

Performance Review Body Monitoring
Report 2018
Preliminary Findings
Part A – Union-wide Conclusions

4 September 2019

Remarks from the Performance Review Body Chair

- 1 The core task of Air Navigation Services Providers (ANSPs) is to control air traffic safely and efficiently. In 2018, many ANSPs have fulfilled this task - a few were unable to do so. The European aviation industry left millions of passengers stranded at airports, waiting for their flights. Airlines incurred millions of Euros in extra cost. Not only stakeholders but also Ministers of Transport promised to learn and to improve. Eurocontrol managed to convince stakeholders to take extraordinary measures to mitigate the effects of lacking capacity. If it was not for several Air Navigation Service Providers putting in extra hours, summer 2019 would be even worse than 2018.
- 2 Most of the air traffic controllers deliver a stellar performance day-in and day-out and may be frustrated that their efforts are neutered by others. Some of them manage over 90 flights en route per hour in a complex environment whilst neighbouring colleagues barely get to half of that number.
- 3 The preliminary results of 2018 show that emergency measures will not be enough to reform European Air Traffic Management, nor will additional air traffic controllers be sufficient. Structural changes are necessary. The SESAR Airspace Architecture Study and the recommendations of the Wise Persons Group indicate possible solutions. It is up to Member States and stakeholders to make change happen.
- 4 Data is crucial evidence to trigger the right measures, both short and long term. This is the reason why this year the Performance Review Body publishes preliminary results of the 2018 Monitoring before the full report comes out in autumn 2019.

Regula Dettling-Ott
Performance Review Body Chair

R. Dettling-Ott

1. Preliminary monitoring results 2018 – The data used

- 5 Monitoring is one of the prime tasks of the Performance Review Body, ensuring that Member States and the European Commission as well as stakeholders are informed of how Air Navigation Service Providers perform in relation to the performance targets. Accurate data is crucial for monitoring. Providing, verifying and analysing it takes time. At the time of writing this preliminary report, the Performance Review Body has at hand only data which Member States have not yet fully verified. In September, the Performance Review Body will be able to publish the full analysis of the 2018 results.
- 6 From the point of view of the Performance Review Body, Member States should make data available earlier – not for the Performance Review Body's sake, but for their own. After some of the European Air Navigation Service Providers, like DFS (Germany) and DSNA (France) have been unable to provide sufficient capacity to the extent experienced in 2018, it is crucial that supervisory authorities and ministries have access to full and complete data, including critical information concerning the number of air traffic controllers and their productivity. As of now, Member States receive or provide this data with a delay of more than a year. Underperforming Area Control Centres, in particular, should be obliged to provide up-to-date numbers on where they stand in terms of managing their controllers, because in the current human-centric processes, proper staffing and rostering directly translate into better performance. There are several Air Navigation Service Providers in Europe demonstrating daily that this is possible thanks to proactive leadership including good labour relationships and good planning.
- 7 The data the Performance Review Body uses for its monitoring is first assessed and verified by Member States and Eurocontrol/the Network Manager (NM).

PRELIMINARY REPORT

2. Facts and figures from 2018

2.1 Traffic continues to increase above plans with higher revenues for Air Navigation Service Providers

- 8 In 2018, the number of commercial flights (Instrument Flight Rule movements) continued to grow with an increase of 3.7% from 2017 to 2018. At the same time, airlines used larger aircraft and thus paid higher charges for the services of Air Traffic Management since these depend on the maximum take-off weight of the aircraft (each chargeable unit is called a 'service unit'). A higher number of movements combined with larger aircraft resulted in substantially increased revenues for Air Navigation Service Providers. In 2018, service units increased by 5.6% which resulted in actual service units being 9.7% higher than the value set in the performance plans in February 2014.¹
- 9 Figures 1 and 2 show these developments: the number of Instrument Flight Rule movements remained within the high forecast, while service units were above the February 2014 high forecast. As actual Instrument Flight Rule movements are within the boundaries of predictability, the traffic growth (and required capacity) should not have come as a surprise to Member States. It makes it difficult to understand why in summer 2018 delays in some of the Area Control Centres were out of control.

Forecast Traffic vs Actual Traffic (Instrument Flight Rule Movements)

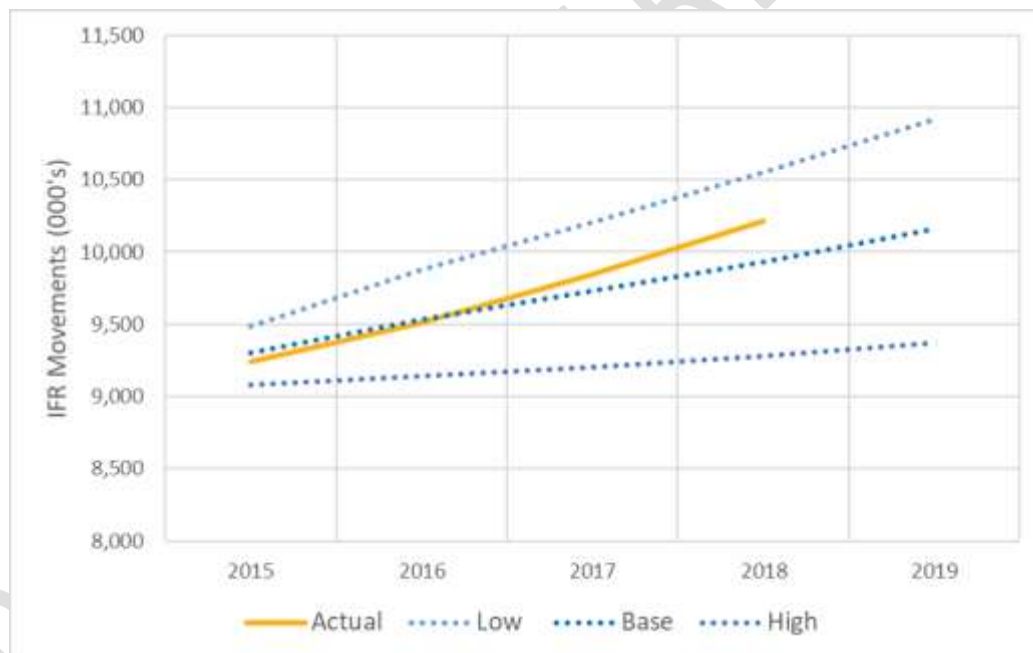


Figure 1 - Actual movements compared with the high, base and low forecasts (Source: 7-year STATFOR forecast February 2014/2019)², showing that the actual traffic is still within the forecast for Reference Period 2.

