also in 2015 [Ref. 15] to improve the methodology and to take changes in the economic and regulatory environment into account.

Cost of ATFM departure delays

Time: The "tactical" delay cost of one additional minute is estimated at €91 per minute (€2009 prices) on average for a flight in Europe.

Fuel: Costs are negligible the delay is usually experienced at the gate with engines off.

Based on the latest update, the estimated average European ATFM delay cost have been adjusted from EUR 81 per minute (2010 value) to EUR 100 per minute (2014 value). The increase in estimated ATFM delay costs is mainly driven by an increase in passenger delay costs (rebooking, compensation and care, etc.) which is the single largest group of at-gate costs, followed by reactionary, crew and maintenance costs. ATFM delays are only marginally affected by changes in jet fuel price as they primarily occur at the gate. More detailed information can be found in the updated University of Westminster report, available for download on the PRC web-page (www.eurocontrol.int/prc).

Cost of "strategic" delays

Although not entirely predictable, a large share of the time inefficiencies experienced every day in the gate-to-gate phase (taxi-out, en-route, terminal holdings) is already embedded in the scheduled block times which limits the impact on punctuality and associated costs.

Fuel price is a major cost driver in the gate-to-gate phase. Following a continuous increase, jet fuel price decreased again notably between 2013 and 2015, reaching a level comparable to 2009 in 2015.

In order to monitor ANS performance over time without any bias from fuel price changes, the average jet fuel price in 2015 was consistently used for all years.

Hence, the "real" cost might have been higher or lower in the individual years, depending on how the 2015 price compares to the price in the respective year.

The latest figures used for the computation of "strategic" delay in the report are provided in the adjacent grey box.

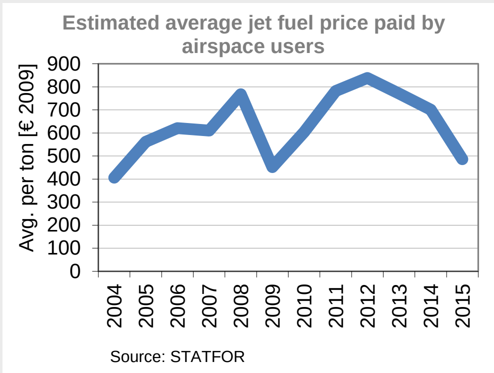
Cost of ANS-related inefficiencies in the gate to gate phase

The "strategic" delay costs in the gate-to-gate phase consist of a time and a fuel component.

Time: The "strategic" delay cost of one additional minute (without fuel) is estimated at €27 per minute (€2009 prices) on average for a flight in Europe (derived from University of Westminster Report).

Fuel: The fuel costs are based on the average annual spot price in 2015 expressed in (€2009 prices). The fuel price paid by airspace users was estimated to be 15% above the spot price and also includes a provision for fuel carriage penalties.

Based STATFOR statistics and the assumptions above, the average jet fuel price in 2015 was calculated at 486 € per tonne (€2009).



Further considerations

It is important to point out that there are inevitably margins of uncertainty in the approximation of delay costs. Although the consolidated view of ANS-related costs to airspace provides a good high-level estimate, it is acknowledged that there is scope for further refinements.

The information used for the analysis in Chapter 2 was derived from and should be read in conjunction with the analyses, assumptions and limitations detailed in Chapters 4 to 6 of this report.

ANNEX IV - AVIATION RISK MODEL

EUROCONTROL AND FAA COOPERATION

Appendix 8 to Annex 5 to NAT-I-3454 between the Federal Aviation Administration (FAA) and EUROCONTROL provides for the FAA and EUROCONTROL to cooperate in the development of a shared web-platform providing an integrated aviation risk model for safety performance evaluation. Attributes of the platform include:

- The classification of accident, incident and event data;
- The calculation of risk;
- The estimation of the impact of proposed changes to the aviation system in a consistent manner.

The shared approach has enabled to create a safety performance evaluation capability made up of:

- A partitioned European web space hosting the Integrated RiSk (IRiS) model;
- A partitioned US web space hosting the Integrated Safety Assessment Model (ISAM);
- A series of associated tools including:
  - The US Airport Surface Anomaly Investigation Capability (*ASAIC*)
  - The EUROCONTROL Flight Plan Hotspot Visualizer (*FHV*)
  - The EUROCONTROL enhanced Separation Performance Visualizer (*eSPV*).

