PRR 2011

Performance Review Report

An Assessment of Air Traffic Management in Europe during the Calendar Year 2011

Performance Review Commission | May 2012

EUROCONTROL

Background

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

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

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DOCUMENT IDENTIFICATION SHEET

DOCUMENT DESCRIPTION

Document Title

Performance Review Commission
Performance Review Report covering the calendar year 2011 (PRR 2011)

PROGRAMME REFERENCE INDEX	EDITION:	EDITION DATE:
PRC Performance Review Report	Final report	10 May 2012

SUMMARY

This report of the Performance Review Commission analyses the performance of the European Air Traffic Management System in 2011 under the Key Performance Areas of Safety, Capacity, Environment, and Cost-Efficiency.

Keywords

Air Traffic Management	Performance Measurement	Performance Areas
Performance Indicators	ATM	ANS

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DOCUMENT STATUS AND TYPE

STATUS		DISTRIBUTION	
Draft	☐	General Public	☑
Proposed Issue	☐	EUROCONTROL Organisation	☐
Released Issue	☑	Restricted	☐

INTERNAL REFERENCE NAME:	PRR 2011

Introduction

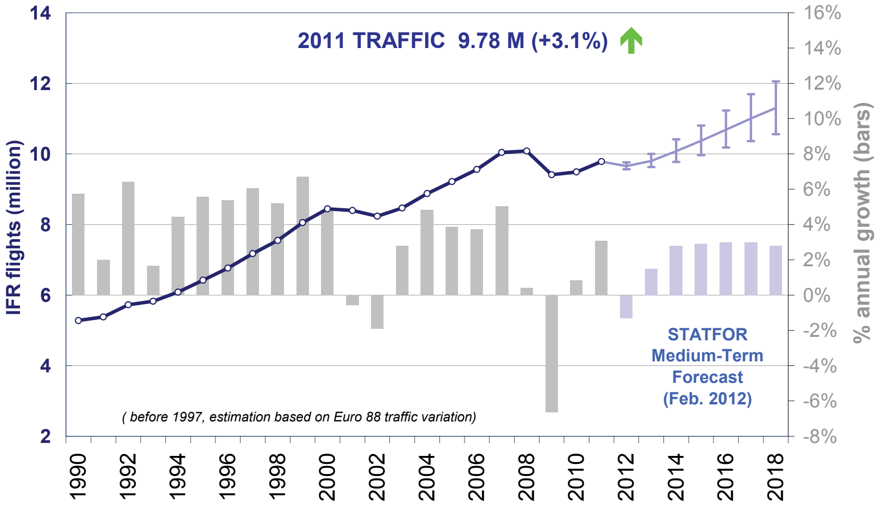
PRR 2011 presents an assessment of the performance of European Air Navigation Services (ANS) for the calendar year 2011.

ANS in European Air Transport

In 2011, IFR traffic grew on average by +3.1% in Europe but remains below the pre-economic crisis levels of 2007 and 2008. Overall, there was a slow traffic recovery in 2011 as some of the observed growth is a compensating effect for the cancellations due to adverse events (ash cloud, strikes, weather) in 2010.

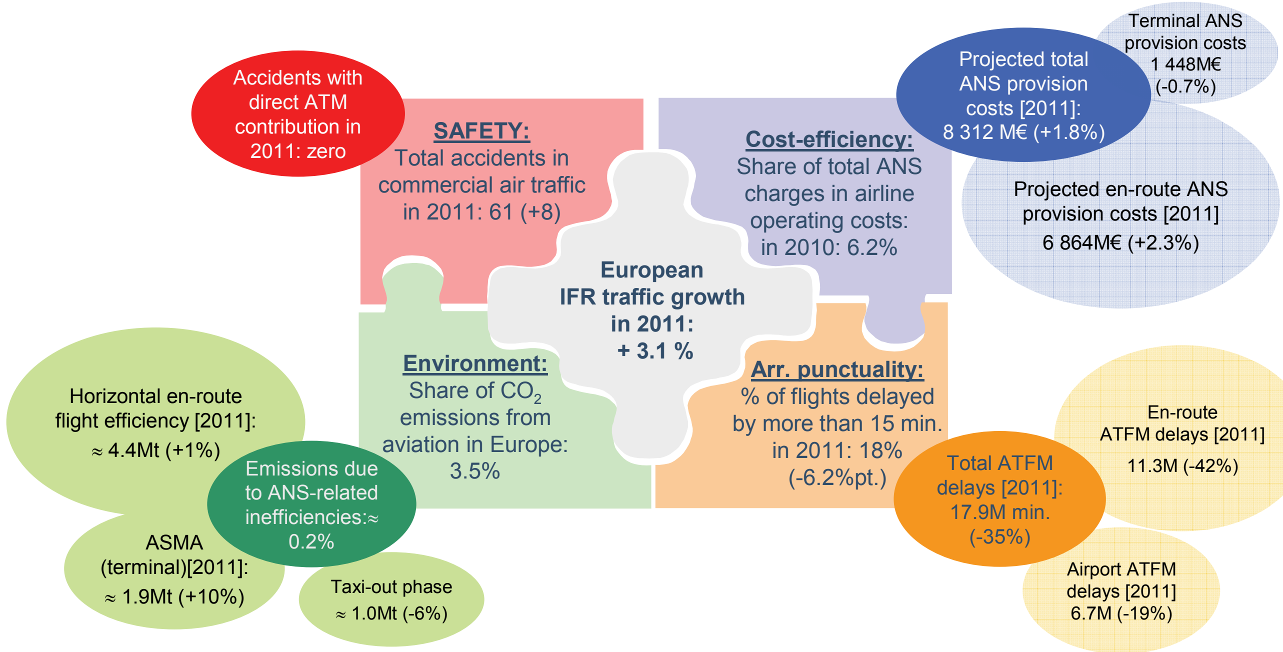
For 2012, the STATFOR Medium Term Forecast [Feb. 2012] predicts a traffic decrease of -1.3% with an average annual growth of +1.0% between 2011 and 2014. Compared to the previous forecast, this is a significant downward revision as a result of the continuing economic crisis in Europe

Traffic growth is not evenly spread across Europe. High growth rates are observed in eastern European States and this trend is forecast to continue between 2012 and 2015.



source : EUROCONTROL/STATFOR (ESRA2008)

The high-level view of ANS performance in the wider context of commercial air traffic operating under Instrument flight rules (IFR) in Europe addresses the key performance areas of the SES performance scheme and includes charges (cost-efficiency), ATFM delays (capacity) and flight efficiency (environment), with an overriding safety objective (safety).

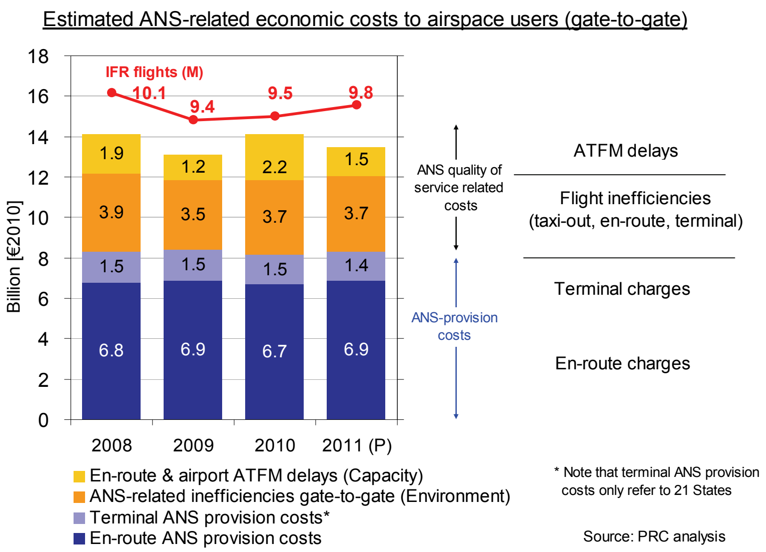


The following points can be noted:

- Safety: Safety is the primary objective of ANS. There was no accident with direct ATM contribution in commercial aviation in Europe in 2011.
- Capacity/Delays: Arrival punctuality improved significantly in 2011 (-6.2% pt.) reaching a level similar to 2009 with subsequent positive effects on the European network. ANS contributed through a substantial reduction in total ATFM delays (-35%), mainly driven by a reduction of en-route ATFM delays (-42%) in 2011.
- Environment/Flight efficiency: Emissions from aviation account for approximately 3.5% of total CO_2 emissions in Europe of which approximately 0.2% is due to ANS-related inefficiencies. ANS-related inefficiencies in the gate-to-gate phase increased in 2011, mainly due to the increase in ASMA additional time.
- Cost-efficiency: Total air navigation charges accounted for 6.2% of airlines' total operating costs in Europe. Despite a projected increase of total ANS provision costs by +1.8%, the costs per unit in Europe decreased notably in 2011, due to the increase in traffic (+3.1%). En-route ANS provision costs accounting for some 80% of total ANS provision are projected to increase by +2.3% in 2011 while terminal ANS provision costs are projected to decrease by -0.7%.

The economic evaluation of ANS performance combines the en-route and terminal ANS provision costs (Cost-efficiency) with the estimated costs to airspace users due to ANS-related inefficiencies (Capacity/ Environment).

Overall, unit costs decreased notably in 2011, as a result of a decrease in total ANS-related economic costs (-4.3%) and a traffic growth of 3.1% which is a good achievement. The reduction results from a substantial improvement in ANS service quality compared to 2010 and thus from a reduction of ANS-related service quality costs of -13% which compensated for the increase in ANS provision costs (+1.8%).



Safety being monitored separately, an overall economic evaluation provides a consolidated high-level view to assess a posteriori the effectiveness of policy objectives at system level and to promote an initial discussion on future ANS performance objectives.

Safety

While incident reporting levels are improving, it is estimated that over 50 000 incidents remain unreported. This estimate is substantially higher than for the preceding reporting period. Currently available data on total numbers of incidents reported do not allow to judge whether the upward trend is caused by an improved level of reporting (positive) or by an increasing number of incidents (negative). Most likely, it is a mixture of both factors. Therefore:

- the five EUROCONTROL Member States (Malta, Monaco, Slovenia, Turkey and Ukraine), which are still not submitting ASTs, should be urged to provide data in 2012 for 2011 onwards;
- the deployment of automatic safety monitoring tools in Europe should be accelerated to complement the manual reporting, in order to improve the reporting culture and consequently the level of reporting. In preparation of and during the deployment, "just culture" needs to be addressed as an important enabler. Sufficient resources are needed to validate the data properly, analyse the results and draw lessons learnt; and,

- there appears to be significant room for improvement in the national safety data flows to capture all of the safety occurrences reported as well as the results of the investigation and analysis.

There is a need to further improve the reporting culture and consequently the level of reporting in Europe. All States should be encouraged to implement Just Culture at all three levels (ANSP, NSA/CAA and State).

With regards to the quality of received reports, it has been observed that the completeness of severity assessment of ATM-related incidents reported through the AST mechanism is deteriorating. Incidents should be analysed using European-wide consistent criteria, which is the first step to uniform assessment of severity. This is necessary to provide meaningful analysis of European-wide levels of risk posed by key risk areas.

The number of reported incidents still under investigation has substantially increased since the last report. States should expedite the investigations, while taking care of just culture aspects, to allow that potential recommendations are derived in a timely manner in order to identify and address key risk areas.

Many NSAs still struggle with the lack of qualified resources. This remains an issue requiring proactive attention by States. Sharing resources within the context of FABs could help to mitigate that situation and preserve the public interest which rests with the NSAs.

In order to provide a consistent safety performance monitoring review across the EUROCONTROL Member States in the future, it would be desirable to encourage non-EU Member States of EUROCONTROL to provide information on 'Effectiveness of Safety Management' and 'Just Culture' to complete the pan-European view.

The State Safety Programme (SSP) implementation is still at an early stage in Europe. A timely implementation of SSPs in all EUROCONTROL States should be promoted so that SSPs will be consistently available.

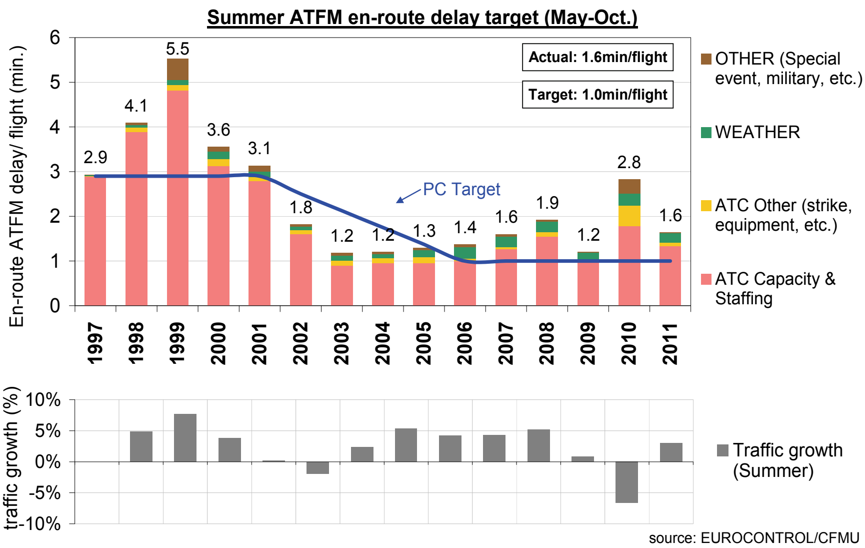
Operational En-route ANS Performance

Notwithstanding a significant improvement in 2011, en-route ATFM delays are still more than 50% higher (1.6 minutes per flight) than the 1 minute summer en-route target set by the Provisional Council.

At almost equal traffic levels, the capacity provided in 2011 is still at the level provided in 2007. This suggests that capacity deployment stagnated and the possibility to close capacity gaps in times of negative or slow traffic growth remained unused.

Notwithstanding the uncertainties presently associated with traffic recovery, it is important to keep a forward looking and proactive approach to capacity planning in order to close existing capacity gaps and to accommodate future traffic growth.

CAPACITY



The majority of en-route ATFM delays are concentrated in only a small number of ACCs which negatively affects the entire European network The 5 most congested ACCs (Madrid, Nicosia, Barcelona, Langen, Athinai + Makedonia) account for more than half (52%) of total en-route ATFM delay in 2011.

En-route ATFM delays due to social tensions and adverse weather decreased notably in 2011. Staffing was the main cause of en-route ATFM delay at most of the critical locations, particularly at weekends when optimum sector configurations could not be deployed. Structural limitations (i.e. airspace configurations etc.) were only observed in a few locations, particularly where traffic growth remained high over the past years (i.e. Warsaw).

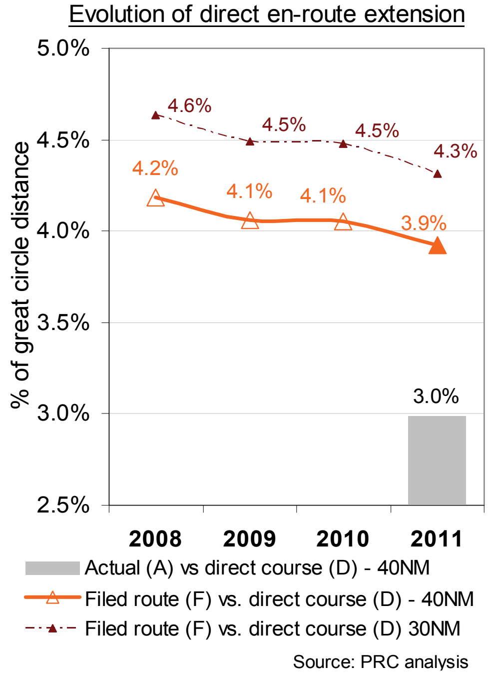
The vast majority of ACCs continued to provide a good performance, and significant improvements in 2011 were observed at some of the most constraining ACCs from 2010 (i.e. French ACCs, Vienna, Warszawa, Zagreb, and Zurich).

Continuing the trend observed over the past years, horizontal en-route flight efficiency improved in 2011.

Of particular relevance is the need to ensure that access to shared airspace is not denied for any user unless the airspace is actually being used for the activity that requires such restriction, either by military or civil airspace users.

As a facilitator bringing stakeholders (FABs, ANSPs, airports, aircraft operators, and military organisations) together, the European Network Manager has a substantial influence on airspace design and utilisation and therefore has an important role to play in the improvement of performance and the achievement of targets (capacity, environment) at network level.

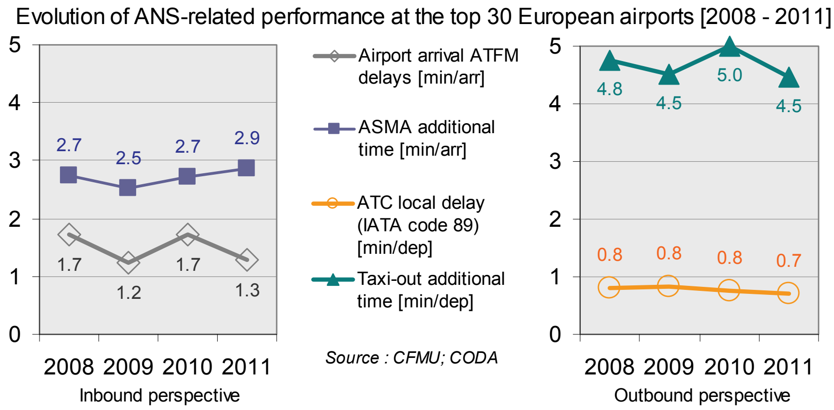
EN-ROUTE FLIGHT EFFICIENCY



Operational ANS Performance at Airports

The analysis ANS-related performance at airports in this chapter focuses on the top 30 European airports in terms of traffic in 2011. Together the top 30 airports accounted for 46% of total airport IFR movements and 62% of total ANS-related inefficiencies at European airports in 2011.

Notwithstanding a substantial traffic growth at the top 30 airports (+4%), average airport ATFM arrival delays (-25%), delays due to local ATC constraints (-7%) and additional taxi out time (-11%) improved in 2011. Better weather conditions than in 2010 helped improving overall performance at airports in 2011.



Although airport ATFM arrival delays decreased at the top 30 airports in 2011, the high level of airport ATFM arrival delays at some regional (Cannes, Istanbul Sabiha Gokçen) and seasonal (Kos, Antalya, Rhodes, Nikos, Chania, Zakinthos) airports had a significant impact on airspace users and the European network. Together they accounted for 10% of the total airport ATFM arrival delay in Europe in 2011. Performance at these airports will be continued to be monitored.

Average additional ASMA time at the top 30 airports increased by +5%, from 2.7 to 2.9 minutes per arrival in 2011.

Airports are key nodes of the aviation network and airport capacity is considered to be one of the main challenges to future air traffic growth. This requires an increased focus on the integration of airports in the ATM network and the optimisation of operations at and around airports.

Depending on the way traffic is managed and distributed along the various phases of flight (airborne vs. ground), ANS has a different impact on airspace users (time, fuel burn, costs), the utilisation of capacity (en-route and airport), and the environment (gaseous emissions).

The management of arrival flows needs to find a balance between the application of ATFM regulations, airborne terminal holdings and the absorption of additional time in the en-route phase through the application of speed control which suggests substantial potential for savings in terms of fuel.

Airport Collaborative Decision Making (A-CDM), including DMAN, demonstrated to be beneficial at some airports in its contribution to a more efficient management of the departure flow. Information from A-CDM, including Target Start-up Approval Times (TSAT), is also expected to further help increasing data quality.

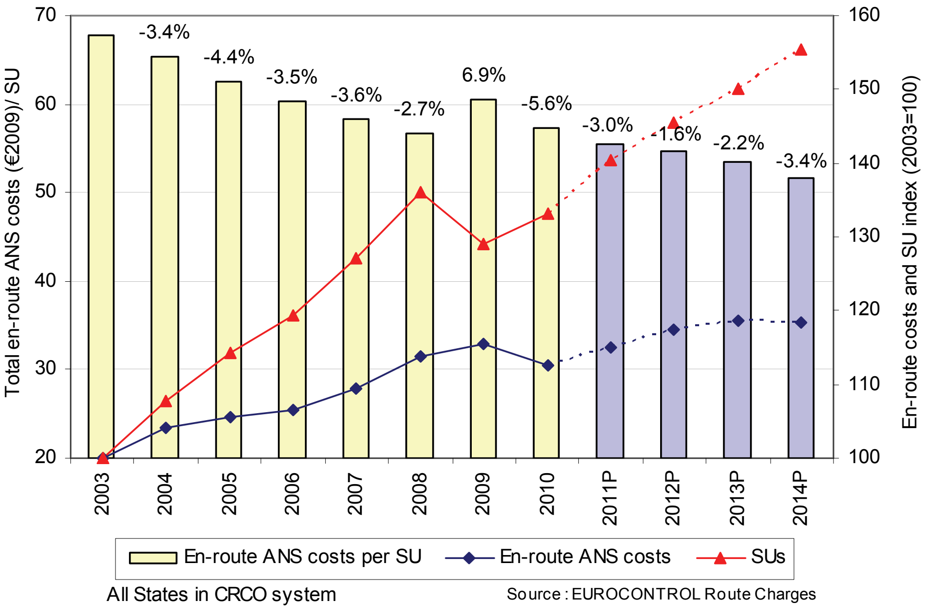
Arrival ATFM delays are monitored by EUROCONTROL, but the other above-mentioned TMA/airport efficiency KPIs are not. Active monitoring and management of those performance indicators, both by the Network Management function and local ATC units, could bring significant benefits.

ANS Cost-efficiency

After a sharp increase in 2009 (+6.9%) reflecting the impact of the traffic downturn, en-route unit costs significantly decreased by -5.6% in 2010. This is due to the fact that while the total number of SU increased by +3.3%, en-route cost-bases reduced by -2.5%.

In April 2009, several European ANSPs stated that they would implement cost-containment measures from 2009 onwards. For a majority of States, 2010 actual en-route costs are lower than the plans made in November 2008. This indicates that the cost-containment measures implemented by the States/ANSPs generated genuine cost-savings in 2010. The efforts made in 2010 to reduce en-route costs compared to the plans (-7.0% which is equivalent to €430M) led to the reduction of the total en-route cost base observed for the EUROCONTROL area (-2.5% in real terms compared to 2009).

After the significant decrease in 2010 (-5.6%), en-route unit costs per SU are planned to further reduce until 2014 to reach €51.7 for the EUROCONTROL area. This represents on average a -3.1% annual en-route unit costs decrease compared to the peak of 2009 (€60.6).



In the context of the performance scheme regulation, the EU-27+2 States submitted Performance Plans to the PRB in June 2011. The 2014 cost-efficiency KPI aggregated from these plans (€55.22) was +2.4% higher than the EU-wide target (€53.92) adopted by the EC. Following the assessment of national/FAB Performance Plans, 21 States were asked to improve their contribution to the EU-wide cost-efficiency target.

The EU-wide Determined Unit Rate is planned to reduce by -3.0% p.a. between 2009 and 2014. Undoubtedly, the collective effort made in 2011 by the ANS industry to prepare for the implementation of the first RP has generated an effective drive towards a better management of cost-efficiency performance despite a deteriorating business environment.

The PRC has the remit to monitor terminal ANS cost-efficiency performance. In the context of the SES Performance Scheme, this remit has been strengthened as of RP1 (2012-2014). Terminal ANS cost-efficiency can for the time being only be monitored for the EU27 States plus Norway and Switzerland as no comparable data is available for the other EUROCONTROL Member States.

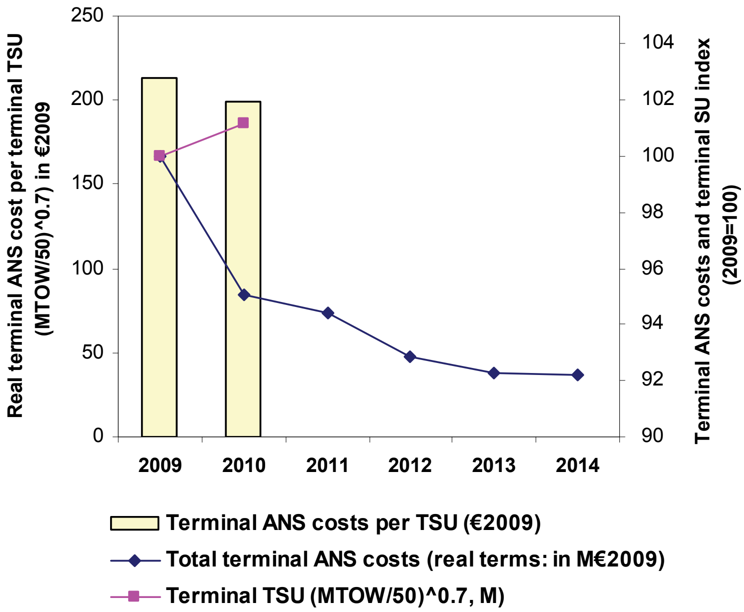
Terminal ANS costs and charges data availability and consistency across the EU27+2 States is gradually improving. The total 2010 terminal ANS costs were reported by 26 States in November 2011. Out of the 26 States, 21 States consistently reported the data for the period 2009-2014. These 21 States (23 terminal charging zones) represent an amount of around €1 416M and cover 211 airports.

For the first time the PRC recomputed the terminal TSU series with a common exponent (MTOW/50)^0.7) which will be mandatory by 2015 for the EU27+2 States. This enables direct comparison of terminal ANS unit costs across States and across time in line with the performance indicators specified in the Performance Scheme Regulation.

In 2010, terminal ANS unit costs decreased at a slightly higher pace than en-route ANS unit costs (-7.0% for terminal and -5.6% for en-route).

In 2010 total terminal ANS costs amounted to €1 416M, a decrease of -5.0% in real terms over 2009 (€1 490M). The Terminal ANS costs are predicted to further decrease, albeit at a lower rate, between 2010 and 2014 (-0.8% p.a. on average).

From year 2011 onwards, no information could be inferred on the terminal TSUs and terminal unit costs forecasts as the series were computed with a common formula for which no forecasts are yet available.



Source: 2012 terminal ANS Costs and Charges, Consultation Hearing, November 2011

In 2010, the terminal ANS costs per total SU ranges from €79 for Sweden-Landvetter to €421 for Slovak Republic, a factor of 5.3. The average for 26 States (28 terminal charging zones) that reported 2010 actual costs amounts to €201.

There is clearly a greater diversity of situations in terminal ANS provision than in en-route. Differences in terminal ANS unit costs across States and across terminal charging zones are driven by a number of factors, some of which are specific to terminal ANS.

PRC Recommendations 2011

The Provisional Council is invited to:

a. **note** the PRC's Performance Review Report for 2011 (PRR 2011) and to submit it to the Permanent Commission;

b. **ensure** that all EUROCONTROL MS provide AST data in accordance with the provisions of CN Decision No. 115 approving the EUROCONTROL Safety Regulatory Requirement – ESARR 2 "Reporting and Assessment of Safety Occurrences in ATM".

c. **urge** those States and ANSPs with incomplete safety incident reporting and analysis to review and improve their processes including follow up, and to invite the Director General to support them as appropriate;

d. **request** those Member States, which are not bound by the provisions of the SES performance scheme, to provide to the PRC - on a voluntary basis - information on 'Effectiveness of Safety Management' and 'Just Culture', and to invite the Director General to support them as appropriate;

e. **urge** those States where State Safety Programmes (SSPs) are not implemented to implement them in a timely manner;

f. **request** States to maintain a forward looking and proactive approach to capacity planning, in order to close existing capacity gaps and to accommodate future traffic growth;

g. **request** States to set up data provision to support continuous improvement in airspace management to allow collaborative decision making with real time information (advanced FUA) with the availability of online SUA-data for the network at the same time ensuring that CDR-availability is online known to the aircraft operator and ANSPs.

h. **request** States to speed up the process of A-CDM implementation in cooperation with aircraft operators, airports and ANSPs taking into consideration that the current A-CDM rollout is well behind the agreed schedule according to the EUROCONTROL A-CDM implementation plan.

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1.1.1 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.

1.1.2 This Performance Review Report (PRR 2011) has been produced by the independent Performance Review Commission (PRC) of EUROCONTROL. The PRC and its supporting Unit the Performance Review Unit (PRU) were established in 1998 and have been conducting performance review, target-setting and cost-effectiveness benchmarking since then.

1.1.3 The purpose of this report is to provide policy makers and ANS stakeholders with objective information and independent advice concerning European ANS performance in 2011, based on research, consultation and information provided by relevant parties.

1.1.4 The draft final report is made available to stakeholders for consultation and written comment from 24 February-09 March 2012. The PRC will consider every comment received and amend the Final Report where warranted.

1.2 Structure of the report

1.2.1 The reader will note that the PRC has slightly re-structured PRR 2011. The aim is to optimise the visibility of key information so that the reports become even more useful to policy makers. The report is structured as follows:

Executive Summary	
Part I	
Chapter 1:	Introduction
Chapter 2:	ANS Performance Review in Europe
Chapter 3:	ANS in European Air Transport
Part II	
Chapter 4:	Safety
Chapter 5:	Operational En-route ANS Performance (Capacity/Environment)
Chapter 6:	Operational ANS Performance at Airports (Capacity/Environment)
Chapter 7:	ANS cost-efficiency

1.2.2 Part I of the report provides a consolidated high level view of the four ANS key performance areas (Safety, Capacity, Environment, Cost-efficiency) in the wider context of European General Air Traffic. It furthermore includes an assessment of the impact of ANS performance on environment as well as an overall economic evaluation. The new Chapter 3 combines elements from previous PRR chapters (traffic, environment, economic assessment) for a consolidated evaluation of ANS performance.

1.2.3 Part II of the report provides a more detailed analysis of ANS performance by Key performance area.

1.3 Geographical scope of the report

1.3.1 Unless otherwise indicated, PRR 2011 refers to ANS performance in the airspace controlled by the 39 Member States of EUROCONTROL in 2011 (see Figure 1-1), hereinafter referred to as "Europe".

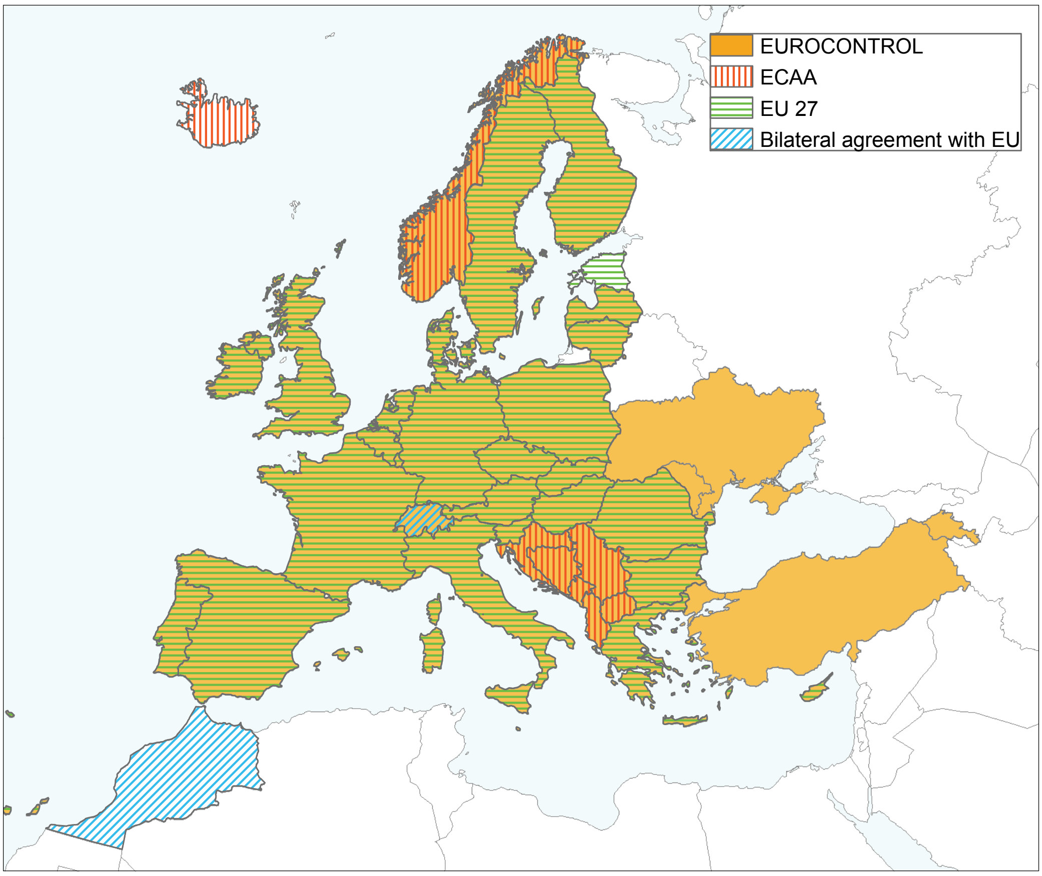

Figure 1-1: EUROCONTROL States [2011]

1.4 Implementation status of PC decisions on PRC recommendations

1.4.1 Article 10.7 of the PRC's Terms of Reference states that, "*the PRC shall track the follow-up of the implementation of its recommendations, and report the results systematically to the Provisional Council*".

1.4.2 The Provisional Council (PC 35, May 2011) adopted unamended the PRC's recommendations arising out of PRR 2010. These recommendations were as follows:

> The Provisional Council requested those States and ANSPs with late and/or incomplete safety incident reporting to review their reporting and investigation systems and to resolve urgently any related issues, and invited the Director General to support them as appropriate.
>
> The Provisional Council agreed to ensure that the use of resources is optimised by harmonising, rationalising and integrating all international audits, inspections, surveys to which NSAs/CAAs and ANSPs are subjected, noting that for EU Member States this optimisation should result in a system organised around the EASA standardisation inspections complemented by ICAO Audits and peer reviews (EASA opinion 02/2010).
>
> The Provisional Council requested the Director General to monitor ANS performance at airports, including ANS efficiency indicators such as pre-departure delays due to local ATC constraint, ASMA and Taxi-out additional times on top of ATFM delays, and to bring solutions to identified issues.

Figure 1-2: PC action on PRC recommendations contained in PRR 2010

1.4.3 Since 2006, the PRC has made 32 recommendations requiring action to the Provisional Council. The implementation status of the associated PC decision is shown in the table below:

KPA/Decision	Implemented	Partially implemented	Not implemented	No action needed, or recent decision	Total
Safety		13			13
Environment/flight efficiency	4	1		1	6
Capacity	2	4		4	10
Cost-efficiency		2		1	3
Total	**6**	**20**		**6**	**32**

Figure 1-3: Implementation status of PC decisions on PRC recommendations

1.4.4 Details of these recommendations are contained in previous performance review reports.

Chapter 2: ANS Performance Review in Europe

KEY POINTS
1. The EUROCONTROL performance review system is a light touch form of ANS regulation, consisting of independent performance monitoring and a target setting system at Pan-European level. It has fostered improved ANS performance in Europe since 1998.
2. The Single European Sky (SES) performance scheme complements and reinforces the EUROCONTROL system with enforceable performance targets set at national or FAB level, in consistency with EU-wide targets. The performance scheme applies to EU States and can be extended to neighbouring States on a voluntary basis. EUROCONTROL has been designated as Performance Review Body and supports the implementation of the performance scheme through the PRC and PRU.
3. The SES targets set for the first reference period (RP1, 2012-14), are expected to give a strong impetus to further performance improvements within the EUROCONTROL Organisation.
4. During RP1, safety will continue to be ensured through regulatory requirements. Over 2009-2014, route charges and ANS-related emissions will remain approximately constant, resulting in more than 2.5 billion Euro savings over RP1 and carbon-neutral growth of aviation as far as ANS is concerned. ATFM delays will also be significantly reduced.

2.1 Introduction

2.1.1 The EUROCONTROL performance review, benchmarking, and target setting system was introduced in 1998 as part of the early implementation of the Revised Convention. The successive Performance Review Commission (PRC) reports have shown significant improvements in performance, but also some significant deterioration in different places and times.

2.1.2 Overall, performance improvements have been fragile and relied solely on peer pressure and States' goodwill. The genuine performance improvements of some States were offset by the lack of performance of others, leading to a patchy situation.

2.1.3 The Single European Sky (SES) performance Regulation 691/2010 [Ref. 1] (hereinafter 'Performance Regulation') complements and reinforces the EUROCONTROL performance system. Its adoption in 2010 marked the start of the implementation of the SES performance scheme, and in particular the preparation for the first reference period (RP1) which runs for three years from 2012 to 2014.

2.1.4 In 2010, EUROCONTROL, acting through its PRC and supported by the Performance Review Unit (PRU), accepted to be designated by the European Commission (EC) as the Performance Review Body (PRB) of the SES until mid 2015 [Ref. 2]. The PRB Chairman is appointed separately by the EC.

2.1.5 The SES performance scheme places greater focus on planning and accountability for performance, target-setting, monitoring, incentives and corrective actions at both European and national/FAB levels. It is coupled with a new Charging regime (Ref charging regulation), which replaces Cost recovery" by a system of Determined costs set at the same time as performance targets. As a result, ANS performance improvements are expected to become quicker and firmer in the SES area, and EUROCONTROL can extend the benefits to the Pan-European dimension.

2.1.6 The PRC's role as PRB is to assist the EC in the implementation of the performance scheme and to assist the National Supervisory Authorities (NSAs) on request. Two of its key tasks include:

- advising the EC in setting EU-wide performance targets and assessing national/Functional Airspace Block (FAB) performance plans; and,
- monitoring the performance of the system in four key performance areas: safety, capacity, environmental impact and cost-efficiency.

2.1.7 A key rationale for the EC when designating EUROCONTROL was to achieve synergies between the SES performance scheme and the EUROCONTROL performance review system. The PRC's commitment is to ensure that common procedures, tools and data feed both systems and hence reduce the overall cost, which will further optimise the performance of pan-European air navigation services, in the interests of all stakeholders.

2.2 The SES Performance Scheme

2.2.1 The SES Performance Scheme is designed as a powerful driver of European ANS performance. The scheme makes provision for EU-wide targets to be set for the Key Performance Areas (KPA) of Safety, Cost-Efficiency, Capacity and Environment, to be transposed into binding national/FAB targets (Cost-efficiency and Capacity in RP1) for which clear accountabilities must be assigned within national/FAB performance plans.

2.2.2 The national/FAB performance plans are important documents. They "register the commitment of Member States, for the duration of the reference period, to achieve the objectives of the Single European Sky and the balance between the needs of all airspace users and supply of services provided by air navigation service providers" (Recital 7 of [Ref. 1]).

2.2.3 The year 2011 also saw the establishment of a European Network Manager. EUROCONTROL was nominated by the EC to take on the role of European 'Network Manager' as defined in Commission Regulation (EU) No 677/2011 laying down detailed rules for the implementation of ATM network functions [Ref. 3]. The NM will have, as from 2012, a key role to play in improving the performance of the European network, through:

- its Strategy Plan and the responsibility of reaching the EU-wide environment performance target set for 2014;
- the role it will play in helping the States and FABs to reach their own performance targets; and,
- assisting the PRB in monitoring Network performance.

2.2.4 The Performance Regulation formalises the flow of data for performance monitoring in the EU. Much of this data is already provided and available to the PRC through existing systems such as CODA and the CFMU. The PRC is working to extend the data requirements to the entire EUROCONTROL area in order to harmonise the data and monitoring activities.

2.2.5 Figure 2-1 provides an overview of the ANS performance indicators specified in the SES legislation and shows where they are addressed in PRR 2011.

	ANS performance indicators	2012-14	PRR 2011
Safety	Effectiveness of safety management ('maturity')	monitoring	Chapter 4
	Application of severity classification scheme	monitoring	
	Separation infringements	monitoring	
	Runway incursions	monitoring	
	ATM special technical events	monitoring	
	Application of Just Culture	monitoring	
Capacity/ Environment	En-route ATFM delay	target	Chapter 5
	Horizontal flight efficiency	target	
	Effective use of civil/military airspace structures	monitoring	
	Airport ATFM delays	monitoring	Chapter 6
	Additional time in taxi-out phase	monitoring	
	Additional time in arrival sequencing and metering area	monitoring	
Cost-efficiency	Determined Unit Rate for en-route-ANS	target	Chapter 7
	Terminal costs and unit rates	monitoring	

Figure 2-1: SES Performance Indicators [2012-14]

2.2.6 More information on the implementation of the SES performance scheme and PRC-PRU role therein can be found at www.eurocontrol.int/prc.

2.3 SES Performance targets

2.3.1 EU-wide targets for 2012-14 are designed to set a challenging but achievable level of ambition. A significant change in performance trends can be expected as a result, even more so as targets are enforceable.

2.3.2 During RP1, which can be considered as a transition period, safety will continue to be ensured through regulatory requirements. This will be complemented by a performance-oriented approach from RP2 onwards (starting in 2015).

2.3.3 The cost-efficiency target coupled with the charging regime will ensure that en-route charges remain nearly constant in real terms between 2009 and 2014, while traffic is expected to grow some +16.7% (see Figure 2-2). The cumulated savings vs. unit rates prevailing in 2009 are estimated at some 2.3 billion euro over RP1.

2.3.4 The environmental target will result in nearly constant ANS-related emissions over 2009-2014, as shown in Figure 2-2. Its achievement will therefore decouple emissions from traffic growth and ensure a carbon-neutral growth of aviation as far as ANS is concerned, well before the 2020 target set by IATA.

2.3.5 Finally, the capacity target will reduce delays below the lowest levels ever achieved, bring them closer to the economic optimum and make capacity more resilient to unexpected high traffic growth.

Safety	States have to monitor and publish a set of Safety PIs.
Capacity	Annual average en-route ATFM delay (all causes) of 0.5 minutes per flight by 2014
Environment	A reduction of horizontal en-route flight extension by 0.75% points versus 2009 baseline.
Cost-efficiency	Determined unit rate for 2014 is set at €53.92

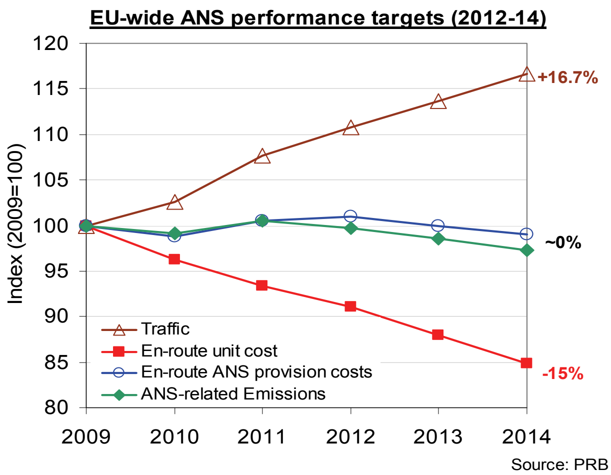

Figure 2-2: EU-wide ANS performance targets [2012-2014]

2.4 Conclusions

2.4.1 The EUROCONTROL performance review system is a light touch form of ANS regulation, consisting of independent performance monitoring and a target setting system at Pan-European level. It has fostered improved ANS performance in Europe since 1998.

2.4.2 The Single European Sky (SES) performance scheme complements and reinforces the EUROCONTROL system with enforceable performance targets set at national or FAB level, in consistency with EU-wide targets. The performance scheme applies to EU States and can be extended to neighbouring States on a voluntary basis. EUROCONTROL has been designated as Performance Review Body and supports the implementation of the performance scheme through the PRC and PRU.

2.4.3 The SES targets set for the first reference period (RP1, 2012-14), are expected to give a strong impetus to further performance improvements within the EUROCONTROL Organisation.

2.4.4 During RP1, safety will continue to be ensured through regulatory requirements. Over 2009-2014, route charges and ANS-related emissions will remain approximately constant, resulting in more than 2.5 billion Euro savings over RP1 and carbon-neutral growth of aviation as far as ANS is concerned. ATFM delays will also be significantly reduced.

KEY POINTS	KEY DATA 2011		
	Traffic demand & Punctuality	2011	% change vs. 2010
1. In 2011, IFR traffic grew on average by +3.1% in Europe but remains below the pre-economic crisis levels of 2007 and 2008.	IFR flights controlled [1]	9.78M	+ 3.1%
2. For 2012, the STATFOR Medium Term Forecast [Feb. 2012] predicts a traffic decrease of -1.3% with an average annual growth of +1.0% between 2011 and 2014.	Flight hours controlled [1]	14.4M	+ 4.4%
	Total distance charged in km[2]	8 946M	+4.2%
3. After a poor performance in 2010 (24.2%), punctuality improved significantly in 2011 (-6.2%pt.) reaching a level similar to 2009 with subsequent positive effects on the European network.	En-route Service Units[2]	119.2M	+4.8%
	Flights with arrival delay > 15 min. compared to schedule	18%	-6.2% pt.
	Economic evaluation (M€ 2010)		
4. In 2011, there was a significant reduction of total ATFM delays (-35%), mainly driven by improvements en-route, with a corresponding positive effect on related costs.	Estimated total ANS provision costs (en-route + terminal)	8 312	+1.8%
5. ANS-related inefficiencies in the gate-to-gate phase increased in 2011, mainly due to the increase in ASMA additional time.	Estimated cost of ANS related inefficiencies in the gate-to-gate phase	3 730	+0.9%
6. Total estimated ANS-related economic costs to airspace users decreased by -4.3% in 2011. This was mainly due to the substantial reduction ATFM delay costs (-35%) and only slightly rising ANS provision costs (+1.8%) combined with a traffic growth of 3.1%.	Estimated cost of en-route and airport ATFM delay	1 450	-35%
	Total estimated ANS-related economic costs to airspace users (M € 2011)	13 492	-4.3%

3.1 Introduction

3.1.1 This chapter provides a high-level view of ANS performance in the wider context of commercial air traffic operating under Instrument flight rules (IFR) in Europe, as defined in Chapter 1. After an overview of the evolution of European air traffic demand, the chapter combines key elements from the more detailed analyses of ANS performance in Chapters 4-7, to provide an overall economic evaluation of ANS performance in Europe.

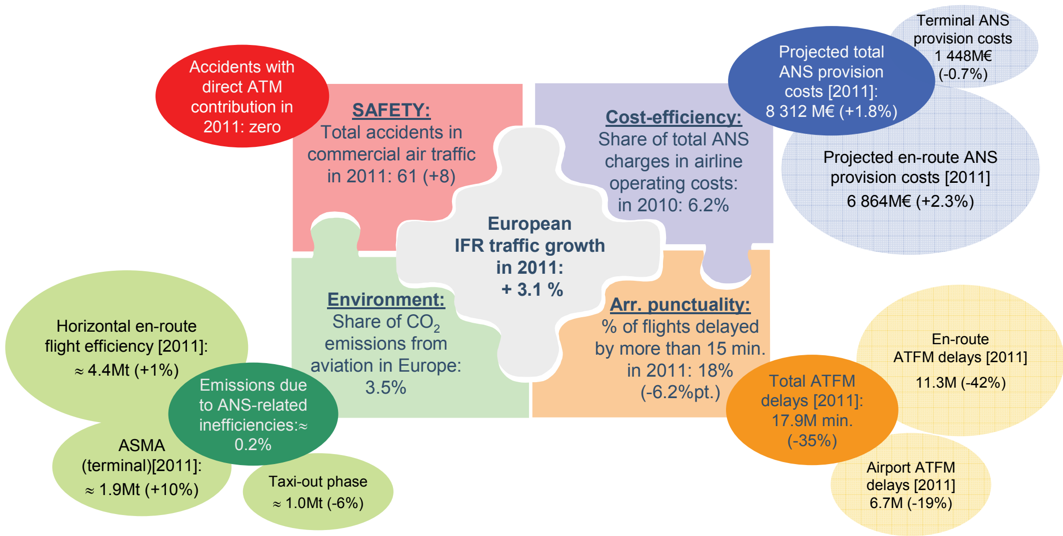

Figure 3-1: ANS performance in the wider context of European commercial air traffic

3.1.2 Figure 3-1 puts ANS performance in the wider context of commercial air traffic in

1 EUROCONTROL Statistical Reference Area (ESRA) 2008 (see Glossary).
2 States in EUROCONTROL Route Charges System in Nov. 2011, excluding Santa Maria (see Glossary).

Europe. The areas addressed cover all the key performance areas of the SES performance scheme and include charges (Cost-efficiency), ATFM delays (Capacity) and flight efficiency (Environment), with an overriding safety objective (Safety):

- Safety: Safety is the primary objective of ANS. There was no accident with direct ATM contribution in commercial aviation in Europe in 2010 (see also Section 3.3 and Chapter 4).
- Capacity/ Delays: Arrival punctuality improved significantly in 2011 (-6.2%pt.) reaching a level similar to 2009 with subsequent positive effects on the European network. ANS contributed through a substantial reduction in total ATFM delays (-35%), mainly driven by a reduction of en-route ATFM delays (see also Section 3.4 and Chapters 5 & 6).
- Environment/ Flight efficiency: Emissions from aviation account for approximately 3.5% of total CO_2 emissions in Europe of which approximately 0.2% due to ANS-related inefficiencies. ANS-related inefficiencies in the gate-to-gate phase increased in 2011, mainly due to the increase in ASMA additional time (see also Section 3.5 and Chapters 5 and 6).
- Cost-efficiency: Total air navigation charges accounted for 6.2% of airlines' total operating costs in Europe. Despite a projected increase of total ANS provision costs by +1.8%, the costs per unit in Europe decreased notably in 2011, due to the increase in traffic (+3.1%). En-route ANS provision costs accounting for some 80% of total ANS provision are projected to increase by +2.3% in 2011 while terminal ANS provision costs are projected to decrease by -0.7% (see also Section 3.6 and Ch. 7).

3.2 European Air Traffic Demand

3.2.1 The output of air transport is often measured in Revenue Passenger Kilometres (RPKs) which is influenced by a number of factors (number of flights, distance, aircraft size, etc.). Figure 3-2 shows the evolution of the high-level air transport indicators between 2003 and 2011 in Europe.