Forecast service units vs. actual service units

¹ This forecast is what many Member States and the European Commission chose as the basis for Reference Period 2.

² Based on the SES area as defined in STATFOR forecast.

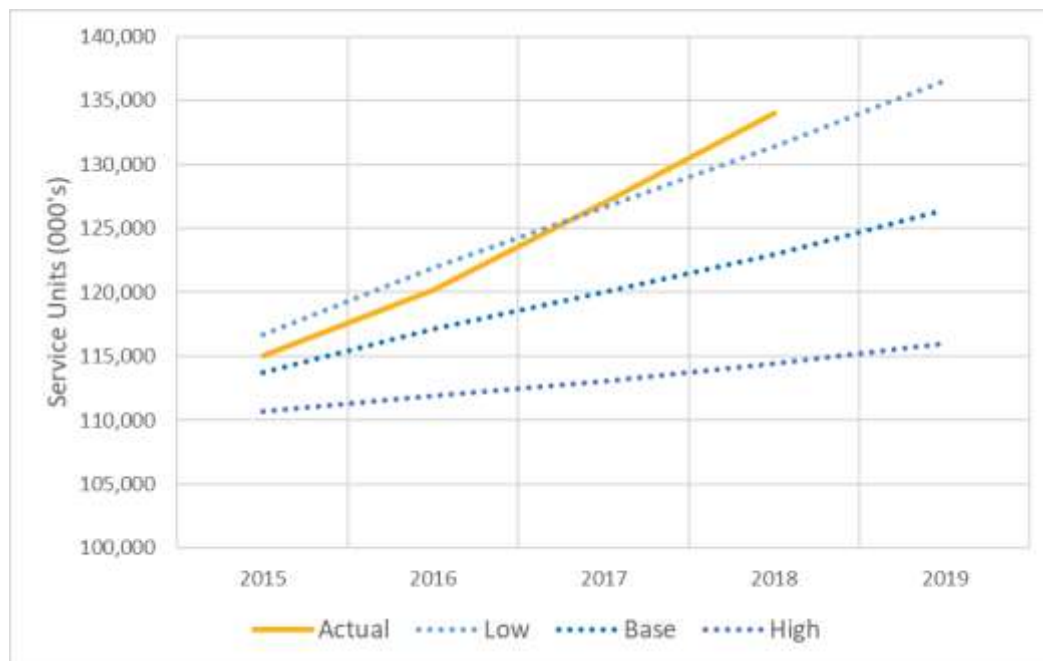


Figure 2 - Actual en route service units compared with the high, base and low forecasts for service units (Source: 7-year STATFOR forecast February 2014/2019), showcasing that service units have shown greater growth than Instrument Flight Rule movements.

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3. Capacity

3.1 Delays increased exponentially in summer 2018

- 10 During most of 2018, en route flights (on an aggregate level) suffered from delays above the target. They increased from an average of 0.94 minutes of delay per flight in 2017 to 1.83 minutes delay per flight in 2018. In both years, the target was 0.5 minutes of delay per flight.

Capacity Performance 2018		
Key Performance Indicator	European Union target	Actual performance
Average ATFM delay minutes per flight	0.5	1.83

- 11 Most of the delays were accumulated in the summer, the largest during July with an average Air Traffic Flow Management (ATFM) delay per flight of 4.04 minutes (an increase from 2.12 minutes per flight in July 2017). Although the accumulation of delays is expected to occur during the peak summer months, the extent of the delays for 2018 was much greater than predicted.
- 12 The three Functional Airspace Blocks (FABs) in the centre of Europe (FAB Central Europe, South-West FAB and FAB Europe Central) were responsible for most of the network delays. FAB European Central and, in particular Germany and France, were the greatest contributors (30% and 32% of the total respectively). DSN and DFS have performed far worse in 2018 compared to the other Air Navigation Service Providers in their comparator group (i.e. with similar operational and economic environments), only Italy achieved its 2018 reference values defined by the Network Manager.
- 13 The Performance Review Body is concerned that the three most underperforming Area Control Centres in 2018, namely Karlsruhe, Reims and Marseille will continue to produce heavy delays on peak days. It will be important to fully understand the reasons of this underperformance. Karlsruhe had no significant increase in traffic, with summer traffic and peak day traffic both lower than in 2016. Its key issue was, and is, a significant shortcoming in available air traffic controllers, a development which has not been anticipated in due time. For Reims and Marseille, a lack of air traffic controllers is also a key reason for their underperformance. For Marseille, there were significant delays due to industrial action.³
- 14 The underperformance of these Area Control Centres is even more remarkable because they are not facing unsurmountable or unexpected difficulties. Several other Air Navigation Service Providers face comparable challenges in terms of traffic, size of airspace and complexity and manage the traffic more efficiently such as Maastricht Upper Area Control Centre (MUAC), Poland or many Functional Airspace Block Central Europe states. It will be important to learn from them how to manage the capacity irrespective of weather because en route traffic in particular is comparable among different parts of Europe.
- 15 Under the Single European Sky (SES) legislation, Air Navigation Service Providers must state the reasons for delay by allocating delay codes. They have a certain discretion using these codes. It is

³ ACE Reports: <https://www.eurocontrol.int/ACE/ACE-Home.html>

difficult to assess in hindsight how the codes were allocated. Analysing the overall picture, the Performance Review Body observes that in 2018, the most common delay codes have increased. Staffing as well as weather causes have increased severely (+193% and +114% respectively).

