PRR 2017

Performance Review Report

An Assessment of Air Traffic Management in Europe during the Calendar Year 2017

Performance Review Commission

May 2018

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…"

All PRC publications are available from the website: http://www.eurocontrol.int/prc/publications

Notice

The PRC has made every effort to ensure that the information and analysis contained in this document are as accurate and complete as possible. Only information from quoted sources has been used and information relating to named parties has been checked with the parties concerned. Despite these precautions, should you find any errors or inconsistencies we would be grateful if you could please bring them to the PRU's attention.

The PRU's e-mail address is pru-support@eurocontrol.int

Copyright notice and Disclaimer

Printed by EUROCONTROL, 96, rue de la Fusée, B-1130 Brussels, Belgium. The PRC's website address is http://www.eurocontrol.int/prc/publications. The PRU's e-mail address is pru-support@eurocontrol.int.

FOREWORD by the PRC Chairman

With the institutional landscape changing over the past years, the PRC's role has evolved in step, to ensure, inter alia, that its tasks complement those of the Performance Review Body of the Single European Sky (SES) and avoid overlaps. The PRC has also reduced its size to seven members.

The PRC's balance of independent expertise will continue to be needed in view of the multifaceted challenges our industry will face over the coming years. I am pleased therefore to welcome Dr Darren Rhodes (ENV), Dr Jan Malawko (Airports) and Marc Baumgartner (OPS) who have joined the PRC since the beginning of 2018.

The introduction of binding economic and capacity performance targets by the SES Performance Scheme in 2012 contributed to a steady improvement in cost-efficiency, while on the capacity side the Air Navigation Service (ANS) system benefited from lower traffic levels caused by the economic crisis which began in 2008.

While the continuous improvement in cost-efficiency is to be welcomed, taking the economic view, i.e. combining provision and delay costs, the PRC notes with concern however that a significant proportion of these cost-efficiency savings are being absorbed by the sustained increase in ATFM delay costs. The PRC recalls that it had expressed concerns in previous performance review reports that delays would also increase unless sufficient attention was focussed on capacity management.

In this current PRR, the PRC provides an analysis of the most constraining regulations in 2017 and reiterates its message that, in view of the often considerable lead times needed to add capacity, over-conservative capacity planning not only has an impact locally in terms of costly delays to airspace users, it also introduces operational uncertainty for the entire network. The Air Navigation Service Provider's challenge is to accommodate demand in a safe and an even more cost-efficient manner. In some cases this may require a higher level of flexibility in capacity planning and deployment

New technologies such as virtual centres, remote towers, flight-centric operations and sector-less ANS, as well as a rapidly growing drone market will further add to this challenge but will also give new opportunities to improve ANS performance in Europe.

As PRC Chairman, I assure you that the PRC will continue to play its part in fostering improvements in overall ANS performance for the benefit of all aviation stakeholders. It will continue to conduct performance review for all of the EUROCONTROL Member States and will carry out research and development into the longer-term evolution of ANS performance review, including benchmarking with regions outside Europe.

Should you wish to contact the PRC, you can find contact details on the inside-back cover of this report.

Pleasant reading!

Ralph Riedle

Ralph Riedle

Chairman

Performance Review Commission

DOCUMENT IDENTIFICATION SHEET

DOCUMENT DESCRIPTION		
Document Title Performance Review Commission Performance Review Report covering the calendar year 2017 (PRR 2017)		
PROGRAMME REFERENCE INDEX:	**EDITION:**	**EDITION DATE:**
PRC Performance Review Report	Final report	16-May-2018

This report of the Performance Review Commission analyses the performance of the European Air Traffic Management System in 2017 under the Key Performance Areas of Safety, Capacity, Environment and Cost-efficiency.

Keywords		
Air Traffic Management	Performance Measurement	
Performance Indicators	ATM	ANS

CONTACT: **Performance Review Unit, EUROCONTROL, 96 Rue de la Fusée,**
B-1130 Brussels, Belgium. Tel: +32 2 729 3956,
E-Mail: pru-support@eurocontrol.int
Web: http://www.eurocontrol.int/ansperformance

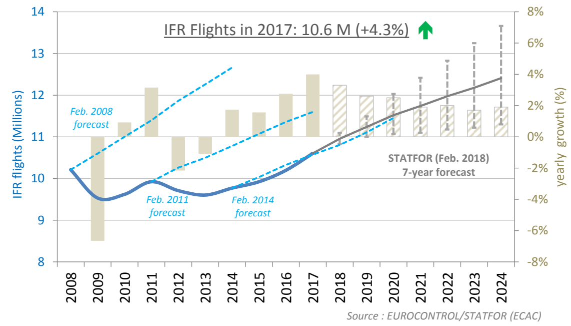
DOCUMENT STATUS AND TYPE			
STATUS		**DISTRIBUTION**	
Draft	☐	General Public	☑
Proposed Issue	☐	EUROCONTROL Organisation	☐
Released Issue	☑	Restricted	☐

INTERNAL REFERENCE NAME:	PRR 2017

ATM Performance in 2017 - Synopsis

Key Performance Indicator | **Data & commentary**

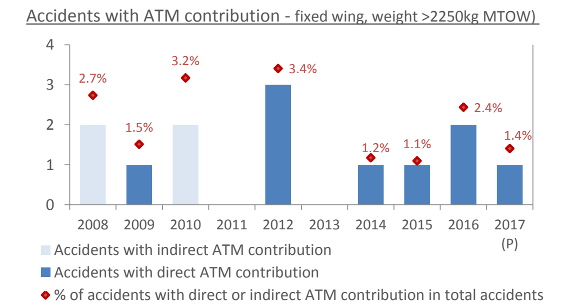
TRAFFIC



IFR flights	Eurocontrol area	Variation
2017	10.6 M	+ 4.3% ↑

In 2017, IFR flights increased on average by +4.3% in the ECAC area which corresponds to the STATFOR high forecast scenario.
For 2018, the Feb. 2018 STATFOR 7-year forecast expects flights to grow by 3.3% (baseline scenario).

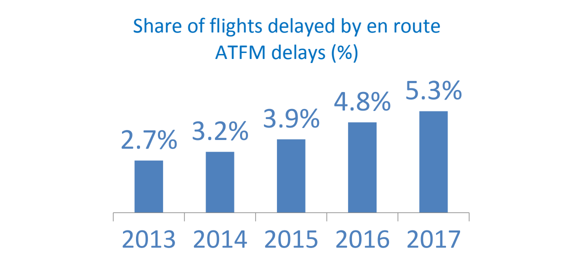
SAFETY



Accidents with direct ANS contribution	Eurocontrol area	Variation
2017 (preliminary)	1	-1

There was one reported accident with direct ATM contribution and none with indirect ATM contribution in 2017 (P).
The share of accidents with ATM contribution (direct or indirect) in total air traffic accidents decreased from 2.4% to 1.4% in 2017.

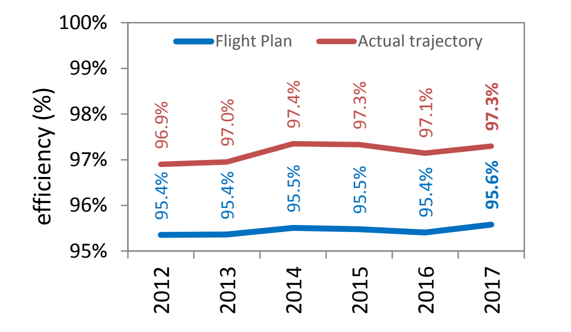
CAPACITY



En-route ATFM delayed flights	Eurocontrol area	Variation
2017	5.3 %	+0.6 %pt. ↑

In 2017, 5.3% of all flights in the EUROCONTROL area were delayed by en-route ATFM delays (+0.6% pt. vs. 2016). The most constraining ACCs in 2017 were Karlsruhe UAC, Nicosia, Marseille, Brest, Maastricht UAC, Barcelona and Bordeaux.

ENVIRONMENT

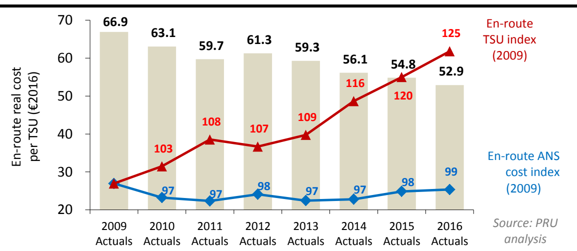


En-route flight efficiency (actual)	Eurocontrol area	Variation
2017	97.3%	+0.2%pt. ↑

Despite the further notable increase in traffic in 2017, horizontal flight efficiency in filed flight plans increased from 95.4% in 2016 to 95.6% in 2017 at Pan-European level.

At the same time, the efficiency of actual trajectories increased from 97.1% to 97.3% in 2017

COST-EFFICIENCY



En-route ANS costs per TSU ($€_{2016}$)	Eurocontrol area	Variation
2016	52.9	-3.5% ↓

In 2016, en-route ANS costs increased by +0.4% while en-route service units increased by +4.1% leading to a further decrease in en-route unit costs by -3.5% compared to 2015.

EXECUTIVE SUMMARY

This report assesses the performance of Air Navigation Services (ANS) in the EUROCONTROL area for the calendar year 2017 for all key performance areas, except for cost-efficiency, which analyses performance in 2016 as this is the latest year for which actual financial data are available.

TRAFFIC

In 2017, air traffic in the EUROCONTROL area continued to increase for the fourth year taking the number of flights past the previously highest level in 2008. On average, the number of controlled flights in 2017 increased by 4.3% compared to 2016, which corresponds to the high forecast scenario predicted by STATFOR in the February 2017 forecast. As in previous years, controlled flight hours, en-route service units and passenger numbers grew at a higher rate than flights.

As a consequence, peak traffic load continued to rise in 2017 and reached the highest level of traffic on record on June 30th when 35,251 flights were served in the EUROCONTROL area. The peak day was 23.8% higher than an average day.

Of the 41 Air Navigation Service Providers (ANSPs) included in the analysis, all but Avinor (Norway) showed an increase in traffic compared to 2016. In absolute terms, DSNA (France), ENAIRE (Spain), DFS (Germany) and NATS (UK) showed the highest year-on-year growth in 2017.

For 2018, the latest STATFOR forecast (Feb. 2018) predicts a growth of 3.1% at system level and an average annual growth rate of 2.3% between 2016 and 2024.

The continued notable traffic growth contributed to a further decrease in overall service quality. The share of flights arriving within 15 minutes of their scheduled time decreased by 0.9 percent points to 79.6% in 2017. At the same time, the average departure delay increased by 1 minute from 11.2 minutes per departure in 2016 to 12.2 minutes in 2017.

SAFETY

Safety is the primary objective of ANS and overall safety levels in the EUROCONTROL area remain high. There were two reported air traffic accidents with direct ANS contribution in 2016 which is the latest year for which validated data are available, and only one in 2017 based on preliminary data.

In absolute terms, the number of three key risk occurrence types: separation minima infringements (SMI), runway incursions (RI), and ATM Specific Occurrences decreased in 2017, while the number of unauthorised penetrations of airspace (UPA) increased. However, in relative terms the rate of occurrences in the EUROCONTROL area stayed almost the same as in 2016: there were 13.8 SMIs and 29.2 UPAs per hundred thousand controlled flight hours in the airspace and less than one (0.8) RIs per ten thousand movements at airports reported in 2017.

The PRC review of the implementation status of the Acceptable Level of Safety Performance (ALoSP) concept in EUROCONTROL Member States suggested that there is a need for common definitions and guidance material in order to ensure a harmonised approach in the EUROCONTROL area.

In 2017 the PRC met EASA representatives in order to present and discuss the findings of the PRC's ALoSP survey and associated potential future actions. The meeting identified potential actions and measures to be taken. EASA and the PRC agreed to further explore working concepts and how to implement further steps.

OPERATIONS (EN-ROUTE)

Following the trend over the past three years, total en-route ATFM delays in 2017 continued to increase at a higher rate (+7.1% vs. 2016) than flights (+4.3% vs. 2016). At the same time, the share of flights delayed by en-route ATFM regulations in the EUROCONTROL area increased from 4.8% to 5.3%.

ATC Capacity/Staffing attributed issues remained by far the main portion of en-route ATFM delays (59.9%), followed by Weather attributed delays (23.2%) and ATC disruptions/ industrial actions (9.9%). The trend analysis shows a continuous increase in ATC Capacity/Staffing and Weather-attributed delays over the past four years which gives reason for concern. It confirms the PRC concerns, raised on several occasions, that ATFM delays could increase notably when traffic grows again if insufficient focus is put on capacity planning and deployment.

The analysis showed that the constraints were mainly concentrated in the European core area where traffic density is highest. In 2017, 82% of all en-route ATFM delay in the EUROCONTROL area was generated by only five air navigation service providers: DSNA (33.4%), DFS (23.1%), Maastricht (13.3%), ENAIRE (7.9%), and DCAC Cyprus (4.3%).

The most constraining ACCs in 2017 were Karlsruhe UAC (18.6%), Maastricht UAC (13.3%), Marseille (12.8%), Brest (10.1%), Bordeaux (5.0%), Nicosia (4.3%) and Barcelona (4.2%), which together accounted for almost 70% of all en-route ATFM delay in the EUROCONTROL area.

The most penalising ATFM en-route regulations were analysed further in terms of delay attributed to elementary sectors and delays attributed to collapsed sectors which - by being collapsed - were already limiting the available capacity for airspace users. Irrespective of the delay causes (Capacity/Staffing or Weather), the results showed a surprisingly high share of ATFM delay (in some cases above 90%) originating from collapsed sectors.

Despite the further notable increase in traffic in 2017, horizontal flight efficiency in filed flight plans increased from 95.4% in 2016 to 95.6% in 2017 at EUROCONTROL level. At the same time, the efficiency of actual trajectories increased from 97.1% to 97.3% in 2017.

PRR 2016 underlined the benefits of the implementation of Free Route Airspace (FRA) which offers a more flexible environment and more choices to airspace users whilst contributing to reduced fuel consumption and emissions and higher flight efficiency. FRA is now in place in a large part of EUROCONTROL airspace. It is not yet implemented in the dense European core area where even small improvements are expected to bring notable benefits. In addition to the implementation of FRA in a given airspace, ANSPs should also work actively with the Network Manager and the Deployment Manager to deliver FRA across the entire EUROCONTROL area, including necessary cross-border implementation.

Complementary to horizontal flight efficiency, the analysis of vertical en-route flight efficiency showed that the highest level of vertical inefficiencies originated from flights on high-density airport pairs in the European core area which were unable to enter the two Upper Area Control Centres Maastricht and Karlsruhe.

The Flexible Use of Airspace concept and closer Civil/Military cooperation and coordination are an important enabler to improve capacity and flight efficiency performance. Future technologies such as "Unmanned Aircraft System" (UAS) are also expected to have an impact on airspace management and would therefore also benefit from the further improvement of identified shortcomings in the application of the FUA concept highlighted in the PRC survey conducted in 2016.

OPERATIONS (@ AIRPORTS)

The analysis of the top 30 European airports in terms of traffic showed an average increase in traffic of 2.2% in 2017. Amsterdam (AMS) remained the airport with the most commercial movements in Europe with a reported 4.5% increase in traffic over 2016. Of the top 30 airports, Lisbon (LIS) and Warsaw (WAW) reported the highest growth (> 11% vs. 2016) while Berlin Tegel (-6.3%) and Rome Fiumicino (-5%) showed the most significant reduction in traffic.

The analysis of the hourly arrival throughputs showed the high saturation level at London Heathrow again but also that Istanbul Atatürk and Istanbul Sabiha Gökçen consistently operate close to the peak declared arrival capacity during most of the day.

Notwithstanding the further increase in traffic, average airport ATFM delays at the top 30 European airports decreased from 1.36 to 1.25 minutes per arrival. The increase in weather-attributed airport arrival ATFM delays in 2017 offset to some extent the decrease in capacity-attributed airport ATFM delays. Overall, 52.2% of all airport arrival ATFM delay in 2017 was weather-attributed, followed by capacity/staffing attributed issues with 40%.

Despite a substantial improvement, the two Istanbul airports still accounted for 32% of all capacity attributed airport arrival ATFM delays in 2017, following the high delays over the previous years. The new Istanbul airport which is presently being built will gradually replace Istanbul Atatürk airport and is expected to ease the capacity situation in Istanbul once it is operational. Although not among the top 30 airports, it is noteworthy that some regional Greek airports still have a significant impact on the network. Seven regional Greek airports accounted for more than 12% of the total airport arrival delays between June and August 2017.

Additional holding (ASMA) time increased slightly in 2017 to 2.19 minutes per arrival at the top 30 airports and remained above 8 minutes per arrival at London Heathrow airport which accounted for one quarter of the total ASMA additional time at the top 30 airports in 2017.

Additional taxi-out time, on the other hand, showed a modest reduction driven mainly by the improvements at Lisbon (LIS), Paris Charles de Gaulle (CDG), Rome (FCO), Madrid (MAD) and Copenhagen (CPH).

Building on the methodology for vertical flight efficiency in climbs and descents, this year's report introduces an analysis measuring the share of flights applying Continuous Descent Operations (CDOs) from higher than 7,000 feet above which the fuel saving effect is considered to be more relevant than the noise effect. At 11 of the top 30 airports, less than 50% of the arrivals applied a CDO from higher than 7,000 feet which suggests scope for further improvement.

ECONOMICS

In 2016, the latest year for which actual financial data are available, the en-route ANS unit costs of the Pan-European system amounted to 52.9 $€_{2016}$ per service unit (TSU). This is -3.5% lower than in 2015 since in 2016 the number of TSUs rose faster (+4.1%) than en-route ANS costs (+0.4%). En-route unit costs are expected to reduce by -1.5% annually over the 2016-2019 period and reach a value of 50.6 $€_{2016}$. If these plans materialise, the en-route unit costs in 2019 will be some -24% lower than in 2009, implying a remarkable cost-efficiency improvement achieved by maintaining the cost-base close to 2009 levels in the context of +2.8% annual increase in TSUs over the period.

In 2016, European terminal ANS unit costs amounted to 183.4 $€_{2016}$ per terminal service unit (TNSU). This is -3.6% lower than in 2015 since TNSUs rose much faster (+4.8%) than terminal ANS costs (+1.0%). Terminal ANS unit costs are expected to decrease by -1.7% annually over the 2016-2019 period and amount to 174.3 $€_{2016}$ in 2019. This performance improvement reflects the fact that total terminal ANS costs are planned to decrease by -1.3% p.a. while TNSUs are expected to increase at an average rate of +1.4% per annum.

Detailed ANSPs benchmarking analysis indicates that in 2016 gate-to-gate ATM/CNS provision costs slightly rose compared to 2015 (+0.7%) and amounted to some €8.1 Billion at Pan-European system level. At the same time traffic, expressed in terms of composite flight hours, increased by +2.4% over this period. As a result, gate-to-gate unit ATM/CNS provision costs in 2016 decreased by -1.7% at Pan-European level.

In order to also consider the service quality provided by ANSPs, the gate-to-gate economic performance combines ATM/CNS provision costs and the cost of ATFM delays.

Although unit ATM/CNS provision costs decreased in 2016, the unit economic costs increased by +1.5% to reach €494 per composite flight-hour reflecting a substantial increase in the unit costs of ATFM delays (+20.3% vs. 2015). In fact, the trend of decreasing ATFM delays observed in previous years stopped in 2013, when a new cycle characterised by higher delays started.

Current analysis provided in the operational ANS performance chapter of this report indicates that the trend of increasing delays continued in 2017 albeit in a lower magnitude since en-route ATFM delays were +7.1% higher than in 2016. It is therefore important to monitor the impact of this increase on the Pan-European system economic cost-effectiveness performance in 2017.

PRC Recommendations 2017

Recommendation	**Rationale**
a) The Provisional Council is invited to: 1) recall that PC/45 (2016) had: "requested 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."; 2) note that the PRC's work on Safety is based primarily on data provided to EUROCONTROL through its Annual Summary Template (AST) reporting mechanism, which is likely to be discontinued by 2020; 3) request the PRC to discuss with the Agency and other relevant parties with a view to ensuring continued access to a reliable source of safety data for its work post 2020; 4) submit this recommendation (a.1-a.3) to the Permanent Commission for approval.	*Safety is clearly the primary objective of ANS.* *As pointed out by the PRC in PRR 2015, with the safety reporting environment changing over the next few years, it has to be accepted that there 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.* *With the PRC monitoring the changes in the safety reporting environment, the PRC underlines its concern raised in PRR 2015 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.*

Recommendation	**Rationale**
b) The Provisional Council is invited to **note** that at pan-European system level, over the 2011-2016 period, ANSP costs remained fairly constant in a context of traffic growth, resulting in cost-effectiveness performance improvements. On the other hand, when considering an economic costs perspective (combining ANSPs costs and ATFM delays), it appears that a significant part of these cost-effectiveness improvements were offset by a new cycle of continuously higher ATFM delays which started in 2014. The evolution of this situation will be monitored by the PRC in future Performance Review Reports;	*The introduction of binding economic and capacity performance targets by the SES Performance Scheme in 2012 contributed to a steady improvement of cost-efficiency while on the capacity side the Air Traffic Management (ATM) system still benefited from the depressed traffic levels, following the start of the economic crisis in 2008.* *The total economic costs enable a more complete view taking also the costs of delay to airspace users into account.*

Recommendation	***Rationale***
c) The Provisional Council is invited to: 1) recall that PC/45 (2016) had requested Member States to task their ANSPs to provide sufficient capacity to meet demand and to accurately identify capacity constraints that adversely impact service provision; 2) request the Director General and the Member States to strengthen the ATFCM process by developing and adopting strict procedures for attributing ATFM delay causes, instead of the current guidelines that lead to inconsistencies and opacity in monitoring capacity performance; 3) submit this recommendation (c.1 and c.2) to the Permanent Commission for approval.	*With traffic now increasing again since 2013, the PRC concerns, outlined in earlier PRR's, were confirmed that delays would increase again, unless sufficient attention was focussed on capacity management.* *Additionally, the PRC has noted significant inconsistencies in the allocation of ATFM delay by the ATFCM operational stakeholders.* *Inconsistency in allocating ATFM delays makes it increasingly difficult to identify the root causes of capacity constraints which in turn prevents appropriate and cost-effective mitigation or resolution.* *The PRC notes that the ATFCM process does not contain rules for attributing ATFM delay, but only 'guidelines'.* *The ATFM delay attribution process should be based on the following principles:* *The primary focus for mitigating or resolving capacity constraints should be on identifying any ANSP-internal constraints that prevent the deployment of maximum declared capacity (e.g. ATC staffing, equipment or airspace management);* *Attribution of delays to external causes (e.g. weather or 3rd party strike) should only be used in cases where no ANSP-internal capacity constraints prevent the deployment of maximum capacity;* *Attribution of delays to ATC capacity should not be used for collapsed sectors or when the regulated capacity is less than the maximum declared capacity of the sector.*

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

This page was intentionally left blank

1 Introduction and context

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.

The purpose of the independent Performance Review Commission (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 [1]. More information about the PRC is given on the inside cover page of this report.

This Performance Review Report (PRR 2017) has been produced by the PRC with its supporting unit the Performance Review Unit (PRU). Its goal is to provide policy makers and ANS stakeholders with objective information and independent advice concerning the performance of European ANS in 2017, based on analysis, consultation and information provided by relevant parties. It also gives some information on other PRC activities in 2017.

As in previous years, stakeholders were consulted on the draft Final Report and were invited to provide comments for the PRC's consideration before the report was finalised and the PRC prepared its recommendations arising out of PRR 2017. The consultation phase was from 16 March – 6 April 2018.

On the basis of PRR 2017 and stakeholders' comments, the PRC will develop and provide independent advice on ANS performance and propose recommendations to the EUROCONTROL States.

1.1.1 Further PRC work

In addition to the PRR which provides an independent holistic view of ANS performance in all EUROCONTROL Member States across all key performance areas, the PRC work focuses on tasks complementary to those of the Performance Review Body of the Single European Sky performance scheme. They include:

- production of annual ATM Cost-Effectiveness (ACE) Benchmarking reports which present yearly factual data and analysis on cost-effectiveness and productivity for Air Navigation Service Providers (ANSPs) in Europe;
- involvement in international benchmarking studies to foster discussions on how to improve the air navigation system for the benefit of all users and to support the International Civil Aviation Organization (ICAO) in establishing common principles and related guidance material for ANS performance benchmarking;
- provision of in-depth analysis and independent ad-hoc studies on ATM performance, either on the PRC's own initiative or at the request of interested parties;
- basic R&D into the development of performance measurement;
- investigation of how performance could be best described/measured in the long-term;
- development of possible future performance indicators and metrics;
- identification of future improvements in performance; and
- ensuring widespread circulation of best practices for ATM performance.

In order to allow easier access and to make information available more quickly, the PRC has developed online reporting tools. More information on the PRC quarterly online ANS performance review as well as information on studies, performance methodologies and data for monitoring ANS performance in the EUROCONTROL area is available online at: http://www.ansperformance.eu/prcq.

1.1.2 Report scope and structure

Unless otherwise indicated, PRR 2017 relates to the calendar year 2017 and refers to ANS performance in the airspace controlled by the 41 Member States of EUROCONTROL (see Figure 1-1), here referred to as "EUROCONTROL area".

In 2016, EUROCONTROL signed comprehensive agreements with Israel and Morocco with a view to fully integrating both States into its working structures.

Work is still in progress in some areas (data collection and validation) to fully include Israel and Morocco in future performance reviews. Where possible, they have been included in the PRR 2017 analyses.

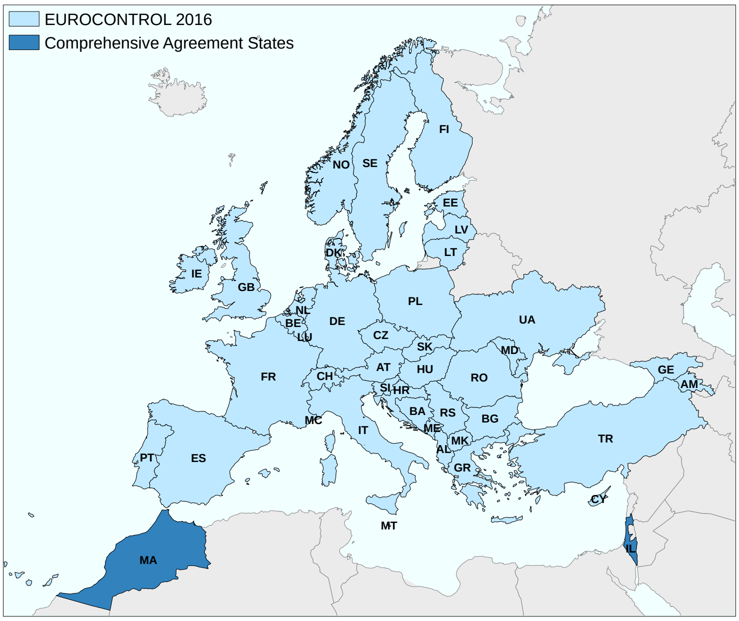


Figure 1-1: EUROCONTROL States (2017)

PRR 2017 addresses the Key Performance Areas: Capacity, Cost Effectiveness, Efficiency, Environmental sustainability and Safety.

It is organised in five chapters:

Chapter 1- Introduction and context: General context including a high level review of air traffic demand and punctuality trends in the EUROCONTROL area.

Furthermore, the chapter provides a high level comparison of the total ANS-related costs in 2008 and 2016 where traffic levels were similar. The chapter also addresses the environmental component of ANS performance.

Chapter 2 – Safety: Review of Safety ANS performance in terms of accidents, ATM-related incidents and the level of safety occurrence reporting in the EUROCONTROL area.

Chapter 3 - En-route ANS Performance: Review of operational en-route ANS performance (ATFM delays, en-route flight efficiency), including a detailed review of the most constraining ACCs in 2017.

Chapter 4 - ANS Performance @ airports: Review of the operational ANS Performance of the top 30 airports in terms of traffic in 2017.

Chapter 5 - ANS Cost-efficiency: Analysis of ANS cost-efficiency performance in 2016 (the latest year for which actual financial data were available) and performance outlook, where possible.

1.2 European air transport key indices

Figure 1-2 shows the evolution of European air traffic indices[1] between 2008 (the year with the highest recorded traffic levels before the start of the economic crisis) and 2017.

The trend already observed over the past years continued also in 2017.

Air traffic in the Pan-European area continued to increase for the fourth year in a row in 2017 and exceeded the previously highest level of 2008.

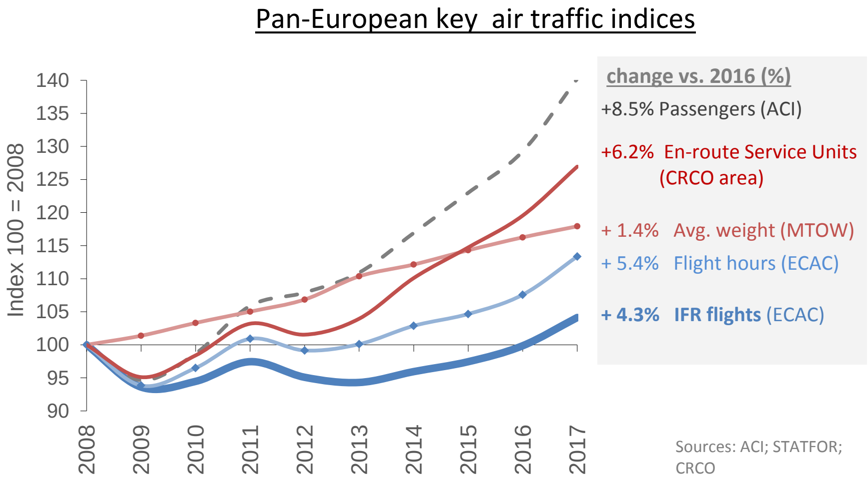


Figure 1-2: European air traffic indices (2008-2017)

In 2017, the number of flights increased by 4.3%[2] (2.5% in 2016) in the ECAC area[3] which corresponds to an additional 1,191 flights per day on average. The observed traffic growth corresponds to the high forecast scenario of +4.3% predicted by STATFOR for 2017 in the 7-year forecast [2].

As in previous years, flight hours (+5.4% vs. 2016) and distance (+5.7% vs. 2016) grew at a higher rate than the number of flights which, together with the further increase of the average take-off weight (+1.4% vs. 2016), led to a higher en-route service unit[4] growth in 2017 (+6.2% vs. 2016).

Figure 1-3 shows the change in terms of flight type, traffic segment, flight distance and flight hours compared to 2016. As was the case in 2016, the main driver of the observed traffic growth in 2017 was the growth in the intra-European low cost traffic segment (STATFOR definition).

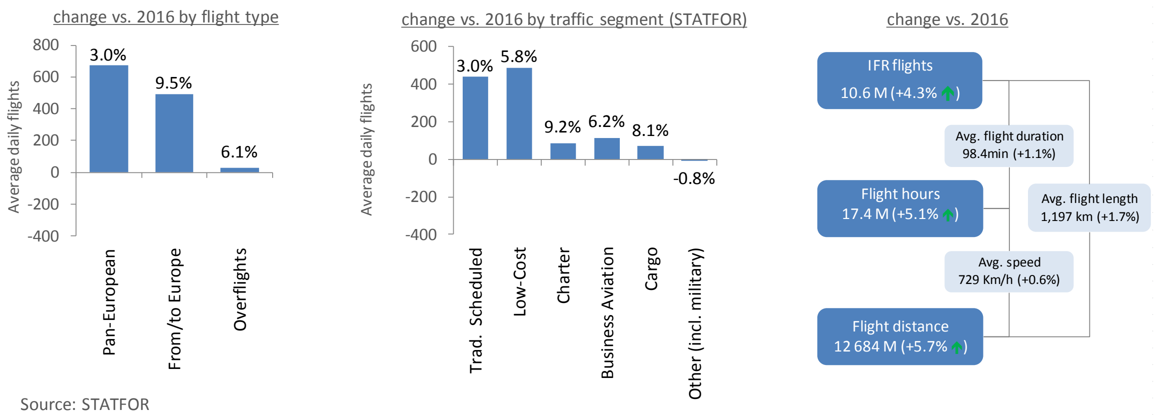


Figure 1-3: Year on year change versus 2016

---

1 Note that the individual indices can refer to slightly different geographical areas.

2 Leap year effect was taken into account.

3 The European Civil Aviation Conference (ECAC) is an intergovernmental organization which was established by ICAO and the Council of Europe. ECAC now totals 44 members, including all 28 EU, 31 of the 32 European Aviation Safety Agency member states, and all 41 EUROCONTROL member states.

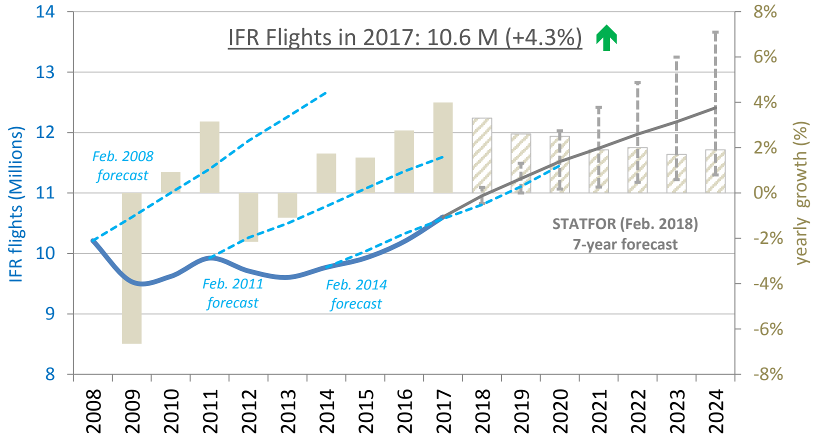
4 Used for charging purposes based on aircraft weight factor and distance factor.

Figure 1-4 shows the evolution of IFR flights in the ECAC area since 2008 together with selected traffic forecasts[5]. The latest STATFOR 7-year forecast [3] predicts flights in the ECAC area to grow by 3.3% in 2018 (Low: 2.1%; High 4.6%).

The average annual growth rate (AAGR) between 2018 and 2024 is forecast to be at 2.3% (baseline).

By 2024, the number of flights in the ECAC area will increase by 17% compared to 2017, reaching a total of 12.4 million flights, according to the base forecast scenario.

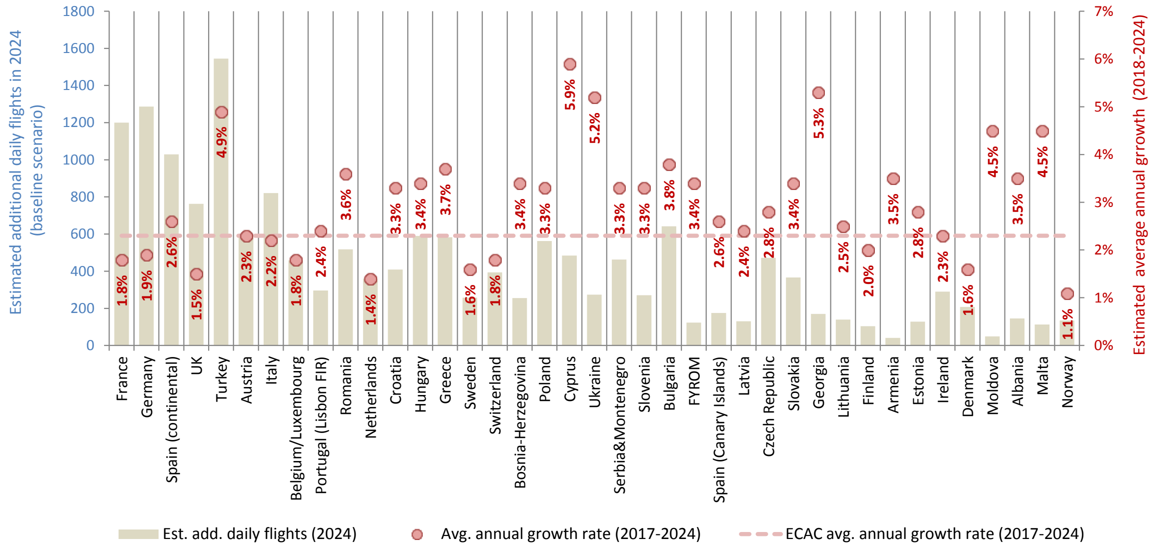
However the expected growth is not evenly distributed across the ECAC area.



Source : EUROCONTROL/STATFOR (ECAC)

Figure 1-4: Evolution of European IFR flights (2008-2024)

Figure 1-5 shows an outlook of the forecast traffic growth over the next seven years by State according to the STATFOR baseline scenario [3]. The bars show the estimated number of additional daily flights in 2024 and the dots indicate the annual average growth rate between 2018 and 2024.