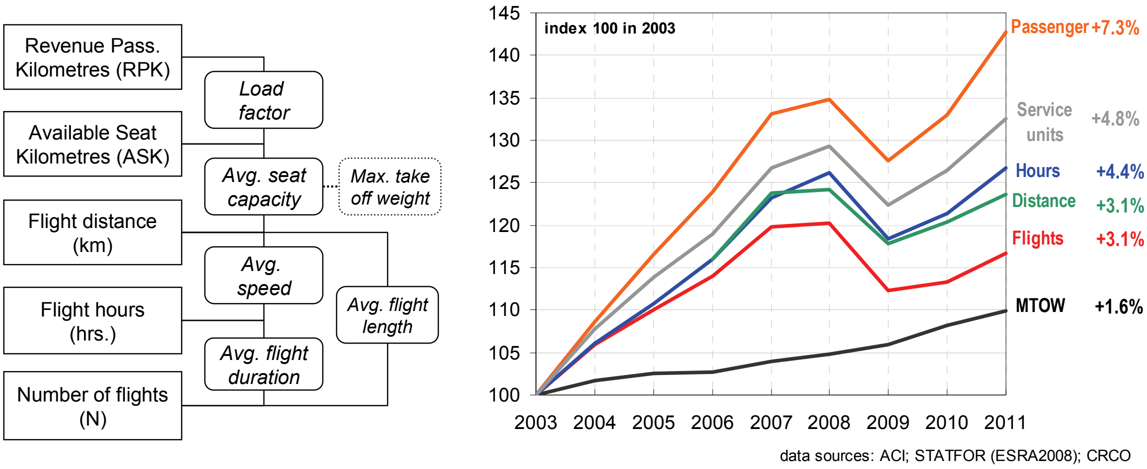

Figure 3-2: Key European traffic indicators and indices – [2003-11]

3.2.2 Despite a drop in all other indicators in 2009, average aircraft weight (MTOW) continued to increase throughout the economic crisis which indicates a lower number of services but with larger aircraft.

3.2.3 In 2011, MTOW increased by 1.6% which, in combination with the growth in traffic (number of flight & distance), resulted in a 4.8% growth of en-route Service Units[3].

3 SU is used for the calculation of route charges and multiplies Aircraft Weight Factor by Distance Factor.

EUROPEAN AIR TRAFFIC GROWTH

3.2.4 Although traffic still remains below the pre-economic crisis levels of 2007 and 2008, European IFR traffic grew on average by +3.1% in 2011 (see Figure 3-3) and by 2.0% during summer. Overall, there was a slow traffic recovery in 2011 as some of the observed growth is a compensating effect for the cancellations due to adverse events in 2010 (ash cloud, strikes, weather).

3.2.5 For 2012, the STATFOR[4] Medium-Term forecast (MTF) published in February 2012 [Ref. 4] predicts a traffic decrease of -1.3% and an average annual growth of +1.0% between 2011 and 2014.

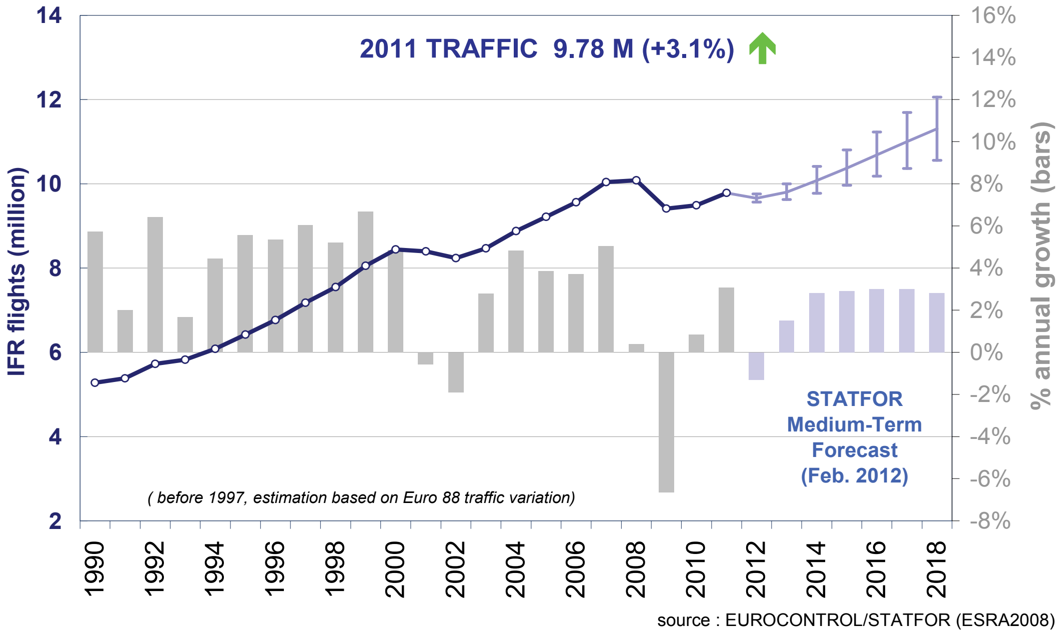

Figure 3-3: Evolution of European IFR traffic [ESRA 08]

3.2.6 Figure 3-4 compares actual observed traffic levels to the published STATFOR MTFs. The STATFOR MTF published in February 2011 [Ref. 5] predicted for 2011 a traffic growth at ESRA 08 level[5] between +5.4% and +3.4% with a baseline scenario of +4.3%. Traffic growth was negatively affected by the continuing economic crisis in Europe and the political unrests in North Africa which particularly had an impact on overflights in some southern European States.

3.2.7 The economic outlook remains uncertain in 2011 and 2012 with the majority of European States revising their economic forecasts downwards. Overall, traffic growth in 2011 was 3.1% and therefore remained 1.2% points below the February 2011 and 1.4% points below the September 2011 STATFOR MTF forecast.

3.2.8 According to the latest STATFOR MTF forecast [February 2012], traffic growth in 2012 is predicted at -1.3% which is substantially lower than the growth expected in the February 2011 forecast.

4 EUROCONTROL Statistics and Forecast Service (STATFOR). The Medium-term forecasts look seven years ahead and are published in February and refreshed in September each year.

5 The EUROCONTROL Statistical Reference Area (ESRA), is designed to include as much as possible of the ECAC area for which data are available from a range of sources within EUROCONTROL (see Glossary for a list of States).

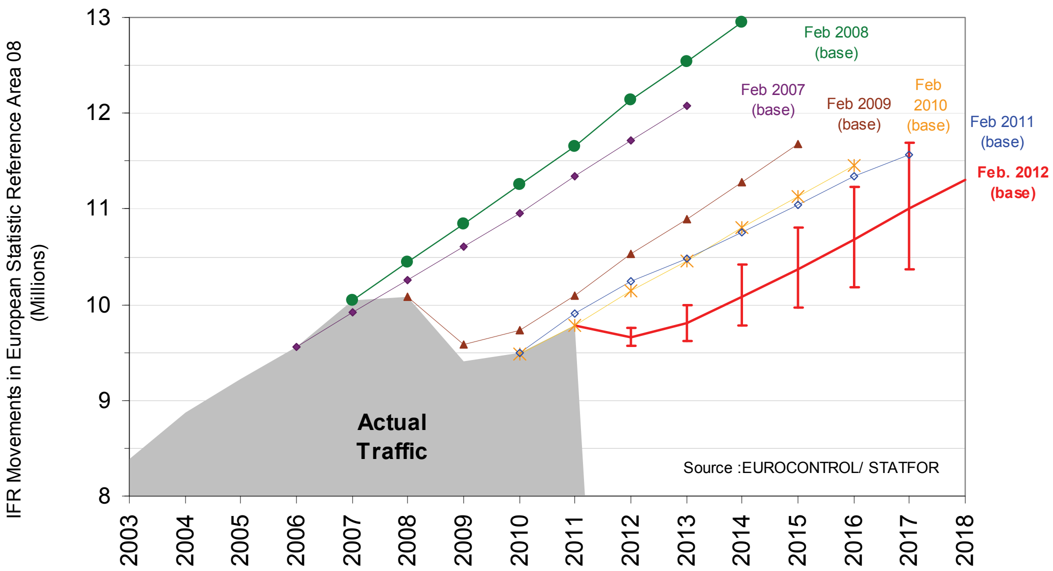

Figure 3-4: STATFOR Medium-term forecasts vs. actual traffic

3.2.9 Forecast accuracy, especially at State level, depends to a large extent on data availability and quality, market size and volatility. The current unstable economic conditions, uncertainties in the recovery in North Africa (e.g. tourism) and the continuing rise of oil price are sources of uncertainty in the forecast - particularly at State level. At European level, the STATFOR forecast is currently the most comprehensive forecast available with a satisfactory level of accuracy under normal circumstances[6].

3.2.10 The forecast range (low to high) provides an indication of the level of uncertainty and is important for ANS service providers to allow for a certain level of flexibility in their capacity planning.

GEOGRAPHICAL DISTRIBUTION OF TRAFFIC GROWTH

3.2.11 As illustrated in Figure 3-5 and Figure 3-6, historic and forecast traffic growth rates are quite contrasted across Europe. Information at ACC level can be found in ANNEX I.

3.2.12 The yearly traffic variation shown in Figure 3-5 is to some extent distorted by the adverse events of 2010 (ash cloud, strikes, weather).

3.2.13 Year on year, traffic growth rates ranged from -15.0% in Malta to 13.4% in Lithuania.

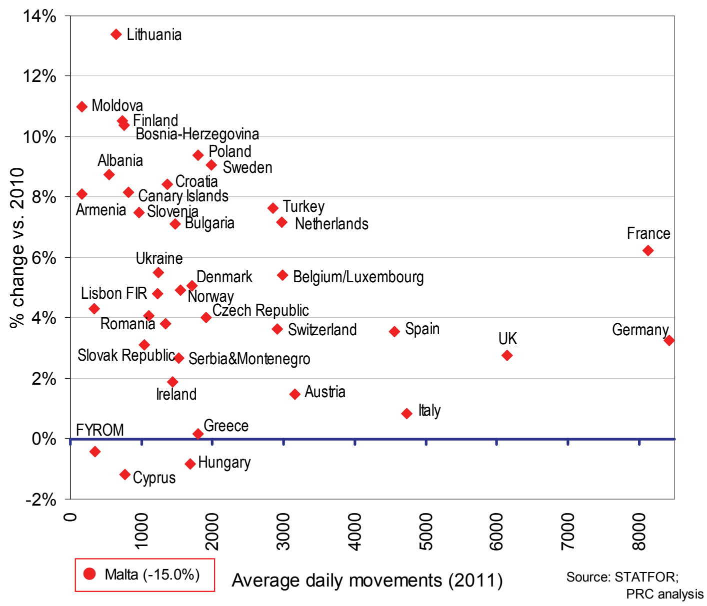

Figure 3-5: Yearly traffic variation 2010/2011 by State

6 For quality assurance purposes, STATFOR also carries out specific audits to assess the accuracy of its forecasts. The reports can be downloaded on EUROCONTROL OneSky or also requested via email.

3.2.14 In absolute terms, France, Germany, Turkey, the Netherlands, the UK, and Spain showed the highest increase compared to 2010. High growth rates were also observed in Finland, Sweden and Poland.

3.2.15 The increase in France, Germany and Spain was mainly related to overflights and international traffic. The growth in Turkey is to a large extent driven by a strong growth of the domestic market.

3.2.16 Figure 3-6 shows contrasted growth rates at State level. High growth rates were observed in Eastern European States and this trend is forecast to continue between 2011 and 2018.

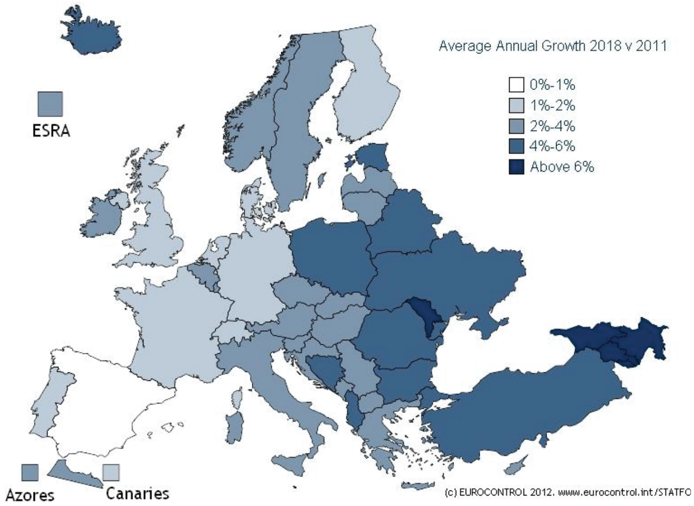

Figure 3-6: Forecast traffic growth 2011-18 by State

3.2.17 According to the STATFOR MTF forecast published in Feb. 2012 [Ref. 4], overall European traffic is forecast to recover to 2007/08 levels by 2014. However, this is not universally the case, with some States (e.g. UK, Ireland, Spain) not expected to return to those traffic levels until 2017 or beyond. Temporary local effects due to the London Olympics and the European football champion-ship in Poland and the Ukraine are expected for 2012.

EUROPEAN TRAFFIC CHARACTERISTICS

3.2.18 If traffic variability is high, resources may be underutilised during off peak times but scarce at peak times. At European level, seasonal traffic variability[7] was 1.14 in 2011 which means that the traffic was 14% higher than average in the peak week. The traffic on the peak day (01 July 2011) was 33 146 flights, 23.6% higher than on an average day.

3.2.19 Figure 3-7 show a contrasted picture across Europe. Whereas the core area of Europe shows only a moderate level of seasonality, high levels of traffic variability are observed in South-East Europe.

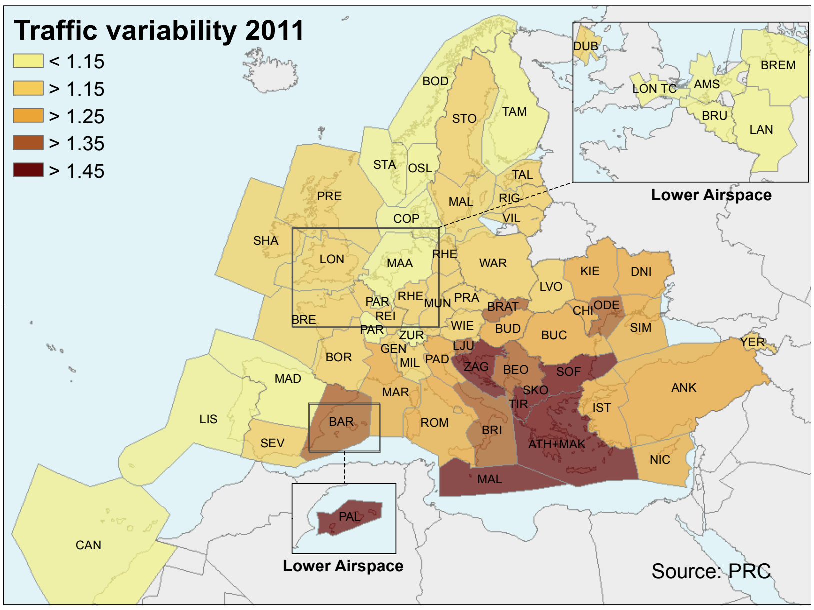

Figure 3-7: Seasonal traffic variations at ATC-Unit level

7 Computed as the ratio between the peak weekly traffic and the average weekly traffic demand over the year.

3.2.20 Traffic complexity is generally regarded as a factor to be considered when analysing ANS performance. The complexity indicator is a composite measure calculated for the entire year which combines adjusted density (concentration of traffic in space and time) and structural complexity (structure of traffic flows) [Ref. 6].

3.2.21 At European level, the aggregate complexity score[8] is relatively stable. In 2011, it was 6.3 minutes of interactions per flight hour (6.1 in 2010). However at local level, the complexity scores differ significantly, as shown in Figure 3-8. London TC[9] (33) has the highest score, followed by Langen ACC (13.8), Karlsruhe (Rhein) ACC (11.7), and Geneva ACC (11.6).

3.2.22 The complexity score in Figure 3-8 represents an annual average. Hence, the complexity score in areas with a high level of variability (see previous section) may be slightly higher during peak months. Information on the methodology and the complexity scores at ANSP level can be found in Annex II.

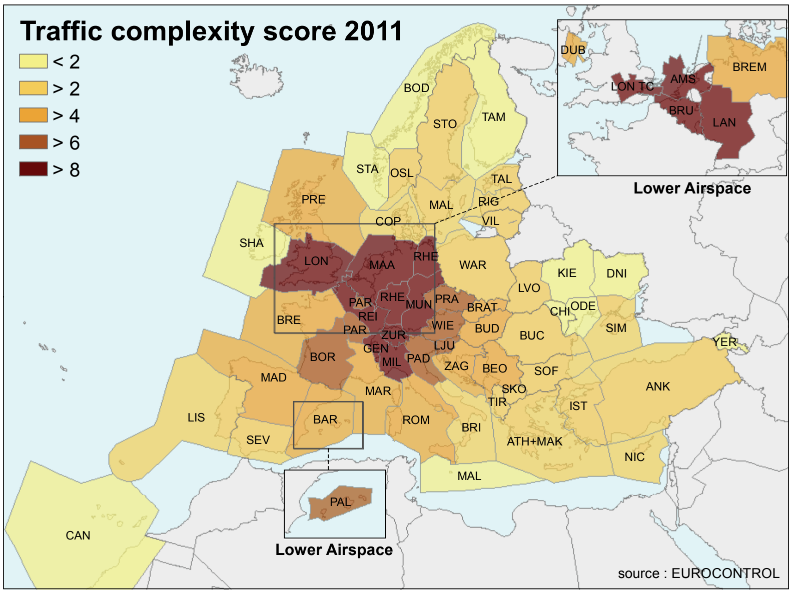

Figure 3-8: Aggregate complexity scores at ATC-Unit level

3.2.23 Traditional scheduled traffic increased by +4.1% in 2011 and accounts for the largest share of total IFR traffic (57.9%).

3.2.24 "Low cost" flights increased by +3.9% reaching a total market share of 22.3% in 2011.

3.2.25 After a substantial growth in 2010 (+5.5%), business aviation continued to grow in 2011 (+2.3%).

3.2.26 Affected by the political unrests in North Africa, the charter segment showed a substantial traffic decrease (–5.8%) in 2011.

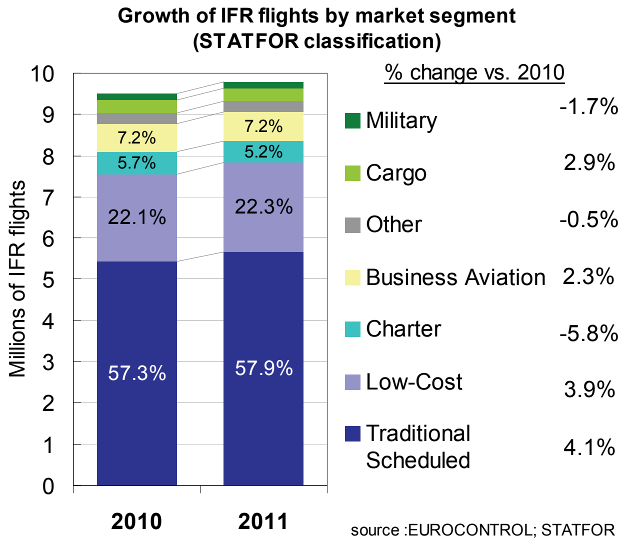

Figure 3-9: IFR flights by market segment

8 A complexity score of 10 means that for each flight hour within the respective airspace, there were on average 10 minutes of potential interactions with other aircraft.

9 The high complexity score for London Terminal Control (TC) is mainly driven by the high traffic density.

TRAFFIC GROWTH AT THE MAIN EUROPEAN AIRPORTS

3.2.27 Figure 3-10 shows the traffic growth at the top 30 European airports[10] which accounted for 45% of all European departures and for 79% of total airport ATFM arrival delays in 2011.

3.2.28 Year on year, traffic growth rates ranged from -10% in Athens to 12.7% for Helsinki (HEL) and Istanbul (IST) airport.

3.2.29 A more detailed analysis of ANS performance at airports is provided in Chapter 6 of this report.

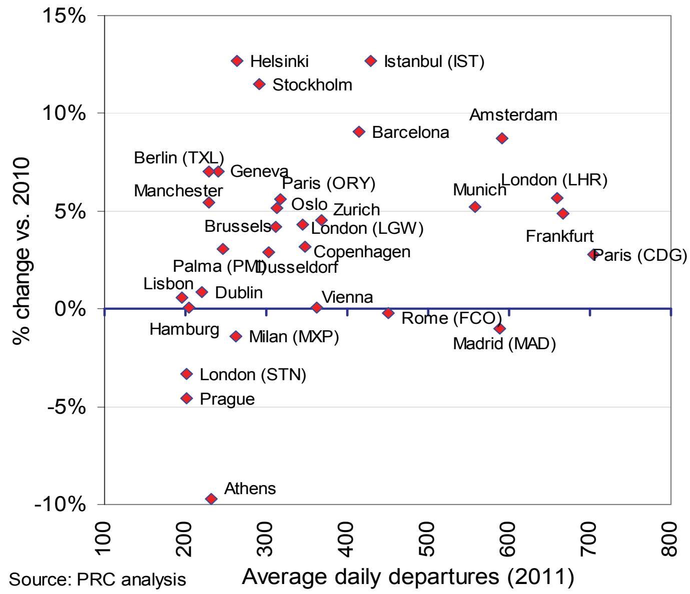

Figure 3-10: Traffic growth at European airports [2011]

3.3 Safety

3.3.1 Safety is the primary objective of ANS. This section puts ANS-related safety performance in the wider context of commercial air traffic in Europe.

3.3.2 The number of accidents in with ATM contribution for commercial air traffic is shown in Figure 3-11.

3.3.3 There was no accident with direct ATM contribution in commercial aviation in Europe in 2011. Overall, the number of accidents with ATM contribution in Europe remains small, which is positive.

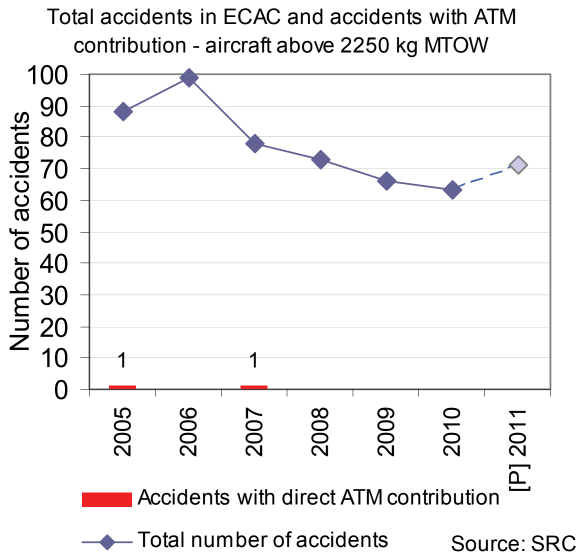

Figure 3-11: Accidents in EUROCONTROL States with ATM contribution [2005-11]

3.3.4 Safety performance can be measured through (1) the number and severity of accidents and incidents ('lagging' indicators) or (2) the verification of the effectiveness of all barriers which are put in place to prevent accidents and incidents to occur ('leading' indicators). Hence safety performance review is about assessing and measuring the status of the ANS safety system with respect to its effectiveness.

3.3.5 A meaningful review of ANS safety performance therefore requires a more in depth analysis of incidents and also of the effectiveness of the ANS system in place to prevent accidents and incidents in the future. A more detailed analysis is provided in Chapter 4.

10 Three year average of IFR movements (arrivals and departures) between 2009 and 2011.

3.4 Service quality

3.4.1 This section presents a synthesis of operational air transport performance and underlying delay drivers in order to provide an estimate of the ANS-related[11] contribution towards air transport service quality in Europe.

AIR TRANSPORT PUNCTUALITY

3.4.2 Apart from Safety which is paramount, punctuality is arguably the most visible manifestation in terms of air transport service quality perceived by passengers. Figure 3-12 shows the percentage of flights delayed by more than 15 minutes compared to airline schedule between 2004 and 2011 in Europe.

3.4.3 After a poor performance in 2010, mainly relating to exceptional events (e.g. ATC industrial actions, social tensions, extreme weather), punctuality improved significantly in 2011 (-6.2%pt.[12]) reaching a level similar to 2009 with subsequent positive effects on the European network.

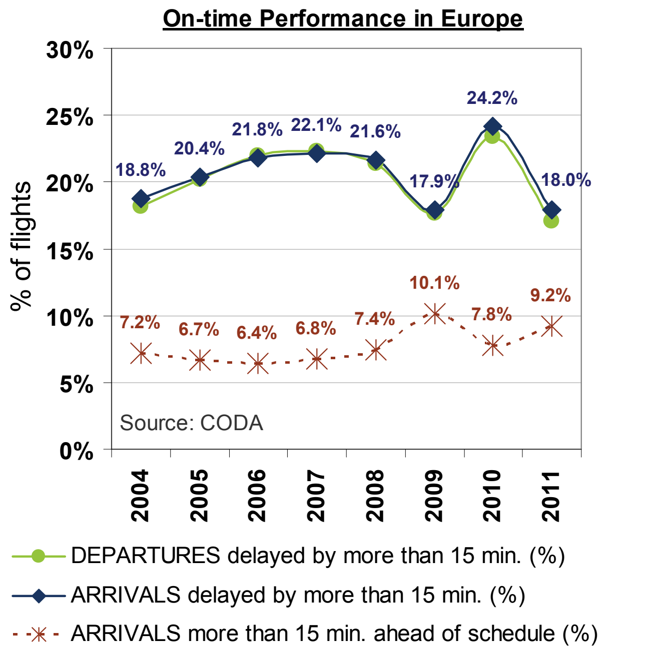

Figure 3-12: On time performance in Europe [2004-11]

Punctuality/ On time performance

The percentage of flights delayed by more than 15 minutes compared to published airline schedule (i.e. Punctuality) is the most commonly used industry standard.

There are many factors contributing to the on time performance of a flight. Punctuality is the "end product" of complex interactions between airlines, airport operators, the Central Flow Management Unit (CFMU) of EUROCONTROL and ANSPs, from the planning and scheduling phases up to the day of operation. Network effects have a strong impact on air transport performance.

While public focus is on delayed flights, it should be pointed out that, from an operational viewpoint, flights arriving more than 15 minutes ahead of schedule may have a similar negative effect on the utilisation of resources (i.e. TMA capacity, en-route capacity, gate availability, etc.) as delayed flights.

3.4.4 Figure 3-12 shows that arrival punctuality is mainly driven by departure delays encountered at the origin airports (departure punctuality) with only comparatively small variations in the gate-to-gate phase.

3.4.5 Although punctuality is the commonly applied industry standard, which has been used for years, it would be useful to move towards a higher level of accuracy (i.e. 5 or 10 minute bands) for the analysis of schedule adherence. This would be appropriate considering the fact that the 15 minute "allowance" represents a large share of the scheduled block time on intra-European flights.

3.4.6 Figure 3-13 shows a breakdown of departure delays reported by airlines to the Central Office for Delay Analysis (CODA)[13]. The IATA delay codes were grouped to enable a

11 "ANS-related" or "ANS-actionable" in this report means that ANS has a significant influence on the operations.

12 Percentage point refers to the difference between two percentages.

13 As of 1st January 2011, air carriers operating more than 35 000 flights within the geographical scope of Regulation EU No 691/2010 are obliged to submit data.

focus on ANS-related delays. ANS-related delays are delays where ANS is the root cause for the delay (i.e. ATC capacity, staffing, ATC equipment) or where an imbalance between demand and capacity (i.e. weather, military training, etc.) was handled by ANS.

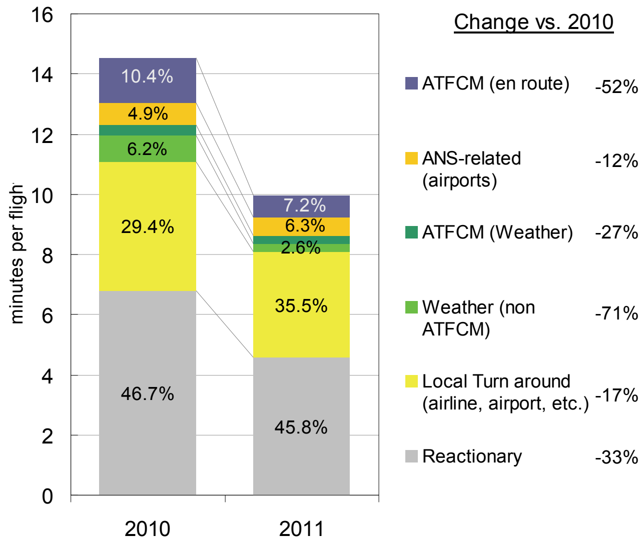

Figure 3-13: Departure delays by cause [2010-11]

Departure delays

Departure delays are delays experienced at the stand before the aircraft departs. The delays are reported by airlines to CODA according to a set of delay codes defined by IATA and refer to delays compared to scheduled departure times.

For a better focus on the ANS related delays the IATA delay codes were grouped:

- En-route ATFCM (IATA codes 81,82),
- ANS-related airport delays (Code 83,89),
- ATFCM due to weather (Code 84),
- Weather non ATFCM such as snow removal or de-icing (Codes 71-77),
- Reactionary delays (Codes 91-96),
- Local turn-around delays are primary delays caused by non-ANS related stakeholders (i.e. airlines, airport, etc.) (all other Codes);

3.4.7 A large share (≈ 46%) of the departure delay reported by airlines is “reactionary” delay caused by primary delay on earlier flight legs which could not be absorbed during the turn-around phase at the airport. As outlined in a previous study [Ref. 7] the analysis of the propagation of delay throughout the network is an inter-related complex issue influenced by many factors (i.e. time and length of primary delay, airline business model and strategy, scheduling practices, etc.) and therefore a research topic in its own right.

3.4.8 Overall, there was a significant reduction of departure delays in 2011. Weather[14] (-71%), en-route ATFM (-52%), weather-related ATFM (-27%) and local turnaround delays (-17%) improved significantly in 2011, with subsequent network effects on reactionary delay (-33%). ANS-related airport delays decreased by -12% in 2011.

3.4.9 While a thorough evaluation of all delay drivers is required to improve overall air transport performance, an in-depth analysis of the complex and interrelated non ANS-related pre-departure processes is beyond the scope of this report[15].

3.4.10 Punctuality is also linked to airline scheduling. The inclusion of “time buffers” in airline schedules to account for a certain level of anticipated travel time variation may therefore hide changes in actual performance.

3.4.11 Figure 3-14 depicts changes of actual and scheduled times on intra European flights between 2004 and 2011, relative to the long term average of the entire period.

Airline scheduling

Airlines build their schedules for the next season on airport slot allocation, crew activity limits, airport connecting times, and by applying a quality of service target to the distribution of previously observed block-to-block times (usually by applying a percentile target to the distribution of previously flown block times).

The level of “schedule padding” is subject to airline strategy and depends on the targeted level of on-time performance.

14 This group contains delays due to unfavourable weather conditions including delays due to snow removal or de-icing. Weather-related delays handled by ANS are not included.

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

3.4.12 On average, scheduled block times (blue line) are quite stable at European system level and only show some notable changes versus the long term average over the past three years. The observed changes in arrival delay (grey area) correspond to the arrival punctuality illustrated in Figure 3-12.

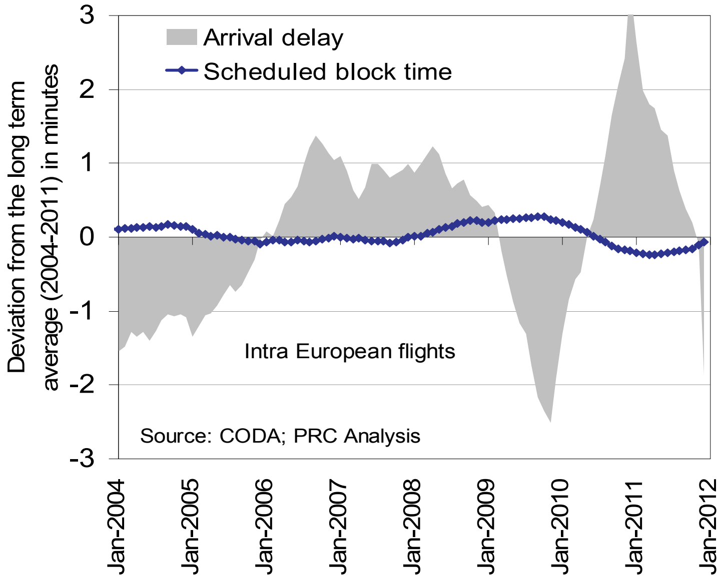

Figure 3-14: Evolution of delays and block times [2004-11]

Evolution of scheduled block times

Punctuality can change as a result of improved operations but also if more time buffers are included in airline schedules.

The analysis of the evolution of scheduled block times is complementary to the analysis of punctuality. It enables to visualise trends over time as it shows the changes relative to the average of the entire period for scheduled block times and arrival delay.

Normalised by selected criteria (origin, destination, aircraft type, etc.), the trend analysis compares actual performance for each flight of a given city pair with the long term average for that city pair (i.e. average of analysis period).

EFFICIENCY AND VARIABILITY OF AIR TRANSPORT OPERATIONS

3.4.13 Although the analysis of performance compared to airline schedules (punctuality) is valid from a passenger point of view and provides valuable first insights, the involvement of many different stakeholders and the inclusion of time buffers in airline schedules require a more detailed analysis of actual operations for the assessment of ANS performance.

3.4.14 This section focuses on the efficiency and variability of actual operations by phase of flight in order to better understand the ANS contribution.

3.4.15 Figure 3-15 shows the level of variability from the airspace users' point of view by phase of flight on intra-European flights[16].

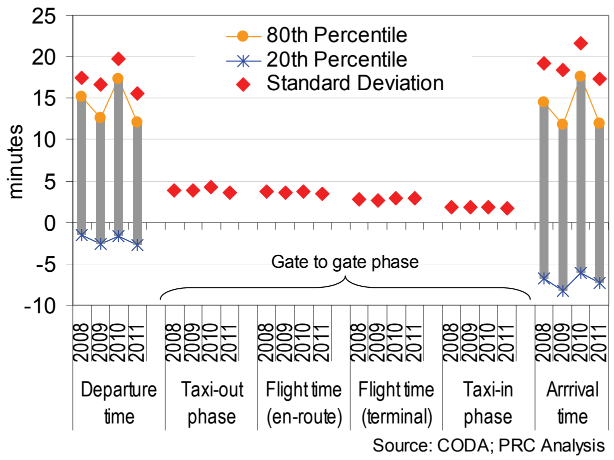

Figure 3-15: Variability of flight phases [2008-11]

Efficiency and Variability of Operations

The "variability" of operations determines the level of predictability for airspace users and hence has an impact on airline scheduling. It focuses on the variance (distribution widths) associated with the individual phases of flight as experienced by airspace users. The higher the variability of operations, the wider the distribution of observed block times and the more time buffer is required in airline schedules to maintain a satisfactory level of punctuality.

'Efficiency' in this report is measured by examining the difference between actual operating time/distance against an un-impeded reference time/distance. "Inefficiencies" can be expressed in terms of time and fuel and also have an environmental impact. Due to inherent necessary (safety) or desired (noise, capacity, cost) limitations the reference values are not necessarily achievable at system level and therefore ANS-related 'inefficiencies" cannot be reduced to zero.

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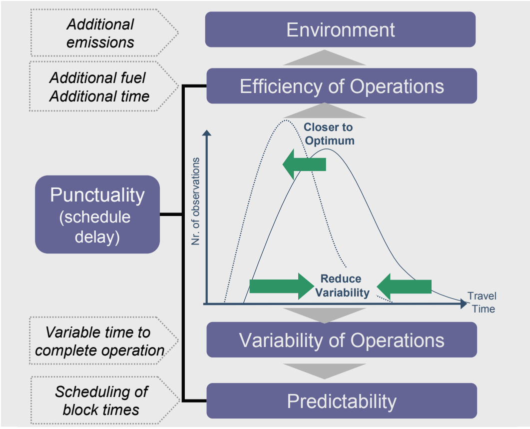
16 In order to limit the impact from outliers, variability is measured as the difference between the 80th and the 20th percentile for each flight phase. Flights scheduled less than 20 times per month are excluded.

3.4.16 As observed in previous analyses (see Figure 3-12), arrival times are mainly driven by variations already encountered at the departure airport with only comparatively small variations in the gate-to-gate phase (taxi out, en-route, terminal, taxi-in).



3.4.17 This is mainly due to the way air traffic is managed in Europe. Flights are usually held at the gates with only comparatively few constraints once they have left the gate.

3.4.18 Although quite low at system level, the level of variability in the taxi-out phase and the level of airborne holdings in the terminal area may differ considerably between airports (see also Chapter 6).

MEASURING ANS-RELATED SERVICE QUALITY

3.4.19 Figure 3-16 shows a conceptual framework for the analysis of ANS-related service quality by phase of flight. The taxi-in phase is presently not addressed in this report but there is a growing interest from stakeholders to also include this segment. Taxi-in performance is considerably affected by stand allocation management. More work is required to understand the influence of ANS on this flight segment.

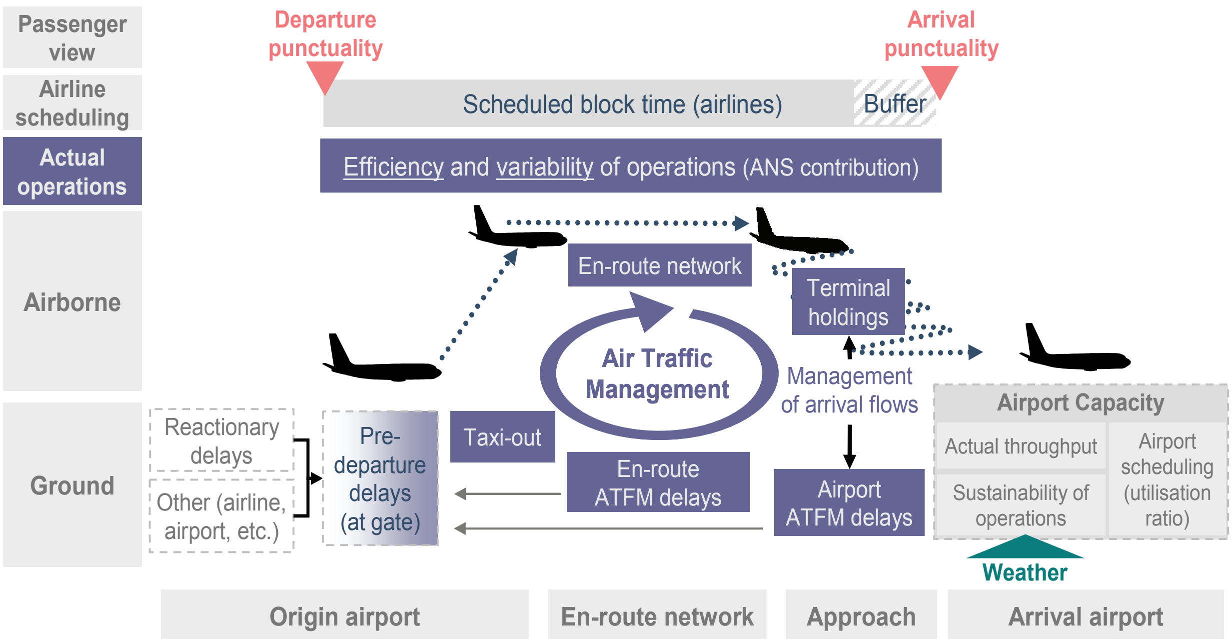


Figure 3-16: Conceptual framework for measuring ANS-related service quality

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

3.4.21 While maximising the use of scarce capacity, there are trade offs[17] to be considered when managing the departure flow at airports (holding at gate vs. queuing at the runway with engines running). The management of arrival flows needs to find a balance between the application of ATFM regulations, airborne terminal holdings and the absorption of additional time in the en-route phase through the application of speed control which suggests substantial potential for savings in terms of fuel [Ref. 8]. ANS-related performance at airports is addressed in more detail in Chapter 6 of this report.

3.4.22 For ATFM delays at the gate, fuel burn is quasi nil but the level of predictability in the scheduling phase is low which is the reason as to why no provision for ATFM delays is usually included in scheduled block times. Hence, the impact of ATFM delays on punctuality and additional time and associated costs to airspace users is significant (i.e. "tactical" delays) but the impact on fuel burn and the environment is negligible.

3.4.23 ANS-related inefficiencies in the gate-to-gate phase (taxi, en-route, terminal holdings) are generally more predictable than ATFM delays at the gate as they are more related to inefficiencies embedded in the route network or congestion levels which are similar every day. From an airspace user point of view, the impact on punctuality is usually low as those inefficiencies are usually already embedded in the scheduled block times ("strategic delays"). However, the impact in terms of additional time, fuel, associated costs and the environment is significant.

3.4.24 Figure 3-17 provides a summary of the ANS-related impact on airspace users' operations in terms of time, fuel burn and associated costs. It can also be seen that ANS has an impact on airspace users' operations in terms of ATFM delays (airport & en-route) at the gate but also on the efficiency of the various flight segments in the gate-to-gate phase.

ANS- related impact on airspace users' operations			Variability	Impact on punctuality	Engine status	Impact on fuel burn/ CO_2 emissions	Impact on airspace users' costs
ANS related inefficiencies	At stand	Airport ATFM	High	High	OFF	Quasi nil	Tactical
		En-route ATFM					
	Gate-to-gate	Taxi-out phase	Low/ moderate	Low/ moderate	ON	High	Strategic
		En-route phase					
		Terminal area					

Figure 3-17: ANS-related impact on airspace users' operations

ESTIMATED ANS-RELATED IMPACT ON OPERATING TIME

3.4.25 Figure 3-18 summarises the current best estimate of the ANS-related impact on operating time. For the interpretation of Figure 3-18, it is important to recall that the estimated inefficiency in the gate-to-gate phase relates to theoretical reference times from a single flight perspective which are, due to inherent necessary (safety) or desired (noise, capacity, etc.) limitations, not achievable at system level.

3.4.26 Moreover, airspace users' preferences to optimise their operations based on time and costs can vary depending on their needs and requirements (wind, route charges, fuel price, business model, etc.). Hence, the great circle distance used to calculate the horizontal en-route flight efficiency may not always correspond to the user preferred profile.

17 It should be noted that there may be trade-offs and interdependencies between and within Key Performance Areas (i.e. Capacity vs. Cost-efficiency) which need to be considered in an overall assessment of ANS-related performance (see also Section 3.6).

	Estimated ANS-related impact on operating time		Reference	Total additional minutes (M) 2011	% change
	IFR traffic			9.78M	+ 3.1%
Total additional minutes	ATFM delay (at stand)	Airport-related	flight plan	6.7 M	-19%
		En-route-related	flight plan	11.3 M	-42%
	Total additional taxi-out time		reference time	22.0 M	-7%
	Total horizontal en-route extension		great circle distance	29.8 M	-0.2%
	Total ASMA additional time		reference time	17.6 M	+8%

Figure 3-18: Estimated ANS-related impact on operating time [2011]

3.4.27 Although traffic grew by 3.1% on average in 2011, all areas but ASMA additional time show an improvement. ANS-related inefficiencies in the taxi-out and en-route phase decreased by -7% and -0.2% respectively in 2011 with positive effects on fuel burn and CO_2 emissions. However, these gains were largely offset by an increase in ASMA additional time (+8%) in 2011. En-route and airport ATFM delays decreased by -42% and -19% respectively in 2011.

3.5 Environmental impact

3.5.1 This section evaluates the environmental impact of ANS which can be divided into the impact on global climate and on local air quality (LAQ) and noise at airports. While the importance of environmentally-friendly facility management (i.e. heating, waste, etc.) and staff commuting are acknowledged, the focus of this section is on the environmental impact of aircraft operations managed by ANS.

ESTIMATED ANS-RELATED IMPACT ON CLIMATE

3.5.2 At European level, the two most relevant policy measures with regard to mitigating the aviation related impact on the environment are the EU Emission Trading Scheme (EU-ETS) and the Single European Sky (SES) initiative.

3.5.3 To cap the aviation sector's CO_2 emissions, the EU decided to include it in the EU-ETS, which was originally limited to stationary sources of CO_2. It requires the aviation sector to either achieve CO_2 emission reductions or to buy allowances on the emissions market. The 1st trading period in which aviation is included came into force on 01 January 2012.

3.5.4 In addition to the EU-ETS, the initiatives such as the SES performance scheme, the Flexible Use of Airspace (FUA), the creation of Functional Airspace Blocks (FABs) and SESAR are expected to drive flight efficiency and capacity improvements with resulting positive effects on fuel burn and the environment.

3.5.5 The environmental impact of ANS on climate is closely related to operational performance which is largely driven by inefficiencies in the 4-D trajectory and associated fuel burn (and emissions). There is a close link between user requirements to minimise fuel burn and reducing Green House Gas emissions[18].

3.5.6 Figure 3-19 summarises the best estimate of the ANS-related impact on fuel burn and CO_2 emissions. As already pointed out for Figure 3-18, it is important to recall that due to inherent necessary (safety) or desired limitations (noise, capacity), ANS-related inefficiencies cannot be totally eliminated.

18 The emissions of CO_2 are directly proportional to fuel consumption (3.15 kg CO_2 /kg fuel)

3.5.7 The horizontal en-route flight path is the main component (≈3.2%), followed by airborne delays in the terminal area (ASMA additional time) which are estimated to be around ≈1.4%. The horizontal en-route flight path is addressed in more detail in the flight efficiency section in Chapter 5 and ANS-related inefficiencies at airports (taxi-out delays, terminal (ASMA) delays) are addressed in more detail in Chapter 6.

	Estimated ANS-related impact on fuel burn and CO_2 emissions		Fuel burn estimations		Estimated CO_2 emissions	
			2011	% change	2011	% of total
	Total within EUROCONTROL airspace		**46Mt**	**+5.1%**	**145 Mt**	**100%**
	per flight (within ECTL airspace)		**4.8t**	**+1.9%**		
ANS related inefficiencies	At stand	Airport ATFM	-	-	-	-
		En-route ATFM	-	-	-	-
	Gate-to-gate	Taxi-out phase	0.32Mt	-6%	1.0 Mt	0.7%
		Horizontal en-route extension	1.40 Mt	+1%	4.4 Mt	3.2%
		Vertical profile (see footnote [19])	0.24 Mt	+3%	0.8 Mt	0.6%
		Arrival Sequencing and Metering area (ASMA)	0.59 Mt	+10%	1.9 Mt	1.4%
	Total estimated ANS-related impact on fuel burn		**2.56 Mt**	**+0.6%**	**8.1 Mt**	**5.8%**

Figure 3-19: Estimated ANS-related impact on fuel burn/environment [2011]

3.5.8 Figure 3-19 shows that ANS contribution towards improving aviation CO_2 efficiency is limited to some 6% of the total aviation-related fuel burn and associated CO_2 emissions in Europe. Or expressed differently, average ANS-related fuel efficiency in Europe is estimated to be around ≈ 94%.

3.5.9 In Europe, aviation accounts for approximately 3.5% of total CO_2 emissions [Ref. 10]. Hence, as shown in Figure 3-20 the share that can be influenced by ANS is approximately 0.2% of total CO_2 emissions in Europe (6% x 3.5% ≈ 0.2%).

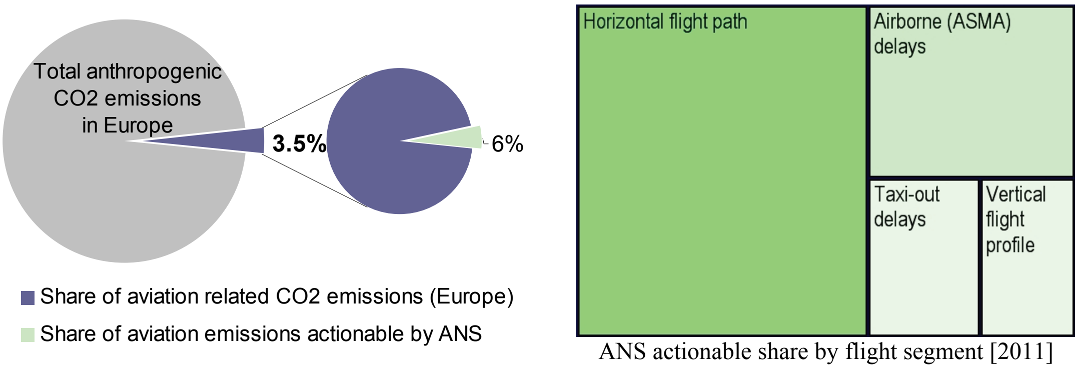


Figure 3-20: Estimated ANS-related impact on European CO2 emissions [2011]

ANS IMPACT ON LOCAL AIR QUALITY (LAQ)

3.5.10 Local Air Quality (LAQ) is an increasingly important issue at and around airports. While there is no specific EU LAQ legislation in relation to aviation, the EC Directive 2008/50/EC [Ref. 11] on ambient air quality and cleaner air for Europe sets clear standards and requires Member States to stay within set limits for these pollutants.

19 The vertical profile in this table is based on a previous study [Ref. 9] estimating vertical inefficiencies due to flight level capping (en-route) and interrupted climb/descent. The ASMA indicator also encompasses vertical and horizontal inefficiencies within the last 40NM (i.e. holding stacks) which might consequently lead to an overestimation of the vertical inefficiencies in approach in this table (see also 6.2.28 ff. on page 69).

3.5.11 The ANS contribution towards improving local air quality is mainly related to operational performance and associated fuel burn during take off and landing and in the taxi phase. For instance, improved taxi efficiency through A-CDM not only reduces fuel burn but also has a positive impact on local air quality (see also Chapter 6).

AIRCRAFT NOISE AT AIRPORTS

3.5.12 One of the major challenges of airport communities is the need to balance airport capacity increases with the need to manage aircraft noise and negative effects on the population in the airport vicinity.

3.5.13 Noise restrictions are usually imposed on airports by Governments or local Planning Authorities and the level of compliance is monitored at local level.