- 16 These numbers are unprecedented, and it seems almost ironic that despite all the technological progress, many Area Control Centres today are less able to cope with weather and lack resilience. Neither Member States nor the Commission, Performance Review Body and Eurocontrol have sufficient data to fully explain these developments. The increase in weather-related delays in some Member States and the number of planned hours of air traffic controllers indicates that the affected Area Control Centres will again record high delays in 2019. Pending further analysis, a more demand-oriented rostering and planning of vacations of air traffic controllers are necessary to maintain capacity in difficult situations.
- 17 The Performance Review Body acknowledges that poor weather inclinations in certain regions create unique circumstances that impact performance. For example, poor weather in a certain Area Control Centre may result in the closure of airspace that re-routes traffic into unaffected areas. Those Area Control Centres may then record higher than normal delays but not assign a weather delay code. Whilst it is not possible for the Performance Review Body to identify these cases, Air Navigation Service Providers are encouraged to investigate the assignment of delay codes.
- 18 Figure 3 shows the declared reasons for delay from 2012 to date. The blue and black dotted line show the indexed values from 2012 for the average delay and the instrument flight rule movements, respectively. The values indicate the disproportionate increase of delays with respect to traffic, 12% increase in traffic against a 288% increase in delays over the same period.

Development of delays in 2018 (including the reasons) compared to increase in instrument flight rule movements

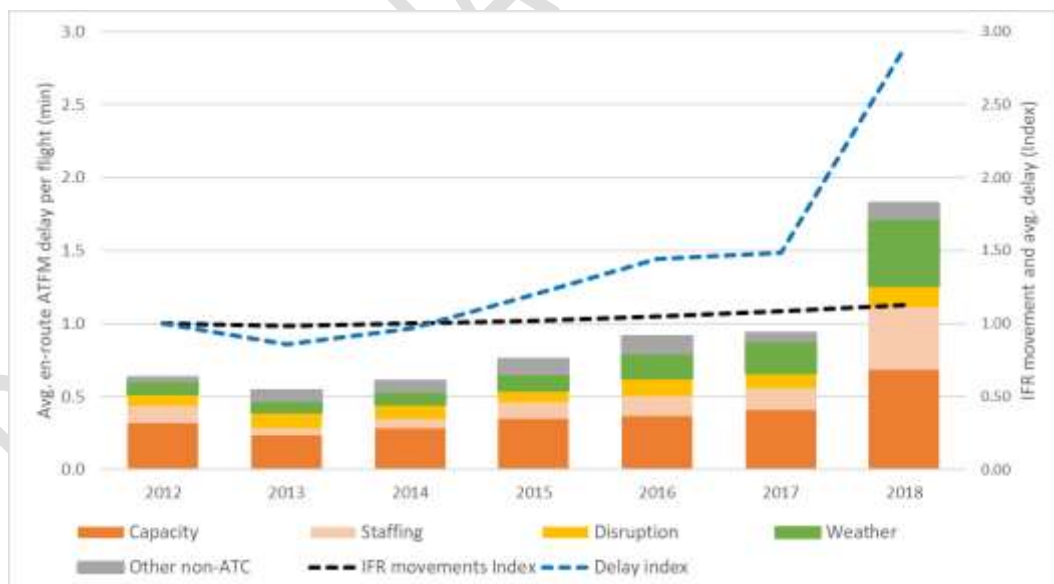


Figure 3 - Average en route Air Traffic Flow Management delay per flight with causes (Source: Performance Review Body elaboration), showing that the delay has increased substantially while traffic has increased far less.

4. Environment

4.1 Environmental performance remains a concern

19 The current Performance Scheme measures environmental performance in terms of the excess horizontal length of the planned route and the actual route an aircraft takes. This so-called horizontal flight efficiency (KEA indicator) has slightly worsened in 2018 (Union-wide level). In 2018, flights deviated 2.83% on average from the shortest available route, up from 2.81% in 2017 (Figure 4). Most FABs showed this worsening performance in horizontal flight efficiency except for UK-Ireland FAB and North Europe FAB (NEFAB). Only South West FAB achieved their 2018 reference value.

Environmental Performance 2018		
Key Performance Indicators	European Union target	Actual performance
KEP – Horizontal flight efficiency of planned route	4.10%	4.71%
KEA – Horizontal flight efficiency of actual route	2.69%	2.83%

20 The reason for the poor performance cannot be attributed to a single cause and is surprising given the improvements in network route structure and local coordination with the military. Possible causes may be increased airspace restrictions, in more cases when airspace users did not fly the improved route and that constraints in capacity resulted in longer routes offered and flown. The latter is likely to have had the largest impact, with May to August having greater variation in horizontal flight efficiency than in previous years.

21 Given the performance in 2018 and the required improvements to meet the planned horizontal flight efficiency targets at the end of 2019, significant actions from Air Navigation Service Providers will be required. In addition, Member States, the Network Manager and airspace users will need to cope with the consequences of the seven measures agreed between the Network Manager and Member States to mitigate the lack of capacity. In some cases, the measures imply longer routes for aircraft.