Source : EUROCONTROL/STATFOR (Feb. 2018)

Figure 1-5: Forecast traffic growth 2018-2024

In absolute terms, Turkey is predicted to have the highest number of additional daily flights in 2024, followed by Germany and France. The highest average annual growth rates between 2018 and 2024 are forecast for Cyprus (5.9%), Georgia (5.3%), Ukraine (5.2%) and Turkey (4.9%).

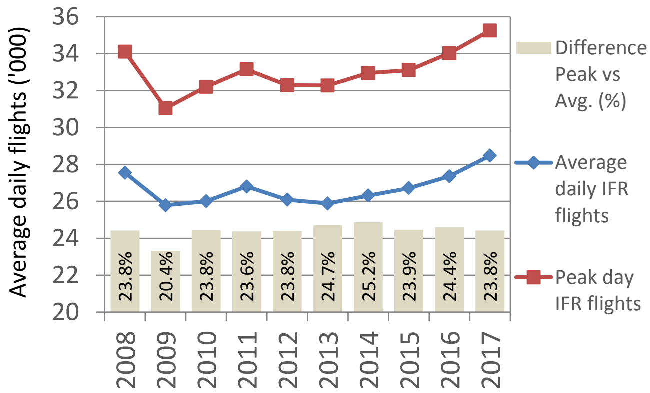
Traffic growth at Air Navigation Service Provider (ANSP) and Area Control Centre (ACC) level is analysed in more detail in Chapter 3. The traffic growth at airport level is analysed in more detail in Chapter 4.

---

5 STATFOR 2008 forecast (before the economic crisis), STATFOR 2011 forecast (before the start of the SES performance scheme), and the latest available STATFOR Sep. 2017 forecast.

Traffic variability can also affect performance if not addressed with appropriate measures. It can be characterised as temporal (seasonal, daily, hourly) and spatial (location of traffic in an airspace) variability.

Figure 1-6 compares the peak day to the average daily number of flights at system level. Peak traffic load continued to rise in 2017 and reached the highest level of traffic on record so far on June 30th 2017 (35 251 flights). The peak day in 2017 was 23.8% higher than an average day.



Source: PRU analysis

Figure 1-6: Evolution of daily traffic levels (EUROCONTROL)

Figure 1-7 shows the traffic variation by day of the week at EUROCONTROL level in 2017. At system level, traffic levels were lowest on weekends and the highest levels were observed on Fridays and Thursdays.

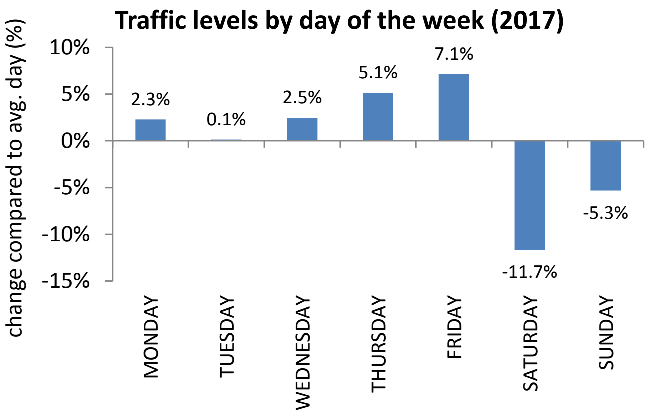


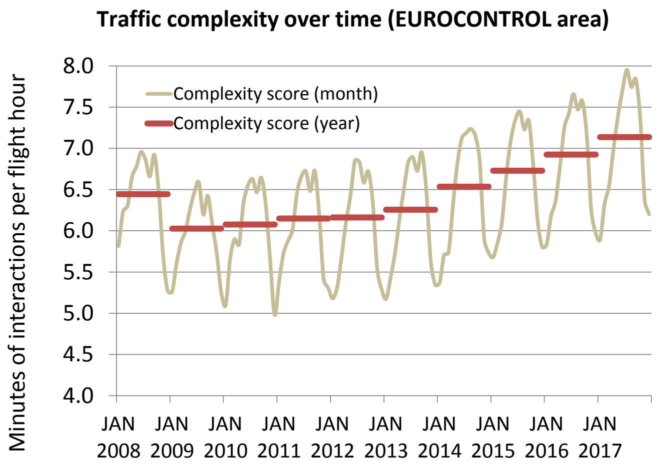
Figure 1-7: Traffic levels by day of the week (2017)

If traffic is highly variable and there is limited flexibility to adjust the capacity provision according to actual traffic demand, the result may be poor service quality or an underutilisation of resources. If addressed proactively, traffic variability can be mitigated or resolved to a certain degree by utilising previous experience. If demand is higher on weekends than on weekdays, then it is possible to roster staffing levels to suit.

It is acknowledged that the local traffic variability can differ significantly compared to the system level. Traffic variability at local level is addressed in more detail in Chapter 3.

Although the relationship between "**traffic complexity**" and ANS performance in general is not straightforward, complexity is a factor to be taken into account when analysing ANS performance.

Figure 1-8 shows the evolution of complexity in the EUROCONTROL area between 2008 and 2017. The monthly trend line (brown) shows a seasonal pattern with the highest level of complexity in summer.



Source: EUROCONTROL/PRU

Figure 1-8: Complexity over time (EUROCONTROL)

Traffic complexity at system level has been increasing continuously since 2013 which corresponds with the observed increase of traffic during the same time.

High density (concentration of traffic in space and time) can lead to a better utilisation of resources but a high structural complexity (intensity of potential interactions between traffic) entails higher ATCO workload and potentially less traffic. Similarly, if demand is higher during certain periods, for example July and August, then it is possible to make more operational staff available by reducing non-critical ancillary activities performed by ATCOs during the peak period. Hence, traffic variability and complexity is therefore a factor that needs to be carefully managed as it may have an impact on productivity, cost-efficiency, and the service quality provided by air navigation service providers.

It is important to point out that the figures shown above represent annual averages for the EUROCONTROL area, and which provide interesting insights. However, at local level the traffic variability and complexity can differ markedly and can even differ from the system-wide trend (e.g. weekend traffic is higher). For this reason, a more detailed analysis at local level is provided at the beginning of Chapter 3 which evaluates en-route ANS performance.

1.3 Air transport punctuality

Punctuality is a commonly used service quality indicator from a passenger point of view. It is defined as the percentage of flights arriving (or departing) within 15 minutes of the scheduled time. Figure 1-9 shows the level of arrival punctuality for the EUROCONTROL area between 2008 and 2017.

Following the trend observed over the past years, arrival punctuality continued to decrease to 79.6% of flights arriving within 15 minutes of their published arrival time.

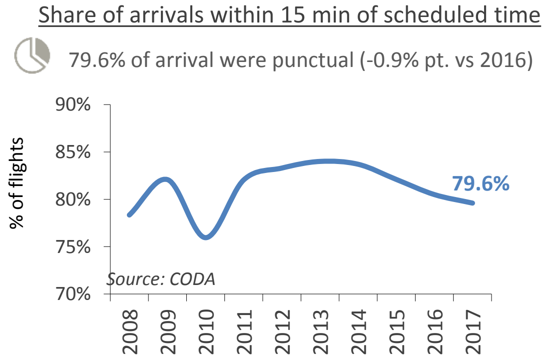


Figure 1-9: Evolution of arrival punctuality (2008-2017)

Previous analyses have shown that arrival punctuality is primarily driven by departure delay at the origin airport with only comparatively small changes once the aircraft has taken off.

To better understand the drivers of departure delays[6] and the contribution of ANS towards operational performance, Figure 1-10 provides a causal breakdown of the delays reported by airlines.

Average departure delay in the EUROCONTROL area increased in 2017 by 1.0 minutes to 12.2 minutes also driven by a further increase in the ANS-related share.

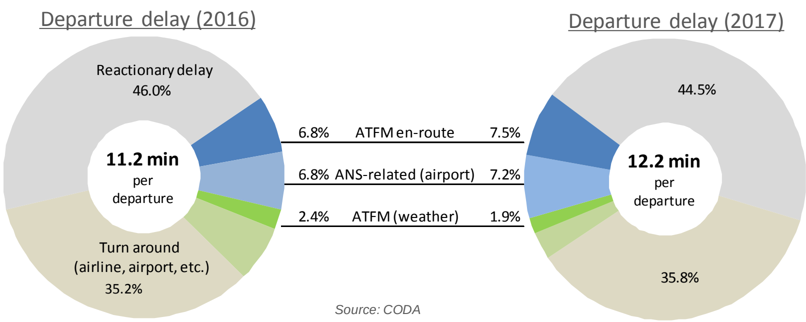


Figure 1-10: ANS contribution towards departure total departure delays

Reactionary delay from previous flight legs accumulate throughout the day and are by far the largest delay category, followed by turn around delays. Despite this further deterioration in 2017, it is noteworthy that the network sensitivity[7] to primary delays decreased from 0.85 to 0.80, leading to a reduction in reactionary delays in relative terms in 2017.

The ANS contribution increased due to en-route traffic flow measures and ATFM weather attributed delays in 2017 but decreased for airport ANS-related performance. 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)[8].

---

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

7 Reactionary delay for each minute of primary delay.

8 The Central Office for Delay Analysis (CODA) publishes detailed monthly, quarterly, and annual reports on more delay categories (see https://www.eurocontrol.int/articles/coda-publications).

1.4 Total estimated ANS-related costs

The start of the economic crisis in 2008 resulted in a significant drop in air traffic. It took eight years (2016) to reach the previously highest traffic level of 2008 again. In 2017, the EUROCONTROL area saw the highest traffic level on record. This section provides a high level comparison in terms of ATM/CNS provision costs and observed ATFM delay levels between 2008 and 2016 which showed comparable traffic levels.

Figure 1-11 shows the evolution of ATM/CNS provision costs (expressed in €$_{2016}$) together with the evolution of ATFM delay and controlled flight hours for the EUROCONTROL area between 2008 and 2016.

It is interesting to note that, although the number of flights served were comparable in 2016 (-0.4% vs. 2008), the controlled flight hours were +5.6% above the level of 2008.

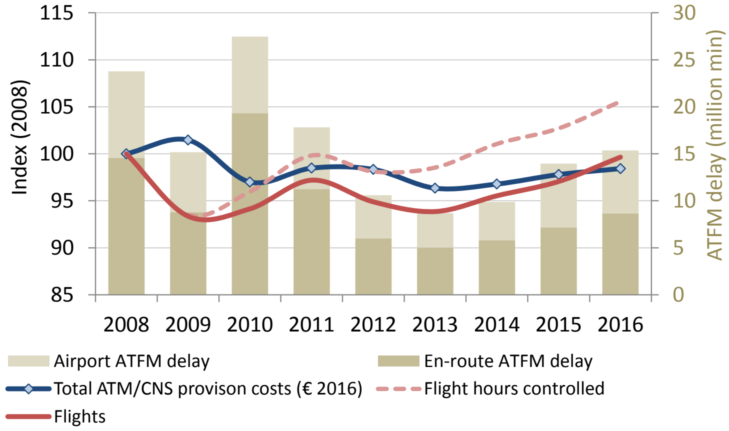


Figure 1-11: ANS provision costs and ATFM delays between 2008 and 2016

The observation is consistent with the results shown in Figure 1-2 on page 3. Average distance and aircraft size grew at a higher rate than the number of flights between 2008 and 2016 leading to more controlled flight hours and a higher level of complexity despite a similar number of flights.

Although the ATFM delay level in 2016 (0.86 min per flight) was still higher than airspace users' expectations, there were significant improvements at system level. En-route ATFM delays in 2016 were 40% lower than in 2008 and airport ATFM delays were 27% lower than in 2008. The share of flights delayed by en-route ATFM regulations decreased from 7.8% in 2008 to 4.8% in 2016.

Figure 1-12 shows a high level comparison in terms of costs. Estimated ATM/CNS provision and ATFM delay costs in 2016 were €1Bn below the 2008 level which was mainly driven by a €843M reduction in ATFM delay costs and a €129M reduction in direct provision costs (mainly support costs).

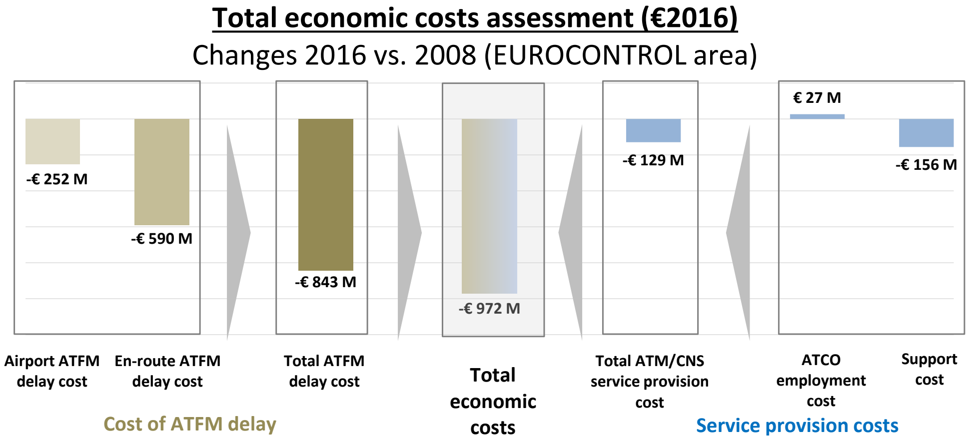


Figure 1-12: Estimated ATM/CNS provision costs and ATFM delay costs (2016 vs. 2008)

At the same time, ATCO hour productivity increased (+10.1% vs. 2008) and support cost per flight hour decreased by -7.9% compared to 2008, leading to an overall reduction of ATM/CNS unit provision costs of -6.8% vs. 2008. Although the ATM system improved compared to 2008, there is clearly scope for further improvement. With the focus mainly on cost savings over the past years, the system benefited from the depressed traffic levels following the start of the economic crisis in 2008. However, with traffic growing again it is vital to work proactively on capacity deployment in order to be able to accommodate forecast demand and to avoid exponential increases of delay costs to airspace users.

1.5 Environmental sustainability

The PRC acknowledges that environmental sustainability is an important political, economic, and societal issue and the entire aviation industry has a responsibility to minimise its impact on the environment which can be broadly divided into the impact on (i) global climate, (ii) local air quality (LAQ), and (iii) noise.

This section puts ANS performance in the wider context of aviation-related environmental performance as not all aspects of the environmental impact of aviation can be influenced by ANS. Additionally, where appropriate, the environmental component of ANS performance is highlighted specifically in the respective operational chapters (ANS-related inefficiencies in terms of fuel and CO_2 emissions).

ANS-related emissions

The environmental impact of aviation on climate results from greenhouse gas (GHG) emissions including CO_2, NOx, and contrails, generated by aircraft engine exhaust. Whereas CO_2 emissions are directly proportional to the fuel burn, NOx emissions are more difficult to quantify as they depend on engine settings and prevailing atmospheric conditions. Moreover, the radiative forcing effect of non-CO_2 emissions depends on altitude, location, and time of the emission.

The global agreement on aviation and climate change reached at ICAO's 37th Assembly in 2010 was an important step towards a sustainable air transport future and makes international aviation the first sector to agree on a 2% annual fuel efficiency improvement, while stabilizing its global CO_2 emissions at 2020 levels – with carbon neutral growth from 2020.

At its 39th General Assembly in October 2016, ICAO approved a global market-based measure to limit and offset emissions from the aviation sector under the name of Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). CORSIA's purpose is to offset any annual increase in total carbon emissions from international civil aviation above 2020 levels in order to achieve the global aspirational goal of carbon neutral growth from 2020 onwards. Domestic carbon emissions from aviation will be addressed under the Paris Agreement which enters into force in 2020. It sets out an action plan to limit global warming.

In Europe, emissions from aviation have been included in the EU emissions trading system (EU ETS) since 2012. The original legislation adopted in 2008 covered all flights in and out of the European Economic Area (EEA). However, the EU decided to limit the obligations for 2012-2016 to flights within the EEA, in order to support the development of a global measure by ICAO for reducing aviation emissions. Pending the development of CORSIA, the EC has proposed to continue the current approach for aviation beyond 2016 and foresees a review of the EU ETS Directive to consider ways of implementing CORSIA in EU law.

In Europe, it is estimated that all aviation emissions account for approximately 3.5-5% of total anthropogenic CO_2 emissions. By far the main contribution to decouple CO_2 emissions growth from air traffic growth is expected to come from technology developments (more efficient aircraft, advances in airframe and engine technology), market based measures, alternative low carbon fuels, and subsequent fleet renewals.

Analysis in previous PRRs showed that approximately 6% of the total aviation related CO_2 emissions in Europe can be influenced by ANS. Hence the share of total European CO_2 emissions that can be influenced by ANS is approximately 0.2-0.3%.

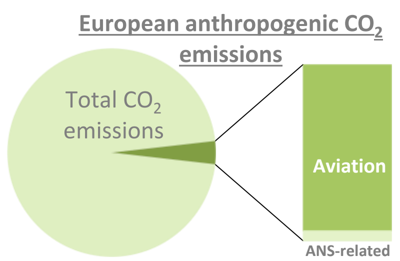


Figure 1-13: Estimated share of CO_2 emissions that can be influenced by ANS

Traditionally, the focus in the ANS context has been on the monitoring of ANS-related operational efficiency which served as a proxy for environmental performance since the distance or time saved by operational measures can be converted into estimated fuel and CO_2 savings. Efficiency gains tend to deliver reduced environmental impact per unit of activity, as well as reduced costs.

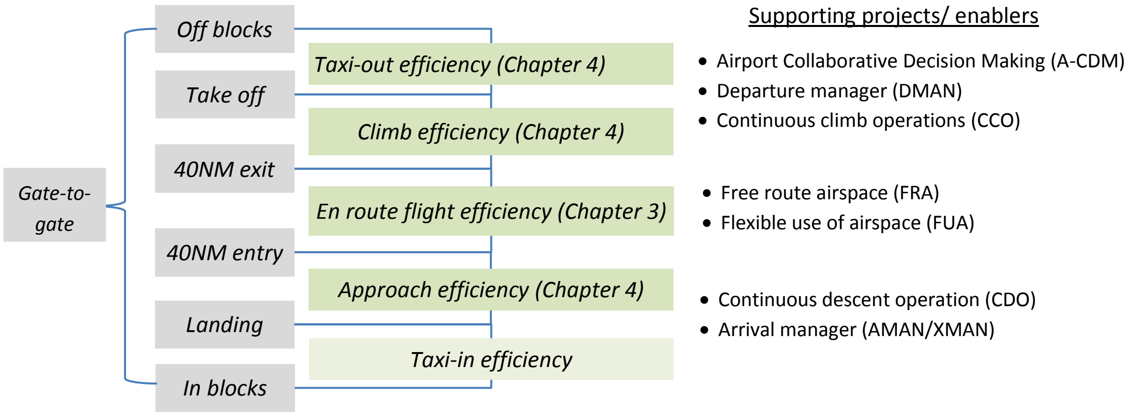


Figure 1-14: Gate-to-gate efficiency by phase of flight

Figure 1-14 provides an overview of the operational efficiency by phase of flight. The environmental dimension will be addressed in the respective section of the chapters.

ANS-related noise emissions

The second large environmental area is aircraft noise which is generally recognised as the most significant environmental impact at airports.

The European Environment Agency estimates that around 3 million people are exposed to noise above 55dB [4].

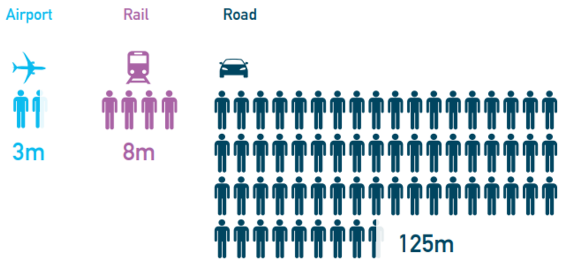


Figure 1-15: Population exposed to noise above 55dB in Europe (in millions) [4]

The noise management at airports is generally under the responsibility of the airport operators which coordinate and cooperate with all parties concerned to reduce noise exposure of the population while optimising the use of scarce airport capacity. Noise restrictions are usually imposed by Governments or local Authorities and the level of compliance is monitored at local level.

Regulation (EU) No 598/2014 lays down rules on the process to be followed for the introduction of noise-related operating restrictions in a consistent manner on an airport-by-airport basis, in accordance with the Balanced Approach which breaks down the affecting factors into (1) land use planning, (2) reduction of noise at source, (3) aircraft operational restrictions and (4) noise abatement operational procedures [5].

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.

Airports face the challenge 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. 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.).

Moreover, there can also be trade-offs between environmental restrictions when different flight paths reduce noise exposure but result in less efficient trajectories and hence increased emissions.

The areas where ANS can contribute to the reduction of aircraft noise are mainly related to operational procedures but the main contributions for reducing noise are expected to come from measures with long lead times outside the control of ANS (land use planning, reduction of noise at source).

Although it is acknowledged that aircraft noise is an important issue at airports, the main factors affecting noise emissions at and around airports are not under the direct control of ANS.

Generally the management of noise is considered to be a local issue which is best addressed through local airport-specific agreements developed in coordination and cooperation with all relevant parties. Due to the complexity of those local agreements, there are presently no commonly agreed Europe-wide indicators specifically addressing ANS performance in the noise context.

In this report, ANS performance in the noise context is however indirectly addressed through the evaluation of continuous descent operations (CDO) and continuous climb operations (CCO) in Chapter 4 which is an area where ANS can have an impact. Noise (and fuel) reductions from CDO/CCO are expected around airports as they keep aircraft higher for longer than a conventional approach.

2 Safety

SYSTEM TREND (AST REPORTING)	2016	2017(P)	Trend	% change
Accidents and incidents				
Total number of reported Accidents with ATM Contribution	2	1	↓	-50
Total number of reported Severity A+B	727	827	↑	14
Total number of reported ATM incidents	25 044	36 487	↑	46
Occurrences not severity classified	24%	8%	↓	-67
Separation Minima Infringements (SMI)				
Total number reported	2 435	2368	↓	-3
Total number of reported Severity A+B	344	287	↓	-17
Runway incursions (RI)				
Total number reported	1 622	1454	↓	-10
Total number of reported Severity A+B	117	104	↓	-11
Unauthorised penetration of airspace (UPA)				
Total number reported	4 646	5012	↑	8
Total number of reported Severity A+B	81	87	↑	7
ATM Specific Occurrences				
Total number reported	17 675	16287	↓	-8
Total number of reported Severity AA+A+B	316	326	↑	3

2.1 Introduction

This chapter reviews the Air Navigation Services (ANS) safety performance of the EUROCONTROL Member States between 2007 and 2017 (note that 2017 data is only preliminary).

Sections 2.2 and 2.3 in this Chapter show the trends in ANS-related accidents and incidents in the EUROCONTROL area. Section 2.4 provides an analysis of the current status of safety data reporting and investigation in EUROCONTROL Member States.

The review of ANS safety performance in this chapter is based on accident and incidents data reported to EUROCONTROL via the Annual Summary Template (AST) reporting mechanism and complemented with additional sources of information when necessary.

As pointed out by the PRC in PRR 2015, with the safety reporting environment changing over the next few years, it has to be accepted that there 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.

With the PRC monitoring the changes in the safety reporting environment, the PRC underlines its concern raised in PRR 2015 that during this transition phase the availability, completeness and quality of safety data and associated safety data analysis will deteriorate due to a lack of arrangements between all parties within the process.

2.2 Accidents

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

Figure 2-1 shows the total number of air traffic accidents in the **EUROCONTROL area** between 2013 and 2017(P), based on AST data submitted by the EUROCONTROL Member States. The data was cross checked and supplemented with the available information from the ICAO Accident/Incident Data Reporting (ADREP).

The analysis covers accidents involving aircraft above 2,250 kg Maximum Take-Off Weight (MTOW), irrespective of whether the ATM domain contributed to the event or not.

In 2017, based on preliminary data, there were 71 accidents in the EUROCONTROL area out of which 8 were fatal. This represents approximately 11% of the total accidents.

The majority of ANS-related accidents between 2013 and 2017 were related to Controlled Flight into Terrain (CFIT) and "Collisions on the ground between aircraft and vehicle/person/obstruction(s)".

Unfortunately, three quarters of the reported accidents were put in the category 'Other' hence the real picture might be different if these were coded differently.

To improve this situation in the future, the EUROCONTROL DPS/SSR Safety Analysis Team will provide further support to Member States in order to improve the quality of accident coding in the national databases.

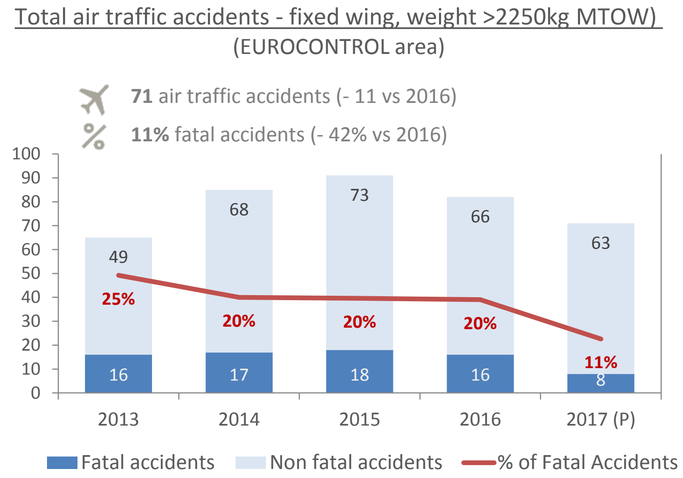


Figure 2-1: Accidents in EUROCONTROL area (2013-17P)

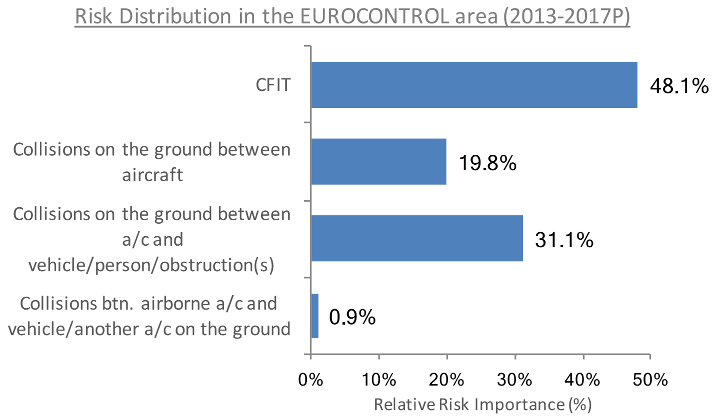


Figure 2-2: Accidents risk distribution (2013-17P)

2.2.1 Air traffic accidents with ATM Contribution

There was one reported accident with direct[9] ATM contribution and none with indirect[10] ATM contribution in 2017.

The share of accidents with ATM contribution (direct or indirect) in total air traffic accidents decreased from 2.4% to 1.4% in 2017.

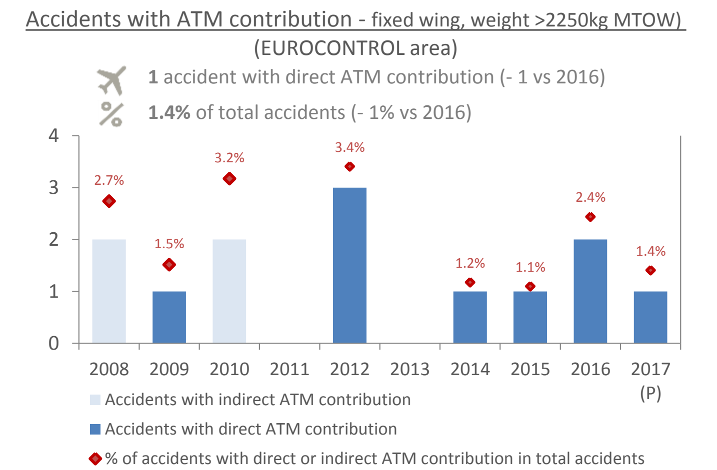


Figure 2-3: Accidents with ATM contribution in the EUROCONTROL area (2008-17P)

---

9 Where at least one ATM event or item was judged to be DIRECTLY in the causal chain of events leading to an accident or incident. Without that ATM event, it is considered that the occurrence would not have happened.

10 Where no ATM event or item was judged to be DIRECTLY in the causal chain of events leading to an accident or incident, but where at least one ATM event potentially increased the level of risk or played a role in the emergence of the occurrence encountered by the aircraft. Without such ATM event, it is considered that the accident or incident might still have happened.

2.3 Incidents

This section provides a review of ATM-related incidents, reported through the EUROCONTROL AST reporting mechanism.

The PRC has made use of, with gratitude, the data provided by the EUROCONTROL DPS/SSR Unit and EUROCONTROL Safety Regulation Commission (SRC) Annual and Intermediate Reports [6].

As opposed to the accident analysis, there is no MTOW limit (2,250 kg) for the ATM-related incidents.

SMI	**13.8** (15 in 2016) **Separation Minima Infringements per 100 thousand flight hours**
RIs	**0.8** (0.9 in 2016) **Runway incursions per 10 thousand movements**
UPAs	**29.2** (28 in 2016) **Unauthorised penetration of airspace per 100 thousand flight hours**

Table 2-1: Occurrence rates (SMI, RI, UPA) in the EUROCONTROL area (2017)

The analysis concentrates on the several key risk occurrence types, namely: separation minima infringements (SMIs), runway incursions (RIs), airspace infringements (AIs)/unauthorised penetrations of airspace (UPAs), and ATM Specific Occurrences (ATM-S).

Table 2-1 shows the EUROCONTROL area overall occurrence rates (as reported by all 38 reporting States) for SMI, RI and UPAs in 2017.

Figure 2-4 shows the underlying distribution of occurrence rates of all 38 reporting EUROCONTROL Member States for three categories of occurrences SMI, RI and UPAs compared to the EUROCONTROL area overall rate.

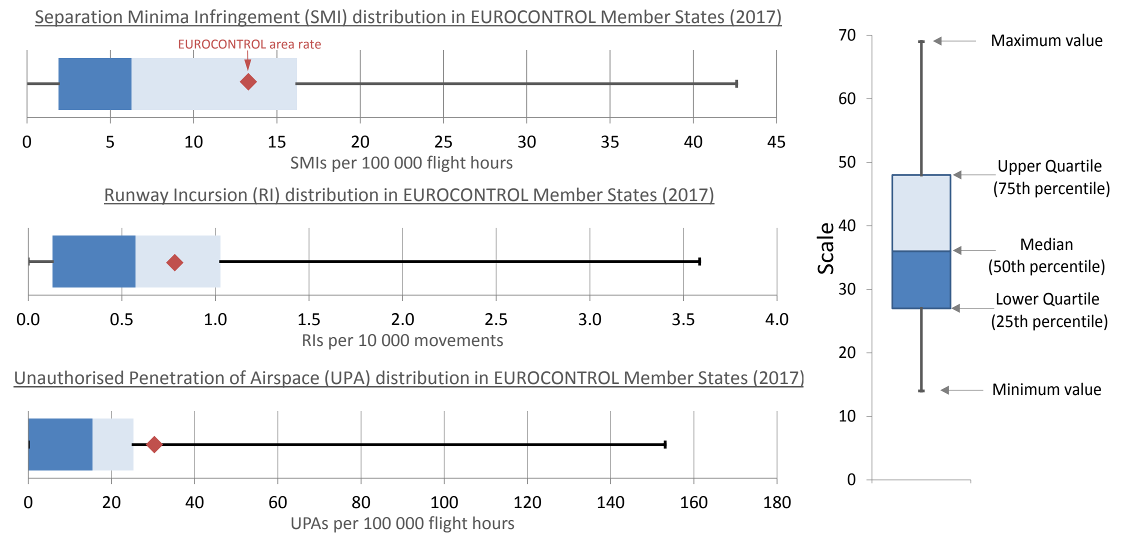
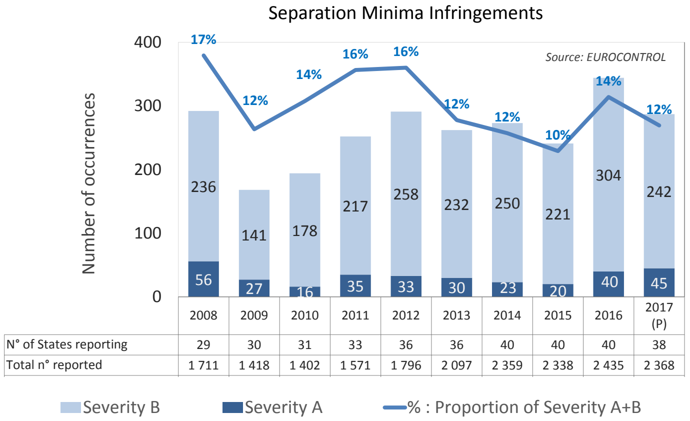


Figure 2-4: Occurrence rates EUROCONTROL area (2017P)

In 2017 (based on preliminary data), the EUROCONTROL area SMI and UPA rates were approximately 13.8 and 29.2 SMIs or UPAs respectively per 100 000 flight hours. The rate of the EUROCONTROL area RIs in 2017 was less than 0.8 RIs per 10 000 movements. The distribution of all three rates is skewed with a small number of States with high occurrence rates compared to the rest of the States.

The next four figures illustrate the trends of SMI, RI, UPAs, and ATM-S occurrences in the period 2008-2017 (preliminary), detailing the evolution of the number of reporting States, the total number of occurrences reported per each category and especially the evolution of risk-bearing (Severity AA/A and Severity B) occurrences in each figure.



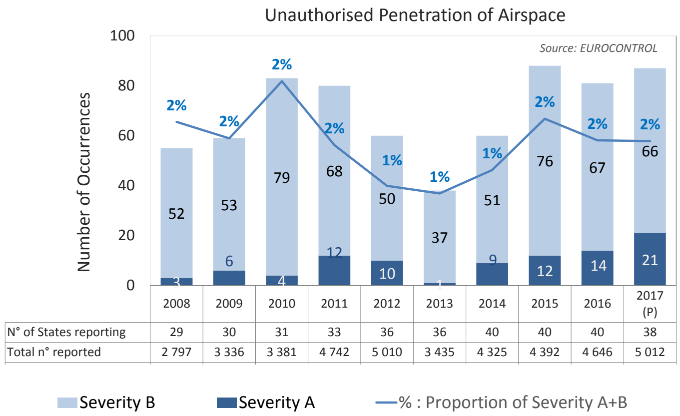
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017 (P)
N° of States reporting	29	30	31	33	36	36	40	40	40	38
Total n° reported	1 711	1 418	1 402	1 571	1 796	2 097	2 359	2 338	2 435	2 368

Figure 2-5: Reported high-risk SMIs (EUROCONTROL)

With an increase in traffic, the total number of reported RIs decreased by -2.8% in 2017.

The number of reported risk bearing SMIs (Severity A+B) decreased in 2017 from 344 to 287 (-16.6%).

Overall, 12% of all SMI occurrences reported in 2017 were categorised as risk bearing occurrences which is 2% less than in 2016.



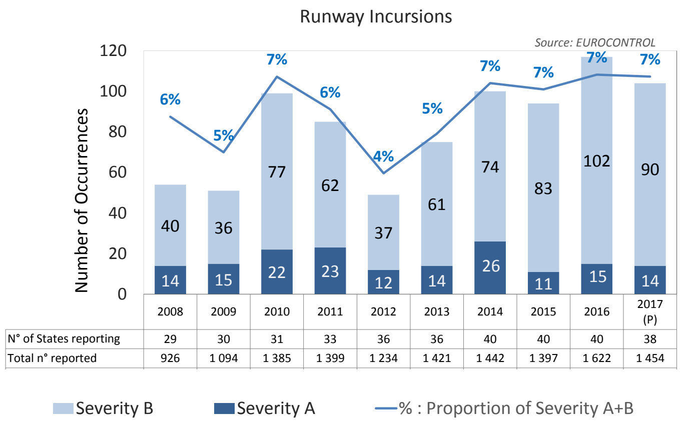
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017 (P)
N° of States reporting	29	30	31	33	36	36	40	40	40	38
Total n° reported	2 797	3 336	3 381	4 742	5 010	3 435	4 325	4 392	4 646	5 012

Figure 2-6: Reported high-risk UPAs (EUROCONTROL)

The total number of reported UPAs increased by +7.9% in 2017.

The number of risk bearing UPA occurrences (Severity A+B) increased from 81 to 87 in 2017 (+7.4%).

Nevertheless, the share of risk bearing UPA occurrences in the total reported UPAs stayed the same at approximately 1.7% in 2017.