3.5.14 Noise management strategy and its implementation are usually under the responsibility of the airport operator, but each operational stakeholder at the airport has a role to play in reducing noise. In Europe, accountability for noise management is generally given to airport operators under rule making and supervision of national authorities.

3.5.15 Accountability for land use planning is given to local authorities, based on land use policies developed at higher levels. ANS have an essential role in support of noise management at airports.

EC directives on noise

Two EC noise Directives of particular importance to aviation were implemented in Europe. The first Directive (2002/30/EC [Ref. 12]) based on the ICAO 'Balanced Approach', specifies the overall approach to airport noise management in Europe.
The second EC Directive (2002/49/EC [Ref. 13]) provides guidance for Member States on the assessment and management of environmental noise using harmonised noise metrics and subsequent publishing of noise management plans. It requires competent authorities in Member States to draw up "strategic noise maps" (i.e. noise contours) for major roads, railways, airports[20] and agglomerations, using harmonised noise indicators and to draw up action plans to reduce noise where necessary.
Additionally, a further EC Directive (2006/93 EC [Ref. 14]) requires Member States to ensure that all civil subsonic jet aeroplanes operating from airports situated in their territory comply with the standards specified in Part II, Chapter 3, Volume 1 of Annex 16 ICAO

3.5.16 Figure 3-21 shows the four elements of the ICAO "balanced approach" to reduce exposure of the population to aircraft noise, related time-scales, organisation in charge, potential improvements and enablers.

	Time scale	Actionable by	Potential improvement	Enablers
Land use planning	Long term (10 -20 years)	Local authorities	Substantial benefits in the long term	Land use policy
Reduction of noise at source		Industry/ aircraft manufacturers/ airlines	Significant over time (*increasing yield with increasing number of new aircraft*)	Technology & fleet renewal
Noise abatement operational procedures	Short to medium term (1-3 years)	CAA / ANSP	Moderate – subject to trade offs with flight efficiency(and hence emissions), delays and runway capacity (*decreasing yields with increasing traffic levels) - congestion*)	ANS & airline performance
Aircraft operational restrictions	Short term (6-12 months)	CAA/ airport operator/ ANSP	Typically moderate – trade off with airport revenues.	Regulatory

Figure 3-21: Main measures to reduce noise exposure around airports

3.5.17 While ANS has a role to play, the noise management at airports is a local issue which requires a well balanced and forward looking local strategy to reduce noise exposure of the population while optimising the use of airport capacity. The process of setting noise

20 "Applicable to 'major airports' shall mean a civil airport, designated by the Member State, which has more than 50 000 movements per year (a movement being a take-off or a landing), excluding those purely for training purposes on light aircraft";

related restrictions at airports has to ensure a balance between the protection of the population living or working in the proximity of airports and the impact on airport capacity and the economic growth of the region (see also Chapter 6).

3.6 Economic evaluation of ANS performance

3.6.1 In Europe, airspace users bear the total economic costs of ANS services, which consist of service provision costs (en-route and terminal) and quality of service related costs (due to ANS-related inefficiencies).

3.6.2 This section combines key elements from the more detailed analyses of ANS performance in Chapters 4-7 in order to provide overall economic evaluation of total ANS-related costs to airspace users in Europe – as opposed to a full societal impact assessment.

3.6.3 Hence, quantifying all ANS-related costs and trends to airspace users is useful to assess whether policy objectives are being met as the evaluation aggregates the respective contributions of the different Key Performance Areas (Cost-effectiveness, Capacity and Environment) to a consolidated monetary view.

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

3.6.5 Figure 3-22 illustrates the interdependency between ANS cost-efficiency and ANS-related operational performance, linked with demand-capacity balancing.

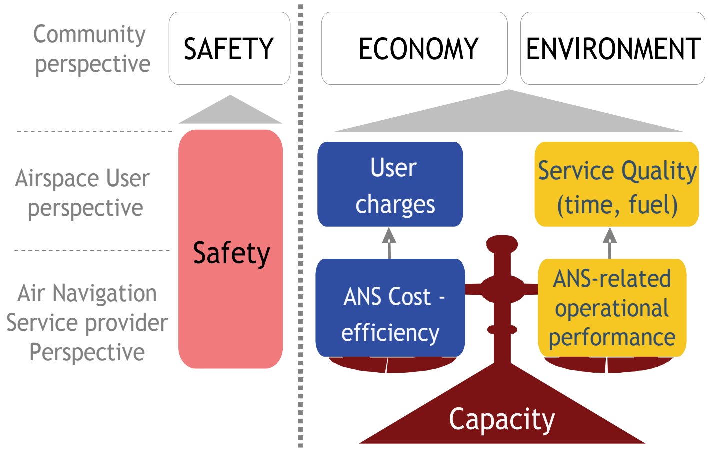


Figure 3-22: Balancing capacity and demand

3.6.6 Insufficient capacity has a negative impact on ANS-related operational performance (high delays, etc.) and on airspace users' costs; while the provision of capacity higher than demand contributes towards higher than necessary user charges (underutilisation of resources).

3.6.7 Additionally, there are interdependencies between the capacity and environment (noise related route extension vs. gaseous emissions) and it may be sometimes necessary to prioritise the level of improvement of certain areas.

3.6.8 Although the economic evaluation in this section enables a consolidated view of ANS-related costs at European level to be developed, there are several important considerations which need to be taken into account which limit the suitability of this approach at local level and for target-setting purposes:

- the interdependencies and trade-offs need to be assessed locally as they are likely to differ according to traffic characteristics, and economic, working and legal framework; and,
- the approach is dependent on exogenous factors such as fuel prices and approximations such as the cost of ANS-related delays to airspace users.

ANS PROVISION COSTS

3.6.9 According to the Association of European Airlines (AEA), air navigation costs accounted for 6.2% of total operating costs in Europe in 2010.

3.6.10 The distribution of the direct operating expenses,[21] which accounted for 61% of total airline expenses (AEA) in 2010, is shown in Figure 3-23.

3.6.11 Figure 3-24 summarises the costs for the provision of en-route and terminal ANS services in Europe (i.e. 6.2% of total airline operating costs) between 2008 and 2011.

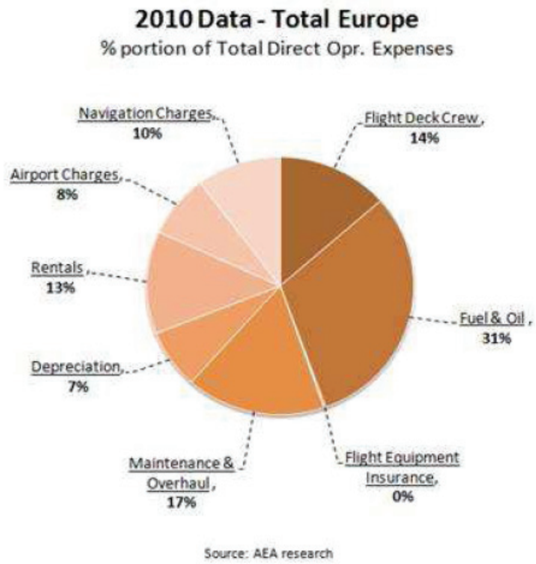


Figure 3-23: Share of ANS charges in AEA direct operating expenses [2010]

3.6.12 Despite a projected increase of total ANS provision costs of +1.8%, the costs per unit decreased notably in 2011, due to the increase in traffic (+3.1%). En-route ANS provision costs are projected to increase by +2.3% in 2011 while terminal ANS provision costs are projected to decrease by -0.7%.

3.6.13 A detailed analysis of en-route and terminal ANS service provision costs is provided in Chapter 7.

All costs are expressed in M € 2010	2008	2009	2010	2011 (P)	Change vs. 2010
IFR flights	10.1	9.4	9.5	9.8	3.1%
En-route ANS provision costs	€ 6 782	€ 6 876	€ 6 706	€ 6 864	2.3%
Terminal ANS provision costs*	€ 1 508	€ 1 535	€ 1 459	€ 1 448	-0.7%
Estimated total ANS provision costs	€ 8 290	€ 8 411	€ 8 165	€ 8 312	1.8%

* Note that Terminal ANS provision costs only refer to 21 States. Source: PRC analysis

Figure 3-24: ANS provision costs in Europe [2008-11]

ESTIMATED COSTS DUE TO ANS-RELATED INEFFICIENCIES

3.6.14 The cost calculations are based on the updated study from the University of Westminster [Ref. 15] which addresses estimated costs to airspace users. It does not address the wider costs of delay which may be applicable in contexts such as the full societal impact of delay.

3.6.15 Estimating ANS-related costs to airspace users is complex and requires expert judgement and assumptions, based on published statistics and

Costs of ANS-related inefficiencies

The costs of ANS related inefficiencies in this report are based on the "European airline delay cost reference values" published by the University of Westminster in March 2011 [Ref. 15]. This study is an update of the report published in May 2004 [Ref. 16] with more recent data and a number of methodological improvements. It has been circulated to airlines and other stakeholders for feedback and key aspects have been presented at major air transport conferences.

21 Indirect airline costs accounted for 39% of total airline operating costs [2010] and include cost of station & ground, cabin attendants, passenger service, load insurance, ticket/ sales & promotion, and general administration.

robust data wherever possible. It should however be noted that there are inevitably margins of uncertainty in the approximation of delay costs.

The estimated airline delay costs include direct costs (fuel, crew, maintenance, etc.) the network effect (i.e. cost of reactionary delays) and passenger related costs.

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

3.6.16 The costs of ANS-related inefficiencies to airspace users were calculated separately for "tactical delays" incurred on the day of operations (infrequent - low predictability) and "strategic delays" which are generally already embedded in the scheduled block times (frequent occurrence - high level of predictability).

3.6.17 As described in paragraph 3.4.22, ANS-related inefficiencies in the gate-to-gate phase (taxi-out, en-route, terminal holdings) have a low level of variability and are usually embedded in scheduled block times.

3.6.18 In this report, ANS-related inefficiencies in the gate-to-gate were considered as "strategic delays", although it is acknowledged that there is an element of unpredictability. They impact on costs to airspace users in terms of additional time and fuel.

Strategic costs of airline delay

The strategic cost of one additional minute (without fuel) is estimated at €27 per minute (€2010 prices) on average for a flight in Europe (derived from [Ref. 15]).
The fuel calculations also include a provision for fuel carriage penalties. The fuel costs are based on the average annual spot price in 2011 (715 €/ ton).

3.6.19 Figure 3-25 shows the evolution of the average jet fuel price between 2004 and 2011. After a significant drop in 2009, due to the global economic crisis, jet fuel price increased again between 2009 and 2011 and has reached a level higher than in 2008.

3.6.20 Although jet fuel price has a significant impact on airspace user costs, in order to enable time series analysis of ANS-related performance, the analysis in the remainder of this chapter removes variations due to changes in jet fuel prices from the estimated costs of ANS-related inefficiencies by applying the 2011 average jet fuel price consistently to all years[22].

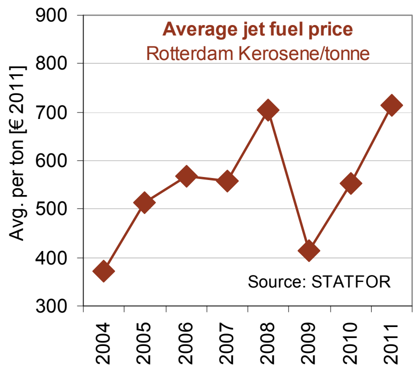


Figure 3-25: Jet fuel price

3.6.21 Figure 3-26 shows the estimated "strategic" costs to airspace users due to ANS-related inefficiencies in the gate-to-gate phase.

	Additional time (M min.)			Additional fuel (Mt)			Estimated additional costs (€2010M)			
	Taxi-out	En-route	ASMA	Taxi-out	En-route	ASMA	Taxi-out	En-route	ASMA	TOTAL
2008	24.9 M	32.0 M	17.8 M	0.36 Mt	1.40 Mt	0.60 Mt	€ 960	€ 1 980	€ 960	€ 3 890
2009	21.7 M	28.8 M	15.2 M	0.31 Mt	1.30 Mt	0.50 Mt	€ 840	€ 1 810	€ 810	€ 3 460
2010	23.6 M	29.9 M	16.3 M	0.35 Mt	1.38 Mt	0.54 Mt	€ 910	€ 1 910	€ 870	€ 3 700
2011	22.0 M	29.8 M	17.6 M	0.32 Mt	1.40 Mt	0.59 Mt	€ 850	€ 1 930	€ 950	€ 3 730

Figure 3-26: Estimated costs of ANS-related inefficiencies [2008-11]

3.6.22 Estimated costs of ANS-related inefficiencies in the gate-to-gate phase increased by 0.9% in 2011, mainly due to the increase in ASMA additional time. Approximately 50% of the overall costs were related to fuel.

22 The "real" cost to airspace users therefore might have been higher or lower in the individual years, depending on how the 2011 price compares to the price in the respective year.

3.6.23 ATFM delays are infrequent and difficult to predict during the scheduling phase (only a small percentage of flights are affected). In this report, ATFM delays were considered as "tactical delays" which impact on costs to airspace users in terms of additional time with a negligible fuel burn[23]. Due to the low level of predictability, the share of passenger related (compensation, rebooking, etc.) and network (reactionary delay) related costs are higher than for "strategic delays".

3.6.24 Figure 3-27 shows the estimated "tactical" costs to airspace users due to ATFM delay in Europe between 2008 and 2011.

Year	ATFM delays (M min.)			Estimated cost of ATFM delays (€2010 Prices)		
	En-route	Airport	Total	En-route	Airport	Total
2008	14.6 M	9.3 M	23.8 M	1 200 M €	750 M €	1 950 M €
2009	8.8 M	6.4 M	15.2 M	700 M €	500 M €	1 200 M €
2010	19.4 M	8.2 M	27.7 M	1 550 M €	650 M €	2 200 M €
2011	11.3 M	6.7 M	17.9 M	900 M €	550 M €	1 450 M €

Source: CFMU, PRC

Figure 3-27: Estimated costs of ATFM delay [2008-11]

Tactical costs of airline delay

One of the most important changes of the recent update of the study on airline delay cost reference values [Ref. 15] is the consideration of "tactical" delays below 15 minutes. Intuitively, this should reduce the average cost per minute, however other factors have significantly increased, and the overall result is a cost of €81 (€2010) per minute (averaged over all ATFM delays), which is close to the €83 used in the PRR 2010 report (but which was applicable to ATFM delays above 15 minutes).

3.6.25 As shown in Figure 3-27, en-route ATFM delays accounted for almost two thirds (63%) of all ATFM delays in 2011 (down from 70% in 2010).

3.6.26 In 2011, there was a significant reduction of total ATFM delays (-35%) with a corresponding positive effect of related costs. En-route ATFM delays decreased substantially in 2011 (-42%) but are still higher than in 2009. Airport ATFM delays decreased by -19% versus 2010.

ECONOMIC EVALUATION OF ANS PERFORMANCE

3.6.27 The economic evaluation of ANS performance combines the en-route and terminal ANS provision costs with the estimated costs to airspace users due to ANS-related inefficiencies[24]. It provides a consolidated high-level view to assess the effectiveness of policy objectives at system level and to promote an initial discussion on future ANS performance objectives.

3.6.28 It is important to recall that the evaluation in this section evaluates the estimated total economic costs of ANS-related performance to airspace users which are not to be mistaken with an assessment of potential savings. Clearly, neither the ANS provision costs nor the ANS-related inefficiencies can be reduced to zero. The discussion on suitable ANS performance objectives therefore requires a more detailed analysis in order to assess the margin for improvement in each of the performance areas.

3.6.29 Figure 3-28 summarises the estimated total ANS-related costs to airspace users. Overall, unit costs decreased in 2011 as a result of a decrease in total ANS-related economic costs (-4.3%) and a traffic growth of 3.1% which is a good achievement.

3.6.30 The reduction in the estimated economic costs to airspace users in 2011 results from a substantial improvement in ANS service quality compared to 2010 and thus from a reduction of ANS-related service quality costs of -13% which compensated for the increase in ANS provision costs (+1.8%).

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23 ATFM delays usually impact aircraft waiting times at the gate with engines off.

24 The costs of cancellations are not considered in the assessment of total economic en-route ANS costs.

All costs are expressed in M € 2010		2008	2009	2010	2011 (P)	Change vs. 2010
	IFR flights (M)	10.1	9.4	9.5	9.8	3.1%
ANS provision costs	En-route ANS provision costs	€ 6 782	€ 6 876	€ 6 706	€ 6 864	2.3%
	Terminal ANS provision costs*	€ 1 508	€ 1 535	€ 1 459	€ 1 448	-0.7%
Cost of ANS-related inefficiencies	En-route & airport ATFM delays (Capacity)	€ 1 950	€ 1 200	€ 2 200	€ 1 450	-35%
	ANS-related inefficiencies gate-to-gate (Environment)	€ 3 890	€ 3 460	€ 3 700	€ 3 730	0.9%
Estimated total ANS-related economic costs to airspace users		€ 14 130	€ 13 071	€ 14 065	€ 13 492	-4.3%

* Note that Terminal ANS provision costs only refer to 21 States. Source: PRC analysis

Figure 3-28: Estimated total ANS-related costs to airspace users [2008-11]

3.6.31 Tactical delay costs due to ATFM delays decreased substantially (-35%) mainly due to improved en-route performance. Estimated costs of ANS-related inefficiencies in the gate-to-gate phase increased by 0.9% in 2011, mainly due to the increase in ASMA additional time.

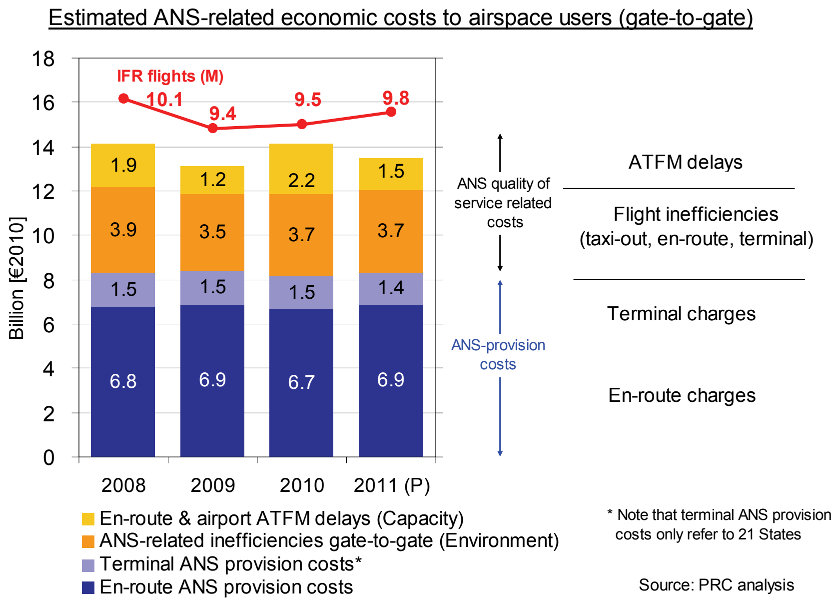


Figure 3-29: Estimated total economic costs of ANS performance [2008-11]

3.6.32 Although the consolidated view of ANS-related costs to airspace users in this section provides a good high-level estimate, there is scope for further refinements:

- presently the terminal ANS provision costs are only consistently available for 21 States and the reporting is not homogenous across Europe (see also Chapter 7);
- there is a need to better understand to what extent ANS-related inefficiencies in the gate-to-gate phase have a "tactical" impact on user costs as not all the inefficiencies are predictable and hence accounted for in the scheduled block times; and,
- the costs of cancellations and estimates of future emission costs[25] have not yet been considered in the overall economic assessment.

3.6.33 Additional analysis would be required to determine to what extent the economic evaluation of ANS-related performance can be applied at a more regional or local level

25 CO_2 from aviation has been included in the EU emission trading scheme since 01 January 2012. Consequently, all fuel use is associated with additional carbon permit cost.

bearing in mind that local flight-efficiency improvements need to be coordinated with adjacent States and could depend on civil/military coordination issues (see Chapter 5).

3.6.34 Thus far, much of the focus has been on the en-route flight phase. The future orientation will be the inclusion of ANS performance at and around airports (i.e. gate to gate perspective) and a strengthening of Safety through target-setting rather than just monitoring within the SES performance scheme.

3.7 Conclusions

3.7.1 In 2011, IFR traffic grew on average by +3.1% in Europe but remains below the pre-economic crisis levels of 2007 and 2008. Overall, there was a slow traffic recovery in 2011 as some of the observed traffic growth in 2011 is a compensating effect for the cancellations due to adverse events (ash cloud, strikes, weather) in 2010.

3.7.2 For 2012, the February 2012 STATFOR Medium Term Forecast predicts a traffic decrease of -1.3% with an average annual growth of +1.0% between 2011 and 2014. Compared to the previous forecast, this is a significant downward revision as a result of the continuing economic crisis in Europe

3.7.3 Traffic growth is not evenly spread across Europe. High growth rates are observed in eastern European States and this trend is forecast to continue between 2012 and 2015.

3.7.4 The high-level view of ANS performance in the wider context of commercial air traffic operating under Instrument flight rules (IFR) in Europe addresses the key performance areas of the SES performance scheme and includes charges (cost-efficiency), ATFM delays (capacity) and flight efficiency (environment), with an overriding safety objective (safety). The following points can be noted:

- Safety: Safety is the primary objective of ANS. There was no accident with direct ATM contribution in commercial aviation in Europe in 2010.
- Capacity/ Delays: Arrival punctuality improved significantly in 2011 (-6.2% pt[26].) reaching a level similar to 2009 with subsequent positive effects on the European network. ANS contributed through a substantial reduction in total ATFM delays (-35%), mainly driven by a reduction of en-route ATFM delays (-42%) in 2011.
- Environment/ Flight efficiency: Emissions from aviation account for approximately 3.5% of total CO_2 emissions in Europe of which approximately 0.2% are due to ANS-related inefficiencies. ANS-related inefficiencies in the gate-to-gate phase increased in 2011, mainly due to the increase in ASMA additional time.
- Cost-efficiency: Total air navigation charges accounted for 6.2% of airlines' total operating costs in Europe. Despite a projected increase of total ANS provision costs by +1.8%, the costs per unit in Europe decreased notably in 2011, due to the increase in traffic (+3.1%). En-route ANS provision costs accounting for some 80% of total ANS provision are projected to increase by +2.3% in 2011 while terminal ANS provision costs are projected to decrease by -0.7%.

3.7.5 Overall, unit costs decreased notably in 2011, as a result of a decrease in total ANS-related economic costs (-4.3%) and a traffic growth of 3.1% which is a good achievement. The reduction results from a substantial improvement in ANS service quality compared to 2010 and thus from a reduction of ANS-related service quality costs of -13% which compensated for the increase in ANS provision costs (+1.8%).

3.7.6 The economic evaluation of ANS performance combines the en-route and terminal ANS

26 Percentage point refers to the difference between two percentages.

provision costs (Cost-efficiency) with the estimated costs to airspace users due to ANS-related inefficiencies (Capacity/Environment).

3.7.7 Safety being monitored separately, an overall economic evaluation provides a consolidated high-level view to assess *a posteriori* the effectiveness of policy objectives at system level and to promote an initial discussion on future ANS performance objectives.

KEY POINTS	KEY DATA		
1. There was an insignificant reduction in the number of Separation Minima Infringements (SMIs) in 2010 (-1%). The share of risk bearing SMIs increased by 15% in 2010.	Performance indicators	2010	% change vs. 2009
2. A considerable increase (+27%) in the total number of reported runway incursions (RIs) was observed in 2010. Risk bearing RIs almost doubled (+94%) in 2010, but this is partially driven by one Member State which changed the way severity is determined and recorded.	Total separation minima infringements	1 402	-1%
3. While the total number of unauthorised airspace penetrations remained at the level of 2009, the share of risk bearing incidents increased substantially in 2010 (+41%).	Separation minima infringements (Severity A+B)	194	+15%
4. Despite a continuous improvement in reporting levels over the past years, it is estimated, by a simple approximation, that over 50.000 incidents still remain unreported.	Total number of reported runway incursions	1 385	+27%
5. A strong increase in the number of occurrence reports without severity classification was observed between 2007 and 2010 leading to a deterioration of the severity assessment situation.	Total number of reported runway incursions (A+B)	99	+94%
6. The State Safety Programme (SSP) implementation is still at its early stage in EUROCONTROL States. Overall SSPs are not consistently available in Europe and ICAO and EASA are promoting their timely implementation.	Total unauthorised penetration of airspace	3 381	+1%
	Unauthorised penetration of airspace (Severity A+B)	83	+41%

4.1 Introduction

4.1.1 This chapter reviews the ANS safety performance of EUROCONTROL Member States. The review of ATM-related accidents and incidents is based on 2010 data (last update in April 2012) and preliminary data for 2011 are reported but not analysed in detail.

4.1.2 The chapter is structured as follows:

- Section 4.2 analyses the number of accidents and most severe incidents available from the SRC Annual Report 2011 [Ref. 17] and the SRC Intermediate Safety Report 2012 [Ref. 18]. It discusses the amount and quality of safety reporting in the EUROCONTROL Member States;
- Section 4.3 looks at State Safety Programmes (SSPs) and safety assurance based on information from ICAO, EUROCONTROL and EASA; and,
- Section 4.4 reports on the review of the National/FAB Performance Plans in summer 2011, for RP1 of the SES performance scheme which started on 01.01.2012.

4.2 ATM-related Accidents and Incidents

ACCIDENTS WITH ATM CONTRIBUTION

4.2.1 The number of accidents[27] with ATM contribution for commercial air traffic in ECAC States are depicted in Figure 4-1. The observable trend implies that the absolute number of accidents with ATM contribution[28] has continued to decrease. However, the numbers shown have limited statistical relevance due to the small numbers involved.

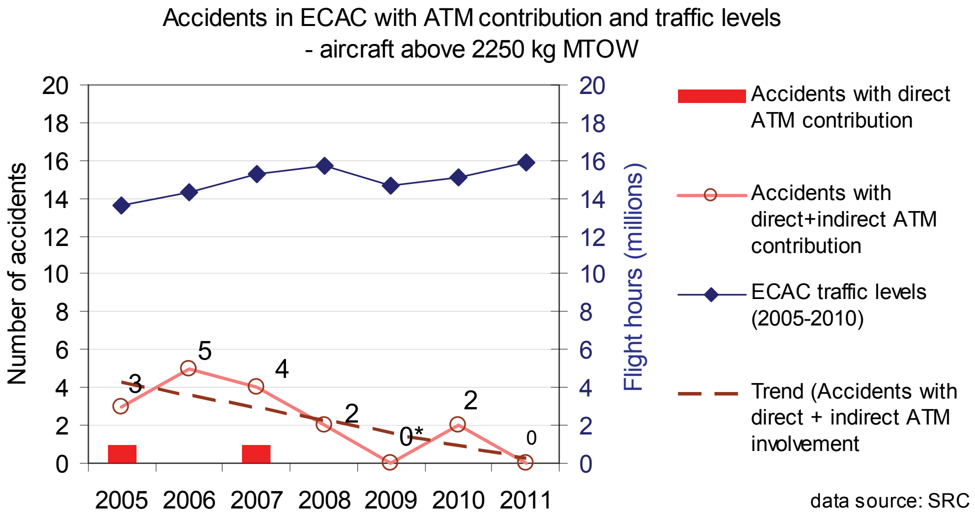


Figure 4-1: Accidents in EUROCONTROL States with ATM contribution [2005-11]

4.2.2 As was the case in preceding years, safety incident reports for 2010 were compiled and reported to EUROCONTROL's DSS/OVS/SAF Unit. Therefore, the corresponding analysis refers to 2010 and only illustrates preliminary data for 2011.

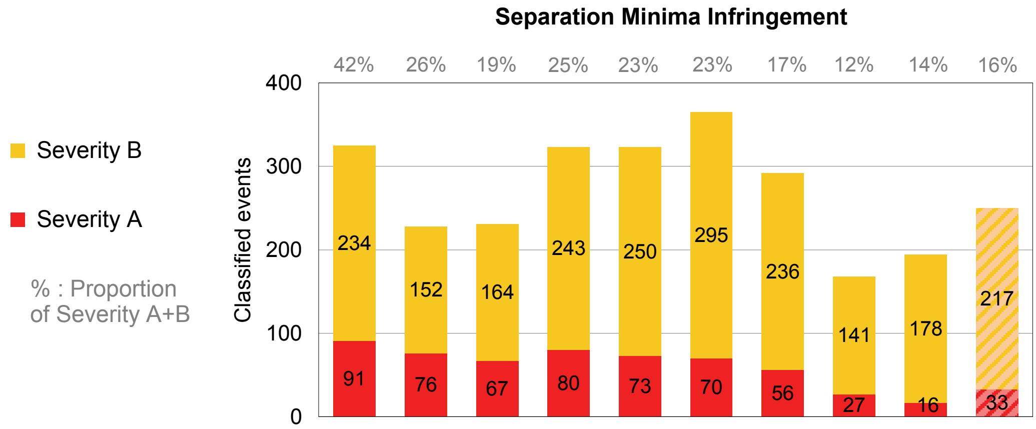
4.2.3 A number of ANSPs, Regulatory and Investigation Authorities started implementing the Risk Analysis Tool (RAT) methodology in 2010 [Ref. 19] and report the results through the Annual Summary Template (AST) mechanism. It is to be expected that differences will exist in the severity assessment's results in comparison with previous years, which consequently will have an impact on the trend analysis, in particular for 'Separation Minima Infringements' and 'Runway Incursions'.

4.2.4 Figure 4-2 depicts the number of reported high-risk (severity A+B) **Separation Minima Infringements** (SMIs). The number of risk-bearing SMIs (severity A+B) showed an increase of 15% in 2010 (from 168 to 194), after a significant decrease of 42% in 2009 but was still below the level of the 2005-2008 period.

4.2.5 There was an insignificant reduction in the number of Separation Minima Infringements (SMIs) in 2010 (-1%). The share of risk bearing SMIs increased by 15% in 2010.

27 Accidents as defined in ICAO Annex 13 and ESARR 2.

28 The notion of 'ATM-contribution' is to consider occurrences to which ATM has contributed directly or indirectly (or that are accountable to ATM); 'ATM-related' refers to occurrences to which ATM has potential for improvement.

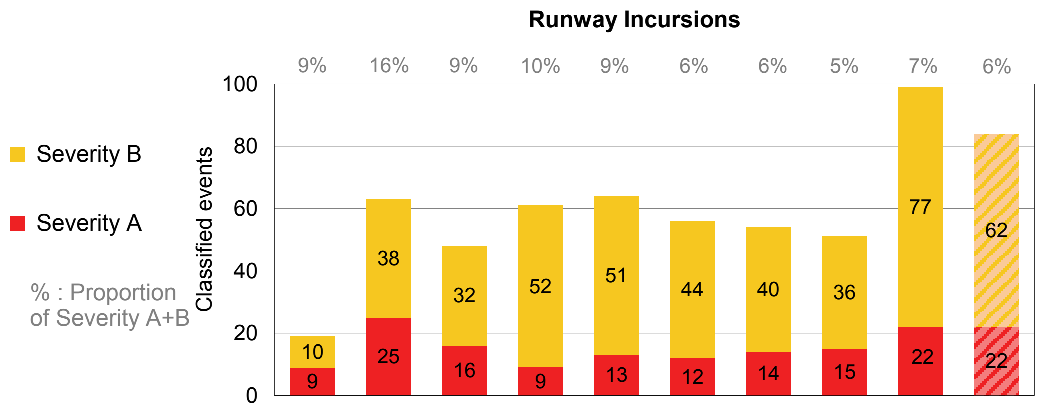


	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011P
N° of ECAC states reporting	27	29	26	26	28	28	29	30	31	32
Total n° of reported SMI	780	889	1 226	1 281	1 398	1 567	1 711	1 418	1402	1570
N° of SMI still under investigation	18	7	205	99	112	119	127	183	124	147

data source : SRC

Figure 4-2: Reported high-risk separation minima infringements in ECAC States [2002-11]

4.2.6 The number of risk-bearing (severity A+B) **Runway Incursions** (RIs) are depicted in Figure 4-3. Data for 2010 show a considerable increase in the total number of reported RIs from 1094 to 1385 (+27%). This increase could be attributed to improved reporting in general, and by some Member States in particular. It could also mean that a genuine increase in the number of RIs exists.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011 P
N° of ECAC states reporting	27	29	26	26	28	28	29	30	31	32
Total n° reported	222	387	564	629	680	885	926	1 094	1 385	1 364
N° still under investigation	2	5	133	146	50	79	35	188	142	146

data source : SRC

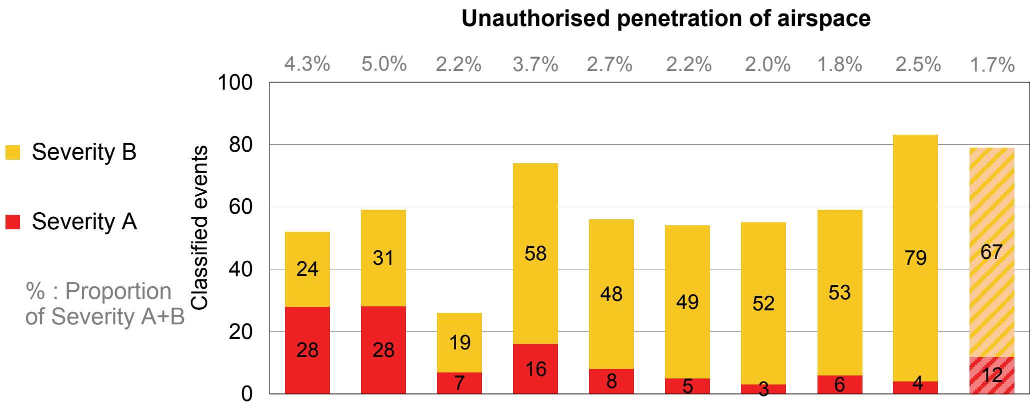
Figure 4-3: Reported high-risk runway incursions in ECAC States [2002-11]

4.2.7 Both, the total number of RI and the number of risk-bearing RIs (severity A+B) increased in 2010. The increase is more significant in severity category B. This is due to the increased number of severity B incidents reported by a number of States. The increase was more prominent in one Member State, which changed the way severity is determined and recorded.

4.2.8 In April 2011, EUROCONTROL issued the second edition of the European Action Plan for Prevention of Runway Incursions (EAPPRI) [Ref. 20]. The increase in the severity of

RIs reported shows that sustained effort in the implementation of its recommendations is crucial. The uniform assessment of severity associated with the RIs is also crucial to provide a meaningful analysis of the level of risk posed by this key risk area. The importance of the full and consistent application of severity classification of the RAT methodology, as one of the Key Performance Indicators (KPIs) for safety in the first reference period, cannot be underestimated.

4.2.9 An unauthorised penetration of airspace (see Figure 4-4) (also commonly referred to as airspace infringement)[29] is a frequent precursor for SMIs and Inadequate Separations[30] (IS). Around 5% of the reported airspace infringements end up in either a SMI or an IS [Ref. 18]. All classes of flights are prone to airspace infringement, in 57% of the incidents General Aviation (GA[31]) involvement was recorded (while in 23% the type of flight was not recorded). This is not a surprise, as most GA VFR flights are conducted outside controlled airspace, whereas IFR flights are contained within controlled airspace and carried out under the supervision of ATC units.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011 P
N° of ECAC states reporting	27	29	26	26	28	28	29	30	31	32
Total n° reported	1 216	1 178	1 209	1 983	2 041	2 416	2 797	3 336	3 381	4 607
N° still under investigation	51	6	77	281	93	171	124	477	360	500

data source : SRC

Figure 4-4: Reported unauthorised penetration of airspace in ECAC States [2002-11]

4.2.10 The data for 2010 show that the total number of reported airspace infringements remained at the level of 2009 while risk-bearing events (severity A+B) increased by 41% (see Figure 4-4). This is due to a rise in the severity B (major) incidents, which is at the highest level since reporting began. In absolute numbers, serious incidents (severity A) decreased from 6 to 4 compared to 2009.

4.2.11 In December 2009, the Provisional Council approved the "European Action Plan for Airspace Infringement Risk Reduction" [Ref. 21] and urged all Member States to start the implementation, at national level, of the agreed European Action Plan for Airspace

29 Definition of unauthorised penetration of airspace (EUROCONTROL HEIDI – ESARR 2 taxonomy): The penetration by an aircraft into a portion of airspace without prior permission of the appropriate authorities (when such prior permission is required).

30 Definition of inadequate separation (EUROCONTROL HEIDI– ESARR2 taxonomy): in the absence of prescribed separation minima, a situation in which aircraft were perceived to pass too close to each other for pilots to ensure safe separation (e.g. VFR and IFR flights perceived to pass too close to each other in airspace Class D or E).

31 GA: ESARR 2 (Appendix C) / ICAO Doc 9713: "General aviation operation - An aircraft operation other than a commercial air transport operation or aerial work operation".

Infringement Risk Reduction before the end of 2011. This is crucial to address the increase in risk associated with the airspace infringements.

4.2.12 It can be observed that the proportion of incidents 'still under investigation' for all categories has not improved since the last reporting period. The number of reported incidents still under investigation has substantially increased from the 2009 'provisional' data (PRR2010) to the 2009 'final' data. The 2010 'provisional' data are already in the same range as the 2009 final data.

AMOUNT AND QUALITY OF SAFETY REPORTING

4.2.13 The total number of reported ESARR2 safety incidents is displayed in Figure 4-5 showing a continuous increasing trend over the past ten years.

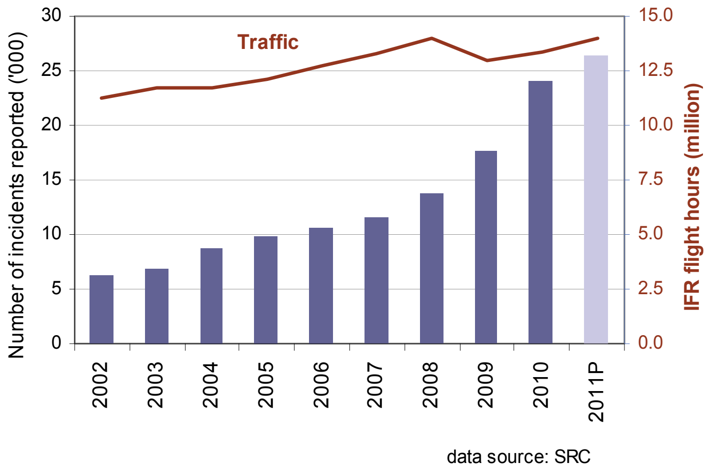


Figure 4-5: Reported ATM incidents vs. million flight hours in EUROCONTROL airspace

4.2.14 The level of reporting of ATM related incidents is displayed in Figure 4-6. The level of reporting is measured against the average ECAC reporting level in 2003, which represents the baseline. The number of States reporting safety incidents has shown a slow but steady improvement over the past six years, with 19 States reporting above this baseline in 2010. In 2010, 12 ECAC States (out of 43) did not submit ASTs to the EUROCONTROL SRC. Of these, seven are EUROCONTROL Member States (Bulgaria, Luxembourg, Malta, Monaco, Slovenia, Turkey and Ukraine). In Spring 2012, Bulgaria and Luxembourg have restarted providing ASTs to the SRC.

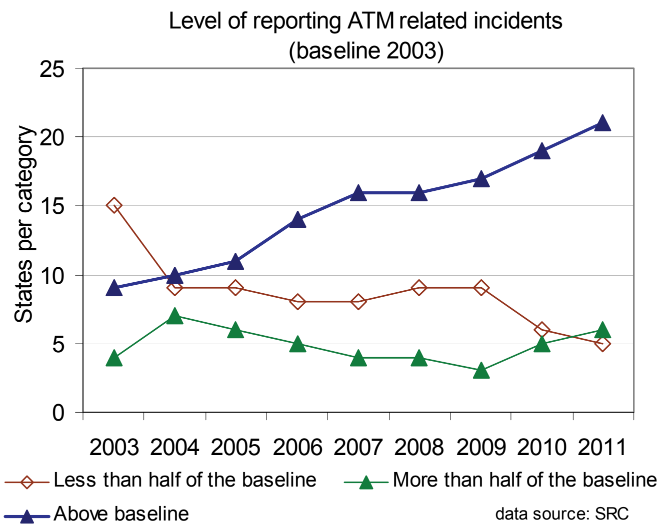


Figure 4-6: Level of reporting of ATM related incidents [2003-11]

4.2.15 The data currently available on total numbers of incidents reported do not allow to judge whether the upward trend is caused by an improved level of reporting (positive) or by an increasing number of incidents (negative). Most likely, it is a mixture of both factors.

4.2.16 While most of the States increased their reporting levels in comparison with previous years (average ECAC rate in Figure 4-7), the same gap is maintained when comparing with States having the highest reporting levels (Average best reporters in Figure 4-7). The encouraging news is that the average reporting level in 2010 (the brown dashed line in Figure 4-7) is above the 2003 reporting level of the "best in class" which illustrates the progress achieved over the past seven years. However, in the meantime the reporting level of the "best in class" has also risen.

4.2.17 To get an estimate of the potential level of manual underreporting at ECAC level, the average number of incidents per flight hour of the three best reporters in 2010 is applied to all ECAC States (see Ref. 17 for full methodology). The simple approximation suggests that the possible additional number of incidents that could have been reported in 2010 (the "Area of improvement" depicted in the graph) amounts to over 50.000 incidents (had all ECAC States reported at the level of the "best" reporters).

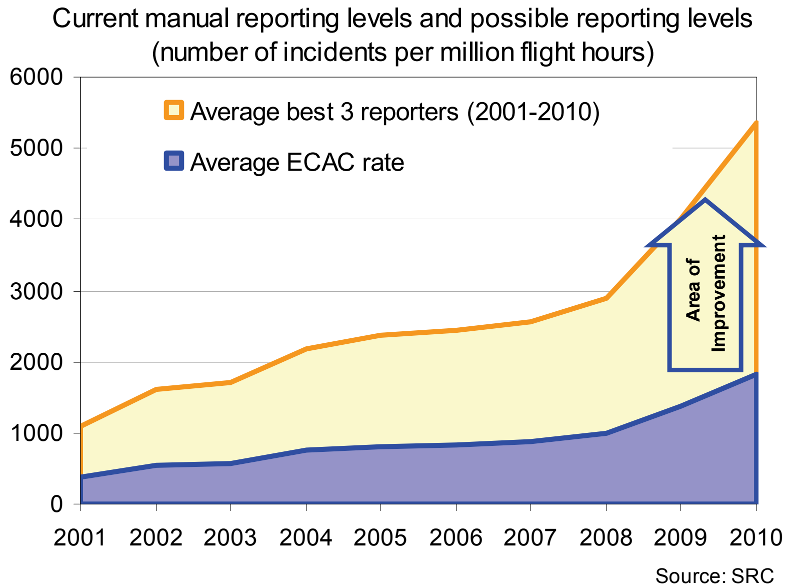


Figure 4-7: Current and possible levels of manual reporting [2001-10]

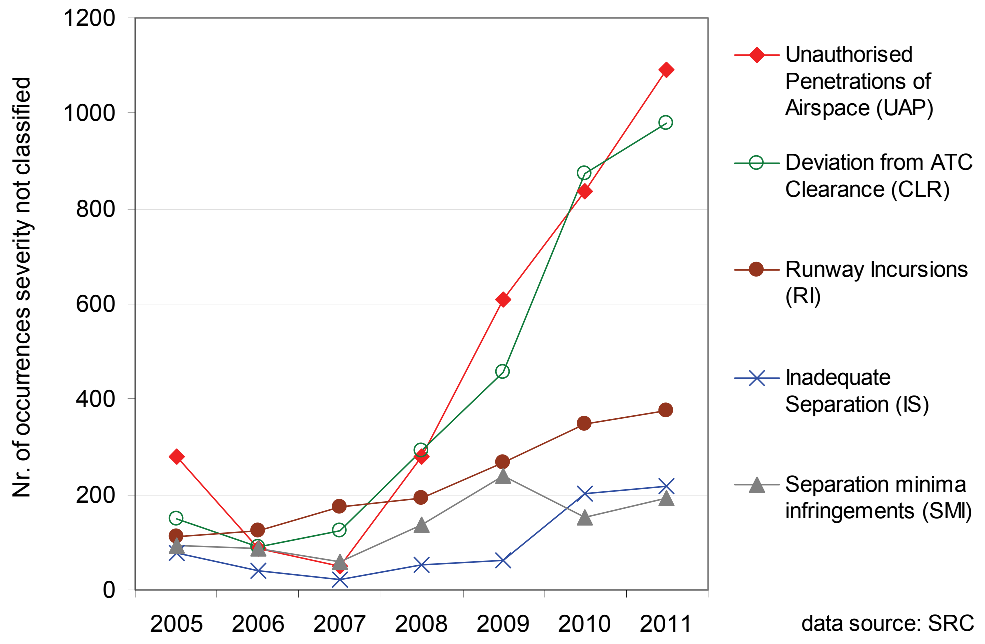
4.2.18 While this approach provides an approximation for the ECAC level, it does not enable the reasons for the estimated level of manual underreporting to be identified. At European level, incidents may remain un-reported for several reasons including: (1) they are not reported by the front line operators or (2) some national data flows do not work properly and the data is not reaching EUROCONTROL.

4.2.19 At European level, closing the gap requires improvements in the reporting of front line operators (i.e. just culture), in the national safety data flows, and at the interface between EUROCONTROL and the States. It also requires improvements in the quality of data.

4.2.20 ESARR2 requires States to ensure 'that the severity of occurrences is determined, the risk posed by occurrences classified, and the results recorded. The SRC Annual Safety Report 2011 [Ref. 17] concludes that the severity assessment situation of ATM-related incidents reported through the AST mechanism is deteriorating (see Figure 4-8). The SRC proposed an Action Plan with the aim to address the root causes, namely:

- Increase in reporting does not lead to an increase in resources available for investigation and safety analysis;

- The severity is not classified at all; and,
- National data flows do not ensure that severity is recorded in the national/ regulator database.



(The March 2011 update to the 2009 data explains the substantial increase in the 2009 incidents in comparison to last year's report)

Data source: SRC

Figure 4-8: Occurrence reports without severity classification in ECAC States [2005-11]

4.3 State Safety Programmes and safety assurance

ICAO SAFETY POLICY AND OBJECTIVES

4.3.1 In 2007 the 36th ICAO Assembly agreed that ICAO shall implement the Global Aviation Safety Plan (GASP) which supports the relevant Strategic Objectives of ICAO (Resolution A36-7). GASP applies to all ICAO Contracting States and contains three safety targets for commercial traffic to be achieved by the end of 2011:

1. Reduce the number of fatal accidents and fatalities worldwide irrespective of the volume of air traffic;
2. Achieve a significant decrease in accident rates, particularly in regions where these remain high; and,
3. No single ICAO region shall have an accident rate (based on a five year sliding average) more than twice the worldwide rate by the end of 2011.

4.3.2 Figure 4-9 shows that the first ICAO target was achieved.

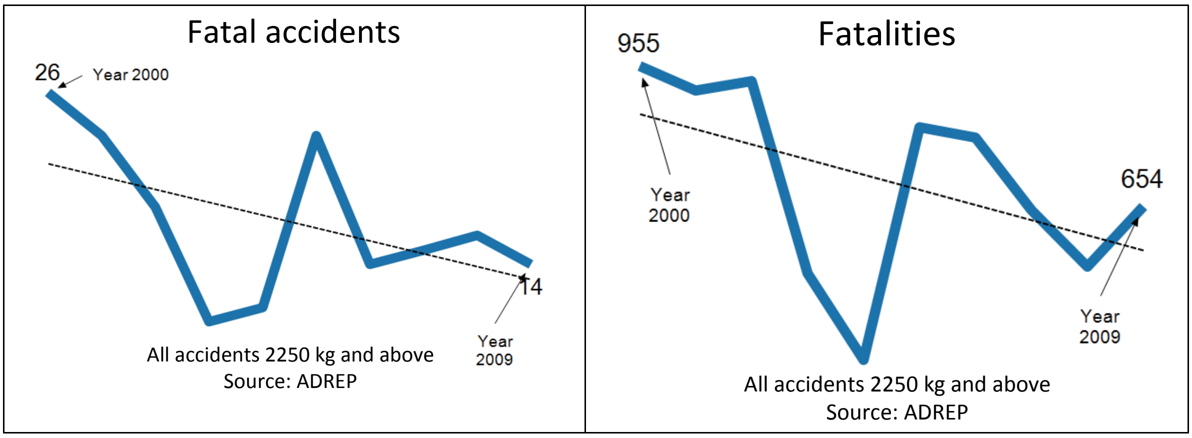


Figure 4-9: ICAO GASP Aviation Targets 1 (ICAO - iSTARS)

4.3.3 The ICAO EUR/NAT Office area of accreditation which contains EUROCONTROL States has an accident rate (based on a five year sliding average) much lower than the world wide average (1.91 versus 4.11). Therefore the third ICAO target is fulfilled in Europe.

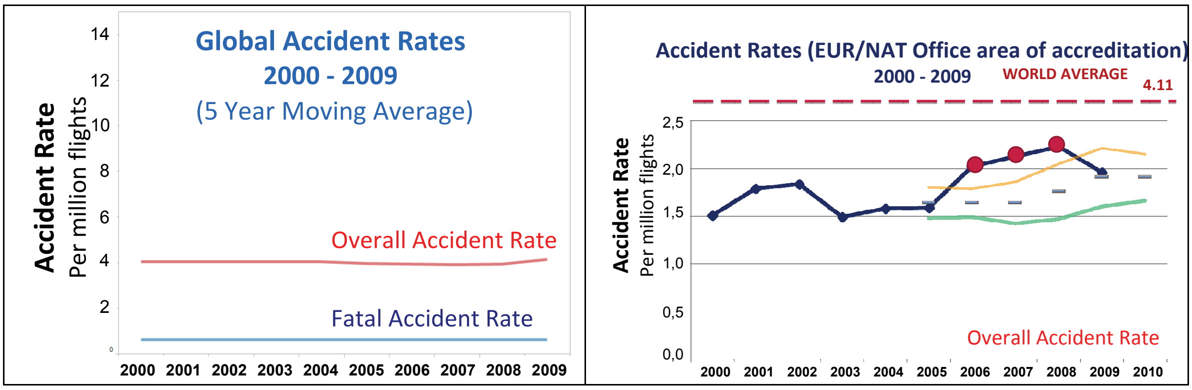


Figure 4-10: ICAO GASP Aviation Targets 2 (source: ICAO - iSTARS)

4.3.4 Figure 4-10 shows that the second target is not being achieved, as the five-year moving average of the worldwide accident rate is slightly increasing. Although the moving average in the ICAO EUR/NAT Office area of accreditation remains well below the world wide average, the accident rate increase between 2006 and 2008 has contributed to the upward trend of the worldwide five-year moving average.