Environmental performance 2018 – percentage of extra horizontal distance flown or planned

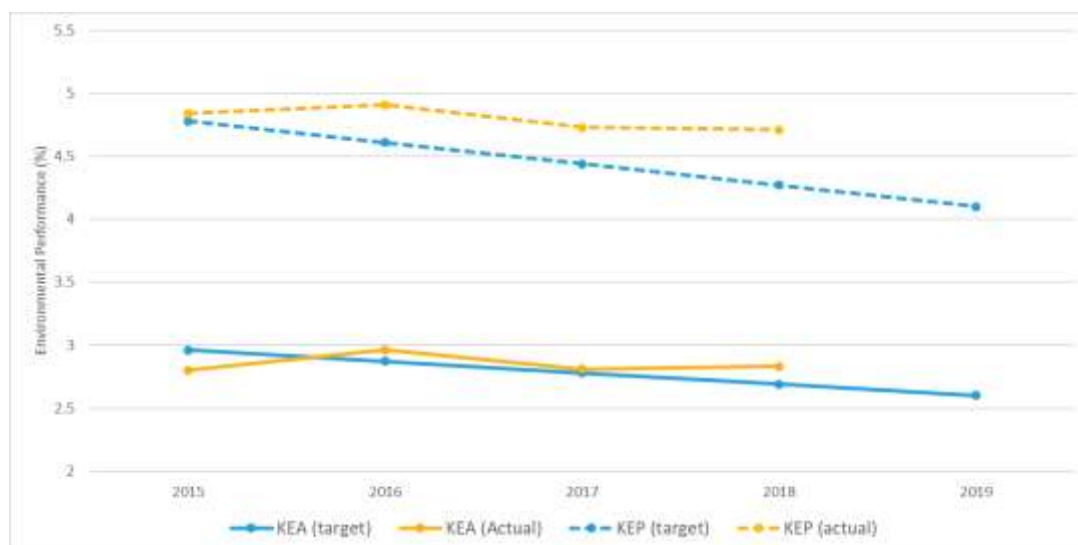


Figure 4 – Actual (KEA) and planned (KEP) horizontal flight efficiencies against respective Reference Period 2 reference values (Source: PRB elaboration of Eurocontrol data), showcasing the worsening performance from 2017 to 2018.

- 22 Improving the environmental performance of aviation has been a vital part of the Single European Sky from the beginning. The goal of saving CO₂ (and fuel) through using more efficient routes was a main driver of the project. Over the years and especially in 2018, this aspect fell behind as the unprecedented delays became the big challenge. The environmental impact of aviation needs to remain at the forefront. The original goal of the Single European Sky included a 10% reduction of impact of aviation on the environment. This implies a reduction of the total gate-to-gate emissions, including improved airport operations and optimized routings in terms of distance and flight levels. The improvements monitored by the Performance Review Body stemming from shortening the distance (horizontal flight efficiency) only covers one area of the total emissions. The focus on the other areas, namely the vertical flight efficiency, should be increased.

4.2 CO₂ output continues to increase

- 23 The European Aviation Environmental Report, published by the European Union Aviation Safety Agency (EASA) in close collaboration with the European Environment Agency and Eurocontrol, assesses other aspects of environmental performance. In January 2019, the latest environmental report was published with a chapter on Air Traffic Management and operations (chapter 4), taking into account data available until 2017.
- 24 The European Aviation Environmental Report 2019 shows that between 2013 and 2017, the total verified CO₂ emissions from aviation covered by the European Union emission trading (EU ETS) have increase by 4.7% on average per year, an increase of 53 million tons to 64 million tons (report p.76). This suggests that traffic growth has mitigated the improvements more fuel-efficient aircraft have brought.⁴

Aviation CO₂ emission growth compared to passenger growth

⁴ 8.1% improvement in fuel efficiency between 2014 and 2017 (kg/passenger km) – European Aviation Environmental Report 2019.

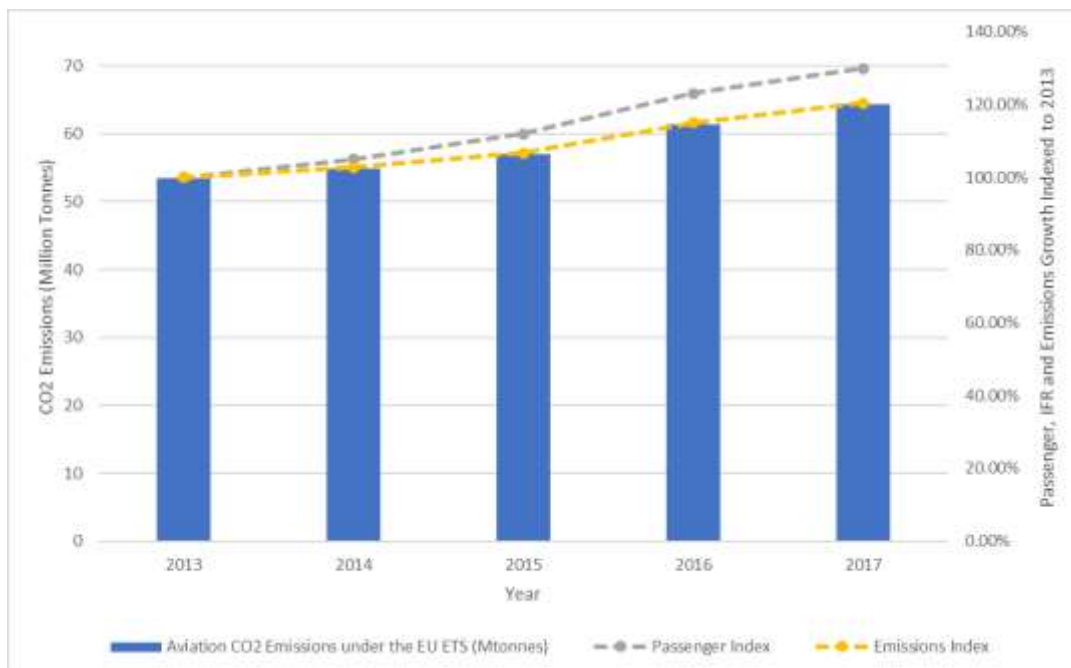


Figure 5 - Aviation CO2 emissions under the EU ETS in 2013- (Source: Performance Review Body Adaptation of European aviation environmental report 2019, Table 6.1 to show the passenger index).