The project has, as of today, established the foundations of a permanent safety monitoring capability and provided modelling capabilities, visualization and reporting/dashboarding aspects.

Considering IRiS, the web-based platform hosts and integrates:

- All current Accident Incident Models (AIM) Safety models (AC/TC/Oceanic MAC, CFIT, RWY EXC. and INC., TWY accidents, Wake related accidents)
- Operational Improvement Steps (OI steps)
- OI influence models
- Traffic & fleet forecast models
- Subject Matter Expert safety assessment features
- Dashboarding capability
- Automatic Report generation capability

IRiS handles the replication of EUROCONTROL models and the instantiation of specific tailored versions. This capability is currently being implemented:

- Throughout the SESAR programme to ensure that new capabilities (Operational Improvements (OIs)) either improve or maintain current safety levels while simultaneously improving capacity and efficiency in the ECAC airspace (this is equally used by the FAA for NextGen and the NAS airspace)
- By UK NATS with the challenging test case of London Terminal Control (TC) within the scope of the NATS SESAR Deployment Programme
- By skyguide, building on the experience of the 2014 test case for Zurich ARR/DEP, for structuring their integrated Safety Management System (iSMS) and providing the 'cornerstone' for the Zurich / Geneva Virtual Centre (VC) programme safety management
- By Riga International airport to provide tailored views of the overall safety case for airport safety nets deployment

The eventual objective is that the shared platform, when implemented in a data rich, high network speed environment, will show near-real-time automated quantification, and can provide an emergent risk monitoring capability for European Air Navigation Service Providers (ANSPs) and FAA facilities. This requires a continuous data acquisition, storage, automatic cleaning and pre-processing of the data and finally feeding into the risk models.

This will enable IRiS to tackle the following questions:

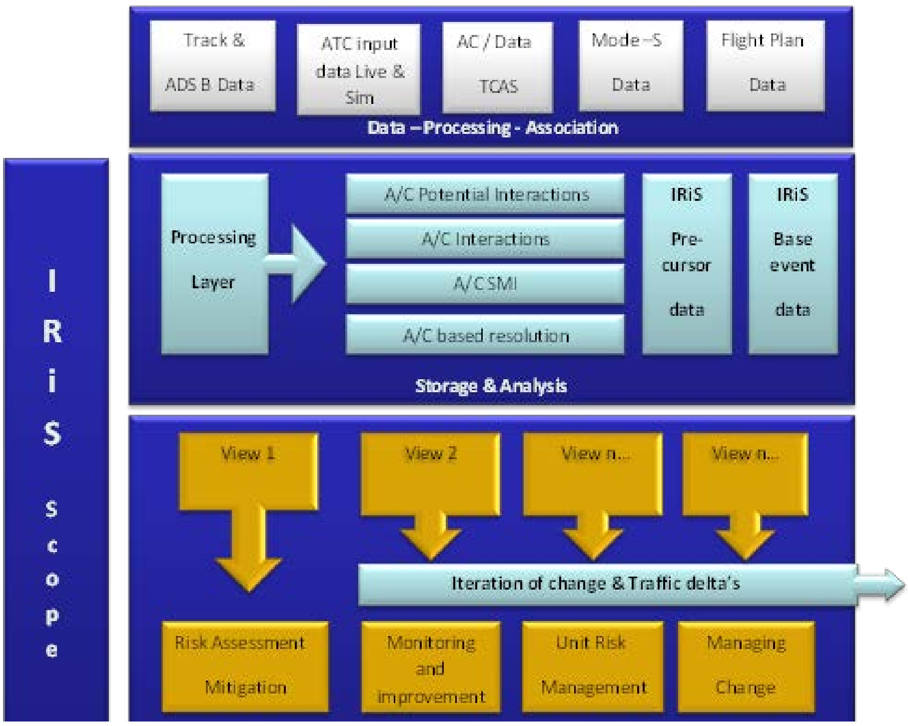
- Can we detect unsafe trends and implement changes that remove these threats before a serious event or worse happens?
- Can we identify which precursors were the likely causes of safety related events?
- Can we avoid that disproportionate focus is given to low priority safety issues, or that a reaction leads to unanticipated side effects?
- Can we identify the most practical way to deal with the safety issue and confirm in retrospect that the problem has gone away?
- Can we identify those to be reached to ensure an appropriate System-wide reaction if the problem is generic, or localised reaction if it is a localised issue?
- Can we evaluate how safety related changes would challenge the safety improvements of the SES, and how other changes will impact that safety record?