4.3.5 In support of the ICAO GASP and to take a more proactive approach which incorporates the analysis of safety risk factors, the ICAO Assembly Resolution A36-4 established a new approach to be applied in the USOAP beyond 2010 which is based on the concept of continuous monitoring (USOAP-CMA).

4.3.6 The new approach also emphasises the distinction between prescriptive[32] and performance-oriented regulation[33] which also co-exist in the State Safety Programmes (SSP) and State Safety Plans as they usually include a combination of prescriptive actions and safety performance targets.

32 Prescriptive regulations establish “what” is to be achieved and “how” it must be achieved (administrative controls, compliance with rules and standards).

33 Performance-oriented regulations establish “what” is to be achieved, but provide flexibility on “how” it must be achieved (risk controls through ALoS). State Safety Programmes (SSPs) and Safety Management Systems (SMS) govern “risk controls” in the context of “administrative controls

State Safety Programmes

4.3.7 In order to further enhance the level of safety obtained in the civil aviation industry, ICAO promotes the principles of safety management revolving around Safety Management Systems (SMS) for service providers and SSP for Contracting States.

4.3.8 A SSP is defined as an integrated set of regulations and activities aimed at improving safety. It includes specific safety activities that must be performed by the State, and regulations and directives promulgated by the State to support fulfilment of its responsibilities concerning safe and efficient delivery of aviation activities in the State.

4.3.9 While in the long-term, the strategic objective of an SSP is the improvement of safety in the State, the organisation of an SSP aims at two short-term, tactical objectives:

1. efficient and effective delivery of safety responsibilities and accountabilities by the State; and,
2. efficient auditing of safety responsibilities and accountabilities by the State.

4.3.10 The notion of the SSP also aims at a third and medium-term objective: the transition from a predominantly prescriptive regulatory environment to an integrated regulatory environment combining prescriptive and performance-oriented regulatory approaches.

4.3.11 An important element of the SSP is the Acceptable Level of Safety (ALoS). An ALoS is composed of a set of safety performance indicators on the basis of which safety performance targets are defined. An ALoS provides a measurable way of ensuring and demonstrating the effectiveness of an SSP or an SMS.

Acceptable Level of Safety (ALoS)

ICAO prescribe that States shall establish a SSP at State level in order to achieve Acceptable Level of Safety (ALoS). ICAO standards also explicitly require States to establish an ALoS to be achieved, as a means to verify satisfactory performance of the SSP and service providers' SMS.

ICAO's SSP requirements place responsibility for the establishment of an ALoS on the State. This is accomplished through the use of data and other resources that contribute to the development of SPIs that are used to measure whether the SSP is achieving an acceptable level of safety.

In the EU context, ALoS will be based on a combination of three tier level Safety Performance Indicators (SPIs):

- Safety measurements as information relative to events with high consequences: 1st tier SPIs providing a general assessment of safety and informing the public and stakeholders;
- Safety performance measurement of events: 2nd tier SPIs focusing on key risk areas(principal risks) which require measures; and
- Safety requirements: 3rd tier SPIs providing information on the effectiveness of the measures.

4.3.12 The steps that can be used to describe the SSP implementation status and the level of implementation in the EUROCONTROL area are shown in Figure 4-11 and Figure 4-12.

Steps to State Safety Programme implementation	
STEP1	The State promulgates a legal framework for the definition of the SSP.
STEP2	The State publishes an SSP which delivers the State's safety responsibility and accountability and it explains in broad lines what are the State's safety objectives and the strategies to achieve them.
STEP3	The State regularly publishes a State Safety Plan which includes a detailed implementation plan for the next 2- 5 years. The State Safety Plan includes identified risks, associated priorities and performance indicators to monitor risks.
STEP4	The State has agreed with each designated ANSPs operating in its FIRs the ALoS.
STEP5	There is a link between the SSP risk priorities and the safety indicators and / or targets published in the National/FAB Performance Plan. This step only applies to those States bound by EU legislation.

Figure 4-11: Steps to SSP implementation in the EUROCONTROL area

4.3.13 Figure 4-12 shows the implementation status of SSP in the EUROCONTROL area. Often there is no incremental approach between Step 1 and 4. A State may publish a draft SSP, but the legal framework has not been promulgated yet or the State has agreed ALoS with ANSPs, but there is not yet an implemented SSP.

Number of States which have completed the following steps:				
STEP1	STEP2	STEP3	STEP4	STEP5*
14	10	6	7	3

* Step 5 only applies to 29 Eurocontrol States instead of 39

Source: EUROCONTROL LSSIPs Edition 2011, PRU, States public data

Figure 4-12: Implementation Status of SSP in EUROCONTROL area

4.3.14 It should be noted that FABEC States have asked the FAB governance bodies to align the FAB safety dimension to the risks identified in the SSPs. However, not all FABEC States have established a mature SSP with risk identification and prioritisation. The FABEC Council has not established safety performance indicators and targets in line with the risks identified in French and Belgian SSPs.

4.3.15 The reasons for the low level of SSP implementation are multi-faceted:

- The SSP is a relatively new ICAO concept;
- State safety experts are in the process of being trained to implement the SSP;
- ANSPs either are not designated for the full FIR or the agreements across ANSPs are not yet finalised;
- There are a number of States which are not yet ready to migrate from a predominantly prescriptive regulatory environment to an integrated combination of prescriptive and performance-based regulatory approaches.

4.3.16 ICAO, EUROCONTROL and EASA are promoting a timely SSP implementation and it is expected that more States will implement SSP in the near future. The PRC will continue monitoring the status of SSP implementation.

SAFETY ASSURANCE

4.3.17 This section addresses safety assurance in ATM which is achieved through international audits of the States and CAAs/NSAs (ICAO USOAP, EUROCONTROL ESIMS, and EASA inspections).

4.3.18 In 2011, the cycle of the ICAO Universal Safety Oversight Audit Programme (USOAP) Comprehensive Systems Approach (CSA) audits was completed. These audits had started in 2005 in order to assess the level of effective implementation of critical elements of a safety oversight system by States.

4.3.19 Based on the information collected during the USOAP-CSA audit cycle between 2005 and 2011 (see paragraph 4.3.17), ICAO has studied the relationship between the accident rate and the lack of effective implementation (LEI) which is the indicator used to benchmark State audit results (States' oversight capability). The analysis shows a dependency which suggests that the indicator can be used as a predictive safety indicator.

4.3.20 According to ICAO, where the ANS LEI indicator is above 50%, the focus for safety actions should be mainly on improving the administrative controls (i.e. safety oversight). Between 50% and 30%, the focus gradually shifts towards risk controls (i.e. SSPs and SMS) and with an ANS LEI below 30% the focus should be mainly on risk controls.

4.3.21 ICAO calculates the ANS LEI indicator for the ICAO EUR/NAT Office area of accreditation at 35.2%[34] which is close to the 30% level. The focus of the ICAO EUR/NAT Office area of accreditation should therefore be on strengthening risk controls.

4.3.22 Although States' ANS safety oversight capabilities in the ICAO EUR/NAT Office area of accreditation is satisfactory compared to the worldwide average (48.3%), the ANS LEI value is variable across EUROCONTROL Member States. Although the majority of EUROCONTROL States have an ANS LEI <30%, there are still 7 States with an ANS LEI >50% (Figure 4-13).

LEI <30%	30%<LEI <50%	LEI>50%
22	9	7

One Eurocontrol State was not included as no LEI was computed for this State.
Source: [ICAO-iSTARS - 31/12/2011]

Figure 4-13: ANS LEI and EUROCONTROL States

4.3.23 The ICAO USOAP-CMA started in 2011 with the main purpose of verifying the implementation of the States' Corrective Action Plans (CAPs) which have been agreed in the context of the ICAO-CSA cycle (2001-2011) between audited States and ICAO. As CAPs will be verified, the LEI indicator of audited States will be updated accordingly.

4.3.24 The EUROCONTROL Safety Regulatory Requirement (ESARR) Implementation Monitoring and Support (ESIMS) Programme is closely coordinated with the ICAO USOAP and audit data and related information are routinely exchanged.

4.3.25 At the end of 2011, the six-year ESIMS cycle was concluded. From November 2005 to December 2011, 42 on-site audits and 8 follow-up audits were completed. Thirty-three final reports had been published by September 2011.

4.3.26 The implementation of ESIMS Corrective Action Plans continues in accordance with the reports received from the States audited so far [Ref. 17]. Whereas overall results are rather satisfactory, the main concerns are related to the surveillance obligations (i.e. effectiveness in audit processes) conducted by NSAs and the resolution of safety concerns (i.e. follow up and enforcement of NSA audits on ANSPs).

4.3.27 The results from ESIMS audits and other monitoring mechanisms have repeatedly shown over the past years, that NSAs struggle with the lack of qualified resources to ensure the safety oversight of all ANSPs operating under their supervision. This is a critical factor to implementing oversight processes, and remains an issue requiring proactive attention by States. The support to NSAs articulated at European level and within the context of FABs may become instrumental to mitigate that situation.

4.3.28 Both the ICAO (USOAP) and EUROCONTROL (ESIMS) audit cycles have been instrumental for the SES Performance Scheme. Thanks to these two activities, it was possible to move the European ANS industry further towards a total performance approach as these international audits have reinforced the safety oversight capabilities of States and consequently their ability not to compromise safety in a context of binding targets for capacity and cost-efficiency. The ESIMS programme will end in 2012, and the continuation of the task will be performed under the EASA standardisation programme with involvement of EUROCONTROL experts.

34 Status 31/12/2011. As ICAO only updates the ANS LEI when the Corrective Action Plan (CAP) is verified by an international audit by ICAO, EUROCONTROL, or EASA, the progress of States that are in the process of implementing CAPs to enhance their oversight capabilities might not be fully reflected in the result.

4.4 SES performance Scheme

4.4.1 Thanks to the ICAO (USOAP) and EUROCONTROL (ESIMS) audit cycles, significant progress has been achieved over the past years. The Single European Sky (SES) initiative of the European Commission (EC) contributed positively to these achievements by filling the gaps in the previously-existing national primary aviation legislation. In those Member States where EC law is applicable, SES has also ensured a common benchmark for safety oversight, notably via Regulation (EU) 1034/2011 [Ref 22] which has repealed Regulation (EC) No 1315/2007 [Ref 23].

OUTLINE OF MAIN CHANGES TO SAFETY FRAMEWORK IN 2011

4.4.2 To put the report in perspective, it may be helpful to recall some significant changes to the safety framework that occurred in 2011. The majority of these changes occurred in the EU context but some did occur in a broader context such as ICAO.

4.4.3 Changes to the EU regulatory framework:

- The European Commission, using the Comitology process, adopted the following rules to implement Regulation 216/2008 (The EASA basic regulation) [Ref. 24]:
  - Commission Implementing Regulation (EU) No 1034/2011 of 17 October 2011 on safety oversight in ATM/ANS [Ref. 22];
  - Commission Implementing Regulation (EU) No 1035/2011 of 17 October 2011 laying down common requirements for the provision of air navigation services [Ref. 25];
  - Commission implementing regulation (EU) No 805/2011 of 10 August 2011 laying down detailed rules for air traffic controllers' licenses and certain certificates [Ref. 26];
  - Commission Regulation (EU) No 1332/2011 of 16 December 2011 laying down common airspace usage requirements and operating procedures for airborne collision avoidance [Ref. 27].

4.4.4 In parallel to the adoption of these rules, the development of EASA standardization process for ATM/ANS has been done at a sustained pace so that standardization inspections replacing ESIMS can start in 2012.

4.4.5 Reflecting its extension of scope, the EASA has published its Annual Safety Review with an ATM chapter for the first time in 2011.

4.4.6 The performance regulation 691/2010 [Ref. 1] was amended by Commission implementing regulation (EU) No 1216/2011 of 24 November 2011 [Ref. 28] to include a more precise definition of the safety KPI for the first reference period and to include their verification mechanisms. In order to provide a consistent safety performance monitoring review across the EUROCONTROL Member States in the future, it would be desirable to encourage non-EU Member States of EUROCONTROL to provide information on 'Effectiveness of Safety Management' and 'Just Culture' to complete the pan-European view.

4.4.7 This amending legislation was complemented by a set of Acceptable means of Compliance and Guidance material adopted by the EASA Executive Director on 16 December 2011 (Decision 2011/017/R) [Ref. 29].

4.4.8 Reflecting the cooperation achieved in particular on KPI, EASA and PRB signed on 14 February a Memorandum of Understanding setting-up their cooperation [Ref. 30;

- The network management function has been formalised by Commission regulation (EU) No 677/2011 of 7 July 2011 laying down detailed rules for the implementation of traffic management (ATM) network functions and amending Regulation (EU) No 691/2010 [Ref. 31];

- The provision of information (including information relative to a safety case) before the establishment and modification of a functional airspace block (FAB) has been requested by Commission Regulation (EU) No 176/2011 of 24 February 2011 [Ref. 32].

4.4.9 In addition to these regulatory changes, the European Commission adopted on 25 October 2011 [Ref. 33] a Communication setting up an Aviation Safety Management System for Europe. This Communication will provide a framework for the European Aviation Safety Programme and Plan and for the States Safety programmes

- At the international level, the ICAO Safety Management Panel tasked to develop an Annex 19 met for the first time in 2011: the Annex 19 will contain as a first step all provisions for SMS in the various fields of activity.

REVIEW OF NATIONAL PERFORMANCE PLANS

4.4.10 Even though national targets are not mandatory for safety during the first reference period (RP1), all Performance Plans include substantial elements on safety performance, such as safety processes, performance indicators and targets in some cases. The plans were assessed by the PRB together with EASA as to their suitability for safety performance monitoring during RP1. A number of observations were made, notably the need to reinforce the safety capabilities of National Supervisory Authorities (NSA) within the concerned State or preferably through the corresponding FAB.

4.4.11 The qualitative assessment of Performance Plans, on the basis of submitted evidence within the plans, conducted by PRB and EASA, mainly verified four items related to safety performance:

- the capability and processes to monitor safety performance with a focus on NSA (risk management in relation with the implementation of the SSP and further establishment of the State Safety Plan, occurrences reporting and investigation, data processing and storage, access and publication of safety data),
- the safety indicators which will be used for monitoring safety performance in RP1,
- the application of safety requirements (NSA resources, audit/inspection processes, oversight of safety changes, and cross-border arrangements), and
- the interrelation between safety and the other performance areas.

4.4.12 The observations of the safety review are detailed in the PRB's report 'Assessment of National / FAB Performance Plans with Performance Targets for the period 2012-2014" [Ref. 34] Vols. I and II, on EU-wide and National level respectively. In conclusion of their review the PRB recommended on EU-wide level, that:

- the European Commission encourages States that have not already done so, to increase their efforts for the timely implementation of SSP, as it is PRB's opinion that this is a fundamental basis for safety improvements;
- the European Commission requests States that have not already done so, to use the opportunity of application of the RAT methodology (during ATM safety occurrence analysis and investigation) to develop safety performance indicators for monitoring purposes as early as possible during RP1 in the context of the performance scheme. The PRB recommends to the European Commission that Member States receive adequate support in implementing the RAT methodology;
- the European Commission, with due regard to independence of the Accident Investigation Board (AIB), invites States to apply the same methodology for analyzing and investigating ATM safety occurrences in all entities (not just the ones mentioned in Regulation (EU) No 691/2010);

- the European Commission encourages all States to implement and prepare for the measurement of Just Culture at three levels (ANSPs, NSA/CAA, and State particularly with regard to MoT and Justice Department);
- the European Commission requests States to include an update on the status of recommendations made by the PRB on safety in their next national Annual Report, as required by Regulation (EU) No 691/2010.

4.4.13 With a view towards the second reference period the PRB considered that a common and harmonised European methodology for development of safety performance indicators and corresponding targets on State level (taking into account EU-wide performance targets) is needed. Accordingly, the PRB recommended that the European Commission invites EASA to develop, with the support of EUROCONTROL as appropriate, an acceptable means of compliance for this programme to be deployed prior to the second reference period.

4.4.14 Currently efforts are under way between PRU and EASA to establish a RP1 Monitoring Plan, identifying roles and responsibilities for of data collection, data validation and verification, and the conduction of the respective safety analyses.

4.5 Conclusions

4.5.1 While incident reporting levels are improving, it is estimated that over 50 000 incidents remain unreported. This estimate is substantially higher than for the preceding reporting period. Currently available data on total numbers of incidents reported do not allow to judge, whether the upward trend is caused by an improved level of reporting (positive) or by an increasing number of incidents (negative). Most likely, it is a mixture of both factors. Therefore:

- the five EUROCONTROL Member States (Malta, Monaco, Slovenia, Turkey and Ukraine), which are still not submitting ASTs, should be urged to provide data in 2012 for 2011 onwards;
- the deployment of automatic safety monitoring tools in Europe should be accelerated to complement the manual reporting, in order to improve the reporting culture and consequently the level of reporting. In preparation of and during the deployment, "just culture" needs to be addressed as an important enabler. Sufficient resources are needed to validate the data properly, analyse the results and draw lessons learnt; and,
- there appears to be significant room for improvement in the national safety data flows to capture all of the safety occurrences reported as well as the results of the investigation and analysis.

4.5.2 There is a need to further improve the reporting culture and consequently the level of reporting in Europe. All States should be encouraged to implement Just Culture at all three levels (ANSP, NSA/CAA and State).

4.5.3 With regards to the quality of received reports, it has been observed that the severity assessment of ATM-related incidents reported through the AST mechanism is deteriorating. Incidents should be analysed using European-wide consistent criteria, which is the first step to uniform assessment of severity. This is necessary to provide meaningful analysis of European-wide levels of risk posed by key risk areas.

4.5.4 The number of reported incidents still under investigation has substantially increased since the last report. States should expedite the investigations, while taking care of just culture aspects, to allow that potential recommendations are derived in a timely manner in order to identify and address key risk areas.

4.5.5 Many NSAs still struggle with the lack of qualified resources. This remains an issue requiring proactive attention by States. Sharing resources within the context of FABs could help to mitigate that situation and preserve the public interest which rests with the NSAs.

4.5.6 In order to provide a consistent safety performance monitoring review across the EUROCONTROL Member States in the future, it would be desirable to encourage Albania, Armenia, Bosnia and Herzegovina, Croatia, Moldova, Monaco, Montenegro, Serbia, FYROM, Turkey and Ukraine to provide information on ‘Effectiveness of Safety Management’ and ‘Just Culture’ to complete the pan-European view.

4.5.7 The State Safety Programme (SSP) implementation is still at an early stage in Europe. A timely implementation of SSPs in all EUROCONTROL States should be promoted so that SSPs will be consistently available.

Chapter 5: Operational En-route ANS Performance

KEY POINTS

1. Notwithstanding a significant improvement compared to 2010 (2.8 min./flight), the PC summer en-route delay target of 1 minute per flight was not met in 2011 (1.6 min./flight).
2. En-route ATFM delays due to social tensions and adverse weather decreased notably in 2011. Staffing was the main cause of en-route ATFM delay at most of the critical locations, particularly at weekends when optimum sector configurations could not be deployed.
3. The five most congested ACCs (Madrid, Nicosia, Barcelona, Langen, Athinai + Makedonia) account for more than half (52%) of total en-route ATFM delay in 2011.
4. Substantial improvement was observed in the French ACCs and at Vienna and Zurich ACC.
5. Continuing the trend observed over the past years, horizontal en-route flight efficiency could be further improved in 2011.

KEY DATA 2011

IFR flights controlled	9.78M	+ 3.1%
Capacity: En-route ATFM delays	**2011**	**% change vs. 2010**
Total en-route ATFM delay (min.)	11.3M	-42.1%
Average Summer en-route ATFM delay per flight (min.)	1.6	- 42%
Average annual en-route ATFM delay per flight (min.)	1.1	- 44%
Flights delayed > 15 min. en-route (%)	3.0%	-2.1% pt.
Avg. ATC Capacity & Staffing related en-route ATFM delay	0.9	-27%
Avg. other ATC related delay (strike, equipment, etc.)	0.1	-85%
Environment : En-route flight efficiency in 2011	**% of GCD**	**NM**
Average horizontal en-route extension per flight	4.6%	22.6
Direct en-route extension (excl. TMA interface) per flight	3.0%	14.9
TMA interface per flight	1.6%	7.7

5.1 Introduction

5.1.1 This chapter reviews operational en-route ANS performance. Section 5.2 reviews Air Traffic Flow Management (ATFM) delays originating from en-route restrictions. Section 5.3 addresses en-route flight efficiency. Section 5.4 deals with flexible use of airspace. Section 5.5 addresses the performance of the European ATM Network Manager.

5.1.2 The environmental and economic impact of operational en-route ANS performance is included in the overall economic assessment in Chapter 3 of this report.

5.1.3 ANS-related operational performance in TMAs and at airports is analysed in Chapter 6. The analysis by phase of flight (en-route vs. airport) enables accountabilities and trade-offs to be viewed more clearly.

5.2 En-route ATFM delays

5.2.1 This section reviews Air Traffic Flow Management (ATFM) delays originating from en-route capacity restrictions.

EUROPEAN ATFM EN-ROUTE DELAY TARGET

5.2.2 The PC target for en-route ATFM delay is one minute per flight over the summer period of 2011 (May to October), and includes all delay causes (capacity, weather, etc.). The capacity targets for the period 2012-2014 differ slightly as they are set over the full year and not just the summer period to be consistent with the SES performance scheme.

5.2.3 Figure 5-1 shows the actual performance compared to the PC summer en-route ATFM delay target between 1997 and 2011.

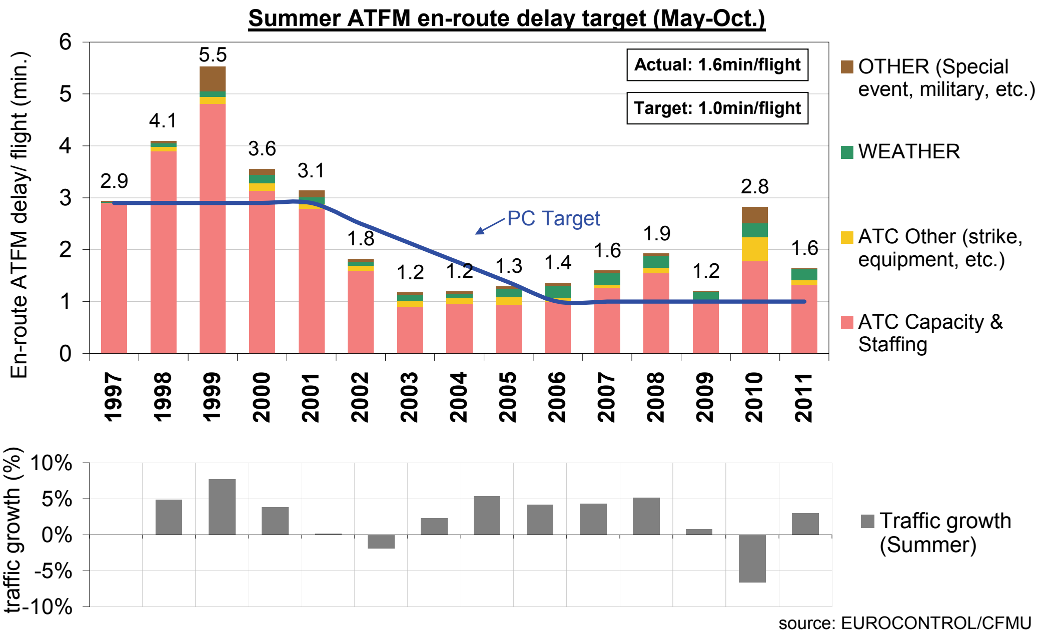


Figure 5-1: Summer ATFM en-route delay target [1997-2011]

5.2.4 After the high delays in 2010, en-route ATFM delays show a significant improvement from 2.8 to 1.6 minutes per flight in summer 2011. This is still more than 50% above the agreed PC en-route summer target of 1 minute per flight.

5.2.5 The capacity at European level is quantified using the "effective capacity[35]". The evolution of effective capacity and air traffic demand in each summer between 1999 and 2011 for the area coordinated by the CFMU is shown in Figure 5-2.

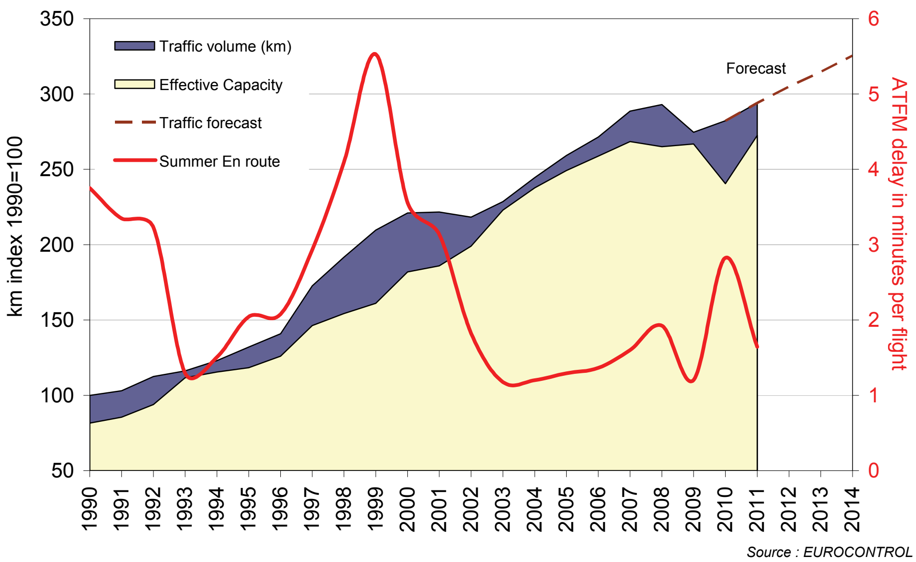


Figure 5-2: Matching effective capacity and air traffic demand [Summer]

5.2.6 After the significant reduction of effective capacity in summer 2010 (-9.8%) mainly related to industrial actions, effective capacity in summer 2011 increased by approximately 13.3% with subsequent positive effects on en-route delay levels. It is important to point out that, at almost equal traffic levels, the capacity provided in summer

35 The effective capacity is defined as the traffic which can be handled, given an average ATFM en-route delay of 1 minute per flight in summer (cf. PRR 5 (2001), Annex 6).

2011 is at the level provided in 2007. This suggests that capacity deployment stagnated and the possibility to close capacity gaps in times of negative or slow traffic growth was not used.

5.2.7 Notwithstanding the uncertainties presently associated with traffic recovery, it is important to keep a forward looking and proactive approach to capacity planning in order to close existing capacity gaps and to accommodate future traffic growth, as capacity enhancement initiatives have a certain lead time to take effect.

EUROPEAN ATFM EN-ROUTE PERFORMANCE

5.2.8 All delay categories show an improvement in 2011: ATC capacity and staffing accounting for the majority of en-route ATFM delays, followed by weather.

5.2.9 Year on year, "ATC Other", comprising delays due to, inter alia, ATC industrial action & ATC equipment, shows the most notable improvement (-81%), with the completed VAFORIT[36] implementation being a significant factor.

5.2.10 The number of flights affected by ATFM en-route regulations decreased from 8.8% in 2010 to 5.7% in 2011; 3.0% of flights were delayed by more than 15 minutes, compared to 5.2% in 2010.

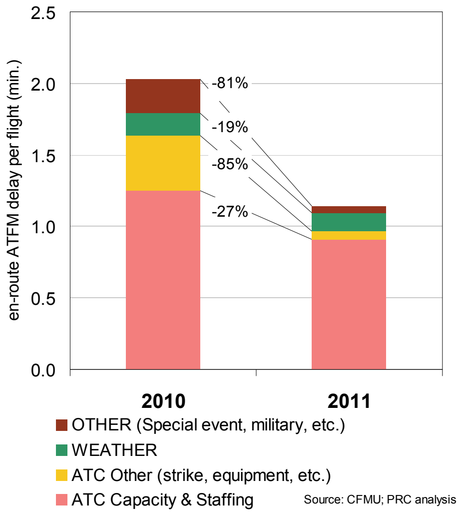


Figure 5-3: En-route delay per flight by cause [2010-11]

5.2.11 Figure 5-4 shows that en-route ATFM delays in 2011 were significantly higher on weekends than on weekdays.

5.2.12 Although the average number of flights is lower on weekends, traffic patterns and distribution across the network is different and the average flight length increases.

5.2.13 The higher average delay on weekends is mainly due to (1) increases in traffic demand in certain ACCs at weekends and (2) staff availability and deployment in those ACCs, which has impact on the ability to provide the necessary capacity.

5.2.14 Delays were particularly higher on weekends at Athinai and Makedonia, Marseille, Madrid and Barcelona ACCs. Each of these ACCs has higher traffic demand at weekends than during weekdays.

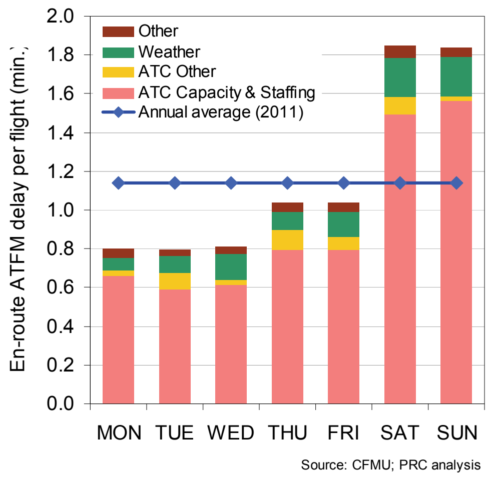


Figure 5-4: En-route ATFM delay – week/ weekends [2011]

36 New air traffic services (ATS) system "P1/VAFORIT" put in place by DFS at Karlsruhe upper area control centre (UAC) in Germany.

5.2.15 Figure 5-5 shows the evolution of en-route ATFM delays in Europe between 2003 and 2011. ATFM delays can be due to capacity constraints where ANS is the root cause (i.e. capacity, staffing, ATC equipment, etc.) but also due to other constraints (i.e. weather problems, military training, etc.) where the situation was handled by ANS. For analysis purposes, the delay reasons were reorganised in larger ATFM delay groups.

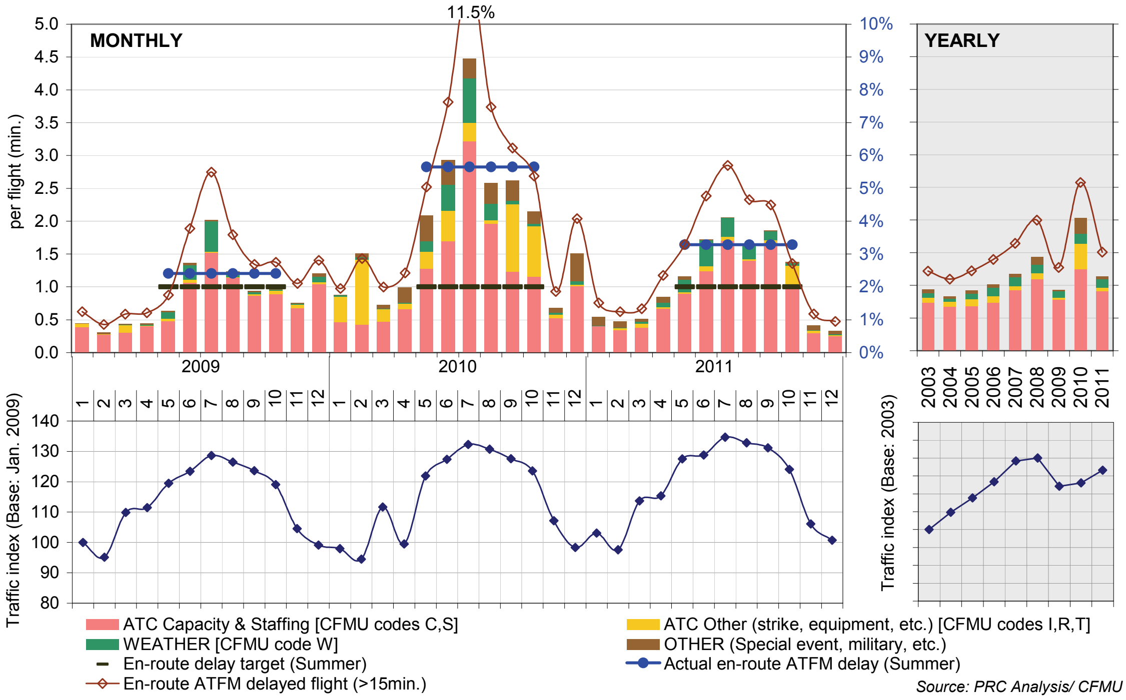


Figure 5-5: Evolution of en-route ATFM delays

5.2.16 As opposed to the indicator shown in Figure 5-2, which only relates to summer performance, the average en-route delay per flight, shown on the right side of Figure 5-5, relates to the full year. This indicator is consistent with the indicator used for capacity target setting in the SES performance scheme (see also Figure 5-6).

CAPACITY TARGET IN THE CONTEXT OF THE SES PERFORMANCE SCHEME

5.2.17 Commission Regulation (EU) No 691/2010 laying down a performance scheme entered into force on 23 August 2010. This marked the start of the implementation of the performance scheme, and in particular preparation for the first reference period (RP1) that runs for three years from 2012 to 2014. Following recommendations from the PRB, EU-wide targets for Cost-Efficiency, Capacity and Environment were adopted by the EC in February 2011 for RP1 (2012-2014). The EU-wide capacity target for RP1 was set at an annual average en-route ATFM delay (all causes) of 0.5 minutes per flight by 2014 (see also Chapter 2).

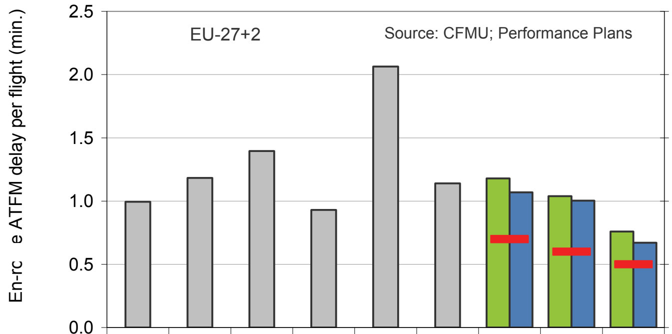
5.2.18 In June 2011, the States subject to SES regulations submitted National/FAB Performance Plans including targets on Capacity and Cost-efficiency. The contribution of these plans to the EU-wide targets was assessed[37] in detail by the PRB during the Summer 2011.

5.2.19 Building on these assessments, the EC made recommendations to a number of States to improve their contribution to the EU-wide capacity target. The relevant States submitted revised Performance Plans in early January 2012.

37 All the documents relating to the assessment of National/FABs Performance Plans are available on the PRB website (http://www.eurocontrol.int/prc/public/standard_page/Performance_Plan.html)

5.2.20 Figure 5-6 shows both the aggregated capacity KPIs between 2006 and 2014 and the EU-wide target for the States subject to SES regulations. There is a positive trend with a narrowing gap between the aggregated capacity plans and the EU-wide target in RP1, showing the efforts made by the parties concerned and also the positive effect of target setting under the SES Performance scheme.

5.2.21 Following the revision of performance plans in December 2011, there was a clear improvement from 0.76 to 0.67 minutes per flight in 2014. Although the revised aggregated targets still fall short of the EU-wide target of 0.5 minutes per flight in 2014 by a not insignificant margin, the planned performance in 2014 will be better than the historical EUROCONTROL delay target of 1 minute per flight which corresponds to 0.7 min./flight over the full year.



	2006	2007	2008	2009	2010	2011	2012	2013	2014
Initial plans							1.18	1.04	0.76
Revised plans							1.07	1.00	0.67
Historic values	1.00	1.18	1.40	0.93	2.06	1.14			
EU-wide target							0.70	0.60	0.50

Figure 5-6: EU-wide capacity target vs. performance plan [EU 27+2]

5.2.22 The latest STATFOR MTF [Ref. 4] presented a significant downward revision of the previous forecast. In view of the lower than expected traffic growth together with the actions of the Network Manager (which are not considered in the aggregation of the individual capacity targets) there is a realistic expectation that capacity performance will be better than projected in the aggregated performance plans in Figure 5-6 (see also Section 5.5 in this Chapter).

LOCAL ATFM EN-ROUTE PERFORMANCE

5.2.23 In order to identify constraining ACCs, the following section evaluates performance at ACC level in line with the capacity objective set out in the ATM 2000+ Strategy "*to provide sufficient capacity to accommodate demand in typical busy hour periods without imposing significant operational, economic or environmental penalties under normal conditions.*"

Applicability of
European wide targets at local level

The European target is set, and the performance is measured, on a per flight basis using the total number of IFR flights within European airspace. The ATFM delay is aggregated from individual ACCs to give the total ATFM delay for European airspace.

However, the number of IFR flights is not cumulative as on average each IFR flight will cross three separate ACCs.

Σ Total European flights $\neq \Sigma$ flights at ACC A + Σ flights at ACC B + Σ flights at ACC C etc…

This means that the EU-wide capacity target cannot be directly applied at a local level.

5.2.24 While capacity constraints can occur from time to time, ACCs should not generate high delays on a regular basis. Figure 5-7 shows the delay performance in terms of the number of days with significant en-route ATFM delays (>1 minute per flight). The selection threshold was set at greater than 30 days.

Most constraining ACCs in 2011	En-route ATFM delay									Traffic demand		
	Days en-route ATFM >1 min.	En-route delay /flight (min.)	% of flights delayed >15 min.	En-route delay ('000)	ATC Capacity & Staffing	ATC Other	Weather	Other (special event, military)	% of total en-route delay	Traffic growth vs 2010 (%)	3 Year Annual average growth rate (08-11)	% of total flight hours 2011
Madrid	168	1.23	3.4%	1 225	97.1%	0.3%	2.1%	0.5%	**10.9%**	3.0%	-1.7%	**3.2%**
Nicosia	160	1.62	4.5%	454	99.2%	0.5%	0.2%	0.0%	**4.0%**	-0.9%	1.2%	**0.9%**
Barcelona	134	1.31	3.7%	1 025	86.2%	0.8%	12.8%	0.1%	**9.1%**	4.0%	-1.8%	**2.5%**
Langen	124	0.96	2.8%	1 201	79.2%	3.6%	16.6%	0.6%	**10.7%**	1.5%	-1.5%	**2.1%**
Athinai+Makedonia	94	3.04	5.8%	1 935	87.9%	11.7%	0.4%	0.0%	**17.2%**	0.0%	0.7%	**3.2%**
Canarias	86	1.09	2.7%	323	74.5%	0.0%	21.7%	3.9%	**2.9%**	8.1%	-1.1%	**1.3%**
Warszawa	75	0.69	1.9%	422	92.3%	1.9%	4.2%	1.5%	**3.8%**	10.2%	2.5%	**2.3%**
Tampere	59	0.65	1.9%	126	98.5%	1.1%	0.4%	0.0%	**1.1%**	16.2%	3.9%	**0.6%**
Marseille	53	0.48	1.4%	490	87.0%	3.0%	9.6%	0.4%	**4.4%**	2.7%	-0.8%	**2.9%**
Tirana	52	0.49	1.4%	96	91.7%	4.9%	3.4%	0.0%	**0.9%**	8.8%	10.0%	**0.3%**
Zagreb	49	0.55	1.5%	257	76.0%	0.4%	23.3%	0.3%	**2.3%**	9.4%	7.3%	**1.3%**
Rhein	47	0.47	1.3%	659	52.7%	4.1%	19.2%	24.1%	**5.9%**	3.5%	-1.3%	**3.3%**
Sevilla	35	0.28	0.8%	103	90.1%	1.9%	5.1%	2.9%	**0.9%**	2.4%	-2.2%	**1.2%**
Munchen	35	0.33	0.9%	487	31.1%	0.3%	53.6%	15.0%	**4.3%**	2.6%	0.4%	**3.1%**

Figure 5-7: Most en-route ATFM constraining ACCs [2011]

5.2.25 The majority of en-route ATFM delays are concentrated in only a small number of ACCs which negatively affects the entire European network. 78.3% of the ATFM en-route delay was generated by 14 ACCs (of a total of 66 ACCs) which controlled 28.3% of total flight hours in Europe. The 5 most constraining ACCs (Madrid, Nicosia, Barcelona, Langen, Athinai + Makedonia) account for more than half (52%) of total en-route ATFM delay in 2011.

5.2.26 Figure 5-8 shows the geographical distribution of the most constraining ACCs in 2010 and 2011. The ATFM en-route delay situation in France improved substantially in 2011. With the exception of Vienna, Padova, and Brindisi ACCs, the delay situation in the South-East axis and Spain remained problematic in 2011.

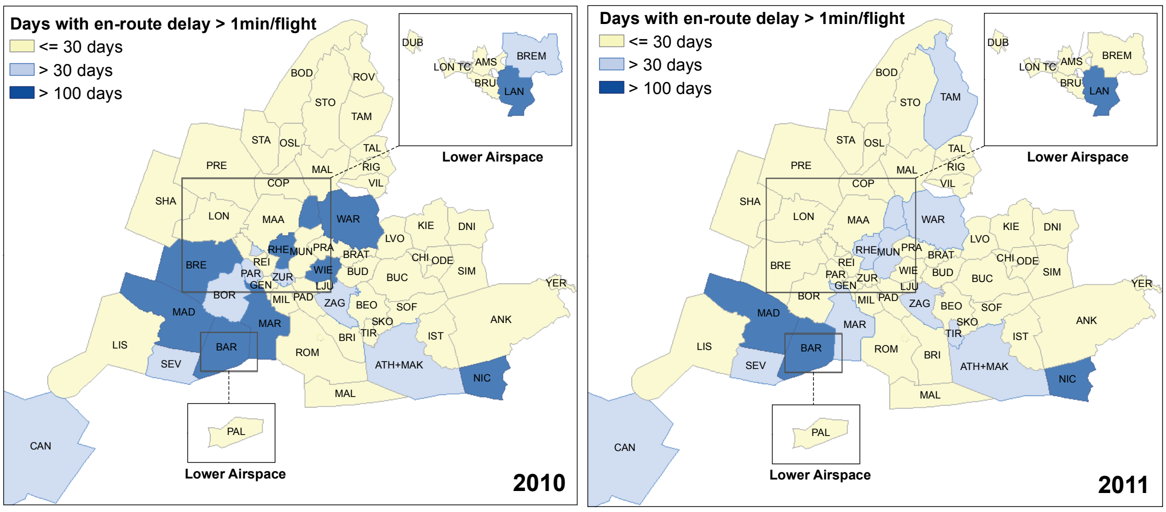


Figure 5-8: Geographical distribution of most delay-generating ACCs

5.2.27 The underlying en-route ATFM delay drivers, as reported by the flow management positions (FMP), are shown in Figure 5-9. In order to provide an indication of the traffic level, the number of controlled IFR flights is plotted as a blue line.

Figure 5-9: ATFM en-route delay drivers (most constraining ACCs) [2008-11]

5.2.28 Figure 5-10 shows the en-route ATFM delays in the top 25 most delay generating en-route sectors by type, and grouped by their respective FMPs, in summer. By far the majority of the en-route ATFM delay originates from collapsed sectors which points to shortcomings in the availability and deployment of staff.

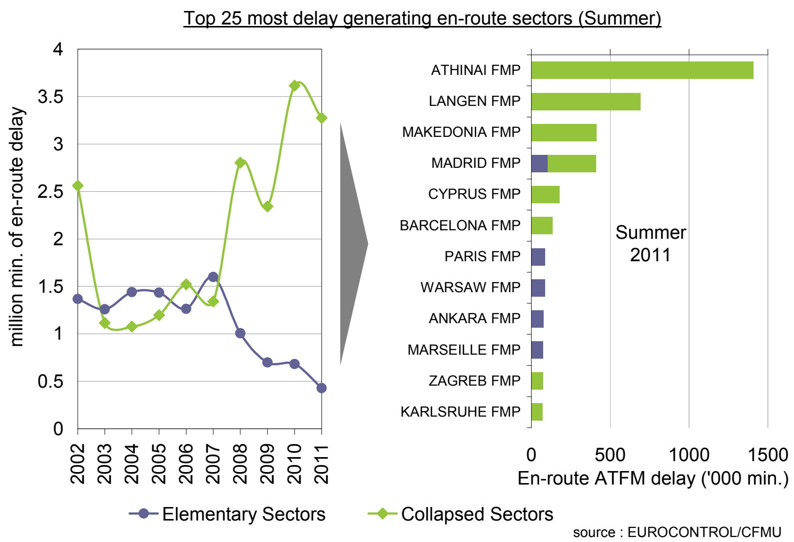


Figure 5-10: ATFM delays due to collapsed/elementary sectors

Elementary/ collapsed sectors:

The airspace is divided into elementary sectors which can be merged into larger (collapsed) sectors. Subject to workload and staff availability, the sector configurations are adjusted to traffic demand.

En-route capacity shortfalls may result from structural limitations (i.e. inability to further split sectors to accommodate the demand) or staffing limitations (i.e. inability deploy maximum configurations due to staff availability).

5.2.29 Figure 5-11 compares actual traffic demand and ATFM delays to the forecast levels in the Medium Term Capacity Plan[38] for the most constraining ACCs in 2011.

38 Forecast source: STATFOR medium-term forecast.

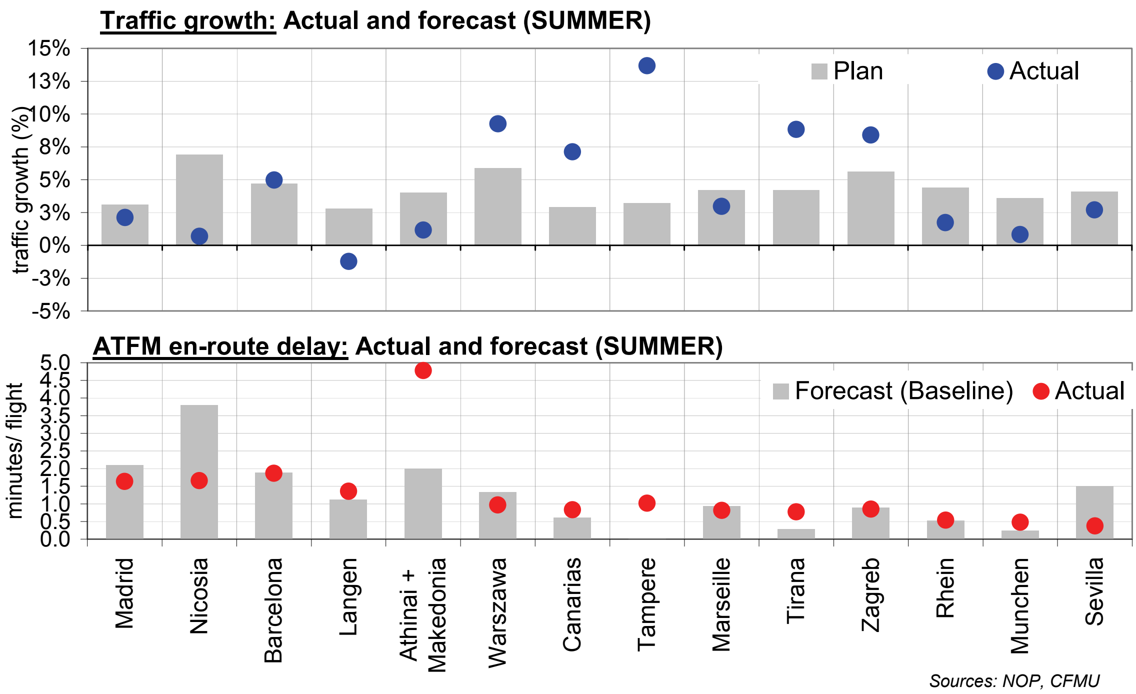


Figure 5-11: Actual versus forecast performance [summer]

5.2.30 The situation in the various constraining ACCs differs notably and a number of interesting points can be noted from the analyses in the previous figures:

- The Spanish ACCs (Madrid, Barcelona, Canarias, Sevilla) together account for 23.8% of all en-route ATFM delay. Delay performance was equal or better than predicted but for a lower than expected traffic growth.
- The situation in Greece remains problematic: delays were much higher than expected even though actual traffic growth was lower than anticipated. Overall Greece account for 17.2% of all en-route ATFM delays in Europe.
- Three of the German ACCs (Karlsruhe, Langen, and Munich) accounted for 20.9% of total en-route delays in Europe. Performance in Karlsruhe improved after the VAFORIT implementation in February 2011 and capacity increased gradually to pre-VAVORIT levels by June 2011. Persistent staffing issues at Langen ACC and adverse weather in the Munich FIR were the main reasons for the delay in the other ACCs.
- Due to the implementation of capacity enhancement measures, and a lower traffic growth than expected, en route ATFM delays in Nicosia ACC in Summer were lower than predicted, at 1.66 minutes per flight instead of the expected 3.8 minutes.
- The higher than expected delays in Tampere ACC were the result of social issues combined with high traffic growth. Since then, the social issues appear to have been resolved and delay has returned to very low levels.
- The performance at Tirana ACC was due to a combination of factors (preparations for opening of new operations room, higher than anticipated traffic growth and good performance by adjacent ACCs). The situation is expected to improve again in 2012.
- Warszawa and Zagreb ACCs continued to reduce en-route ATFM delays, despite a stronger than expected traffic growth in 2011 which is a significant improvement.