4.3 Other environment indicators

- 25 As part of the Performance Review Body’s monitoring activities, a number of environmental indicators are measured beyond horizontal flight efficiencies notably the additional time in terminal airspace and the additional taxi-out time. Both indicators have a significant impact on the environmental impact of aviation, as well as on a delay.
- 26 The most constrained airports have the highest impact – in some cases with additional time in local airspace and during taxiing greater than 7 minutes per flight. Many airports have only recently started to monitor these indicators. These will require further analysis as more airports report environmental data.

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5. Cost efficiency

5.1 Determined costs decreased with lowest underspend during this Reference Period (Reference Period 2)

- 27 In 2018, Member States met the Union-wide target for en route cost-efficiency. The Union-wide actual unit costs were lower than the 2018 determined unit cost.

Cost-Efficiency Performance 2018		
Key Performance Indicator	European Union target	Actual performance
En route cost per forecast service unit (€2009)	50.38	45.42

- 28 Figure 6 shows the evolution of actual and determined values over Reference Period 2 (in terms of total costs and unit costs). Regarding the local targets, only two Member States, Portugal and Sweden, did not achieve the cost efficiency targets.

Actual costs vs Determined (planned) costs

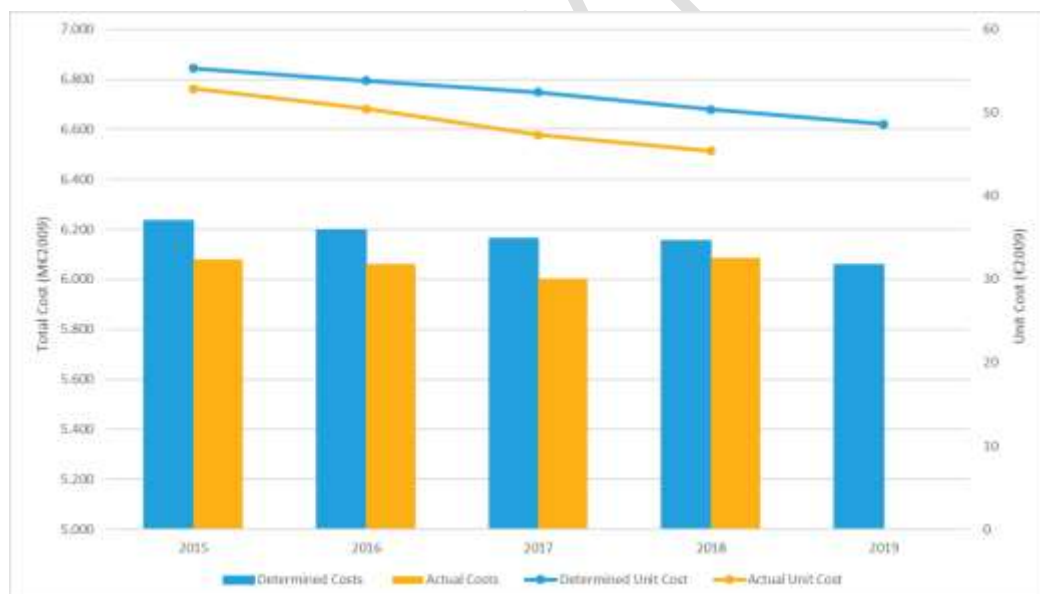


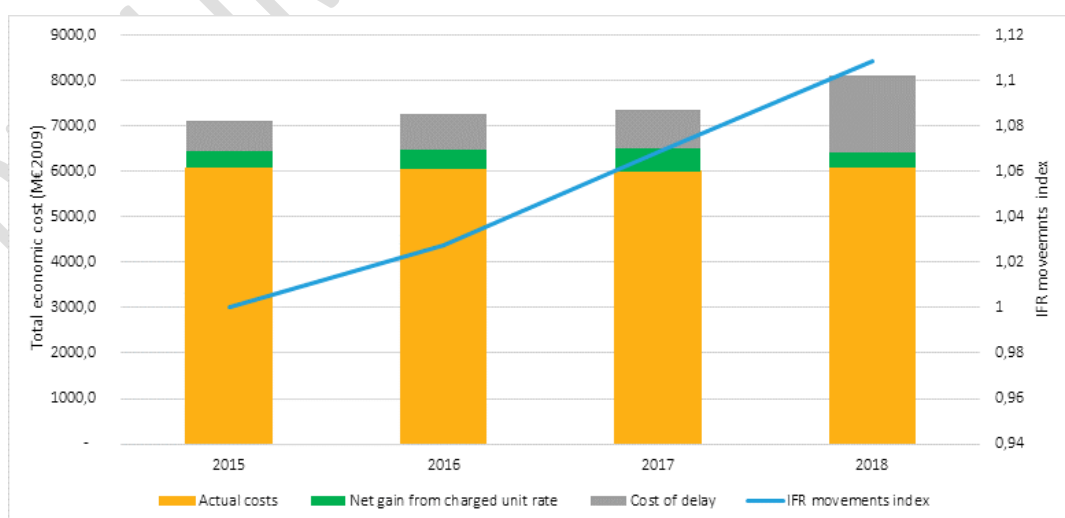
Figure 6 – En route unit and total cost Actual vs Performance Plans (Source: Performance Review Body elaboration), showing actual costs below the determined cost for the entire Reference Period 2 period.