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017 (P)
N° of States reporting	29	30	31	33	36	36	40	40	40	38
Total n° reported	926	1 094	1 385	1 399	1 234	1 421	1 442	1 397	1 622	1 454

Figure 2-7: Reported high-risk RIs (EUROCONTROL)

The total number of reported RIs decreased by -10.4% in 2017.

The reported risk bearing RIs (Severity A+B) decreased slightly from 117 to 104 in 2017 (-11%).

The share of risk bearing RIs stayed the same at 7.2% of the total reported RI occurrences in 2017.

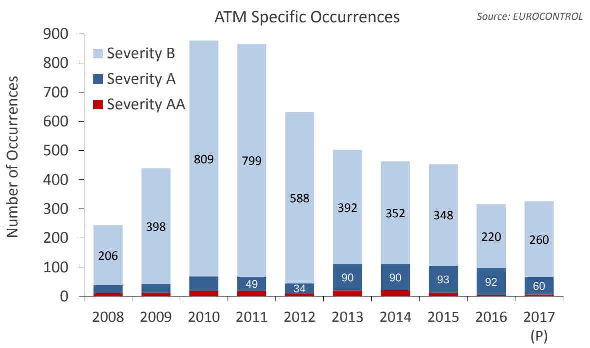


Figure 2-8: Reported high-risk ATM Spec. Occurrences (EUROCONTROL)

The total number of reported ATM Specific Occurrences decreased by -7.9% in 2017.

The total number of risk bearing ATM specific occurrences increased from 316 to 326 in 2017 (+3.2%).

At the same time, the share of risk bearing ATM Specific Occurrences increased only slightly from 1.8% to 2% in 2017.

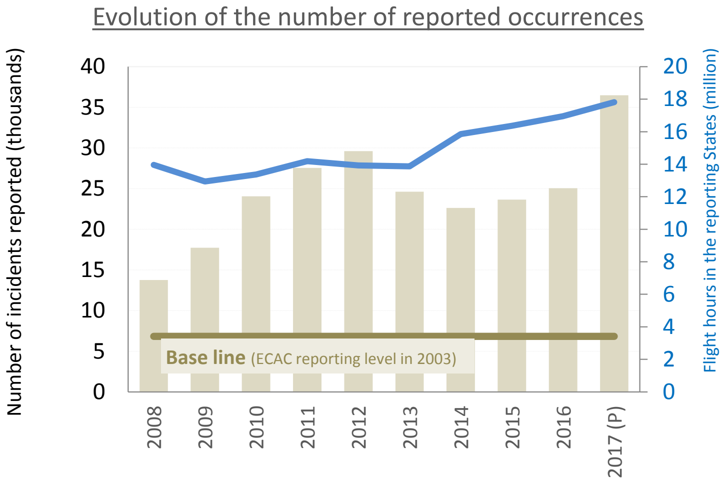
2.4 Reporting and Investigation

This section provides a review of the quality and completeness of ATM-related occurrences (operational and ATM specific occurrences) reported through the AST mechanism.

2.4.1 Total number of reported occurrences

The preliminary 2017 data were received from 38 EUROCONTROL Member States (two States did not submit data in this year cycle).

The number of reported occurrences increased by +45.7% in 2017.



Source: EUROCONTROL

Figure 2-9: Reported occurrences (2008-2017P)

A big increase in the number of reported occurrences is probably mainly due to implementation of the Occurrence Reporting Regulation 376/2014 (related to requirement that more types of occurrences are to be reported, that were not collected by AST before, such as bird strike, laser interference, etc.) and the alignment of AST reporting with those occurrences required in 376/2014.

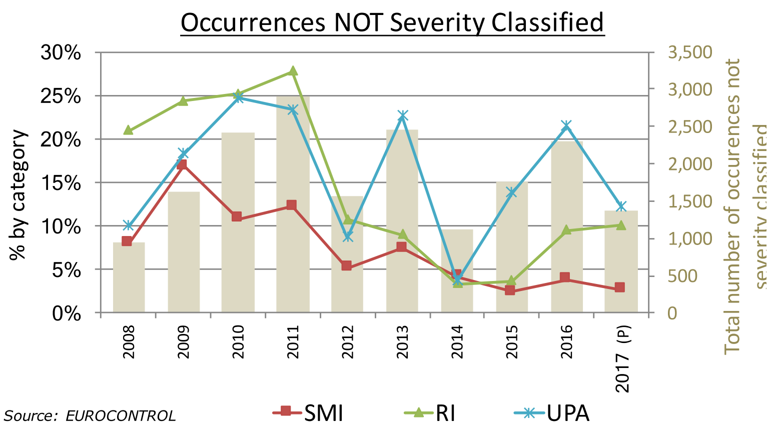
Nevertheless, the available data does not allow conclusions to be drawn if the observed year-on-year change represents a genuine safety performance variation or if it is due to different reporting levels.

2.4.2 Unclassified or undetermined occurrences

Figure 2-10 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 2018, covering the reporting year 2016 (final) and 2017 (preliminary).

In 2017, based on preliminary data, 8% of reported occurrences were still not severity classified. If the occurrences where the severity is *"not determined"* are added (i.e. insufficient data provided to fully assess the severity), the percentage rises to 18.6%.

Considering each type of occurrence separately (not just SMIs, RIs and UPAs), the percentage varies between 2% and 42%. If the occurrences where the severity is *"not determined"* are also included, the range increases to 9% and 55% of total number of reported occurrences in each occurrence category.



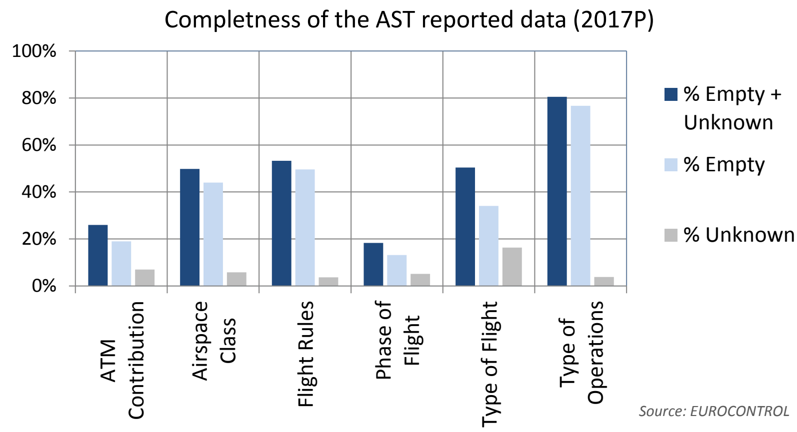
Source: EUROCONTROL

Figure 2-10: Severity not classified or not determined (2008-2017P)

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[11] and can also have other potential downstream repercussions such as the inadequate prevention of similar incidents or inadequate sharing and dissemination of lessons learned.

2.4.3 Completeness of safety data

Figure 2-11 shows the typical fields that are either left blank or marked *Unknown* in the AST, submitted by the EUROCONTROL Member States. The one of special concern for ATM safety performance is *ATM Contribution* field, which in undetermined in almost 26% of reports.



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 2-11: Completeness of AST reported data in 2017(P)

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.

2.5 Acceptable Level of Safety Performance (ALoSP)

The Provisional Council (PC) of EUROCONTROL, at its 45th Session (June 2016), requested the PRC to review the implementation status of the ALoSP and to report back to the PC/47 (June 2017). Following this request, in November 2016, the PRU on behalf of the PRC initiated the study to review the "Implementation of Acceptable Level of Safety Performance (ALoSP) concept in EUROCONTROL Member States".

At its 47th session of 22 June 2017, the PC noted the report submitted by the PRC.

In July 2017 the PRC approached EASA with the request to present and discuss the findings of the ALoSP survey and associated potential future actions. EASA welcomed the opportunity and a meeting between the PRC and EASA was held on 7 November 2017 at EASA HQ in Cologne.

The meeting identified potential actions and measures to be taken. One of the quick wins identified was raising awareness about existing guidance material on the subject.

It is also expected that the dialogue between the PRC and EASA should continue beyond the development of cooperation on implementation of ALoSP, in order to explore opportunities for the optimisation of the use of resources. EASA and PRC intend to further explore working concepts and how to implement further steps.

The PRC will collaborate with EUROCONTROL/TEC[12] in the context of the EUROCONTROL/ EASA Work Programme (2018-2019).

---

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

12 Support to EU on ATM technical regulation.

2.6 Conclusions

Despite the continued traffic growth, safety levels in the EUROCONTROL area remained at a constantly high level. There was one reported accident with direct ATM contribution in 2017, based on preliminary data.

In absolute terms, the number of all key risk occurrence types SMIs, RIs, and ATM-S decreased in 2017, while the number of UPAs increased. However, in relative terms the rate of occurrences in the EUROCONTROL area stayed almost the same as in 2016: there were 13.8 SMIs and 29.2 UPAs per hundred thousand controlled flight hours in the airspace and less than one (0.8) RIs per ten thousand movements at airports reported in 2017.

A big increase in the number of reported occurrences in 2017 (approx. 46%) is probably mainly due to implementation of the Occurrence Reporting Regulation 376/2014 and the alignment of AST reporting with those occurrences required in 376/2014.

The quality and completeness of safety data reported to EUROCONTROL has increased over the past years but with scope for further improvement, particularly in terms of severity classification. Although this has been pointed out by the PRC on several occasions, 8% of the reported occurrences were still not severity classified in 2017, which is a considerable decrease compared to 2016 (66%).

This page was intentionally left blank

3 Operational en-route ANS Performance

SYSTEM TRENDS	2017	Trend	change vs. 2016
IFR flights controlled	10.6M	↑	+4.3%
Capacity			
En-route ATFM delayed flights	5.3%	↑	+0.6 %pt.
Average en-route ATFM delay per flight (min.)	0.88	↑	+0.03 min
Total en-route ATFM delay (min.)	9.3M	↑	+7.1%
Environment/ Efficiency			
Average horizontal en-route efficiency (flight plan)	95.6%	↑	+0.2%pt
Average horizontal en-route efficiency (actual)	97.3%	↑	+0.2%pt.

3.1 Introduction

This chapter reviews operational en-route ANS performance in the EUROCONTROL area in 2017.

Section 3.2 describes the main changes in air traffic demand by Air Traffic Service Providers (ANSP) in 2017. Section 3.3 analyses ANS-related operational en-route efficiency by evaluating constraints on airspace users' flight trajectories, including en-route ATFM delays and horizontal and vertical flight efficiency. Flexible use of airspace is addressed in Section 3.4.

The performance indicators used for the analysis in this chapter, expected benefits and supporting initiatives are shown in Table 3-1 below.

Related indicators in this chapter	• En-route ATFM delays [ICAO GANP KPI07] • Horizontal en-route flight efficiency [ICAO GANP KPI04/ KPI05] • Vertical en-route flight efficiency [ICAO GANP KPI18]
Expected benefits	• Reduce delay and fuel burn (CO_2 emissions) • Improve route network design • Improved airspace management (Civil/Military coordination)
Supporting projects/ initiatives	• Free route airspace (FRA) • Route network design improvements • Flexible use of airspace (FUA) • Enhanced flow performance through network operational planning

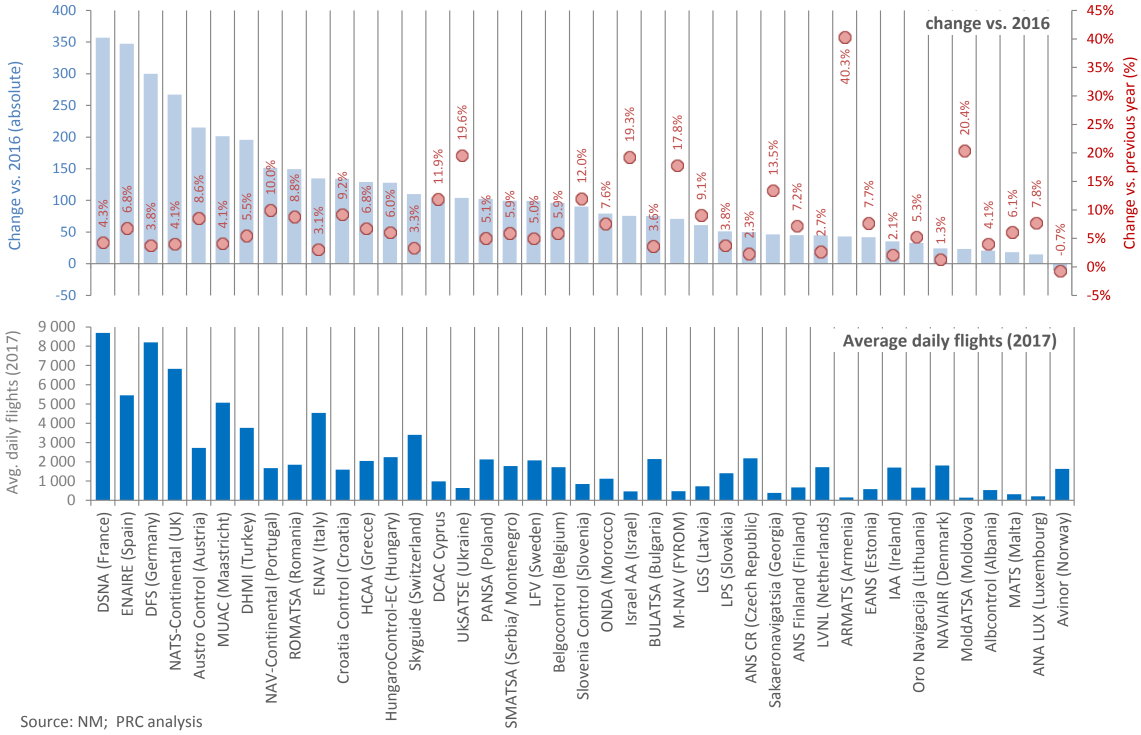
Table 3-1: Operational en-route ANS performance (Overview)

Based on the work of the PRC and the international benchmarking activities, some of the indicators used in this chapter are also promoted by ICAO as part of the update of the Global Air Navigation Plan (GANP). When applicable, the corresponding GANP indicators are shown in brackets in the list of performance indicators in Table 3-1. More information on the GANP indicators is available online in the ICAO performance objective catalogue [7].

The ATFM delay cost estimates in this report are based on a study from the University of Westminster [8] which addresses estimated costs to airspace users. Inevitably, there are margins of uncertainty in delay costs estimates, which should therefore be handled with caution. The report is available for download on the PRC website.

3.2 Traffic evolution

Figure 3-1 shows the number of average daily flights by ANSP in 2017 at the bottom and the change compared to 2016 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.



Source: NM; PRC analysis

Figure 3-1: Traffic evolution by ANSP (2017/2016)

The 4.3% traffic increase in the EUROCONTROL area in 2017 was not homogenous throughout the network. All ANSPs except Avinor (Norway) showed an increase in traffic compared to 2016.

In absolute terms, DSNA (France), ENAIRE (Spain), DFS (Germany) and NATS (UK) showed the highest year on year growth in 2017.

It is also noteworthy that traffic is starting to recover in Ukraine after the substantial reduction following the start of the crisis in Ukraine and the downing of MH17 in 2014.

Figure 3-2 illustrates the traffic growth by Area Control Centre (ACC) which confirms the contrasted picture already observed at ANSP level in Figure 3-1.

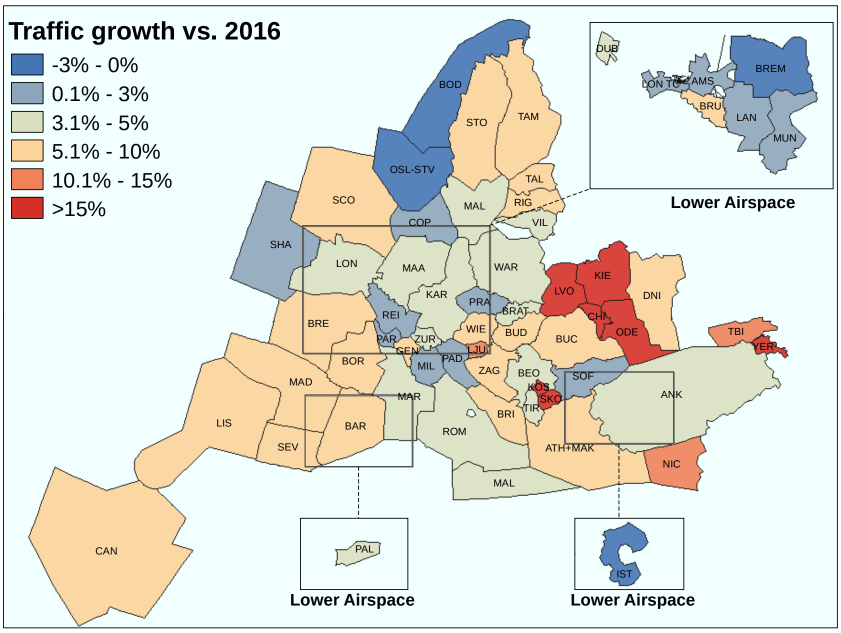


Figure 3-2: Traffic growth by ACC (2017)

ANS performance needs to consider air traffic **variability** and **complexity**. Providing sufficient capacity to satisfy demand in the future involves a number of factors including, inter alia, the order of magnitude of the expected traffic volume changes, the lead time before the change occurs, the level of predictability, and the level of flexibility in capacity deployment.

Figure 3-3 provides an indication of the level of variability between peak and average weeks in each of the ACCs in 2017. Comparatively high levels can be observed in ACCs affected by holiday traffic peaks in the summer. In some ACCs, traffic in the peak week is more than 50% higher than in the average week.

The annual complexity score for each ANSP in 2017 is shown in Figure 3-4. It combines the adjusted traffic density (x-axis) and structural complexity (y-axis). More information on the methodology and more granular data are available from the ANS performance data portal.

The various ANSPs show a contrasted picture in terms of complexity with Skyguide showing the highest level, followed by NATS, Maastricht, DFS and Belgocontrol.

Figure 3-5 shows a map of the traffic complexity by ACC in 2017. As can be expected, the highest complexity scores are observed in the European core area with scores notably higher than the EUROCONTROL average.

It is important to point out that traffic variability and complexity in this section are shown as weekly or annual averages. The results can differ notably at other granularity levels (daily, hourly, etc.).

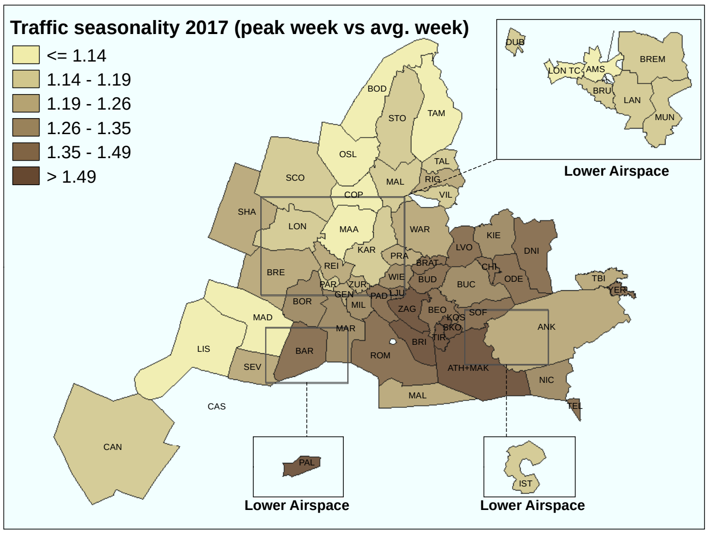


Figure 3-3: Traffic variability by ACC (2017)

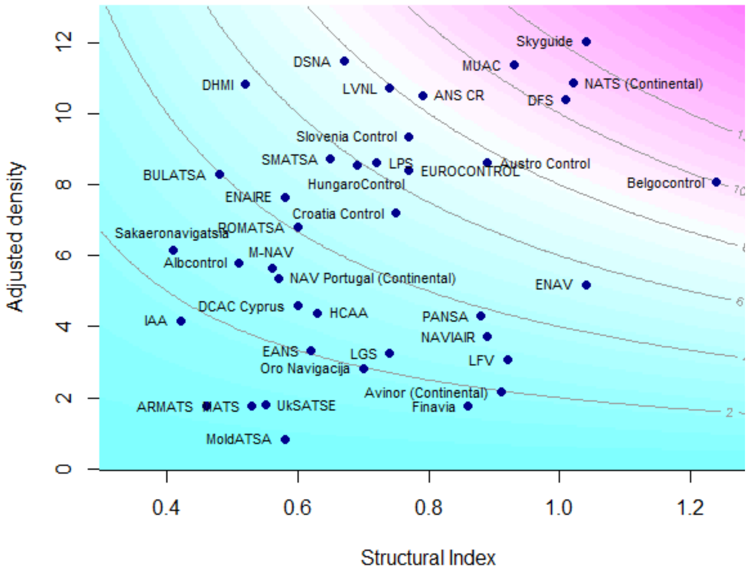


Figure 3-4: Traffic complexity by ANSP (2017)

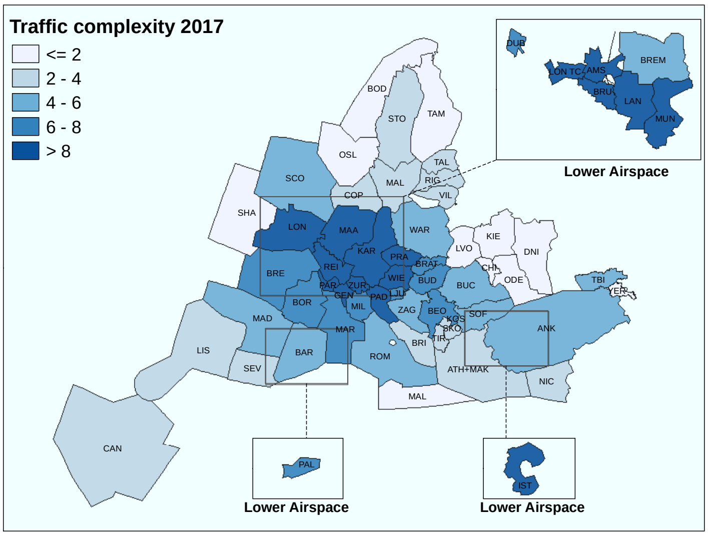


Figure 3-5: Traffic complexity by ACC (2017)

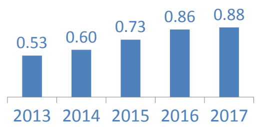
3.3 ANS-related operational en-route efficiency

This section evaluates ANS-related flight efficiency constraints on airspace users’ flight trajectories. It addresses several performance areas including efficiency (time, fuel), predictability and environmental sustainability (emissions, noise).

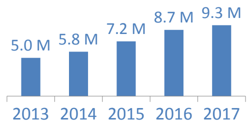
3.3.1 En-route air traffic flow management (ATFM) delays

Following the trend over the past three years, total en-route ATFM delays continued to increase at a higher rate (+7.1% vs. 2016) than flights (+4.3% vs. 2016) leading to a further increase in the average en-route ATFM delay per flight in 2017.

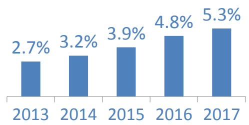
In 2017, 5.3% of all flights in the EUROCONTROL area were delayed by en-route ATFM regulations, which corresponds to a 0.6 percent point increase year on year.



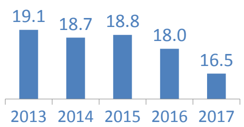
0.88 min (+0.03% vs. 2016)
average en-route ATFM delay per flight



9.3M min (+7.1% vs. 2016)
En-route ATFM delay



5.3 % (+0.6% pt. vs. 2016)
en-route ATFM delayed flights



16.5 min (-1.5 min vs. 2016)
ATFM delay per en-route delayed flight

At the same time, the average en-route ATFM delay per delayed flight decreased from 18.1 to 16.5 minutes per flight.

The analysis in this section focuses on constraints imposed on aircraft operators through the implementation of en-route ATFM regulations.

Figure 3-6 provides a more detailed breakdown of en-route ATFM delays, according to the delay classifications, as reported by the local flow management positions (FMPs).

As was the case in previous years, Capacity & Staffing attributed delays remain by far the main portion of en-route ATFM delays (59.9%), followed by Weather attributed delays (23.2%), ATC disruptions/industrial actions (9.9%) and Event attributed delays (3.1%) which also includes delays due to ATC system upgrades.

Constraints imposed by en-route ATFM delays	Delayed flights 2017	Delayed flights vs 2016	Delay per delayed flight 2017	Delay per delayed flight vs 2016	Total delay minutes 2017	Total delay minutes % of total	Total delay minutes vs 2016
ER Capacity (ATC)	2.6%	0.4%	14.6	-0.8	4.0 M	43.4%	0.5 M
ER Staffing (ATC)	1.0%	0.3%	13.9	-2.1	1.5 M	16.4%	0.3 M
ER Disruptions (ATC)	0.3%	0.0%	33.1	-5.9	0.9 M	9.9%	-0.1 M
ER Weather	1.0%	0.2%	20.4	-0.2	2.1 M	23.2%	0.6 M
ER Events	0.2%	-0.3%	13.7	-3.3	0.3 M	3.1%	-0.5 M
ER Capacity	0.1%	0.1%	14.3	-1.0	0.2 M	2.3%	0.1 M
ER Disruptions	0.1%	-0.1%	20.0	-0.8	0.2 M	1.7%	-0.1 M
Total	**5.3%**	0.6%	**16.5**	-1.5	**9.3 M**	**100%**	**0.6 M**

Figure 3-6: En-route ATFM delays by reported cause

Figure 3-7 shows the share of en-route ATFM delayed flights by delay category between 2012 and 2017. There has been a continuous increase in the share of flights delayed due to ATC capacity, staffing, and weather attributed en-route ATFM regulations which require careful evaluation.

The further performance deterioration observed in 2017 confirms the PRC concerns, raised on several previous occasions, that ATFM delays could increase significantly when traffic grows again if insufficient priority is given to timely capacity planning and deployment.

Combined, 3.6% of all flights were delayed due to ATC Capacity or Staffing attributed ATFM regulations, an increase of 0.6 percent points on 2016.

Despite a slight reduction in average delay per delayed flight, ATC Capacity and Staffing attributed en-route ATFM delays amounted to 5.6 million minutes of delay which corresponds to an estimated €560M in additional costs to airspace users.

As can be seen in Figure 3-8 (right-hand graph) DSNA (France), DFS (Germany), EUROCONTROL (Maastricht UAC), and ENAIRE (Spain) accounted for more than three quarters of total ATC Capacity or Staffing attributed en-route ATFM delay in 2017.

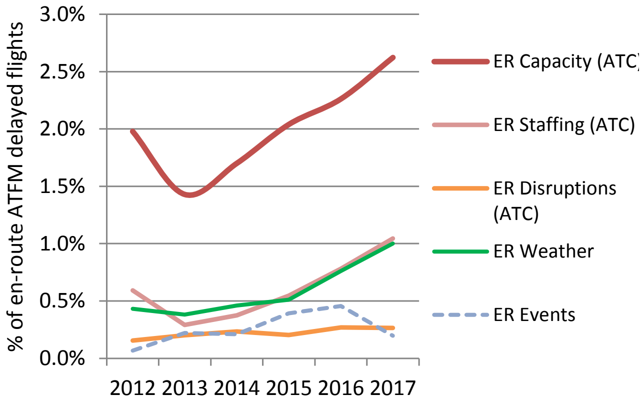


Figure 3-7: Share of en-route ATFM delayed flights by attributed delay category

Impact of ATC capacity & staffing attributed ATFM delays on airline operations (2017)

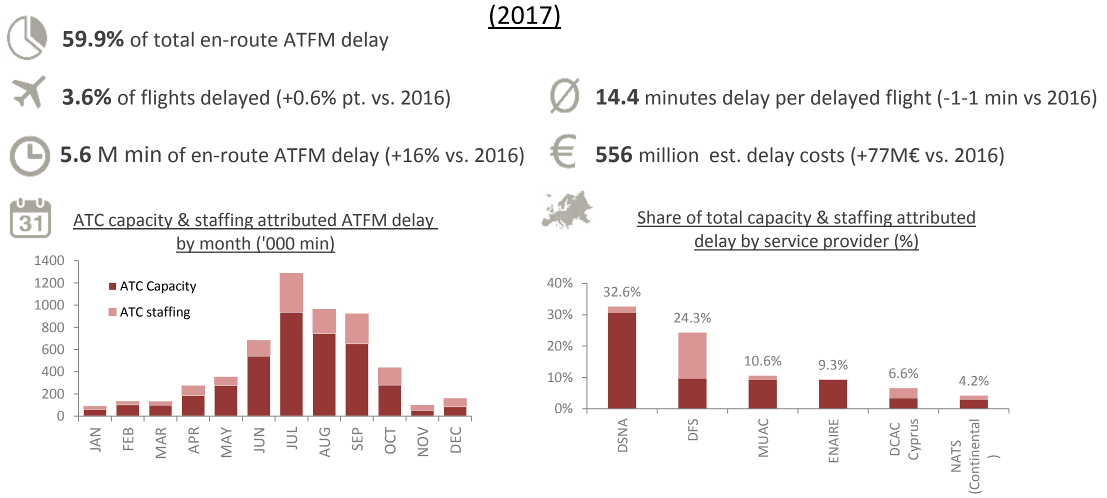


Figure 3-8: Estimated ATC Capacity & Staffing attributed impact on airline operations (2017)

Figure 3-9 shows the share of ATC Capacity & Staffing attributed en-route ATFM delay by ACC area of responsibility in 2017.

It can be seen that ATC Capacity & Staffing attributed en-route ATFM delays are concentrated in five ACCs (Karlsruhe, Marseille, Brest, Maastricht, and Nicosia) which together accounted for 62% of all ATC Capacity & Staffing attributed delay in 2017.

The PRC analysed the "ATC Capacity & Staffing" delay category in terms of (i) delay attributed to elementary sectors and (ii) delays attributed to collapsed sectors which, by being collapsed, already limited the available capacity for airspace users.

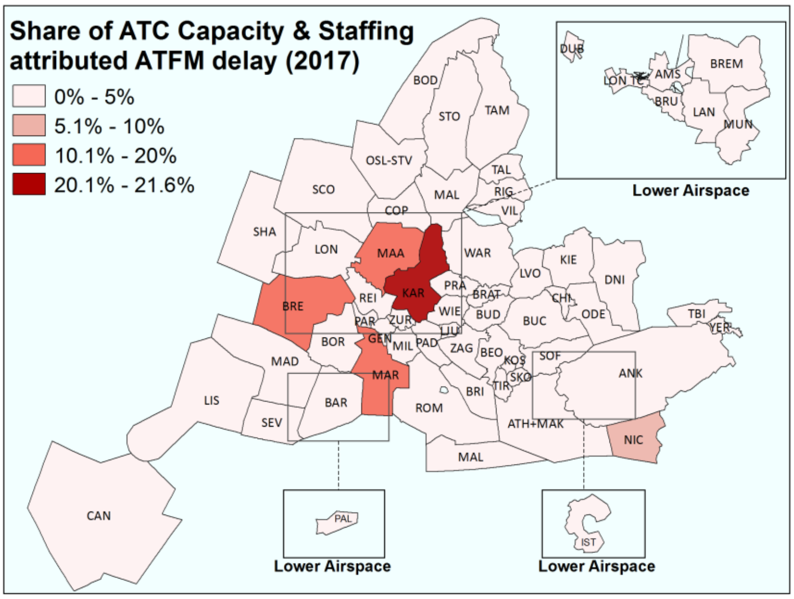


Figure 3-9: Share of capacity/staffing attributed en-route ATFM delay

The PRC recognises that certain elementary sectors are always collapsed (For example a ‘sector’ with three vertical elements may only ever be opened as two superimposed sectors, with a variable upper/lower interface). Therefore the PRC considers only laterally adjacent sectors and the complete aggregation of constituent vertical sectors (e.g. 3/3 vertical elements) as being ‘collapsed’ in this analysis.

Figure 3-10 shows that a significant amount of ATFM en-route delays were attributed to ATC sectors that were already applying capacity constraints by being collapsed.

Collapsed Sector

An ATC sector that can be de-collapsed/split into two or more pre-defined operational sectors, to provide additional capacity.

ATC workload is the critical element to ensure safety: the ATCO needs to effectively identify, assess, solve, and monitor the resolution of conflicts. Larger sectors mean more potential conflict points to be assessed, solved and monitored - smaller sectors allow ATCO to focus on fewer number of potential conflict points.

Collapsing sectors, whilst reducing ATC workload associated with the handover of traffic, generally raises ATC workload due to increased number of potential conflict points. In certain cases, collapsing sectors may also require the ATCO to change the scaling of the ATM situation display making the assessment of potential conflicts more problematic.

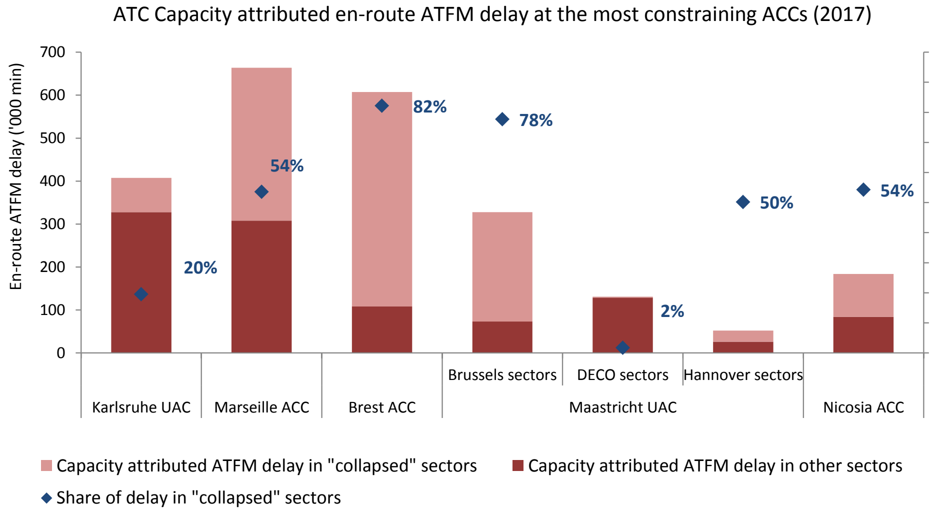


Figure 3-10: Capacity attributed en-route ATFM delay at the most constraining ACCs (2017)

Airspace users should not receive delays or other penalties due to ANSP-internal capacity constraints. Table 3-2 shows the staffing attributed en-route ATFM delays by ACC, the share of the total ATC staffing attributed en-route ATFM delays, and an estimate of the associated costs to airspace users in 2017.

ANSP Entity	Total en-route delay attributed to ATC staffing (000 minutes)	Share of Network ATC staffing attributed delays (2017)	Approximate cost to users due to inadequate staffing
Karlsruhe UAC	732	48%	€73 million
Nicosia ACC	180	12%	€18 million
Athinai/Makedonia ACC	81	5%	€8 million
Langen ACC	79	5%	€8 million
MUAC	76	5%	€8 million
Brest ACC	53	3%	€5 million
Marseille ACC	44	3%	€4 million

Table 3-2: En-route ATFM delays attributed to ATC staffing (2017)

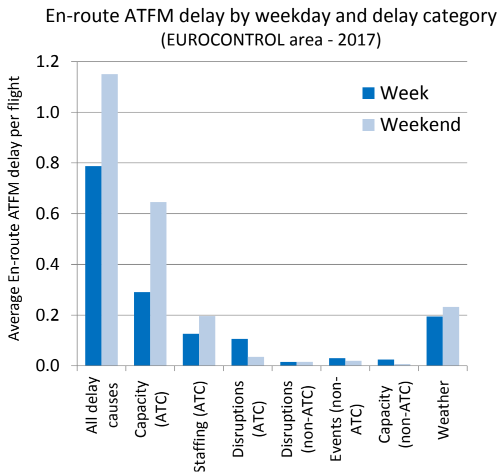
The PRC notes the asymmetric cost of ATC staffing delays: deploying adequate staffing levels may infer a cost for the ANSP (passed on to the users if the full cost-recovery methodology is applicable) whereas failing to deploy sufficient staffing levels results in significant costs for the users but no associated direct costs for the ANSPs.

Failing to provide adequate staffing levels can include failing to anticipate future ATCO levels and train replacements; failing to address existing capacity problems by planning for capacity growth; failing to deploy existing ATC staff according to traffic demand; failing to consider normal staff absences due to sickness etc.; failing to consider foreseeable essential training requirements and operational-related activities – both current and developmental, and the amount of non-critical ancillary activities being performed by ATC qualified personnel etc.