5.2.31 With the majority of en-route ATFM delays concentrated in a limited number of ACCs, it is important to point out that the vast majority of ATC units maintained a good level of performance in 2011. In addition to Zagreb and Warszawa, some ACCs showed considerable improvements in 2011 and are no longer among the constraining ACCs:

- Initiatives to improve sector configurations and opening schemes as well as additional staff resulted in a significant performance improvement at Vienna ACC in 2011. Performance in summer 2011 (0.34) was much better than forecast (1.69), albeit with a lower than anticipated traffic growth.
- With the exception of Marseille ACC, all French ACCs continued the good performance observed before 2010.
- Zurich ACC was able to continue the positive trend observed over the past years and is no longer among the most constraining ACCs in Europe in 2011.

5.3 En-route Flight Efficiency

5.3.1 En-route flight efficiency has a horizontal (distance) and a vertical (altitude) component. The focus of this section is on horizontal en-route flight efficiency, which in general is of higher economic and environmental importance than the vertical component across Europe as a whole [Ref. 35].

5.3.2 Deviations from the optimum trajectory generate additional flight time and fuel burn with a corresponding impact on airspace users' costs and the environment (see Chapter 3).

5.3.3 The horizontal en-route flight efficiency indicator takes a single flight perspective. It relates observed performance to the great circle distance (GCD), which is a theoretical (and unachievable) situation where each aircraft would be alone in the system and not be subject to any constraints. In high density areas, flow-separation is essential for safety and capacity reasons with a consequent impact on flight efficiency.

Horizontal flight efficiency

The KPI for horizontal en-route flight efficiency is "En-route extension". En-route extension is defined as the difference between the length of the actual trajectory (A) and the Great Circle Distance (G) between the departure and arrival terminal areas (radius of 40NM around airports).

Where a flight departs or arrives outside Europe, only that part inside European airspace is considered. En-route extension can be further broken down into:

- direct route extension which is the difference between the actual flown route (A) and the direct course (D); and,
- the TMA interface which is the difference between the direct course (D) and the great circle distance (G).

In order to harmonise indicators used within the SES performance scheme and the PRR, the radius around the airports of 30NM used in previous PRRs was changed to 40NM in this year's report.

5.3.4 While the GCD used for the calculation of the indicator is the shortest route in terms of distance between two terminal entry points (radius of 40NM [39] around airports), it is acknowledged that it may not be the shortest route in terms of time when meteorological conditions are considered or may not fully correspond to the economic preferences of airspace users [40].

39 In order to harmonise performance indicators with the SES performance scheme, the radius around the airports was changed from 30NM to 40NM in this report.

40 Economic preferences may be influenced by factors such as wind, route charges and congested airspace.

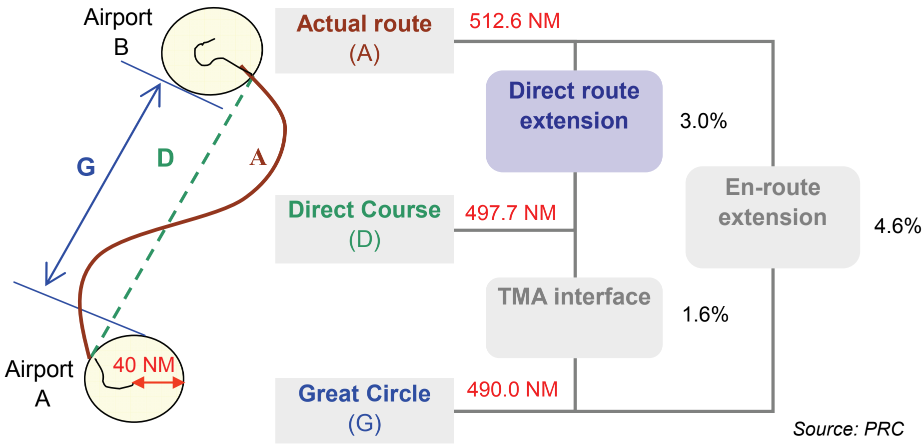


Figure 5-12: Horizontal en-route flight efficiency [2011]

5.3.5 Figure 5-12 shows that the average horizontal en-route extension in 2011 was 4.6% (22.6 NM), of which 3.0% (14.9 NM) was related to inefficiencies in the en-route phase (direct route extension) and 1.6% (7.7 NM) to the interfaces with the TMAs.

5.3.6 The "direct route extension" is concerned with the actual en-route flight path and accounts for the main share of total en-route extension (3.0% in 2011). The "TMA interface" is more related to the location of the TMA entry points and accounts for 1.6% of total en-route extension in 2011.

5.3.7 Improvement of the "TMA interface" is a complex area and more research is required to gain a better understanding of potential future benefits. The remainder of this chapter therefore focuses on "direct en-route extension" to provide a better understanding of the various areas where ANS can help reduce inefficiencies in the actual horizontal en-route flight path.

5.3.8 Figure 5-13 shows the actual routing (A)[41] compared to the direct course (D) and the evolution of the routes filed in the flight plan (F) compared to the direct course (D) between 2008 and 2011 using the new methodology (radius of 40NM). For reference, the indicator used in previous PRRs (30 NM radius) is also displayed.

5.3.9 Due to the increased focus on improving flight efficiency over the past years, direct en-route extension continuously improved between 2008 and 2010, only interrupted in 2010 as a result of airspace users' having to circumnavigate airspace affected by industrial action or the volcanic ash cloud.

5.3.10 The estimated annual savings of a 0.1% reduction of flight inefficiency corresponds to approximately 30 000 t of saved fuel and 92 000t of CO_2 in 2011.

5.3.11 More direct routings given by ATC in the tactical phase contribute towards reducing the level of inefficiency of the actual trajectory compared to the filed route.

5.3.12 The comparison between the route filed in the flight plan (F) and the direct course (D) is mainly concerned with en-route airspace design but also with route availability (CDR & RAD restrictions) and route utilisation (flight planning).

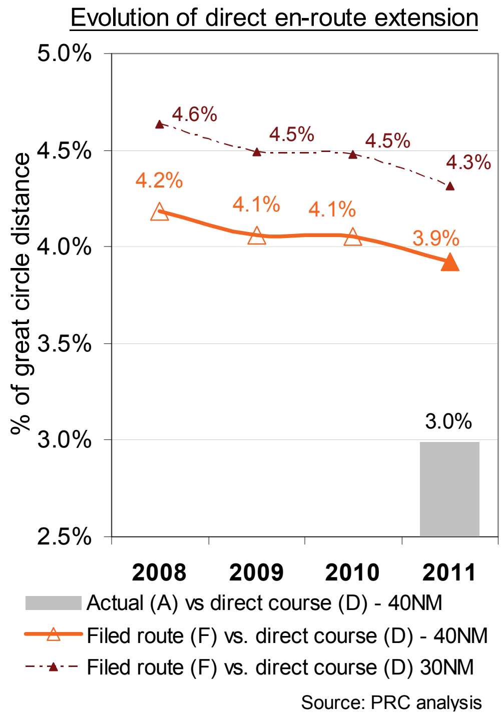


Figure 5-13: Direct route extension between 2008 and 2011

RAD & CDRs

The Route Availability Document (RAD) collects restrictions that govern and limit the use of the route network. RAD restrictions contribute to the safety and capacity by ensuring that the ATCO's workload is not impacted by traffic flying unusual routes.

Conditional Routes (CDRs) are non-permanent routes of the route network usually established through shared airspace (civil/military) or to address specific ATC conditions (sectorisation, etc.). They can be planned and used under specific conditions.

5.3.13 The flexible use of civil/military airspace structures also plays an important role in this context and is therefore considered in more detail in section 5.4 of this chapter.

5.3.14 Figure 5-13 shows a continuous reduction of the inefficiencies embedded in the filed routes (F) between 2008 and 2011 which is also of particular relevance for RP1 of the SES performance scheme. As outlined in Chapter 2, the EU-wide target for Environment during RP1 is to improve en-route extension based on the last filed flight plan by 0.75 percentage points between 2009 and 2014.

5.3.15 The EU-wide target for Environment has been set so as to provide environmental benefits by decoupling ANS-related emissions from traffic growth.

41 Different from previous PRRs in which (A) was based on the CFMU flight profile; the calculation in this PRR is based on Correlated Position Reports (CPR) which are available since 2011.

5.3.16 Figure 5-14, shows that achieving the EU-wide Environment target will result in a carbon-neutral growth of aviation insofar as ANS is concerned, which will be a remarkable achievement.

5.3.17 As a facilitator, bringing stakeholders (FABs, ANSPs, airports, aircraft operators, and military organisations) together, the European Network Manager has a substantial influence on airspace design and utilisation and therefore an important role to play in the improvement of performance and the achievement of targets at network level.

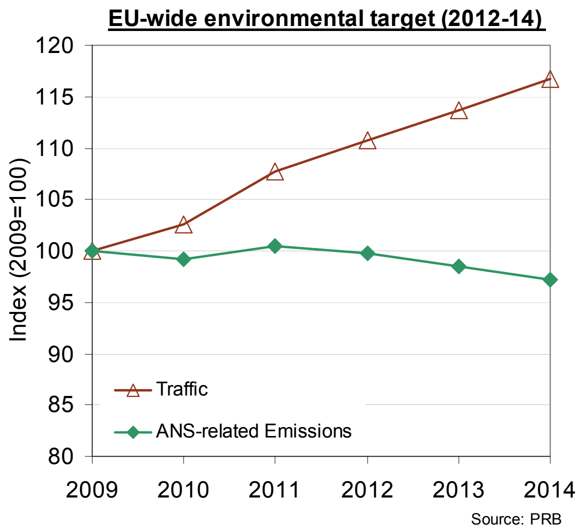


Figure 5-14: EU-wide environmental target versus emission index

5.3.18 In view of this significant environmental and economic impact of the EU-wide environmental target and in the absence of mandatory national/FAB targets, accountability for meeting the EU-wide environmental target rests with the Network Manager in RP1. European Network management performance is addressed in more detail in Section 5.5 of this Chapter.

5.3.19 The airspace design projects implemented over the past years have resulted in a continuous improvement of en-route flight efficiency. In preparation for summer 2011, a further 191 airspace improvement packages aiming at enhancing capacity and flight efficiency were implemented. Further improvements will require the joint efforts of all stakeholders and should concentrate on:

- ensuring that the projects included in ARN V7 and updates are delivered on time;
- enhanced utilisation of civil military structures; and,
- improvements in airspace user flight planning.

5.3.20 Much focus has been put on improving en-route airspace design over the past years. The implementation of “Free route airspace (FRA) initiatives” aimed at enhancing en-route flight efficiency started as early as 2009 and clear benefits can be seen in those areas where it has been implemented.

5.3.21 Figure 5-15 illustrates the implementation status of FRA initiatives that are currently included in the ARN Version-8[42]. FRA is implemented in Portugal, Ireland, Denmark & Sweden, and in the Upper Area Control Centres in Maastricht (MUAC) and Karlsruhe. In 2009, Portugal and Ireland implemented FRA and it is permanently applicable above flight level 245 where there is no longer a fixed route network.

Free Route Airspace (FRA) Concept

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

FRA refers to a specific portion of airspace within which airspace users may freely plan their routes between an entry point and an exit point without reference to the fixed Air Traffic Services (ATS) route network. Within this airspace, flights remain at all times subject to air traffic control and to any overriding airspace restrictions.

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

5.3.22 FRA implementation above FL 285 started in Sweden in January 2010 and was implemented in the entire DK/SE FAB in November 2011. Although most aircraft were already given the shortest routing whenever possible in the past, the implementation of FRA now allows the planning of direct flights between entry and exit points. It also removes the fuel carriage penalties[43] related to the fixed route network above FL 285. The fuel savings are estimated at 1.3% per flight on average [Ref. 36].

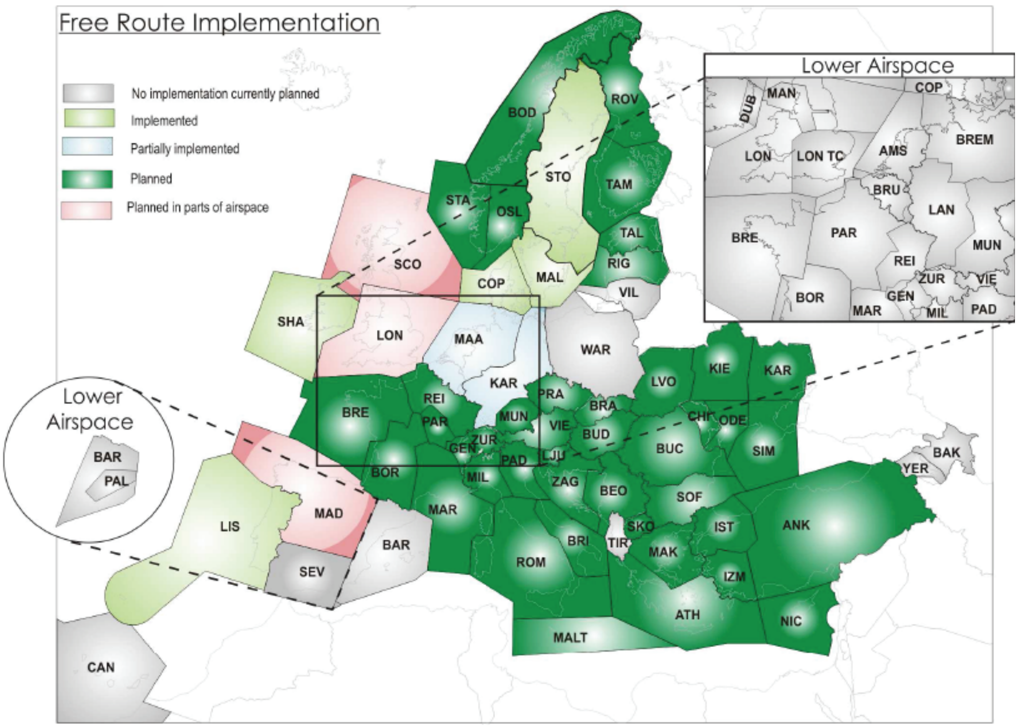


Figure 5-15: Implementation of Free route airspace initiatives [ARN V8]

5.3.23 FRA implementation is also progressing within FABEC. Maastricht and Karlsruhe have opted for geographical (by sectors and flow) and time-based (weekends, night, etc.) implementation of FRA phased over 2011 and 2012. FABEC expects that the yearly benefits in MUAC airspace alone amount to 0.63M NM of saved flight distance, 1 300 hours of saved flight time, 3 900t of fuel and 12 300 t of CO_2 [Ref. 37].

42 The Version-8 of the European ATS Route Network Plan (ARN Version-8) develops, identifies and evaluates the airspace projects aimed to be implemented over the period 2012-2014.

43 Airspace users were obliged to plan their routing according to the published fixed air routes and to consequently carry extra fuel with an impact on weight and fuel consumption.

5.3.24 Figure 5-16 illustrates the relative savings that could be achieved at national level, Functional Airspace Block (FAB) level, and European level. Route extension could be reduced by 61.6% if flights could fly a direct route within each States, and additional 10.4% savings could be achieved by improving the interface between States within a FAB. A significant part (27.9%) can only be addressed at European level.

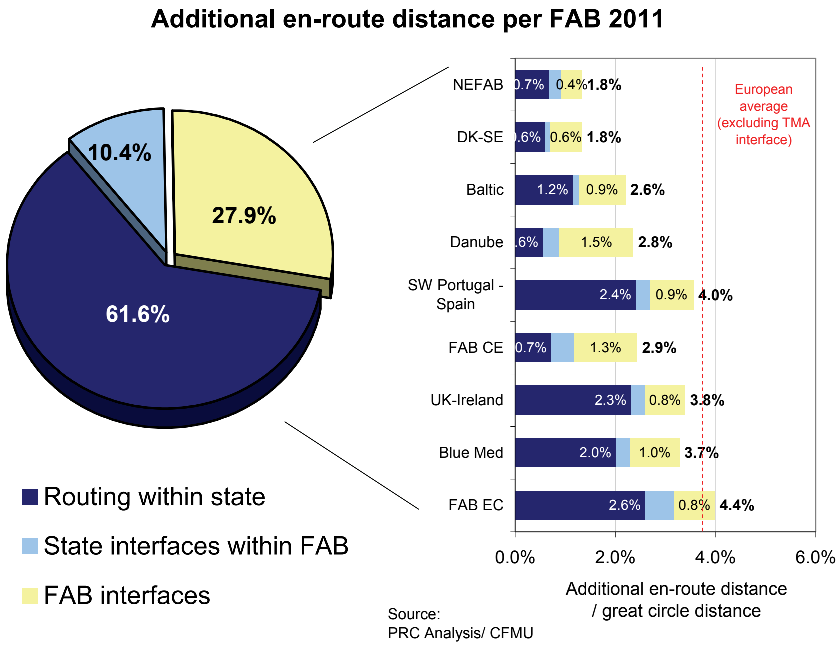


Figure 5-16: Additional en-route distance per FAB

5.3.25 The improvement of European flight efficiency and the optimisation of the European route network is, by definition, a Pan-European issue which requires a holistic approach carefully coordinated by the Network Manager (see also Section 5.5 of this Chapter). Uncoordinated, local initiatives may not deliver the desired objective, especially if the airspace is comparatively small and a large proportion of the observed inefficiency is due to the interface with adjacent States or FABs.

5.4 Flexible Use of Airspace

5.4.1 To meet the increasing needs of both sets of stakeholders, in terms of volume and time, close civil/military co-operation and co-ordination across all ATM-related activities is key.

5.4.2 Since 1996, EUROCONTROL States have been applying the FUA concept to meet the requirements of both civil and military airspace users, and this was formalised as part of SES legislation, applicable to the EU member states, in EU Regulation 2150/2005[Ref. 38].

The Flexible use of Airspace (FUA) Concept

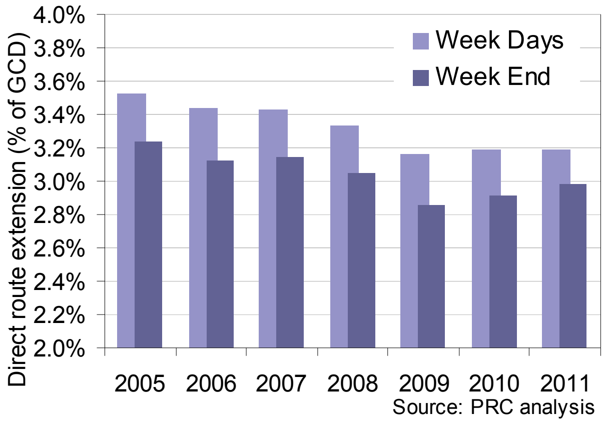
With the application of the Flexible Use of Airspace Concept (FUA), airspace is no longer designated as "civil" or "military" airspace, but considered as one continuum and allocated according to user requirements.

The implementation of the FUA concept is applicable at three separate, but dependent levels: Level 1, at strategic level within the State/ FAB; Level 2, at pre-tactical level within the State/ FAB; and Level 3, at tactical level within the State / FAB.

5.4.3 From a civilian point of view, the benefit of FUA is improved en-route flight efficiency and additional capacity (see previous section). From a military viewpoint, FUA enables military training and operational requirements to be met through achieving effective airspace utilization and preventing wastage of airspace.

5.4.4 As shown in Figure 5-17 [44], there is an improvement, albeit slight, in flight efficiency during weekends, when military activity is minimal, compared to weekdays, when the military are most active.

5.4.5 However, counter-intuitively, in 2011, when the balance between the supply and demand of capacity is analysed, a marked deterioration is noticed between weekend and weekdays in 2011 (see also paragraph 5.2.12 ff.).



Note: The results relate to a radius of 40NM which is different from previous years (30NM).

Figure 5-17: Direct route extension week/weekend

5.4.6 Initial analysis shows that despite minimal military activity, other factors were at play including varying traffic density and complexity; shortcomings in the availability and deployment of ATC personnel and the under-utilisation of the CDR network [Ref. 39].

5.4.7 It is evident that further work is required to assess the benefits that are realised by the application of the FUA concept throughout Europe, and the potential scope for further benefits.

MONITORING PERFORMANCE RELATING TO THE FLEXIBLE USE OF AIRSPACE

5.4.8 The Performance Scheme, established as part of the SES legislation, includes a KPI on the effective use of civil military airspace structures to be monitored during the first Reference Period (2012-2014).

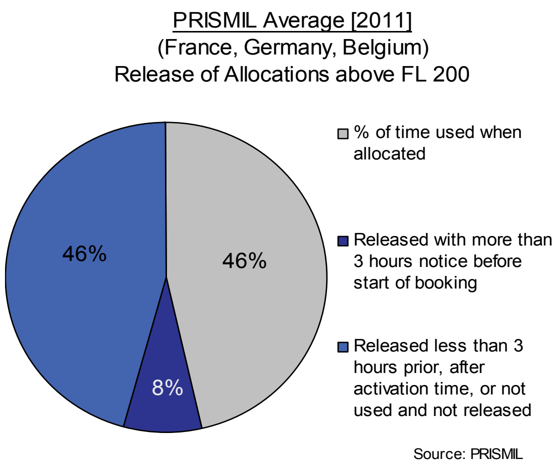


Figure 5-18: Efficiency of booking procedures [2011]

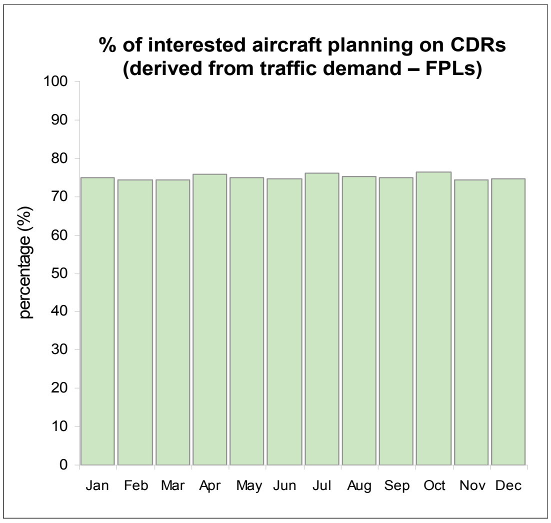


Figure 5-19: Planned use of CDRs [2011]

5.4.9 This KPI is principally concerned with use of FUA by the aircraft operators, as it monitors how effectively planned airspace allocations were actually used (Figure 5-18), and how effectively plannable CDRs were used by aircraft operators (see Figure 5-19).

44 Due to a change in methodology from 30NM to 40NM and the use of more accurate CPR data for the calculation, the values are not directly comparable to previous PRR reports.

5.4.10 The efficiency of booking procedures shall be monitored closely to see if improvement can be made to minimise over-bookings, and to see if improvement can be made in the notification of airspace release to allow aircraft operators to take advantage of dynamic updates of airspace when filing flight plans.

5.4.11 The use of plannable CDRs shall be monitored closely to ensure that aircraft operators are making use of the efforts of military and civil stakeholders in making more route options available.

5.4.12 The optimum benefit to all airspace users, both civil and military, is considered to be achieved by dynamically updating the network picture according to the operational situation.

5.4.13 The PRC welcomes the continuous improvements in airspace management such as the Rolling AUP/UUP process, and the development of tools which allow collaborative decision-making with real-time information. The PRC further welcomes planned developments in airspace management such as the online availability of SUA data for the Network, at the same time ensuring that CDR availability is online known.

5.4.14 The PRC shall take advantage of any further data that is provided by States to assist in the analysis and monitoring of FUA.

5.4.15 The PRC also intends to conduct further monitoring and analysis on the performance of States/FAB in meeting the requirements of both civil and military airspace users by implementing the flexible use of airspace.

5.4.16 This is also supported within the EC Regulation 691/2010 where, for RP2, it sets the national/FAB environment KPI as being the development of a national/FAB improvement process on route design before the end of the reference period including the effective use of civil/military airspace structures.

5.4.17 This is understood as requiring the States/FAB to monitor performance in improving route design within the state / FAB, to meet the needs of airspace users (safety, capacity & flight efficiency), by using the tools associated with FUA such as TSA/TRA, CDRs etc.

5.5 European ATM Network Manager Performance

5.5.1 Network management takes a central position in the European ATM system, requiring a continuous evaluation of user requirements in order to facilitate, in a collaborative partnership with stakeholders, the timely deployment of sufficient capacity and the best utilisation of airspace at an acceptable cost and without impairing safety.

5.5.2 The Network Manager is also a key element of the SES II package and EUROCONTROL was nominated by the European Commission to take on the role of European 'Network Manager' as defined in the Single European Sky II (SES) legislation.

5.5.3 EUROCONTROL already performs a number of the tasks laid out in Commission Regulation (EU) No 677/2011 laying down detailed rules for the implementation of ATM network functions [Ref. 3], which comprise, inter alia, Air Traffic Flow Management (ATFM), ATC capacity enhancement, route development and

Network management in SES

The legal basis for the Network functions is provided in Article 6 of the revised airspace regulation [Ref. 40].

Designated by the EC (Art. 6.2), an impartial and competent body responsible for the optimum use of airspace including the design of the European route network and coordination of scarce resources within aviation frequency bands used by general air traffic.

Designated by the States (Art. 6.6), an impartial and competent body responsible for Air Traffic Flow Management (ATFM).

The European Commission may add to the list of Network functions after consultation of the support to the deployment of technological improvements across the European ATM network.

5.5.4 Another important aspect is the better integration of airports in the European ATM network.

stakeholders.
In this context, two Regulations are of particular relevance:
(i) Regulation 677/2011 laying down the detailed rules for the implementation of the Network functions [Ref. 3]; and,
(ii) Regulation 255/2010 laying down the common rules on air traffic flow management [Ref. 41].

5.5.5 The Network Manager is required to develop a Performance Plan, which must be adopted as part of the Network Strategy Plan before the beginning of each reference period. The Network Manager's Performance Plan is expected to be available by spring 2012 and shall contain, inter alia, various actions to achieve the EU-wide environmental performance target. The plan will then be assessed by the PRB in accordance with the performance scheme regulation.

5.5.6 The network functions are provided in support of all EUROCONTROL States. In its unique position as a facilitator bringing the various stakeholders together and in view of its influence on airspace design and use, the Network Manager will play a vital role in the achievement of EU-wide performance targets with a particular accountability for meeting the environmental target.

5.5.7 The preparation for the role of the SES 'Network Manager' and the need to adapt processes to the SES performance scheme not only helped to produce a more accurate Network Operations Plan but also facilitated the identification of possible problem areas and the development of actions to mitigate disruptions to the European network (i.e. procedures to handle industrial action, severe weather as well as measures to mitigate the impact of the severe capacity shortfall in Greece on the network).

5.5.8 The Network Manager's performance would need to be assessed on its ability to ensure performance across the network by developing and implementing common procedures for designing, planning and managing the European ATM network in a collaborative partnership with stakeholder.

ATFM PERFORMANCE ASSESSMENT

5.5.9 Figure 5-20 shows the evolution of three high-level indicators used evaluating the efficiency of ATFM measures put in place to protect en-route sectors or airport from receiving more traffic than ATC can safely handle.

5.5.10 "ATFM slot adherence" measures the share of take-offs outside the ATFM slot tolerance window (-5min +10 min) and improved continuously between 2003 and 2011 in Europe.

ATFM performance assessment

Regulation (EC) No 255/2010 [Ref. 41] of 25 March 2010 laying down common rules on air traffic flow management aims at optimising the available capacity of the European air traffic management network (EATMN) and enhance air traffic flow management (ATFM) processes by establishing requirements for ATFM.

It requires, inter alia, the central unit for ATFM to produce annual reports indicating the quality of the ATFM in the airspace of the Regulation including causes of ATFM measures, impact of measures and adherence to ATFM measures.

5.5.11 ATC at the respective departure airport has a joint responsibility with aircraft operators to make sure that the aircraft depart within the allocated ATFM window in order to avoid over-deliveries which occur when more aircraft than planned enter a protected sector (see also ATFM slot adherence at airports in Chapter 6).

5.5.12 The share of regulated hours with over deliveries in Europe is around 10% and should be reduced as much as possible to increase system confidence which can in turn free latent capacity kept as a reserve to protect controllers from excessive workload.

5.5.13 There is also scope to improve those cases where ATFM regulations were avoidable as there was no excess of demand. This is largely linked to predictability and accuracy of the information when the decision to call for an ATFM regulation is taken (i.e. several hours before the anticipated capacity shortfall).

5.5.14 Enhanced traffic projections through A-CDM implementation at more airports (see also Chapter 6) but also improvements in aviation metrological capabilities could help improving performance in this area.

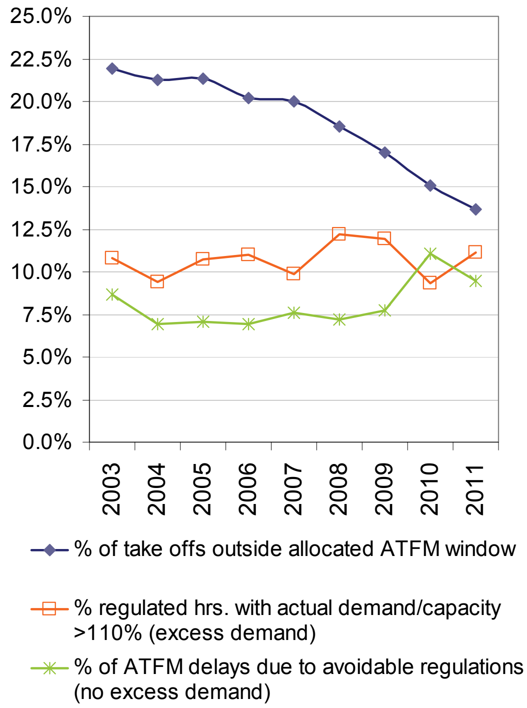


Figure 5-20: ATFM performance (network indicators)

5.6 Conclusions

5.6.1 Notwithstanding a significant improvement in 2011, en-route ATFM delays are still more than 50% higher (1.6 minutes per flight) than the 1 minute summer en-route target set by the Provisional Council.

5.6.2 At almost equal traffic levels, the capacity provided in 2011 is still at the level provided in 2007. This suggests that capacity deployment stagnated and the possibility to close capacity gaps in times of negative or slow traffic growth remained unused.

5.6.3 Notwithstanding the uncertainties presently associated with traffic recovery, it is important to keep a forward looking and proactive approach to capacity planning in order to close existing capacity gaps and to accommodate future traffic growth.

5.6.4 The majority of en-route ATFM delays are concentrated in only a small number of ACCs which negatively affects the entire European network The 5 most congested ACCs (Madrid, Nicosia, Barcelona, Langen, Athinai + Makedonia) account for more than half (52%) of total en-route ATFM delay in 2011.

5.6.5 En-route ATFM delays due to social tensions and adverse weather decreased notably in 2011. Staffing was the main cause of en-route ATFM delay at most of the critical locations, particularly at weekends when optimum sector configurations could not be deployed. Structural limitations (i.e. airspace configurations etc.) were only observed in a few locations, particularly where traffic growth remained high over the past years (i.e. Warsaw).

5.6.6 The vast majority of ACCs continued to provide a good performance, and significant improvements were observed in 2011 at some of the most constraining ACCs from 2010 (i.e. French ACCs, Vienna, Warszawa, Zagreb, and Zurich).

5.6.7 Continuing the trend observed over the past years, horizontal en-route flight efficiency improved in 2011.

5.6.8 Of particular relevance is the need to ensure that access to shared airspace is not denied for any user unless the airspace is actually being used for the activity that requires such restriction, either by military or civil airspace users.

5.6.9 As a facilitator bringing stakeholders (FABs, ANSPs, airports, aircraft operators, and military organisations) together, the European Network Manager has a substantial influence on airspace design and utilisation and therefore has an important role to play in the improvement of performance and the achievement of targets (Capacity, Environment) at network level.

Chapter 6: Operational ANS Performance at Airports

KEY POINTS	KEY DATA 2011		
	Top 30 European airports in terms of traffic	2011	% change vs. 2010
1. Notwithstanding a substantial traffic growth of 4% at the top 30 airports, average airport ATFM arrival delays (-25%), delays due to local ATC constraints (-7%) and additional taxi out time (-11%) improved in 2011. Better weather conditions than in 2010 helped improving overall performance at airports in 2011.	Average daily movements	21 863	+4%
2. Average additional ASMA time at the top 30 airports increased by +5% from 2.7 to 2.9 minutes per arrival in 2011.	Avg. airport ATFM delay per arrival (min.)	1.3	-25%
3. Although airport ATFM arrival delays decreased at the top 30 airports in 2011, the high level of airport ATFM arrival delays at some regional (Cannes, Istanbul Sabiha Gokçen) and seasonal (Kos, Antalya, Rhodes, Nikos, Chania, Zakinthos) airports had a significant impact on airspace users and the European network.	Avg. ASMA additional time per arrival (min.)	2.9	+5%
	Avg. ATC related gate delay per departure (min.)	0.7	-7%
4. The new data flow set up in 2011 is getting to maturity and is expected to enhance performance analysis in the future.	Avg. additional taxi-out time per departure (min.)	4.5	-11%

6.1 Introduction

6.1.1 The chapter reviews ANS-related performance at the top 30 European airports in terms of traffic in 2011 (hereinafter 'top 30'). Together the top 30 airports accounted for 46% of total airport IFR movements and 62% of total ANS-related[45] inefficiencies at European airports in 2011.

6.1.2 The methodologies used to calculate the performance indicators in this chapter are based on the "ATMAP performance framework" [Ref. 42], developed in consultation with some of the major ANSPs, airlines and airport operators in Europe[46].

6.1.3 The analysis of these indicators is based on information currently available in EUROCONTROL, via CFMU, CODA, METAR and Slot Coordinators. During 2011, a new data flow was set up by the PRU and CODA with airports in order to implement Annex IV of EC Regulation 691/2010 [Ref. 1]. Cooperation is ongoing with airport operators, aircraft operators, ANSPs and coordinators to enhance information sharing, data completeness and overall quality.

6.1.4 In this chapter, Section 6.2 provides an overview of ANS-related performance at the top 30 airports whilst Section 6.2.40 looks at factors affecting the observed performance. Section 6.4 illustrates some possible strategies or initiatives to improve ANS-related performance at airports. Section 6.5 evaluates the environmental impact of ANS at airports. The conclusions are contained in Section 6.6.

6.1.5 This chapter focuses on measuring how efficiently ANS balance capacity and demand at airports. The PRC evaluates neither airport performance outside ANS responsibility nor requirements to expand airport capacity (e.g. through new infrastructure such as additional runways, taxiways, etc.). Safety (including runway incursion) is addressed in Chapter 4.

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45 "ANS-related inefficiency" in this report means that ANS has a significant influence in improving the operations. However due to trade-offs with other key performance areas, a certain level of "inefficiency" may be necessary or in order to optimise system performance (see also paragraph 6.1.7)..

46 Unless stated otherwise, the indicators were calculated for local operating hours between 06h00 and 21h59.

6.1.6 Airport performance is everyone's business. Airport operations performance is the result of complex interaction between many actors, including airport operators, local ANSP, aircraft operators, and ground handlers. Although it is acknowledged that various factors may affect performance at airports, the ANS-related indicators presented in this chapter aim at measuring performance in areas where ANS has a substantial influence.

6.1.7 The next section provides a more detailed analysis of ANS-related operational performance at European airports. For the interpretation of the results, the following points should be borne in mind:

- .”additional times” are measured as the difference between the actual situation and an ideal (unimpeded) statistical reference time when there is no congestion;
- runway capacity is a valuable resource and a certain level of “queuing time” is unavoidable and even necessary if an airport is to operate close to its capacity limit;
- In many cases, explicit delay (or on-time criteria) are agreed during the airport scheduling process; and,
- The overall results are presented for the full year, without taking weather conditions and/or environmental restrictions into consideration.

6.2 ANS-related operational performance at European airports

6.2.1 Depending on the phase of flight (airborne vs. ground), the efficiency and predictability of operations managed by ANS have a different impact on airspace users in terms of time, fuel burn and hence cost and the environment (see also Section 3.4 in Chapter 3).

6.2.2 Whereas ANS-related delays at the gate result in time penalties and additional costs, delays after start-up also generate additional fuel burn.

6.2.3 Figure 6-1 shows the conceptual framework for the analysis of ANS-related performance at airports used in this chapter. The framework also addresses the three performance indicators (Airport ATFM delays, ASMA additional time, and taxi out additional time) required to be monitored in RP1 (2012-14) of the SES performance scheme.

Figure 6-1: Conceptual framework of ANS-related performance at airports

6.2.4 The inbound perspective illustrates possible trade-offs between the application of ATFM airport regulations (i.e. holdings at the gate at the various origin airports) and airborne terminal holdings (ASMA additional time). The application of speed control in arrival management to absorb additional time already in the en-route phase suggests substantial potential savings in terms of fuel [Ref. 43] but requires more research for future consideration in this chapter.

6.2.5 A complete gate-to-gate perspective would require taxi-in time to be measured. There is a growing interest by stakeholders to monitor the performance of additional taxi-in time. However, additional time in the taxi-in phase can result from various causes, such as the choice for runway exit, taxi-routeing efficiency, stand saturation, and stand allocation management. Consequently, additional work and data is required to evaluate the impact of ANS on taxi-in performance for future consideration in this chapter.

6.2.6 The outbound perspective shows the balance between ANS-related departure holdings at the gate and queuing for the runway with engines running (see also Section 6.4 on Airport Collaborative Decision Making (A-CDM) in this chapter).

6.2.7 It is desirable that the right dynamic balance is achieved, by each airport, in managing departures and arrivals so as to maximise the use of available runway capacity whilst minimising the environmental effects of queuing (additional fuel burn and gaseous emissions).

6.2.8 The relationship between flight cancellations and ANS performance is presently not evaluated in this chapter. Information to be collected in accordance with Regulation (EU) No 691/2010 [Ref. 1] will enable such analysis to be included in future reports.

6.2.9 Figure 6-2 shows the four performance indicators illustrated in Figure 6-1 at aggregated level for the top 30 European airports between 2008 and 2011.

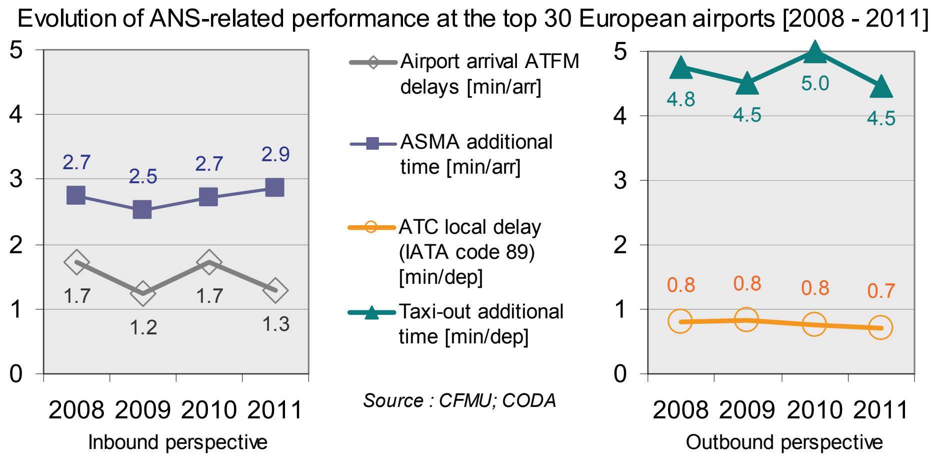

Figure 6-2: Evolution of ANS-related performance at top 30 airports [2008-2011]

6.2.10 In 2011, average airport ATFM arrival delay showed a substantial decrease of -25% to 1.3 minutes per arrival. At the same time, additional time in the Arrival Sequencing and Metering Area (ASMA) increased from 2.7 to 2.9 minutes per arrival, which represents a 5% increase year on year (see left side of Figure 6-2).

6.2.11 Average additional taxi-out time at the top 30 European airports decreased from 5.0 to 4.5 min. per departure (-11%) in 2011. Average delay generated by local ATC (IATA code 89) showed a similar trend and decreased by -7% from 0.8 to 0.7 min. per departure.

6.2.12 The evaluation of the four performance indicators by airport in 2011 in Figure 6-3 shows that performance varies considerably across the top 30 European airports.

6.2.13 The left side of Figure 6-3 shows average airport arrival ATFM delays and ASMA additional times for arrivals and the right side illustrates average delays generated by local ATC (IATA code 89) and additional taxi-out times for departures at the top 30 airports in 2011.

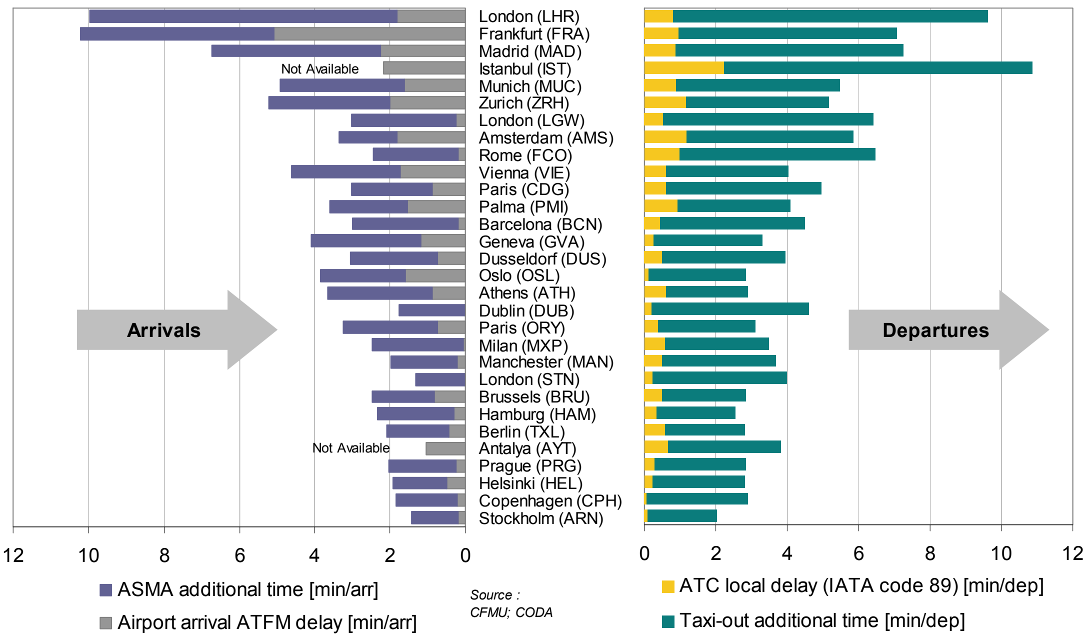

Figure 6-3: ANS-related operational performance at the top 30 airports [2011]

6.2.14 The following sections provide a more detailed analysis by performance indicator. For clarity reasons, only the 10 most penalising airports of the top 30 airports are shown on the figures. Additionally, airports not included in the top 30 airports but with an exceptionally high level of delay are also addressed.

AIRPORT ATFM ARRIVAL DELAYS

6.2.15 Aircraft that are expected to arrive during periods of capacity shortfall at the destination airport are held on the ground at their departure airports by the application of ATFM regulations.

6.2.16 Reducing ATFM delay (by releasing too many aircraft) at the origin airport when the destination airport's capacities are constrained potentially increases airborne delay (i.e. holding or extended final approaches) while the excessive application of ATFM regulations may result in the under utilisation of capacity and thus increase overall delay.

6.2.17 Figure 6-4 shows the 10 most penalising airports of the top 30 airports in terms of airport ATFM arrival delay in 2011. The underlying ATFM delay reasons were grouped into capacity (either airport or ATC), weather, and all other codes [47].

6.2.18 On average, airport ATFM arrival delays at the top 30 airports substantially decreased from 1.7 to 1.3 minutes per arrival (-25%) in 2011.

6.2.19 Among the top 30 airports, Frankfurt (FRA) airport shows the highest level of ATFM arrival delay per flight in 2011. Consistent with previous years, by far the majority of the delay at Frankfurt (FRA) was related to weather. Other airport with a high share of weather-related airport ATFM arrival delays were Zurich (ZRH), Amsterdam (AMS), London (LHR), Vienna (VIE), Munich (MUC), and Oslo (OSL)[48].

6.2.20 Despite a high traffic growth (+12.6%), capacity related airport ATFM arrival delay at

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47 Regulations on traffic volumes EGLL60, EGLL60WX, EGLLTCWX, EHFIRAM, LEBLFIN, LECMARR1 have been reclassified as airport regulations.

48 The increase of ATFM delay at Oslo (OSL) classified at "All other Codes" was due to the implementation of a new airspace and route structure at the airport in April 2011.

Istanbul (IST) airport could be substantially reduced in 2011.

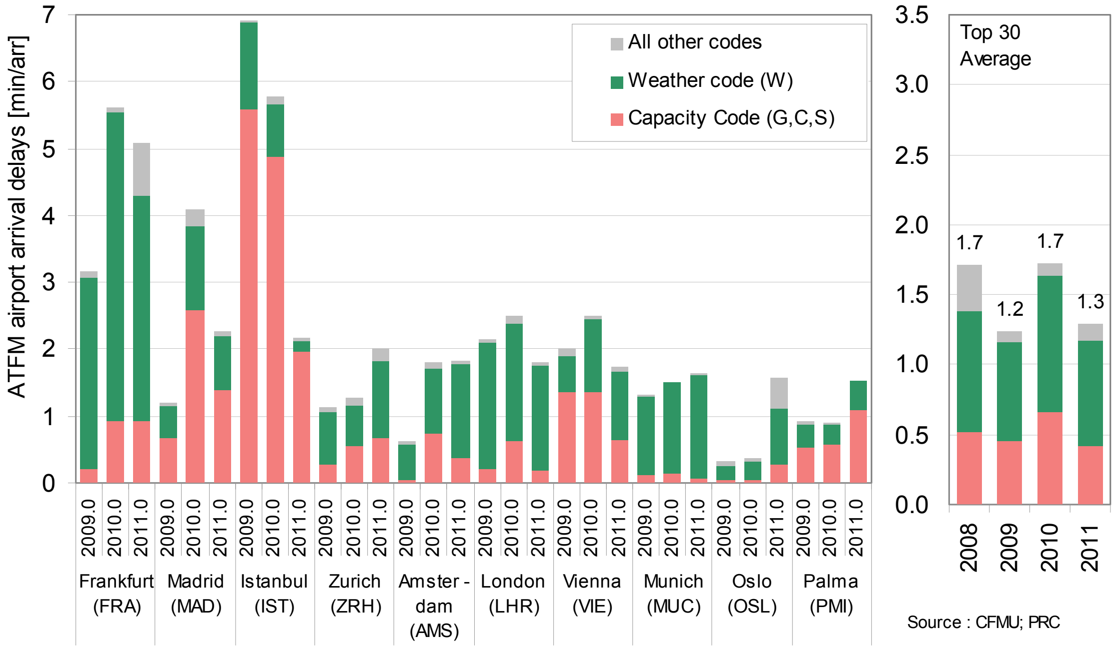

Figure 6-4: Airport arrival ATFM delays [2009-2011]

6.2.21 Although airport ATFM arrival delays decreased at the top 30 airports in 2011, the high level of airport ATFM arrival delays at some regional (Cannes, Istanbul Sabiha Gokçen[49]) and seasonal (Kos, Antalya, Rhodes, Nikos, Chania, Zakinthos) airports had a significant impact on airspace users and the European network. Together they accounted for 10% of the total airport ATFM arrival delay in Europe in 2011 (i.e. 50% of the ATFM delay generated by Frankfurt (FRA) in 2011).

6.2.22 On a per flight level, some of these airports were the most penalising in Europe in 2011: an average of 14 minutes per arrival was observed at Kos Airport, 12 minutes at Zakynthos, and 9 minutes at Cannes. These secondary airports experience a high level of seasonal traffic variability which is a contributing factor to the poor performance levels observed. Performance at these airports will be continued to be monitored.

ARRIVAL SEQUENCING & METERING AREA (ASMA) ADDITIONAL TIME (40NM TO LANDING)

6.2.23 This section addresses inefficiencies due to airborne holding, metering and sequencing of arrivals. For this exercise, the locally defined terminal manoeuvring area (TMA) is not suitable for comparisons due to considerable variations in shape and size and ATM strategies. Hence, in order to capture tactical arrival control measures (sequencing, flow integration, speed control, spacing, stretching, etc.), irrespective of local ATM strategies, a standard "Arrival Sequencing and Metering Area" (ASMA) was defined as the airspace within a radius of 40NM around an airport.

6.2.24 The actual transit times within the 40 NM ASMA ring are affected by a number of ANS and non-ANS related parameters including flow management measures, airspace design, airports configuration,

> **ASMA additional time**
>
> ASMA (Arrival Sequencing and Metering Area) is the airspace within a radius of 40NM around an airport. The ASMA additional time is a proxy for the average arrival runway queuing time on the inbound traffic flow, during times when the airport is congested.

49 With 11.5 Million passengers, Istanbul Sabiha Gokçen was the fastest growing airport in the world in 2010, with an increase of 74.7%.

aircraft type, pilot performance, environmental restrictions, and to some extent the objectives agreed by the State/NSA following advice given by the airport scheduling committee when declaring the airport capacity.

6.2.25 The "additional" time is used as a proxy for the level of inefficiency within the last 40NM. It is defined as the average additional time beyond the unimpeded transit time for each airport.

The computation of the indicator is based on three consecutive steps:

- determination of the average unimpeded time between entering the 40 NM radius and landing, for groups of similar inbound flights (same ASMA entry octagon, same arrival runway, same aircraft class);
- calculation of the average additional time for each group of flights by comparing the average actual to the average unimpeded ASMA time; and,
- the calculation of the average additional ASMA time for the airport which is the weighted average of the average ASMA additional times of all groups of similar inbound flights.

6.2.26 Figure 6-5 shows the 10 most penalising airports of the top 30 European airports in terms of additional time in the Arrival Sequencing and Metering Area (ASMA). Overall, average additional ASMA time at the top 30 airports increased by +5% from 2.7 to 2.9 minutes per arrival in 2011.