- 29 This result is caused by en route costs being below determined cost (-1.1%) and service units above forecast values (+9.7%). In terms of actual cost, 2018 showed a slightly different picture: as expected, actual costs in 2018 rose for the first time in Reference Period 2, growing by 1.4% compared to 2017.
- 30 In 2018, Air Navigation Service Providers generated additional gains for the provision of en route services through cost sharing, traffic risk sharing and incentives, as set out under the Performance Scheme. These are legal mechanisms by which Air Navigation Service Providers can gain additional revenue for activities beyond what was planned – the aim is to ensure quality of service. In 2018,

this amounted to 220M€₂₀₀₉, bringing the total of additional gains from en route services from since 2015 (Reference Period 2) so far to almost 1BN€₂₀₀₉. Compared with 2017, the additional gains dropped by 32%. Most of this decrease is due to a 108M€₂₀₀₉ (or 65%) decrease in cost sharing – i.e. the Member States operated closer to what was planned for Reference Period 2. At the same time, additional gains from traffic risk sharing in 2018 were only 11M€₂₀₀₉ (or 7%) higher than in 2017. As in previous years, incentives (i.e. bonuses and penalties) continued to have a limited effect. Despite the high delays in 2018, the penalties Air Navigation Service Providers had to pay to airspace users for this poor performance only amounted to 4.5M€₂₀₀₉ and this was less than the incentives paid.

- 31 Figure 7 shows the estimated expenditure paid by airspace users for air navigation services and the cost of delay (at 100€ per minute) they incurred.⁵ In 2018 the expenditure amounted to 8.2BN€₂₀₀₉, of which 6BN€₂₀₀₉ corresponds to actual costs of the service provided, 336M€₂₀₀₉ are the difference between charged amount and actual costs and, finally, 1.7BN€₂₀₀₉ from the cost of ATFM delays. This is considerably more than the 4.5M€₂₀₀₉ of penalties that Air Navigation Service Providers had to pay to airspace users.
- 32 In the years 2015 to 2018, the total expenditure of airlines for en route air navigation services amounts to 30BN€₂₀₀₉ of which 24BN€₂₀₀₉ corresponds to actual costs of the Air Navigation Service Provider, 1.6BN€₂₀₀₉ are gains and 4.3BN€₂₀₀₉ are the cost of ATFM delay.
- 33 The analysis of the cost incurred in 2018 must take into account that part of the actual costs may be considered as additional gain to the service provider, specifically the surplus embedded in the cost of capital (equaling 285 M€₂₀₀₉ in 2018 and 1BN€₂₀₀₉ in Reference Period 2 to date). With respect to 2017 and 2018, part of the charged amounts must be returned to the airlines in 2019 and 2020 (total of 750MN€₂₀₀₉).
- 34 It is positive to note that actual costs have remained almost constant since 2015, and the gains are generally shrinking. However, considering the increasing ATFM delays, the expenditure for airspace users has dramatically risen during the recent four years. Not having to bear the larger part of the costs of the additional delays they inflict on air space users, the monopolistic service providers face weak incentives to keep delays at the agreed level.

Total economic cost to airlines since 2015 (Reference Period 2) including the increase in traffic



⁵ 100€ in 2014 Euros as defined in the study by the University of Westminster 'The cost of delay to air transport in Europe'.

Figure 7 – Union-wide total economic cost (Source: PRB elaboration), showing that cost and gains of Air Navigation Service Providers have remained constant while the cost of delays born by airlines have substantially increased.

- 35 In terms of investments, for the first time in Reference Period 2, Member States in 2018 invested more than planned. Figure 8 shows the difference between the actual and planned capital expenditure for each Member State as a magnitude in 2018 (orange and blue bars) and as percentage of Reference Period 2 to date (grey line).⁶

Capital expenditure spending 2018 (planned vs. actual)

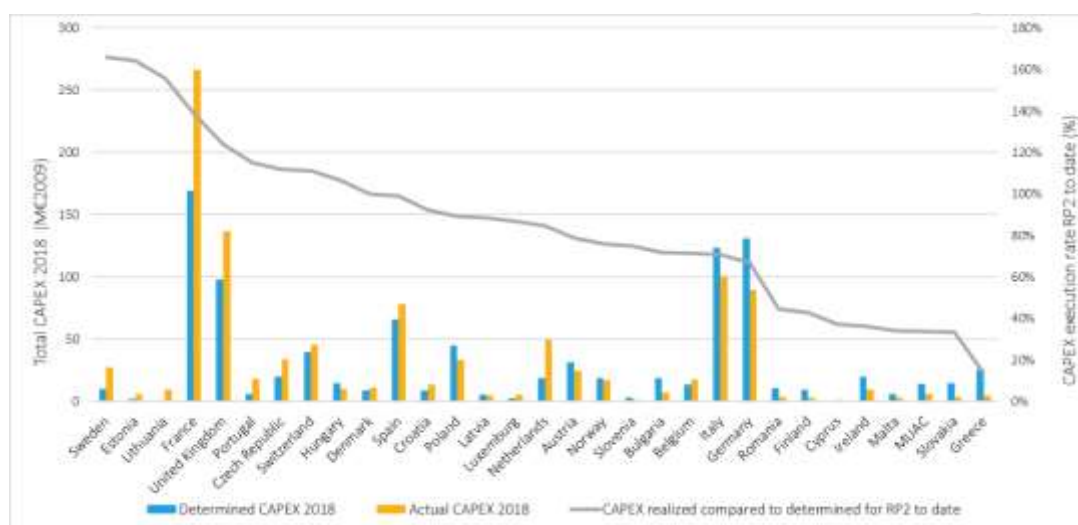


Figure 8 – Actual capital expenditure spending compared to planned spending (Source: PRB elaboration. Most Member States spent more than planned capital expenditure overspending during 2018.)