The PRC considers that ANSPs have the capability to mitigate or resolve each facet of staffing issues. ANSPs can review succession planning and implement adequate training programs; ANSPs can evaluate current and future capacity constraints and implement proactive capacity plans; ANSPs can evaluate the priority given to non-critical ancillary activity demands against the current staffing situation. ANSPs can implement rostering flexibility to ensure that suitable staff numbers are available to satisfy traffic demand. ANSPs can ensure sufficient staffing cover to handle staff absences due to essential training and operational-related activities, as well as vacation and sickness.

Closer examination of ATFM en-route delays also shows that the 50% higher average delay per flight on weekends in the EUROCONTROL area (despite a 11% lower traffic level and minimal military training activity) is mainly due to ATC Capacity and ATC Staffing attributed delays, which are substantially higher on weekends (see left side of Figure 3-11). From previous analyses it is known that the traffic patterns change on weekends both in space and time: fewer short-haul and domestic flights.

The analysis on the right side of Figure 3-11 shows the ACCs where the difference in average en-route ATFM delay between weekdays and weekends was greater than 0.2 minutes per flight (y-axis). The x-axis provides an indication of the change in traffic and the size of the bubble gives an indication of delay that could be avoided if the flights on weekends had the same average delay than on weekdays.



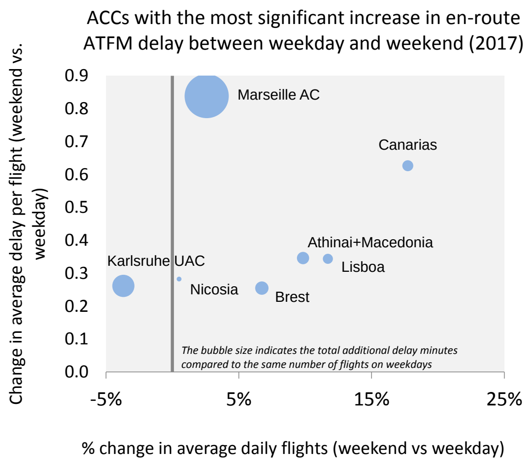


Figure 3-11: Changes in week/weekend delay (2017)

The increase observed on weekends is predominantly driven by Marseille ACC, Karlsruhe UAC, Brest ACC, Athinai/Macedonia ACC, Canarias ACC, Lisboa ACC and Nicosia ACC.

With the exception of Karlsruhe UAC (where more than 40% of the delay on weekends was attributed to ATC Staffing), the ACCs reported higher average-traffic on weekends than on weekdays despite the lower overall traffic level at EUROCONTROL level.

The trends shown in Figure 3-7 also show a substantial increase in weather-attributed en-route ATFM delays shown in more detail in Figure 3-12. In 2017, weather attributed en-route ATFM delays accounted for 23.2% of all en-route ATFM delays delaying 1.0% of the flights but with a comparatively high average delay per delayed flight of 20.4 minutes.

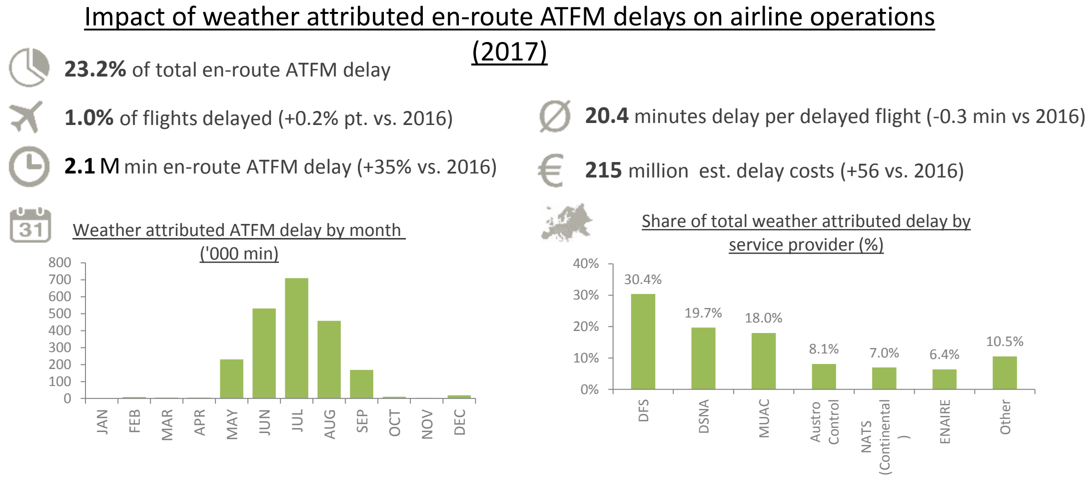


Figure 3-12: Impact of weather attributed en-route ATFM delays on airline operations (2017)

More than two thirds of the weather attributed en-route ATFM delay in 2017 were allocated between DFS (30.4%), DSNA (19.7%) and MUAC (18%). Figure 3-13 shows that the vast majority of the weather-attributed en-route ATFM delays were located in the core area with the highest density of traffic.

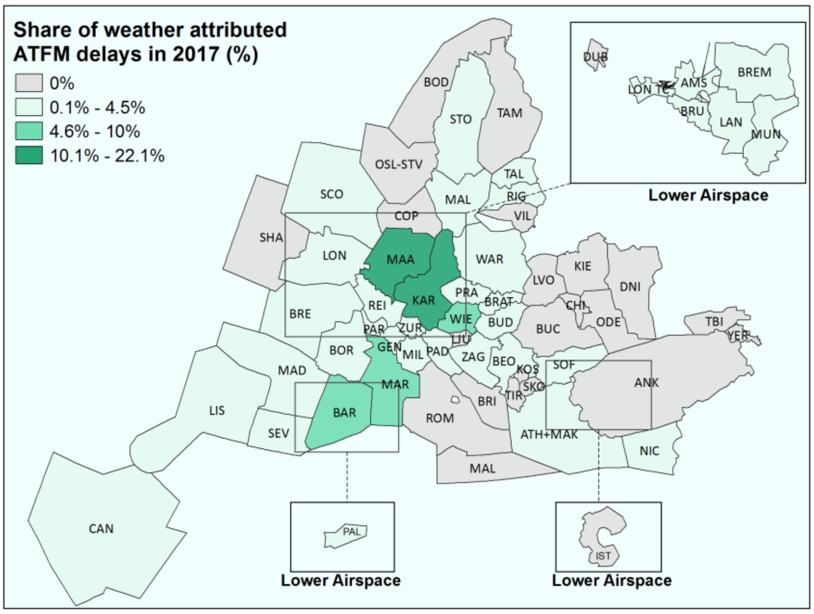


Figure 3-13: Share of weather attributed en-route ATFM delay (2017)

As with ATC Capacity & Staffing attributed ATFM delays, the weather attributed delays were concentrated in a few ACCs/UACs. Together, Karlsruhe, Maastricht, Marseille, Wien, and Barcelona accounted for 63% of total weather attributed en-route ATFM delay in 2017.

Altogether, the costs of weather attributed en-route ATFM delay in Europe are estimated to be around €215 million, an increase of €56 million compared to 2016.

Closer analysis was carried out on the weather-attributed en-route ATFM delay during 2017 in terms of delays attributed to elementary sectors and delays attributed to collapsed sectors which, by being collapsed, were already limiting the available capacity for airspace users.

It is evident, from the analysis in Figure 3-14, that a considerable amount (more than 60%) of weather attributed ATFM en-route delays was attributed to ATC sectors that were already applying capacity constraints by being collapsed. Since weather-attributed capacity constraints result in partial reduction of available capacity the effects are amplified in collapsed sectors, compared to sectors being opened at declared capacity levels.

For example, adjacent (or superimposed) sector A and sector B have respective declared capacities of 50 and 40 flights per hour giving up to a maximum of 90 flights per hour. When collapsed into sector AB, the declared capacity is 70 flights per hour.

If adverse weather reduces capacity by 20% then the resulting capacity of sector AB will be 56 flights per hour, whereas, if sector A and sector B are opened simultaneously, the available capacity will be 40 (sector A) and 32 (sector B) giving a maximum of up to 72 flights per hour in the same airspace.

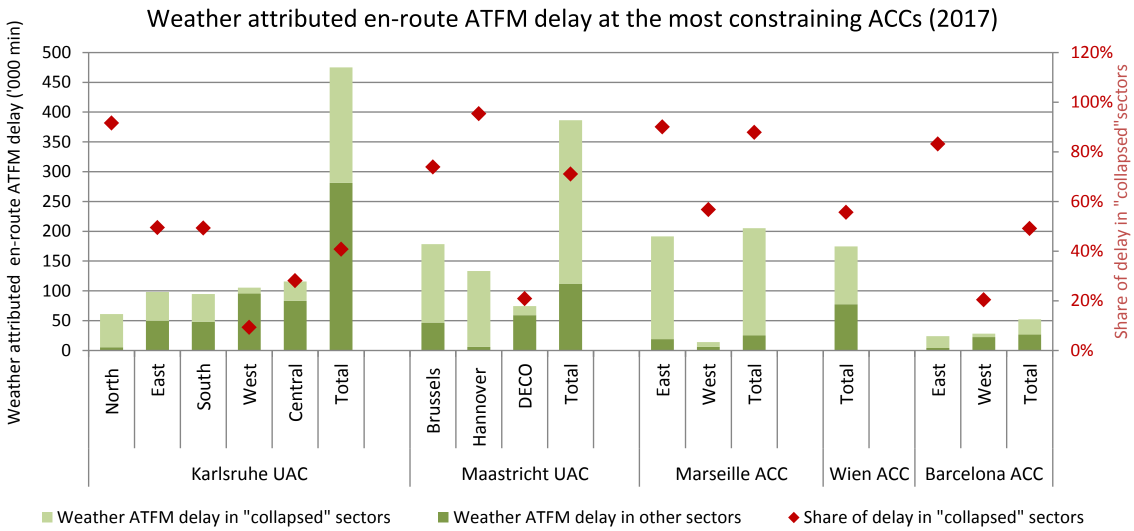


Figure 3-14: Weather attributed en-route ATFM delay at the most constraining ACCs (2017)

Table 3-3 shows the weather attributed en-route ATFM delays by originating entity, the share of the total weather attributed delay and an estimate of the associated costs to airspace users in 2017.

ANSP Entity	Total en-route delay attributed to en route weather (000 minutes)	Share of network total of weather attributed delays (2017)	Approximate cost to users due to impact of adverse weather
Karlsruhe UAC	475	22%	€48 million
MUAC	387	18%	€39 million
Marseille ACC	203	10%	€20 million
Wien ACC	175	8%	€17 million
Barcelona APP & ACC	106	5%	€11 million

Table 3-3: En-route ATFM delays attributed to weather (2017)

It appears that capacity constraints are frequently attributed to external factors, such as weather, instead of the internal cause of the initial capacity constraint, such as ATC staffing – which can be resolved or mitigated by the ANSP.

The PRC considers that the effects of adverse weather on ATC capacity can be greatly mitigated if ATC sectors are opened to satisfy the actual traffic demand.

Most constraining ANSPs and ACCs

Figure 3-15 shows the most constraining ANSPs in 2017, based on the share of flights delayed by ATFM regulations (x-axis) and the average delay per delayed flight (y-axis).

In 2017, DSNA (France) generated 33.4% of all en-route ATFM delays in the EUROCONTROL area, followed by DFS (23.1%), Maastricht (13.3%), ENAIRE (7.9%), and DCAC Cyprus (4.3%).

In 2017, more than 4% of the flights going through airspace controlled by Cyprus, DSNA, DFS, and MUAC were delayed by ATFM regulations with varying levels of average delay per delayed flight.

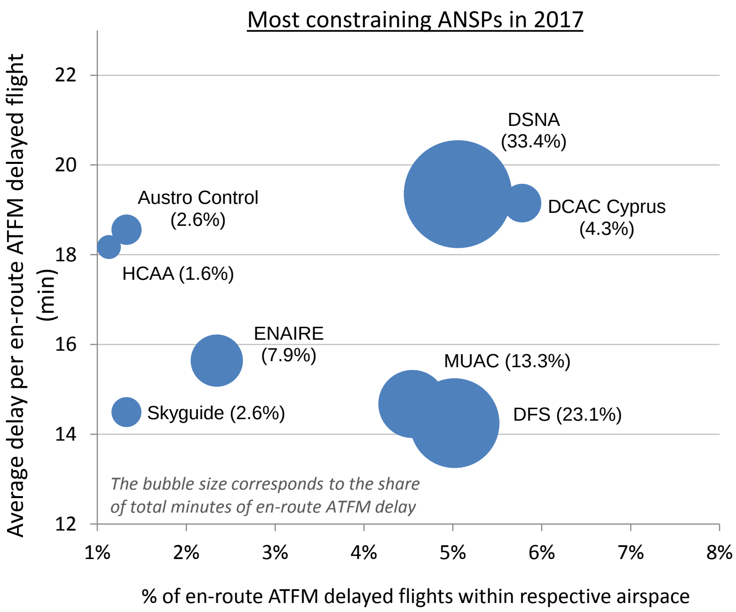


Figure 3-15: Most constraining ANSPs in 2017

Figure 3-16 shows the same analysis at ACC level based on ACCs, which delayed more than 2% of flights going through their respective airspace in 2017.

Based on this analysis, Karlsruhe UAC, Maastricht UAC, Marseille, Brest, Bordeaux, Nicosia and Barcelona were the most constraining ACCs in 2017.

It is interesting to note the differences in the share of delayed flights and the average delay per delayed flight.

Together, those seven ACCs accounted for almost 70% of total en-route ATFM delays in the EUROCONTROL area in 2017.

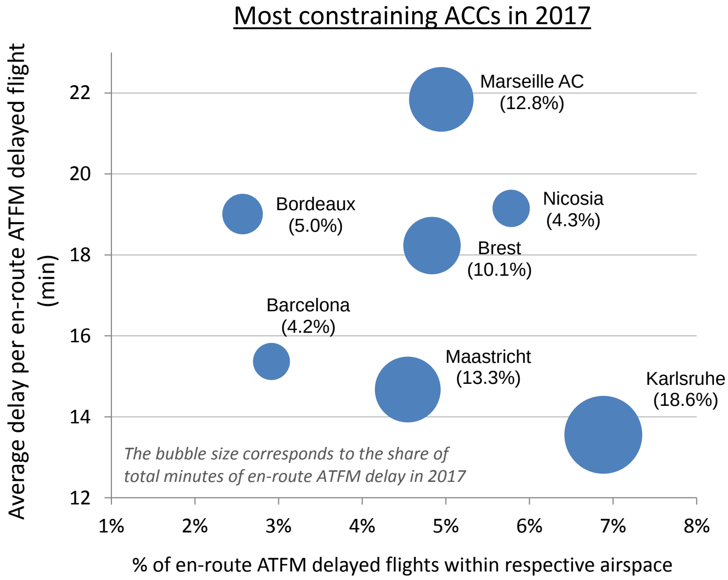


Figure 3-16: Most constraining ACCs in 2017

In previous Performance Review Reports the PRC looked at the 'most penalising ACCs' over the preceding twelve month period and tried to identify the main constraints to capacity performance in each ACC. For this PRR the PRC has decided to take a different approach.

The PRC has decided to focus on the individual ATFM regulations caused by capacity bottlenecks, resulting in delays to airspace users. Since ATFM regulations attributed to ATC staffing and adverse weather have already been highlighted above, the PRC has decided to concentrate on the en-route ATFM delays attributed to ATC capacity.

To most people, a regulation attributed to ATC capacity would be expected when the traffic demand is higher than the declared capacity of the ATC sector. (The declared capacity can be considered as a safety brake to prevent the relevant ATCO from becoming overloaded.) It is frequently assumed (but not always correct) that increasing the declared capacity of a sector would require some form of investment by the ANSP, or the NSA, be it in providing additional, or more proficient, ATCOs; better equipage or changes in airspace structures.

The PRC has conducted several analyses on capacity bottlenecks, beginning with the most penalising individual en-route ATFM regulation which, in the opinion of the FMP requesting the regulation, should be attributed to ATC capacity.

Capacity Bottlenecks: Most penalising ATFM regulations attributed to ATC capacity

Table 3-4 below shows the most penalising individual ATC capacity attributed en-route ATFM regulations in 2017.

Date	ANSP entity (ACC or sub-ACC)	Total delay for single regulation (minutes)	Geographical location – specific sector configuration	Total Capacity attributed delay at same specific sector configuration 2017
22/06/2017	MUAC Brussels sectors	8 777	Brussels East High FL335+	69 339
16/07/2017	Nicosia ACC	7 441	NICOSIA E1 + E2 GND-UNL	90 852
25/02/2017	Canarias ACC	6 997	Norte Este sector	43 656
22/06/2017	MUAC DECO sectors	6 553	Delta West Low sector FL245-FL355	62 930
30/09/2017	Marseille ACC	5 254	LFMST + LFMBT + LFMAJ + LFMMN	54 870
22/07/2017	Marseille ACC	5 216	LFMST + LFMBT + LFMAJ + LFMMN	54 870
11/02/2017	Paris ACC	5 144	PARIS PU + TU+ HP + UT + UP	11 420
22/06/2017	MUAC DECO sectors	5 020	Delta West High FL355+	65 775
25/03/2017	Canarias ACC	4 814	Norte Este sector	43 656
12/08/2017	Karlsruhe UAC	4 457	Soellingen 245-355	44 464
09/04/2017	Nicosia ACC	4 406	NICOSIA S1 GND-UNL	55 926
01/07/2017	MUAC Brussels sectors	4 387	BRUS OLNO FL245-999	151 589

Table 3-4: Twelve most penalising ATFM regulations attributed to ATC capacity in 2017

The PRC is aware that several of the ANSPs monitor capacity throughput based on sector occupancy rather than strictly according to sector entries. The PRC is also aware that ANSPs and the Network Manager also apply Short Term ATFCM measures (STAM) to particular flights to avoid imposing regulations. The PRC notes that both these approaches can provide higher hourly throughput of traffic whilst ensuring safety, than using the sector entries approach. However, when the expected demand exceeds the available capacity (based on occupancy) the ANSP reverts to the normal capacity regulation process as implemented by the Network Manager and requests regulations based on sector entries. Therefore the analysis of regulations based on sector entries is also valid for those ANSPs that use sector occupancy.

The analysis considered historical capacity and traffic data from NEST[13] and ATFM source data from Network Manager, as used in other PRU reports.

Methodology of Analysis

The PRC considered the sector infrastructure for each of the geographical locations associated with the ATFM regulations. This includes physical characteristics such as vertical or lateral limits; possibility for collapse/de-collapse including respective declared capacity; and historic delays for the same locations.

Civil/Military airspace structures were considered and whether or not they were reserved or allocated for military operations and training on the day of operations. The notified meteorological conditions were reviewed, both forecasted and actual in the relevant airspace and surrounding areas.

The PRC reviewed the evolution of the capacity constraints and ATFM regulations on the day of operations, with special regard to regulated capacity levels and other relevant ATFM regulations e.g. re-routing scenarios in place.

Finally, where relevant, the PRC reviewed the historic evolution of declared capacity for each sector using ATFM regulations from previous years.

13 EUROCONTROL Network Strategic Tool

Common themes

Analysis of the most penalising individual ATC capacity attributed en-route ATFM regulations in 2017 highlighted a number of common themes. These are shown below, together with links to previous relevant PRC recommendations:

- **Attribution of external capacity constraint:** The influence of adverse weather and/or military activity operations and training was not always reflected in the reason for regulation.

  (Recommendations in PRR2015 and PRR2013 requested States "to accurately identify specific capacity constraints that adversely impact the service provided to airspace users" and "ensure an accurate and consistent classification of ATFM delays to enable constraints on European ATM to be correctly identified and resolved or mitigated")

- **Application of internal capacity constraints:** ANSPs were regulating traffic at capacity levels below the published declared capacity (without providing an explanation); were safely handling traffic for sustained periods at levels above published declared capacity, or were publishing declared capacity levels, and regulating traffic, at levels lower than historic figures for the same sector configuration. In such cases there would appear to be potential latent capacity that could be provided to airspace users at no cost to the ANSP.

  (Recommendation in PRR2015 requested Member States "…to review sector capacities, both with and without airspace restrictions, to increase network performance.")

- **Operation of collapsed sectors during periods of high demand:** ICAO expects ANSPs to provide sufficient capacity to handle traffic during peak demand periods. Reducing capacity levels in peak periods by operating collapsed sectors is an issue that can, and should, be remedied by ANSPs.

  (Recommendations in PRR2015 and PRR2014 requested States "…to provide capacity to meet demand instead of regulating demand to meet reduced capacity" and "to ensure that capacity is made available during peak demand.")

- **Resolving capacity bottlenecks**: Capacity bottlenecks, even those that have been bottlenecks for a considerable period of time, are not being mitigated or resolved through the addition of extra capacity.

  (Recommendations from PRR2014, PRR2012 and PRR2011, requested States to "develop and implement capacity plans which are at minimum, in line with reference capacity profile…"; "taking due consideration of forecasted traffic demand; ensure capacity plans are implemented as promised…" and "to implement a forward-looking and proactive approach to capacity planning, in order to close existing capacity gaps and to accommodate future traffic growth.")

3.3.2 En-route flight efficiency

This section evaluates en-route flight efficiency in the EUROCONTROL area. En-route flight efficiency has a horizontal (distance) and vertical (altitude) component. More information on methodologies (approach, limitations) and data for monitoring the ANS-related performance is available online at: http://ansperformance.eu/.

The European ATM system needs to become more efficient to keep up with demand and to reduce operational inefficiencies while coping with increasing traffic levels. Nonetheless, for a number of reasons including inter alia, safety, weather and capacity issues, 100% flight efficiency can never be achieved.

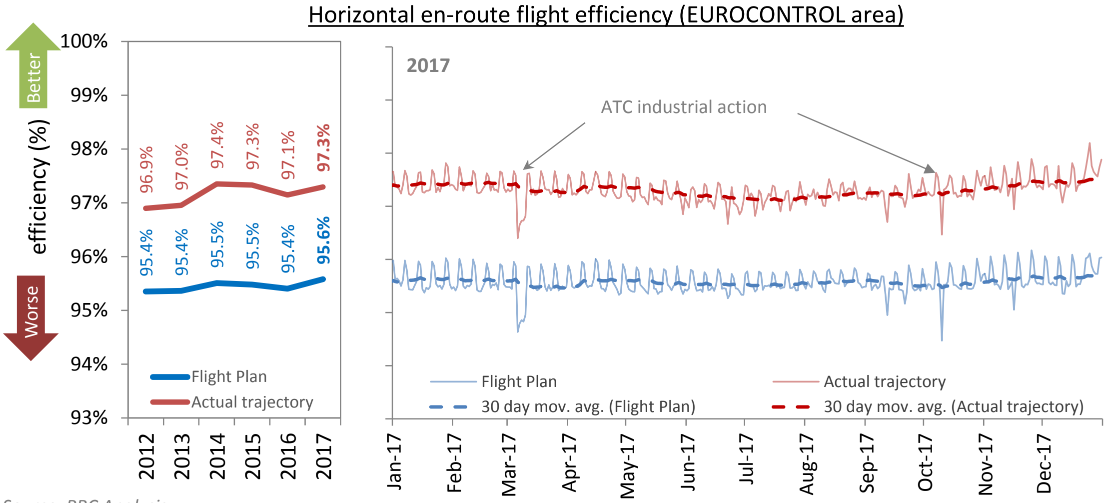
Environmental sustainability, *positive effect on noise and air quality*

Flight efficiency has an environmental component as extra fuel burn is directly proportional to extra emissions.

3.3.2.1 Horizontal en-route flight efficiency

Horizontal flight efficiency is expressed as ratio of total distances and is therefore an average per distance (within the areas) and not an average per flight. It should be noted that the 100% level is a theoretical value which for the various reasons (see above) can never be achieved.

Figure 3-17 shows the en-route flight efficiency for the actual trajectory and the last filed flight plan for the EUROCONTROL area[14].



Source: PRC Analysis

Figure 3-17: Horizontal en-route flight efficiency (EUROCONTROL area)

Horizontal flight efficiency in filed flight plans increased from 95.4% in 2016 to 95.6% in 2017 at Pan-European level and the efficiency of actual trajectories increased from 97.1% to 97.3% in 2017. This was achieved even though there was a significant increase in traffic in 2017.

Although on fewer days than in 2016, the daily values on the right side of Figure 3-17 clearly shows the effects of ATC industrial action on specific days in 2017.

Flight efficiency is expressed as a percentage with respect to distances, without specific consideration of the number of flights. The consideration of the additional kilometres flown and the average per flight provide an additional perspective and a more complete picture of the contribution to the overall value for the EUROCONTROL area.

Figure 3-18 shows the total additional distance (actual trajectories) of the State at the top of the figure and the horizontal en-route flight efficiency by State for 2017 at the bottom. Those States where FRA is fully implemented all day are highlighted in red.

---

14 The airspace analysed in this section refers to the NMOC area.

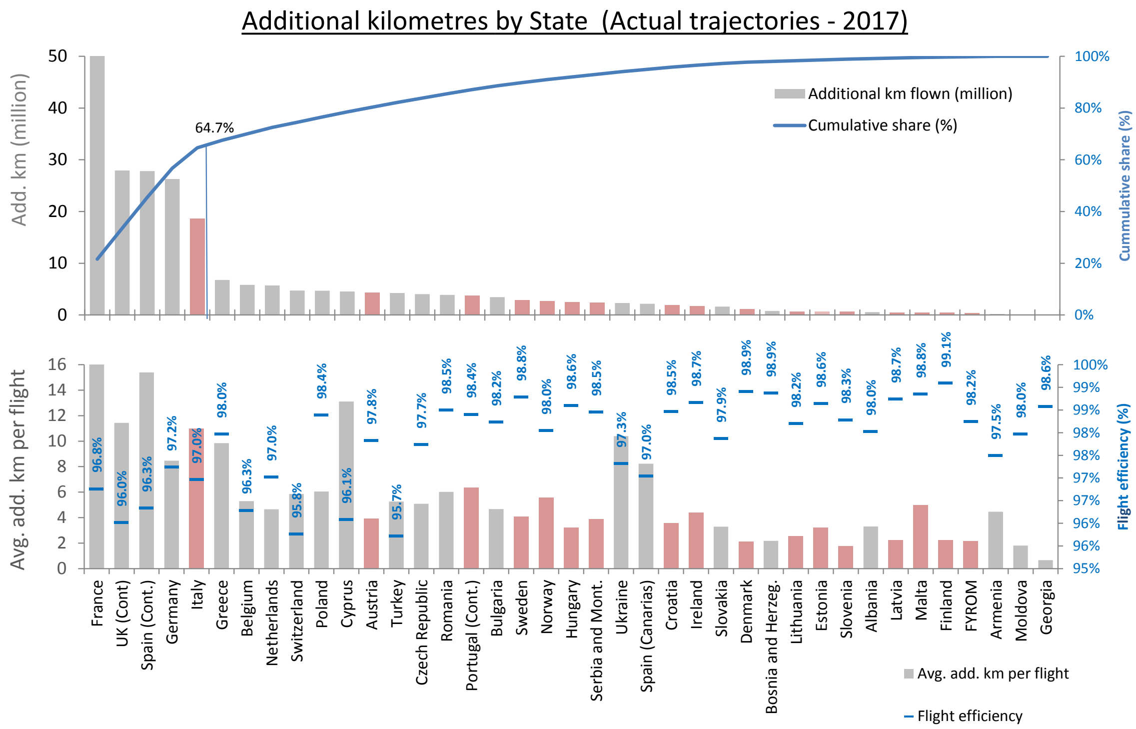


Figure 3-18: Horizontal en-route flight efficiency by State (actual trajectories – 2017)

France combines a below average flight efficiency with long average flight segments (and a high traffic volume) which consequently results in a substantial amount of total additional kilometres. As a result of the comparatively low flight efficiency and the traffic volume, France, UK, Spain (Cont.), Germany and Italy accounted for almost two thirds of total additional distance in 2017.

This is also illustrated in Figure 3-19 which shows on the left side the flight efficiency levels (actual trajectory) in 2017 by geographical location and on the right side the traffic density levels to provide an order of magnitude of the traffic volume (red lines indicate the highest segment loads) which makes it more challenging to improve flight efficiency.

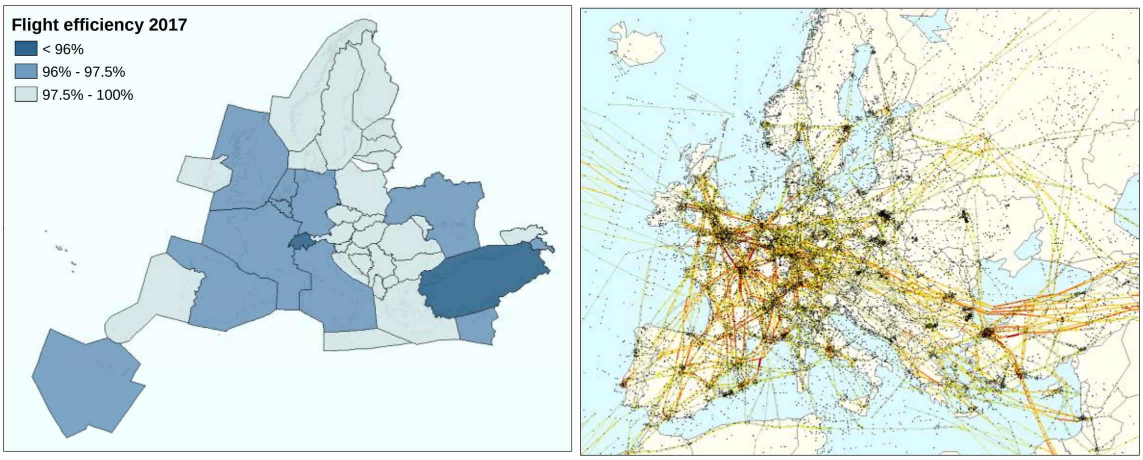


Figure 3-19: Horizontal en-route flight efficiency by State (geographical overview)

Figure 3-20 shows the changes in terms of average additional distance per flight (primary axis) and the changes in percentage points in terms of flight efficiency (secondary axis) compared to 2016 by State. The most significant improvement in 2017 was observed for Switzerland (introduction of new DCTs in 2017), followed by Italy, Spain (Canarias) and Norway.

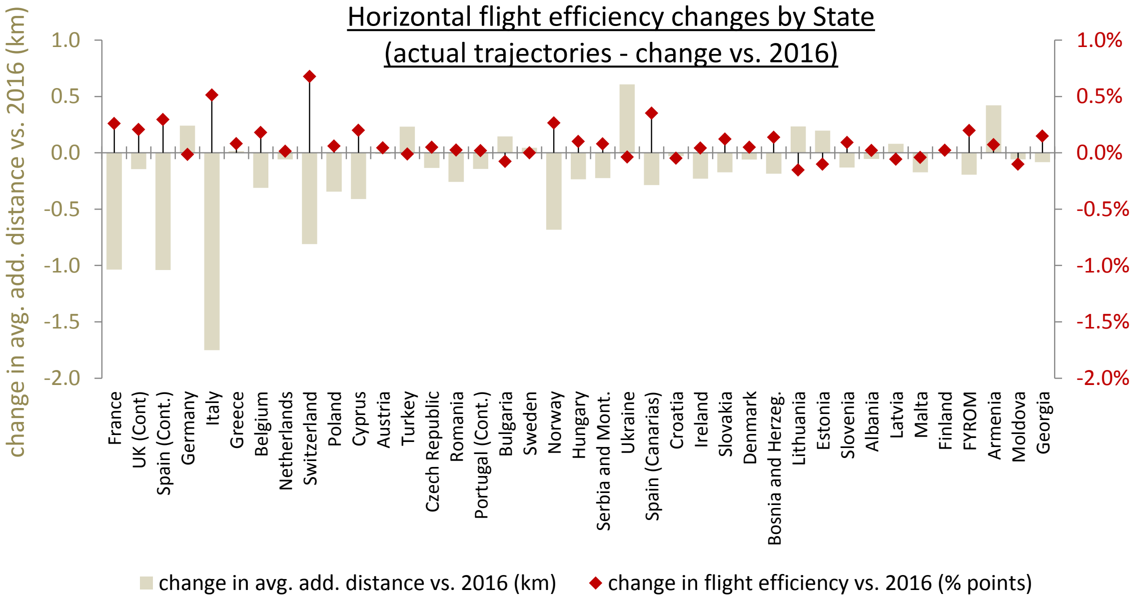


Figure 3-20: Horizontal en-route flight efficiency changes vs 2016 by State

The improvements appear to be driven by the implementation of Free Route Airspace (FRA) for overflying traffic in Italy in December 2016 and the completion of the last milestone of the North European Free Route Airspace (NEFRA) initiative in May 2017 by connecting the FRA in Norway with the FRA already available across Denmark, Estonia, Finland, Latvia, and Sweden.

FRA at various levels and times is now in place in a large part of EUROCONTROL airspace and last year's PRR underlined the benefits of the implementation of FRA which leads to more choices for airspace users and a more flexible environment responding more dynamically to changes in traffic flows. This in turn reduces fuel consumption and emissions and improves overall flight efficiency.

Free route airspace, *optimised 2D/3D Routes*

Free Route Airspace gives the aircraft operators more freedom in the choice of the flight plan and the possibility to avoid some of the restrictions imposed by a rigid route network. The expected benefits are, inter alia, reduced fuel burn (costs) and gaseous emissions.

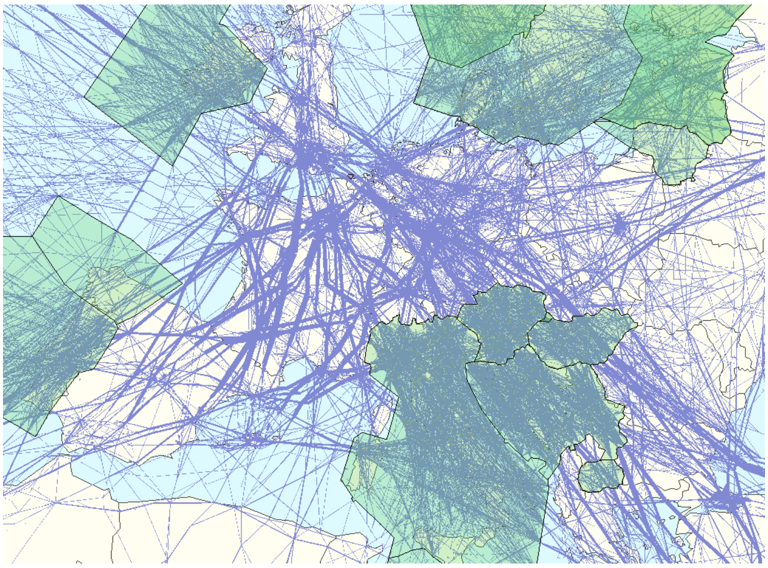


Figure 3-21: Status of free route implementation in 2017 (24H)

Figure 3-21 provides an overview of the status of the free route implementation (24H) in the EUROCONTROL area in 2017 (FRA airspace is shown in green) and the flight plan trajectories on a random summer day.

The higher degree of flexibility for flight planning is clearly visible as the trajectories are much more scattered in those areas where FRA has been successfully implemented.

Although flight efficiency can never be 100%, the benefits that the implementation of FRA can bring in terms of flight efficiency gains and resulting reductions in costs, fuel burn and emissions are substantial. Expected benefits vary by airspace and depend, inter alia, on traffic volume, complexity and other factors. Figure 3-21 shows that FRA is not yet implemented in the dense European core area which has the highest variation in terms of horizontal and vertical traffic flows.

As a result of the high traffic volumes, the benefits of even small flight efficiency improvements in the core area will be substantial but, in view of the numerous factors and complexities involved and with traffic levels growing again, improvements may become more and more challenging.

In addition to the implementation of FRA in a given airspace, ANSPs should also work actively with the Network Manager and the Deployment Manager to deliver FRA across the entire EUROCONTROL area, including necessary cross-border implementation.

The flight efficiency methodology considers the entire flight trajectory which can be broken down into a local component (within given airspace) and network component (cross-border or terminal interface). Figure 3-22 provides an analysis of the two components at EUROCONTROL level (left) and at State level (right). Those States where FRA is fully implemented all day are again highlighted in red.