6.2.27 Figure 6-5 shows that ASMA additional time varies considerably across airports. London Heathrow (LHR) is a clear outlier[50], having by far the highest level of additional time within the last 40NM, followed by Frankfurt (FRA) and Madrid (MAD).

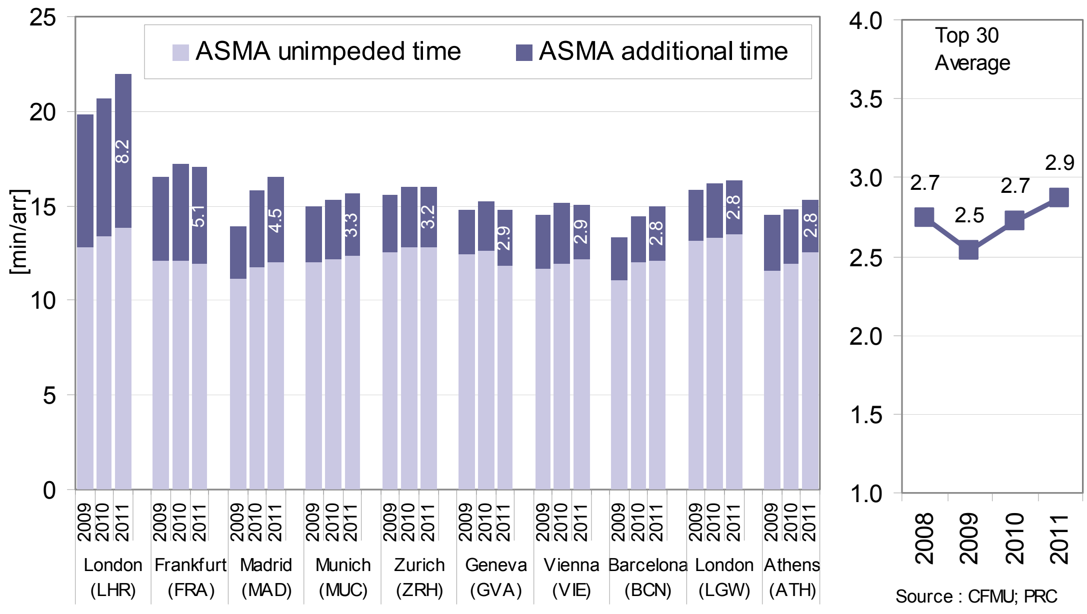

Figure 6-5: ASMA additional time [2009-2011]

6.2.28 In order to maximise runway throughput, ANS may need to queue arriving aircraft and to distribute the resulting additional time along the trajectory in terms of holdings, sequencing or speed control already in the en-route phase. The ASMA indicator measures those inefficiencies by relating the actual time between entering a 40NM radius and landing to an unimpeded reference time. While this indicator combines horizontal and vertical elements into a good proxy for the total level of ANS-related inefficiencies, it does not enable to separate the horizontal and the vertical dimension.

50 It should be noted that performance at London Heathrow airport (LHR) is influenced by decisions taken during the airport scheduling process regarding average holding in stack.

6.2.29 Figure 6-6 compares the ASMA additional time at London Heathrow (black line) to a methodology [Ref. 8] measuring additional fuel burn due to vertical inefficiencies in descent (red line) in Figure 6-6. There is a strong correlation between the two indicators confirming that vertical inefficiencies are linked to the need to sequence arrivals which is already encompassed in the ASMA indicator.

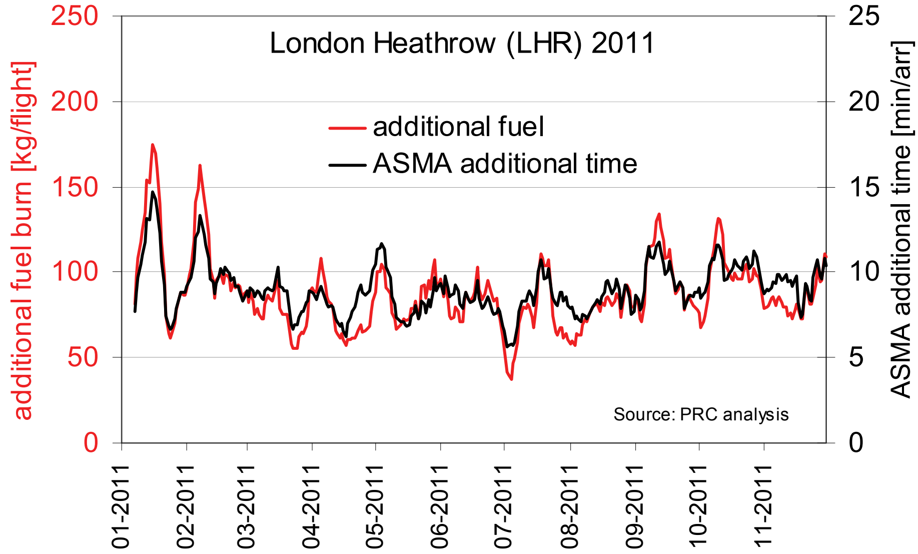

Figure 6-6: Vertical inefficiencies and additional ASMA time in descent

6.2.30 The development of a complementary, distance based, indicator addressing horizontal inefficiencies in the terminal area would require a substantial improvement of the radar data available at EUROCONTROL level as well as online information from AMAN systems in addition to cross centre arrival management information (XMAN).

DEPARTURE DELAYS DUE TO LOCAL ATC

6.2.31 When there are ATC constraints at the departure airport, outbound traffic may be held at the stand, without issuing ATFM regulations. Those departure delays due to local ATC constraints are included in the delay reported to CODA by airlines (see also grey box).

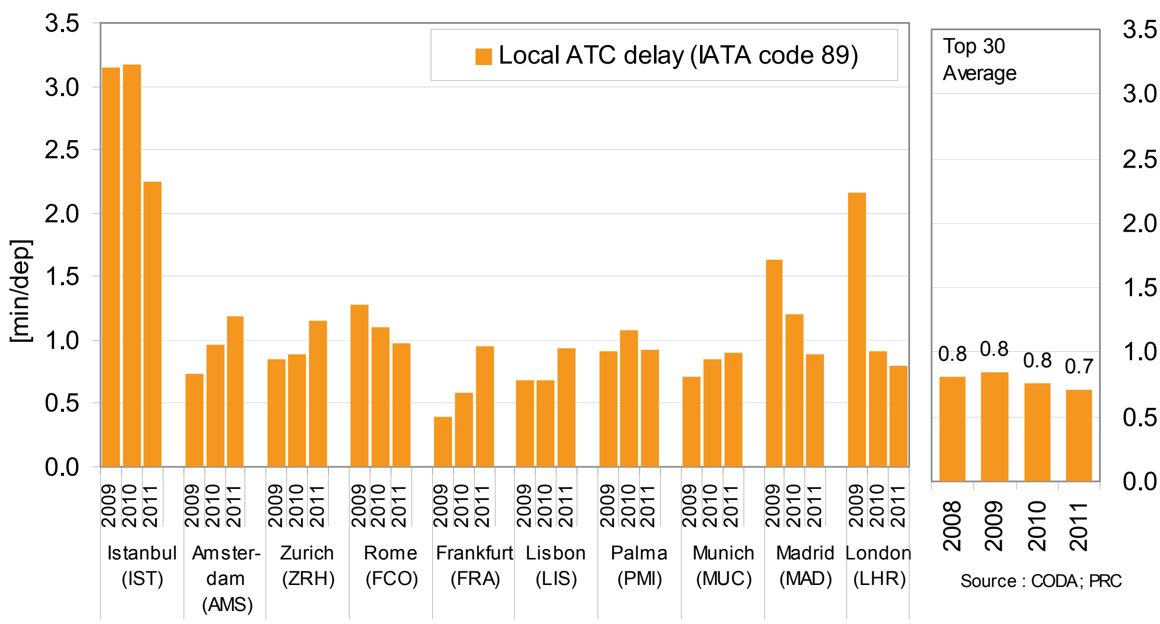

Figure 6-7: Local ATC delays (IATA code 89)

6.2.32 Figure 6-7 shows the 10 most penalising airports of the top 30 airports due to local ATC constraints. Overall, delays due to local ATC constraints at the top 30 airports decreased by -7% to 0.7 minutes per departure in 2011.

6.2.33 Although a notable improvement was observed in 2011, Istanbul (IST) airport shows by far the highest level of delay due to local ATC constraints (IATA code 89), followed by Amsterdam (AMS), Zurich (ZRH) and Rome (FCO).

6.2.34 In 2010, the recorded delay levels at London Heathrow (LHR) airport dropped substantially.

6.2.35 The reduction of delay at London Heathrow (LHR) was not due to a genuine performance improvement but rather due to a change in the way the delay was recorded by airlines in a joint effort to increase the level of accuracy in delay reporting.

ATC local Departure delays

Departure delays due to local ATC are a proxy for ATC induced delays at the departure stand as a result of demand/capacity imbalances in the manoeuvring area and/or TMA/CTR airspace nearby the airport.

This delay is measured by using the IATA delay code 89 which, besides delays caused by ATC constraints, also includes delays due to late push-back approval and other reasons. One advantage of using this data is the universal application of the IATA standard delay codes across European aviation. Current limitations of using the IATA delay code 89 are:

- it is currently not possible to filter out delays due to late push-back approval generated by an apron management unit which is not under ANS provider's responsibility; and,
- the data accuracy varies across airports depending on procedures which are in place to control the quality of the assignment of code 89.

The implementation of A-CDM at airports would significantly help to improve data quality and to measure delays due to local ATC constraints with higher accuracy.

ADDITIONAL TAXI-OUT TIMES

6.2.36 Taxi-out efficiency in the next sections refers to the period between the time when the aircraft leaves the stand (actual off-block time) and the take-off time. The additional time is measured as the average additional time beyond an unimpeded reference time [Ref. 42].

6.2.37 The taxi-out phase and hence the performance measure is influenced by a number of factors such as take-off queue size (waiting time at the runway), distance to runway (runway configuration, stand location), downstream restrictions, aircraft type, and remote de-icing to name a few. Of these aforementioned causal factors, the take-off queue size[51] is considered to be the most important one [Ref. 44].

6.2.38 Overall, additional taxi-out time decreased by -11% at the top 30 European airports in 2011, to an average of 4.5 minutes per departure. Figure 6-8 shows the results for the 10 most penalising airports in 2011.

6.2.39 A significant number of airports including London Heathrow (LHR), Istanbul (IST), and Madrid (MAD) show a high level of additional taxi-out time.

Taxi out additional time

The taxi-out additional time is a proxy for the average runway queuing time on the outbound traffic flow, during times when the airport is congested.

The computation of the indicator is based on three consecutive steps:

- determination of the unimpeded time between stand and take-off, for groups of similar outbound flights (same aircraft class);
- calculation of the average additional time for each group of similar flights by comparing the average actual to the average unimpeded taxi-out time; and,
- the calculation of the average additional taxi out time for the airport which is the weighted average of the average taxi-out additional times of all groups of similar outbound flights.

51 The queue size that an aircraft experienced was measured as the number of take-offs that took place between its pushback and take-off time.

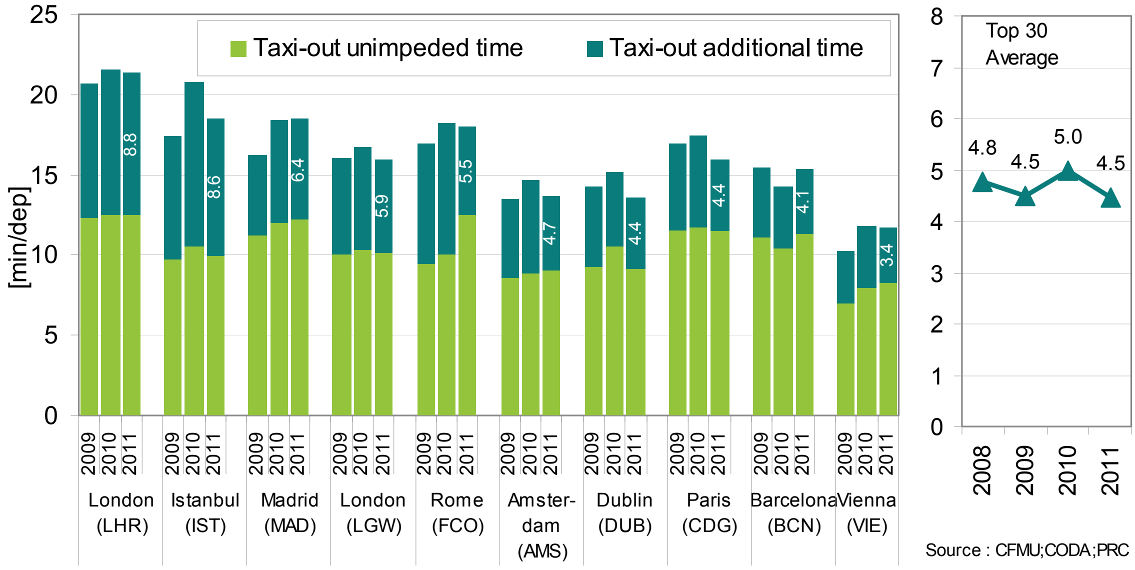

Figure 6-8: Additional taxi-out times [2009-2011]

6.2.40 A-CDM and DMAN are key enablers to reduce taxi-out additional times. The push-back times and the taxi-out phase are managed to optimise the departure sequence at the runway. The aim is to keep aircraft at the stand to keep additional time and fuel burn in the taxi out phase to a minimum (see also Section 6.4).

6.3 Factors affecting ANS-related operational performance at airports

6.3.1 Figure 6-9 provides a simplified view of the main factors affecting ANS-related performance at airport including:

- airport scheduling and the intensity of operations at the airport (i.e. the number of allocated airport slots and day-to-day changes in the operational environment, affecting capacity and/or demand);
- weather conditions and the number of "bad" weather days in a season;
- the level of ANS' operational capacity: its ability to meet the airport capacity declaration in optimal operating conditions, and ability to sustain airport capacity in adverse weather conditions;
- the ANS' ability to manage flow and capacity, whilst reducing the impact of capacity-demand imbalances; and,
- the environmental management strategy at the airport, including noise, and its impact on the use of runways and surrounding airspace.

6.3.2 Airports are usually designated as 'coordinated' following an objective capacity analysis when the airport capacity is insufficient to fulfil airlines' demand during peak hours. The subsequent airport scheduling process aims at matching airline demand with airport capacity several months before the actual day of operations. With the exception of Athens and Hamburg which are scheduled-facilitated, all the top 30 Airports analysed in this chapter are coordinated.

6.3.3 The declared airport capacity [52] is decided by the coordination committee [53] and/or by the State itself. It represents an agreed compromise between the maximisation of airport

52 The airport capacity declaration is a local process and can vary by airport. There is no harmonised method to declare an airport's capacity in Europe.

53 The responsibility to set up a coordination committee lies with the respective State.

infrastructure utilisation and the quality of service considered as locally acceptable. This trade-off is usually agreed between the airport managing body, the airlines, and the local ATC provider during the airport capacity declaration process.

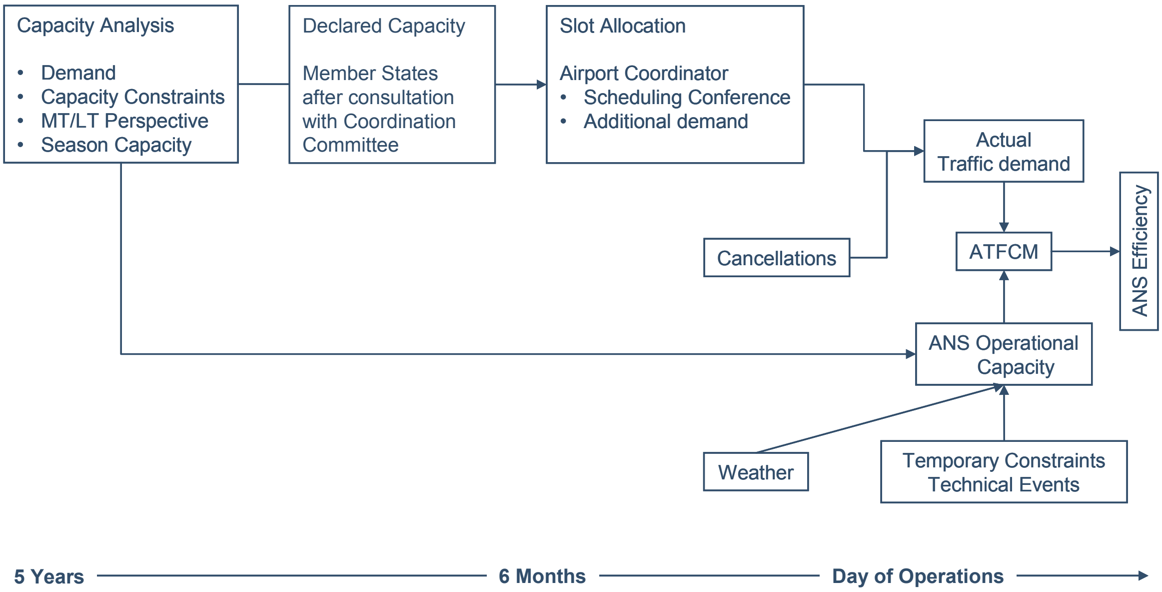

Figure 6-9: Factors affecting ANS-related operational performance at airports

6.3.4 Once the capacity has been declared, airport slots are allocated to airlines according to rules laid out in EC Regulation 95/1993 [Ref. 45] and subsequent amendments.

6.3.5 In December 2011, the European Commission adopted a comprehensive package of measures to address capacity shortage at Europe's airports and improve the quality of services offered to passengers - the "Better Airports" package [Ref. 46]. The package consists of a policy summary document and three legislative proposals, on slots, ground-handling and noise to improve performance at European airports.

6.3.6 In order to get an initial understanding of the level of saturation at airports, Figure 6-10 shows the average number of "congested" hours per day of operations during the peak month, where the global throughput was higher than 90% of the declared capacity.

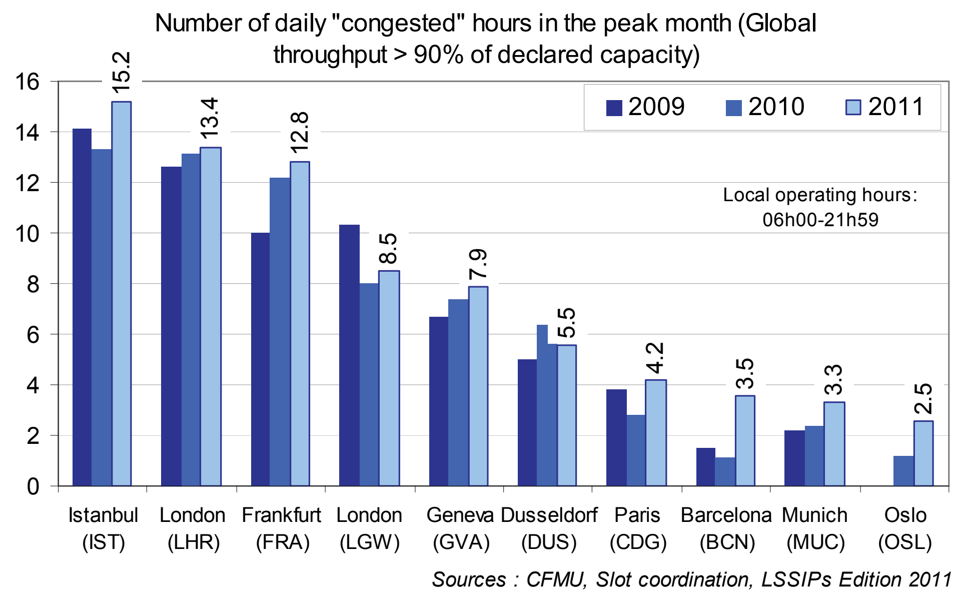

Figure 6-10: Hours with a global throughput higher than 90% of the declared capacity

6.3.7 After a substantial drop in 2009 and 2010, the number of hours with a throughput higher than 90% of the declared capacity increased again at most airports in 2011 which is consistent with overall traffic growth. Notwithstanding this positive trend, European traffic levels are still below the pre-economic crisis levels of 2007 and 2008.

6.3.8 The airports with the highest number of daily busy hours in the peak month in 2011 were Istanbul Atatürk (IST), London Heathrow (LHR), Frankfurt (FRA), London Gatwick (LGW) and Geneva (GVA).

6.3.9 Although the measure provides a first indication of the actual intensity of operations compared to the declared capacity at airports, in view of the long lead times and local specificities, it does not allow to conclude on requirements to expand airport capacity (e.g. through new infrastructure such as additional runways, taxiways, etc.).

6.3.10 Airports are key nodes of the aviation network and airport capacity is considered to be one of the main challenges to future air traffic growth [Ref. 47]. This requires an increased focus on the integration of airports in the ATM network and the optimisation of operations at and around airports.

6.3.11 As shown in the simplified view in Figure 6-11, there exists some correlation between the intensity of operations[54] and the level of service.

6.3.12 Other factors such as ATC and airport equipment, airspace design, airport configuration, airline performance, environmental and noise restrictions, and airport scheduling also influence ANS-related performance at airports and more work is required to better understand the interrelation between service quality, airport capacity and demand balancing, traffic variability and other factors such as meteorological conditions.

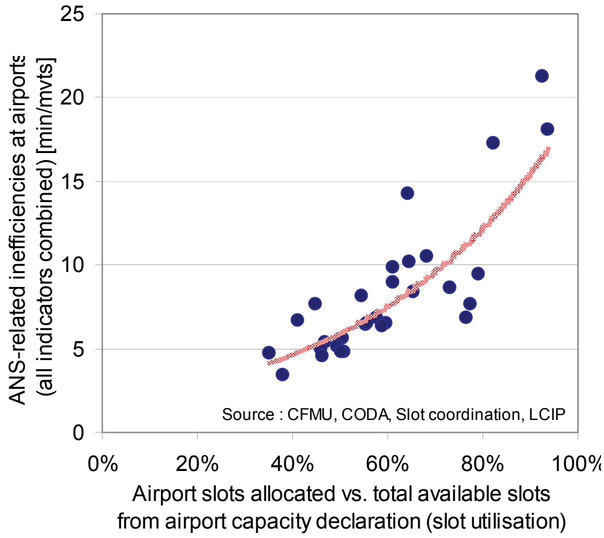

Figure 6-11: Interrelation between intensity of operations and service quality [2011]

WEATHER CONDITIONS

6.3.13 Generally, ANS and airside airport performance are dependent on weather conditions, and they must be considered when seeking to put in perspective the level of performance achieved at a given airport.

6.3.14 The impact of weather phenomena on operations can vary significantly by airport and depends, inter alia, on a number of factors including:

- the ANS and airport equipment to mitigate adverse weather;
- the exposure of given runway systems to particular wind conditions;
- the negative interaction between noise constraints and weather; and,
- the ANS flow management strategy to cope with airport capacity drops.

6.3.15 In Airport Collaborative Decision Making (A-CDM), the analysis of weather is

54 The intensity of operations is expressed as the share of operated airport slots compared to the total number of available airport slots based on the declared airport capacity (06h00-22h00 local time).

fundamental to enhancing ANS and airport airside performances. It is necessary to cross-analyse weather data with flights, capacity and performance data to improve ANS and airport performance.

6.3.16 When analysing a given year or a given season, it is necessary to identify which proportion of performance variation is related to an improvement of airport/ANS processes and to weather conditions. Differences between airports which operate under similar conditions cannot be excluded. The level of mitigation of adverse weather conditions (infrastructures, equipment) could make the difference from one airport to another. Furthermore, it could be expected that an airport could perform better in some days of operations than in other days with similar weather conditions. Post-analysis could reveal practices which would be worth applying in a systematic way in all days of operations for improving performance.

6.3.17 Generally, the main weather conditions which could affect airport and/or ANS performance are: Poor visibility, freezing conditions, strong winds and convective weather. ANS is directly accountable to put in place mitigation measures for a number of weather phenomena, more particularly visibility and wind. Furthermore, ANS is accountable for minimising the loss of capacity utilisation under convective weather such as thunderstorms and cumulonimbus. The mitigation of the impact of precipitations and freezing conditions is under the responsibility of airport maintenance and de-icing teams. However, in such weather circumstances, ANS is accountable for executing its functions as established in airport plans (e.g. airport winter plan).

6.3.18 The PRC have been collecting weather information since April 2009 and developed an algorithm for consistent application in consultation with the ATMAP group.

6.3.19 The ATMAP algorithm [Ref. 48] uses METAR data observing weather phenomena grouped under five categories: Visibility and ceiling, wind, freezing conditions, and dangerous phenomena [55] such as CB activity and thunderstorms.

6.3.20 Figure 6-12 shows the weather conditions at the top 30 airports in 2010 and 2011. It shows the share of days on which weather conditions might have affected performance at those airports.

ATMAP weather algorithm

The ATMAP weather algorithm is applied to METAR information with the following objectives:

- Measure weather conditions consistently across European airports;
- Provide an objective and consolidated measure of the intensity and duration of weather phenomena which could make ANS and airside airport operations more complex or difficult;
- Classify days of operations in two categories (good and bad weather) for high level performance analyses.

When classifying days of operations into “good weather” and “bad weather” days, the main intention is to extract the “good weather” days from a given set of days in a year or an IATA season. This will enable ANS performance to be evaluated when the impact of weather is absent or marginal. The second intention is to investigate in “bad weather” days how the weather phenomena have impacted performance. Bad weather days could be classified by categories (freezing, wind, poor visibility, etc.) and then analysed.

Airspace users expect ANS/airport performance to deliver constant and predictable performance in the majority of days of operations in a year or IATA season. Having an ANS/airport which has excellent performance in “good weather” days, but which suffers significant capacity drops in “bad weather” days or other marginal conditions is not a desirable situation for airspace users.

55 The principal dangerous weather phenomena are Cumulonimbus (CB), Thunderstorms & Hail (see also Glossary).

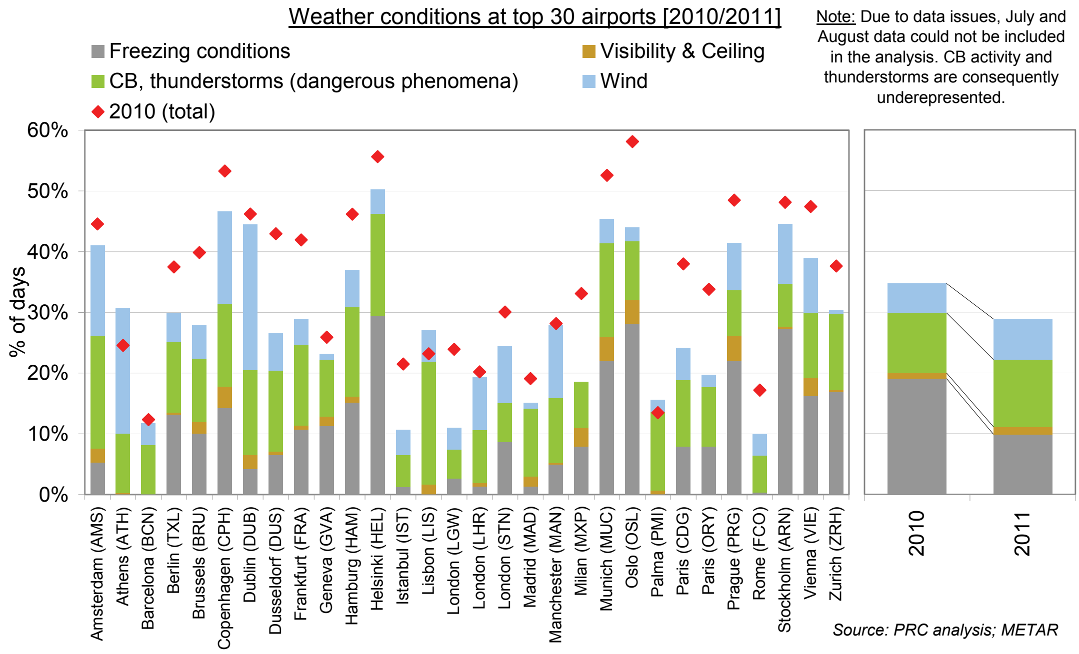

Figure 6-12: Weather conditions at the top 30 airports [2010/11]

6.3.21 Although the analysis in Figure 6-12 is not representative for the full year (due to data gaps in July and August), the data suggests the overall number of bad weather days decreased in 2011. Freezing conditions and Dangerous Phenomena such as Thunderstorms remained predominant causes.

6.4 Improving ANS-related performance at airports

6.4.1 ANS-related performance at airports could be improved through:

- the enhancement of local enablers; and,
- an enhanced relationship between airport and network operations.

6.4.2 Airport Collaborative Decision Making (A-CDM) remains one of the promising enablers to improve performance. A-CDM aims at improving operational efficiency at airports by reducing delays, improving the predictability of events during the progress of a flight and optimising the utilisation of resources. With a particular focus on the aircraft turn-round and pre-departure sequencing process, one key element of the A-CDM is the implementation of an accurate target off-block time (TOBT) by using Milestones approach [Ref. 49]. The TOBT is improving the predictability during the turnaround process of aircraft.

6.4.3 The difference between the target off-block time and the scheduled off-block time (SOBT) provides a good indication of delay due to aircraft operations. On the other side, the difference between the target start-up approval time (TSAT) provided by ATC and the target off-block time indicates delay due to ATC constraints which would significantly help to improve data quality and the current indicator for measuring delays due to local ATC constraints (see also paragraph 6.2.31 ff. on page 70).

6.4.4 With A-CDM, Air Traffic Control (ATC), airport operators and airlines benefit from improved runway and capacity operational plans. More accurate take-off time predictions will lead to more accurate calculation of the network demand by the Network Manager. This enhanced flow and capacity management demonstrated to result in better ATFM slot compliance and reduced number of missed slots.

6.4.5 Regulation 255/2010 [Ref. 41] is expected to have a positive impact on ATFM slot adherence, which is addressed directly in its Article 11. At airports where the share of take-offs outside the ATFM slot window is 20% or higher, the respective ATS units have to provide relevant information of non-compliance and the actions taken to ensure adherence to ATFM slots.

ATFM slot adherence

ATFM slot adherence measures the share of take-offs outside the allocated ATFM window. An ATFM slot tolerance window (-5min +10 min) is available to ATC to organise the departure sequencing.
ATC at the departure airport has a joint responsibility with aircraft operators to depart within the allocated ATFM window in order to avoid over-deliveries.

6.4.6 Local Implementation of Airport Collaborative Decision Making (A-CDM) can also improve situational awareness and allow improved variable taxi time calculation, collaborative pre departure sequencing. In both normal and adverse weather conditions.

6.4.7 For instance, the A-CDM team at Paris Charles-de-Gaulle reports a 1-minute reduction of taxi time in normal conditions and not less than 4-minute reduction in adverse conditions.

6.4.8 Figure 6-13 shows the evolution of additional taxi-out time at Munich (MUC), Brussels (BRU) and Frankfurt (FRA) between 2007 and 2011. While a positive trend can be observed at all airports, it is noteworthy that improvements are already visible at Brussels and Frankfurt airport during the A-CDM implementation phase when information is shared among stakeholders.

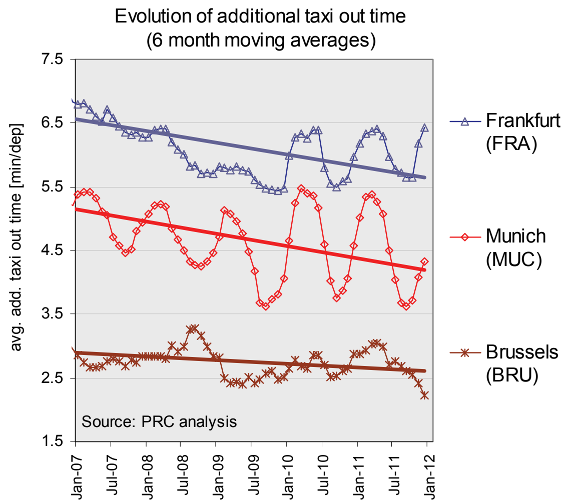

Figure 6-13: Additional taxi-out time at A-CDM airports

6.4.9 Figure 6-14 shows the current status of A-CDM implementation in Europe from the LSSIP report 2011. Beyond the four fully A-CDM compliant airports (Brussels (BRU), Frankfurt (FRA), Munich (MUC), and Paris (CDG)), another 6 airports were planned to be fully implemented by end of 2012 (Amsterdam, London Heathrow, Helsinki, Prague, Geneva, and Berlin Brandenburg).

6.4.10 A-CDM implementation is ongoing at the following airports: Vienna, Zurich, Rome Fiumicino, Stockholm, Kiev, Budapest, Dublin, Oslo, Warsaw, Lisbon, Madrid, Palma, Istanbul, Lyon, London Gatwick and Manchester and three airports plan to start implementation in 2013[56].

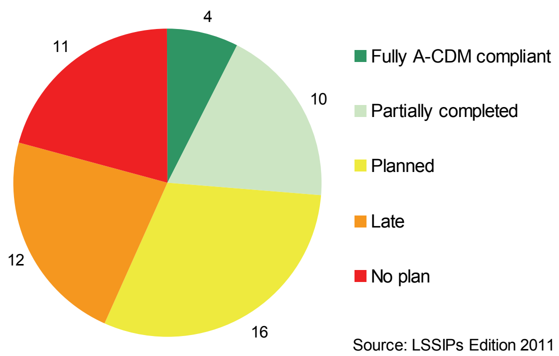

Figure 6-14: Status of A-CDM implementation in Europe

56 Differences between the actual A-CDM status and the status reported in LSSIP Edition 2011 may occur due to changes after the end of the reporting period.

NETWORK LEVEL

6.4.11 A higher level of accuracy through A-CDM not only benefits ground operations but can be used to improve en-route operational planning as well as to more accurately plan the management of the whole of the European network. Local decisions can have implications across Europe and linking the airports to the network through A-CDM has a positive effect both in terms of capacity and predictability, which is improving the performance of all stakeholders. This linkage can be done by the Network Manager and is one of the major benefits that this function will bring to European ATM as a whole.

6.4.12 A study assessing the impact of A-CDM implementation on the European network [Ref. 50], estimated that the increase in sector capacity through more accurate predictions could be up to 4% and the scope to reduce en-route delay is estimated to be up to 50%.

6.4.13 The positive results recorded in this study show that the expected benefits from the implementation of A-CDM could extend from the local airport environment to the network level. However, the achievement of these potential gains depends on a large number of airports implementing A-CDM[57] supplying data to the Network Manager to the same level of accuracy.

6.4.14 It is commonly recognised that there could be significant improvements in ANS performance, if the relationship between the network and the airport was enhanced and awareness of the traffic/capacity situation was shared at network and local levels.

6.4.15 When A-CDM has been implemented locally, the link with the ATM Network can be strengthened through exchange of flight update messages. This is a main building block of the Airport CDM concept.

6.4.16 The sharing of information between the Network functions and the airport will provide the following benefits:

- an improved traffic picture (actual and predicted traffic) at all nodes of the network including airports;
- a common awareness where the network problems are located and which nodes of the network are impacted; and,
- the avoidance of misperceptions on the status of performance and associated misunderstandings across aviation stakeholders.

6.4.17 In order to achieve these benefits the provision of higher update rates of radar information which are currently provided to the network management in intervals of 1 to 3 min should be envisaged.

6.4.18 For the benefits of the airspace users, the Network Manager should receive online data from AMAN systems in addition to cross-centre Arrival Manager information.

6.4.19 A higher predictability of the traffic calculated in the different sectors could be achieved if the current slot window of – 5 to + 10 min could be reduced using A-CDM information and making them available online to the Network Manager.

ARRIVAL MANAGEMENT

6.4.20 The availability of tools, procedures and airspace design solutions influence the level of ASMA additional times. A substantial number of States have implemented or plan to implement, the Arrival Manager (AMAN) function. Most major airports are equipped

57 A-CDM network benefits from a global point of view are estimated to start at around 16 airports and the network benefit curve becomes flat once around 80 airports have implemented A-CDM.

with such a tool, but others such as, inter alia, Madrid (MAD), Rome (FCO), Barcelona (BCN) and Istanbul (IST) are not equipped yet

6.4.21 Figure 6-15 below shows progress towards implementation of basic AMAN to improve sequencing and metering of arriving aircraft in selected TMAs and Airports. The full and coordinated exploitation of the AMAN tool would be very useful at congested airports.

6.4.22 The use of AMAN is generally limited to TMA/CTR[58] airspace and ideally should extend further away through appropriate coordination with upstream ATC sectors or units.

6.4.23 A further constraint to ANS performance during strong wind conditions is the fact that separations standards between arrival flights are expressed in distance rather than time. The introduction of time based arrival management is currently being developed at a number of locations in Europe.

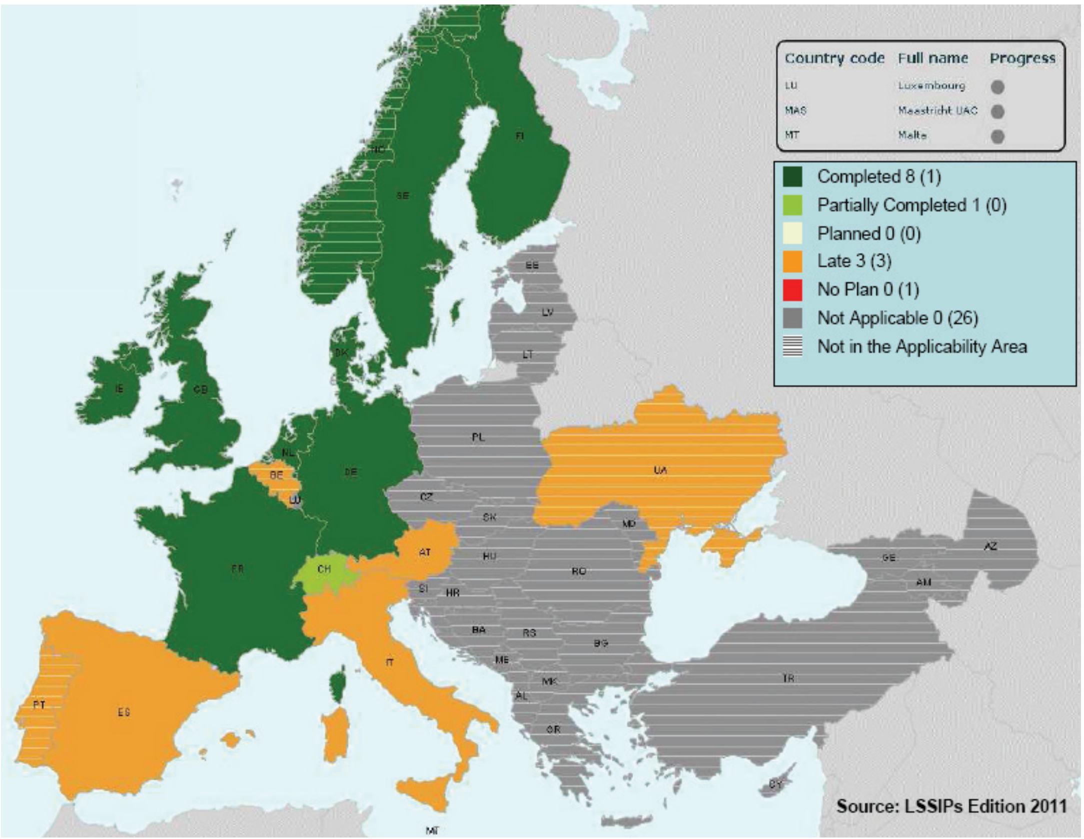

Figure 6-15: AMAN implementation status

6.5 Environmental impact of ANS at airports

6.5.1 Noise and local air quality are the most important local factors from an environmental viewpoint for local communities and airports alike, and in recent years a number of EC directives addressing noise and local air quality have been adopted.

LOCAL AIR QUALITY (LAQ)

6.5.2 Pollutants released into the atmosphere by activities affect local air quality (LAQ) and represent an increasingly important issue at airports. Nitrogen oxides (NOx) are regarded to be the most significant pollutant. At airports, the emission inventory can be broadly divided into three categories:

58 Terminal Manoeuvring Area (TMA) and Control Zones (CTR).

- passenger and staff travel to/from the airport (by car, bus, train);
- airport infrastructure and aircraft handling (auxiliary power units (APUs), airside vehicles, stationary power plants, construction, etc) within the airport perimeter; and,
- emissions from aircraft during landing and take off[59] but also when aircraft taxi (engine technology and operational efficiency).

6.5.3 Local initiatives at airports aimed at improving local air quality usually consist of a mix of measures including low emission airside vehicle fleet, staff travel, use of fixed ground power instead of APUs, and improved efficiency of operations. Additionally to the positive impact on local air quality, those initiatives also contribute to a smaller extent towards reducing the impact of aviation on climate.

> **Local air quality:**
>
> Local air quality LAQ is concerned with potential health effects of air pollution. Aircraft, road vehicles and other sources such as power plants at and around airports emit a number of pollutants, particularly Nitrogen Oxides (NOx) and Particulate Matter (PM10) which impact on human health.
>
> From a local air quality point of view, NOx is generally considered to be the most significant pollutant. It is a by-product of combustion of hydrocarbon fuels in air at high temperatures and pressures.

6.5.4 While there is no specific EU LAQ legislation in relation to aviation, the EC Directive 2008/50/EC [Ref. 11] on ambient air quality and cleaner air for Europe sets clear standards and requires Member States to stay within set limits for these pollutants.

6.5.5 The ANS contribution towards improving local air quality is mainly related to operational performance and associated fuel burn during take off and landing and in the taxi phase (i.e. improved taxi efficiency through A-CDM).

AIRCRAFT NOISE AT AIRPORTS

6.5.6 The process of setting noise related restrictions at airports has to ensure a balance between the protection of the population living or working in the proximity of airports and the impact on airport capacity and the economic growth of the region.

6.5.7 Regarding noise, the "Better Airports" package [Ref. 46] proposes the establishment of rules and procedures with regard to the introduction of noise related operating restrictions at European Union airports within a balanced approach.

6.5.8 The objective is to strengthen the application of the ICAO "balanced approach" and ensure robust noise assessment processes through facilitation of specific environmental noise abatement objectives, and to assess their interdependence with other environmental objectives at the level of individual airports. Further, to enable selection of the most cost effective noise mitigation measures in accordance with the Balanced Approach so as to achieve the sustainable development of the airport and air traffic management network capacity from a gate to gate perspective.

6.5.9 The ICAO Balanced Approach:

- reducing noise at source (from use of quieter aircraft);
- making best use of land (plan and manage the land surrounding airports);
- introducing operational noise abatement procedures (by using specific runways, routes procedures); and,
- imposing noise related operating restrictions (such as night ban or exclusion of noisier aircraft).

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59 The potential adverse effects of pollutants released within an aircraft's landing and take-off cycle (LTO). The standard LTO cycle is considered by ICAO to be up to 3000 feet or 915 metres above ground level.

6.6 Conclusions

6.6.1 The analysis ANS-related performance at airports in this chapter focuses on the top 30 European airports in terms of traffic in 2011. Together the top 30 airports accounted for 46% of total airport IFR movements and 62% of total ANS-related inefficiencies at European airports in 2011.

6.6.2 Notwithstanding a substantial traffic growth at the top 30 airports (+4%), average airport ATFM arrival delays (-25%), delays due to local ATC constraints (-7%) and additional taxi out time (-11%) improved in 2011. Better weather conditions than in 2010 helped improving overall performance at airports in 2011.

6.6.3 Although airport ATFM arrival delays decreased at the top 30 airports in 2011, the high level of airport ATFM arrival delays at some regional (Cannes, Istanbul Sabiha Gokçen) and seasonal (Kos, Antalya, Rhodes, Nikos, Chania, Zakinthos) airports had a significant impact on airspace users and the European network. Together they accounted for 10% of the total airport ATFM arrival delay in Europe in 2011. Performance at these airports will be continued to be monitored.

6.6.4 Average additional ASMA time at the top 30 airports increased by +5% from 2.7 to 2.9 minutes per arrival in 2011.

6.6.5 Airports are key nodes of the aviation network and airport capacity is considered to be one of the main challenges to future air traffic growth. This requires an increased focus on the integration of airports in the ATM network and the optimisation of operations at and around airports.

6.6.6 Depending on the way traffic is managed and distributed along the various phases of flight (airborne vs. ground), ANS has a different impact on airspace users (time, fuel burn, costs), the utilisation of capacity (en-route and airport), and the environment (gaseous emissions).

6.6.7 The management of arrival flows needs to find a balance between the application of ATFM regulations, airborne terminal holdings and the absorption of additional time in the en-route phase through the application of speed control which suggests substantial potential for savings in terms of fuel.

6.6.8 Airport Collaborative Decision Making (A-CDM), including DMAN, demonstrated to be beneficial at some airports in its contribution to a more efficient management of the departure flow. Information from A-CDM, including Target Start-up Approval Times (TSAT), is also expected to further help increasing data quality.

6.6.9 Arrival ATFM delays are monitored by EUROCONTROL, but the other above-mentioned TMA/airport efficiency KPIs are not. Active monitoring and management of those performance indicators, both by the Network Management function and local ATC units, could bring significant benefits.

KEY POINTS	KEY DATA	2010	vs. 09
EN-ROUTE ANS	En-route ANS unit costs for EUROCONTROL Area		
• After a sharp increase in 2009 (+6.9%), en-route unit costs per SU decreased by -5.6% in 2010 to reach €57.2, a level close to 2008. This cost-efficiency improvement is mainly driven by a decrease in total en-route ANS costs (-2.5%) while traffic volumes (SUs) increased by +3.3%. This is an important result since total en-route ANS costs never declined during the last decade. • In 2009, following the economic downturn several States/ANSPs introduced cost-containment measures in order to mitigate the effect of the declining traffic, the outcome of most of these measures mainly materialised in 2010 and generated some €430M of savings compared to previous years plans. • According to the information provided by EUROCONTROL Member States in November 2011, en-route unit costs per SU are expected to decrease by -3.1% per annum between 2009 and 2014. • Undoubtedly, the collective effort made in 2011 by the ANS industry to prepare for the implementation of the first Reference Period of the SES Performance Scheme has generated an effective drive towards a better management of cost-efficiency performance despite a deteriorating business environment.	Total en-route ANS costs (M€)	6 462	-2.5%
	Service units (M)	113	+3.3%
	En-route ANS costs per SU (€2009)	57.2	-5.6%
	Planned average annual growth rate of en-route unit costs per SU between 2010-14 (Nov. 2011 plans)		-2.5%
TERMINAL ANS	Terminal ANS cost-efficiency for SES reporting States		
• The PRC computed terminal ANS unit costs for all SES reporting States using the common terminal TSU formula mandatory by 2015 for the purpose of the Charging. Regulation. This enables for the first time to compare terminal performance across States and across time (2009-2014). • High level analysis indicates that: ○ Terminal ANS costs decreased in 2010 compared to 2009 (-5.0%); ○ Terminal ANS unit costs decreased in 2010 compared to 2009 (-7.0%); ○ Terminal ANS costs are planned to further decrease over RP1 (-3.0% in 2014 vs. 2010 or -0.8% p.a. on average) • Terminal ANS provision is a more dynamic environment than en-route and differences in terminal ANS unit costs across States may be driven by a number of factors (traffic levels, cost allocation, number of airports, etc.).	Total terminal ANS costs (M€)	1 416	-5.0%
	Recomputed terminal service units ((MTOW/50)^0.7) (M TSU)	7.1	+2.1%
	Terminal ANS costs per terminal TSU (€2009)	198.8	-7.0%
	Planned average annual growth rate of terminal ANS costs between 2010-14 (Nov. 2011 plans)		-0.8%
GATE-TO-GATE ANSP BENCHMARKING	Gate-to-gate ATM/CNS provision costs		
• In 2010, composite flight-hours slightly increased (+2.1%), while ATM/CNS provision costs fell by -4.8% in real terms resulting in a significant decrease in unit ATM/CNS provision costs (-6.8%). Cost-containment measures implemented by several European ANSPs generated genuine cost savings. • However, the decrease in ATM/CNS provision unit costs was outweighed by a sharp increase in ATFM delays (+77.4%) which is rather disappointing given the relatively low traffic growth experienced in 2010. Overall, the result was a +4.6% rise in unit economic costs in 2010.	Gate-to-gate ATM/CNS provision costs (M€ 2010)	7 476	-4.8%
	Composite flight-hours (M)	17.8	+2.1%
	Gate-to-gate ATM/CNS provision costs per composite flight-hour (€ 2010)	419	-6.8%

7.1 Introduction

7.1.1 This chapter analyses en-route cost-efficiency performance for the year 2010 (i.e. the latest year for which actual financial data are available) for the EUROCONTROL area (Section 7.2) and for individual EUROCONTROL Member States (Section 7.3). It also considers the reactivity of the ANS industry in 2010 to the significant traffic downturn in 2009. In particular, it analyses the impact of the cost containment measures implemented by the States in 2009 and 2010 on their en-route cost-bases.

7.1.2 This chapter also shows how cost-efficiency performance is planned to evolve between 2011 and 2014 for the EUROCONTROL area (Section 7.4). It also considers the information on cost-efficiency provided by the EU-27+2 States in their Performance Plan in the context of Commission Regulation (EU) No 691/2010 (hereinafter the "performance scheme regulation").

7.1.3 Sections 7.5 to 7.6.present a high level analysis of data on terminal ANS costs and unit rates reported to the European Commission by EU Member States, as well as Norway and Switzerland, in accordance with regulatory requirements relating to terminal ANS cost-efficiency in Commission Regulation (EC) N°1794/2006 (hereinafter the "charging regulation”) [Ref. 51]) and Commission Regulation (EU) N°691/2010 [Ref. 1]).

7.1.4 Finally, for the purposes of benchmarking ANSPs’ performance and comparing like with like, the PRC is monitoring since 2001 a gate-to-gate cost-effectiveness KPI which focuses on ATM/CNS costs incurred by ANSPs. Highlights and findings from this analysis are reported in Section 7.7.