- 36 In 2018, at Union-wide level Air Navigation Service Providers overspent 84.97M€₂₀₀₉ (8.9%) compared to the planned capital expenditure. Despite this overspend, Member States are still lagging by 285M€₂₀₀₉ or 7% compared with the total planned investments for Reference Period 2.
- 37 The Member States with the greatest overspend in 2018 were France, spending, 96.76M€₂₀₀₉ (57.08%) more than originally planned, the UK, which spent 38.74 M€₂₀₀₉ (39.52%) more, and The Netherlands, which overspent 30.42M€₂₀₀₉ (159.62%). The Member States with the greatest underspend were Germany (41.34M€₂₀₀₉ vs. 31.60%), Italy (22.94M€₂₀₀₉ vs. 18.55%), and Greece (20.80M€₂₀₀₉ vs. 80.47%).
- 38 In 2018, a number of Member States continued to spend less on staff costs than planned (Figure 9). This continues the general trend of Reference Period 2 regarding lower expenditures on operational costs, despite higher delays. In some other Member States, staff costs have substantially increased over Reference Period 2. In the cases of Sweden and Czech Republic the increase is due to higher pension contributions, which are not included in the Determined Unit Cost.
- 39 The Performance Review Body finds it surprising that Member States with a very poor capacity performance, such as France and Germany are underspending in staff costs, both in total since 2015 (Reference Period 2) and in 2018 (between 3-4%). One would expect an increase in costs to accommodate for the additional traffic and to improve capacity performance. These issues have been known since 2016. As it takes two years on average to train an air traffic controller, it would

⁶ The Performance Review Body will publish a capital expenditure report later in 2019 analysing the capital expenditure of Air Navigation Service Providers in more details during Reference Period 2.

be expected to see greater staff costs (assuming staff costs per air traffic controller remain stable) translating into integrated newly trained controllers in 2018.

Operational expenditure spending (operational expenditures – staff cost) 2018 planned vs. actual for each charging zone (CZ)⁷

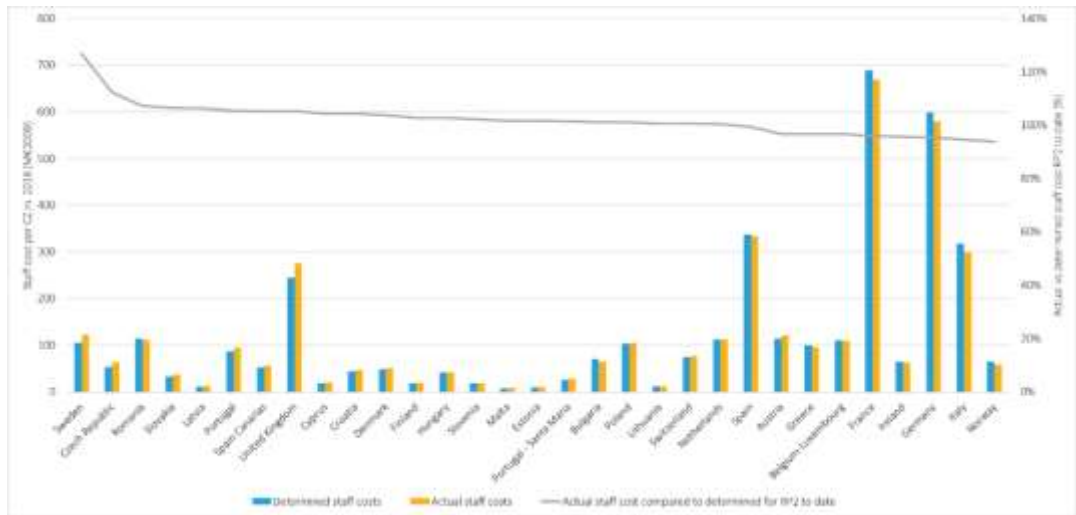


Figure 9 – Staff costs Actual vs Determined staff costs (Source: PRB elaboration), showing that some States have lower staff costs than originally planned.

⁷ A charging zone is the area for which a Member State will receive revenues for the provision of air navigation services

6. Safety

6.1 Air Navigation Services related European Union accidents and serious incidents show a downward trend and safety management scores are improving

- 40 Under the Performance Scheme, the Effectiveness of Safety Management (EoS_M) and the application of the Risk Analysis Tool (RAT) are assessed both for the national authorities and for the Air Navigation Service Providers.
- 41 Safety levels of the Air Navigation Service Providers remain high. The number of accidents and serious incidents related to Air Traffic Management fluctuate around a plateau with a small increase in 2018 (Figure 10).⁸ Out of four aviation accidents in 2018, only one was with indirect contribution of Air Traffic Management and was non-fatal (turbulence encounter). The data indicates that Air Navigation Service Providers are managing the major risks well and continue to improve, although the rate of improvement is levelling out.

Number of accidents and serious incidents related to Air Traffic Management

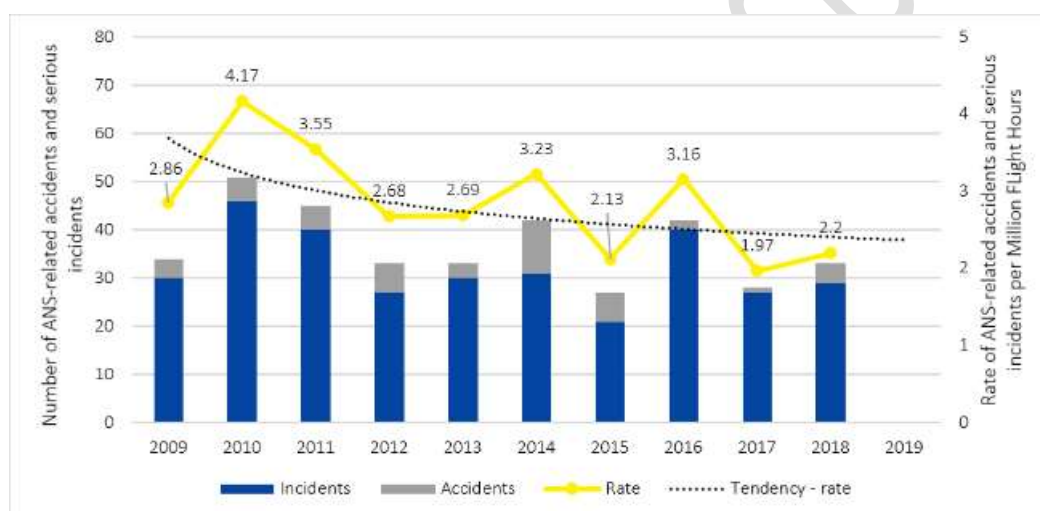


Figure 10 – Number of Air Navigation Services related accidents and serious incidents (Source: PRB elaboration of EASA draft monitoring data), showing improvements over the last years; the rate of improvement is levelling out.