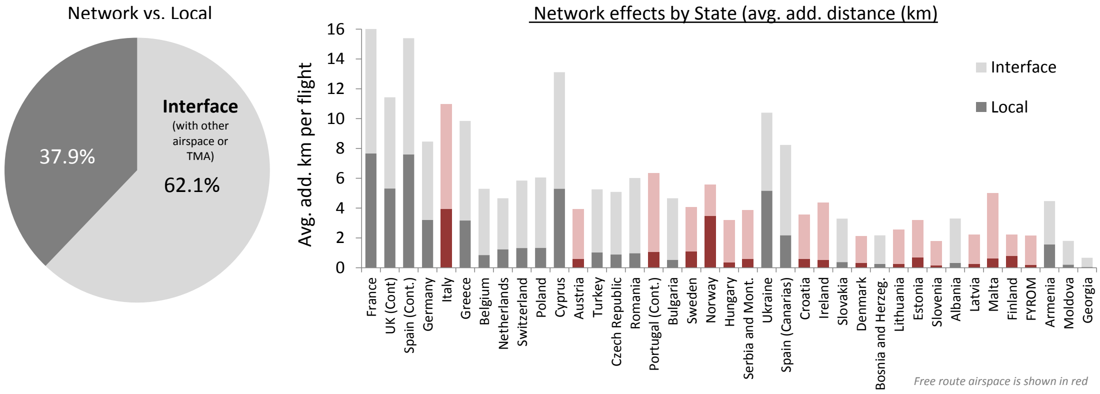


Figure 3-22: Local and network effects on flight efficiency by State (2017)

Overall, almost two thirds (62%) of the observed flight inefficiencies originate from the network component (i.e. cross-border and terminal interface).

In general, States where FRA is implemented show a very low local component (the darker part of the bars), while other States show potential for further reduction of those local inefficiencies. There is potential for additional reduction in the length of the trajectories by reducing the network component (the lighter part of the bars).

This requires the joint effort of all involved parties, best coordinated by the Network Manager. In 2016 Austria and Slovenia launched a cross-border initiative called SAXFRA which will merge with the South East Europe Free Route Airspace (SEAFRA) covering Croatia, Bosnia-Herzegovina, Serbia and Montenegro in the future.

As specified in the European ATM Master Plan and supported by Commission implementing regulation (EU) No 716/2014 [9], Free Route Airspace on a H24 basis should be implemented throughout the entire EUROCONTROL area[15] by 2022.

In this context it is important to ensure that the benefits of free route airspace can be fully exploited by airspace users in their flight planning systems. This requires all involved parties to work proactively together to create an efficient communication interface between the ANSPs and NM (airspace availability, military activity) on the one side and the airspace users including their flight plan service providers on the other side.

Similar to the analysis in Figure 3-11 on page 25 which reviewed the level of ATFM en-route delay by day of the week, Figure 3-23 evaluates the level of flight efficiency by weekday.

Contrary to the higher level of en-route ATFM delays on weekends observed in Figure 3-11, the analysis in Figure 3-23 shows that, at EUROCONTROL level, the horizontal flight efficiency is higher on weekends than on weekdays.

---

15 Updates on the status of FRA implementation can be found on the corresponding EUROCONTROL web page.

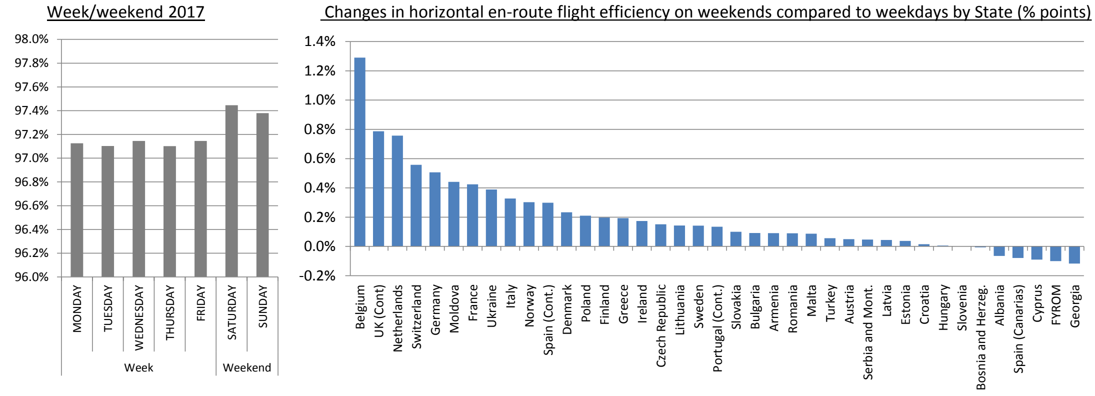


Figure 3-23: Horizontal en-route flight efficiency by State (week – weekend changes)

The better flight efficiency on weekends is due to a number of factors including, inter alia, better availability of segregated and free route airspace on weekends (absence of military training activity) and different traffic characteristics with on average longer flights than on weekdays.

Work is ongoing to better understand and quantify the individual factors affecting horizontal flight efficiency (flight planning, awareness of route availability, Civil/Military coordination, etc.) in order to identify and formulate strategies for future improvements. An important next step for a better understanding of the constraints imposed on airspace users 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).

3.3.2.2 Vertical en-route flight efficiency

The focus of the following section is on the evaluation of vertical flight efficiency in the <u>en-route phase</u> rather than in the climb and descent phases which are addressed in Chapter 4 of this report. More information is available at http://www.eurocontrol.int/ansperformance/dataportal.

The analysis in this section does not aim at quantifying the total amount of vertical en-route inefficiencies (VFI) in the EUROCONTROL area nor does it identify all underlying reasons for the observed inefficiencies. Instead, it provides an initial understanding of the level of vertical flight inefficiencies on specific airport pairs in order to evaluate some cases in more detail. It should be noted that there might be good reasons for certain vertical restrictions (safety, capacity) and the results should therefore be interpreted in this context.

Figure 3-24 shows the average vertical en-route flight inefficiency per flight for all airport pairs with at least 1000 movements per year between May 2015 (AIRAC cycle 1505) and the end of 2017.

The seasonal patterns with higher vertical en-route flight inefficiency in the summer are clearly visible and the average appears to increase over the analysed period.

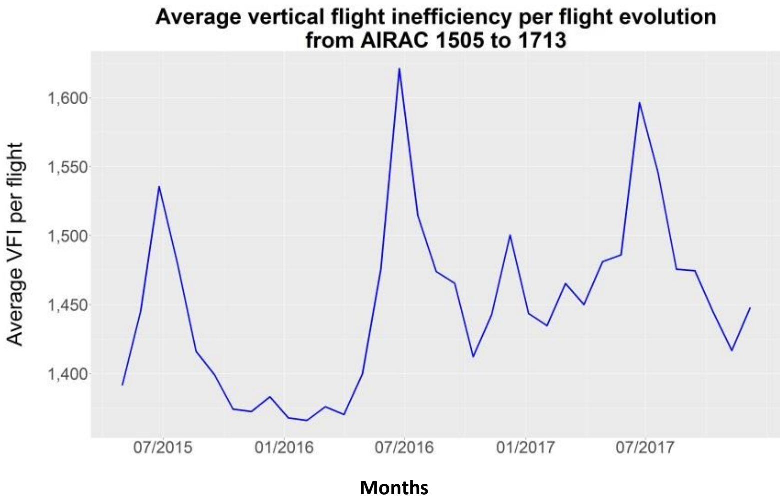


Figure 3-24: Evolution of average vertical flight inefficiency per flight

Figure 3-25 provides a more detailed analysis of the 20 least efficient city pairs in terms of total vertical inefficiency in Oct/Nov 2017 (AIRAC 1711). The total VFI values take into account the number of movements on the airport pairs so the average inefficiency experienced by every flight might not be high but the overall result is high because of the high traffic numbers.

The airport pairs are mainly between high density airports and the airport pair with the highest level of vertical inefficiency was Toulouse to Paris Orly.

It is worth noting that Amsterdam (EHAM) appears in seven and Frankfurt (EDDF) in five of the 20 identified city pairs.

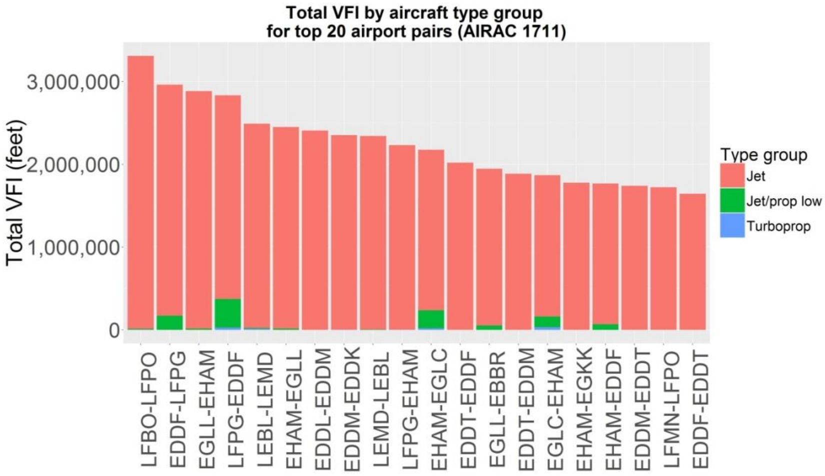


Figure 3-25: Top 20 airport pairs in terms of total vertical flight inefficiency

The different colours illustrate the inefficiency share by aircraft group, categorised according to cruising altitude. As could be expected because of the on average higher cruising altitude, the largest share of the inefficiencies in the vertical en-route phase is experienced by jet aircraft.

In order to better visualise the computed results, Figure 3-26 shows the top 20 airport pairs on a two dimensional map (left) to visualise the location and on a three dimensional map (right) to visualise the vertical en-route inefficiency.

The left map of Figure 3-26 shows that all but four of the airport pairs are in the geographic area of Maastricht (blue) and Karlsruhe (green) Upper Area Control Centre (UAC).

The vertical profile on the right side of Figure 3-26 shows that the flights on the identified least efficient airport pairs appear to be unable to enter the two UACs due to (RAD) restrictions. Their optimum vertical trajectory would enter Maastricht and Karlsruhe UAC for a comparatively short period of time and so potentially increase vertical complexity (and reduce throughput) in the two UACs.

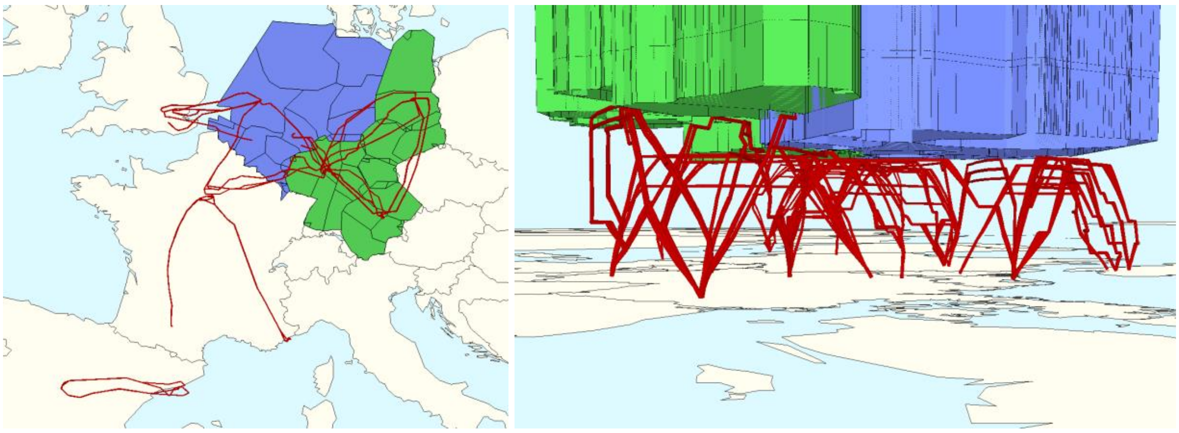


Figure 3-26: Chart of top 20 airport pairs in terms of total vertical flight inefficiency

The airport pair Toulouse to Paris Orly (LFBO-LFPO) has the highest amount of total en-route vertical flight inefficiency. This is a consequence of the high number of flights on this airport pair (723 flights during AIRAC cycle 1711) and also a high average vertical flight inefficiency per flight.

The average vertical flight inefficiency was 5,721 feet per flight which is partly due to RAD restriction LF4238 which doesn't allow flights to file a flight plan higher than FL345. This can be seen in Figure 3-27 which shows the distribution of the maximum altitudes of flights from Toulouse to Paris Orly in blue and reference flights on similar airport pairs in red. The flights between Toulouse and Paris Orly adhere to the RAD restriction but there are also a significant number of flights with a notably lower altitude than the highest altitude that can be filed (FL345).

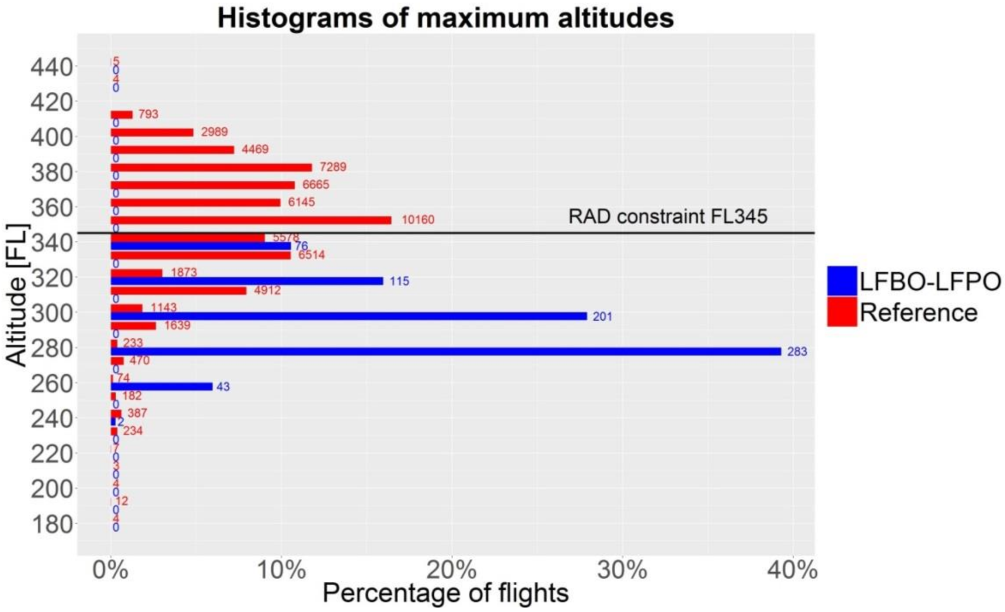


Figure 3-27: Distributions of maximum altitudes for LFBO-LFPO

According to the airlines operating on that route, in order to sequence the flights into Paris Orly DSNA requires flights to descend quite early to be at a lower altitude. This results in an implicit altitude restriction for the flights. Since the airlines are aware of this procedure, they already take it into account during the flight planning phase.

3.4 Flexible use of airspace

As reported in PRR 2016, the PRC, in accordance with Article 10(h) of its Terms of Reference, commissioned a report in 2007 entitled “Evaluation of Civil/Military Airspace utilisation”. The report was a direct response to a request from EUROCONTROL’s Provisional Council in July 2004 concerning airspace utilisation and implementation on the FUA concept.

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.

In PRR 2014 a review of Civil/Military coordination and cooperation arrangements in just three Member States, identified significant differences in how the States manage airspace to provide the optimum benefit for both Civil and Military airspace users. In light of this review, the PRC presented recommendations regarding Civil/Military coordination and cooperation for consideration by the Provisional Council.

Accordingly, the Provisional Council at its 43rd session (May 2015) gave the following mandate to the PRC:

(i) Request the PRC, in accordance with Article 10(h) of the PRC’s Terms of Reference, to review arrangements for Civil/Military coordination and cooperation in Member States by the end of 2015;

(ii) Request the Civil and Military authorities in the Member States to assist the PRC to conduct this review;

(iii) Invite the PRC to report to PC 44 (December 2015).

In 2015, the PRC developed an on-line questionnaire and invited all EUROCONTROL Member States to provide the necessary information on Civil/Military coordination and cooperation. The questionnaire focused in particular on the information available to the level 2 actors of air space 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 results of the Civil/Military coordination and cooperation questionnaire indicated that there is scope for improvement in the overall processes related to the management of airspace.

The main identified issues relate to the:

- lack of impact assessments for restricted or segregated airspaces and the effect they have on general air traffic in terms of available ATC capacity and route options;
- absence of clear national/regional strategic objectives for both OAT and GAT;
- haphazard flow of information throughout the ASM process (availability of the right information to the relevant parties at the right time).

There is a need to ensure a functioning 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 improve processes where necessary for the benefit of all airspace users.

Future technologies such as “Unmanned Aircraft System” (UAS), are expected to have an impact on airspace management. The segregation of airspace for UAS operations could benefit from the experience gained from the work carried out in each Member State concerning the application of the FUA concept.

The PRC is minded to study how Member States will handle these new technologies in order to get an understanding of the impact on ANS performance.

3.5 Conclusions

In 2017 air traffic in the EUROCONTROL area continued to grow for the fourth consecutive year. On average traffic increased by 4.3% over 2016 with substantial growth also in the dense European core area. In absolute terms, DSNA (France), ENAIRE (Spain), DFS (Germany) and NATS (UK) reported the highest year-on-year growth in 2017 and Avinor (Norway) and ONDA (Morocco) were the only two ANSPs with a negative growth.

Total en-route ATFM delays in the EUROCONTROL area also continued to increase in 2017 (+7.1% vs. 2016). Overall, the share of flights delayed by en-route ATFM regulations increased from 4.8% to 5.3% in 2017 but the average delay per delayed flight decreased by 1.5 minutes to 16.5 minutes.

In 2017, ATC Capacity/Staffing attributed issues remained by far the main portion of en-route ATFM delays (59.9%), followed by weather attributed delays (23.2%) and ATC disruptions/industrial actions (9.9%). However, the analysis of the reported delay categories shows a continuous increase in ATC Capacity/ Staffing and Weather-attributed delays over the past four years which gives reason for concern.

The analysis showed that the constraints were mainly concentrated in the European core area where traffic density is highest. In 2017, 82% all en-route ATFM delays in the EUROCONTROL area was generated by only five air navigation service providers: DSNA (33.4%), DFS (23.1%), Maastricht (13.3%), ENAIRE (7.9%), and DCAC Cyprus (4.3%). The most constraining ACCs in 2017 were Karlsruhe UAC, Maastricht UAC, Marseille, Brest, Bordeaux, Nicosia and Barcelona which together accounted for almost 70% of all en-route ATFM delay in the EUROCONTROL area.

The most penalising ATFM en-route regulations were analysed further in terms of delay attributed to elementary sectors and delays attributed to collapsed sectors which - by being collapsed - were already limiting the available capacity for airspace users. Irrespective of the delay causes (capacity/staffing or weather), the results showed a surprisingly high share of ATFM delay (in some cases above 90%) originating from collapsed sectors.

In view of the asymmetric cost of ATFM delays (i.e. no costs to ANSP but high costs to airspace users), ANSPs are expected to make all efforts to deploy sufficient capacity to accommodate demand when required. With the focus mainly on cost savings over the past years, the system benefited from the depressed traffic levels following the economic crisis in 2008. However, with traffic growing again it is vital to work proactively on capacity deployment in order to be able to accommodate future demand and to avoid exponential increases of delay costs to airspace users.

Horizontal flight efficiency in filed flight plans increased from 95.4% in 2016 to 95.6% in 2017 at EUROCONTROL level. At the same time, the efficiency of actual trajectories increased from 97.1% to 97.3% in 2017. This was achieved notwithstanding the further notable increase in traffic in 2017.

PRR 2016 underlined the benefits of the implementation of Free Route Airspace (FRA) which offers a more flexible environment and more choices to airspace users whilst contributing to reduced fuel consumption and emissions and higher flight efficiency. FRA is now in place in a large part of EUROCONTROL airspace but not yet implemented in the dense European core area. As a result of the high traffic volumes, the benefits of even small flight efficiency improvements in the European core area in will be substantial.

In addition to the implementation of FRA in a given airspace, ANSPs should also work actively with the Network Manager and the Deployment Manager to deliver FRA across the entire EUROCONTROL area, including necessary cross-border implementation.

Analysis of vertical en-route flight efficiency showed that the highest level of inefficiencies originated from flights on high density airport pairs in the European core area which were unable to enter the two Upper Area Control Centres Maastricht and Karlsruhe.

The Flexible Use of Airspace (FUA) concept and the closer Civil/Military cooperation and coordination are an important enabler to improve capacity and flight efficiency performance. Future technologies such as “Unmanned Aircraft System” (UAS), are also expected to have an impact on airspace management and would therefore also benefit from the further improvement of identified shortcomings in the application of the FUA concept highlighted in the PRC survey conducted in 2016.

This page was intentionally left blank

4 Operational ANS Performance at Airports

SYSTEM TREND (TOP 30 AIRPORTS IN TERMS OF TRAFFIC)	2017	Trend	change vs. 2016
Average daily movements (arrivals + departures)	22 880	↑	+2.3%
Arrival flow management (per arrival)			
Average Airport Arrival ATFM Delay	1.25	↓	-0.11 min
Average Additional ASMA Time (without Turkish airports)	2.15	→	+/-0.0 min
Average time flown level during descent (without Turkish airports)	3.11	→	-0.02 min
Departure flow management (per departure)			
Average additional Taxi-out Time (without Turkish airports)	3.8	↓	-0.1 min
Average time flown level during climb (without Turkish airports)	0.5	→	+/-0.0 min

4.1 Introduction

The provision of sufficient airport capacity is one of the key challenges for future air transport growth. This chapter provides a review of operational ANS performance at major European airports. The evaluation of future airport capacity requirements (e.g. new runways, taxiways, etc.) is beyond the scope of this report.

This chapter evaluates the top 30 airports in terms of IFR movements in 2017 (see Figure 4-1), which have the strongest impact on network-wide performance.

Any unusual performance observed at an airport not included in the top 30 airports is commented on in the respective sections of the chapter.

Further information on the underlying methodologies and data for monitoring the ANS-related performance at the top 30 and all other reviewed airports is available online on the ANS performance data portal.

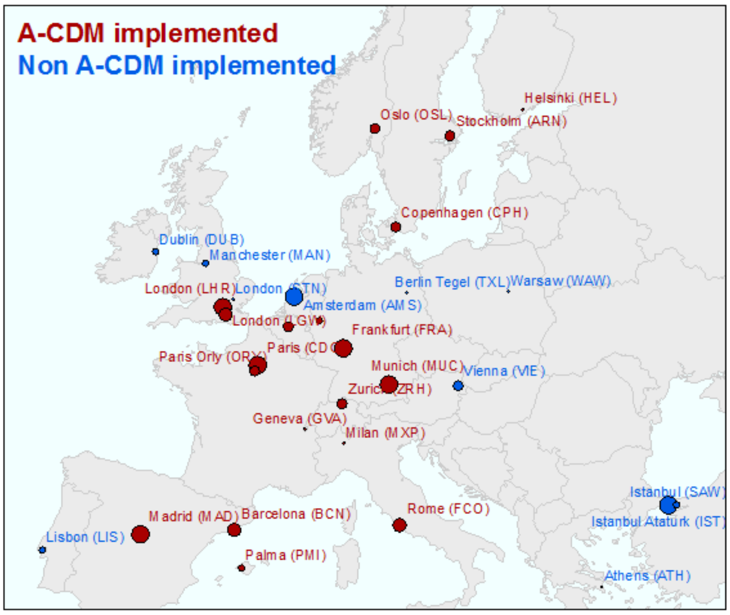
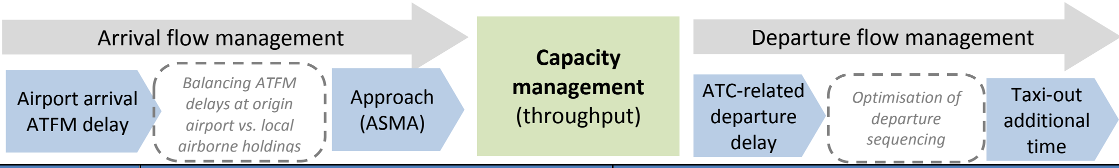


Figure 4-1: Top 30 European airports in terms of traffic in 2017

For the interpretation of the analyses in this chapter it should be noted 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 sometimes difficult. While at airports, ANS is often not the root cause for a capacity/demand imbalance (e.g. adverse weather, policy decisions in the airport scheduling phase, traffic demand variation, airport layout), the way traffic is managed has an effect on airspace users (time, fuel burn, costs), the utilisation of available capacity and the environment. 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.

The following sections evaluate ANS-related inefficiencies on the departure and arrival traffic flow at the top 30 airports. The performance indicators used for the analysis in this chapter are shown in Figure 4-2.



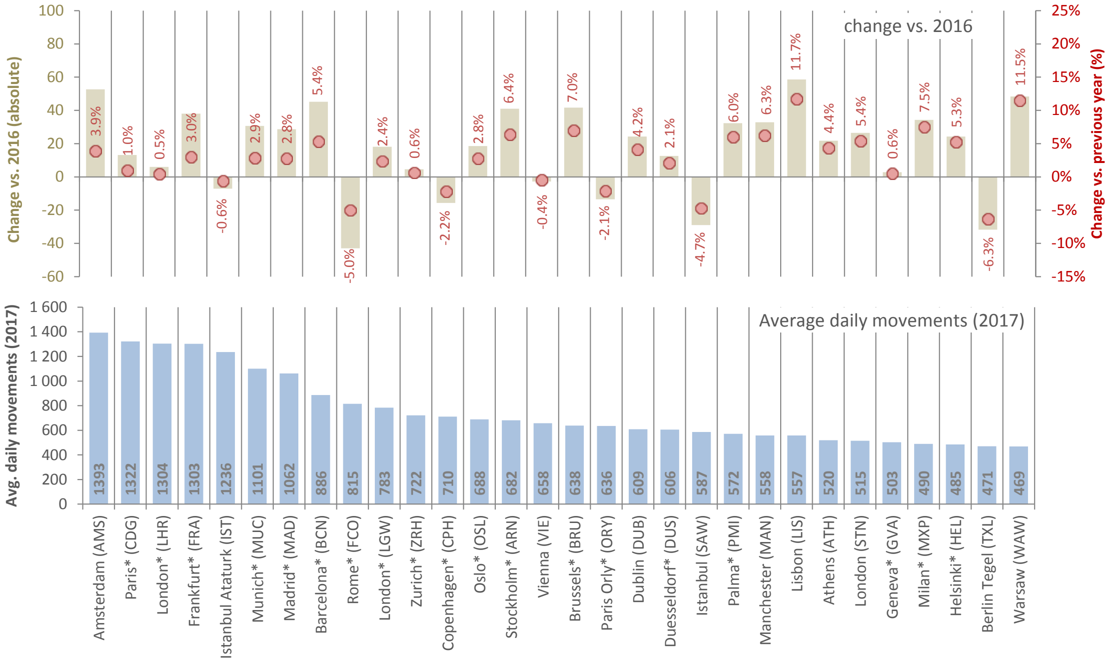
	Arrival flow management	Departure flow management
Related indicators	• Airport ATFM arrival delay [ICAO GANP KPI 12] • Additional Arrival Sequencing and Metering Area (ASMA) time [ICAO GANP KPI 08] • Average level time in descent	• ATC-pre departure delay • Additional taxi-out time [ICAO GANP KPI 02] • ATFM slot adherence [ICAO GANP KPI 03] • Average level time in climb
Expected benefits	• Reduction of airborne terminal holdings • Support to fuel efficient descent trajectory • Maximise airport throughput	• Minimise ANS-related departure delays • Optimise push back time sequencing • Optimum taxi routing (distance & time) • Adherence to ATFM departure slots
Supporting projects/ initiatives	• Continuous descent operation (CDO) • Performance based navigation (PBN) • Arrival manager (AMAN/XMAN) • RECAT EU	• Airport Collaborative Decision Making (A-CDM) • Departure manager (DMAN) • Continuous climb operations (CCO)

Figure 4-2: ANS-related operational performance at airports (overview)

Based on the work of the PRC and the international benchmarking activities, some of the indicators used in this chapter are also promoted by ICAO as part of the update of the Global Air Navigation Plan (GANP). When applicable, the corresponding GANP indicators are shown in brackets in the list of performance indicators in Figure 4-2. More information on the GANP indicators is available online in the ICAO performance objective catalogue [7].

4.2 Traffic evolution at the top 30 European airports

Figure 4-3 shows the evolution of average daily IFR movements at the top 30 airports in absolute and relative terms[16].



** A-CDM implemented airport*

Source: Network manager; PRC analysis

Figure 4-3: Traffic variation at the top 30 European airports (2017/2016)

---

16 The ranking is based on IFR movements, which is different from commercial movements (ACI Europe statistics).

The list of top 30 airports remains unchanged from 2016 although their ranking in terms of number of movements has shifted in some cases. Together the top 30 airports accounted for 44.1% of all arrivals in the EUROCONTROL area in 2017. On average, movements (arrival + departure) at the top 30 airports in 2017 increased by 2.3% compared to 2016, which corresponds to 514 additional movements each day.

Amsterdam continued its growth in 2017 (+3.9% vs. 2016) and remained the airport with the highest number of commercial movements in the EUROCONTROL area.

Seven of the top 30 airports showed a decrease in traffic in 2017: Berlin (TXL), Rome (FCO), Istanbul (SAW), Copenhagen (CPH), Paris (ORY), and Vienna (VIE). The collapse of Monarch Airlines and Air Berlin in October 2017 had an impact on a number of airports, most notably on the operations at Berlin Tegel (TXL) airport which reported a 6.3% reduction of traffic in 2017. As a result of the Alitalia crisis, traffic numbers at Rome (FCO) airport also dropped notably by 5.0% in 2017.

The highest growth compared to 2016 was observed at Lisbon (LIS) and Warsaw (WAW) airports which both grew by more than 10% compared to 2016. Milan (MXP), Brussels (BRU), Stockholm (ARN), Palma (PMI), Barcelona (BCN), London (STN), and Helsinki (HEL) all reported a substantial traffic growth of more than 5% compared to 2016.

The number of passengers at the top 30 airports in 2017 increased by 6.0% compared to the previous year. The highest year-on-year growth was observed at Warsaw airport (+22.7%), followed by Lisbon (+18.8%), Milan Malpensa (+14.2%) and Brussels (+13.6%) [9].

4.3 Capacity management (airports)

With some major European airports already being saturated during most of the day, sufficient airport capacity is considered to be one of the major constraints to future traffic growth in Europe.

At congested airports, one of the primary tools for balancing capacity and demand already in the strategic phase is the airport slot coordination process. But even after unaccommodated demand is removed in the strategic phase through the allocation of airport slots, there is an important trade-off between the maximised use of scarce capacity and the acceptable level of operational inefficiencies to be considered. The closer airports operate to their maximum capacity, the more severe is the impact in terms of operational inefficiencies if capacity decreases (due to exogenous events such as adverse weather, etc.).

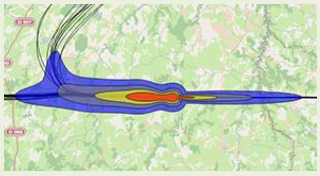
A number of initiatives to further increase airport capacity including, inter alia, time based separation and improved wake vortex separation standards, are being implemented at a number of capacity constrained airports across Europe. The PRC will monitor the benefits of such initiatives in terms of performance.

Environmental sustainability,

positive impact on noise and air quality

Noise emissions are generally recognised as the most significant environmental impact at airports.

Today, noise levels are automatically monitored at many airports in compliance with the noise indicators and contour maps specified in the EU Environmental Noise Directive [20].



From a capacity management point of view, airports face the challenge of balancing the need to increase capacity to accommodate further growth with the need to limit negative effects on the population in the vicinity of the airport. This can include trade-offs between environmental restrictions when different flight paths reduce noise exposure but result in less efficient trajectories and hence increased emissions.

While ANS clearly has a role to play, the main influencing factors such as quieter engines, land use planning or political decisions are outside the control of ANS.

The noise management at airports is therefore generally considered to be a local issue with limited scope for ANS-related performance improvements.

Figure 4-4 compares the declared peak arrival capacities (brown bars) to actual throughput at the top 30 airports in 2017 (06:00-22:00 local time) to provide an understanding of the distribution of the arrival throughput.

The “peak service rate[17]” is used as a proxy to evaluate the peak throughput that can be achieved in ideal conditions and with a sufficient supply of demand. The box plots give an indication of the degree of dispersion of the arrival throughput at the airport. The wider the ranges, the more spread out the distribution of the arrival throughput.

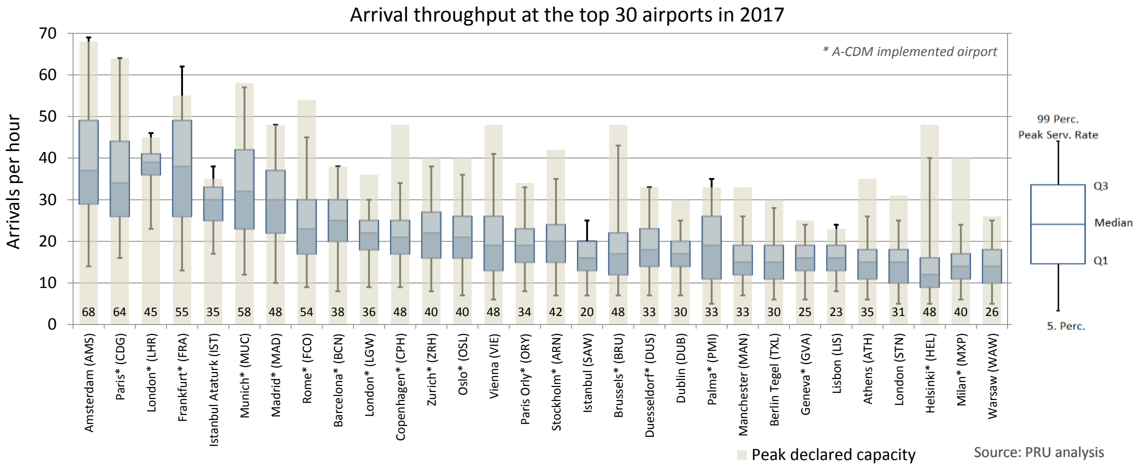


Figure 4-4: Arrival throughput at the top 30 airports

London Heathrow and both Istanbul airports show a narrow distribution with a compact interquartile range (blue box) which suggests a constant traffic demand throughout most of the day close to the declared peak arrival capacity.

Figure 4-5 shows the historic evolution of the total hourly throughputs between 2008 and 2017 (median and peak service rate). The substantial growth of both Istanbul airports in terms of peak and median throughput over the past 10 years is clearly visible. The narrow gap between peak and median throughput indicates again a narrow distribution or a continuous operation close to the peak.

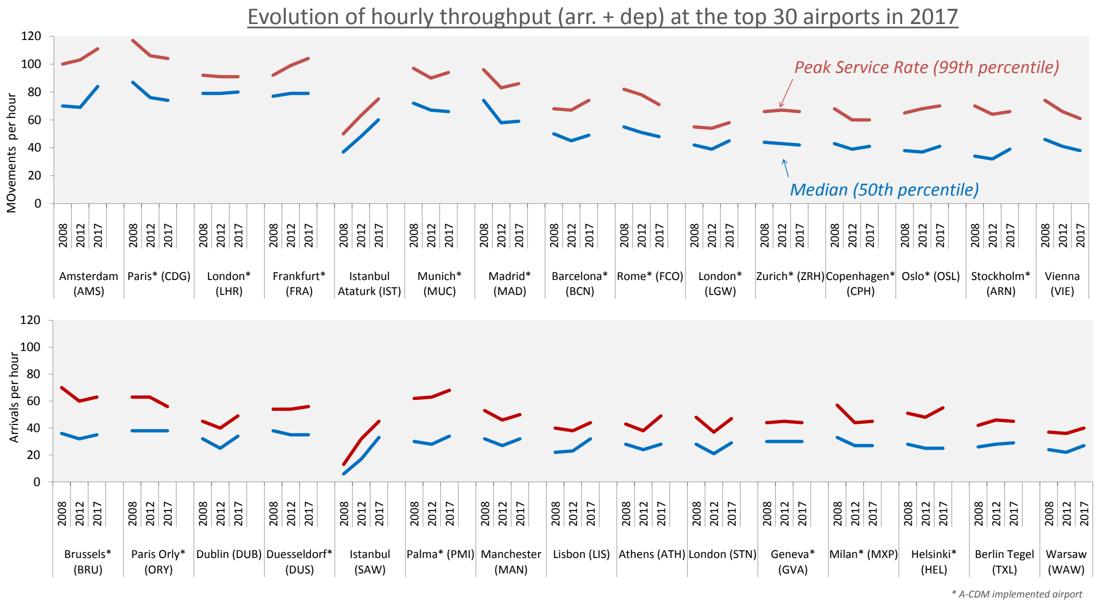


Figure 4-5: Evolution of hourly movements at the top 30 airports (2008-2017)

17 The peak service rate (or peak throughput) is a proxy for the operational airport capacity provided in ideal conditions. It is based on the cumulative distribution of the movements per hour, on a rolling basis of 5 minutes.