Methodological note

This year the name of this chapter has changed from cost-effectiveness to ANS cost-efficiency. In previous PRR reports, the indicator used to measure en-route cost-efficiency was obtained by dividing the total real en-route ANS costs (i.e. deflated costs) from national cost-bases by the number of kilometres charged to airspace users. This indicator slightly differs from the cost-efficiency KPI defined in the performance scheme regulation (EU) N°691/2010 (see Annex I, Section 1.4) which is the ratio of en-route determined costs and service units.

The only discrepancy between the cost-efficiency KPI and the indicator analysed in previous PRRs arises from the use of different output metrics (service units which also include a component relating to aircraft weight, besides the distance controlled). Time series analyses suggest that although these output metrics are different, they are highly correlated (0.98).

In order, to ensure a better consistency with the performance scheme regulation, the cost-efficiency indicator analysed in this chapter is expressed in terms of **costs per service unit**. Furthermore, in order to ensure consistency with the information provided in national/FAB Performance Plans, the financial figures reported in Sections 7.2 to 7.6 of this Chapter are expressed in **Euro 2009**.

Finally it should be noted that in this chapter, the term EUROCONTROL Area refers to all the States that were integrated into the Route Charges system in 2010. Similarly, EU-27+2 States refer to the 27 States member of the European Union plus Switzerland and Norway.

7.2 En-route cost-efficiency analysis for EUROCONTROL Area (2010)

7.2.1 Figure 7-1 summarises the main relevant cost-effectiveness data and shows the changes in the en-route ANS costs per km and per SU between 2009 and 2014 for the EUROCONTROL Area. For the sake of consistency and harmonisation with SES metrics (see box above), the analysis provided in Sections 7.2 to 7.4 focuses on the **en-route ANS costs per SU**.

€2009 Prices		2009	2010	2011P	2012P	2013P	2014P	10/09	14/10 p.a.
Contracting States (Route Charges System)		35	35	36	36	36	36	35	35
Total en-route ANS costs (M€2009)		6 630	6 462	6 611	6 746	6 812	6 808	-2.5%	1.3%
National costs (M€)		5 951	5 799	6 012	6 107	6 160	6 141	-2.5%	1.4%
EUROCONTROL Maastricht (M€)		141	137	133	137	139	144	-3.1%	1.3%
EUROCONTROL Agency (Parts I & IX) (M€)		538	526	465	503	513	522	-2.1%	-0.2%
Total distance charged (M km)		8 302	8 538	9 001	9 333	9 631	9 960	2.8%	3.9%
En-route total service unit (M SU)		109	113	119	123	127	132	3.3%	3.9%
En-route real unit costs	(€2009/km)	0.80	0.76	0.73	0.72	0.71	0.68	-5.2%	-2.5%
	(€2009/SU)	60.60	57.21	55.51	54.63	53.46	51.66	-5.6%	-2.5%

Figure 7-1: Real en-route ANS costs per SU for EUROCONTROL Area [€2009]

7.2.2 In 2010, at European system level en-route costs per SU amounted to €57.2. This is -5.6% lower than in 2009 (€60.6) and close to 2008 levels (€56.7). This improvement results from the combination of a decrease in total en-route ANS costs (-2.5% in real terms) with an increase in traffic volumes (+3.3% in terms of SUs). This is an important result since total en-route ANS costs never declined during the decade, even after the traffic downturn in the wake of the September 11 terrorist attacks and the outbreak of SARS[60] in 2002.

7.2.3 In 2009, several European ANSPs stated that they would implement short-term and medium-term cost-containment measures in order to reduce the impact of the economic

60 Severe Acute Respiratory Syndrome.

downturn on airspace users. This analysis started in PRR 2010 and it is updated in this section in the light of the latest information on actual 2010 data. Figure 7-2 below compares the plans in terms of en-route ANS costs[61] and traffic prepared by the States in November 2008, i.e. when the impact of the financial crisis and economic downturn could not be reflected in States/ANSPs plans, with the information on 2009 and 2010 actual costs and SUs provided for the purposes of the November 2011 session of the Enlarged Committee.

	2009	2010
En-route ANS costs planned in Nov. 2008 (€'000)	6 105 789	6 199 717
Actual en-route ANS costs (€'000)	5 936 020	5 767 690
Difference between actual en-route ANS costs and Nov. 2008 plans (%)	-2.8%	-7.0%
Number of en-route SUs planned in Nov. 2008 ('000)	108 660	113 074
Actual en-route SUs ('000)	99 356	103 336
Difference between actual en-route SUs and Nov. 2008 plans (%)	-8.6%	-8.6%

Figure 7-2: Comparison of en-route ANS costs and SUs for the EUROCONTROL Area (data provided in Nov.'08 versus Nov'11) [€2009]

7.2.4 Figure 7-2 indicates that for 2009 and 2010, the actual number of SUs is some 8-9% lower than planned in November 2008. This reflects the impact of the sharp traffic downturn in 2009.

7.2.5 Figure 7-2 also shows that 2009 actual en-route ANS costs are -2.8% lower than planned in November 2008 (see first column). Given that each percentage reduction of the en-route cost-base amounts to some €65M, the "savings" for the year 2009 compared to previous year's plans are valued at some €170M for the EUROCONTROL area.

7.2.6 Similarly, 2010 actual en-route ANS costs are -7.0% lower than planned in November 2008 (see second column). The "savings" for the year 2010 compared to plans are significantly larger than in 2009 and valued at some €430M for the EUROCONTROL area. This is a clear indication that the impact of cost-containment measures introduced in 2009 mainly materialised in 2010, due to short term rigidities and unavoidable lead time to adjust ANS costs downwards.

7.3 En-route cost-efficiency analysis at State level (2010)

7.3.1 Figure 7-3 below shows the en-route cost-efficiency indicator for the EUROCONTROL Member States in 2010. In order, to ensure a better consistency with the performance scheme regulation, the en-route cost-efficiency indicator is computed at State level and expressed in terms of ANS costs per service unit.

7.3.2 In 2010, en-route ANS unit costs per SU range from €92.9 for Switzerland[62] to €23.9 for Turkey, a factor of nearly four. It is noteworthy that over the recent years, Turkey experienced traffic growth much higher than the European average (e.g. +9.9% p.a. on average between 2003 and 2010 compared to +3.3% p.a. for the EUROCONTROL area). This higher traffic growth was absorbed while keeping costs fairly constant (+0.6% p.a. between 2003 and 2010) and despite a significant capital investment programme relating to the Turkish ATC modernisation project (SMART).

61 In March 2011, the UK provided the PRC with a series of en-route costs for the period 2009-2014 based on the methodology for determined costs as defined in the Performance Scheme regulation (EU 691/2010). These figures are not directly comparable with the information provided by the UK in November 2008 for the purposes of the Enlarged Committee for Route Charges. For this reason, in this chapter the UK has been excluded from Figure 7-2 and Figure 7-4.

62 It is important to note that the level of Switzerland 2010 en-route unit costs expressed in Euro 2009 is affected by the appreciation of the Swiss Franc compared to the Euro (5% between 2008 and 2009).

7.3.3 The two dotted lines in Figure 7-3 represent the top and bottom quartiles[63] and provide an indication of the dispersion of unit en-route ANS costs across all the EUROCONTROL Member States. In 2010, there were some €31 per SU between the top and bottom quartiles, a value comparable to 2009.

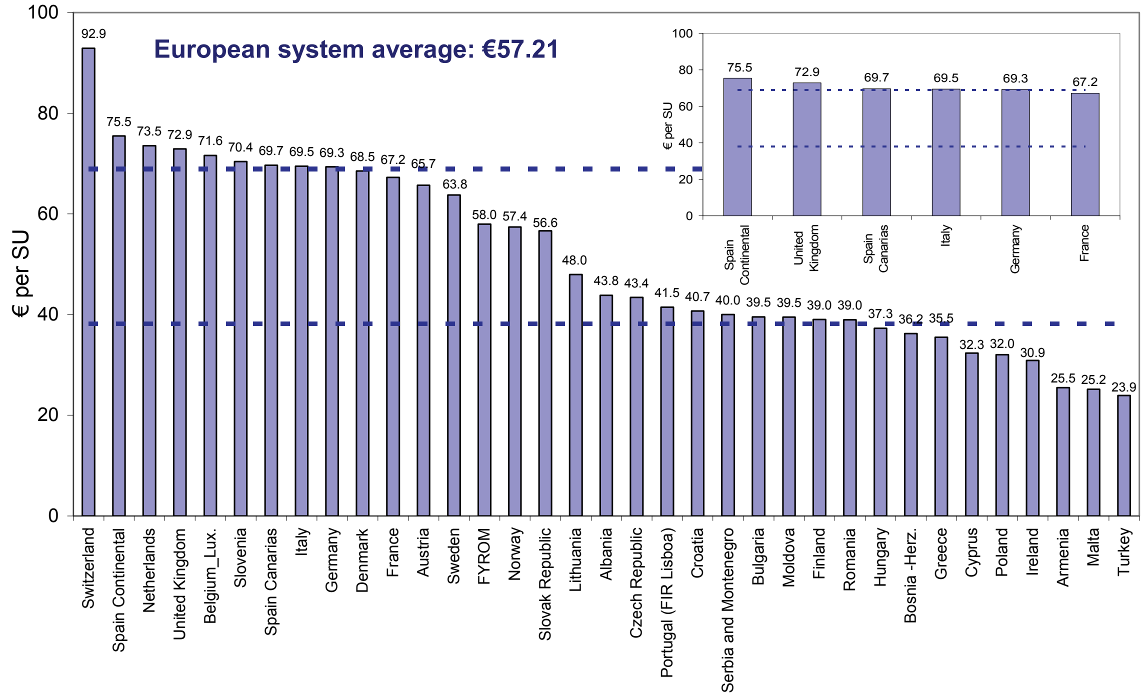


Figure 7-3: Comparison of 2010 en-route ANS unit costs for EUROCONTROL Member States [€2009]

7.3.4 Figure 7-3 also shows that in 2010 Spain Continental unit costs per SU are +9% higher than the average of the other four largest States, while this gap was +35% in 2009. The cost-efficiency improvements observed for Spain in 2010 mainly result from the implementation of a specific law (Law 9/2010). Besides a number of structural changes, the application of Law 09/2010, brought significant changes in the determination of ATCO contractual working hours and overtime hours[64]. The Law 9/2010 also requires that the chargeable unit rate of Spain converges towards the average chargeable unit rate of the five largest States by 2013.

7.3.5 It should be noted that in 2010, the Netherlands en-route cost-base include exceptional costs of €22M. These exceptional costs, which generated an under-recovery to be recovered in subsequent years will be used by the Dutch ATSP (LVNL) to build an Equity capital. Without these exceptional costs, en-route costs per SU in the Netherlands would amount to €65.4 in 2010 (instead of €73.5). Similarly, Hungary 2010 en-route cost-base includes significant exceptional costs relating to a one-off change in pension-related costs for HungaroControl. Germany 2010 en-route costs also include exceptional costs (some €15M) arising from the revaluation of DFS pension obligations following the transition to IFRS. These costs have been spread over a period of 15 years starting from 2007.

63 25% of observations lie below the bottom quartile, whilst 25% lie above the top quartile; the remaining 50% lie between the two quartiles. Thus in Figure 7-3, 75% of ANSPs have en-route costs per SU higher than €38.

64 The main issues addressed by the law relate to the regulation of shifts and the determination of ATCO contractual working hours and overtime hours. In particular, ATCO contractual working hours were increased from 1200 hours per year to 1670 hours in order to better match with the traffic demand and the number of ATCO overtime hours were capped at 80 hours per year (i.e. well below the average 500 overtime hours in 2009).

7.3.6 The KPI presented in Figure 7-3 is a factual indicator. It is important to note that differences in unit en-route ANS costs may be driven by cost-inefficiencies but also by economic and operational factors[65] (e.g. cost of living, size of operations, traffic complexity, etc.) and variances in cost allocation methodology between en-route and terminal ANS across States/ANSPs.

7.3.7 It is also important to note that substantial changes of the national currency against the Euro may, in some cases, significantly affect the level of 2010 en-route unit costs when expressed in Euro. This is particularly the case for the UK and Switzerland. Indeed, the level of the UK 2010 en-route unit costs expressed in Euro 2009 benefits from the significant depreciation (23%) of the Pound compared to the Euro between 2007 and 2009. On the other hand, the level of Switzerland 2010 en-route unit costs expressed in Euro 2009 is affected by the appreciation of the Swiss Franc compared to the Euro (5% between 2008 and 2009).

7.3.8 As indicated in Section 7.2 above, following the implementation of cost-containment measures since 2009, some €430M savings were generated in 2010 for the EUROCONTROL area. In order to better understand how these cost-containment measures impacted EUROCONTROL Member States en-route cost-bases, Figure 7-4 below shows the difference between actual 2010 en-route costs and the plans made in November 2008 for 2010 (see x-axis).

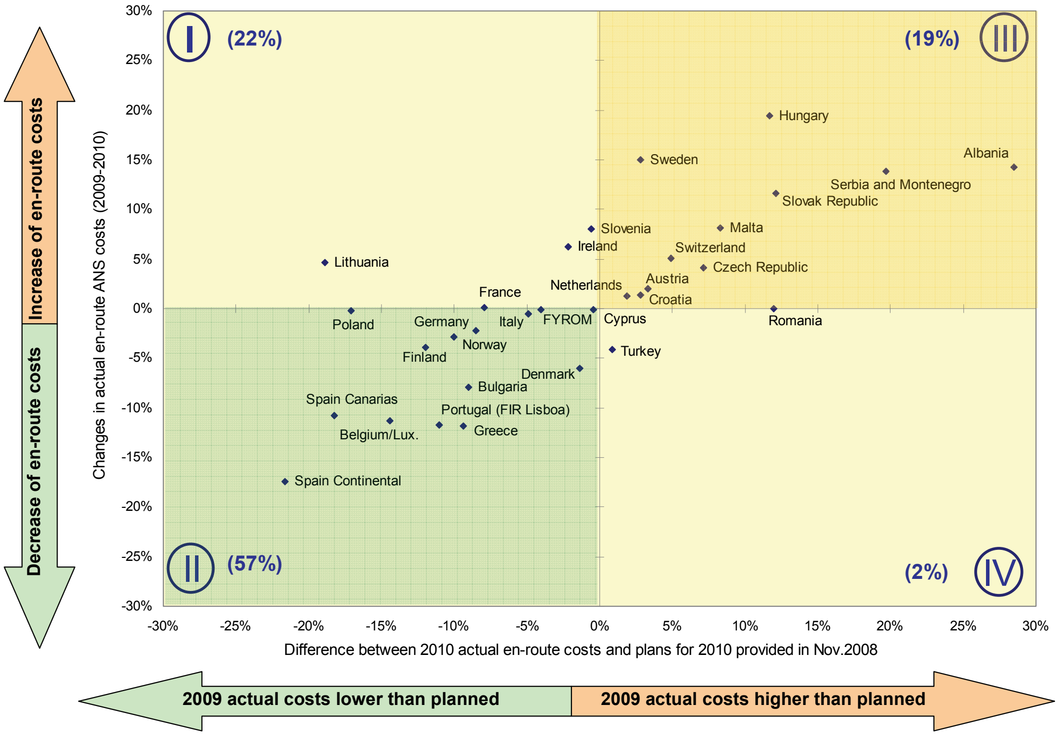


Figure 7-4: Comparison of 2010 actual en-route ANS costs with Nov '08 plans [€2009]

7.3.9 Figure 7-4 also presents the changes in actual en-route ANS costs between 2009 and 2010 (see y-axis). This information is useful to understand whether the implementation of cost-containment measures led to a reduction of the en-route cost-base compared to 2009.

65 Further details on factors affecting cost-efficiency performance are available in the ACE 2010 Benchmarking Report.

7.3.10 It is important to analyse the information provided in Figure 7-4 in the light of the difference between the traffic planned for 2010 in November 2008 and the actual traffic in 2010.

7.3.11 Figure 7-5 indicates that for 17 States, the actual traffic growth rate in 2010 was substantially higher than planned in November 2008. This is particularly the case for Moldova, Malta, Albania, Croatia, Slovak Republic, Turkey, Slovenia and Bosnia and Herzegovina. For these States, the number of SUs increased by at least +10% in 2010.

7.3.12 It is noteworthy that in 2010, traffic decreased for two States: UK (-4%) and to a lower extent France (-1%), indicating that traffic volumes did not bounce back in 2010 after the sharp decrease experienced in 2009.

States	Actual SUs growth rate (2009)	Actual SUs growth rate (2010)	2010 SUs growth rate planned in Nov.2008
Albania	9%	14%	3%
Austria	-6%	1%	4%
Belgium/Lux.	-6%	2%	6%
Bosnia-Herz.	10%	10%	5%
Bulgaria	3%	1%	4%
Croatia	2%	12%	3%
Cyprus	-3%	6%	7%
Czech Republic	0%	8%	3%
Denmark	-8%	4%	4%
Finland	-8%	2%	2%
France	-7%	-1%	3%
FYROM	-1%	2%	5%
Germany	-7%	2%	2%
Greece	-3%	8%	3%
Hungary	-3%	3%	3%
Ireland	-7%	2%	7%
Italy	-6%	6%	3%
Lithuania	-10%	9%	8%
Malta	-1%	17%	8%
Moldova	20%	31%	3%
Netherlands	-7%	2%	2%
Norway	-3%	6%	1%
Poland	-4%	7%	2%
Portugal (FIR Lisboa)	-7%	5%	2%
Romania	-3%	9%	12%
Serbia and Montenegro	2%	2%	4%
Slovak Republic	1%	12%	0%
Slovenia	-3%	10%	5%
Spain Canarias	-13%	3%	4%
Spain Continental	-8%	3%	8%
Sweden	-11%	1%	6%
Switzerland	-5%	1%	6%
Turkey	6%	10%	1%
United Kingdom	-10%	-4%	3%

Figure 7-5: Actual 2010 traffic compared to Nov. 2008 plans (SUs)

7.3.13 Figure 7-4 indicates that for 18 out of 33 States (representing some 75% of the EUROCONTROL area total en-route costs), 2010 actual en-route costs are lower than planned in November 2008 (see Quadrants I and II). This indicates a certain degree of reactivity to the traffic shock experienced in 2009, and would suggest that these States implemented cost-containment measures in 2010.

7.3.14 For 14 States (representing some 53% of the EUROCONTROL area total en-route costs), actual 2010 en-route costs are both lower than planned in November 2008 and lower than 2009 actual en-route costs (see Quadrant II). This is particularly the case for Spain Continental and Canarias, Belgium/Luxembourg and Portugal (FIR Lisboa).

7.3.15 For Spain Continental and Spain Canarias, actual 2010 en-route costs are respectively -22% and -18% lower than planned in November 2008. This mainly reflects the impact of Law 9/2010 on the Spanish cost-bases (see §7.3.4 above).

7.3.16 Belgium/Luxembourg en-route costs reduced by -11.3% in 2010, this significant decrease mainly reflects the deduction from the en-route cost-base of costs associated to the provision of ATC services in regional airports which were in the past charged to en-route airspace users.

7.3.17 Similarly, Portugal (FIR Lisboa) en-route cost-base reduced by -11.7% in 2010. This decrease is mainly driven by (a) the cost-containment measures implemented by NAV Portugal (in line with the "Growing and Stability Programme" of the Portuguese Government), and (b) the fact that the 2009 en-route cost-base included exceptional costs relating to the depreciation of pension costs which arose from a change in actuarial assumptions in 2005.

7.3.18 On the other hand, Figure 7-4 shows that for 15 States actual 2010 en-route costs are higher than planned in November 2008 (see Quadrants III and IV). For thirteen[66] of these States, actual 2010 en-route costs are both higher than planned in November 2008 and higher than 2009 actual costs (see Quadrant III). For Albania, Croatia, Slovak Republic, Moldova and Czech Republic which are part of Quadrant III traffic volumes did not fall in 2009 and the actual traffic growth in 2010 was significantly higher than planned in November 2008. For some of these States actual traffic volumes significantly larger than expected may have led to actual costs higher than planned in order to provide the adequate level of ATC capacity.

7.4 Planned changes in en-route cost-efficiency for EUROCONTROL area (2011-2014)

7.4.1 Figure 7-6 below shows that after a sharp increase in 2009 (+6.9%), en-route costs per SU significantly decreased by -5.6% in 2010 to reach €57.2, a level close to 2008. As analysed in more details in Sections 7.2 and 7.3 above, this positive achievement is mainly due to the implementation of cost-containment measures in 2009 and 2010.

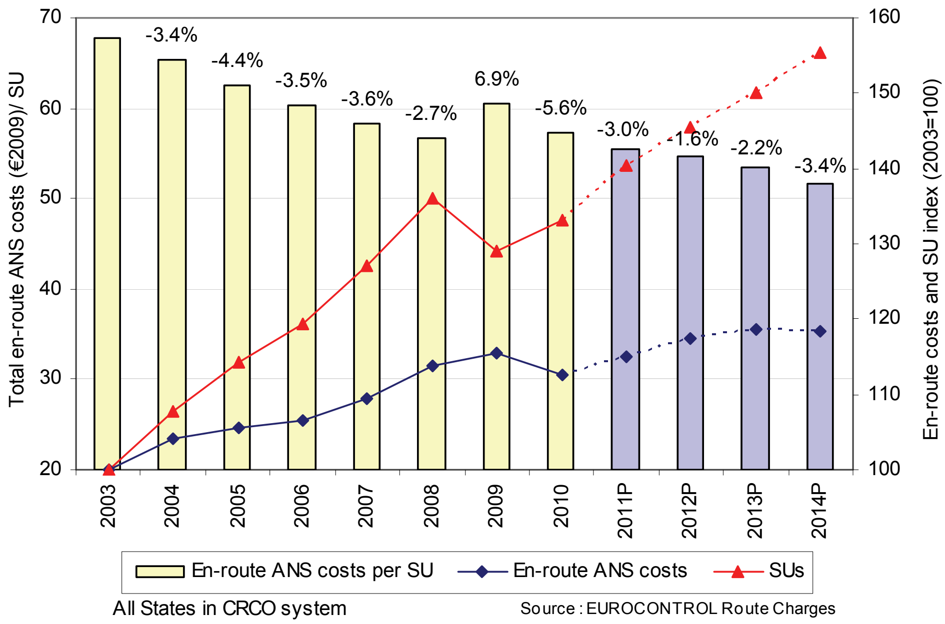


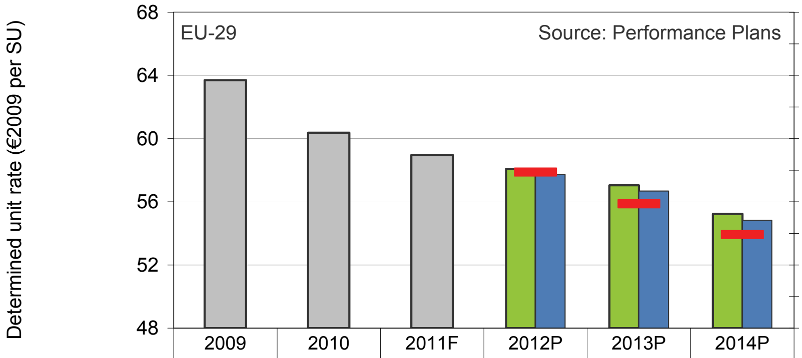
Figure 7-6: Real en-route unit costs per SU, total costs and traffic [€2009]

7.4.2 Figure 7-6 shows that en-route unit costs per SU are planned to continuously reduce until 2014 (i.e. an average reduction of -3.1% p.a. between 2009 and 2014). As shown in Figure 7-6, this planned decrease is mainly due to a forecast increase in traffic volumes (+3.8% p.a. between 2009 and 2014) while in the meantime total en-route ANS costs are planned to slightly increase (+0.5% p.a.).

7.4.3 Commission Regulation (EU) No 691/2010 laying down a performance scheme entered into force on 23 August 2010. This marked the start of the implementation of the performance scheme, and in particular preparation for the first reference period (RP1) that runs for three years from 2012 to 2014. Following recommendations from the PRB, EU-wide targets for Cost-Efficiency, Capacity and Environment were adopted by the EC in February 2011 for RP1 (2012-2014) [Ref. 52]. The EU-wide target for cost-efficiency is a Determined Unit Rate (DUR) of €53.92 for the year 2014 (expressed in Euro 2009). This corresponds to an average reduction of -3.2% p.a. between 2009 and 2014.

66 Bosnia and Herzegovina 2009 actual en-route costs were more than 25% higher than planned in November 2008.

7.4.4 In June 2011, the States bound by SES regulations submitted National/FAB Performance Plans including targets on Capacity and Cost-efficiency. As shown in Figure 7-7 below, based on June 2011 Performance Plans, in 2014 the aggregated DUR (€55.22, see green bar) was +2.4% higher than the EU-wide target (€53.92, see red line). The contribution of each individual plan to the EU-wide target was assessed in details by the PRB during the Summer 2011. Building on these assessments, the EC recommended to 21 States to improve their contribution to the EU-wide cost-efficiency target. These States submitted revised Performance Plans in early January 2012 (see blue bars in Figure 7-7).



	2009	2010	2011F	2012P	2013P	2014P
Initial plans				58.08	57.04	55.22
Revised plans				57.73	56.68	54.83
Historic values	63.70	60.37	58.97			
EU-wide targets				57.88	55.87	53.92

Figure 7-7: Comparison of EU-wide cost-efficiency target with aggregated Performance Plans targets [€2009]

7.4.5 Based on the revised Performance Plans submitted in December 2011, the EU-wide Determined Unit Rate is planned to reduce by -3.0% p.a. between 2009 and 2014. This is better than the plans provided by States in November 2010 and translates into cumulative savings of €127M over RP1 compared to the initial Performance Plans provided in June 2011.

7.4.6 Undoubtedly, the collective effort made in 2011 by the ANS industry to prepare for the implementation of the first RP has generated an effective drive towards a better management of cost-efficiency performance despite a deteriorating business environment.

7.5 Terminal ANS cost-efficiency in Europe

7.5.1 The PRC has the remit to monitor terminal ANS cost-efficiency performance. In the context of the SES Performance Scheme, this remit has been strengthened as of RP1 (2012-2014). The monitoring of terminal ANS cost-efficiency performance will start officially in 2012 and is essentially carried out on the basis of data reported to the European Commission by EU Member States, as well as Norway and Switzerland, in accordance with regulatory requirements relating to the Charging Regulation and the Performance Regulation.

7.5.2 Within the EUROCONTROL area the terminal ANS costs and unit rates information is available only for 27 Member States of the European Union as well as Norway and Switzerland. Therefore, for the purpose of the analysis in this chapter, the PRC considers these 29 States.

7.5.3 Although gradually improving, terminal ANS cost-efficiency data, documentation and validation have a much lower level of maturity than en-route ANS economic information. At the same time, despite transparency improvements on terminal ANS costs and unit rate information at the European level, there is still a great deal of diversity in terms of the information reported by the States.

7.6 Terminal ANS cost-efficiency in EU-27+Norway and Switzerland (2010)

7.6.1 The total 2010 terminal ANS costs were reported by 26 States[67] (for 28 terminal charging zones) in November 2011. Out of the 26 States, 21 States (23 terminal charging zones) consistently reported the data for the period 2009-2014. These 21 States cover 211 airports in 2010, which represent around 93% of the traffic at the airports subject to performance monitoring during RP1 in the EU-27 plus Norway and Switzerland.

7.6.2 Figure 7-8 shows the evolution of terminal ANS costs and other key relevant metrics for those 21 States[68] for the period 2009-2014.

	2009A	2010A	2011F	2012P	2013P	2014P	10 vs 09	14 vs 10	14/10 p.a.
Number of States reporting	21	21	21	21	21	21			
Number of charging zones covered	23	23	23	23	23	23			
Number of airports covered	202	211	207	208	207	207			
Total terminal ANS costs (M€ 2009)	1 490	1 416	1 406	1 383	1 374	1 373	-5.0%	-3.0%	-0.8%
Annual %		-5.0%	-0.7%	-1.6%	-0.6%	-0.1%			
Terminal TSU (MTOW/50)^0.7, M)	7.0	7.1	n/a	n/a	n/a	n/a	1.8%		
Annual %		1.8%							
Real Terminal ANS unit cost (per TSU in €2009)	213.0	198.8	n/a	n/a	n/a	n/a	-6.7%		
Annual %		-6.7%							
Total movements (millions)	12.0	12.1	n/a	n/a	n/a	n/a	0.9%		
Annual %		0.9%							
Real unit costs per MVTS (€2009)	124	117	n/a	n/a	n/a	n/a	-5.8%		
Annual %		-5.8%							

Figure 7-8: Terminal ANS unit costs at European system level (21 States)[69] [€2009]

7.6.3 For those 21 States in 2010, total terminal ANS costs amounted to €1 416 M, a decrease of -5.0% in real terms over 2009 (€1 490 M). Between 2010 and 2014, the terminal ANS costs are predicted to further decrease, albeit at a lower rate (-0.8% p.a. on average).

7.6.4 In 2010 the average terminal ANS unit cost for the 21 States amounted to €198.8, which was -7.0% lower than in 2009 in real terms (€213.6). This was the result of a reduction in total terminal ANS costs (-5.0%) coupled with an increase of total terminal service units (2.1%).

Methodological note on "real terminal ANS unit cost" indicator

The "real terminal ANS unit cost" is computed as the "total terminal ANS costs" divided by "total terminal service units":

- "Total terminal ANS costs" are in reference to Table 2 of the reporting tables in the Charging Regulation (line "total costs for the zone");
- "Total terminal service units" are in reference to series recomputed by the CRCO, based on their database and using the service unit formula that will become mandatory for the charging scheme purpose from 2015 onwards (MTOW/50)^0.7).

Cost series are expressed in real terms, in EUR 2009 (i.e. deflated series).
This indicator has been computed for the purpose of comparing terminal ANS unit costs across States, in line with the terminal ANS cost-efficiency indicator defined in the Performance Regulation[70].

7.6.5 Although the same 21 States are used for the time series comparison, the number of airports reported varies from year to year as States removed or added a number of airports in their terminal charging zone. Between 2009 and 2010 the number of airports increased from 202 to 211 (8 more airports in Italy and 1 more in Lithuania in 2010).

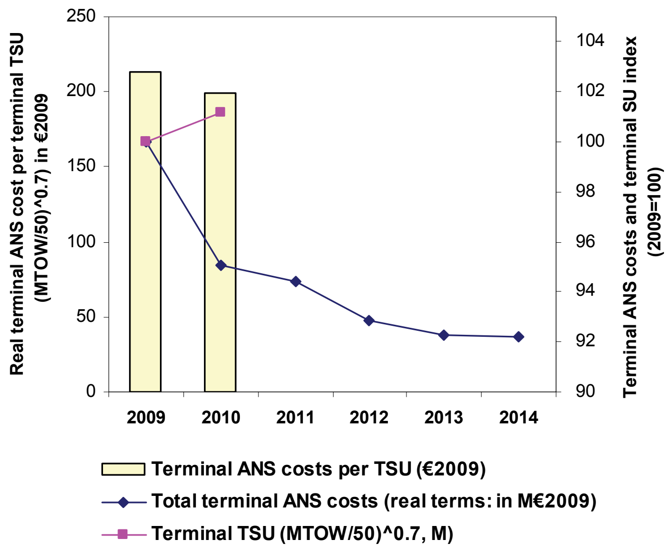
67 Data are available from the November 2011 Commission Consultation Hearing (for 25 States) and the national performance plan (for Estonia).

68 Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Lithuania, Netherlands, Poland, Portugal, Romania, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

69 No EU-wide information is available on planned terminal TSUs, hence the lack of visibility on some of the metrics presented in Figure 7-8.

70 No 691/2010, see Annex I, Section 1.4

7.6.6 Figure 7-9 illustrates the trends at system level in total terminal ANS costs, total terminal service units and terminal ANS unit costs per TSU. From 2011 onwards, no information could be inferred on the terminal TSUs forecasts as the series were computed with a common formula for which no forecasts are yet available. As a result the PRC cannot consolidate and compute the planned terminal ANS unit costs at system level.

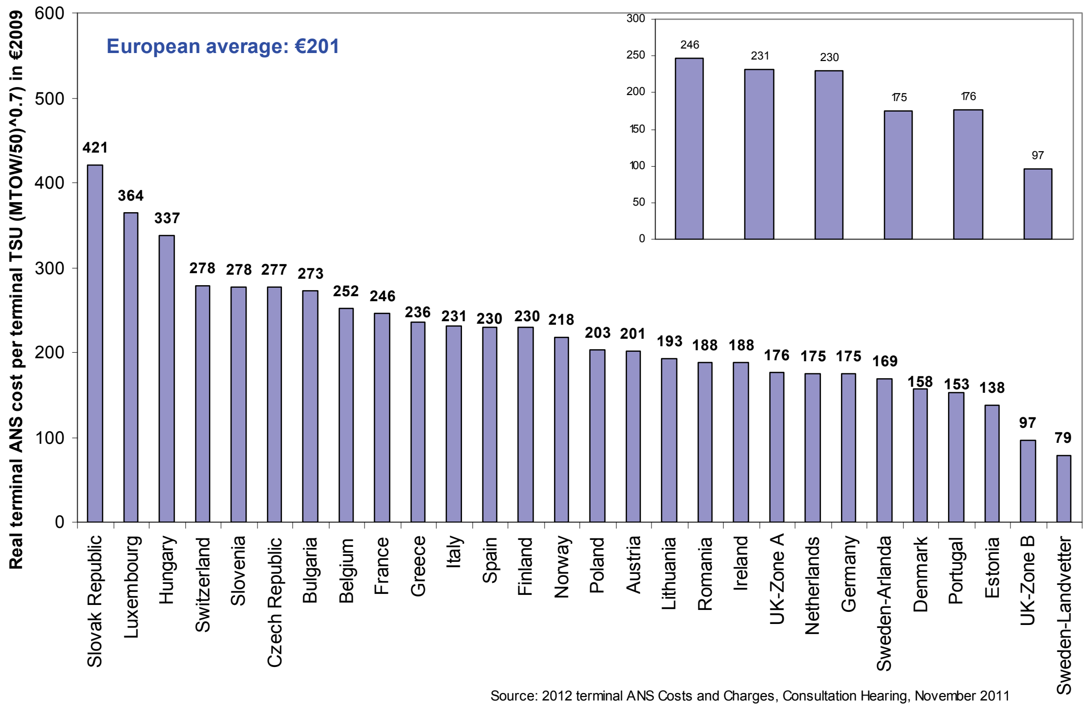


Source: 2012 terminal ANS Costs and Charges, Consultation Hearing, November 2011

Figure 7-9: Terminal ANS cost-efficiency overview 2009-2014

7.6.7 Nevertheless, since from 2010 onwards the terminal ANS costs are forecasted to gradually decrease and the traffic in terms of airport movements is globally not expected to decrease, all else equal, the trend of terminal ANS unit costs should continue to decrease until 2014. This planned improvement of terminal ANS cost-efficiency is very encouraging and consistent with the en-route trends (see Figure 7-6).

7.6.8 Figure 7-10 shows a cross-section of real terminal ANS unit costs by terminal charging zone in 2010. In this context it is important to recall that, due to the diversity in prevailing economic and operational conditions, the interpretation requires a note of caution (see also §7.6.10 below).



Source: 2012 terminal ANS Costs and Charges, Consultation Hearing, November 2011

Figure 7-10: Comparison of 2010 terminal ANS unit costs by terminal charging zone for EU-27+Norway and Switzerland

7.6.9 In 2010, the terminal ANS costs per TSU ranges from €79 for Sweden-Landvetter to €421 for Slovak Republic, a factor of 5.3. The average for 26 States (28 terminal charging zones) that reported 2010 actual costs amounts to €201.

7.6.10 There is clearly a greater diversity of situations in terminal ANS provision than in en-route. Differences in terminal ANS unit costs may be driven by a number of factors (some of which are specific to terminal ANS) including:

- differences in cost allocation between en-route and terminal;
- traffic levels;
- number of airports covered by a terminal charging zone;
- scope of the service provided at airports by the ANSP, including, responsibility, use and ownership of airport-related assets;
- level of state subsidies to cover terminal ANS costs;
- market organisation (e.g. contestability).
- differences in the economic environment (cost of living).

7.6.11 The terminal ANS costs per terminal TSU also substantially differ among the five largest States (France, Germany, Italy, Spain, and the UK).Terminal ANS costs for the six related terminal charging zones range from €97 for UK-Zone B[71] to €246 for France. Together they account for some 68% (€1 016M) of the total terminal ANS costs in 2010 for the 26 reporting States. The low unit cost for UK-Zone B (€97) should deserve a more detailed analysis in order to better understand the drivers for this apparent superior performance.

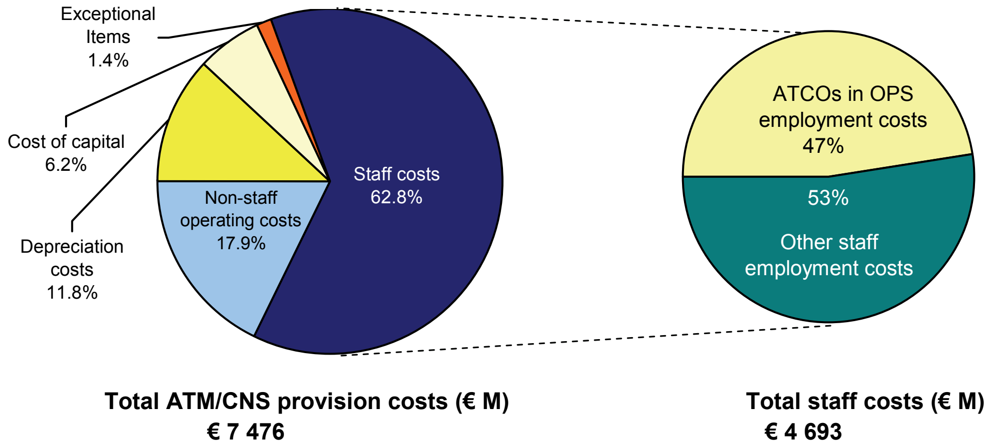
7.7 Gate-to-gate ANSPs' cost-effectiveness performance

7.7.1 The ANSP cost-effectiveness focuses on ATM/CNS provision costs which are under the direct control and responsibility of the ANSP. Detailed benchmarking analysis is available in the first draft ACE 2010 Benchmarking Report.

7.7.2 Figure 7-11 shows a detailed breakdown of gate-to-gate[72] 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.

71 Comprising terminal ANS costs for London Heathrow Airport, London Gatwick Airport, London Stansted Airport and Manchester Airport.

72 Detailed information on the computation of ATFM delays costs is provided in Paragraph 3.6.24 of this Report.



ATM/CNS provision costs (€ M)	En-route	%	Terminal	%	Gate-to-gate	%
Staff costs	3 607	62.5%	1 086	63.6%	4 693	62.8%
ATCOs in OPS employment costs	n.a.	n.a.	n.a.	n.a.	2 225	-
Other staff employment costs	n.a.	n.a.	n.a.	n.a.	2 468	-
Non-staff operating costs	1 013	17.6%	322	18.8%	1 335	17.9%
Depreciation costs	694	12.0%	190	11.1%	884	11.8%
Cost of capital	372	6.4%	89	5.2%	461	6.2%
Exceptional Items	83	1.4%	20	1.2%	103	1.4%
Total	5 769	100.0%	1 707	100.0%	7 476	100.0%

Figure 7-11: Breakdown of gate-to-gate ATM/CNS provision costs 2010 [€2010]

7.7.3 The cost-effectiveness analysis presented in this section is factual. It is important to note that local performance is impacted by several factors which are different across European States, and some of these are typically outside (exogenous) an ANSP's direct control. A genuine measurement of cost inefficiencies would require full account to be taken of identified and measurable exogenous factors.

7.7.4 The quality of service provided by ANSPs has an impact on the efficiency of aircraft operations, which carry with them additional costs that need to be taken into consideration for a full economic assessment of ANSP performance. The quality of service associated with ATM/CNS provision by ANSPs is, for the time being, assessed only in terms of ATFM ground delays, which can be measured consistently, can be attributed to ANSPs, and can be expressed in monetary terms. The indicator of "economic" cost-effectiveness is therefore the ATM/CNS provision costs plus the costs of ATFM ground delay, all expressed per composite flight-hour.

Composite flight-hours[73]

The "composite gate-to-gate flight-hours" combines the two separate output measures for en-route and terminal ANS. Composite flight-hours are computed by weighting the en-route and terminal output measures using their respective unit costs. This average weighting factor is calculated at European system level using ANSPs costs and outputs data relating to the period 2002-2010 and amounts to 0.26.

The composite flight-hours are therefore defined as:

En-route flight-hours + (0.26 × airport movements)

Although the composite gate-to-gate output metric does not fully reflect all aspects of the complexity of the services provided, it is nevertheless the best metric currently available for the analysis of gate-to-gate cost-effectiveness.

73 Further information on the computation of the composite flight-hours can be found in the ACE 2010 Benchmarking Report (May 2012).

GATE-TO-GATE COST-EFFECTIVENESS

2006-2010 TRENDS

7.7.5 Figure 7-12 below displays the trend at European level of the gate-to-gate "economic" unit costs per composite flight-hour between 2006 and 2010 for a consistent sample of 36 ANSPs[74] for which data for a time-series analysis was available. At system level, economic costs per composite flight-hour slightly increased between 2006 and 2009 (i.e. +1.0% p.a. in real terms) and then significantly rose in 2010 (i.e. +4.6% in real terms).

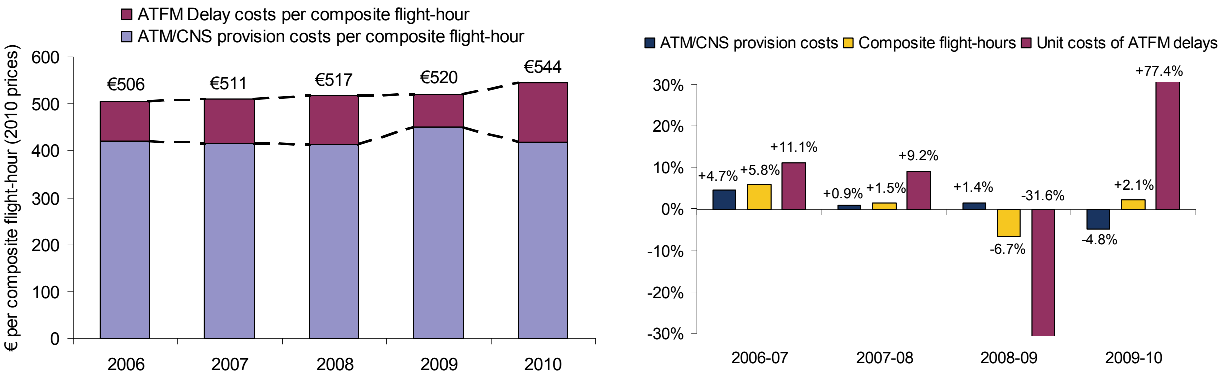


Figure 7-12: Changes in economic cost-effectiveness (2006-2010) [€2010]

7.7.6 The left-hand side of Figure 7-12 indicates that in 2009, traffic volumes significantly fell (-6.7%) reflecting the impact of the economic crisis on the ANS industry. In the meantime, gate-to-gate ATM/CNS provision costs slightly increased (+1.4% in real terms), leading to a +8.7% increase in unit ATM/CNS provision costs. Figure 7-12 indicates that this significant increase was compensated by a sharp decrease in the unit costs of ATFM delays[75] (-31.6%) and as a result unit economic costs remained fairly constant in 2009 (+0.7%).

7.7.7 In 2010, the number of composite flight-hours slightly increased by +2.1%. This is much lower than the levels achieved before the economic crisis (+4-6% a year over 2004-2007) indicating that traffic growth did not bounce back in 2010 following the downturn experienced in 2009. In the meantime, ATM/CNS provision costs fell by -4.8% in real terms. This is an important result which indicates that the cost-containment measures implemented by several European ANSPs generated genuine cost savings which led to a decrease of ATM/CNS provision costs in 2010.

7.7.8 However, the decrease in ATM/CNS provision costs was outweighed by a sharp increase in the unit costs of ATFM delays (+77.4%) which is disappointing given the relatively low traffic growth experienced in 2010. Overall, the result was a +4.6% rise in unit economic costs in 2010.

7.7.9 Figure 7-14 shows that in 2010, economic costs per composite flight-hour have increased for 18 ANSPs. The largest increases have been in DSNA (+41%), DCAC Cyprus (+23%) and DFS (+14%). For these three ANSPs, the rise in unit economic costs is mainly due to a significant increase of ATFM delays. The rise in unit economic costs in two of the five largest ANSPs (DFS and DSNA) significantly contributed to the increase observed at European system level.

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74 ARMATS was excluded from this analysis since it started to provide data as from 2009.

75 The ATFM delays data reported in Figure 7-12, Figure 7-13 and Figure 7-14 relate to the total minutes of ATFM delays. These include en-route ATFM delays but also delays arising from the terminal environment (i.e. from aerodrome capacity and weather issues).

7.7.10 Figure 7-13 shows that in 2010 for Aena, Austro Control, Croatia Control, DCAC Cyprus, DFS, DHMI, DSNA, HCAA, PANSA and Skyguide, the unit costs of ATFM delays accounted for more than 20% of the economic unit costs.

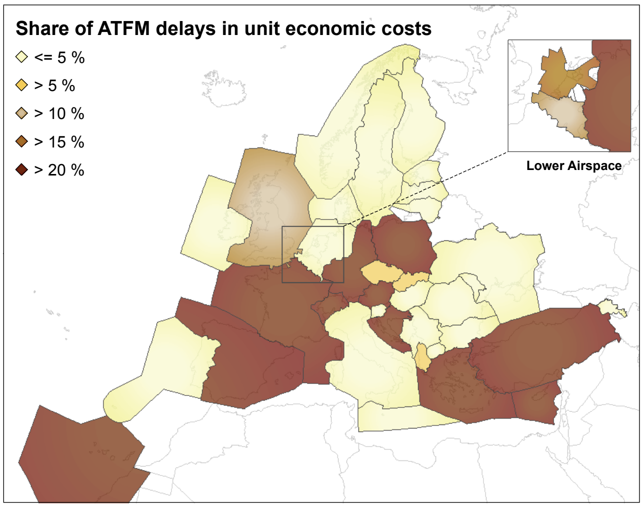
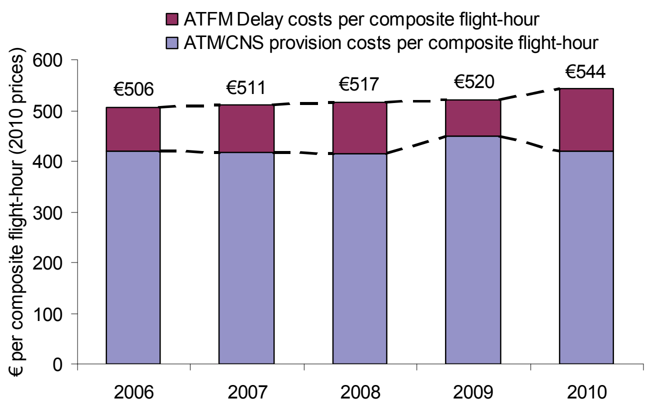


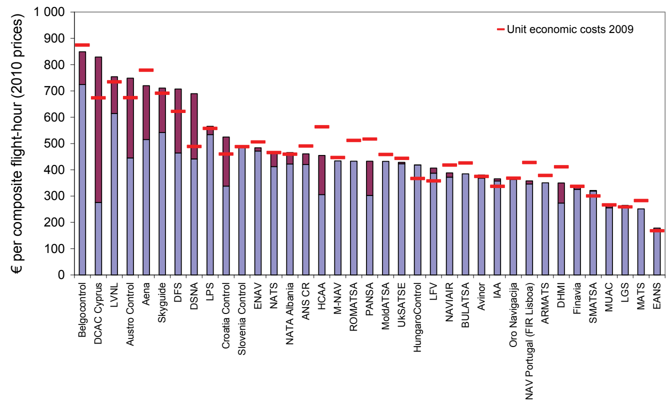
Figure 7-13: Share of ATFM delays in unit economic costs in 2010

7.7.11 Several ANSPs such as Austro Control have had recurrent capacity issues for several years and did not manage to implement the necessary measures to address them, although the traffic downturn in 2009 and the relatively lower traffic growth in 2010 were opportunities to reduce the capacity gap.

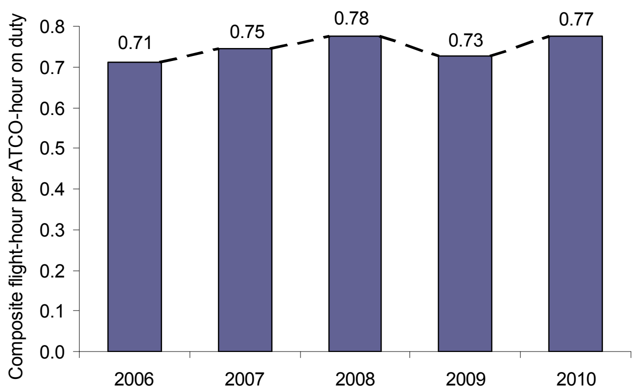
7.7.12 The large share of ATFM delay unit costs for DSNA (36%) and AENA (28%) reflect an increase in ATFM delays mainly relating to social tensions (for AENA this is due to the transition period that was ongoing in Spain in 2010). The increase in ATFM delays for DFS was mainly due to staff training relating to the implementation of the VAFORIT system in Rhein ACC.