2016 OBJECTIVES

In 2016, building upon the capability established in 2015, an environment can proceed that has three main components:

1. A powerful data warehousing solution that can:
   a. Aggregate data from multiple sources into a unified database so a single query engine can be used to mine and present data
   b. Integrate data from multiple source systems
   c. Provide a single common data model
2. A data analytics layer eventually, handling automatically near-real-time data and providing consistent outputs
3. A unique safety risk management framework with IRiS that provides the structure for the pre-processed data (as per 2. above) so that it makes sense to the aviation business users and add values to decision makers (notably support dissemination of safety lessons and decision making, e.g., with respect to further changes to the Aviation System)

This environment is described in the figure below.



ANNEX V - RECONCILIATION WITH PRB 2014 MONITORING REPORT (16/11/2015)

Actual 2014 data - RP1 SES States - reconciliation with PRB annual Monitoring Report

The actual 2014 data used in this PRR 2015 report are based on States' November 2015 submissions to the enlarged Committee for Route Charges. The table below shows how this information reconciles with what was reported in the context of the PRB 2014 Monitoring Report (Figure 25, p. 40):

	En route total costs (RP1) in €2009	En route total Service Units	En-route unit cost (RP1) in €2009
	2014A	2014A	2014A
PRB Annual Monitoring Report 2014	5 947 263 158	109 836 771	54.15
PRR 2015	5 945 420 950	109 834 193	54.13
Differences in value	**-1 842 209**	**-2 578**	**-0.02**
Differences in percentage	**-0.03%**	**-0.002%**	**-0.03%**

The actual 2014 en-route costs for the RP1 SES States are marginally lower by -1.8 M€2009 in this PRR 2015 report (November 2015 data) compared to the figure published in the PRB 2014 Monitoring Report (based on June 2015 data submissions, except for Italy provided on 5 October 2015), as Malta revised its 2014 actual en-route costs downwards (by -2.5 M€2009) and Cyprus and France revised their 2014 actual en-route costs upwards (by +0.2 M€2009 and + 0.4 M€2009, respectively).

The difference in actual 2014 en-route total service units is due to a slight downwards revision by Finland.

ANNEX VI - GLOSSARY

ACC	Area Control Centre. That part of ATC that is concerned with en-route traffic coming from or going to adjacent centres or APP. It is a unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction.
Accident **(ICAO Annex 13)**	An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which: a) a person is fatally or seriously injured as a result of: • Being in the aircraft, or • Direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or • Direct exposure to jet blast, except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or b) the aircraft sustains damage or structural failure which: • Adversely affects the structural strength, performance or flight characteristics of the aircraft, and • Would normally require major repair or replacement of the affected component, except for engine failure or damage, when the damage is limited to the engine, its cowlings or accessories, or for damage limited to propellers, wing tips, antennas, tyres, brakes, fairings, small dents or puncture holes in the aircraft skin; c) the aircraft is missing or completely inaccessible.
A-CDM	Airport Collaborative Decision-Making
ACE Reports	Air Traffic Management Cost-Effectiveness (ACE) Benchmarking Reports
ACI	Airports Council International (http://www.aci-europe.org/)
AEA	Association of European Airlines (http://www.aea.be)
Aena	see ENAIRE
Agency	The EUROCONTROL Agency
AIP	Aeronautical Information Publication
Airspace Infringement	(also known as unauthorised penetration of airspace). The penetration by an aircraft into a portion of airspace without prior permission of the appropriate authorities (when such prior permission is required). EUROCONTROL HEIDI – ESARR 2 taxonomy
AIS	Aeronautical Information Service
ALAQS	EUROCONTROL Airport Local Air Quality Studies
Albcontrol	National Air Traffic Agency, Albania
ALoS	Acceptable Level of Safety
ALoSP	Acceptable Level of Safety Performance
AMAN	Arrival Management Function
AMC	Airspace Management Cell
ANS	Air Navigation Service. A generic term describing the totality of services provided in order to ensure the safety, regularity and efficiency of air navigation and the appropriate functioning of the air navigation system.
ANS CR	Air Navigation Services of the Czech Republic
ANSP	Air Navigation Services Provider
APU	Auxiliary Power Units (aircraft)
ARMATS	Armenian Air Traffic Services
ASBU	ICAO Aviation System Block Upgrade
ASM	Airspace Management
ASMA	Arrival Sequencing and Metering Area
ASMT	EUROCONTROL Automatic Safety Monitoring Tool
AST	Annual Summary Template