Frankfurt showed a steep increase in peak throughput over the past few years while the median throughput remained stable. The opening of the new runway in 2011 (for arrivals only) provided more flexibility to accommodate higher arrival peaks which in turn help to reduce arrival ATFM delays. It is interesting to point out that the observed peak arrival throughput at Frankfurt (FRA) in 2017 was 62 arrivals per hour which was notably above the peak declared capacity in 2017 (55).

The analysis in this section only provides a high-level indication of operations at the top 30 airports. This analysis does not allow direct comparisons to be made between those airports. A more detailed analysis would need to consider factors such as, inter alia, runway layout, mode of operation, and available runway configurations and societal factors such as noise and environmental policies.

4.4 ANS-related operational efficiency at and around airports

4.4.1 Arrival flow management

This section analyses ANS-related inefficiencies on the arrival flow in terms of arrival ATFM delay and additional time in the arrival sequencing and metering area (ASMA time). Whereas ATFM delays have an impact in terms of delay on the ground, additional ASMA time has also a direct impact in terms of fuel burn and emissions.

2017	Top 30 airports
	5.2 M min (-5.7% vs. 2016) **Airport ATFM delay**
	6.5.% (-0.3% pt. vs. 2016) **Airport ATFM delayed arrivals**
	52.2% (+4.4% vs. 2016) **Weather airport ATFM delay**
	7.7 M min (+2.4% vs. 2016) **Additional ASMA time**

The observed inefficiencies in the arrival flow at the top 30 airports resulted in 5.2 million minutes of airport ATFM arrival delay (-5.7% vs. 2016) and 7.7 million minutes of additional ASMA time (+2.4% vs. 2016) in 2017.

Overall, 6.5% (-0.3 %pt. vs. 2016) of the arrivals at the top 30 airports were delayed by airport ATFM regulations in 2017 which is more than twice the EUROCONTROL average (3.1% of arrivals).

The main reason for airport ATFM regulations in 2017 was adverse weather which increased by 4.4% compared to 2016. Overall, 52.2% of all airport arrival ATFM delay in 2017 was weather attributed, followed by capacity/staffing attributed issues with 40%.

Figure 4-6 shows the arrival ATFM delay (top of figure) and the additional ASMA time (bottom of figure) per arrival at the top 30 European airports in 2017.

Overall, the average additional ASMA time increased slightly in 2017. As was the case in previous years, London Heathrow (LHR) stands out with an average additional ASMA time of more than 8 minutes per arrival and accounted for one quarter of the total additional ASMA time at the top 30 airports in 2017. LHR's performance results from decisions made during the airport slot allocation process, and agreed with airspace users, to ensure constant demand in order to maximise the use of scarce runway capacity.

Average airport ATFM delays at the top 30 European airports decreased from 1.36 to 1.25 minutes per arrival in 2017. Although from a very high level (11 min per arrival in 2016), the most notable improvement in 2017 was observed for Istanbul Sabiha Gökçen Airport (SAW) where ATFM arrival delay reduced by 5.5 minutes on average. This is to a large extent linked to the 4.7% traffic reduction year on year which helped to reduce capacity-related arrival ATFM delays in 2017 notably.

Compared to 2016, the average delay per arrival increased notably at Amsterdam (AMS), London (LGW), and Lisbon (LIS). Due to its high traffic volume and the further increase in 2017, Amsterdam (AMS) had the highest impact in the network. Almost half of the total airport arrival ATFM delay in the EUROCONTROL area was generated by five airports: Amsterdam (13.8%), Istanbul Sabiha Gökçen (11.2%), Istanbul Atatürk (8.3%), London Heathrow (6.9%), and London Gatwick (5.3%).

Following the high delays over the previous years, the two Istanbul airports still accounted for 32% of all capacity/staffing attributed airport arrival ATFM delays in 2017, despite the substantial improvement observed in 2017. The new Istanbul airport which is presently being built will gradually replace Istanbul Atatürk airport and will ease the capacity situation in Istanbul once it is operational.

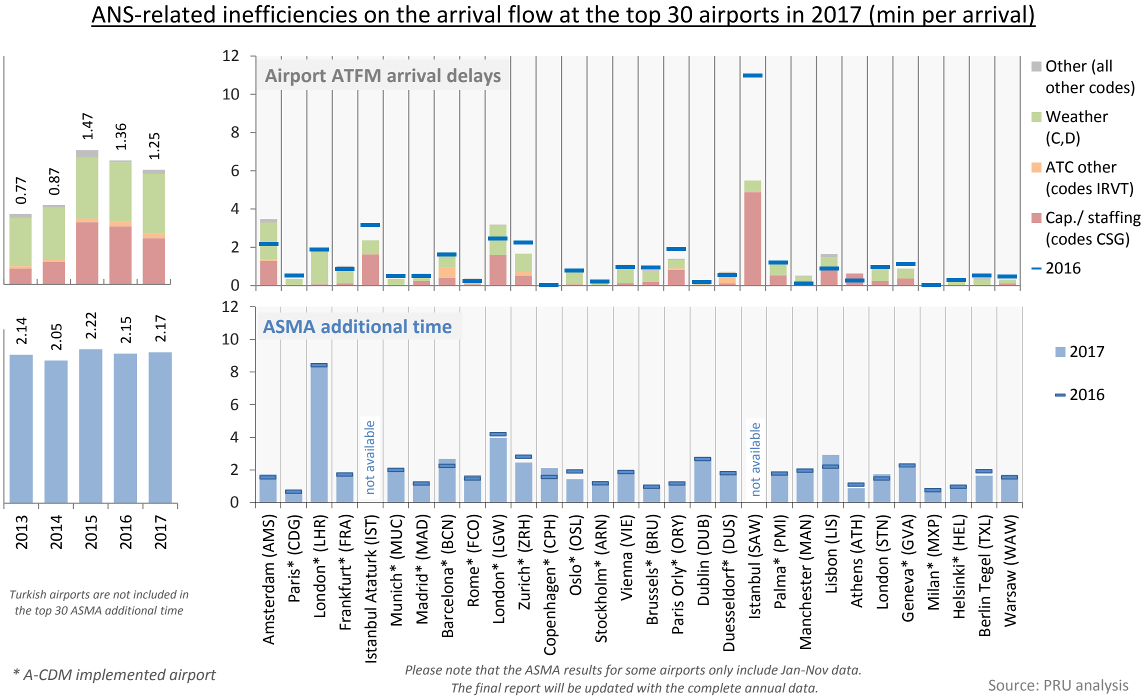


Figure 4-6: ANS-related inefficiencies on the arrival flow at the top 30 airports in 2017

Figure 4-7 shows the average airport ATFM delay per delayed arrival on the primary axis and the share of the ATFM delayed flights on the secondary axis. Although the share of flights arriving at Sabiha Gökçen Airport (SAW) decreased from 42.5% in 2016 almost every fourth flight arriving in 2017 was still delayed by ATFM delays.

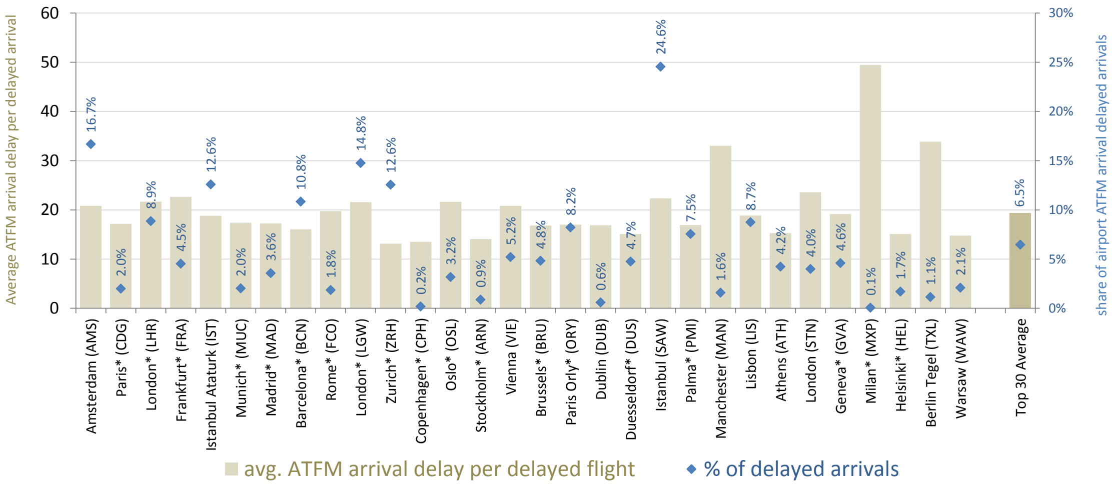


Figure 4-7: Arrival ATFM delayed arrivals at the top 30 airports (2017)

Figure 4-8 shows the hourly arrival rate at Istanbul Sabiha Gökçen Airport (SAW) in 2017 (left) together with daily capacity attributed airport arrival ATFM regulations (right).

The analysis of the ATFM airport arrival capacity regulations shows a systematic management of the demand through ATFM regulations (especially for the last arrival wave of the day), despite the airport being fully coordinated. The rate of these regulations was in most cases 20 arrivals per hour, which corresponds to the declared arrival capacity of the airport.

Such a systematic use of ATFM regulations during the same time of the day should not be observed at coordinated airports as the airport slot coordination process should restrict demand already in the

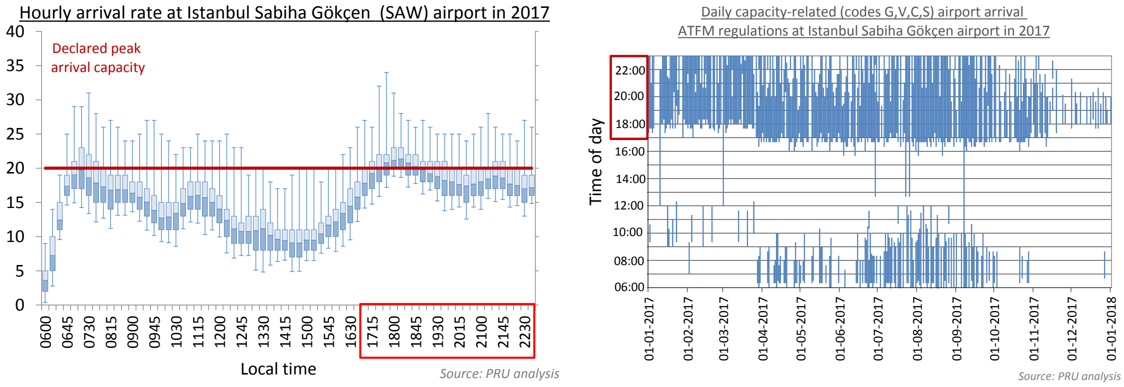


Figure 4-8: Capacity-related ATFM regulations at Istanbul Sabiha Gökçen Airport (SAW)

strategic phase to avoid frequent overloads during the day of operations.

As already pointed out in previous reports, it would be interesting to analyse the additional ASMA time together with the observed ATFM delay levels but this has not been possible due to a lack of data. There is work in progress to establish the required data flow and the PRC looks forward to also including the Turkish airports in the respective analyses in future PRRs.

Regional Greek airports

Although not shown in the top 30 airports, it is worth noting that some regional Greek airports still have a significant impact on the European network in summer. In 2017, seven regional Greek airports generated more capacity attributed airport ATFM arrival delay than Amsterdam (AMS) airport.

Between June and August 2017, the seven airports (Mikonos, Santorini, Zakinthos, Khania, Heraklion, Kefallinia, Rodos) accounted for 12.2% of the total airport ATFM delay in Europe, while handling only 1.5% of the traffic.

Figure 4-9 shows the observed arrival throughput at the seven airports between June and August 2017 together with the arrival rates used in the capacity attributed airport arrival ATFM regulations during that time.

The average ATFM regulated arrival rates at some airports are surprisingly low as they are close to the median of the observed throughput.

For instance, at Mikonos (JMK) the average capacity attributed ATFM arrival rate was set to three arrivals per hour which was below the median

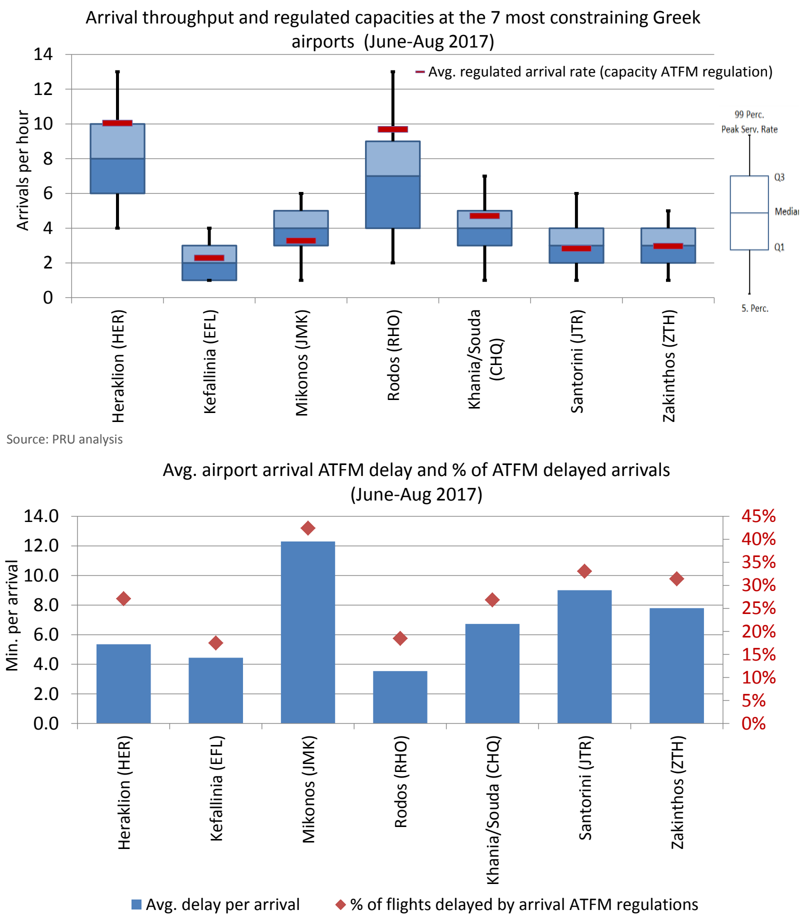


Figure 4-9: Arrival throughput/ATFM delays at regional Greek airports (June-Aug 2017)

throughput of the airport. The corresponding effect on airspace users can be seen in Figure 4-9 which shows that Mikonos (JMK) generated the highest average delay per arrival (12.3 min/arr).

In view of the comparatively low airport capacity available (parking positions, lack of parallel taxiways and runway exits), those airports would appear to be very sensitive to even minor traffic variability. Although the systematic application of capacity attributed ATFM regulations to manage demand should not occur at fully coordinated airports (all seven airports are fully coordinated during summer), ATFM regulations seem to be used frequently as a measure to handle traffic variability.

4.4.2 Departure flow management

This section analyses ANS-related inefficiencies on the departure flow at the top 30 European airports in terms of ATFM departure slot adherence, additional taxi-out time, and, ATC pre-departure delays at the gate.

4.4.2.1 ATFM departure slot adherence

ATFM departure slot adherence ensures that traffic does not exceed regulated capacity and increases overall traffic flow predictability. ATFM regulated flights are required to take off at a calculated time (ATC has a 15 minute slot tolerance window [-5 min, +10 min] to sequence departures).

ATFM slot adherence at the top 30 airports (2017)

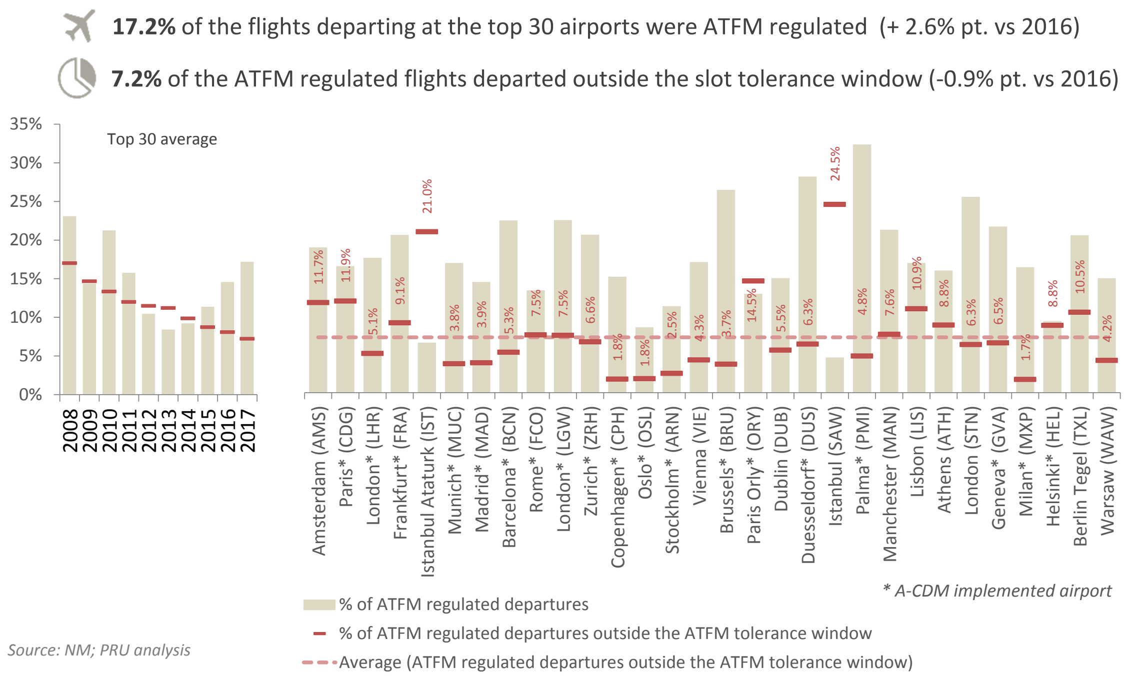


Figure 4-10: ATFM slot adherence at airport (2017)

Figure 4-10 shows that although the share of ATFM regulated departures at the top 30 airports (brown bar) continued to increase from 14.6% to 17.2% in 2017, the share of ATFM regulated flights departing outside the ATFM slot tolerance window (red line) further decreased from 8.1% to 7.2% which is positive in terms of network predictability.

Although with a comparatively small share of ATFM regulated departures, the two Istanbul airports showed by far the highest share of departures outside the ATFM slot tolerance window in 2017.

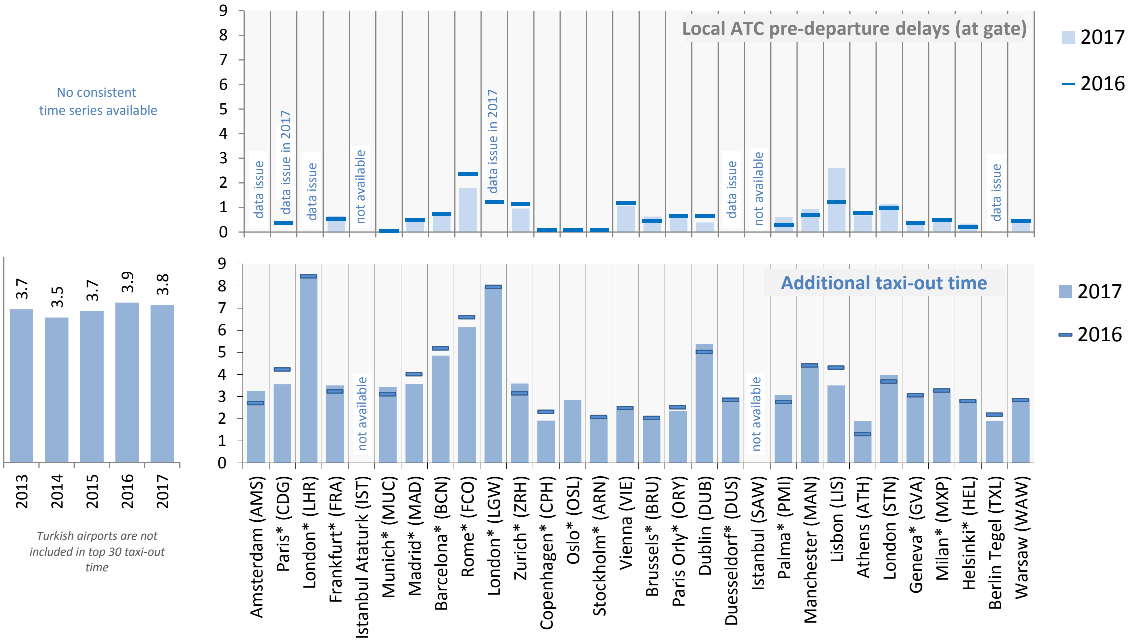
4.4.2.2 ANS-related inefficiencies on the departure flow

Figure 4-11 shows the local ATC departure delays (top of figure) and the taxi-out additional time at the top 30 airports in 2017.

Different from the additional ASMA time, the average additional taxi-out time decreased slightly at the top 30 airports in 2017 from 3.9 minutes to 3.8 minutes per departure (excluding the two

Istanbul airports for which no data was available). In 2017, the highest levels of average additional taxi-out times were observed at London (LHR), London (LGW), Rome (FCO), Barcelona (BCN) and Dublin (DUB). At the same time, notable improvements were observed at Paris (CDG), Madrid (MAD), Copenhagen (CPH), Rome (FCO) and Lisbon (LIS).

ANS-related inefficiencies on the departure flow at the top 30 airports in 2017 (min per departure)



* A-CDM implemented airport

Source: NM; Airports

Figure 4-11: ANS-related inefficiencies on the departure flow at the top 30 airports in 2017

Local ATC pre-departure delay addresses the effect of capacity/demand imbalances surrounding the departure process. The local ATC departure delay is derived from off-block delays attributed to IATA delay codes reported by airlines, more specifically code 89.

Different from previous years, the data analysed in Figure 4-11 is based on data directly provided by airport operators. Unlike CODA[18] data, the Airport Operator Data Flow covers all departures from airports and is therefore also used for the analysis of additional taxi out and ASMA times. As highlighted in PRR 2016, while the data flow has a better coverage, some data quality issues do exist. Hence, Figure 4-11 only shows those airports reaching a minimum quality threshold in 2017 which does not allow a year-on-year comparison at top 30 airport level to be made.

Subject to sufficient capacity at the gates, airport collaborative decision making (A-CDM) is an enabler to optimise the departure sequence while keeping additional taxi-out time to a necessary minimum. The goal is to keep aircraft at the gate in order to keep costly taxi-out inefficiencies and subsequent additional fuel burn to a minimum.

Figure 4-12 shows the additional taxi-out time as a function of departure throughput for some larger European airports. For London (LHR) a continuous increase can be observed, in contrast to Munich (MUC) airport which shows a flat profile irrespective of the throughput.

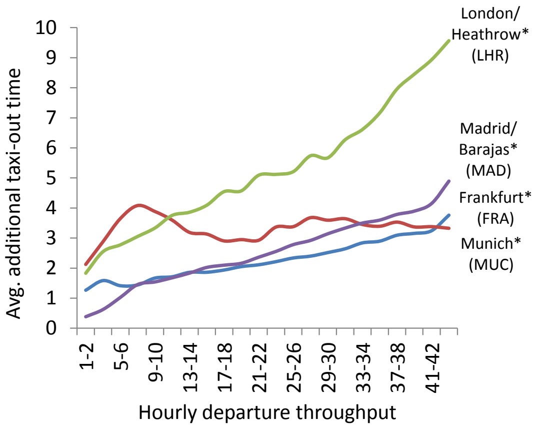


Figure 4-12: Additional taxi-out time as a function of departure throughput (2017)

---

[18] EUROCONTROL Central Office for Delay Analysis (CODA).

4.4.3 Vertical flight efficiency during climb and descent

Today, a large number of airports in the EUROCONTROL area already declare that they offer Continuous Descent Operations (CDO) but the offers differ notably in terms of techniques, procedures and availability (limited by hours of operation and commencement height).

In order to better address the vertical dimension of flight efficiency during the climb and descent phase, the PRU developed a methodology [10] based on the outcome of the EUROCONTROL CCO/CDO task force in 2015/16 which included airspace users, industry organisations, airports, FABs/ANSPs and aircraft manufacturers. More information on the methodology and data are available on the ANS performance data portal.

Environment sustainability,
positive impact on noise and air quality

Reducing intermediate level-offs and diversions during climb and descent can save substantial amounts of fuel and CO_2 and also reduce noise levels in the vicinity of airports.

The lower the level segment, the higher the additional fuel consumption.

An optimum (full) CDO starts from the top of descent point at the end of the cruise phase. A full Continuous Climb Operation (CCO) ends at the top of climb-point at the beginning of the cruise phase. However, due to constraints in the airspace structure, CDO/CCO may only be available from different levels, which in turn affects the overall efficiency.

Figure 4-13 provides an understanding about the share of flights applying CDOs/CCOs at the top 30 airports. The share of full CDO/CCO operations at the top 30 airports was almost identical to the 2016 values.

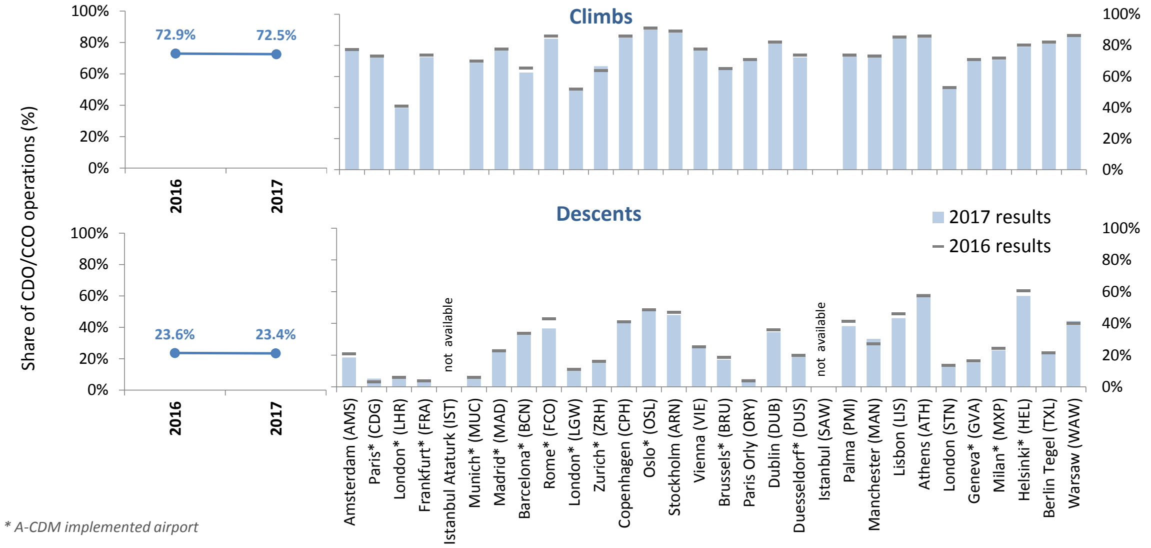


Figure 4-13: Share of full CDO/CCO operations at the top 30 airports

On average, 23.4% of the flights at the top 30 airports performed a full CDO compared to 72.5% performing a CCO. The CCO performance ranges from 39.7% (London LHR) to 90.9% (Oslo OSL) while CDO performance ranges from 4.4% (Frankfurt FRA) to 58.7% (Athens ATH).

Figure 4-14 shows the average time flown level per flight within a 200NM radius around the airport. Generally, climb-outs (top bar chart) were less subject to level-offs than descents (bottom bar chart).

For descents, a significant amount of level flight can be observed. On average, the time flown level during descent was more than six times higher than the time flown level during climb. Also the average time flown level per flight remained unchanged in 2017. The average time flown level per flight during climbs was 0.53 minutes compared to 3.11 minutes for descents in 2017.

The average time flown level per flight for climbs ranged from 0.2 (Oslo OSL) to 1.1 (London LHR) while for descents the range was from 0.8 (Athens ATH) to 6.4 minutes (Paris Orly ORY).

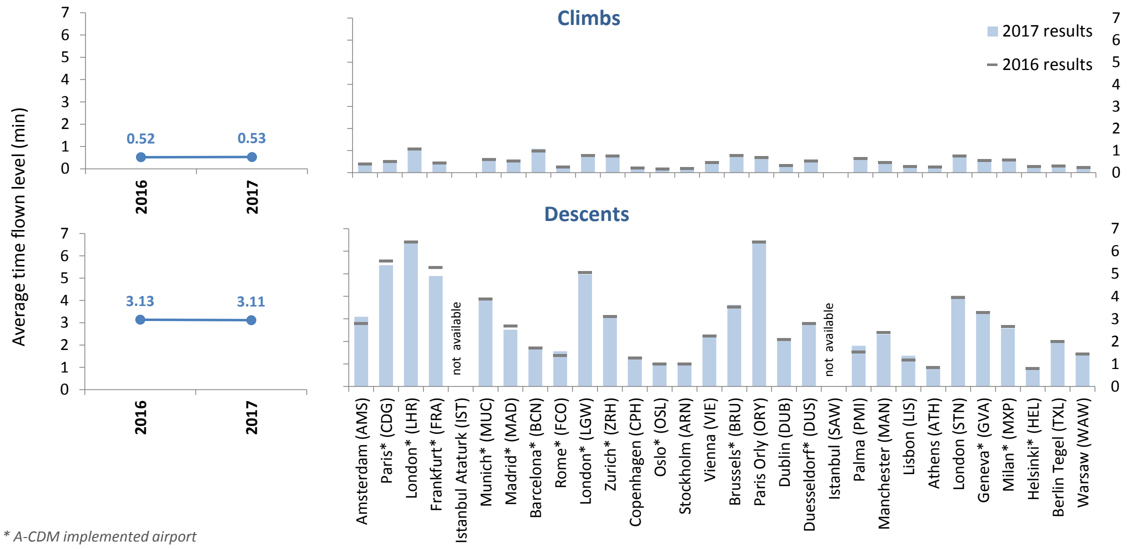


Figure 4-14: Average time flown level per flight at the top 30 airports

The efficiency of climbs and descents clearly has an impact on fuel burn and emissions but also on the noise levels of terminal operations.

While measuring CDO from lower levels is of relevance for noise reasons, for fuel and emission savings CDO should be measured from top of descent.

For descents the altitude from which the additional noise from an aircraft can be distinguished from background noise is 7,000 feet while for climbs this is until 10,000 feet [11].

Figure 4-15 and Figure 4-16 show the share of flights respectively performing a CDO from higher than 7,000 feet and a CCO until higher than 10,000 feet.

At 11 of the top 30 airports, less than 50% of the arrivals applied a CDO from higher than 7,000 feet while almost all flights performed a CCO until higher than 10,000 feet.

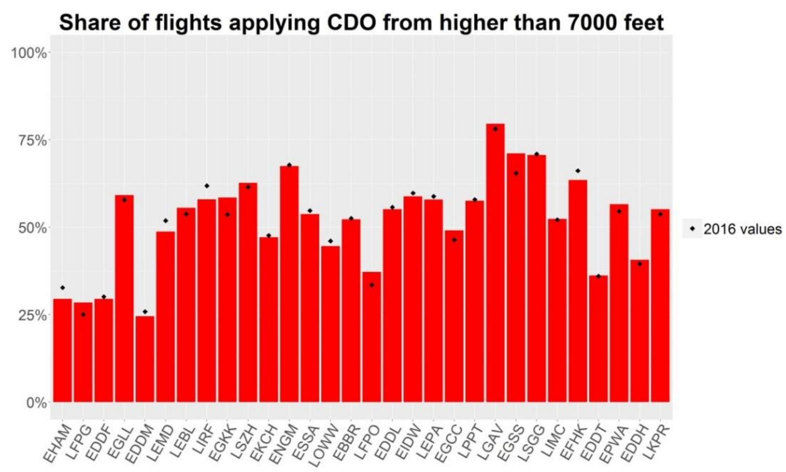


Figure 4-15: Share of flights applying CDO from higher than 7000 feet

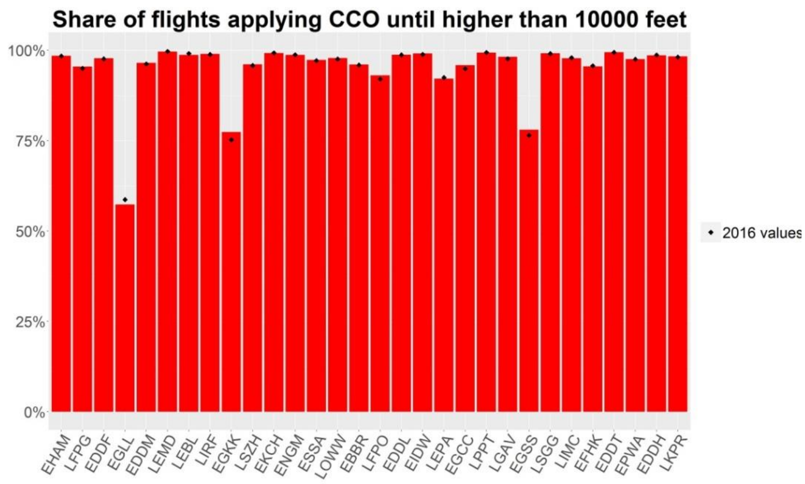


Figure 4-16: Share of flights applying CCO until higher than 10000 feet

4.5 Conclusions

Controlled movements at the top 30 airports in the EUROCONTROL area (in terms of traffic) increased for the fourth consecutive year in 2017. Average daily movements increased by +2.3% compared to 2016, which corresponds to 514 additional movements each day.

Amsterdam continued its growth in 2017 (+3.9% vs. 2016) and remained the airport with the highest number of commercial movements in the EUROCONTROL area.

Seven of the top 30 airports showed a decrease in traffic in 2017: Berlin (TXL), Rome (FCO), Istanbul (SAW), Copenhagen (CPH), Paris (ORY), and Vienna (VIE). The highest growth compared to 2016 was observed at Lisbon (LIS) and Warsaw (WAW) airports which both grew by more than 10% compared to 2016. Milan (MXP), Brussels (BRU), Stockholm (ARN), Palma (PMI), Barcelona (BCN), London (STN), and Helsinki (HEL) reported all a substantial traffic growth of more than 5% compared to 2016.

In 2017, the average additional ASMA time at the top 30 airports increased slightly to 2.19 minutes per arrival. As was the case in previous years, London Heathrow stood out with an average additional ASMA time of more than 8 minutes per arrival.

ATFM delays at the top 30 airports decreased in 2017 to 1.25 minutes per arrival. Overall, 6.5% (-0.3 %pt. vs. 2016) arrivals at the top 30 airports were delayed by airport ATFM arrival regulations. Overall, 52.2% of the airport arrival ATFM delay in 2017 was weather attributed, followed by capacity/staffing attributed issues with 40%.

As was the case in 2016, airport arrival ATFM delay was still concentrated among a few airports. Almost half of the total airport arrival ATFM delay in the EUROCONTROL area was generated by five airports: Amsterdam (13.8%), Istanbul Sabiha Gökçen (11.2%), Istanbul Atatürk (8.3%), London Heathrow (6.9%), and London Gatwick (5.3%).

Despite the substantial improvement observed in 2017, the two Istanbul airports still accounted for 32% of all capacity/staffing attributed airport arrival ATFM delays in the EUROCONTROL area. The observed performance is directly related to the impressive traffic growth over the past years. Istanbul Atatürk and Istanbul Sabiha Gökçen show up together with London Heathrow as airports with a continuously high arrival throughput close to the peak declared arrival capacity. The situation in Istanbul is expected to improve with the opening of the first phase of the new airport in 2018.

Although not shown in the top 30 airports, it is worth noting that some regional Greek airports still have a significant impact on the network, especially during summer. Seven regional Greek airports generated 5.4% of the total airport arrival ATFM delays which is more than London (LGW) airport.

Notwithstanding a higher number of ATFM regulated flights in 2017, overall ATFM slot adherence at the top 30 airports improved again which is positive in terms of network predictability.

Different from additional ASMA time, the average additional taxi-out time decreased slightly at the top 30 airports in 2017 to reach 3.8 minutes per departure. The additional taxi-out times in 2017 were highest at London (LHR), London (LGW), Rome (FCO), Barcelona (BCN) and Dublin (DUB). A notable improvement can be observed at Paris (CDG), Madrid (MAD), Copenhagen (CPH), Rome (FCO) and Lisbon (LIS).