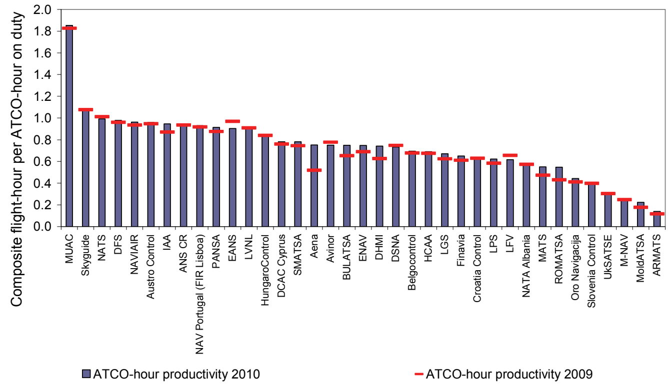
Economic gate-to-gate cost-effectiveness



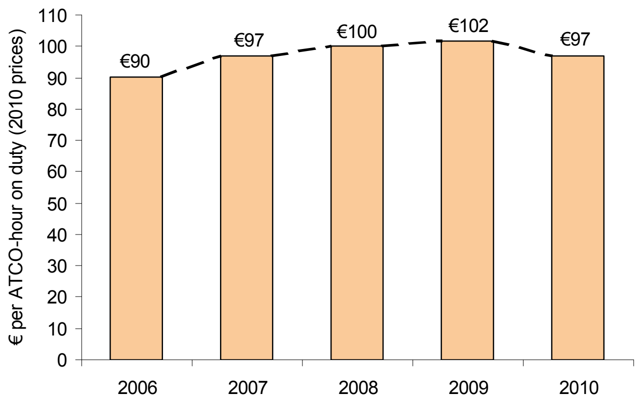


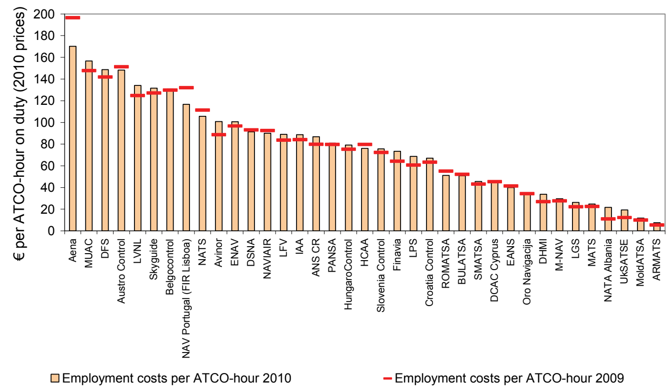
Gate-to-gate ATCO-hour productivity



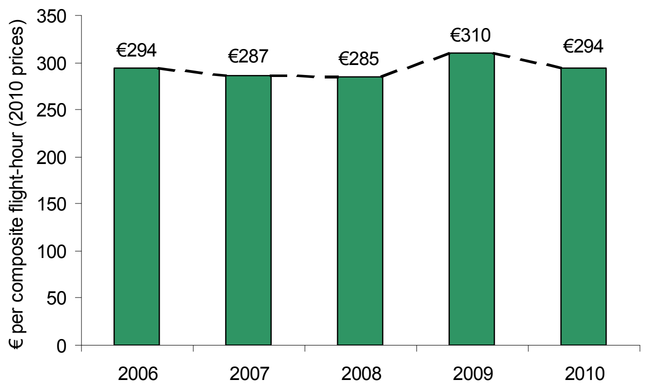


Gate-to-gate employment costs per ATCO-hour





Gate-to-gate support costs per composite flight-hour



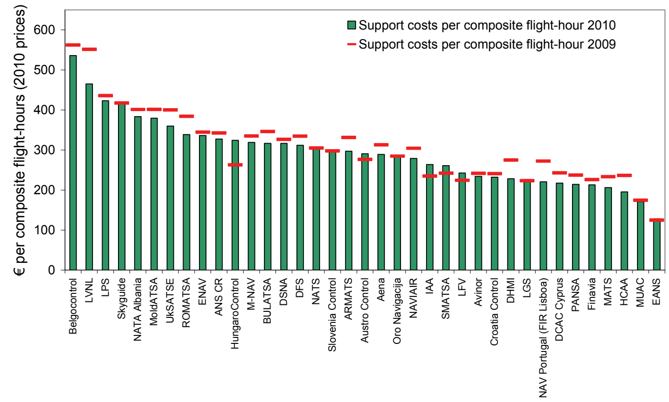


Figure 7-14: ATM/CNS cost-effectiveness comparisons, 2006-2010 [€2010]

7.7.13 The cost-effectiveness indicator 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 7-15 shows how the various components contributed to the overall improvement in cost-effectiveness (-6.8% decrease in unit costs) between 2009 and 2010.

7.7.14 In 2010, the increase in ATCO-hour productivity (+6.7%) was accompanied by a decrease in employment costs per ATCO-hour (-5.0%), thereby resulting in a substantial decrease in ATCO employment costs per composite flight-hour (-11.0%). Figure 7-15 also indicates that while traffic volumes increased by +2.1%, support costs reduced by -2.9%, resulting in a decrease in support costs per composite flight-hour (-4.9%). The central part of Figure 7-15 shows that between 2009 and 2010, given the respective weights of ATCO employment costs (30%) and support costs (70%), unit ATM/CNS provision costs decreased by -6.8%.

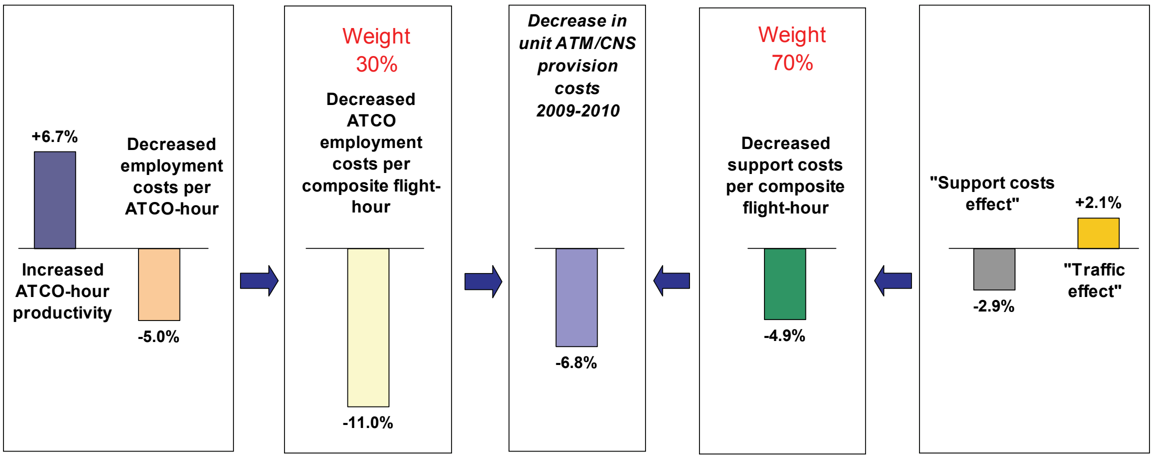


Figure 7-15: Breakdown of changes in cost-effectiveness, 2009-2010 [€2010]

7.7.15 Further details about the changes in ATCO-hour productivity, employment costs per ATCO-hour and unit support costs at ANSP level can be found in forthcoming ACE 2010 Benchmarking Report.

7.8 Conclusions

7.8.1 After a sharp increase in 2009 (+6.9%) reflecting the impact of the traffic downturn, en-route unit costs significantly decreased by -5.6% in 2010. This is due to the fact that while the total number of SU increased by +3.3%, en-route cost-bases reduced by -2.5%.

7.8.2 In April 2009, several European ANSPs stated that they would implement cost-containment measures from 2009 onwards. For a majority of States, 2010 actual en-route costs are lower than the plans made in November 2008. This indicates that the cost-containment measures implemented by the States/ANSPs generated genuine cost-savings in 2010. The efforts made in 2010 to reduce en-route costs compared to the plans (-7.0% which is equivalent to €430M) led to the reduction of the total en-route cost base observed for the EUROCONTROL area (-2.5% in real terms compared to 2009).

7.8.3 After the significant decrease in 2010 (-5.6%), en-route unit costs per SU are planned to further reduce until 2014 to reach €51.7 for the EUROCONTROL area. This represents on average a -3.1% annual en-route unit costs decrease compared to the peak of 2009 (€60.6).

7.8.4 In the context of the performance scheme regulation, the EU-27+2 States submitted Performance Plans to the PRB in June 2011. The 2014 cost-efficiency KPI aggregated from these plans (€55.22) was +2.4% higher than the EU-wide target (€53.92) adopted by the EC. Following the assessment of national/FAB Performance Plans, 21 States were asked to improve their contribution to the EU-wide cost-efficiency target.

7.8.5 The EU-wide Determined Unit Rate is planned to reduce by -3.0% p.a. between 2009 and 2014. Undoubtedly, the collective effort made in 2011 by the ANS industry to prepare for the implementation of the first RP has generated an effective drive towards a better management of cost-efficiency performance despite a deteriorating business environment.

7.8.6 The PRC has the remit to monitor terminal ANS cost-efficiency performance. In the context of the SES Performance Scheme, this remit has been strengthened as of RP1 (2012-2014). Terminal ANS cost-efficiency can for the time being only be monitored for the EU27 States plus Norway and Switzerland as no comparable data is available for the other EUROCONTROL Member States.

7.8.7 Terminal ANS costs and charges data availability and consistency across the EU27+2 States is gradually improving. The total 2010 terminal ANS costs were reported by 26 States in November 2011. Out of the 26 States, 21 States (23 terminal charging zones) consistently reported the data for the period 2009-2014. These 21 States (23 terminal charging zones) cover 211 airports and represent an amount of around €1 416M, a decrease of -5.0% in real terms over 2009 (€1 490M). The Terminal ANS costs are predicted to further decrease, albeit at a lower rate, between 2010 and 2014 (-0.8% p.a. on average).

7.8.8 For the first time the PRC recomputed the terminal TSU series with a common exponent (MTOW/50)^0.7) which will be mandatory by 2015 for the EU27+2 States. This enables direct comparison of terminal ANS unit costs across States and across time in line with the performance indicators specified in the Performance Scheme Regulation.

7.8.9 In 2010, terminal ANS unit costs decreased at a slightly higher pace than en-route ANS unit costs (-7.0% for terminal and -5.6% for en-route).

7.8.10 In 2010, the terminal ANS unit costs range from €79 for Sweden-Landvetter to €421 for Slovak Republic, a factor of 5.3. The average for 26 States (28 terminal charging zones) that reported 2010 actual costs amounts to €201.

7.8.11 There is clearly a greater diversity of situations in terminal ANS provision than in en-route. Differences in terminal ANS unit costs across States and across terminal charging zones are driven by a number of factors, some of which are specific to terminal ANS.

ANNEX I - ACC TRAFFIC AND DELAY DATA (2008-2011)

3Y-AAGR = Annual average growth rate		Traffic evolution						Total ATFM delay per flight				En-route ATFM delay per flight				Causes of en-route ATFM delay in 2011			
		Avg. daily traffic				2011/10 growth (%)	3Y-AAGR												
State	ACC	2008	2009	2010	2011			2008	2009	2010	2011	2008	2009	2010	2011	Capacity/ Staffing	ATC Other	Weather	Other reasons
Albania	Tirana	405	442	497	541	8.8%	10.0%	0.1	0.1	0.1	0.5	0.1	0.1	0.1	0.5	91.7%	4.9%	3.4%	
Armenia	Yerevan		119	132	147	10.9%													
Austria	Wien	2 108	1 976	1 968	2 015	2.4%	-1.6%	2.1	1.6	2.0	0.5	1.4	1.2	1.5	0.2	74.4%	0.9%	23.1%	1.6%
Belgium	Brussels	1 606	1 470	1 471	1 547	5.2%	-1.3%	0.6	0.6	0.6	0.2	0.2	0.2	0.2	0.0	77.9%	7.2%	13.8%	1.1%
Bosnia and Herzegovina	Sarajevo	2	1	4	6														
Bulgaria	Sofia	1 187	1 230	1 322	1 418	7.3%	6.0%	0.0			0.1	0.0			0.1	100.0%			
	Varna	42																	
Croatia	Zagreb	1 039	1 063	1 177	1 287	9.4%	7.3%	2.1	0.7	1.1	0.6	2.1	0.7	1.1	0.5	76.0%	0.4%	23.3%	0.3%
Cyprus	Nicosia	739	729	776	769	-0.9%	1.2%	2.7	2.4	3.6	1.6	2.7	2.3	3.6	1.6	99.2%	0.5%	0.2%	0.0%
Czech Republic	Praha	1 782	1 707	1 771	1 841	4.0%	1.0%	0.5	0.3	0.2	0.0	0.4	0.3	0.1	0.0	53.7%	35.5%	10.8%	
Denmark	Kobenhavn	1 456	1 354	1 403	1 476	5.2%	0.4%	2.6	0.1	0.1	0.1	2.3	0.0	0.0	0.0	49.7%			50.3%
Estonia	Tallinn	433	401	410	468	14.2%	2.5%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0%			
Finland	Tampere	474	444	459	533	16.2%	3.9%	0.1	0.1	0.2	0.9	0.0	0.0	0.0	0.6	98.5%	1.1%	0.4%	
	Rovaniemi +	92	92	81															
France	Bordeaux	2 324	2 121	2 114	2 238	5.9%	-1.3%	0.1	0.0	1.1	0.1	0.0	0.0	1.1	0.1	65.9%	25.8%	8.2%	0.1%
	Brest	2 460	2 248	2 228	2 440	9.5%	-0.4%	0.1	0.1	2.3	0.1	0.1	0.1	2.3	0.1	78.5%	15.3%	4.3%	2.0%
	Marseille	2 867	2 692	2 731	2 804	2.7%	-0.8%	0.1	0.1	3.0	0.5	0.1	0.1	3.0	0.5	87.0%	3.0%	9.6%	0.4%
	Paris	3 449	3 265	3 122	3 283	5.2%	-1.7%	1.0	0.7	1.4	0.6	0.5	0.2	0.8	0.3	71.3%	3.9%	11.8%	13.0%
	Reims	2 457	2 174	2 141	2 311	7.9%	-2.1%	0.5	0.1	0.3	0.2	0.5	0.1	0.3	0.2	69.8%	9.0%	19.0%	2.3%
FYROM	Skopje	336	337	340	340	-0.1%	0.3%												
Germany	Bremen	1 762	1 623	1 661	1 709	2.9%	-1.1%	0.3	0.4	0.6	0.3	0.2	0.3	0.3	0.2	81.4%		16.3%	2.3%
	Langen	3 577	3 363	3 381	3 433	1.5%	-1.5%	1.2	1.3	2.3	2.0	0.3	0.6	1.1	1.0	79.2%	3.6%	16.6%	0.6%
	Munchen	4 021	3 780	3 977	4 079	2.6%	0.4%	0.4	0.4	0.4	0.6	0.2	0.2	0.2	0.3	31.1%	0.3%	53.6%	15.0%
	Rhein	4 012	3 744	3 739	3 868	3.5%	-1.3%	0.9	0.6	1.4	0.5	0.9	0.6	1.4	0.5	52.7%	4.1%	19.2%	24.1%
Greece	Athinai+Macedonia	1 699	1 693	1 742	1 742	0.0%	0.7%	2.2	2.2	1.6	4.0	1.5	1.2	1.0	3.0	87.9%	11.7%	0.4%	
Hungary	Budapest	1 602	1 572	1 612	1 594	-1.1%	-0.3%	0.0	0.1	0.0	0.0		0.0	0.0					
Ireland	Dublin	620	520	480	488	1.6%	-7.8%	1.5	0.1	0.2	0.0	0.3	0.0	0.0	0.0				
	Shannon	1 204	1 086	1 072	1 089	1.6%	-3.4%	0.1		0.0		0.1		0.0					
Italy	Brindisi	865	817	863	872	1.0%	0.2%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	Milano	1 783	1 664	1 700	1 719	1.1%	-1.3%	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0				
	Padova	1 799	1 673	1 792	1 865	4.1%	1.1%	0.4	0.2	0.1	0.1	0.1	0.0	0.0	0.0	61.5%	15.4%	23.1%	
	Roma	2 699	2 585	2 680	2 659	-0.8%	-0.6%	0.5	0.1	0.1	0.1	0.0	0.0	0.0	0.0				
Latvia ++	Riga	515	460	477	639	33.9%	7.4%				0.0				0.0	100.0%			
Lithuania	Vilnius	583	515	512	533	4.2%	-3.0%												
	Maastricht	4 395	4 068	4 171	4 405	5.6%	0.0%	0.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0	35.6%	28.9%	35.1%	0.3%
Malta	Malta	231	233	260	222	-14.7%	-1.5%	0.0	0.0	0.0	0.0	0.0	0.0		0.0				
Moldova	Chisinau	110	119	147	162	10.5%	13.5%												
The Netherlands	Amsterdam	1 439	1 331	1 330	1 416	6.5%	-0.6%	1.1	0.3	0.9	0.9	0.0	0.0	0.2	0.1	87.0%	0.2%	12.7%	
Norway	Bodo	530	522	534	544	1.8%	0.8%	0.1	0.0	0.0	0.0	0.0		0.0	0.0	18.6%	81.4%		
	Oslo	929	866	891	884	-0.9%	-1.8%	0.2	0.1	0.1	0.6	0.0	0.0	0.0	0.0	79.7%	20.3%		
	Stavanger	558	540	541	588	8.7%	1.7%	0.1	0.4	0.1	0.2	0.1	0.3	0.1	0.1	55.5%	18.3%		26.2%
Poland *	Warszawa	1 558	1 438	1 524	1 680	10.2%	2.5%	2.2	1.8	1.2	0.7	2.1	1.7	1.2	0.7	92.3%	1.9%	4.2%	1.5%
Portugal	Lisboa	1 121	1 036	1 097	1 153	5.1%	0.8%	0.4	0.1	0.1	0.3	0.2	0.0	0.0	0.2	56.5%	39.7%		3.8%
	Santa Maria	283	274	290	307	5.8%	2.6%												
Romania	Bucuresti	1 212	1 186	1 284	1 333	3.8%	3.1%	0.0		0.0				0.0					
Serbia	Beograd	1 314	1 373	1 459	1 502	3.0%	4.4%	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	56.5%			43.5%
Slovak Republic	Bratislava	1 567	1 653	1 840	2 002	8.8%	8.4%	0.9	1.6	1.3	0.7		0.0	0.0	0.1	90.6%			9.4%
Slovenia	Ljubjana	671	632	673	741	10.0%	3.2%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		59.5%		40.5%
Spain	Barcelona	2 250	2 033	2 054	2 136	4.0%	-1.8%	0.4	0.2	1.9	1.4	0.2	0.1	1.8	1.3	86.2%	0.8%	12.8%	0.1%
	Madrid	2 860	2 609	2 649	2 727	3.0%	-1.7%	1.1	1.2	2.5	1.8	0.7	0.7	1.4	1.2	97.1%	0.3%	2.1%	0.5%
	Palma	733	678	685	717	4.7%	-0.8%	0.9	0.6	0.6	1.0	0.0	0.1	0.1	0.4	83.1%		16.9%	
	Sevilla	1 067	956	978	1 001	2.4%	-2.2%	0.1	0.2	0.5	0.3	0.1	0.2	0.5	0.3	90.1%	1.9%	5.1%	2.9%
	Canarias	840	730	753	814	8.1%	-1.1%	0.5	1.7	1.4	1.4	0.3	1.6	1.2	1.1	74.5%		21.7%	3.9%
Sweden	Malmo	1 448	1 271	1 295	1 390	7.3%	-1.4%	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	77.3%		22.7%	
	Stockholm	1 128	1 028	1 021	1 094	7.2%	-1.1%	0.1	0.1	0.3	0.2	0.0	0.0	0.2	0.1	70.6%	12.4%	15.8%	1.2%
Switzerland	Geneva	1 813	1 645	1 648	1 704	3.4%	-2.1%	0.8	0.4	0.6	0.3	0.5	0.2	0.3	0.2	65.3%		33.1%	1.5%
	Zurich	2 156	2 014	2 031	2 078	2.3%	-1.3%	1.1	0.8	0.7	0.6	0.8	0.6	0.5	0.2	73.4%	0.0%	8.7%	17.8%
Turkey	Ankara	1 544	1 600	1 760	1 914	8.7%	7.3%	0.5	0.2	0.2	0.3	0.2	0.1	0.1	0.2	57.1%	35.8%		7.1%
	Istanbul	1 567	1 653	1 840	2 002	8.8%	8.4%	0.9	1.6	1.3	0.7		0.0	0.0	0.1	90.6%			9.4%
Ukraine	Kyiv	547	488	536	608	13.5%	3.5%		0.1	0.1			0.0	0.1					
	Dnipropetrovs'k ALL**			314	403	28.4%				0.0				0.0					
	Simferopol	481	463	559	544	-2.6%	4.1%			0.0				0.0					
	L'viv	428	416	448	482	7.7%	4.0%			0.0				0.0					
	Odesa	208	202	244	260	6.4%	7.7%			0.0				0.0					
United Kingdom	London AC	5 427	4 980	4 798	4 969	3.6%	-3.0%	0.6	0.2	0.1	0.2	0.6	0.2	0.1	0.2	72.1%	3.1%	14.6%	10.2%
	London TC	3 780	3 480	3 318	3 419	3.0%	-3.4%	1.1	0.6	0.6	0.4	0.1	0.0	0.0	0.0	83.9%		16.1%	
	Prestwick			2 402	2 450	2.0%				0.2	0.1			0.1	0.1	40.5%	47.5%	6.2%	5.8%
	Manchester	1 569	1 352					0.2	0.1			0.1	0.0						
	Scottish	1 800	1 582					0.2	0.0			0.2	0.0						

ACCs geographical areas might change over time, preventing year on year comparision (e.g. Prestwick, Dnipropetrovs'k ALL)
* does not include EPWWICTA and EPKKTMA
** Dnipropetrovs'k ALL was created in March 2010 replacing Kharkiv, Dnipropetrov'k and Donetsk' ACCs
+ Rovaniemi ACC was merged with Tampere ACC in 2011.   ++ The high traffic growth in 2011 is mainly due to Latvia joining the IFPS zone.

ANNEX II - TRAFFIC COMPLEXITY

The PRU, in close collaboration with ANSPs, has defined a set of complexity indicators that could be applied in ANSP benchmarking. The complexity indicators are computed on a systematic basis for each day of the year. This annex presents for each ANSP the complexity score computed over the full year (365 days). The full report is available at the PRC webpage.

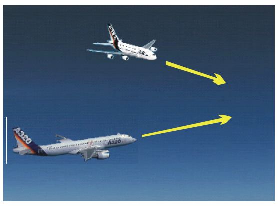
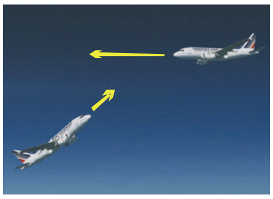
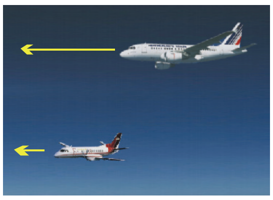
The complexity indicators are based on the concept of "interactions". Interactions arise when there are two aircraft in the same "place" at the same time. For the purpose of this study, an interaction is defined as the simultaneous presence of two aircraft in a cell of 20x20 nautical miles and 3,000 feet in height.

For each ANSP the complexity score is the product of two components:

Complexity score = Traffic density x Structural index

Traffic density indicator is a measure of the potential number of interactions between aircraft. The indicator is defined as the total duration of all interactions (in minutes) per flight-hour controlled in a given volume of airspace.

The structural complexity originates from horizontal, vertical, and speed interactions. The Structural index is computed as the sum of the three indicators

	**Horizontal interactions indicator**: A measure of the complexity of the flow structure based on the potential interactions between aircraft on different headings. The indicator is defined as the ratio of the duration of horizontal interactions to the total duration of all interactions.
	**Vertical interactions indicator**: A measure of the complexity arising from aircraft in vertical evolution based on the potential interactions between climbing, cruising and descending aircraft. The indicator is defined as the ratio of the duration of vertical interactions to the total duration of all interactions
	**Speed interactions indicator**: A measure of the complexity arising from the aircraft mix based on the potential interactions between aircraft of different speeds. The indicator is defined as the ratio of the duration of speed interactions to the total duration of all interactions

ANSP Complexity score (2011)

State	ANSP	Complexity score	Adjusted[76] Density	Structural index			
				Vertical	Horizontal	Speed	Total
		a *e	a	b	c	d	e=b+c+d
CH	Skyguide	12.2	11.1	0.28	0.60	0.22	1.10
DE	DFS	11.4	10.4	0.28	0.55	0.26	1.09
UK	NATS	11.1	9.9	0.38	0.44	0.30	1.13
BE	Belgocontrol	11.0	8.0	0.41	0.55	0.42	1.37
MUAC	MUAC	9.6	10.0	0.26	0.54	0.17	0.97
NL	LVNL	9.5	10.0	0.20	0.41	0.34	0.95
AT	Austro Control	7.5	8.2	0.20	0.51	0.21	0.92
CZ	ANS CR	7.4	8.2	0.17	0.54	0.19	0.90
SI	Slovenia Control	6.8	9.0	0.13	0.52	0.11	0.76
FR	DSNA	6.8	9.8	0.15	0.41	0.14	0.70
IT	ENAV	5.7	5.4	0.28	0.58	0.19	1.04
LY	SMATSA	5.3	9.1	0.05	0.48	0.06	0.58
SK	LPS	5.0	6.5	0.13	0.48	0.16	0.77
ES	Aena	4.9	7.2	0.17	0.39	0.13	0.68
HU	HungaroControl	4.8	7.0	0.08	0.47	0.13	0.68
HR	Croatia Control	4.4	7.3	0.06	0.48	0.08	0.61
PL	PANSA	4.2	4.5	0.15	0.53	0.26	0.93
DK	NAVIAIR	3.8	3.9	0.20	0.56	0.22	0.98
TR	DHMI	3.7	6.0	0.15	0.36	0.11	0.61
RO	ROMATSA	3.2	5.2	0.07	0.42	0.13	0.62
SE	LFV	3.1	3.2	0.24	0.49	0.24	0.97
BU	BULATSA	2.9	7.1	0.05	0.29	0.06	0.40
MK	M-NAV	2.8	5.0	0.10	0.41	0.05	0.56
CY	DCAC Cyprus	2.8	4.4	0.14	0.37	0.12	0.63
AL	NATA Albania	2.7	6.1	0.05	0.35	0.04	0.44
EE	EANS	2.5	3.5	0.17	0.33	0.23	0.72
GR	HCAA	2.5	4.2	0.11	0.38	0.09	0.58
PT	NAV Portugal (FIR Lisboa)	2.4	3.9	0.16	0.38	0.08	0.61
LV	LGS	2.3	3.2	0.10	0.49	0.16	0.74
NO	Avinor	2.3	2.1	0.32	0.49	0.27	1.07
FI	Finavia	2.1	2.1	0.29	0.35	0.37	1.01
LT	Oro Navigacija	2.1	2.9	0.08	0.47	0.18	0.73
UA	UkSATSE	2.0	2.8	0.07	0.44	0.19	0.70
IE	IAA	1.7	3.8	0.09	0.25	0.12	0.46
MD	MoldATSA	1.3	1.8	0.05	0.44	0.21	0.70
MT	MATS	1.0	1.6	0.08	0.36	0.18	0.63
AM	ARMATS	0.8	1.3	0.07	0.38	0.16	0.62
	Average	6.3	7.4	0.21	0.46	0.18	0.85

76 A measure of the potential number of interactions between aircraft in a given volume of airspace. See full report on "Complexity Metrics for ANSP Benchmarking Analysis".

ANNEX III - GLOSSARY

A-CDM	Airport Collaborative Decision-Making
ACARE	Advisory Council for Aeronautics Research in Europe
ACC	Area Control Centre. That part of ATC that is concerned with en-route traffic coming from or going to adjacent centres or APP. It is a unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction.
Accident **(ICAO Annex 13)**	An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which: a) a person is fatally or seriously injured as a result of: • Being in the aircraft, or • Direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or • Direct exposure to jet blast, except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or b) the aircraft sustains damage or structural failure which: • Adversely affects the structural strength, performance or flight characteristics of the aircraft, and • Would normally require major repair or replacement of the affected component, except for engine failure or damage, when the damage is limited to the engine, its cowlings or accessories, or for damage limited to propellers, wing tips, antennas, tyres, brakes, fairings, small dents or puncture holes in the aircraft skin; c) the aircraft is missing or completely inaccessible.
ACE Reports	Air Traffic Management Cost-Effectiveness (ACE) Benchmarking Reports
ACI	Airports Council International (http://www.aci-europe.org/)
AEA	Association of European Airlines (http://www.aea.be)
Aena	Aeropuertos Españoles y Navegación Aérea, ANS Provider - Spain
Agency	The EUROCONTROL Agency
AIRE	Atlantic Interoperability Initiative to Reduce Emissions
Airspace Infringement	(also known as unauthorised penetration of airspace). The penetration by an aircraft into a portion of airspace without prior permission of the appropriate authorities (when such prior permission is required). EUROCONTROL HEIDI – ESARR 2 taxonomy
Airside	The aircraft movement area (stands, apron, taxiway system, runways etc.) to which access is controlled.
AIS	Aeronautical Information Service
ALAQS	EUROCONTROL Airport Local Air Quality Studies
ALoS	Acceptable level of Safety
AMAN	Arrival Management Function
AMC	Airspace Management Cell
ANS	Air Navigation Service. A generic term describing the totality of services provided in order to ensure the safety, regularity and efficiency of air navigation and the appropriate functioning of the air navigation system.
ANS CR	Air Navigation Services of the Czech Republic. ANS Provider - Czech Republic.
ANSB	Air Navigation Services Board
ANSP	Air Navigation Services Provider
AO	Aircraft Operator
APP	Approach Control Unit
APU	Auxiliary Power Units
ARMATS	Armenian Air Traffic Services, ANS Provider - Armenia
ARN V7	**A**TS **R**oute **N**etwork (ARN) - Version 7

ASK	Available seat-kilometres (ASK): Total number of seats available for the transportation of paying passengers multiplied by the number of kilometres flown
ASM	Airspace Management
ASMA!	Arrival Sequencing and Metering Area
ASMT	EUROCONTROL Automatic Safety Monitoring Tool
AST	Annual Summary Template
ATC	Air Traffic Control. A service operated by the appropriate authority to promote the safe, orderly and expeditious flow of air traffic.
ATCO	Air Traffic Control Officer
ATFCM	Air Traffic Flow and Capacity Management.
ATFM	Air Traffic Flow Management. ATFM is established to support ATC in ensuring an optimum flow of traffic to, from, through or within defined areas during times when demand exceeds, or is expected to exceed, the available capacity of the ATC system, including relevant aerodromes.
ATFM delay (NMD definition)	The duration between the last Take-Off time requested by the aircraft operator and the Take-Off slot given by the EUROCONTROL Network Management Directorate
ATFM Regulation	When traffic demand is anticipated to exceed the declared capacity in en-route control centres or at the departure/arrival airport, ATC units may call for “ATFM regulations”.
ATK	Available tonne kilometres (ATK) is a unit to measure the capacity of an airline. One ATK is equivalent to the capacity to transport one tonne of freight over one kilometre.
ATM	Air Traffic Management. A system consisting of a ground part and an air part, both of which are needed to ensure the safe and efficient movement of aircraft during all phases of operation. The airborne part of ATM consists of the functional capability which interacts with the ground part to attain the general objectives of ATM. The ground part of ATM comprises the functions of Air Traffic Services (ATS), Airspace Management (ASM) and Air Traffic Flow Management (ATFM). Air traffic services are the primary components of ATM.
ATMAP	ATM Performance at Airports
ATS	Air Traffic Service. A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service.
ATSP	Air Traffic Service Provider
Austro Control	Austro Control: Österreichische Gesellschaft für Zivilluftfahrt mbH, ANS Provider - Austria
AVINOR	ANS Provider - Norway
Bad weather	For the purpose of this report, “bad weather” is defined as any weather condition (e.g. strong wind, low visibility, snow) which causes a significant drop in the available airport capacity.
Belgocontrol	ANS Provider - Belgium
BULATSA	Air Traffic Services Authority of Bulgaria. ANS Provider - Bulgaria.
CAA	Civil Aviation Authority
CANSO	Civil Air Navigation Services Organisation (http://www.canso.org)
CDA	Continuous Descent Approach
CDO	Continuous Descent Operation, a collective term which also includes CDA (continuous descent approach).
CDM	Collaborative Decision Making
CDR	Conditional Routes
CE	Critical Elements (of a State’s safety oversight system)
CEF	Capacity Enhancement Function
CFMU (See NMD)	Formerly the EUROCONTROL Central Flow Management Unit. Now the EUROCONTROL Network Management Directorate (NMD)
CLR	Deviation from ATC clearance
CMA	Continuous Monitoring Approach (ICAO USOAP Cycle)
CNG	Carbon-Neutral Growth
CNS	Communications, Navigation, Surveillance.
CO_2	Carbon dioxide
Composite flight	En-route flight hours plus IFR airport movements weighted by a factor that reflected the relative

hour	importance of terminal and en-route costs in the cost base (see ACE reports)
CODA	EUROCONTROL Central Office for Delay Analysis
CRCO	EUROCONTROL Central Route Charges Office
Croatia Control	Hrvatska kontrola zračne plovidbe d.o.o. ANS Provider - Croatia,
CSA	Comprehensive system Approach (ICAO USOAP Cycle)
CTOT	Calculated Take-Off Time
Dangerous Phenomena	The principal dangerous weather phenomena are: Cumulonimbus (CB) with or without precipitation, Tower Cumulus (TCU), Thunder with or without precipitation (TS) , Ice Pellets (PL),Small Hail and/or Snow Pellets (GS); Hail (GR), Funnel cloud (tornado or waterspout) (FC) , Squall (SQ) , Volcanic Ash (VA), Dust-storm (DS), Sandstorm (SS), Sand (SA), Dust/sand whirls (PO)
DCAC Cyprus	Department of Civil Aviation of Cyprus. ANS Provider - Cyprus.
DFS	DFS Deutsche Flugsicherung GmbH, ANS Provider - Germany
DGCA	Directors General of Civil Aviation
DHMi	Devlet Hava Meydanlari Isletmesi Genel Müdürlügü (DHMi), General Directorate of State Airports Authority, Turkey. ANS Provider – Turkey.
DLTA	Difference from Long-Term Average metric. It is designed to measure relative change in time-based performance (e.g. flight time) normalised by selected criteria (origin, destination, aircraft type, etc.) for which sufficient data are available. The analysis compares actual performance for each flight of a given city pair with the long term average (i.e. average between 2003 and 2009) for that city pair.
DMAN	Departure Management Functions
DSNA	Direction des Services de la Navigation Aérienne. ANS Provider - France
DSS/OVS/SAF Unit	EUROCONTROL Directorate Single Sky/Oversight/Safety Unit. Formerly the Safety Regulation Unit.
DUR	Determined Unit Rate
EAD	European AIS Database
EANS	Estonian Air Navigation Services. ANS Provider – Estonia.
EAPPRI	European Action Plan for the Prevention of Runway Incursions
EASA	European Aviation Safety Agency
EATM	European Air Traffic Management (EUROCONTROL)
EATMN	European Air Traffic Management Network (SES legislation) chapter 5 §5.2.28)
EC	European Commission
ECAA	European Common Aviation Area. This is a multilateral agreement signed in December 2005 by the European Community and 9 partners (Albania, Bosnia and Herzegovina, Croatia, FYROM, Iceland, Montenegro, Norway, Serbia, the United Nations Interim Administration Mission in Kosovo). The ECAA commits the signatories to continue harmonising with EU legislation. More details are available on the website: http://ec.europa.eu/transport/air_portal/international/doc/com_2006_0113_en.pdf
ECAC	European Civil Aviation Conference.
ECCAIRS	European accident and incident database
ECTL	Acronym for EUROCONTROL
EEA	European Economic Area (EU Member States + Iceland, Norway and Lichtenstein)
EEA	European Environmental Agency
Effective capacity	The traffic level that can be handled with optimum delay (cf. PRR 5 (2001) Annex 6)
ENAV	Ente Nazionale di Assistenza al Volo (ENAV). ANS Provider - Italy
ERA	European Regional Airlines Association (http://www.eraa.org)
ESARR **ESARR 1** **ESARR 2** **ESARR 3** **ESARR 4** **ESARR 5** **ESARR 6**	EUROCONTROL Safety Regulatory Requirement "Safety Oversight in ATM" "Reporting and Analysis of Safety Occurrences in ATM" "Use of Safety Management Systems by ATM Service Providers" "Risk Assessment and Mitigation in ATM" "ATM Services' Personnel" "Software in ATM Systems"
ESIMS	ESARR Support Implementation & Monitoring Programme

ESRA 2008 Area	European Statistical Reference Area (see STATFOR Reports) Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Canary Islands, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, FYROM, Germany, Greece, Hungary, Ireland, Italy, Lisbon FIR, Luxembourg, Malta, Moldova, Montenegro, Netherlands, Norway, Poland, Romania, Santa Maria FIR, Serbia, Slovak Republic , Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom
ESSIP	European Single Sky ImPlementation plan
EU-ETS	Emissions Trading Scheme. The objective of the EU ETS is to reduce greenhouse gas emissions in a cost-effective way and contribute to meeting the EU's Kyoto Protocol targets.
EU	European Union
EU States **(see also SES States)**	Twenty-seven Member States on 31 December 2011. Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom.
EUROCONTROL	The European Organisation for the Safety of Air Navigation. It comprises Member States and the Agency.
EUROCONTROL Member States	Thirty-nine Member States on 31 December 2011. Albania, Armenia, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, FYROM, Turkey, Ukraine and United Kingdom. .
EUROCONTROL Route Charges System	A regional cost-recovery system that funds air navigation facilities and services and supports Air Traffic Management developments. It is operated by the EUROCONTROL Central Route Charges Office (CRCO), based in Brussels. www.eurocontrol.int/crco
EUROSTAT	The Statistical Office of the European Community
FAB	Functional Airspace Blocks
FABEC States	Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland
FINAVIA	ANS provider – Finland
FIR	Flight Information Region. An airspace of defined dimensions within which flight information service and alerting service are provided.
FL	Flight Level. Altitude above sea level in 100 feet units measured according to a standard atmosphere. Strictly speaking a flight level is an indication of pressure, not of altitude. Only above the transition level (which depends on the local QNH but is typically 4000 feet above sea level) flight levels are used to indicate altitude, below the transition level feet are used.
FMP	Flow Management Position
FPSP	Flight Plan Service Providers
FUA	Flexible Use of Airspace
FYROM	Former Yugoslav Republic of Macedonia
GA **(General Aviation)**	All civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire.
GASP	Global Aviation Safety Plan
GAT	General Air Traffic. Encompasses all flights conducted in accordance with the rules and procedures of ICAO.PRR 2010 uses the same classification of GAT IFR traffic as STATFOR:
GCD	Great Circle Distance
GDP	Gross Domestic Product
HCAA	Hellenic Civil Aviation Authority. ANS Provider - Greece
HungaroControl	ANS Provider - Hungary
IAA	Irish Aviation Authority. ANS Provider - Ireland
IATA	International Air Transport Association (www.iata.org)
ICAO	International Civil Aviation Organization
ICAO EUR/NAT	ICAO EUR/NAT Office area of accreditation
ICAO iSTARS	ICAO Integrated Safety Trend Analysis and Reporting System
IFR	Instrument Flight Rules. Properly equipped aircraft are allowed to fly under bad-weather conditions

	following instrument flight rules.
Inadequate Separation	In the absence of prescribed separation minima, a situation in which aircraft were perceived to pass too close to each other for pilots to ensure safe separation (e.g. VFR and IFR flights perceived to pass too close to each other in airspace Class D or E). EUROCONTROL HEIDI – ESARR 2 taxonomy).
Incident **(ICAO Annex 13)**	An occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.
Incident Category A **(ICAO Doc 4444)**	A serious incident**:** AIRPROX - Risk Of Collision: "The risk classification of an aircraft proximity in which serious risk of collision has existed".
Incident Category B **(ICAO Doc 4444)**	A major incident. AIRPROX - Safety Not Assured: "The risk classification of an aircraft proximity in which the safety of the aircraft may have been compromised".
Interested parties	Government regulatory bodies, Air Navigation Service Providers, Airport authorities, Airspace users, International civil aviation organisations, EUROCONTROL Agency, the advisory bodies to the Permanent Commission, European Commission, representatives of airspace users, airports and staff organisations and other agencies or international organisations which may contribute to the work of the PRC.
IS	Inadequate separation
JRC	EC Joint Research Centre
JC **Just culture**	The EUROCONTROL definition of "just culture", also adopted by other European aviation stakeholders, is a culture in which "*front line operators or others are not punished for actions, omissions or decisions taken by them that are commensurate with their experience and training, but where gross negligence, wilful violations and destructive acts are not tolerated.*"
KPA	Key Performance Area
KPI	Key Performance Indicator
LAQ	Local Air Quality
LEI	Lack of Effective Implementation
LFV	Luftfartsverket. ANS Provider - Sweden.
LGS	SJSC Latvijas Gaisa Satiksme (LGS). ANS Provider - Latvia
Long haul traffic	Traffic flow, for which every airport-to-airport distance is more than 4000km
LTO	Landing and Take-off Cycle
LPS	Letové Prevádzkové Služby. ANS Provider - Slovak Republic
LSSIP	Local Single Sky ImPlementation plans/reports (formerly Local Convergence and Implementation Plans)
LVNL	Luchtverkeersleiding Nederland. ANS Provider - Netherlands
M-NAV	M-NAV - Macedonian Air Navigation Service Provider, PCL. ANS provider in the Republic of Macedonia
Maastricht UAC	The EUROCONTROL Upper Area Centre (UAC) Maastricht. It provides ATS in the upper airspace of Belgium, Luxembourg, Netherlands and Northern Germany.
MATS	Malta Air Traffic Services Ltd. ANS Provider - Malta
MET	Meteorological Services for Air Navigation
METAR	Meteorological Terminal Aviation Routine Weather Report or Meteorological Aerodrome Report
MIL	Military flights
MoldATSA	Moldavian Air Traffic Services Authority. ANS Provider - Moldova
MTF	Medium Term Forecast
MTOW	Maximum Take-off Weight
MUAC	Maastricht Upper Area Control Centre, EUROCONTROL
NATA Albania	National Air Traffic Agency. ANS Provider - Albania
NATS	National Air Traffic Services. ANS Provider - United Kingdom
NAV Portugal	Navegação Aérea de Portugal – NAV Portugal, E.P.E.
NAVIAIR	Naviair, Air Navigation Services. ANS Provider – Denmark
NERL	NATS (En Route) Limited

NM	Nautical mile (1.852 km)
NM	Network Manager
NMD	EUROCONTROL Network Management Directorate (formerly the EUROCONTROL Central Flow Management Unit - CFMU).
NO_2	Nitrogen dioxide
NOx	Oxides of Nitrogen
NSA	National supervisory Authorities
Occurrence (Source: ESARR 2)	Accidents, serious incidents and incidents as well as other defects or malfunctioning of an aircraft, its equipment and any element of the Air Navigation System which is used or intended to be used for the purpose or in connection with the operation of an aircraft or with the provision of an air traffic management service or navigational aid to an aircraft.
OPS	Operational Services
Organisation	See "EUROCONTROL".
Oro Navigacija	State Enterprise Oro Navigacija. ANS Provider - Lithuania
Passenger Load factor	Revenue passenger-kilometres (RPK) divided by the number of available seat-kilometres (ASK).
PANSA	Polish Air Navigation Services Agency. ANS Provider - Poland
PC	Provisional Council of EUROCONTROL
Permanent Commission	The governing body of EUROCONTROL. It is responsible for formulating the Organisation's general policy.
PI	Performance Indicator
PM10	Particulate Matter, with an aerodynamic diameter of less than 10 micrometers
PRB	Performance Review Body of the Single European Sky
PRC	Performance Review Commission
Primary Delay	A delay other than reactionary
PRISMIL	Pan-European Repository of Information Supporting Civil-Military Performance Measurements.
Productivity	Hourly productivity is measured as Flight-hours per ATCO-hour (see ACE reports)
PRR	Performance Review Report (i.e. PRR 2011 covering the calendar year 2011)
PRU	Performance Review Unit
RAT	Risk Analysis Tool for Safety
R&D	Research & Development
RAD	Route availability document
Reactionary delay	Delay caused by late arrival of aircraft or crew from previous journeys
Revised Convention	Revised EUROCONTROL International Convention relating to co-operation for the Safety of Air Navigation of 13 December 1960, as amended, which was opened for signature on 27 June 1997.
ROMATSA	Romanian Air Traffic Services Administration. ANS Provider - Romania
RP1	First Reference Period (2012-2014) of the SES Performance Scheme
RP2	Second Reference Period (2014-2019) of the SES Performance Scheme
RPK	Revenue passenger-kilometre (RPK): One fare-paying passenger transported one kilometre.
RTK	Revenue Tonne Kilometre
RI	**Runway incursion**: Any unauthorised presence on a runway of aircraft, vehicle, person or object where an avoiding action was required to prevent a collision with an aircraft. Source: ESARR 2.
SPI	Safety Performance Indicator
SARPs	Standards and Recommended Practices (ICAO)
SM	Separation Minima is the minimum required distance between aircraft. Vertically usually 1000 ft below flight level 290, 2000 ft above flight level 290. Horizontally, depending on the radar, 3 NM or more. In the absence of radar, horizontal separation is achieved through time-separation (e.g. 15 minutes between passing a certain navigation point).
SMI	Separation Minima Infringement: A situation in which prescribed separation minima were not maintained between aircraft.

SMS	Safety Management System
Serious incident (ICAO Annex 13)	An incident involving circumstances indicating that an accident nearly occurred.
SES	Single European Sky (EU)
SFMS	Framework Maturity Survey (SFMS
SES States	The 27 EU States (see “EU States” above) plus Norway and Switzerland
SESAR	The Single European Sky ATM Research programme
Severity	The severity of an accident is expressed according to: • the *level of damage* to the aircraft (ICAO Annex 13 identifies four levels: destroyed: substantially destroyed, slightly damaged and no damage); • the *type and number of injuries* (ICAO Annex 13 identifies three levels of injuries: fatal, serious and minor/none). PRRs focus on Severity A (Serious Incident) and Severity B (Major Incident).
Skyguide	ANS Provider - Switzerland
Slot (ATFM)	A take-off time window assigned to an IFR flight for ATFM purposes
Slovenia Control	ANS Provider - Slovenia
SMATSA	Serbia and Montenegro Air Traffic Services Agency
SMI	Separation minima infringement.
SO_x	Sulphur oxide gases
SRC	Safety Regulation Commission
SRU	(see DSS/OVS/SAF)
SSC	Single Sky Committee
SSP	State Safety Programme
STATFOR	EUROCONTROL Statistics & Forecasts Service
SUA	Special Use Airspace
SU	Service Units
Summer period	May to October inclusive
Taxi-in	The time from touch-down to arrival block time
Taxi-out	The time from off-block to take-off, including eventual holding before take-off
TC	Terminal Control
TMA	Terminal manoeuvring area
TRA	Temporary Reserved Area
TSA	Temporary Segregated Area
UAC	Upper Airspace Area Control Centre
UAP	Unauthorised penetration of airspace (also known as Airspace Infringement). The penetration by an aircraft into a portion of airspace without prior permission of the appropriate authorities (when such prior permission is required). EUROCONTROL HEIDI – ESARR 2 taxonomy
UK CAA	United Kingdom Civil Aviation Authority
UK NATS	United Kingdom National Air Traffic Services
UkSATSE	Ukrainian State Air Traffic Service Enterprise. ANS Provider - Ukraine
UR	Unit Rate
USD	US dollar
USOAP	ICAO Universal Safety Oversight Audit Programme
VAFORIT	DFS Project - Vertical advanced Flight Data Processing System (FDP) operational requirements implementation
VFR	Visual Flight Rules
XMAN	Cross Border Arrival Management

ANNEX IV - REFERENCES

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http://www.EUROCONTROL.int/prc

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About the Performance Review Commission

The Performance Review Commission (PRC) provides independent advice on European Air Traffic Management (ATM) Performance to the EUROCONTROL Commission through the Provisional Council.

The PRC was established in 1998, following the adoption of the European Civil Aviation Conference (ECAC) Institutional Strategy the previous year. A key feature of this Strategy is that "an independent Performance Review System covering all aspects of ATM in the ECAC area will be established to put greater emphasis on performance and improved cost-effectiveness, in response to objectives set at a political level".

The PRC reviews the performance of the European ATM System under various Key Performance Areas. It proposes performance targets, assesses to what extent agreed targets and high-level objectives are met and seeks to ensure that they are achieved. The PRC/PRU analyses and benchmarks the cost-effectiveness and productivity of Air Navigation Service Providers in its annual ATM cost-effectiveness (ACE) Benchmarking reports. It also produces ad hoc reports on specific subjects.

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 holds consultation meetings with stakeholders on specific subjects.

The PRC consists of 12 Members, including the Chairman and Vice-Chairman:

Mr. Marc Baumgartner
Mr. Hannes Bjurstrom
Mr. Frank Brenner **Vice Chairman**
Mr. René Brun
Mr. Dragan Draganov
Dr. Ricardo Genova
Mr. Giorgio Iscra
Mr. Mustafa Kilic
Ms. Anne Lambert
Mr. Keld Ludvigsen **Chairman**
Mr. J. Revuelta Lapique
Mr. Kálmán Seregélyes

PRC Members must have senior professional experience of air traffic management (planning, technical, operational or economic aspects) and/or safety or economic regulation in one or more of the following areas: government regulatory bodies, air navigation services, airports, aircraft operations, military, research and development.

Once appointed, PRC Members must act completely independently of States, national and international organisations.

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

The PRC can be contacted via the PRU. More contact details can be found at: http://www.eurocontrol.int/articles/contact-us

PRC PROCESSES

The PRC reviews ATM performance issues on its own initiative, at the request of the deliberating bodies of EUROCONTROL or of third parties. As already stated, it produces annual Performance Review Reports, ACE reports and ad hoc reports.

The PRC gathers relevant information, consults concerned parties, draws conclusions, and submits its reports and recommendations for decision to the Permanent Commission, through the Provisional Council. PRC publications can be found at www.eurocontrol.int/prc/publications where copies can also be ordered.