- 42 During 2018, the Air Navigation Service Providers improved the effectiveness of their safety management (Figure 11) and the scores for the Management Objectives: Safety Policy and Objectives, Safety Risk Management, Safety Assurance, Safety Promotion. All Air Navigation Service Providers have achieved the target for the safety culture objectives. Although many Air Navigation Service Providers are on track to or have already reached the target for Reference Period 2 for the remaining objectives, some Air Navigation Service Providers will require further improvements. If the current rate of improvement continues, it is likely that not all Air Navigation Service Providers will reach the target by end of Reference Period 2.

⁸ “ANS related” means that the Air Navigation Service system may not have contributed to a given occurrence, but it may have a role in preventing similar occurrences in the future.

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

Number of Air Navigation Service Providers meeting the EU-wide target and associated average EoS M score increase

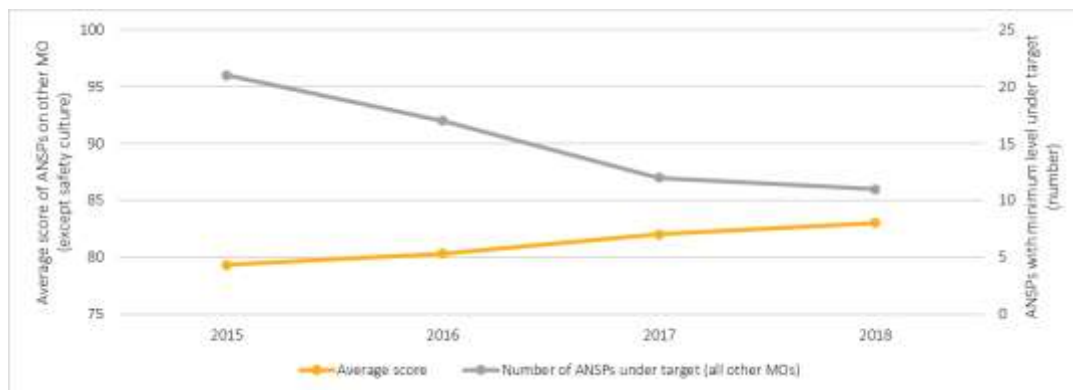


Figure 11 – Development in the Effectiveness of Safety Management of the Air Navigation Service Providers (all management objectives except safety culture) (Source: Performance Review Body elaboration of European Aviation Safety Agency draft monitoring data), showing a constant improvement during Reference Period 2 levelling out after 2017).

- 43 Member States have also improved the Effectiveness of their Safety Management. While the number of Member States with a minimum level below the target did not improve from 2016 to 2017, further improvements were seen between 2017 and 2018 with six Member States reaching the target level for Reference Period 2. However, as for Air Navigation Service Providers, not all Member States will reach the target at the end of Reference Period 2. Improvement measures need to be implemented for RP3.
- 44 Member States below the target have a minimum maturity level of B (target being level C) with one State (Belgium) still being at level A in one Management Objective. A number of Member States (Bulgaria, and Hungary), despite being below targets, have only shown little improvements over Reference Period 2 with other Member States below target (Denmark, Estonia and Portugal) improving over Reference Period 2, but not sufficient to reach the targets.

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7. Key conclusions

- 45 In 2018, European Air Navigation Service Providers managed a record number of flights, slightly more than in 2017. Their services were **safe** – there was no accident of severe incident related to air traffic management in 2018.
- 46 In terms of **capacity**, many of the Member States met or came very close to meeting the targets. However, eight out of more than 50 Area Control Centres caused 69% of the total delays, with many unable to provide the necessary capacity due to a lack of air traffic controllers and inadequate rostering. This caused unprecedented delays and impacting the entire European network. Millions of passengers were affected. 2019 (until July) shows that – compared to 2018 – delays (per flight) were reduced, although traffic slightly increased (+1.7%). The joint efforts of all stakeholders have rendered positive results. However, delays remain far too high in 2019 (12 min per flight for all causes). The Air Navigation Service Providers contributed delays three times above the EU-wide targets.
- 47 There is a significant **gap between the increase in traffic and the increase in delays**. On a year-to-year basis, traffic in summer 2018 was a moderate 3.7% higher than in 2017. In some of the critical areas, the increase was even lower (Germany, France). Nevertheless, delays in these areas exploded for lack of air traffic controllers. There is insufficient reliable and up-to-date information on the number of operational air traffic controllers at each Area Control Centre and Member State. Given this is the most important cause of delay, benchmarking and understanding the air traffic controller numbers across Europe is paramount. Member States should report more actual data to the Network Manager and the European Commission.
- 48 Several Air Navigation Service Providers caused significant higher delays due to weather issues. In some parts of Europe, there is insufficient resilience to cope with (expected) weather situations.
- 49 In terms of **cost**, the results of 2018 are better than the targets. This finding is also disconcerting: most Air Navigation Service Providers did not invest as planned and/or did not spend the money they received from airlines. Underspending is one of the reasons for lack of capacity.
- 50 **Environmental performance** in terms of unnecessary extension of routes flown by airlines was unsatisfactory in 2018. Air Navigation Service Providers and airspace users need to become more efficient in terms of providing and then choosing the environmentally best routing. The horizontal flight efficiency is not the only area where improvements are required. Gate-to-gate emissions should also be considered.