ATC	Air Traffic Control. A service operated by the appropriate authority to promote the safe, orderly and expeditious flow of air traffic.
ATCO	Air Traffic Control Officer
ATFCM	Air Traffic Flow and Capacity Management.
ATFM	Air Traffic Flow Management. ATFM is established to support ATC in ensuring an optimum flow of traffic to, from, through or within defined areas during times when demand exceeds, or is expected to exceed, the available capacity of the ATC system, including relevant aerodromes.
ATFM delay	The duration between the last Take-Off time requested by the aircraft operator and the Take-Off slot given by the EUROCONTROL Network Management Directorate. (NMD definition)
ATFM Regulation	When traffic demand is anticipated to exceed the declared capacity in en-route control centres or at the departure/arrival airport, ATC units may call for “ATFM regulations”.
ATM	Air Traffic Management. A system consisting of a ground part and an air part, both of which are needed to ensure the safe and efficient movement of aircraft during all phases of operation. The airborne part of ATM consists of the functional capability which interacts with the ground part to attain the general objectives of ATM. The ground part of ATM comprises the functions of Air Traffic Services (ATS), Airspace Management (ASM) and Air Traffic Flow Management (ATFM). Air traffic services are the primary components of ATM.
ATMAP	ATM Performance at Airports
ATS	Air Traffic Service. A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service.
AUP	Airspace Use Plan
Austro Control	Austro Control: Österreichische Gesellschaft für Zivilluftfahrt mbH
AVINOR	Avinor Flysikring, Norway
Belgocontrol	Belgocontrol, Belgium
BHANSA	ANS Provider - Bosnia & Herzegovina
BULATSA	Air Traffic Services Authority of Bulgaria. ANS Provider - Bulgaria.
CAA	Civil Aviation Authority
CAEP	ICAO Committee on Aviation Environmental Protection
CANSO	Civil Air Navigation Services Organisation (http://www.canso.org)
CAST	ICAO Commercial Aviation Safety Team
CAT	Commercial Air Transport
CCO	Continuous Climb Operation
CDA	Continuous Descent Approach
CDM	Collaborative Decision Making
CDO	Continuous Descent Operation
CDR	Conditional Routes
CEF	Capacity Enhancement Function
CFMU (See NMD)	Formerly the EUROCONTROL Central Flow Management Unit. Now the EUROCONTROL Network Management Directorate (NMD)
CICTT	ICAO Common Taxonomy Team
CLR	Deviation from ATC clearance
CNS	Communications, Navigation, Surveillance
CO_2	Carbon dioxide
CODA	EUROCONTROL Central Office for Delay Analysis
Composite flight hour	En-route flight hours plus IFR airport movements weighted by a factor that reflected the relative importance of terminal and en-route costs in the cost base (see ACE reports)
CRCO	EUROCONTROL Central Route Charges Office
Croatia Control	Hrvatska kontrola zračne plovidbe d.o.o. –Croatian Air Navigation Services
CTOT	Calculated Take-Off Time
DCAC Cyprus	Department of Civil Aviation of Cyprus.
DCT	Direct Route
DFS	DFS Deutsche Flugsicherung GmbH, Germany
DGCA	Directors General of Civil Aviation
DHMi	Devlet Hava Meydanlari Isletmesi Genel Müdürlügü (DHMi), Turkey