Different from previous years, the analysis of ATC pre-departure delays is now based on data directly provided by airport operators. As highlighted in PRR 2016, while the airport data flow has a better coverage, there are still some data quality issues. A new data quality assurance process has been introduced to guarantee the reliability of the results. Nevertheless this currently limits the number of airports with a valid analysis.

Building on the methodology for vertical flight efficiency in climbs and descents, this year's report introduced an analysis measuring the share of flights applying Continuous Descent Operations (CDOs) from higher than 7000 feet which is the altitude from which additional noise from an aircraft can be distinguished from background noise. Above 7,000 feet the fuel saving effect is considered to be more relevant than the noise effect. At 11 of the top 30 airports, less than 50% of the arrivals applied a CDO from higher than 7,000 feet, which suggests scope for further improvement.

5 ANS Cost-efficiency (2016)

SYSTEM TREND	2016	Trend	change vs. 2015
En-route ANS cost-efficiency performance (38 Charging Zones)			
Total en-route ANS costs (M€$_{2016}$)	7 318	↑	+0.4%
En-route service units (M)	138	↑	+4.1%
En-route ANS costs per service unit (€$_{2016}$)	52.9	↓	-3.5%
Terminal ANS cost-efficiency performance (34 Charging Zones)			
Total terminal ANS costs (M€$_{2016}$)	1 214	↑	+1.0%
Terminal service units (M)	6.6	↑	+4.8%
Terminal ANS costs per terminal service unit (€$_{2016}$)	183.4	↓	-3.6%
Air Navigation Service Provider gate-to-gate economic performance (38 ANSPs)			
Gate-to-gate ATM/CNS provision costs (M€$_{2016}$)	8 092	↑	+0.7%
Composite flight-hours (M)	19.5	↑	+2.4%
Gate-to-gate ATM/CNS provision costs per composite flight-hour (€$_{2016}$)	415	↓	-1.7%
Gate-to-gate unit costs of ATFM delays[19] (€$_{2016}$)	79	↑	+20.3%
Gate-to-gate economic costs per composite flight-hour (€$_{2016}$)	494	↑	+1.5%

5.1 Introduction

This chapter analyses ANS cost-efficiency performance in 2016 (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 39 States[20] operating 38 en-route charging zones[21] that are part of the multilateral agreement for Route Charges. This includes the 30 States which are subject to the requirements of the Single European Sky (SES) Performance Scheme ("SES States") and also 9 EUROCONTROL Member States which are not bound by SES regulations (see section 5.2 below).

The cost-efficiency performance of SES States in 2016 has already been scrutinised in accordance with the SES Regulations and the results have been reflected in the Performance Review Body (PRB) 2016 Monitoring Report. The annual Performance Review Report published by the PRC does not seek to duplicate this analysis nor assess performance against SES targets. Indeed, the focus in this report is on the changes in terms of cost-effectiveness performance from one year to another and not on the comparison of actual and planned performance as in the PRB reports. In addition, this chapter takes into account the SES data and aggregates it with the information provided by the non-SES States to present a Pan-European view. This chapter also provides an outlook for the 2017-2019 period.

Section 5.2 presents a detailed analysis of en-route cost-efficiency performance at Pan-European system level. Section 5.3 gives an evaluation of terminal ANS costs within the SES area. In order to

19 Caution is needed when interpreting changes in ATFM delays between 2015 and 2016 since the NM implemented a new methodology to calculate ATFM delays in April 2016. The impact of the use of this new calculation methodology is detailed in Section 5.4.1 below.

20 This is different from the 41 EUROCONTROL Member States in 2016 since: (1) Ukraine is a EUROCONTROL Member State which is not yet integrated into the multilateral agreement for Route Charges, and (2) Monaco en-route costs are included in the French cost-base.

21 Note that in the Route Charges system, two en-route charging zones include more than one State (Belgium-Luxembourg and Serbia-Montenegro). Similarly, there are two charging zones for Spain (Spain Continental and Spain Canarias).

ensure consistency and comparability with indicators presented in the 2016 ATM Cost-Effectiveness (ACE) Benchmarking Report, the cost-efficiency indicators presented in Sections 5.2 and 5.3 are expressed in terms of costs per service unit and in Euro 2016.

Finally, Section 5.4 provides a factual benchmarking analysis of ANSPs' 2016 gate-to-gate economic performance focusing on ATM/CNS costs which are under ANSPs direct responsibility, and including the estimated costs of total ATFM delays (en-route and airport) attributable to the respective service providers.

Treatment of financial values for time-series analysis in PRR

Presentation and comparison of historical series of financial data from different countries poses problems, especially when different currencies are involved, and inflation rates differ. There is a danger that time-series comparisons can be distorted by transient variations in exchange rates.

For this reason in the PRR, the financial elements of performance are assessed, for each year, in national currency. They are then converted to national currency in 2016 prices using national inflation rates. Finally, for comparison purposes in 2016, all national currencies are converted to Euros using the 2016 exchange rate.

This treatment is applied consistently throughout Chapter 5 for en-route, terminal and gate-to-gate ANS.

5.2 En-route ANS cost-efficiency performance

The analysis of en-route ANS cost-efficiency in this section refers to the 38 en-route charging zones which were part of EUROCONTROL's Route Charges System in 2016 (with the exception of Portugal Santa Maria).

As shown in Figure 5-1, the “SES States” refer to the 28 Member States of the European Union (EU), plus Switzerland and Norway. These States operate under the “determined costs” method which includes specific risk-sharing arrangements, defined in the Charging Regulation [12] aiming at incentivising economic performance and driving cost-efficiency improvements.

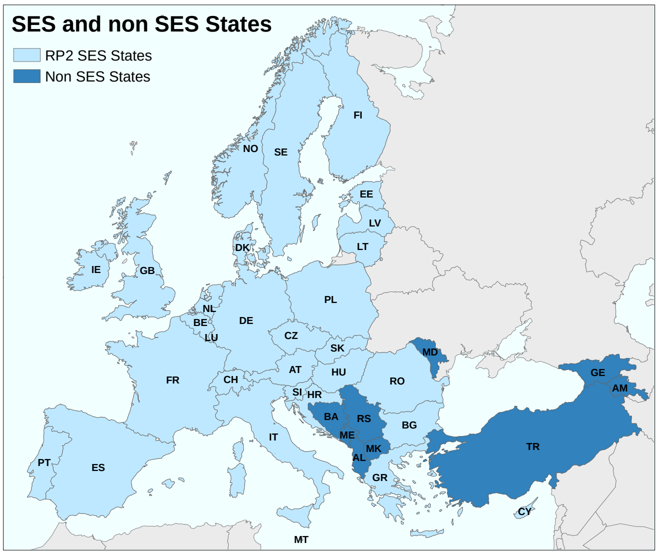


Figure 5-1: SES and non-SES States

The “non-SES States“ refer to nine States which are not bound by SES regulations but which were part of the EUROCONTROL Multilateral Route Charges System in 2016 (i.e. Albania, Armenia, Bosnia-Herzegovina, FYROM, Georgia, Moldova, Serbia, Montenegro and Turkey). For these nine States, the “full cost-recovery method” applied in 2016.

5.2.1 Trends in en-route cost-efficiency performance at Pan-European system level

The analysis presented in this section focuses on the 38 Charging Zones that consistently provided en-route costs data over the 2009-2016 period. Georgia, which started to provide actual en-route costs data for the year 2014 onwards is therefore not included in this trend analysis.

Significant changes in data reporting and in the geographical scope of the analysis were introduced in 2015 which marked the beginning of the second reference period under the SES Performance Scheme. Most notably, the changes included:

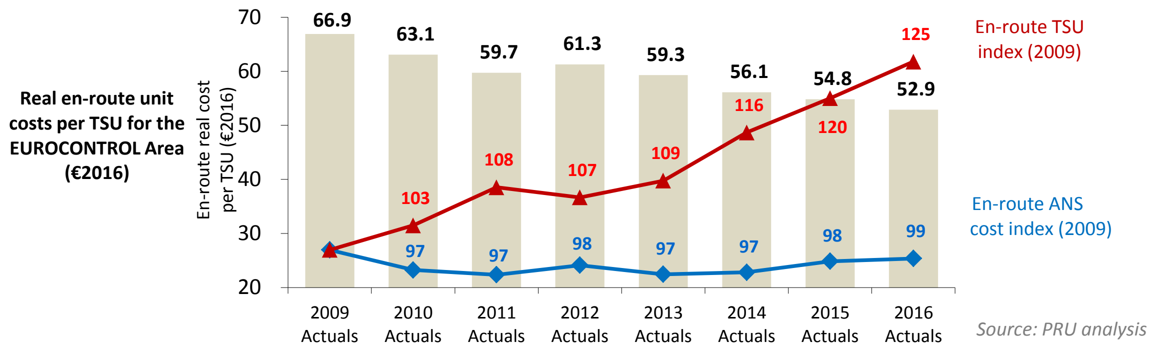
- adjustments to the determined unit cost (DUC) calculation methodology which from 2015 onwards excludes costs for VFR exempted flights,
- the inclusion of the costs associated to Croatia en-route Charging Zone,
- exclusion of costs associated with the provision of ATC in the KFOR sector from

HungaroControl cost-base since these costs are already reported in Bosnia-Herzegovina en-route costs; and

- exclusion of part of Croatia Control costs (which have been allocated to Bosnia-Herzegovina en-route cost base) from the Croatian en-route cost-base in order to avoid double counting[22].

In order to ensure consistency in time-series comparison, the adjustments described above have been implemented on the historical data reported for the SES States in Figure 5-2 below.

Figure 5-2 shows that in 2016, at Pan-European level, en-route total service units (TSUs) increased faster (+4.1%) than en-route ANS costs (+0.4%). As a result, en-route unit costs decreased by -3.5% compared to 2015. This is the fourth consecutive year of en-route unit costs reduction at Pan-European system level.



	2009 Actuals	2010 Actuals	2011 Actuals	2012 Actuals	2013 Actuals	2014 Actuals	2015 Actuals	2016 Actuals	2016 vs 2015	2009-16 AAGR
Total en-route ANS costs (M€2016)	**7 402**	**7 204**	**7 157**	**7 251**	**7 162**	**7 181**	**7 291**	**7 318**	**0.4%**	**-0.2%**
SES States (EU-28+2)	7 025	6 820	6 702	6 813	6 711	6 691	6 772	6 749	-0.3%	-0.6%
Other 8 States in the Route Charges System	377	383	455	439	451	490	519	569	9.6%	6.1%
Total en-route service units (M TSUs)	**111**	**114**	**120**	**118**	**121**	**128**	**133**	**138**	**4.1%**	**3.2%**
SES States (EU-28+2)	99	102	107	105	107	112	115	120	4.5%	2.7%
Other 8 States in the Route Charges System	11	12	13	13	14	16	18	18	1.4%	7.1%
En-route real unit cost per TSU (€2016)	**66.9**	**63.1**	**59.7**	**61.3**	**59.3**	**56.1**	**54.8**	**52.9**	**-3.5%**	**-3.3%**
SES States (EU-28+2)	70.7	66.9	62.8	64.8	62.8	60.0	58.9	56.2	-4.6%	-3.2%
Other 8 States in the Route Charges System	33.5	31.2	34.5	33.3	32.3	30.0	28.9	31.2	8.1%	-1.0%

Figure 5-2: Real en-route unit costs per TSU for EUROCONTROL area (€$_{2016}$)

Over the 2009-2016 period, en-route unit costs reduced by -3.3% p.a. on average. With the exception of 2012, TSUs rose continuously over the 2009-2016 period (+3.2% p.a.). In the meantime, en-route costs remained fairly constant (-0.2% p.a.). In other words, the TSU growth observed since 2009 has been absorbed without significant increases in costs at Pan-European system level. When interpreting these trends, it is important to recall that 2009 was an exceptional year for the ANS industry since, following the economic crisis, en-route TSUs fell by some -5% at system level.

Figure 5-2 also shows that en-route unit costs reduced for both SES States (-3.2% p.a.) and non-SES States (-1.0% p.a.) over the 2009-2016 period. It is noteworthy that the underlying drivers for these performance improvements are different.

Indeed, the en-route unit costs decrease for SES States (-3.2% p.a.) was achieved by slightly reducing costs (-0.6% p.a.) while TSUs rose by +2.7% p.a. over the 2009-2016 period. On the other hand, the en-route unit costs reduction achieved between 2009 and 2016 by non-SES States (-1.0% p.a.) reflects the fact that although en-route costs rose by +6.1% p.a., TSUs increased slightly faster (+7.1% p.a.). The latter was mainly driven by Turkey, which represents some 76% of the total TSUs generated by non-SES States over this period.

[22] Further details on the changes in scope and the impact of adjustments implemented on the historical cost efficiency data are provided on pg. 52-53 of PRR 2016 [14].

In this context, it is important to note that in 2016 Turkey recorded a much lower TSU growth (+1.4%) than in previous years (+10.7% in 2015 and +20.4% in 2014). It is understood that in 2016 the TSU growth in Turkey was affected by a series of adverse events including several terrorist attacks and a travel ban which was imposed by the Russian Federation on charter flights until August 2016. In the meantime, Turkey en-route cost-base was +14.2% higher than in 2015 resulting in a unit costs increase of +12.7% in 2016. Detailed analysis shows that in 2016 en-route unit costs also increased for Armenia (+13.7%), Bosnia and Herzegovina (+11.1%), Albania (+7.7%) and FYROM (+6.5%). As a result, for non-SES States, en-route unit costs rose by +8.1% in 2016, breaking a series of four years of consecutive decreases.

At the same time, for the SES States as a whole, TSUs rose by +4.5% in 2016. This growth, which follows the increases in TSUs recorded in 2014 (+4.4%) and 2015 (+3.0%), is primarily driven by four of the largest SES States. Indeed, in 2016 TSUs rose significantly in Spain (+8.1% when the two Charging Zones are considered together), United Kingdom (+7.1%), France (+5.4%) and Germany (+4.5%), which together represent 46% of the total TSUs recorded by SES States. As a result, since SES States en-route costs remained fairly constant (-0.3%), en-route unit costs reduced by -4.6% in 2016.

When interpreting this result, it is important to note that Germany reported a negative component in its 2016 en-route cost-base (-50 M€$_{2016}$). This substantial amount consists of two main components: a) IFRS transition costs (39 M€$_{2016}$), and (b) a negative amount (-89 M€$_{2016}$) reflecting a contribution of the German State in DFS equity for the year 2016. The latter amount is mostly reflecting a State subsidy intended to strengthen DFS equity position. For charging purposes, these negative costs allow to significantly reduce the unit rate charged to airspace users. Excluding the State contribution from Germany cost-base, en-route costs for SES States would be +0.4% higher than in 2015 (instead of -0.3% lower).

Detailed changes in en-route unit costs at a State level are analysed in the Section below.

5.2.2 Actual en-route unit costs at charging zone level

Figure 5-3 below shows the level of en-route unit costs[23] for each individual charging zone in 2016. En-route unit costs ranged from 88.2 €$_{2016}$ for Switzerland to 20.0 €$_{2016}$ for Malta, a factor of more than four between these two charging zones.

It is important to note that, for States operating outside the Euro zone, substantial changes of the national currency against the Euro may significantly affect the level of en-route unit costs when expressed in Euros. For example, the level of Switzerland unit costs (88.2 €$_{2016}$) is negatively affected by the substantial changes of the Swiss Franc against the Euro over the recent years (appreciation of some +14% in 2015). Assuming that the Swiss Franc had remained at its 2014 level, Switzerland 2016 en-route unit costs would amount to some €79.1.

Figure 5-3 also presents the changes in en-route unit costs, TSUs and costs compared to 2015. In 2016, en-route unit costs increased for 14 en-route CZs out of the 38 included in the analysis. For seven charging zones, en-route unit costs rose by more than +5% in 2016. This includes Armenia (+13.7%), Turkey (+12.7%), Romania (+12.4%), Bosnia-Herzegovina (+11.1%), Georgia (+9.3%), Albania (+7.7%) and FYROM (+6.5%).

For most of these States, the increase in unit costs mostly reflects an increasing en-route cost-base in the context of lower TSUs in 2016. This is particularly the case for Romania (+9.3% costs and -2.8% TSUs), Bosnia-Herzegovina (+10.6% costs and -0.4% TSUs), Georgia (+7.4% costs and -1.7% TSUs) and FYROM (+0.8% costs and -5.3% TSUs).

[23] The actual unit costs reflected in Figure 5-3 only refer to the ratio of actual costs and TSUs recorded for 2016 and should not be confused with chargeable unit rate since the under and over recoveries stemming from previous years are not considered in this graph.

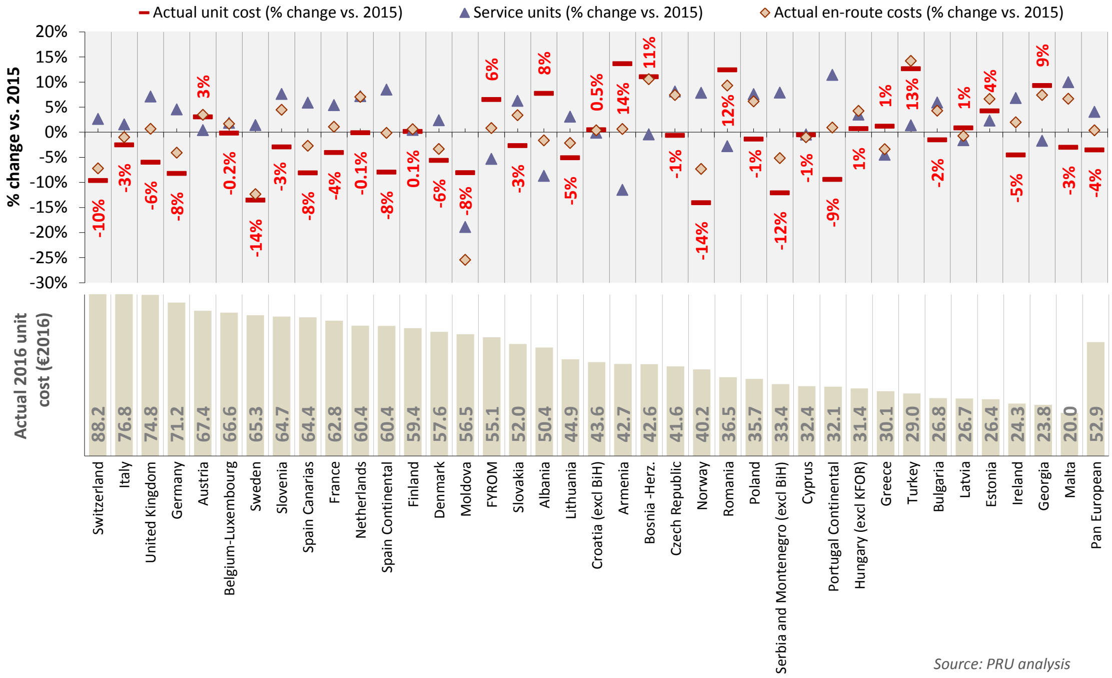


Figure 5-3: 2016 Real en-route ANS costs per TSU by charging zone (€2016)

While Albania successfully reduced its cost-base in 2016 (-1.6%), this was not sufficient to compensate for the significant decrease in TSUs (-8.7%). At the same time, the opposite effect is observed for Turkey, which reported a significant increase in costs (+14.2%) while TSUs rose by +1.4%. As a result, both of these States recorded significant increases in en-route unit costs (+7.7% and +12.7% respectively).

For Armenia, en-route costs remained relatively stable between 2015 and 2016 (+0.6%), however, this was not sufficient to compensate for the significant decrease in TSUs (-11.5%). It is noteworthy that Armenia has been experiencing a decrease in TSUs for the fifth consecutive year with an overall decrease of -34.4% recorded between 2011 and 2016.

On the other hand, Figure 5-3 indicates that for 12 CZs, en-route unit costs decreased by more than -5% in 2016. Substantial unit costs reductions were observed for Norway (-14.1%), Sweden (-13.6%), Serbia and Montenegro (-12.1%), Switzerland (-9.6%), Portugal (-9.4%), Germany (-8.2%), Spain Canarias (-8.1%), Moldova (-8.1%), Spain Continental (-8.0%), United Kingdom (-6.0%), Denmark (-5.6%) and Lithuania (-5.1%). For most of these CZs, the unit costs reduction mainly reflects lower or fairly constant en-route costs combined with an increase of TSUs.

On the other hand, the en-route unit costs decrease observed for Moldova (-8.1%) is entirely due to a substantial cost reduction (-25.5%) while TSUs decreased significantly (-18.9%). In 2016, Moldova en-route costs substantially reduced for the third consecutive year after 2014 (-37.6%) and 2015 (-21.0%). As a result, Moldova 2016 en-route costs are -63% lower than in 2013. This reduction should be seen in the light of the measures implemented by Moldova to compensate for the steep fall in TSUs experienced since 2013 (-75.1%) which resulted from the establishment of restricted areas in the Ukrainian airspace and the corresponding changes in traffic flows.

As indicated in Figure 5-3, Germany 2016 unit costs are -8.2% lower than in 2015. This reduction is due to the combination of lower costs (-4.1%) while TSUs rose by +4.5%. As discussed in section 5.2.1, the decrease in en-route costs for Germany is significantly affected by the reporting of negative exceptional costs in 2016 associated with a State contribution in order to reinforce DFS financial position. If the State contribution were excluded from the en-route cost-base, then Germany en-route costs would be +0.8% higher than in 2015 instead of -4.1% lower.

5.2.3 Pan-European en-route cost-efficiency outlook for 2017-2019

The objective of this section is to provide information on planned changes in en-route unit costs at Pan-European system level for the period 2017-2019. It is based on data reported by EUROCONTROL Member States in the en-route reporting tables submitted in November 2017 in the context of the Enlarged Committee for Route Charges[24].

Overall, at Pan-European level, en-route unit costs are expected to reduce by -1.5% per year on average between 2016 and 2019. This reflects the fact that over this period TSUs are planned to increase faster (+1.8% p.a.) than en-route costs (+0.3% p.a.).

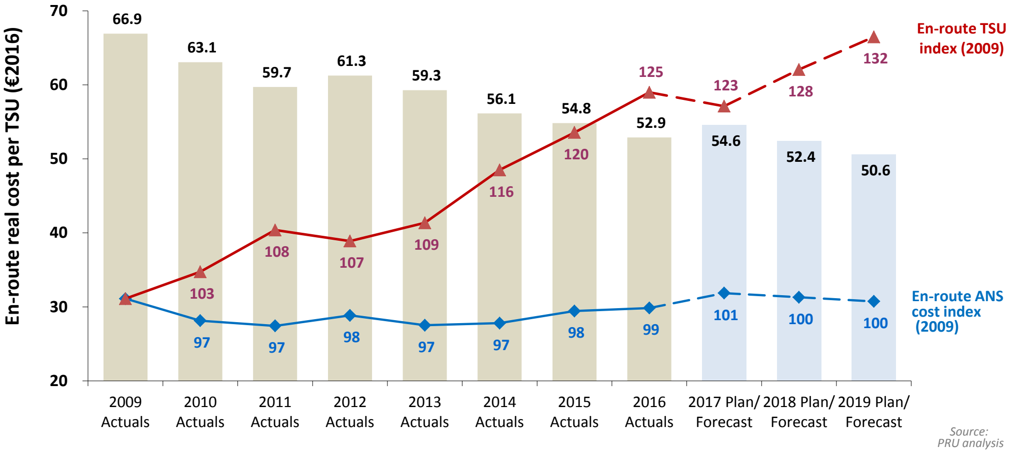


Figure 5-4: Pan-European en-route cost-efficiency outlook 2017-2019 (€$_{2016}$)

It is important to note that the apparent decrease of en-route TSUs presented in Figure 5-4 above for the year 2017 (-1.3%) is mainly due to the fact that for States bound by SES regulations, the planned data reported for the years 2017-2019 reflect the determined TSU figures provided in the RP2 Performance Plans which are not updated on a yearly basis. Actual data [3] shows that 2017 TSUs are +6.2% higher than in 2016 indicating that all else equal, the Pan-European system actual en-route unit costs for the year 2017 is likely to be substantially lower than the figure shown in Figure 5-4 (54.6 €$_{2016}$).

Figure 5-4 shows that in 2019, en-route unit costs at Pan-European level[25] are expected to amount to 50.6 €$_{2016}$. This is -24.4% lower than in 2009 (66.9 €$_{2016}$). If current plans materialise, this remarkable cost-efficiency performance improvement will be achieved by maintaining the cost-base close to 2009 levels in the context of a +2.8% annual TSU increase over the period. Furthermore, if the actual traffic growth over the 2017-2019 period is higher than current forecasts then, all else equal, the Pan-European system en-route unit costs in 2019 might be even lower than currently planned.

Detailed analysis indicates that over the 2016-2019 period, en-route unit costs are expected to reduce for 24 en-route CZs. In particular, en-route unit costs are expected to decrease by more than -5% p.a. for four CZs: Armenia (-12.4% p.a.), Moldova (-10.3% p.a.), Finland (-6.1% p.a.), Sweden (-5.3% p.a.).

On the other hand, en-route unit costs are expected to increase significantly for Ireland and Portugal Continental (+5.4% p.a. for both CZ). For these en-route CZs, the increase in unit costs should be seen in the light of a planned reduction in TSUs (-1.6% p.a. and -3.3% p.a. respectively) while en-route costs are expected to rise (+3.8% p.a. and +1.9% p.a., respectively).

---

24 It is understood that two SES States (Romania and Portugal) have submitted requests to the European Commission to revise their adopted RP2 en-route cost-efficiency targets for years 2018-2019. For these States, the information used in Figure 5-4 reflects the data provided in the November 2017 submission to the Enlarged Committee for Route Charges which does not include the proposed revisions.

25 Note that the data presented in Figure 5-4 is based on the sample of 37 States which consistently provided data since 2009 and therefore does not include information on Georgia which started to provide data in 2014.

5.3 Terminal ANS cost-efficiency performance

The analysis of terminal ANS cost-efficiency in this section refers to the SES States (see Figure 5-5) which are required to provide terminal ANS costs and unit rates information in accordance with EU legislation [12].

As for en-route, "SES States" refers to the 28 Member States of the European Union (EU), plus Switzerland and Norway. These States report on 36 Terminal Charging Zones (TCZs), generally one per State, but two for Italy, two for UK and five for Belgium.

2016 is the second year for which the "determined costs" method is applied for terminal ANS.

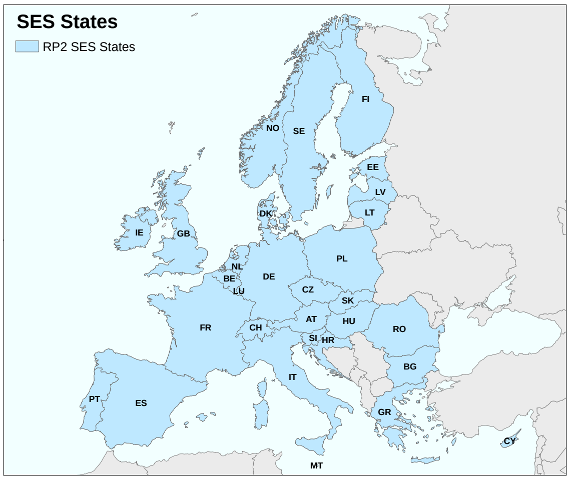


Figure 5-5: Geographical scope of terminal ANS cost-efficiency analysis

The terminal cost-efficiency KPI is computed as the ratio of terminal ANS costs with terminal navigation service units (TNSUs).

TNSUs are computed as a function of the maximum take-off weight ((MTOW/50)$^{\alpha}$). Since 2015, in accordance with the Charging Scheme Regulation [13], all States use a common formula (MTOW/50)$^{0.7}$ to compute TNSUs. This allows for a better comparison of the level of unit terminal costs per TNSU which is achieved by the different charging zones.

This analysis includes 34 TCZs comprising 165 airports. This is two airports more than reported in PRR 2016 due to additional airports included in the Portuguese (Cascais aerodrome) and the Polish (Olsztyn-Mazury airport) TCZs. It should be noted that the two UK TCZs have been excluded from this analysis since:

a) information relating to UK TCZ B, which refers to nine airports where terminal ANS are provided on a contractual basis, is not publicly available; and
b) UK TCZ C (London Approach) is not directly comparable with other TCZs since the service provided is of a different nature. Indeed, London Approach is making the transition between the en-route and terminal phases for the five London Airports which are also part of TCZ B.

In addition, for three States (i.e. Cyprus, Belgium and Spain) the unit costs presented in this analysis do not consider other revenues which are used to subsidise all or part of terminal ANS costs.

5.3.1 Trends in actual terminal ANS cost-efficiency performance at European system

Figure 5-6 below provides a summary of actual terminal ANS performance at European system level for the period 2015-2016. As explained in PRR 2016 [14], no consistent dataset is available at system level prior to 2015 due to a) introduction of a common formula to compute TNSUs (described above), and b) a number of changes in reporting scope introduced with at start of second reference period. As a result, the data recorded prior to 2015 for both terminal ANS costs and terminal ANS service units is not directly comparable at a charging zone and European system level.

	2015 Actuals	2016 Actuals	2016 vs 2015
Total terminal ANS costs (M€2016)	1 202	1 214	1.0%
Total terminal service units ('000 TNSUs)	6 319	6 622	4.8%
Real terminal unit cost per TNSU (€2016)	**190.2**	**183.4**	**-3.6%**

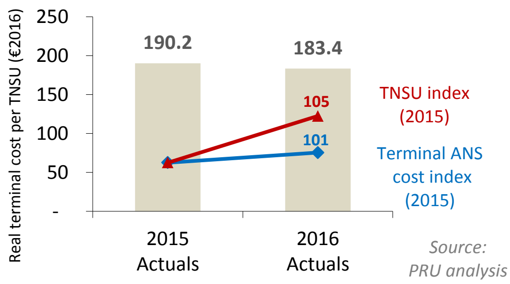


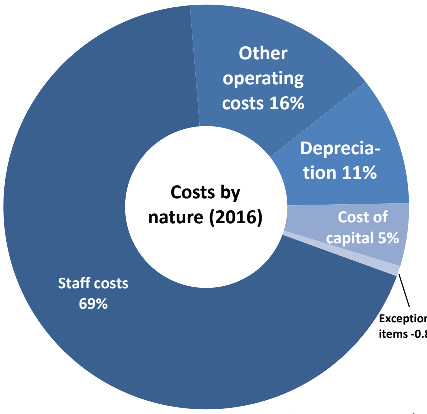
Figure 5-6: Real terminal ANS cost per TNSU at European System level (€$_{2016}$)

Figure 5-6 shows the changes in terminal ANS costs, TNSUs and unit costs between 2015 and 2016 at European system level. It is expected that with the availability of additional actual terminal ANS data in the future, this figure will be developed to show a five-year trend analysis.

Over the 2015-2016 period, terminal ANS unit costs reduced by -3.6% since TNSUs rose much faster (+4.8%) than terminal costs (+1.0%). Figure 5-8 shows a breakdown of terminal costs and provides additional insight into the changes by each cost category.

As shown in Figure 5-7, terminal costs in 2016 can be broken down into the following main components:

- Staff costs – the largest category representing some 69% of total terminal costs;
- The second largest category, other operating costs, accounts for 16% of the total;
- Capital-related costs which represent 16% of total terminal costs can be further broken down into depreciation (11%) and cost of capital (5%);
- Finally, exceptional costs recorded in 2016 are negative and account for less than 1% of total costs.



Source: PRU analysis

Figure 5-7: Breakdown of terminal ANS costs by nature

Figure 5-8 below shows how the costs associated to these different categories changed between 2015 and 2016.

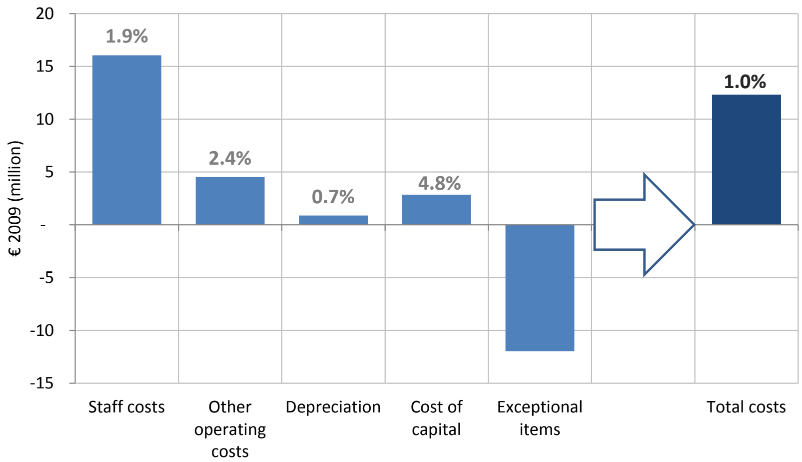


Figure 5-8: Breakdown of changes in terminal costs (2015-2016, (€$_{2016}$))

In 2016, the increase in terminal ANS costs (+1.0% or +12 M€$_{2016}$) reflects higher staff costs (+1.9% or +16.0 M€$_{2016}$), other operating costs (+2.4% or +4.5 M€$_{2016}$), depreciation (+0.7% or +0.9 M€$_{2016}$) and cost of capital (+4.8% or +2.9 M€$_{2016}$). At the same time, a significant decrease was recorded for exceptional item costs (-12.0 M€$_{2016}$).

As detailed on p.57 of this report, the decrease in exceptional costs observed at European system level is driven by the fact that Germany reported a negative component in its terminal cost-base (-23 M€$_{2016}$) reflecting the contribution of the German State in DFS equity for the year 2016. Without these exceptional costs arising from the German State intervention, the European system terminal ANS costs would be +2.1% higher than in 2015, instead of +1.0%.

5.3.2 Terminal ANS 2016 cost-efficiency performance at terminal charging zone level

Figure 5-9 below presents a composite view of the changes in terminal ANS unit costs for the 34 TCZs included in this analysis. The upper part of the figure shows the changes in terminal costs, TNSUs and terminal unit costs between 2015 and 2016, while the lower part provides information on the level of terminal ANS unit costs in 2016. For the sake of completeness, the bottom chart of Figure 5-9 also shows the number of airports included in each of the charging zones (see number in brackets).

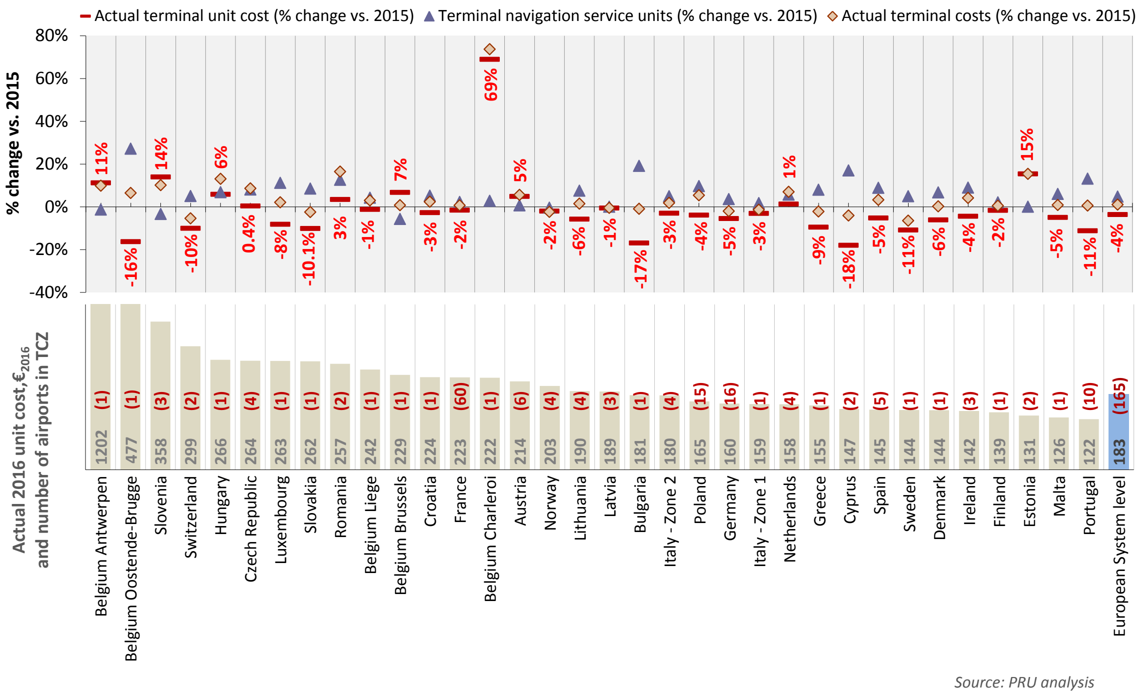


Figure 5-9: 2016 Real terminal ANS costs per TNSU by charging zone (€$_{2016}$)

Figure 5-9 indicates that in 2016, the average terminal ANS costs per TNSU amounted to 183.4 €$_{2016}$ at system level. Figure 5-9 also shows that the terminal unit costs ranged from 1 202 €$_{2016}$ for Belgium Antwerpen, to 122 €$_{2016}$ for Portugal, a factor of almost 10.