	General Directorate of State Airports Authority, Turkey.
DMAN	Departure Manager
DSNA	Direction des Services de la Navigation Aérienne, France
DUR	Determined Unit Rate
EAD	European AIS Database
EANS	Estonian Air Navigation Services,Estonia
EASA	European Aviation Safety Agency
EASP	European Aviation Safety Programme
EAUP	European Airspace Use Plan
EC	European Commission
ECAC	European Civil Aviation Conference
ECCAIRS	European Co-ordination Centre for Accident and Incident Reporting Systems
ECR	European Central Repository
ECTL	Acronym for EUROCONTROL
EEA	European Economic Area
Effective capacity	The traffic level that can be handled with optimum delay (cf. PRR 5 (2001) Annex 6)
EFTMS	EUROCONTROL Enhanced Tactical Flow Management System
ENAIRE	Formerly AENA – Air Navigation Service Provider of Spain
ENAV	Ente Nazionale di Assistenza al volo S.p.A., Italy
EoSM	Effectiveness of Safety Management
EPAS	European Plan for Aviation Safety
ERATO	En-Route Air Traffic Organizer
ERNIP	European Route Network Improvement Plan
ESRA 2008 Area	European Statistical Reference Area (see STATFOR Reports) Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Canary Islands, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, FYROM, Germany, Greece, Hungary, Ireland, Italy, Lisbon FIR, Luxembourg, Malta, Moldova, Montenegro, Netherlands, Norway, Poland, Romania, Santa Maria FIR, Serbia, Slovak Republic , Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom
ESSIP	European Single Sky ImPlementation plan
EU-ETS	Emissions Trading Scheme. The objective of the EU ETS is to reduce greenhouse gas emissions in a cost-effective way and contribute to meeting the EU's Kyoto Protocol targets.
EU States **(28 States in 2015)**	Member States of the European Union: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom of Great Britain and Northern Ireland
EUROCONTROL	The European Organisation for the Safety of Air Navigation. It comprises Member States and the Agency.
EUROCONTROL Member States **(41 States in 2015)**	Albania, Armenia, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, The former Yugoslav Republic of Macedonia, Turkey, Ukraine and United Kingdom of Great Britain and Northern Ireland
EUROCONTROL Route Charges System	A regional cost-recovery system that funds air navigation facilities and services and supports Air Traffic Management developments. It is operated by the EUROCONTROL Central Route Charges Office (CRCO), based in Brussels. www.eurocontrol.int/crco
EUROSTAT	The Statistical Office of the European Community
EUUP	Updates to the European Airspace Use Plan (EAUP)
FAB	Functional Airspace Blocks
FABEC States	Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland
Finavia	Finavia, Finland
FIR	Flight Information Region. An airspace of defined dimensions within which flight information service and alerting service are provided.
FL	Flight Level. Altitude above sea level in 100 feet units measured according to a standard

	atmosphere.
FMP	Flow Management Position
FRA	Free Route Airspace
FUA	Flexible Use of Airspace
FYROM	Former Yugoslav Republic of Macedonia
GA	General Aviation. All civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire.
GANP	Global Air Navigation Capacity & Efficiency Plan (ICAO)
GAT	General Air Traffic. Encompasses all flights conducted in accordance with the rules and procedures of ICAO. PRR 2014 uses the same classification of GAT IFR traffic as STATFOR:
GCD	Great Circle Distance
GDP	Gross Domestic Product
GHG	Greenhouse Gas emissions
HCAA	Hellenic Civil Aviation Authority, Greece
HungaroControl	–HungaroControl, Hungary
IAA	Irish Aviation Authority, Ireland
IATA	International Air Transport Association (www.iata.org)
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules. Properly equipped aircraft are allowed to fly under bad-weather conditions following instrument flight rules.
IMC	Instrument Meteorological Conditions
Incident	An occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation. (ICAO Annex 13)
Incident Category A	A serious incident**:** AIRPROX - Risk Of Collision: "The risk classification of an aircraft proximity in which serious risk of collision has existed". (ICAO Doc 4444)
Incident Category B	A major incident. AIRPROX - Safety Not Assured: "The risk classification of an aircraft proximity in which the safety of the aircraft may have been compromised". (ICAO Doc 4444)
IRis	Integrated RiSk Model
IS	Inadequate separation
JC **Just culture**	The EUROCONTROL definition of "just culture", also adopted by other European aviation stakeholders, is a culture in which "*front line operators or others are not punished for actions, omissions or decisions taken by them that are commensurate with their experience and training, but where gross negligence, wilful violations and destructive acts are not tolerated.*"
JRC Ispra	Joint Research Centre of the European Commission
KPA	Key Performance Area
KPI	Key Performance Indicator
LAQ	Local Air Quality
LFV	Luftfartsverket. ANS Provider - Sweden.
LGS	Latvijas Gaisa Satiksme (LGS, Latvia
LPS	Letové Prevádzkové Služby Slovenskej republiky štátny podnik Slovak Republic
LSSIP	Local Single Sky ImPlementation plans/reports (formerly Local Convergence and Implementation Plans)
LTO	Landing and Take-off Cycle
LVNL	Luchtverkeersleiding Nederland, The Netherlands
Maastricht UAC	The EUROCONTROL Upper Area Centre (UAC) Maastricht. It provides ATS in the upper airspace of Belgium, Luxembourg, Netherlands and Northern Germany.
MAC	Mid-air collision
MATS	Malta Air Traffic Services Ltd, Malta
MBM	Market Based Measure
MET	Meteorological Services for Air Navigation
METAR	Meteorological Terminal Aviation Routine Weather Report or Meteorological Aerodrome Report
MIL	Military flights
M-NAV	Air Navigation Services Provider of the former Yugoslav Republic of Macedonia
MoldATSA	Moldavian Air Traffic Services Authority, Moldova

MORS	Mandatory Occurrence Reporting Systems
MTOW	Maximum Take-off Weight
MUAC	Maastricht Upper Area Centre
NATA Albania	National Air Traffic Agency. ANS Provider - Albania
NATS	National Air Traffic Services, United Kingdom
NAV Portugal	Navegação Aérea de Portugal – NAV Portugal, E.P.E.
NAVIAIR	Air Navigation Services – Flyvesikringstjenesten, Denmark
Near MAC	Near Mid-Air Collision
NERL	NATS (En Route) Limited
NM	Nautical mile (1.852 km)
NM	Network Manager
NMD	EUROCONTROL Network Management Directorate (formerly the EUROCONTROL Central Flow Management Unit - CFMU).
NO_2	Nitrogen dioxide
NOA	Network of Aviation Safety Analysts
NOP	Network Operations Plan
NOTAM	Notices to Airmen
NSA	National Supervisory Authority
OAT	Operational Air Traffic
Occurrence (Source: ESARR 2)	Accidents, serious incidents and incidents as well as other defects or malfunctioning of an aircraft, its equipment and any element of the Air Navigation System which is used or intended to be used for the purpose or in connection with the operation of an aircraft or with the provision of an air traffic management service or navigational aid to an aircraft.
OPS	Operations
Organisation	See “EUROCONTROL”.
Oro Navigacija	State Enterprise Oro Navigacija, Lithuania
PANSA	Polish Air Navigation Services Agency, Poland
PBE	Performance Based Environment
PC	Provisional Council of EUROCONTROL
Permanent Commission	The governing body of EUROCONTROL. It is responsible for formulating the Organisation’s general policy.
PI	Performance Indicator
PRB	Performance Review Body of the Single European Sky
PRC	Performance Review Commission
Primary Delay	A delay other than reactionary
Productivity	Hourly productivity is measured as Flight-hours per ATCO-hour (see ACE reports)
Punctuality	The share of flights arriving/departing within 15 minutes after the scheduled arrival/departure time (airline schedules)
PRR	Performance Review Report
PRU	Performance Review Unit
R&D	Research & Development
RAD	Route availability document
RAT	Risk Analysis Tool for Safety
Reactionary delay	Delay caused by late arrival of aircraft, crew, passengers or baggage from previous journeys
Revised Convention	Revised EUROCONTROL International Convention relating to co-operation for the Safety of Air Navigation of 13 December 1960, as amended, which was opened for signature on 27 June 1997.
RI	**Runway incursion**: Any unauthorised presence on a runway of aircraft, vehicle, person or object where an avoiding action was required to prevent a collision with an aircraft. Source: ESARR 2.
ROMATSA	Romanian Air Traffic Services Administration, Romania
RP1	First Reference Period (2012-2014) of the SES Performance Scheme
RP2	Second Reference Period (2015-2019) of the SES Performance Scheme
RVSM	Reduced Vertical Separation Minima
Serious incident	An incident involving circumstances indicating that an accident nearly occurred. (ICAO Annex 13)