Caution is needed when interpreting these results since several factors on top of performance-related issues can affect the level of terminal unit costs in a specific TCZ. These factors include the number and size of aerodromes included in the charging zone, the use of different cost-allocation between en-route and terminal ANS, differences in TNSUs numbers across TCZs and the scope of ANS provided.

For instance, Figure 5-9 shows that the two Belgian TCZs (Belgium Antwerpen and Oostende-Brugge) with the highest unit terminal costs in 2016 only include one airport each and represent 0.6% of the total terminal ANS costs at European system level. Similarly, while the French TCZ reflects the information relating to 60 airports (including regional airports), only the five main airports are included in the two Italian TCZs.

The upper half of Figure 5-9 indicates that terminal unit costs rose for 10 TCZs. For four of these TCZs, terminal unit costs increased by more than +10% in 2016. This includes Belgium Charleroi (+69.0%), Estonia (+15.4%), Slovenia (+14.0%) and Belgium Antwerpen (+11.3%). Detailed analysis indicates that these increases mainly reflect substantially higher terminal ANS costs in 2016.

On the other hand, Figure 5-9 indicates that seven TCZs managed to reduce their unit costs by more than -10% in 2016: Cyprus (-18.0%), Bulgaria (-16.9%), Belgium Oostende-Brugge (-16.3%), Portugal (-11.2%), Sweden (-10.9%), Slovakia (-10.1%) and Switzerland (-10.0%). Except for Belgium Oostende-Brugge, the performance improvements observed in 2016 for these TCZs stem from a combination of lower or fairly stable costs with an increase in TNSUs.

5.3.3 Terminal ANS cost-efficiency performance: outlook for 2017-2019

The objective of this section is to provide information on planned terminal unit costs at system level for the period 2017-2019. It is based on data reported in the terminal reporting tables submitted to the EC in November 2017[26].

Figure 5-10 below shows the planned changes in real terminal ANS costs and TNSUs between 2016 and 2019 for all TCZs included in this analysis.

Figure 5-10 shows that total terminal ANS costs are expected to decrease (-1.3% p.a.) between 2016 and 2019 while TNSUs are foreseen to increase at an average rate of +0.4% per annum.

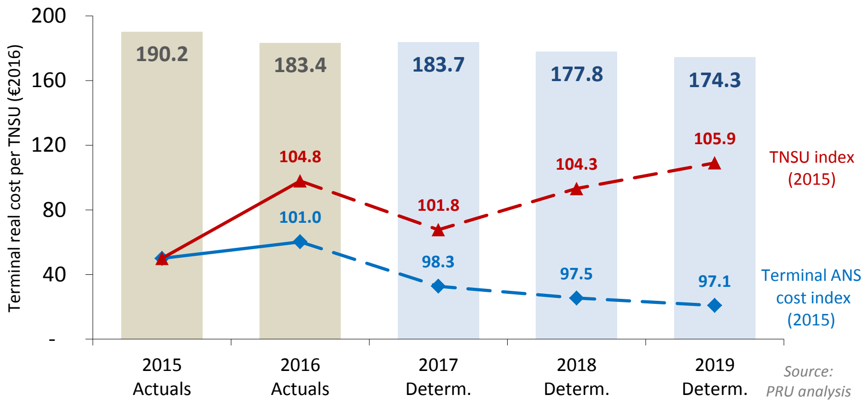


Figure 5-10: Real terminal ANS costs per TNSU, total costs (€$_{2016}$) and TNSUs

As a result, terminal ANS unit costs are expected to reduce from 183.4 €$_{2016}$ in 2016 to 174.3 €$_{2016}$ in 2019 (or -1.7% p.a.).

It is important to note that the apparent decrease of TNSUs presented in Figure 5-10 above for the year 2017 (-2.9%) is mainly due to the fact that the planned data reported for the years 2017-2019 reflect the determined TNSU figures provided in the RP2 Performance Plans which are not updated on a yearly basis. Actual data [3] shows that 2017 TNSUs are +4.0% higher than in 2016 indicating that all else equal, the Pan-European system actual terminal ANS unit costs for the year 2017 is likely to be lower than the figure shown in Figure 5-4 (183.7 €$_{2016}$).

As discussed above, while at system level, terminal ANS costs are expected to decrease by -1.3% p.a. over the period. Different trends are observed for individual TCZs. Indeed, between 2016 and 2019 unit terminal ANS costs are expected to decrease by more than -5% p.a. for six TCZs: Germany (-9.2% p.a.), Slovenia (-8.5% p.a.), Sweden (-7.8% p.a.), Belgium Oostende-Brugge (-7.6% p.a.) and Romania (-5.2% p.a.). Except for Belgium Oostende-Brugge whose terminal costs are expected to rise by +2.3% p.a., all these TCZs forecast substantial reductions in terminal unit costs over the 2016-2019 period.

On the other hand, terminal unit costs are expected to increase significantly for Greece (+14.0% p.a.), Malta (+10.4% p.a.), Portugal (+8.5% p.a.), Cyprus (+7.5% p.a.), Belgium Antwerpen (+7.0% p.a.) and Ireland (+5.2% p.a.). For all these TCZs, the planned increase in unit costs mainly reflects higher terminal ANS costs which, at the exception of Malta, are combined with an expected decrease in TNSUs.

[26] It is understood that the Netherlands, Portugal and Romania have requested the European Commission to revise the adopted RP2 terminal determined unit costs for years 2018-2019. For these States, the information used in Figure 5-10 reflects the data provided in the respective RP2 national Performance Plan and does not include the proposed RP2 cost-efficiency revisions.

5.4 ANSPs gate-to-gate economic performance

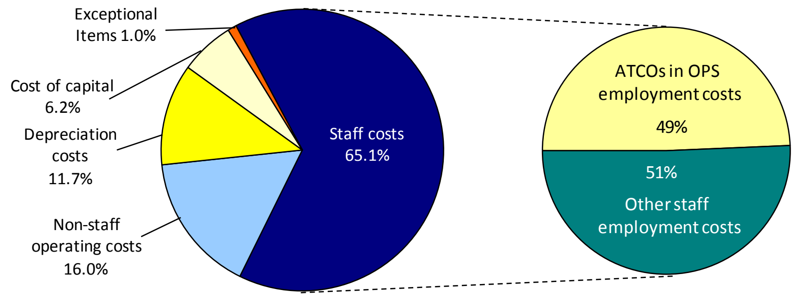
The ATM Cost-Effectiveness (ACE) benchmarking analysis is a Pan-European review and comparison of ATM cost-effectiveness for 38 Air Navigation Service Providers (ANSPs). This includes 30 ANSPs which were part of the SES on 1st January 2016, and hence subject to relevant SES regulations and obligations. Detailed analysis is given in the ACE 2016 Benchmarking Report [16].

The ACE 2016 data analysis presents information on performance indicators relating to the benchmarking of cost-effectiveness and productivity performance for the year 2016, and shows how these indicators changed over time (2011-2016). It examines both individual ANSPs and the Pan-European ATM/CNS system as a whole. It is important to note that the year under review (2016) is the latest year for which actual financial data are currently available.

Some elements of ANS provision are outside the control of individual ANSPs. These elements include the costs of aeronautical MET services, the costs of the EUROCONTROL Agency and costs associated to regulatory and governmental authorities. Therefore, from a methodological point of view, the ACE Benchmarking analysis focuses on the specific costs of providing gate-to-gate ATM/CNS services which are under the direct responsibility of the ANSP.

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 and terminal KPIs which are provided in the previous sections of this chapter.

Figure 5-11 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: **€ 8 092 M**

	En-route		Terminal		Gate-to-gate	
	€ M	%	€ M	%	€ M	%
Staff costs	4 075	64.2%	1 191	68.0%	5 265	65.1%
ATCOs in OPS employment costs	2 000	n/appl	597	n/appl	2 597	n/appl
Other staff employment costs	2 075	n/appl	593	n/appl	2 668	n/appl
Non-staff operating costs	1 003	15.8%	294	16.8%	1 297	16.0%
Depreciation costs	784	12.4%	159	9.1%	943	11.7%
Cost of capital	416	6.6%	89	5.1%	504	6.2%
Exceptional Items	65	1.0%	17	1.0%	82	1.0%
Total ATM/CNS provision costs	6 342	100.0%	1 750	100.0%	8 092	100.0%

Figure 5-11: Breakdown of gate-to-gate ATM/CNS provision costs 2016 ($€_{2016}$)

Figure 5-11 indicates that in 2016, at Pan-European system level, gate-to-gate ATM/CNS provision costs amount to some €8.1 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 of (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.

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 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 delay, all expressed per composite flight-hour. Further details on the methodology used to compute economic costs are available in the ACE 2016 Benchmarking Report [16].

5.4.1 Economic cost-effectiveness performance (2011-2016)

Figure 5-12 below shows the comparison of ANSPs gate-to-gate economic cost per composite flight-hour ("unit economic costs" thereafter) in 2016. The economic cost-effectiveness indicator at Pan-European level amounts to €494 per composite flight-hour in 2016, and, on average, ATFM delays represent 16% of the total economic costs. Figure 5-12 indicates that in 2016 unit economic costs ranged from €924 for Belgocontrol to €198 for MATS; a factor of more than four. Figure 5-12 also indicates that DFS had the highest unit economic costs amongst the five largest ANSPs.

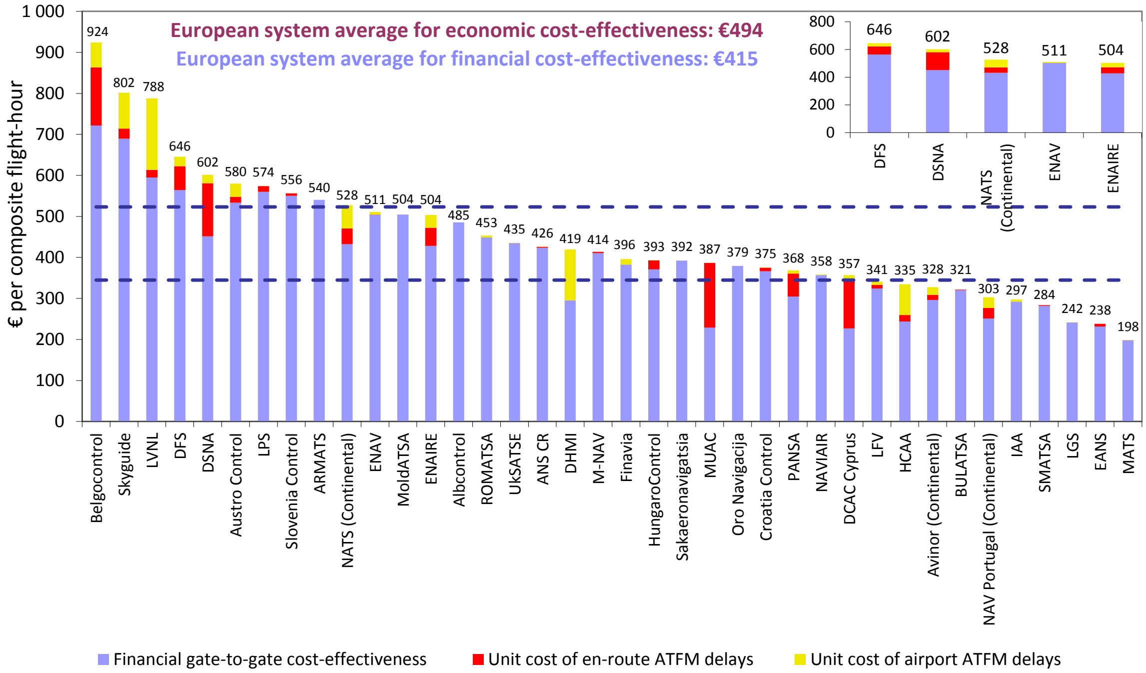


Figure 5-12: Economic gate-to-gate cost-effectiveness indicator, 2016

Figure 5-13 below displays the trend at Pan-European level of the unit economic costs between 2011 and 2016 for a consistent sample of 37 ANSPs for which data for a time-series analysis was available[27]. The left-hand side of the Figure 5-13 shows the changes in unit economic costs, while the right-hand side provides complementary information on the year-on-year changes in ATM/CNS provision costs, composite flight-hours and unit costs of ATFM delays.

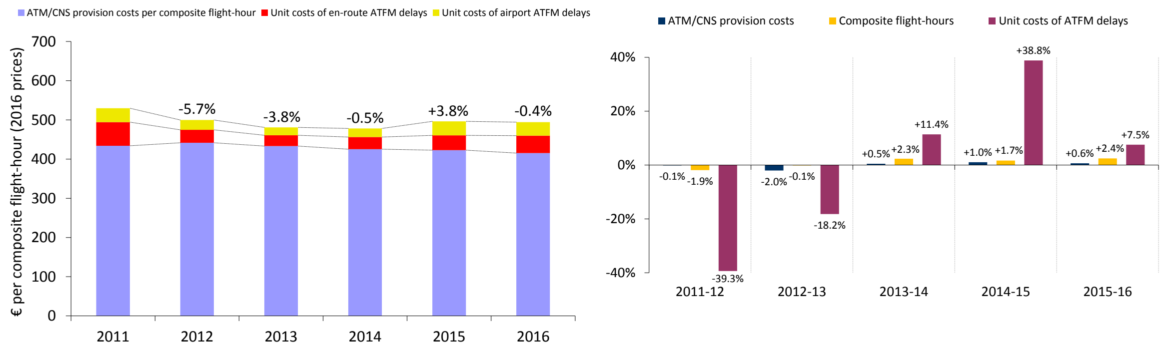


Figure 5-13: Changes in economic cost-effectiveness, 2011-2016 (€$_{2016}$)

Figure 5-13 also shows that in 2016, at face value, unit economic costs reduced by -0.4% compared to 2015 given that the increase in the unit costs of ATFM delays (+7.4%) was more than compensated by a reduction in unit ATM/CNS provision costs (-1.7%) since traffic rose faster (+2.4%) than ATM/CNS provision costs (+0.6%).

However, it is important to note that the change in the unit costs of ATFM delays (+7.4%) is affected by a change in the methodology used by the EUROCONTROL Network Manager to calculate delays in April 2016[28]. This change resulted in substantially less ATFM delays compared to those computed for the previous years. When computed according to the old methodology, the unit costs of gate-to-gate ATFM delays rose by +20.3% in 2016 and unit economic costs were +1.5% higher than in 2015. This adjustment is shown in Figure 5-14 below.

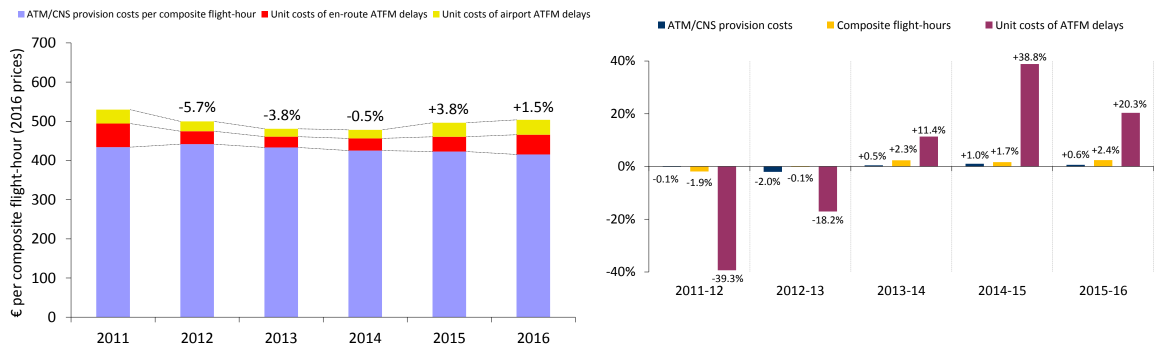


Figure 5-14: Adjusted changes in economic cost-effectiveness, 2011-2016 (€$_{2016}$)

---

27 Sakaeronavigatsia which provided data for the first time as part of the ACE 2015 cycle is not included in this analysis. Therefore, the increase in ATM/CNS provision costs reported for 2016 in the right-hand side charts of Figure 5-13 and Figure 5-14 slightly differ from the information reported on p.51 which is based on a sample of 38 ANSPs (including Sakaeronavigatsia).

28 ANSPs noticed that the use of the Ready Message (REA) - whilst attempting to improve punctuality for aircraft – could result in artificial changes to the computed ATFM delay for individual flights and for the ANSP that has requested the regulation. The ANSPs brought this to the attention of the Network Management Board (NMB). The ANSPs, together with the airspace users and the Network Manager reviewed the existing situation and developed a more accurate process which avoids artificial changes to the computed ATFM delay when a REA message is used. The more accurate process was presented to the NMB and approved in March 2015 for implementation with NM software release 20.0 on April 04 2016. More information on this adjustment is available at: http://ansperformance.eu/references/methodology/ATFM_delay_calculation.html and in the 2016 NM Network Operation Report (http://www.eurocontrol.int/publications/annual-network-operations-report-2016).

In order to ensure consistency in time-series analysis, the changes in unit economic costs and ATFM delays analysed in this in this section of the report are computed using the old calculation methodology as shown in Figure 5-14.

Figure 5-15 shows the long-term trends in terms of ATM/CNS provision costs, composite flight-hours, ATFM delays and unit economic costs.

The trend of decreasing ATFM delays, which began in 2011, stopped in 2014 when a new cycle characterised by higher delays started (+14.0% in 2014, +41.1% in 2015 and +23.3% in 2016).

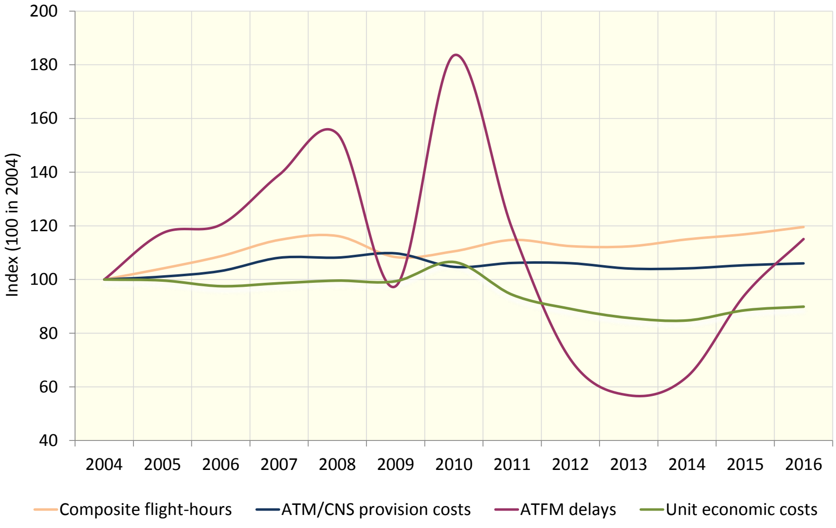


Figure 5-15: Long-term trends in traffic, ATM/CNS provision costs and ATFM delays

Figure 5-15 also shows that over the period from 2004 to 2016 the ATM/CNS provision costs remained relatively flat (+0.5% p.a.), while the traffic in terms of composite flight-hours increased by +1.5% p.a.

Figure 5-16 below shows the contribution of each of the 38 ANSPs to the change in ATFM delays observed in 2016 at Pan-European system level. To ensure consistency in the computation of ATFM delays time-series, the left hand chart of Figure 5-16 is based on the old methodology before the NM adjustment in April 2016. The right-hand chart is showing the situation in 2016 reflecting the NM adjustment as explained above.

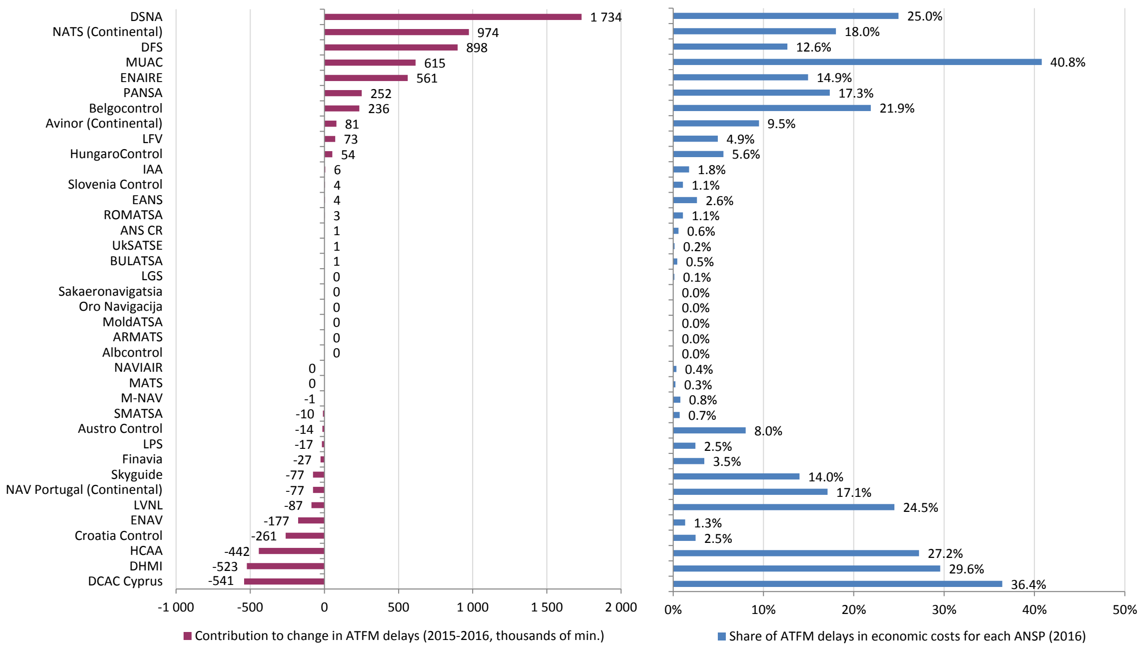


Figure 5-16: ANSPs contribution to ATFM delays increase at Pan-European system level in 2016

Figure 5-16 indicates that the increase in ATFM delays observed at system level in 2016 mainly reflects very large increases for a few ANSPs (DSNA, NATS, DFS, MUAC and ENAIRE). The right-hand side of Figure 5-16 shows that, as a result, for most of these ANSPs the share of ATFM delays in economic costs in 2016 is significantly higher than the European average (16%). This is particularly the case for DSNA (25.0%) and MUAC (40.8%). The main factors explaining the increase in ATFM delays for the top five contributors are:

- the training and implementation of the ERATO stripless environment at Brest ACC, as well as industrial actions for DSNA;
- the training and implementation of the new iTEC ATM system in Prestwick ACC for NATS in the first half of 2016;
- weather and ATC capacity issues in Karlsruhe ACC during the Summer period for DFS;
- capacity issues mainly due to shifting traffic flows for MUAC, as well as, adverse weather phenomena; and
- capacity issues in Barcelona and Canarias ACCs for ENAIRE.

Information provided in Chapter 3 (Operational en-route ANS performance) of this report indicates that the increasing trend of ATFM delays continued in 2017 albeit in a lower magnitude since en-route ATFM delays were +7.1% higher than in 2016.

Figure 5-17 below shows how the unit ATM/CNS provision costs (see blue part of the bar in Figure 5-17) 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 5-17 also shows how these various components contributed to the overall change in cost-effectiveness between 2015 and 2016.

Figure 5-17 shows that in 2016, ATCO employment costs per ATCO-hour (+1.4%) and ATCO-hour productivity (+1.2%) rose at a relatively similar pace. As a result, ATCO employment costs per composite flight-hour remained fairly constant (+0.2%). In the meantime, unit support costs fell by -2.6% since the number of composite flight-hours increased (+2.4%) while support costs remained close to 2015 levels (-0.3%). As a result, in 2016 unit ATM/CNS provision costs reduced by -1.7% at Pan-European system level.

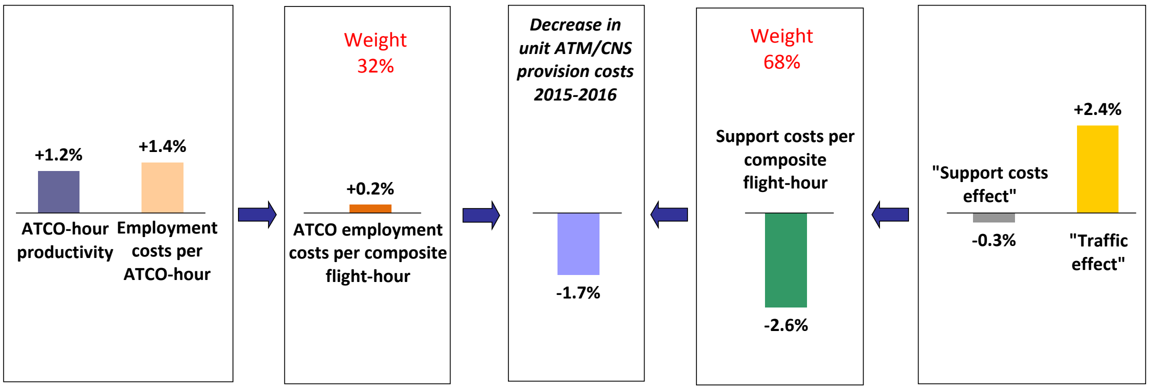


Figure 5-17: Breakdown of changes in cost-effectiveness, 2015-2016 (€$_{2016}$)

More details on the changes in unit ATM/CNS provision costs at ANSP and Pan-European system levels are available in the ACE 2016 Benchmarking Report.

In addition, time-series of ANSPs cost-effectiveness performance data for the period 2002-2016 are available online in the ATM cost-effectiveness dashboard that was launched in January 2018.

5.5 Conclusions

PRR 2017 analyses performance in 2017 for all key performance areas, except for cost-efficiency, which focuses on performance in 2016 as this is the latest year for which actual financial data are available. PRR 2017 also presents an outlook on forecasted cost-efficiency trends for the period 2017-2019.

In 2016 the **en-route ANS cost-efficiency performance** of the Pan-European system improved for the fourth consecutive year since real en-route unit cost per service unit (TSU) reduced by -3.5% to reach an amount of 52.9 $€_{2016}$. This performance improvement is driven by the fact that in 2016 the slight increase in en-route ANS costs (+0.4%) was more than compensated by higher TSUs (+4.1%).

Over the 2009-2016 period, en-route unit costs reduced by -3.3% p.a., reflecting performance improvements achieved by both SES (-3.2% p.a.) and non-SES States (-1.0% p.a.). The unit costs decrease observed for SES States over this period was achieved by slightly reducing costs (-0.6% p.a.) in the context of increasing TSUs (+2.7% p.a.). This is different for non-SES States, for which the improvement in en-route unit costs was driven by significant TSU growth (+7.1% p.a.) which more than compensated the increase in en-route costs (+6.1%). It is noteworthy that in 2016, en-route unit costs rose by +8.1% for non-SES States. This increase, which marks the end of four years of consecutive reductions, mainly reflects a substantially lower traffic growth for some non-SES States in 2016 while costs continued to increase.

The outlook for 2017-2019 suggests that, at Pan-European system level, en-route unit costs are expected to further decrease by -1.3% p.a. to reach an amount of 50.6 $€_{2016}$ in 2019. If these plans materialise, 2019 en-route unit costs will be -24.4% lower than in 2009 resulting in a remarkable cost-efficiency performance improvement over this period. In addition, if the actual traffic growth over the 2017-2019 period is higher than current forecasts then, all else equal, the Pan-European system en-route unit costs in 2019 might be even lower than currently planned.

Real **terminal ANS unit costs** per terminal navigation service unit (TNSU) decreased by -3.6% when compared to 2015 and amounted to 183.4 $€_{2016}$. The drivers for this improvement are similar to those observed for en-route ANS since the growth in TNSUs (+4.8%) more than compensated for the increase in terminal ANS costs (+1.0%). The outlook for the 2017-2019 period suggests that total terminal ANS costs are planned to decrease by -1.3% p.a. until 2019 since terminal costs are planned to reduce by -1.3% p.a. while TNSUs are expected to slightly rise (+0.4% p.a.).

Detailed benchmarking analysis focusing on ANSPs cost-efficiency shows that in 2016 the **gate-to-gate unit costs** of the Pan-European system reduced by -1.7%. In the meantime, the ATFM delays generated by the ANSPs rose for the third consecutive year in 2016 (+23.3%), negatively impacting the Pan-European system's economic cost-effectiveness performance. The increasing trend of ATFM delays continued in 2017 albeit of a lower magnitude since en-route ATFM delays were +7.1% higher than in 2016. It will therefore be important to monitor the impact of this increase on the Pan-European system's economic cost-effectiveness performance in 2017.

[1] PRC, Performance Review Commission, *PRC's Terms of Reference,* 2003.

[2] STATFOR, "EUROCONTROL STATFOR 7-year forecast," Feb. 2017.

[3] STATFOR, "EUROCONTROL STATFOR 7-year forecast," Feb. 2018.

[4] European Environment Agency, "Exposure to environmental noise in Europe," 2014.

[5] EC, European Commission, "Regulation (EU) No 598/2014 on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Union airports within a Balanced Approach and repealing Directive 2002/30/EC," 2014.

[6] SRC, Commission Safety Review, "Annual Safety Report for 2013," EUROCONTROL, Brussels, February 2014.

[7] ICAO, "ICAO Performance Objective Catalogue," ICAO, 2017. [Online]. Available: https://www4.icao.int/aid/ASBU/PerformanceObjective.

[8] University of Westminster, "European airline delay cost reference values – updated and extended values," December 2015.

[9] European Commission (EC), "Commission Implementing Regulation (EU) No 716/2014 of 27 June 2014 on the establishment of the Pilot Common Project supporting the implementation of the European Air Traffic Management Master Plan," 2014.

[10] ACI, Airports Council International Europe, "ACI EUROPE Airport Traffic Report - December Q4 H2 FY 2017," 2018.

[11] EUROCONTROL Performance Review Unit, "Vertical Flight Efficiency During Climb and Descent," 2016.

[12] CANSO, ACI, "Managing the impacts of aviation noise," 2015.

[13] European Commission (EC), "Commission Regulation (EC) No 1794/2006 of 6 December 2006 laying down a common charging scheme for air navigation services amended by Commission Regulation (EC)," 2006.

[14] European Commission (EC), "Commission Implementing Regulation (EU) No 391/2013 of 3 May 2013 laying down a common charging scheme for air navigation services.," 2013.

[15] Performance Review Commission, "Performance Review Report (PRR) 2016," June 2016.

[16] EUROCONTROL Performance Review Commission, "ATM Cost-effectiveness (ACE) 2016 Benchmarking Report. Report commissioned by the Performance Review Commission," Available online at http://www.eurocontrol.int/prc/publications, May 2018.

[17] NATS, "Reports," [Online]. Available: http://www.heathrow.com/file_source/HeathrowNoise/Static/LHR-FP-REPORT-Q32015-FINAL.pdf. [Accessed 14 January 2016].

[18] ICAO, International Civil Aviation Organization, "Global Air Navigation Plan (GANP)," 2016. [Online]. Available: https://www.icao.int/airnavigation/Pages/GANP-Resources.aspx.

[19] SESAR, "SESAR," 2015. [Online]. Available: https://www.atmmasterplan.eu/.

[20] EUROCONTROL Performance Review Unit, "Vertical Flight Efficiency During Climb and Descent," 2016.

[21] European Commission (EC), "Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise," 2002.

This page was intentionally left blank

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. Marc Baumgartner **Vice Chairman**
Mr. Juan Bujia-Lorenzo
Captain Hasan Erdurak
Ms. Marja Hutchings
Dr Jan Malawko
Dr Darren Rhodes
Mr. Ralph Riedle **Chairman**

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.

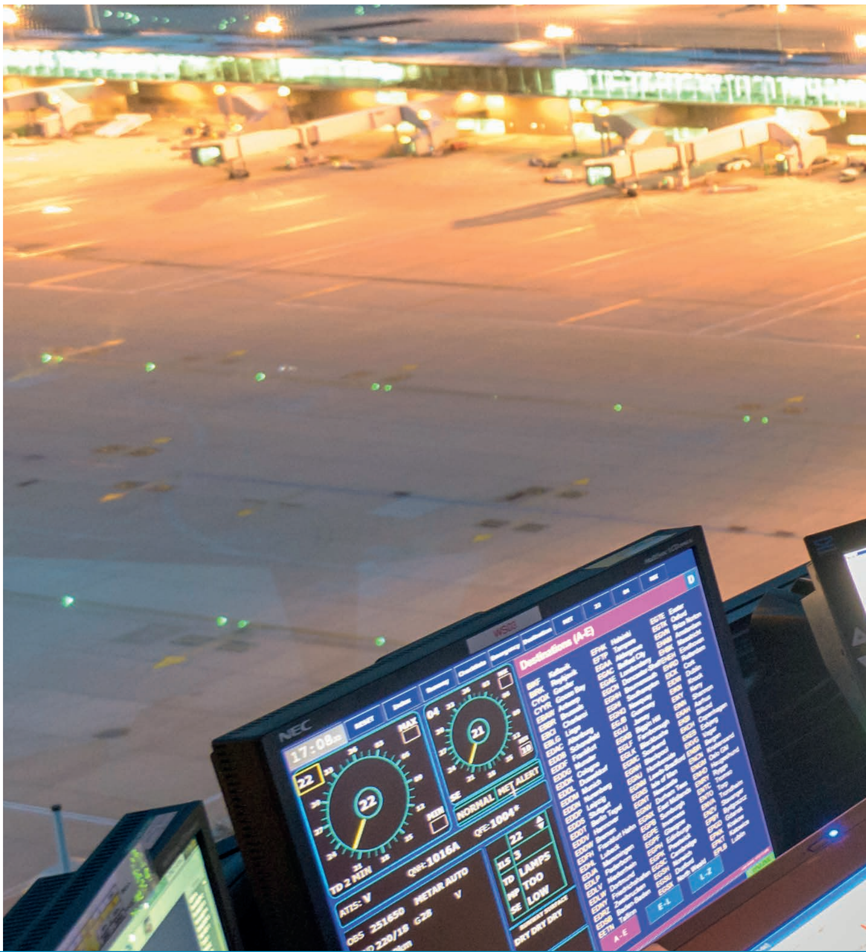
The Performance Review Unit (PRU) supports the PRC and operates administratively under, but independently of, the EUROCONTROL Agency. The PRU's e-mail address is pru-support@eurocontrol.int

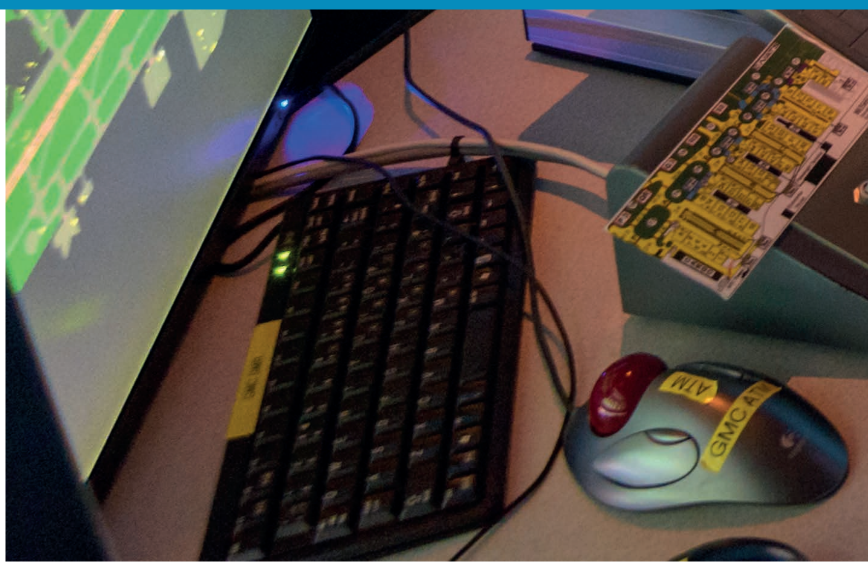
The PRC can be contacted via the PRU or through its website http://www.eurocontrol.int/prc/publications.

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 http://www.eurocontrol.int/prc/publications where copies can also be ordered.





EUROCONTROL

For any further information please contact:

Performance Review Unit, 96 Rue de la Fusée,
B-1130 Brussels, Belgium

Tel: +32 2 729 3956

pru-support@eurocontrol.int

http://www.eurocontrol.int/prc/publications