SES	Single European Sky (EU)
SES States	The 28 Member States of the European Union (see "EU States" above) plus Norway and Switzerland
SESAR	The Single European Sky ATM Research programme
Severity	The severity of an accident is expressed according to: • the level of damage to the aircraft (ICAO Annex 13 identifies four levels: destroyed: substantially destroyed, slightly damaged and no damage); • the type and number of injuries (ICAO Annex 13 identifies three levels of injuries: fatal, serious and minor/none). PRRs focus on Severity A (Serious Incident) and Severity B (Major Incident).
SIA	Safety Investigation Authority
SID	Standard Instrument Departure
Skyguide	ANS Provider - Switzerland
Slot (ATFM)	A take-off time window assigned to an IFR flight for ATFM purposes
Slovenia Control	Slovenia Control ,Slovenia
SM	Separation Minima is the minimum required distance between aircraft. Vertically usually 1000 feet below flight level 290, 2000 feet above flight level 290. Horizontally, depending on the radar, 3 NM or more.
SMATSA	Serbia and Montenegro Air Traffic Services Agency
SMI	Separation minima infringement
SM ICG	Safety Management International Collaboration Group
SMS	Safety Management System
SRC	Safety Regulation Commission
SSC	Single Sky Committee
SSP	State Safety Programme
STAPES	System of Airport Noise Exposure Studies
STATFOR	EUROCONTROL Statistics & Forecasts Service
SU	Service Units
SUA	Special Use Airspace
TBS	Time Based Separation
TCZ	Terminal Charging Zone
TMA	Terminal manoeuvring area
TNSU	Terminal Navigation Service Units
TOBT	Target Off-Block Time
TRA	Temporary Reserved Area
TSA	Temporary Segregated Area
TSAT	Target Start-up Approval Time
UAC	Upper Airspace Area Control Centre
UK CAA	United Kingdom Civil Aviation Authority
UK NATS	United Kingdom National Air Traffic Services
UkSATSE	Ukrainian State Air Traffic Service Enterprise
UPA	Unauthorised penetration of airspace (also known as Airspace Infringement). The penetration by an aircraft into a portion of airspace without prior permission of the appropriate authorities (when such prior permission is required). EUROCONTROL HEIDI – ESARR 2 taxonomy
USOAP	ICAO Universal Safety Oversight Audit Programme
VFR	Visual Flight Rules
XMAN	Cross border arrival management

ANNEX VII - REFERENCES

PRC documentation can be consulted and downloaded from the PRC website

http://www.EUROCONTROL.int/prc

1 Article 1 of the PRC's Terms of Reference, adopted in 2003.

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About the Performance Review Commission

The Performance Review Commission (PRC) provides independent advice on European Air Traffic Management (ATM) Performance to the EUROCONTROL Commission through the Provisional Council.

The PRC was established in 1998, following the adoption of the European Civil Aviation Conference (ECAC) Institutional Strategy the previous year. A key feature of this Strategy is that "*an independent Performance Review System covering all aspects of ATM in the ECAC area will be established to put greater emphasis on performance and improved cost-effectiveness, in response to objectives set at a political level*".

Through its reports, the PRC seeks to assist stakeholders in understanding from a global perspective why, where, when, and possibly how, ATM performance should be improved, in knowing which areas deserve special attention, and in learning from past successes and mistakes. The spirit of these reports is neither to praise nor to criticise, but to help everyone involved in effectively improving performance in the future.

The PRC holds 5 plenary meetings a year, in addition to taskforce and ad hoc meetings. The PRC also consults with stakeholders on specific subjects.

Mr. Laurent Barthelemy
Mr. Marc Baumgartner
Mr. René Brun
Mr. Juan Bujia-Lorenzo
Captain Hasan Erdurak
Ms. Marja Hutchings
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Mr. Antero Lahtinen **Vice Chairman**
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PRC Members must have senior professional experience of air traffic management (planning, technical, operational or economic aspects) and/or safety or economic regulation in one or more of the following areas: government regulatory bodies, air navigation services, airports, aircraft operations, military, research and development.

Once appointed, PRC Members must act completely independently of States, national and international organisations.

The Performance Review Unit (PRU) supports the PRC and operates administratively under, but independently of, the EUROCONTROL Agency. The PRU's e-mail address is PRU@eurocontrol.int.

The PRC can be contacted via the PRU or through its website www.eurocontrol.int/prc.

PRC PROCESSES

The PRC reviews ATM performance issues on its own initiative, at the request of the deliberating bodies of EUROCONTROL or of third parties. As already stated, it produces annual Performance Review Reports, ACE reports and ad hoc reports.

The PRC gathers relevant information, consults concerned parties, draws conclusions, and submits its reports and recommendations for decision to the Permanent Commission, through the Provisional Council. PRC publications can be found at www.eurocontrol.int/prc where copies can also be ordered.

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